VCR Troubleshooting & Repair

Gregory R. Capelo · Robert C. Brenner

- Step-by-step details to maximize performance
- How to avoid breakdowns
- Covers stereo (MTS/MCS), SuperVHS, H-VS, and Barcode programming

Third Edition

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Preface

Seven-fifty for a movie? You've got to be kidding! Not really. Movie theater prices have increased steadily (almost in direct proportion to our kids' allowances). The five-cent Saturday matinee of the late forties has become the $7.50 "flick" of today.

However, an interesting phenomenon is occurring in the movie-watching consumer marketplace. Fewer people attend the expensive premiere showing, where long lines wrap lazily around the theater building. Instead, they prefer the comfort of home or apartment with a video cassette recorder or player, a large-screen television, a rented movie, handy snacks, and drinks.

From the moment the first commercial home video player came on the market, attendance at movie theaters began a slow but steady decline. At the same time, the number of users who were purchasing their own video cassette recorder (VCR) machines steadily increased. This increase became a torrent as VCR prices dropped from their original $1200 to less than $250 today. The standard features on machines today, such as wireless remote, multiday and multievent timers, Hi-Fi stereo, and direct cable capability, were either not technically available fifteen years ago, or simply too costly for the home video user.

GROWTH OF THE VCR MARKET

The video recorder market has steadily evolved over the last twenty years and is just now beginning to reach its prime. Today we can display fantastic color films on wide screens and with ear-rumbling sound. Stereo effects that could be experienced only in movie theaters are now possible at home. We can reproduce the same visual and sound effects from a rented copy of *Star Wars* that we saw and felt in the theater as a huge star cruiser roared out of the ceiling above and onto the screen. Sounds from a half dozen stereo speakers can fill our video world with the powerful engine rumble and action of this amazing space adventure. Today, far more films are seen at home on VCRs than in theaters, and this gap is widening.

In 1980, about 3 percent of U.S. households owned video cassette recorders. In 1995 over 90 percent of all U.S. households own a VCR! In Eu-

rope and Japan, the number of homes with VCRs is almost as high. The VCR is as common as an automobile or a telephone. Given this rate of acceptance and use, a new VCR is now being built every second. The number of home VCR owners worldwide is growing at an increasing rate.

A spokesman for RCA stated that ". . . while a number of households are still without the pleasures of home video, an ever-growing number of consumers are (now) buying their second VCR." Many of the VCRs sold in 1994 were second purchases . . . second units or upgraded replacements.

Often an upgraded model can be purchased for less than the cost of an original machine. Users find a second VCR convenient for taping from one set while watching a program on another. A second VCR is also indispensable for editing home videos and making copies of your masterpiece for relatives.

TROUBLESHOOTING AND REPAIR

Owning a VCR is fun, it's exciting, and it's entertaining. But when the machine begins to act strangely or the picture on your TV starts looking weird, the thrill quickly fades and a form of recreational panic sets in. This stress reaches a peak when the VCR owner sets the machine on the repair center counter and learns there is a $65 charge just to open the unit to find the problem.

To make matters worse, the problem can often be traced to operator error or to some simple action that would have restored normal operation. Nowhere is the adage "Read the manual if you want to save time and money" more important and repeatedly confirmed than with the ownership and use of a VCR. Yet the manual is usually the first thing that the owner misplaces or tosses away.

This book has been written to help all the users who either don't understand or can no longer find their operator's manual. It guides both novice and experienced VCR users through the magic of video recording. But more important, it gives valuable insights into those things that you can do yourself to restore correct operation or prevent failures from occurring.

OVERVIEW AND CHAPTER ORGANIZATION

This third edition has been revised to include troubleshooting and repair of current video cassette recorders. In addition to older models, it describes mechanical and electrical failures common to current machines, with techniques for determining the likely cause for malfunction. New circuit descriptions address 8mm, Hi 8, and Super VHS models.

This book is designed to provide information on VCR maintenance regardless of a person's repair experience and understanding of electronic and mechanical principles. The order in which the chapters appear segregates the book in two sections. Chapters 1 through 4 constitute the first section.

