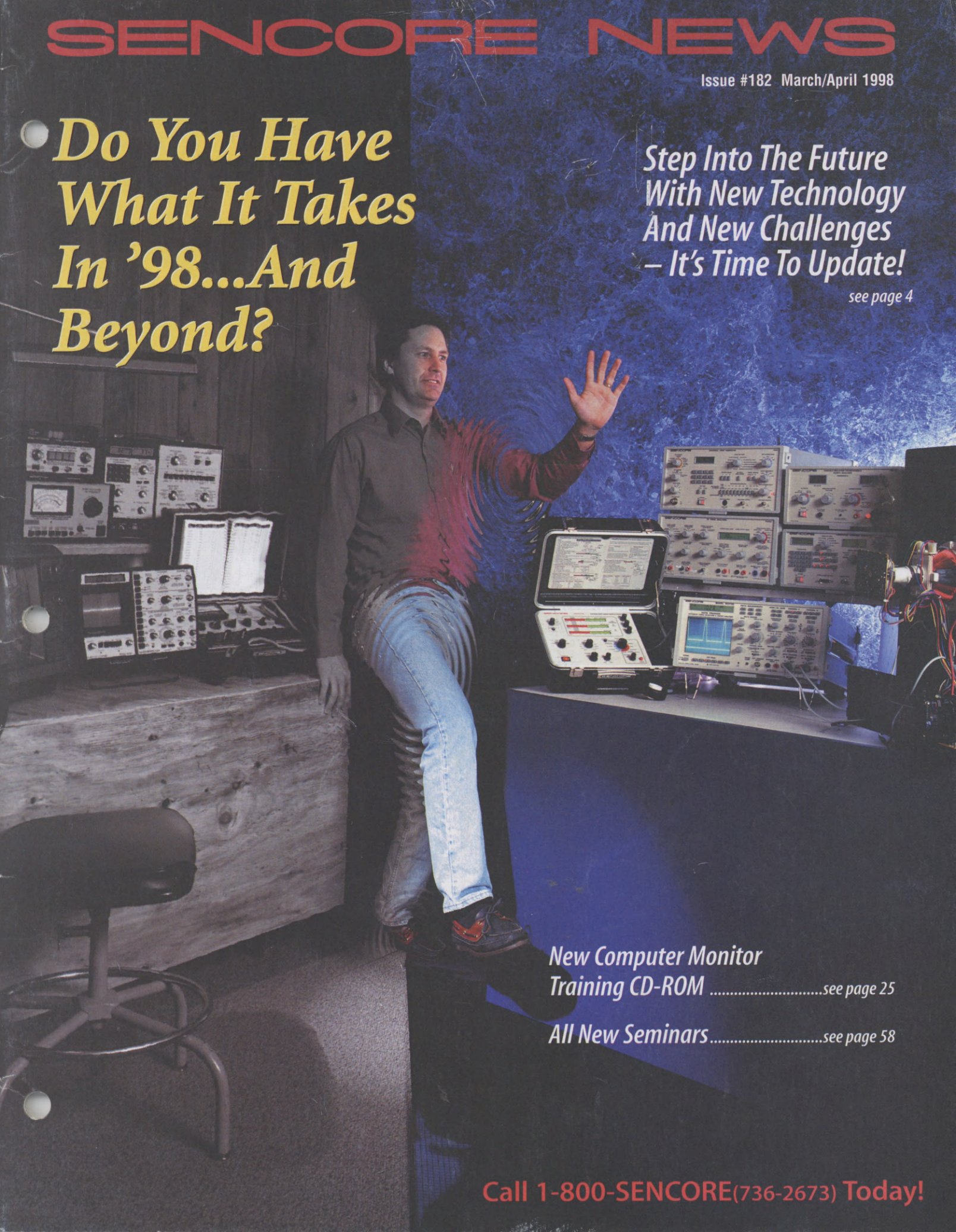
SENCORE NEWS

Issue #182 March/April 1998

Do You Have What It Takes In '98...And Beyond?

Step Into The Future With New Technology And New Challenges – It's Time To Update!

see page 4



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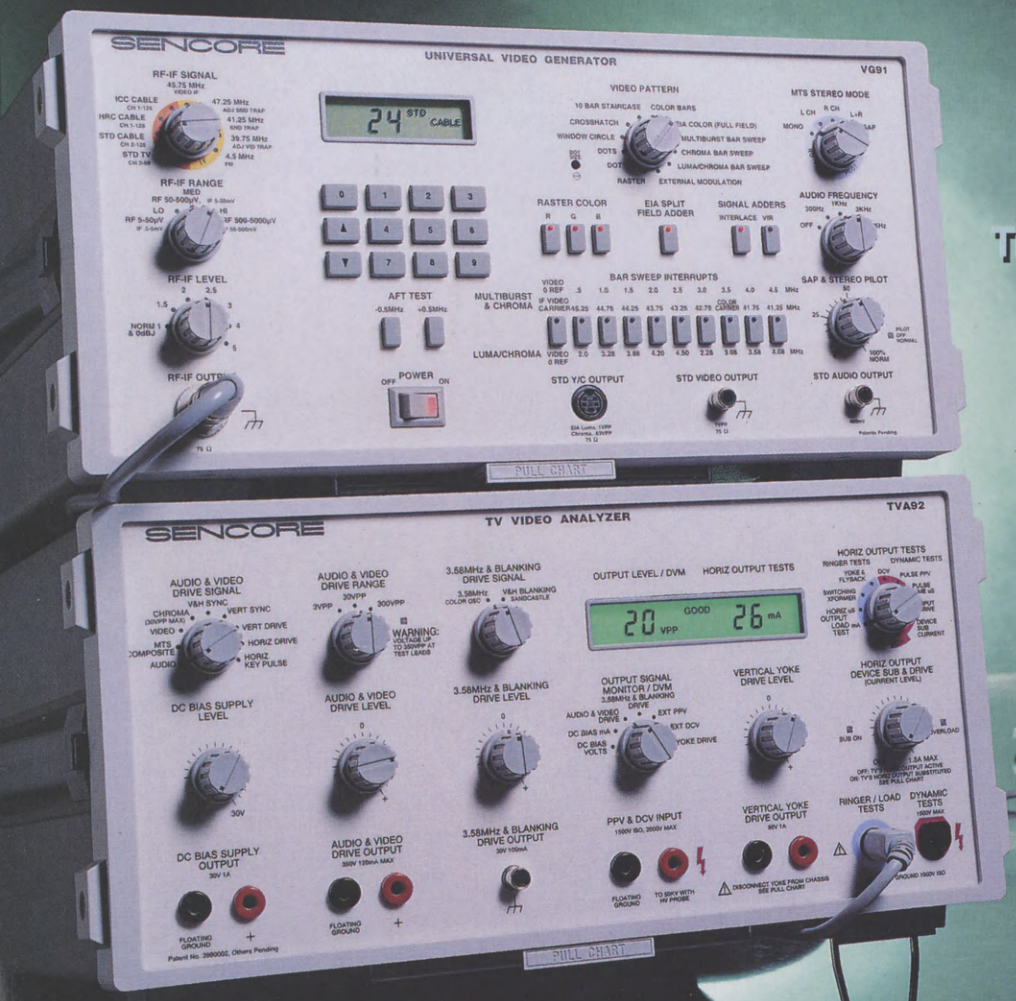

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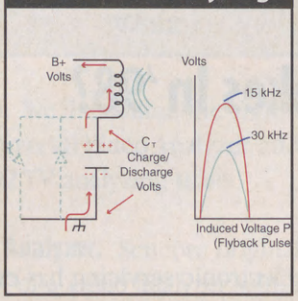
Horizontal Analyzing



page 19

New Training CD-ROM

page 25

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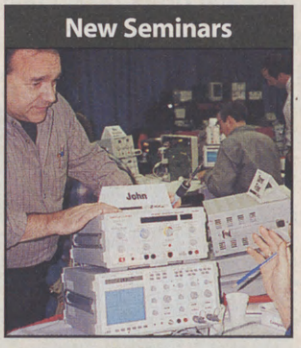

page 58

about the cover...