They provide a general introduction to VCR routine maintenance and repair for both the interested VCR owner and the novice repair person. No basic understanding of electronic theory or VCR operation is assumed. Basic troubleshooting skills are presented, followed by an introduction to VCR troubleshooting and routine maintenance. Additional useful information has been included in the appendix to supplement each chapter.

The first part concludes with a discussion of typical failures in Chapter 4. The troubleshooting flowcharts in this chapter are designed to aid novice and experienced technicians as well as VCR owners who want to diagnose and repair common failures in their own machines. At the end of each troubleshooting flowchart is a list of possible causes for a malfunction. Some VCR owners may elect to perform troubleshooting techniques learned in the first three chapters and directed by a flowchart.

When finding the failed component requires costly test equipment or a more experienced technician, the troubleshooting flowchart suggests taking your machine to a service center for final repair. Knowing when a repair requires service center action is helpful. By this point, you'll also know the type of repair necessary. This prevents unnecessary expense and faster corrective action.

The second part of this book consists of Chapters 5 through 7. These chapters are provided for those readers serious about understanding VCR operation and electronic troubleshooting. You are assumed to have knowledge of basic electronic theory and troubleshooting. This section guides you through the magnetic and electronic theory associated with VCR circuit operation and introduces you to the various tools and test equipment used by VCR service centers. This information is useful for service technicians new to the trade. The appendix contains additional information to aid the serious technician.

The following section describes the contents of each chapter and of the appendix and glossary at the end of this book.

CHAPTER SYNOPSIS

Chapter 1, "Introduction to VCR Maintenance," provides a quick overview of the history of the video machine and describes why VCR maintenance is so important. This preliminary chapter sets the stage for the rest of the book and shows both the novice and the experienced VCR user how each can gain maximum benefit from the book.

Chapter 2, "Basic Troubleshooting," covers the basic steps in analyzing problems and repairing your own VCR. It describes the troubleshooting process and gives insight into VCR components.

Chapter 3, "Routine Preventive Maintenance," describes in depth how you can prevent the breakdown of your machine and preserve precious video tapes.

In Chapter 4, "Specific Troubleshooting & Repair," you will find detailed flowcharts covering common VCR problems. These problems include a screen that won't display, noise lines dancing across the screen, a VCR that won't record, and a VCR that won't play back.

Chapter 5, "Magnetic Recording Theory," assists those who wish to better understand the principles behind video magnetic recording. This chapter covers video tapes, the process of magnetizing the particles on the tape, and the techniques for playing back and reproducing the video and audio information stored on the tape.

Chapter 6, "VCR Color Processing Theory," deals with the color information recorded and played back on a video tape recorder. It describes timebase error, TV broadcast signals, color-under in both record and playback, and symptoms of chroma record failure.

Chapter 7, "Luminance Operating Theory," explains how the FM luminance signal is recorded and played back, automatic gain control, clamps, filters, white and dark clip, limiters, compensation, de-emphasis, and current improvements to signal resolution.

In Chapter 8, "VCR Servo Control," you learn capstan and drum and direct drive servo operation in both record and playback. This includes signal phase, tracking, speed control, signal modulation, special effects and symptoms of servo failure.

Chapter 9, "VCR Audio Processing: Theory and Troubleshooting," is an in-depth look at audio recording and playback. This chapter covers linear track specifications, frequency modulation, companding, dropout, demodulation, de-multiplexing, signal processing, and pulse code modulation.

Chapter 10, "Miscellaneous VCR Circuits," is a catch-all chapter that incorporates additional subjects that most technicians want to know. Each section in itself is not sufficient to warrant its own chapter, so all are combined in this information-packed chapter. Specifically, Chapter 10 covers system control, tuners, RF modulators, demodulators, hook-up configurations, power supply theory and troubleshooting, and tuner, demodulator and RF modulator troubleshooting.

In Chapter 11, "Advanced Troubleshooting," you are introduced to the various types of tools and test equipment that become second nature to VCR repair technicians. After describing the "tools of the trade," the chapter explains how to use tools to find failures, how to work with solder and circuit board repair. It even deals with recommended equipment for the service technician's bench. Servicers of VCRs can use this chapter to familiarize new technicians with the equipment they will be using on the job.

Each chapter concludes with review questions to reinforce key points and aid in information retention. The questions are designed to enhance the use of this book in classroom situations. Answers to the chapter questions can be found in the appendix.

The appendix provides more meat-and-potatoes information related to the VCR. It covers selection criteria for VCRs and video tapes, editing and dubbing procedures, a suggested periodic maintenance schedule, and a pre-

ventive maintenance check-off chart. Finally, the appendix contains answers to the chapter review questions.

The glossary explains over 200 terms and expressions common to video cassette recorder servicing.

Included in this book are two comprehensive flowcharts covering the playback and record modes of the VCR. These charts show the big picture view of VCR operation.

VCR Troubleshooting & Repair concludes with a comprehensive index that references the subjects in this manual to a specific book page.

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Chapter 1

Introduction to VCR Maintenance

Chapter 1 presents a brief history of the development of both the VCR and VTR. A basic overview of the internal operation of this magnificent machine is provided as an introduction to problem failure and analysis. The importance of learning to troubleshoot is also addressed.

"I still recall when I was a kid and my grandfather telling me that someday there would be an electronic device that could record pictures right off the television set. This machine would have the ability to play back both sound and picture immediately after it had been recorded. Then, during a later visit to his house, he proudly showed me his new Sony reel-to-reel half inch Portable Video Recorder Model AV3400. It was big and bulky, and was designed primarily for industrial use, but true to his word, there it was. It only recorded in black and white, and used large magnetic tape reels that held a half hour of program and had to be manually threaded in a fashion similar to an audio reel-to-reel tape recorder.

This marvel of that day included a black and white video camera and a special cable to record television programs. To record a TV program, he had to use a special monitor/receiver that could alter the TV signal so it could be recorded. The monitor/receiver connected to the recorder through an eight-pin connector and cable.

The possibilities for this new device excited me. My grandfather then told me that someday in the not-too-distant future there would be a device that could reproduce color video and be able to record a TV program using its own tuner without even having the TV on."—Capelo

For the past few years, futurists have been telling us that during our lifetime we will make three major purchases—a house, a car, and a computer. Lately, this expression has evolved into ". . . a house, a car, and AN ELECTRONIC SUPPORT AND ENTERTAINMENT CENTER."

The last purchase item includes the TV, the stereo, the computer, and the video cassette recorder.

As consumers, we owe much to the broadcast industry for its persistence in developing video tape recording. About twenty years before the introduction of the AV-3400, U.S. manufacturers such as Ampex and RCA busily worked on designs for video tape recorder (VTR) systems. Experiments were performed in 1951 to develop a rotating write-and-read head for recording and playback of video information.

In October 1952, the first barely visible video picture was demonstrated to an Ampex patent attorney and Ampex corporation founder Alexander Poniatoff. Also in that same year, Bing Crosby Enterprises demonstrated a broadcast VTR using fixed video heads and very high tape speeds. RCA introduced a longitudinal head VTR in 1953. It wasn't until January 2, 1955, that the first video tape recorder was produced using frequency modulation (FM) recording and special playback techniques. In that same year, a VTR using ½-inch tape was demonstrated in a closed circuit telecast from New York City to St. Paul, Minnesota. In 1958, sports history was made when the Los Angeles Rams football team used a video tape recorder to review the team's performance during a game's half time period.

In 1960, Toshiba introduced a process called ***helical scan*** that resulted in smaller and lighter broadcast tape recorders. Two years later, RCA announced that it had developed the first fully transistorized VTR. But it wasn't until 1965 that Sony introduced the first consumer video (CV) VTR. This reel-to-reel machine used ½-inch wide video tape on reels that were 7½ inches in diameter. It could record one hour of black and white video using a technique called ***skip field*** recording. By skipping every other field of video information, one hour of recording time could be placed on a 7½-inch reel of magnetic tape. During playback, the recorded fields were played back twice reproducing an approximation of the original video image. But close observation revealed some loss of detail in the playback picture and a slight vertical jitter in the image.