Do you have what it takes for servicing in 1998 and beyond? The challenges ahead will determine if your service center is equipped for efficient repair work. The article starting on page 4 discusses these challenges and analyzes what you'll need to stay competitive.

Sencore News #182

SENCORE NEWS

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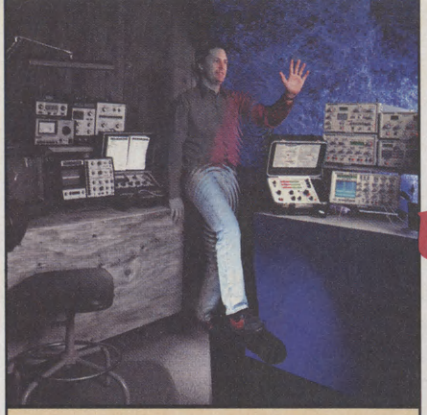


By Brian Phelps
Product Marketing Manager
Sencore Electronics

Update '98
Do You Have What It Takes In '98?

With the recent changes in technology, you're probably wondering what's coming for the service industry; and you may be curious how you will remain competitive and make a good profit in the coming years. There are actually several areas of servicing in today's world, but to simplify the solution, we'll concentrate on the area of television service to convey our message. So, let's get started and answer three "YES" or "NO" questions:

- **Can you isolate a horizontal problem to component level in 10 minutes and know if it will be a profitable repair or not?**
- **Can you align new EEPROMs or align the new menu controlled tuners in less than 10-15 minutes?**
- **Are your estimates more accurate and are your total profits higher than they were ten years ago?**

If you can seriously answer "YES" to all three of these questions, then you may already have what it takes for today's servicing. But, if you answered "NO" to any of the questions, you may be lacking what it takes to properly service today's technology and should be looking at an update in 1998.

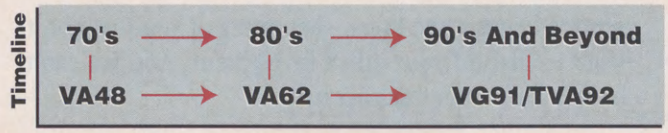
Today's video products use digital circuits that make your troubleshooting more difficult than it was in the 70's and 80's. Mechanical tuners are all but gone, so is the spray can of tuner wash. Modular circuit board design has made the transformation into the unitized chassis. TVs have gotten larger and are heavily involved with the home theatre sector. Next comes the merging of the TV and computer world.

Electronic servicing has evolved into one of this nation's most challenging and exciting businesses. But what do you do when it comes time to address those growing pains that develop from an increase of consumer equipment needing service, new demands from modern circuits, or wanting to capitalize on new service potentials? You may have customers walking through your front door and you may have a full supply of schematics, but that doesn't mean much unless you have the proper test equipment to service their product.

Fig. 1: New products and new technology require efficient and capable equipment and test methods to be competitive in today's market.

Some service centers believe they can still use the same techniques, equipment, and management practices as they did just 10 years ago. Ask yourself, "Am I servicing the same products with the same circuits?" If you answered "NO", then it's time for you to make a change and update in '98.

Let's take a look at an example of how Sencore instruments have evolved over the years to keep pace with the technology changes and the needs of



the servicer. We'll examine the VA48 Video Analyzer, VA62(A) Universal Video Analyzer, and the new VG91/TVA92 TV analyzing team.

VA48 Video Analyzer. Sencore originally introduced the concept of a video analyzer with its VA48 Video Analyzer. This instrument set the stage for TV service instruments. And, at the time it was a state-of-the-art instrument that met the needs of the servicer. It supplied VHF and UHF channels, basic video patterns, a flyback tester, and introduced the signal injection troubleshooting method making it the most sought after analyzer during its time.

VA62(A) Universal Video Analyzer. During the early 1980's, the TV service industry again underwent some changes. The accuracy of the tuners and the introduction of SAW filters greatly improved the RF and IF capabilities of televisions. Improved video performance sprouted the need for tighter spec'd video patterns. New cable channels, digital accuracy, interlacing, and IF trap setting were becoming the buzz words throughout the industry.

The VA62 Video Analyzer was introduced as the solution. It expanded on the features of its predecessor, the VA48, and offered the digital tuning and accuracy that was now needed. Plus, the VA62 was developed with the concept of expandability.

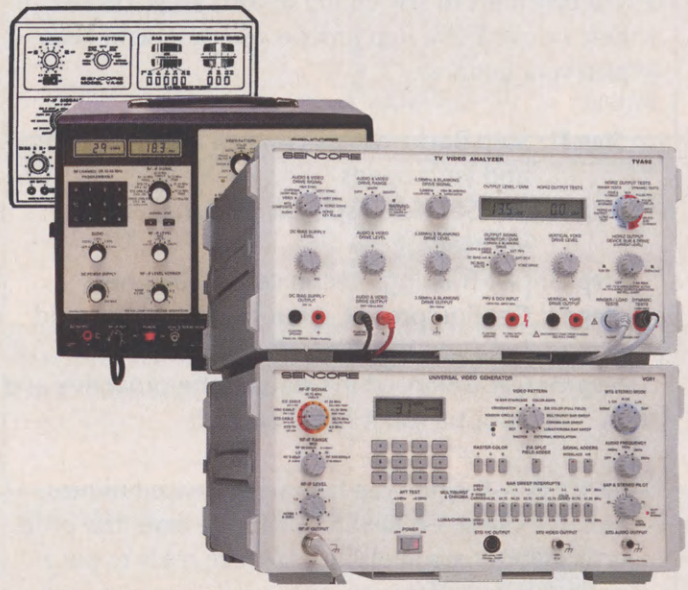


Fig. 2: The new VG91 and TVA92 TV Analyzers have all the benefits of the VA48 and VA62(A), plus the updated features you need in the high-tech, competitive servicing world of today.

Soon after the VA62(A)'s introduction, Sencore started work on accessories to match the growing needs of the servicer. We developed an NTSC pattern generator, a VCR test accessory, an MTS stereo generator accessory, and eventually an RGB generator. This exclusive system filled the needs of servicers. They had a complete system that became the industry standard for TV analyzing.

VG91 Universal Video Generator/TVA92 TV Video Analyzer. Eventually, with the growth of digital signals and changes in signal processing methods, televisions changed, and your needs changed as well. Prices started dropping and manufacturers began offering features and quality unheard of in the 70's and 80's. The television servicer began looking in additional directions to maintain their profits for their business, such as: VCR, camcorders, monitors, CD, and audio. The service industry began to hear the phrases, "It's a throw-away society," "It's cheaper to buy new," and "I want an estimate before you do anything else."

The other side of the coin was a completely different story for servicers. The price of large screen TVs and home theatre equipment dropped enough to fit in most consumers price range. Owners of 19 inch sets started updating to 27 or 31 inch sets (and larger) as the price became more affordable and features were added. These high dollar purchases are still in the living room and won't likely be discarded when they need service.

Sencore's solution was the VG91 Universal Video Generator and TVA92 TV Video Analyzer servicing team with all the solutions offered by the VA48 and VA62 plus more. This servicing team provides the channels to test and align today's digital tuners. It incorporates the accessories of the VA62 into one integrated system, while building on the fundamentals and techniques used by servicers for decades. It simplifies, yet enhances your testing ability.

But most importantly, the VG91/TVA92 system allows you to service today's technology televisions and make a profit whenever possible. This exclusive system allows you to quickly estimate and pinpoint defects so you can determine if the TV is a profitable repair for your business - or if you need to advise your customer to buy a new TV.

The VG91/TVA92 system is truly the solution for the 90's and beyond. Servicers told us they were struggling in the horizontal circuits. So, we added patented tests that allow you to service the horizontal circuit with the

television UNPLUGGED. Servicers told us they were struggling when they tried to isolate defective vertical yoke problems. So, we added an exclusive vertical yoke drive test that allows you to drive directly into the yoke and look for a normal picture on the CRT. Plus, there are many other features, such as: all cable channels, automatic AFT test, new horizontal and vertical drive signals, DC supply current meter, etc. - all added to the system that you simply must try on the your bench to appreciate what they can do for you.

NOTE: For a complete listing showing how the New Sencore instruments stack up against the 70s and 80s instruments, refer to the chart on page 7.

So Where Do You Go From Here?

"I like the VG91/TVA92 system, but I've made my investment in the VA62 (or other.)"

When Sencore packaged the VA62(A) for the market, it was as an expandable instrument with all the test and signals you'd need for testing TVs. We still stand behind that claim. The VA62 will allow you to get by servicing for years to come, and I'm sure you're still seeing many of the older TVs coming in for service.

However, if you're in the service business to make a good living and be as profitable as you can be, then Sencore has a solution for you that does much more than let you get by. We call it our "Trade-In/Trade-Up Program".

Trade-In/Trade-Up To Have What It Takes In '98 And Beyond!

We know that most of the service centers throughout the country have made an investment in the VA62(A) Video Analyzers. And, through talking with some key service centers, we know that many of you just don't want to discard your initial investment. And we can't blame you for feeling that way.

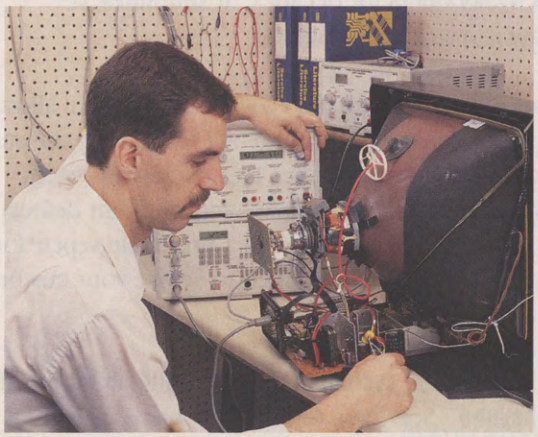


Fig. 3: Update your service bench for '98 and beyond with the VG91/TVA92 TV Video Analyzing system.

That's why we're allowing servicers to Trade-In/Trade-Up your VA62(A). That's right, we'll give you $800 for your used VA62(A) - regardless of the current condition. Plus, if your VA62(A) is in need of some service or recalibration, you're actually saving even more by investing in the new VG91/TVA92 and saving the service fees.

Call your Area Representative for more details on the Trade-In/Trade-Up program and how our exclusive "Pay As You Grow" Investment Plans can put the new technology instruments on your bench for less than $99 per month.

When It's Time To Update - Where Do You Start?

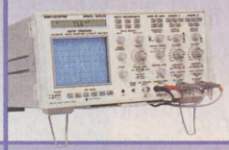
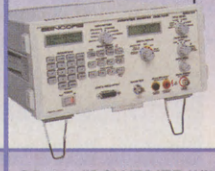
Everyone's aware of what is happening with the technology of the products being serviced, and we all know (deep down) that we need to update and stay on top of technology to survive. To help you decide which products you should be looking at updating on your bench, the following page provides a detailed chart of Sencore's older products and our new instruments. Look through the chart and you'll see key areas where your business could be improved from a test instrument perspective.

But, what additional steps do you need to take when deciding what to update? Actually it's not as difficult as you may think to stay on top of technology. In fact, here's a quick five step process you can use to help plan your business.

Step #1: Step Back - assess yourself, your business, and your needs
Step #2: Set Goals - be specific, but challenge yourself
Step #3: Get Training - technical and business
Step #4: Get Equipment - your equipment should help you build your business
Step #5: Get Going - don't sit back, be proactive and adopt a "Do it now!" attitude

To see how Sencore can help your service business, give us a call at **1-800-SENCORE.** We have new product support items available and we're ready to put a package together for you. SN

Update '98 – See How Your Existing Sencore Instruments Compare!

Sencore's Old Product	Sencore's New Product	Reason For Update *(difference between old and new)*	Reason You Must Have One
VA62(A) Universal Video Analyzer Or VA48 Video Analyzer	VG91 Universal Video Generator & TVA92 TV Video Analyzer 	• Digital tuners • Incorporated MTS Stereo • Automated AFT tests • Selectable raster color • New horiz. circuit tests • New vertical yoke tests	Provide customers with fast and accurate estimates, and complete/time efficient repairs
SC60(A) Widebander 60 MHz Oscilloscope Or SC61 60 MHz Waveform Analyzer Or SC3080 80 MHz Waveform Analyzer	SC3100 100 MHz Waveform & Circuit Analyzer 	• 100 MHz bandwidth • Autoranged attenuator • Fiddle-free autoranged timebase • Integrated ohms & current measurements • Bandwidth limiting • 2,500 volt protection	Quickly and completely analyze any test point to 100 MHz with just one probe hook-up
LC53 "Z Meter" Capacitor-Inductor Analyzer Or LC75 "Z Meter" Or LC76 "PORTA-Z" Or LC77 "AUTO-Z"	LC102 "AUTO-Z" Automatic Capacitor/Inductor Analyzer 	• Automatic Good/Bad indication • Automatic lead zeroing • Battery operation • Tests all failure modes • Stop testing safety alarm • Patented ESR test	Dynamically analyze caps and coils for all defects without errors
CR70 "BEAM BUILDER" Universal CRT Analyzer & Restorer Or CR31(A) "Super Mac" CRT Tester & Restorer	CR7000 "BEAM-RITE" CRT Analyzer & Restorer 	• 3 gun simultaneous display • Faster and easier to use • Industry standard emission tests • New socket design • Improved restoration	Accurately test and safely restore any CRT fast
No preceding instrument	HA2500 Universal Horizontal Analyzer 	• Fast all format computer monitor analyzing • Substitute switch mode power supply • Provide accurate estimates • Prevent burnt-out parts	Simplify complex computer monitor horizontal circuit analyzing with one test cable hook-up
No preceding instrument	CM2125 Computer Monitor Analyzer 	• All formats – CGA to Hi-Res • Exclusive troubleshooting drive signals • Test yokes and flybacks • Performance testing troubleshooting patterns	Dynamically analyze and test any computer monitor from the input connector to the CRT
PR57 "POWERITE" Variable Isolation Transformer & Safety Analyzer	PR570 "POWERITE II" Variable Isolation Transformer & Safety Analyzer 	• Digital, dual read-out volts and current • Variable current trip protection • Auto-toggle safety leakage test • AC outlet test	Confidently monitor and analyze AC power supply conditions with full protection
SM2001 Service Center Manager	SA32 Service Assistant 	• Windows compatible • Runs faster and more friendly • Several feature updates • Several new features to help run your entire business	The first user-friendly business service software that is customer-friendly too... just click and go!

By Brian Phelps
Product Marketing Manager
Sencore Electronics

Ten Steps To Successful Servicing With Your Video Analyzing Team

Guarantee Your Success With The VG91 & TVA92

Many electronic technicians see the Sencore Video Analyzing Team, the VG91 Universal Video Generator and TVA92 TV Video Analyzer, as a tool which is used primarily for "tough dog" problems. While this exclusive equipment does a good job of helping you troubleshoot the tough problems, the team can serve a more important function on nearly every set you service.