Skip field technology did enable the recording of wider tracks of information on the tape which made it possible for the machine to tolerate some minor mechanical errors, with one major disadvantage. A normal TV cannot easily reproduce a playback picture without severe bending or flagging of vertical objects on the screen. Electronic synchronization of horizontal signals didn't work well when the same field was played twice, so special monitor/receivers were offered as optical accessories. These receivers had modified horizontal automatic frequency control circuits that produced a horizontally stable playback picture. These monitor/receivers don't have their own tuner for channel selection.

Other manufacturers followed shortly with the introduction of new ½-inch reel-to-reel recorders. However, there was no interchangeability from one manufacturer to another. As new models were introduced by the same manufacturer, users discovered that tapes recorded on one model could not be played back on a different machine.

In 1968, Japanese manufacturers organized the Electronic Industries Association of Japan (EIAJ) and established a standard for ½-inch VTRs. These standards included mechanical and electrical specifications. Several manufacturers in Japan such as JVC, Matsushita, and Sony produced VTRs meeting these new specifications. EIAJ developed specifications for color recording about a year later.

The ½-inch reel-to-reel VTRs became very popular in industry, but the consumer market had not yet discovered home video recording.

Under pressure by the EIAJ, skip field recording was discontinued, and a process called ***full field recording*** was developed.

THE FIRST CARTRIDGE MACHINE

In 1969, Ampex designed a cartridge machine based on the Japanese color recording format. It used a plastic cassette to hold the magnetic tape reels, but it was never commercially manufactured. Then, in 1971, Sony introduced the U-Matic ¾-inch tape format mounted in its own cartridge or cassette. U-Matic-capable video cassette recorders were not sold to the public until 1972, and many Japanese companies bought licenses from Sony to manufacture tape recorders based on this new format.

Although recent video cassette recorders (VCR) format developments threaten the future of machines based on the ¾-inch U-Matic format, these machines are still widely used in industry, education, and government. The large size and high cost of U-Matic recorders and U-Matic tape cartridges deterred consumers and kept this market extremely small.

In the early 1970s, an American company called Cartrivision, a division of Arco Industries, introduced a machine that used a cartridge containing two reels mounted one on top of the other. Using a modified form of skip field recording to conserve tape, the machine provided color picture information. This recording process skipped two fields for every single field it recorded (instead of skipping every other field like the Japanese machines did). Each recorded field was then played back three consecutive times. For example, field 1 was recorded, but fields 2 and 3 were skipped. Field 4 was recorded, the next two fields were skipped, and so on. During playback, field 1 would be played three times, then field 4 would be repeated three times.

Discontinuity in motion was visible in moving subjects, and this VCR required a modified TV to play back horizontally stable pictures. Cartrivision hoped to capture the consumer market by making available prerecorded movies and sports events. These machines were actually test-marketed in Chicago by Sears & Roebuck, but poor sales caused the project to be abandoned.

THE CONSUMER MARKET

The consumer market for VCRs really began in 1974 when Sony introduced the Betamax home VCR in Japan. Beta-format VCRs were not available in the United States until almost two years later.

In the meantime, JVC introduced another format called VHS for "Video Home System." The VHS format received wide publicity and was adopted by many other manufacturers. VCR sales in Japan grew rapidly and soon Japanese VCRs were being sold in the United States. Zenith, Sanyo, Sony, Sears, and Toshiba began selling Beta-format machines, while Quasar, Panasonic, RCA, and JVC sold VHS machines.

Today, VCRs from many other manufacturers and from countries other than Japan are reaching American markets. Korean companies, for example, are manufacturing VHS machines designed to the same specifications as the EIAJ units and there are estimated to be over 90 million VCRs in the United States today.

The choice of format is between Beta, VHS, and 8mm. VHS is by far the most dominant format today. The Beta format is still available but only through Sony. Betamax enthusiasts prefer the video reproduction quality of the Beta format over that provided by the more popular VHS. Although the 8mm format was introduced in 1985, it has not been widely accepted as a home taping format. Most of its popularity is found in the camcorder market.