The processes covered in this article are based on reports from many successful technicians who use Sencore test equipment and video analyzers. If you adopt these methods, you will find that troubleshooting is easier, your customers will respect you more, and you'll have fewer callbacks for marginal performance. As a side benefit, you will be using your Video Analyzing Team more often, so you will become more skilled at using it when you do meet those tough-dog problems.

Learn The 10 Steps That Can Guarantee Your Success

If you break your servicing down into separate tasks, you'll see that most service jobs need the same steps. You might try to skip a step or two, but doing so often leads to more work later, as you may have to back up and re-do the skipped steps.

You can attempt these steps without the Video Analyzing Team, but your troubleshooting will be more difficult with more component-level testing, and you'll have more backtracking because you followed the wrong circuit path. The Video Analyzing Team gives you all the tests you need in one, integrated analyzing team. It has been designed to give you the best effectiveness in any video troubleshooting. As you see, the Video Analyzing Team plays a role in three out of the 10 steps used by successful servicers.

Here are the 10 steps used by successful servicers:

1. Ask customer for symptoms and history
2. Do performance test with customer
3. Determine all related symptoms
4. Check for obvious defects
5. Narrow problem to functional block/defective stage
6. Pinpoint bad components
7. Replace bad components
8. Re-test to confirm operation restored
9. Repair secondary symptoms
10. Run complete performance test

Let's look at these steps in more detail so that you can understand why each is important.

Step 1 Ask the customer for symptoms and history.

Many servicers get a chuckle about this step. Often times, they explain, the only clue they get from a customer is, "It just quit working." While this may be all you can get from some customers, the set's owner can often fill some very important gaps in the diagnosis process.

Notice that this step asks for two kinds of information: symptoms and history. If the customer can explain the exact symptom, such as, "The picture went dim first, then the sound quit a week later," you can get an important clue about the mode of the failure. Modern television receivers often appear to work fine one

moment, then fail to start the next time. So the reply, "It just doesn't work," might be all the customer knows.

Don't forget to ask about the set's history. Did it do this before? Has it been fixed by another shop? If so, when and where? Were there any unusual symptoms in the week or month before the failure, such as popping in the audio or flickering in the picture? Was there a thunderstorm in the area recently? All these clues can be especially helpful when tracing an intermittent or a failure that's out of the ordinary.

Step 2 Do a performance test with your customer.

Few technicians bother with this step, yet some of Sencore's most successful customers tell us that it's the most important. With the customer watching, plug the set into a live outlet and run through every function to see what works and what does not. Sometimes, you'll find there's really nothing wrong - the problem is a dead AC outlet, a switch in the wrong position, or a disconnected cable TV tap.

But, there's an even more important reason to run through a complete performance test. The set may have more than one problem and the customer has only mentioned the most recent one. For example, they may be complaining about the loss of vertical deflection, but your test shows that audio is also weak. Or, they may not have noticed the low brightness caused by a weak picture tube, and may be glad to learn that you can restore the picture tube with the Sencore CR7000 "BEAM-RITE".

Fig. 1: Always do a performance test with your customer. A little extra time invested up front can save confusion, embarrassment, and lost revenue down the road.

Most especially, a complete performance test shows the customer that you are concerned about doing the job correctly. You've taken the time up front to show that you want to do a complete job, with the customer knowing about the work before you start.

The Video Analyzing Team lets you test the performance of every TV circuit by simply connecting to the antenna terminals. You don't even need to take the back off the set to perform these tests. The Video Analyzing Team's exclusive signals and patterns give you the capability to help identify and show problems to your customer before the work begins.

Before the customer leaves your shop (or before they leave the room if you're doing home service), have them agree with you on what they want fixed. You and your customer should come to an agreement on such questions as whether they want the picture tube restored, or whether there are some other, secondary problems they want you to look at. By pointing out that there are several, unrelated problems, it's easier to itemize the bill. Otherwise, they may think that all your work was to find only one problem, and may feel you are overcharging them when the final bill is presented.

Step 3 Determine all related symptoms.

Here's one of the steps where many technicians build in their own inefficiency. Instead of identifying ALL the symptoms, they find one symptom and begin tracing it. But, this symptom may be a secondary symptom of an even larger problem. If they had taken a few more moments, they may have noticed that two or three symptoms all point to the same source, such as a bad tuner, or poorly regulated power supply.

If you use all the features of the Video Analyzing Team, this step becomes easy. The information gained from the performance test in step 2 has already identified the main symptoms. Now, it's a matter of using the Video Analyzing Team to further define these symptoms, by making a more detailed test, or by using additional Video Analyzing Team functions that weren't used during the simple performance test.

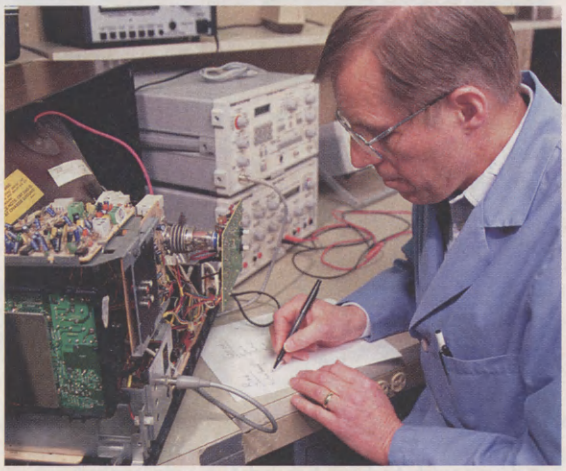


Fig. 2: Determine all related symptoms before you start so you can troubleshoot the primary symptom first.

If you confirm several symptoms, you need to decide which one to troubleshoot first. You shouldn't try to follow more than one symptom at a time, because it is too easy to get crossed up as one may affect the other. Since one problem can cause multiple symptoms, finding one bad component often clears up all the symptoms. Always repair circuit problems in the following order:

1. **High Voltage**
2. **Sweep**
3. **Sync**
4. **Luminance (video)**
5. **Color**
6. **Audio**

Each of these general symptoms directs you to one of the areas of the "trouble tree" troubleshooting guide supplied with the Video Analyzing Team. They, in turn, let you isolate the defective stage in the fewest steps possible.

Step 4 Check for obvious defects.

This step relies on your senses of observation and your own practical experience. If, for example, you see a burned resistor, or smell smoke, you should attend to these obvious defects, even before making a measurement. Sometimes repairing the burned part solves the problem. But, even if it doesn't, you have fixed something you know must be corrected before the service job is done.

You may also know that a particular chassis has a manufacturing defect which causes a particular symptom. Service literature, for example, may instruct you to resolder certain connections, or to replace certain components with improved ones. Here again, checking for these obvious defects first ensures that they won't mislead you in your final troubleshooting.

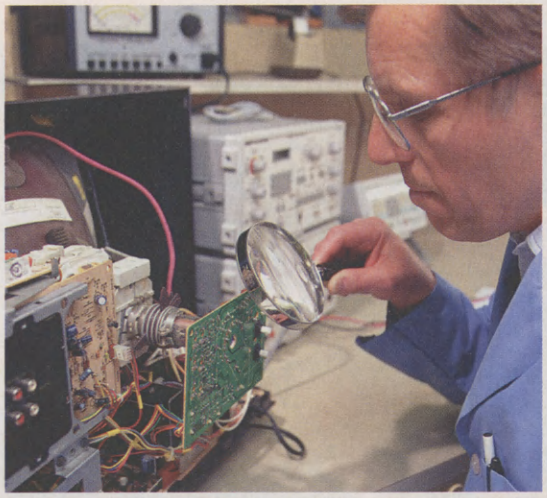


Fig. 3: Making a quick check for obvious defects can sometimes save you a lot of troubleshooting time.