Current Beta-format machines have three recording and playback speeds: Beta I, Beta II, and Beta III. The early Beta I speed produced excellent video but limited recording time to about an hour and thirty minutes. Although Beta I was superseded by Beta II and III, it was recently reintroduced for the consumer who is

especially conscious of video quality. Many of Sony's VCR products can play all three speeds.

VHS machines are by far the most prevalent and have three speeds: SP (standard play), LP (long play), and EP (extended play) or SLP (super long play). The length of recording and playback time is associated with the speed in which the tape passes through the machine. Faster speeds produce higher quality video reproductions but short duration recording capability. Slower speeds enable long duration recording (such as an entire baseball game) but experience a fall-off in picture and normal (non-Hi-Fi audio) track sound quality. Everything's a trade-off.

Table 1.1 compares the current video tape formats with recording and playback times.

The possibilities and benefits associated with VCR use are endless. Favorite television programs can be viewed at convenient times. Prerecorded classics can be rented or purchased and played at home. Special entertainment and educational programs can be recorded and viewed repeatedly. With the use of a video camera, family events can be recorded and a visual history produced for future enjoyment. Many owners of home movie films are now having their 8mm and 16mm films reproduced on video tape for enjoyment on a VCR.

Table 1.1.
Comparison of Video Tapes and Run Time

Beta (L750 Tape)	
Beta I	90 minutes
Beta II	180 minutes
Beta III	270 minutes
VHS (T-120 tape)	
SP (standard play)	120 minutes
LP (long play)	240 minutes
EP (extended play)	360 minutes
SLP (super long play)	360 minutes
8mm (MP-120 tape)	
SP (standard play)	120 minutes
EP (extended play)	240 minutes

UNDERSTANDING THE VCR

Connecting a VCR to a television in basic configurations is relatively easy. The hook-up is similar to connecting your TV to the antenna cable system in your home or business. Record and playback operations are much like those of an audio cassette recorder in a stereo.

By understanding the electronic and mechanical theory and operation of a VCR, you will develop a genuine respect for these marvelous machines and a sensitivity for their proper care. You will also understand the machine's limitations.

The old expression "if you've seen one, you've seen them all" has relevance in the world of VCRs. In a sense the basic principles of operation have changed little since their invention; only the techniques or methods change. The most basic VCR currently available uses the same principles for magnetic recording as the stereo hi-fi VCR priced three times higher. No matter what type or size box is used to package the recorder, the basic workings inside are common.

There must be an input section, a recorder section, a storage medium, a reader section, and an output section as shown in Fig. 1.1. The input includes camera, microphone, another VCR, and cable and television signal paths. The recorder section converts all the input signals into a form suitable for saving, then writes or records that information on some form of storage medium.

The storage medium is the video tape itself. It's housed in a plastic cassette and comes in several sizes (formats). The cassettes are kept in special dust-preventing sleeves.

The reader section brings stored information, such as color television programs and sound signals, off the tape and converts it into signals suitable for the output unit. This output unit is actually the cable from your VCR to the television or to another VCR.

In all cases, the box, the television, and the "bells and whistles" (advanced features) can change, but the basic operation remains

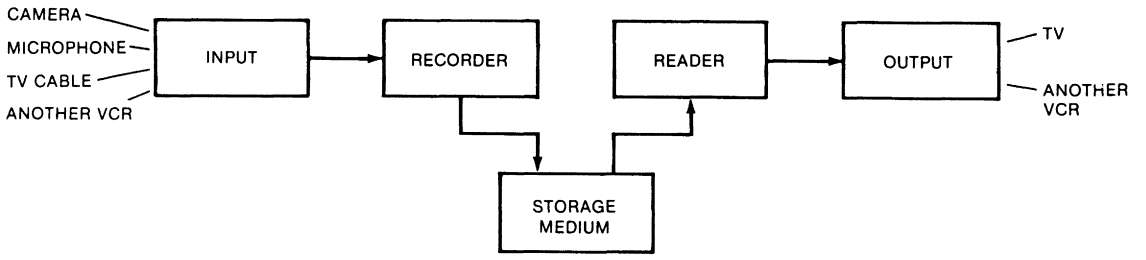

Fig. 1.1. The basic components in every VCR system.

the same. A $20 audio recorder uses the same principles for record and playback as the video recorder near your television. The input signal from the microphone or broadcast station is passed from the input to the record section. Here the combined effort of electronic circuitry and mechanical parts positions the magnetic tape and then writes information magnetically on the top layer of the tape.