Step 5 Narrow the problem to one functional block.

Up to this point, the Video Analyzing Team has been used to make general tests. Now it's time to put its full analyzing capabilities to work with functional analyzing. Functional analyzing means that you base your troubleshooting on the function of a circuit, instead of the specific parameters of each component. This lets you move through the suspect stages much faster than using conventional troubleshooting methods, such as analyzing waveforms with an oscilloscope or measuring DC voltages with a voltmeter.

Functional analyzing uses duplicate signals substituted into each of the stages you think might cause the symptom identified earlier. These substitute signals are good, so injecting them into a good circuit causes it to operate normally. If you inject a signal into a test point, and the symptoms improve, you know that all the circuits from there to the output are working correctly. If, by comparison, the symptoms remain, you know that the bad circuit is affecting the substituted signal, and the problem is between the injection point and the output.

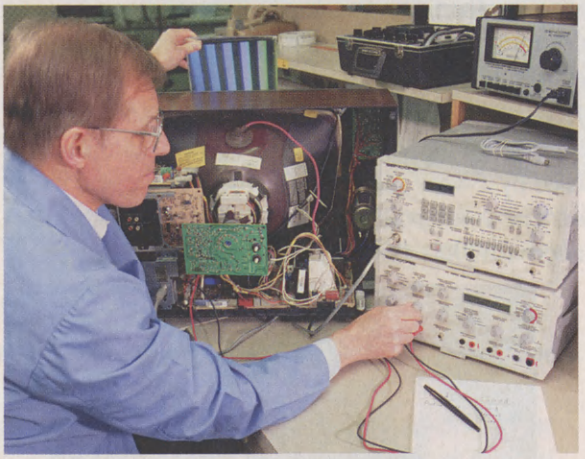


Fig. 4: The Video Analyzing Team helps narrow the problem to a single functional block defective stage.

You inject the Video Analyzing Team signal right over the top of the signals at the test point. There's no need to disconnect components to interrupt the original signal, because the Video Analyzing Team output circuits "swamp" out the signal already in the circuit. This is done by using output amplifiers with a driving impedance well below the normal circuit impedance, allowing the Video Analyzing Team to over-power the circuit signal. The Video Analyzing Team has DC blocking built-in, so you don't need to worry about shorting out bias circuits and damaging good components in good circuits.

If you use the "divide and conquer" troubleshooting

method, you'll find the bad stage in four troubleshooting stages or less (steps 3-6 above). The Video Analyzing Team is supplied with troubleshooting guides based on this highly effective troubleshooting method.

The guides instruct you to substitute into a test point about half-way through the circuits related to the symptoms. If the symptom improves, you have proven that all the circuits to the output are good. Now you move the injection point toward the input. If the symptom remains, you are now ahead of the bad stage, so you move your injection point toward the output. In either case, you divide the remaining stages in half again. This halving process repeats until you have found the bad stage. You know that you have the bad stage when you get an improvement in the symptom when injecting at its output and the original symptom when injecting at its input. The isolated stage has only a few parts that might be bad. These are tested with conventional testing methods.

Step 6 Pinpoint bad components.

It's only after using the Video Analyzing Team to isolate a single stage that you bring in your conventional testers. You might use your SC3100 "AUTO TRACKER" to look at a signal. You might use your volt/ohmmeter to measure a resistor or to test a power supply. You can use the LC102 "AUTO-Z" to test a capacitor or an inductor, or you can use the TF46 Portable "SUPER CRICKET" to test a transistor. In addition to DC and peak-to-peak voltages, the Video Analyzing Team's digital meter lets you test flyback transformers, yokes, and high-voltage triplers all with special tests.

Now that the Video Analyzing Team has narrowed the suspect parts to a dozen or so, conventional test methods are your most effective means of narrowing the defect to a single component. Functional analyzing isolates the problem stage, and conventional tests point you to the defective part. It's a troubleshooting team that's time-tested and proven to be the most effective analyzing method available.

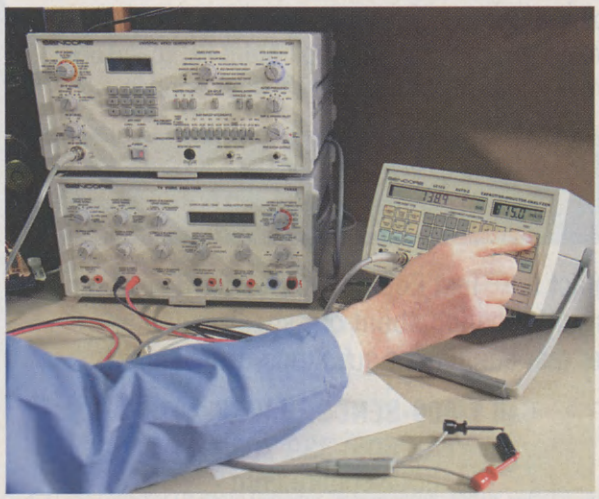


Fig. 5: Conventional analyzing methods lead you to the defective part. Here the LC102 "AUTO-Z" locates a capacitor with excessive leakage.

Step 7 Replace bad components.

This step doesn't directly involve the Video Analyzing Team. It is a good idea, however, to use component tests and common sense to check components associated with the bad part you found. For example, don't forget to check emitter resistors if a transistor was bad. Also, look for cracked PC boards, bad solder connections, and other mechanical problems.

Step 8 Re-test to confirm proper operation.

Changing a bad part may only fix part of the problem. Double check your work by using the Video Analyzing Team signal to dynamically test the circuit associated with the original problem. The exclusive video patterns produced by the Video Analyzing Team provide dynamic tests you can interpret right on the screen of the TV. For example, the Multiburst Bar Sweep video pattern checks the video bandwidth of the IF stages, video detector, and video amplifiers. The 10 Bar Staircase pattern dynamically tests those same stages for gray scale tracking and dynamic range. And the Chroma Bar Sweep confirms that the color circuits work correctly.

If your tests show there is still a problem, use the Video Analyzing Team's signal substitution to find its cause. This time, start at the circuit you just repaired to learn whether another part in the same circuit might be defective.

Step 9 Repair secondary symptoms.

If repairing the first problem did not clear up the secondary problems, you now turn your attention to them. Move back to step number 3, and follow the troubleshooting sequence to find each remaining problem, one at a time. Use your Video Analyzing Team to test, isolate, and then confirm each defect.

Step 10 Run complete performance test again.

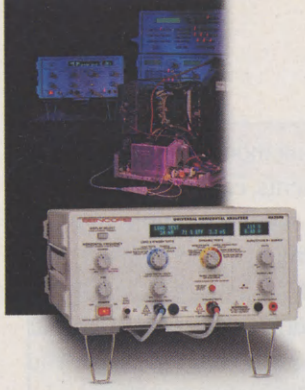
When you have found and repaired all the problems, repeat all the steps of the performance test used at the beginning of the process. It's important to repeat this test so you don't miss any hidden problems or any

Fig. 6: After the repairs have been made, be sure to run a complete performance test again to make sure you don't miss any problems.

symptoms that have mysteriously appeared since you did the performance test in step 2. Even if it's not your fault, your customer could lose faith in your servicing abilities if his/her product is returned with any kind of defect.

The Video Analyzing Team does much more than help you fix "tough dogs." It is a complete video analyzing team, which becomes part of a professional approach to video servicing. The ten steps we've covered apply equally well to TV receivers, video monitors, VCRs, and NTSC capable computer monitors. It applies to any video system based on NTSC standards. Each situation will naturally be different, but as a general rule, these steps will quickly lead you to the problem (you probably do most of the steps without even thinking about them).

If you follow the steps used by successful servicers, your customer will know you are doing a good job. More importantly, each step directs you to the problem, using the most efficient troubleshooting methods ever devised. That translates to less time wasted and higher profits on every service job. If you have questions on these methods or the Video Analyzing Team, call us toll-free at **1-800-SENCORE.** We'll discuss your analyzing needs and help come up with a solution. SN



By Glen Kropuenske
Application Engineer
Sencore Electronics

How To Dynamically Analyze Monitor Horizontal Circuits - Automatically!

Understanding The HA2500's Dynamic "METER" Tests

The fastest way to diagnose horizontal output and related stage problems is to make voltage and waveform measurements in the horizontal output stage. But, horizontal output stage voltages exceed most test instrument and test probe protection limits. If you have an instrument with sufficient voltage protection, chances are cursor or marker adjustments are required, resulting in measurement setting or resolution errors. Furthermore, multiple measurements at both the base and collector mean each must be probed separately and considerable setup and interpretation time is needed for each measurement.

The HA2500's Dynamic Tests "METER" provides automatic measurements of voltages in the horizontal output stage without worry of test instrument damage. Autoranged horizontal output measurements are displayed faster and more accurately than with any other test method. All measurements are simultaneously shown in the bright fluorescent panel. This article shows you the ease of use and interpretation provided by the HA2500 for horizontal output stage analyzing.

HA2500 Dynamic Tests "Meter"

The HA2500's Dynamic Tests "METER" analyzes voltage parameters at the collector (or drain) and base (or gate) of the horizontal output transistor. The Dynamic Test Meter works on all types of horizontal output stages with grounded emitter or source horizontal output transistors, either bipolar or MOSFET types.

The Collector Or Drain DCV/uS/VPP tests measure the DC voltage (DCV), the peak-to-peak amplitude (VPP), and the duration in microseconds (uS) of the inductive voltage pulse produced by the horizontal output stage. All three measurements are displayed simultaneously in the center fluorescent display panel as shown in Fig. 1.

The BASE OR GATE VPP/kHz tests measure the voltage peak-to-peak (VPP) and frequency (kHz) of the input drive waveform at the base of the horizontal output transistor. Both measurements are automatic and simultaneously displayed as shown in Fig. 2.

Three Simple Connections - Automatic Measurements

The HA2500's Dynamic Tests "Meter" measurements are made with the specially designed Dynamic Test Lead. Three clip connections to the horizontal output transistor is all that's required. If the horizontal output transistor is removed, the connections are made to the circuit points corresponding to the transistor elements.

The Dynamic Test Lead is labeled and color coded for easy connection. The

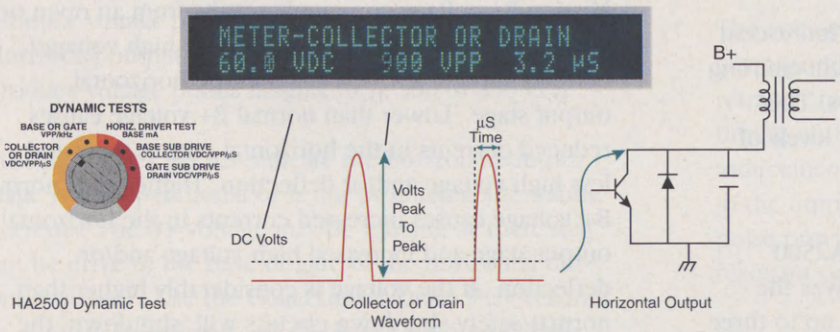


Fig. 1: The Collector Or Drain Dynamic Tests measure the DC voltage, pulse PPV, and pulse duration in microseconds.

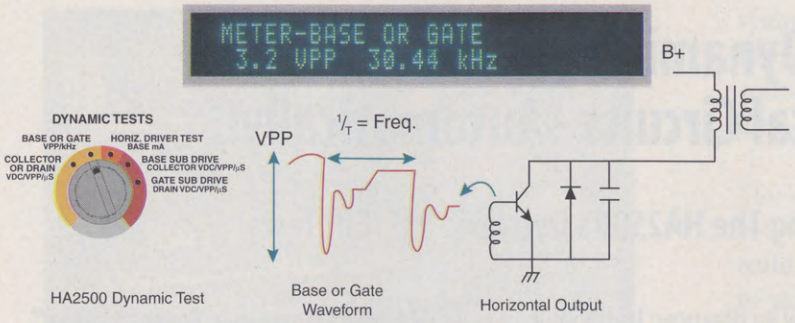


Fig. 2: The Base Or Gate Dynamic Tests measure the VPP and frequency of the horizontal drive to the base or gate of the horizontal output transistor.

yellow clip connects to the collector or drain of the horizontal output transistor. The blue clip connects to the base or gate, and the black lead connects to horizontal ground, typically at the emitter or source.

To Perform the "COLLECTOR OR DRAIN" or "BASE OR GATE" Dynamic Tests:

1. Remove chassis AC voltage & connect the Dynamic Test Lead clips.
2. Connect the Dynamic Test Lead.
3. Set the DYNAMIC TESTS switch to "COLLECTOR OR DRAIN DCV/uS/VPP".
4. Push DISPLAY SELECT button.
   Note: Changing the DYNAMIC TESTS switch automatically selects Dynamic Tests readout.
5. Apply AC volts to the chassis.
6. Read the DCV, VPP, and uS readouts in the center fluorescent panel.
7. Set the DYNAMIC TESTS switch to "BASE OR GATE FREQ/VPP".
8. Read the VPP and FREQ. readouts in the center fluorescent panel.

Simultaneous Measurements On Bright Fluorescent Display

The display panel of the HA2500 features a fluorescent matrix display. The fluorescent material is light-emitting rather than light-reflecting, as in LCD displays. This results in a clear and bright display under all levels of light conditions and viewing angles.

The matrix display and automation of the HA2500 greatly reduce the time required to fully analyze the horizontal output stage. The HA2500 makes up to three fully automatic measurements and displays them on the fluorescent panel simultaneously. With conventional test instruments, each of the three measurements would require multiple steps and instrument adjustments. The HA2500 requires only one step, selecting the Dynamic Tests Switch and viewing the display. With the HA2500, you'll save time on each occasion you use it to analyze a horizontal output stage compared to your current method.

Diagnose Horizontal Defects In A Fraction Of The Time

Interpreting The Collector Or Drain "Meter"

The HA2500 Universal Horizontal Analyzer's Dynamic Tests "METER" readouts direct you to suspect stages to isolate horizontal related problems. The Collector Or Drain DCV readout measures the DC voltage or B+ power supply voltage to the horizontal output stage. The DCV readout should agree with the schematic or the B+ voltage known to be normal for the chassis. Improper DCV readings indicate a change in the normal load current to the horizontal output stage, a B+ power supply defect or high voltage or deflection B+ regulator problem.

If without a schematic, you can estimate the normal DCV reading or B+ voltage. While the normal voltage varies among computer monitors, there are some common B+ voltage ranges depending on the display's frequency and resolution capabilities. A VGA-only monitor commonly uses a B+ supply voltage of 75-95 volts. In a multi-frequency display, the HV/Defl. regulator changes the B+ supply voltage to the horizontal output depending on the frequency of operation. At VGA (31.5 kHz), the B+ voltage may be approximately 80 volts and increase to 130 volts as operating frequencies near 60 kHz.

A low or missing DCV reading prevents the horizontal output stage from producing alternating currents. Missing B+ voltage commonly results from an open or circuit defect within the B+ supply or high voltage/deflection regulator, or a short in the horizontal output stage. Lower than normal B+ voltage causes reduced currents in the horizontal output stage and less high voltage and/or deflection. Higher than normal B+ voltage causes increased currents in the horizontal output stage and increased high voltage and/or deflection. If the voltage is considerably higher than normal, safety shutdown circuits will "shutdown" the horizontal output stage.