The same thing occurs in your VCR, but the electronic and mechanical components are far more complex and operating requirements (specifications) far more stringent. Your VCR must be capable of handling both video and audio signals. A great deal of information must be stored on the tape and tolerances are rigidly controlled.

The magnetic tape in the plastic video cassette housing is similar to the brown magnetic tape in an audio cassette. It's constructed from a long strip of plastic or mylar wound onto a reel. On one side of the tape, the manufacturer glues a material that can easily be magnetized, usually a form of iron oxide mixed in an adhesive binder.

In the recorder is a cylinder called a *head cylinder* or *head drum*, around which the tape is pulled. Tiny electromagnets called *heads* are mounted in the surface of the drum. Electric signals from the video and audio part of the recorder section are passed through coils of wire in these heads.

The heads produce a tiny magnetic field that changes in direct proportion with the changing audio or video signals. The heads make contact with the oxide surface of the tape passing around the drum, thus causing the head magnetic field to be felt by the tape. The oxide on the tape becomes magnetized in direct proportion to the signal in the head. Since several heads are on the drum, several electric signals are converted to magnetic fields applied to the tape, thus transferring the audio or video information onto the strip of tape where it's stored for later retrieval (playback).

When you insert a tape cassette into your VCR and begin to play back the stored information, complicated gears, arms, and other mechanisms pull the tape into the machine and place the tape against read heads located on the drum cylinder.

These heads sense the tiny energy fields stored in the magnetic layer of the tape and convert the changing magnetic fields (patterns of magnetic particles) into small electric signals. These signals are amplified to make them strong enough to send out on the coaxial cable which runs from your VCR to a nearby television set. The television set converts these electronic video and audio signals into light images on the screen and sound from a vibrating speaker system.

It's that simple . . . in basic theory, at least. But to accomplish these feats, very complex circuitry and arrangement of mechanical devices are required. Tolerances are extremely tight, and signal levels are strictly controlled to enable excellent quality video from the surface of a shiny brown tape. Ensuring that these parts combine to reproduce brilliant video and ear-pleasing audio is the subject of the following chapters.

The VCR is a complex, precision machine. It's expected to operate correctly and without fail. Care and proper operation are mostly ignored while everything is functioning properly. But when the machine begins to fail from months of neglect and misuse, you really learn to respect it.

WHY TROUBLESHOOT

One visit to a VCR repair center can leave a permanent impression on your mind and pocketbook. Most repair center costs average $125. In addition to charging for the replacement parts, many service centers charge a flat fee for labor, which ranges between $75 and $140. The average labor charge is $50 per hour; typically, two to three hours are spent troubleshooting and repairing a machine, so the repair costs quickly add up.

Some repair centers fix only the immediate problem. Others also replace worn belts and do alignment checks to extend the operational life of the machine.

The value of a book teaching troubleshooting and repair for the novice is more evident when you understand the causes for typical VCR failures—dirt buildup and the wear-out of belts and pulleys.

Users don't intentionally damage a VCR, but lack of knowledge and proper preventive maintenance can be costly. This book provides understanding and appreciation for the VCR so you can give it the tender loving care it needs. It will also help you identify problems quickly, fix failures, and get on with the show. VCRs can serve you well for many months; this guide will show you how and why.

CHAPTER REVIEW QUESTIONS

1. In what year was the first consumer video tape recorder introduced?
2. What Japanese organization addressed the concern about tape interchangeability between manufacturers?
3. What are five disadvantages of the early skip field recorders?
4. What does the acronym VHS mean?