Lead Connections For Dynamic Tests:

Lead Clip Color	Lead Label	Connect to:
Black	E or S	Emitter or Source of H.O.T
Yellow	C or D	Collector or Drain of H.O.T
Blue	B or G	Base or Gate of H.O.T

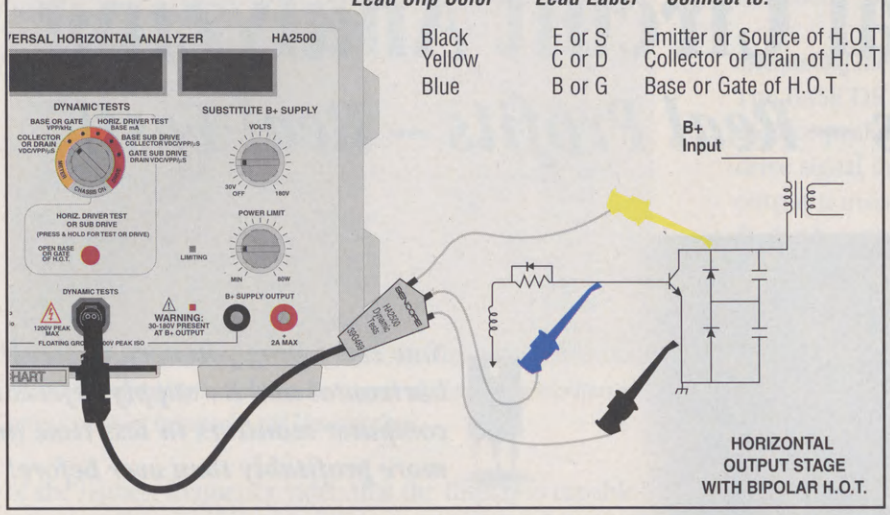


Fig. 3: The COLLECTOR OR DRAIN and BASE OR GATE Dynamic Tests require three simple Dynamic Test Lead connections to the horizontal output transistor.

Alternating currents in the horizontal output stage produce an inductive voltage pulse, commonly called a flyback pulse. The volts peak-to-peak (VPP) of the flyback pulse provides insight on the operation of the horizontal output stage. The HA2500's Collector Or Drain VPP readout measures the VPP of the flyback pulse automatically requiring no range selection.

A VPP reading indicates the presence of flyback pulses in the horizontal output stage. Flyback pulses indicate B+ voltage is present, horizontal drive is switching the horizontal output transistor and alternating currents are being produced in the horizontal output stage. The amplitude of the flyback pulses or VPP readings reflect the level of current alternating in the horizontal output stage. Normal VPP readings indicate the horizontal output stage current is proper to produce normal high voltage and/or deflection.

Most computer monitor horizontal output stages with bipolar output transistors and B+ voltage >35 volts produce voltage pulses ranging from 800 to 1200 VPP. Horizontal output stages with MOSFET output transistors produce voltage pulses ranging from 500 to 850 VPP.

Missing flyback pulses indicate the horizontal output stage is not operational or is not producing alternating currents. The B+ voltage may be missing or there may not be drive to the base or gate of the horizontal output transistor. Use the Collector Or Drain DCV readout to confirm B+ voltage and the Base Or Gate VPP/kHz readouts to check for the presence of horizontal drive. If these are normal, an open horizontal output transistor, output stage component, or circuit path exists.

Lower than normal VPP readings result from decreased currents in the horizontal output stage. Decreased currents commonly result from a decrease in the B+ voltage to the horizontal output stage, a change in the resonant timing of the output stage, or insufficient base drive or transistor beta. Reduced B+ voltage likely indicates a defect in the B+ power supply or HV/deflection regulator. A timing defect caused by an increase in the inductance or capacitance of the stage slows the rate of current change reducing the VPP readout. An open in the yoke current path alters the timing in this manner.

An increase from the normal VPP results from an increase in current alternating in the horizontal output stage. The most common cause is an increase in the B+ voltage to the horizontal output stage caused by B+ supply or HV/deflection regulator defects. A timing defect in the horizontal output stage may also cause increased VPP readings. Timing problems are commonly caused by a flyback internal shorted turn, an added current load on a flyback secondary, or a decrease in an output stage timing capacitor value. Use the Collector Or Drain uS readout to identify a change in the resonant timing of the horizontal output stage.

The COLLECTOR OR DRAIN uS readout measures the duration of time in microseconds of the voltage pulse produced at the collector or drain of the horizontal output transistor. The uS time is measured between the 5% level of the voltage peak for pulses greater than 20 VPP. This provides an automatic pulse time measurement with reasonable accuracy for all pulses >100 VPP.

The voltage developed by the horizontal output stage corresponds to the charge and discharge of the retrace capacitor(s). This time reflects the resonant timing of the horizontal output stage and relates to the inductance and capacitance values of the components in the output stage. The duration or time of the voltage pulse provides useful information about the normal resonant operation of the horizontal output stage.

The normal pulse uS timing of the horizontal output stage depends on the shortest horizontal blanking time

THE NEW HA2500

Horizontal Circuit Analyzing

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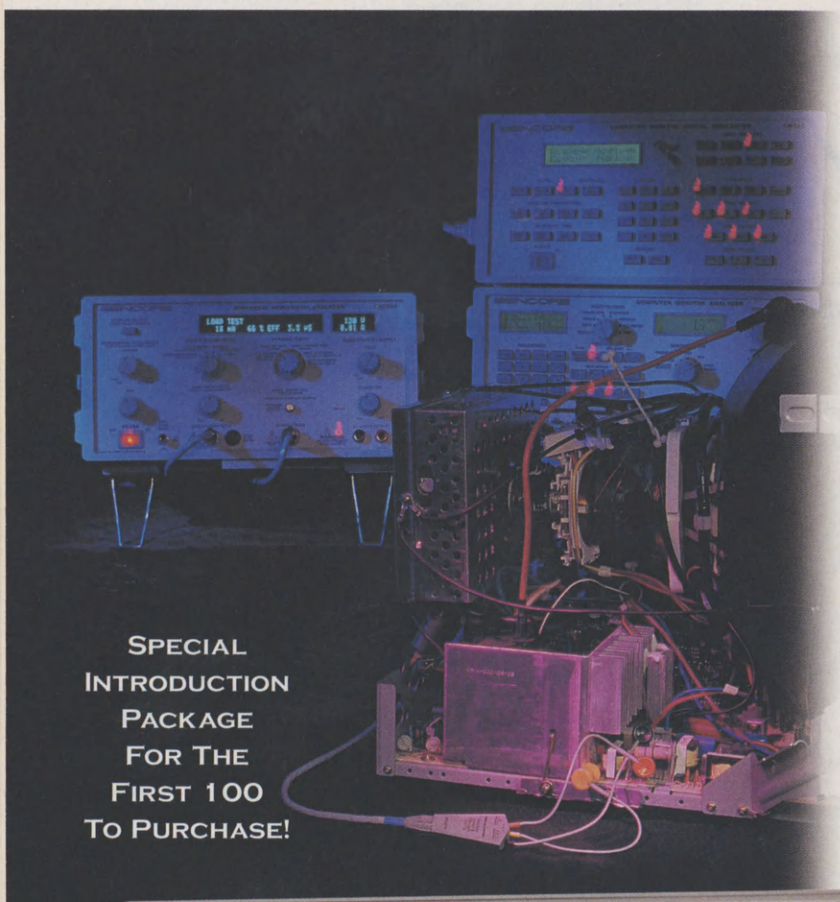