Chapter 2

Basic Troubleshooting

Like automobiles, VCRs break down after lots of use. Some break down sooner than others. Finding the problem can be easy or difficult, depending on your understanding of how to analyze a problem, identify the failed part, and step toward the correct repair. This chapter will show you how to find problems in your VCR in the shortest amount of time.

INTRODUCTION TO TROUBLESHOOTING

Imagine for a moment that you're in the midst of watching a video tape when suddenly the TV screen goes blank and the VCR stops working. What do you do? What failed?

This chapter is devoted to something we often wish we could pass off or ignore—trouble. Trouble is like a flat tire: no one wants it, but when it happens we want to fix it quickly and get the experience behind us. Knowledge and action overcome trouble.

You know from reading the owner's manual that your VCR is an electromechanical machine; it operates using analog and digital principles to record and play back audio and video signals.

A VCR generally doesn't break down slowly, with graceful degradation (at least you can't see it). If it fails, it's usually with a hard, consistent failure. In addition, the electronic devices that make up your VCR function within strict rules of logic. The most effective way to respond to a failure in these devices is to think the problem through just as the machine operates, logically. Understand what should happen and compare the "shoulds," one by one, with what is really happening.

A deductive technique called troubleshooting is particularly appropriate for solving VCR failure problems. Troubleshooting could be really frustrating if you were left to struggle through the process by yourself. This book provides you with the techniques for quick and easy troubleshooting and repair.

Before examining troubleshooting steps, let's review some important safety precautions.

SAFETY PRECAUTIONS DURING TROUBLESHOOTING AND REPAIR

As you would with any electrical device, you must observe certain precautions to prevent injury to yourself or damage to the VCR. Observing these precautions can save you time, money, frustration, and possibly injury.

1. Stay out of the power supply.
2. Observe the manufacturer's service safety precautions printed in the service manual.
3. Turn the power off and unplug the VCR whenever possible.
4. Ground yourself against static electricity.
5. Handle video tapes carefully.
6. Don't cycle the power quickly.
7. Keep liquids away from the VCR.
8. Handle components with care.

Don't troubleshoot the VCR power supply. These circuits convert the 115-volt line power in your home or office into the 5–10 volts used by the circuit boards. That 115 volts of electricity can be painful! It could be deadly! Some VCR power supplies are connected to one side of the AC power line for their ground reference. If you touch this type of power supply without the proper isolation, you could get shocked. Limit power supply repairs to fuse replacement, and only replace fuses with the AC cord disconnected. Be sure the replacement fuse has the same current rating as the old one.

Familiarize yourself with the safety precautions outlined in the service manual before opening the VCR.

Always turn the power off, and then pull the power cord out before touching anything inside the VCR. Touch a grounded metal object like a desk lamp to discharge any static electricity present in your body. Many failures are caused by static electricity on people who don't follow this rule.

Handle your video tapes carefully. Don't lay tapes on a very dusty, dirty surface. Keep cigarette ash away from the tapes and VCR. Don't touch the tape surface. Don't set your tapes on, or in front of, a TV or color monitor. Magnetic energy generated by the TV will weaken and possibly even erase the magnetic signals on the tape.

Don't cycle the power on and off quickly. Wait 7 to 10 seconds for the capacitors in the power supply to discharge fully and the circuits to return to a stable (quiescent) condition.

Keep liquids away from the unit. It's amazing how sticky soda pop (soft drink) becomes after frying components all over the inside of the unit.

Handle components with care. Don't let integrated circuits (IC chips) lie around. The pins will get bent. Watch out for static electricity—IC chips may need special handling.

STEPS TO SUCCESSFUL TROUBLESHOOTING

Effective and efficient troubleshooting requires gathering clues and applying deductive reasoning to isolate the problem. Once you know the cause of the problem, you can analyze, test, and substitute (good components for suspected bad components) to find the particular part that has failed.

The use of special test equipment such as an NTSC pattern generator and an oscilloscope can speed the analysis, but for many failures, good old brain power can suffice. Once you determine whether the problem is electronic or mechanical, deductive analysis changes to intelligent trial-and-error replacement. Reducing the number of suspected components to just a few and using intelligent