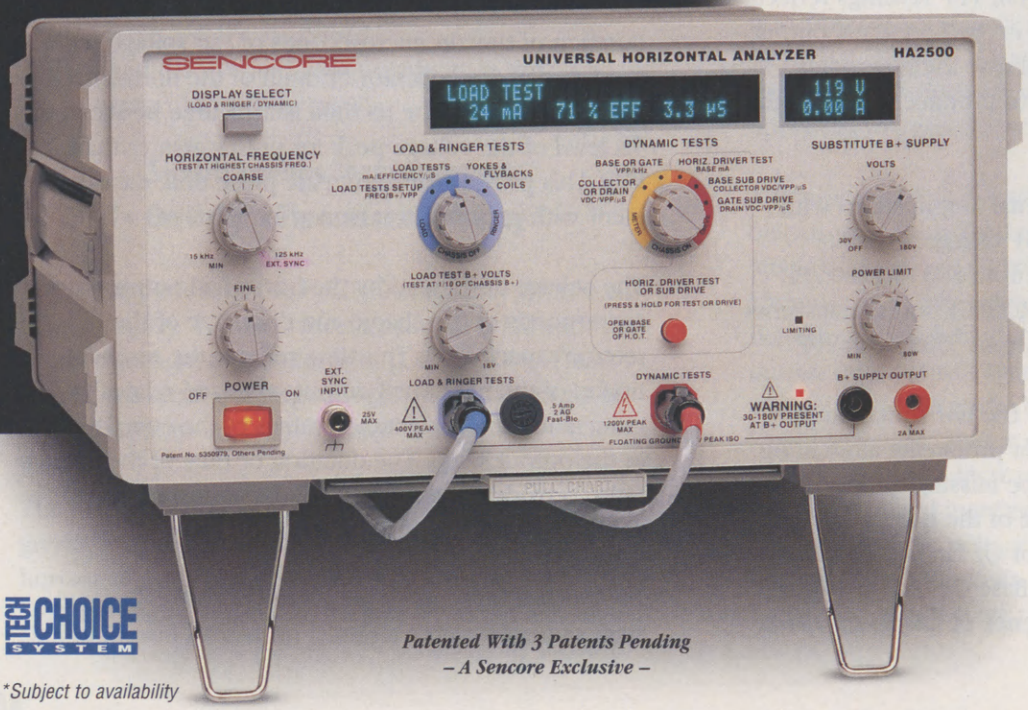
SPECIAL INTRODUCTION PACKAGE FOR THE FIRST 100 TO PURCHASE!

Now everything you need to localize horizontal and B+ supply defects in computer monitors in less time and more profitably than ever before!

Are you tired of replacing components only to have them blow out when you power up the monitor? How do you accurately test the horizontal circuit when the power supply is also down? How much more profitable would you be by using one instrument with all the tests you'll need at your fingertips?

Sencore's new HA2500 Universal Horizontal Analyzer is the one instrument designed specifically for analyzing all horizontal and B+ related defects. The HA2500 teams up with any of the Sencore computer monitor generators to give you complete monitor analyzing. Plus, the HA2500 provides these exclusive features in a stand-alone or sync-locked instrument:

- Chassis "OFF" horizontal output analyzing
- Dynamic horizontal output metering
- Exclusive horizontal driver testing
- Special output transistor base or gate substitution
- Exclusive B+ power supply substitution



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Scan Format	Horiz. Frequency	Horiz. Blanking Time	Typical µS Range
TV- NTSC	15.7 kHz	11 µS	11.0 - 15 µS
CGA	15.7 kHz	18 µS	11.0 - 18.5 µS
MDA, Hercules	18.4 kHz	10 µS	7.0 - 10.5 µS
VGA	31.5 kHz	6.35 µS	5.0 - 7.0 µS
VESA	38 kHz	6.1 µS	4.8 - 7.0 µS
XGA	35.5 kHz	5.3 µS	4.2 - 6.0 µS
VESA	46.88 kHz	5.17 µS	4.1 - 5.5 µS
XGA-2	39 kHz	4.57 µS	3.6 - 5.0 µS
Generic	48 kHz	4.35 µS	3.5 - 5.0 µS
DEC	54 kHz	3.6 µS	2.8 - 4.5 µS
VESA	60.02 kHz	3.56 µS	2.8 - 4.5 µS
VESA	63.98 kHz	3.78 µS	3.0 - 4.5 µS
VESA	75.0 kHz	3.46 µS	2.8 - 4.0 µS
VESA	79.98 kHz	3.0 µS	2.4 - 3.5 µS
VESA	81.25 kHz	3.2 µS	2.5 - 3.5 µS
VESA	93.75 kHz	2.765 µS	2.2 - 3.5 µS
VESA	106.25 kHz	2.44 µS	2.0 - 3.5 µS

Chart 1: The typical flyback pulse time range in uS of computer monitors of various scanning frequencies and blanking times.

of the highest frequency video that the display is capable of reproducing. Furthermore, the uS timing is influenced by the overscan and underscan characteristics of the display. To determine what a normal uS reading is for a particular horizontal output stage, reference the Typical uS Pulse Time Range shown in Chart 1.

A normal pulse time indicates the resonant timing of the horizontal output stage is appropriate to produce normal PPV pulses and proper high voltage and deflection. It also confirms normal timing to properly blank the video during retrace. A pulse time that is shorter than the anticipated normal uS range may indicate the display and horizontal output stage is designed to handle higher display resolution with video containing faster horizontal blanking times.

A pulse time that is confirmed shorter than the normal uS range indicates a reduced inductance or capacitance value of the horizontal output stage. The inductance of the flyback or coil can be reduced by a shorted turn or loading of a secondary winding. A reduced retrace capacitance value also causes a shorter than normal uS reading. Shorter than normal uS readings result in increased PPV readings with the normal B+ voltage applied to the horizontal output stage.

A pulse time that is longer than the anticipated µS range may be an indication that the display is not capable of displaying the resolution and horizontal frequency you thought, or indicates the timing of the horizontal output stage is reduced. The inductance or capacitance of the horizontal output stage has been effectively increased. The likely cause of this in combination high voltage/deflection horizontal output stages is an open in the yoke or its series components. Longer than normal uS readings usually result in decreased PPV readings with the normal B+ voltage applied to the horizontal output stage.

Interpreting The Base Or Gate "Meter"

The BASE OR GATE VPP readout measures the amplitude or peak-to-peak voltage (PPV) of the horizontal drive signal input to the base or gate of the horizontal output transistor. The PPV measurement is automatic for both positive or negative polarity voltage peaks.

Normal VPP readings at the base or gate of the horizontal output transistor vary slightly between output stages and output transistor types. FET horizontal output stages have base input drive voltages typically ranging from 5 to 18 volts peak-to-peak. Zener diodes from the gate to source limit the maximum drive voltage to prevent damage to the FET output transistor. Bipolar horizontal output stages have drive peak-to-peak voltages ranging from 4 to 25 VPP. While the VPP readings may change when the horizontal output transistor is removed, the VPP readings should remain in the typical ranges listed.

Base Or Gate VPP readings in the typical range indicate the presence of proper drive voltage to the base or gate of the horizontal output transistor. The presence of drive indicates the horizontal oscillator and driver stages are functioning. VPP readings that are higher than the typical range shown likely do not indicate a circuit problem. The high VPP readings are likely due

COLLECTOR/DRAIN READOUTS	PROBABLE CAUSES
VDC = 0	No ACV, Bad B+ power supply, Open HV/Defl. regulator, Shorted H.O.T.
VDC = lower than normal	Bad HV/Defl. regulation, B+ supply defect, Severe load or short in Horiz. Output.
VDC = higher than normal	B+ Supply Regulation, Shorted or bad HV/Defl. regulator, No load current to Horiz. Output.
VPP = 0.0 VPP or <5VPP	Little or no B+ volts, No Horiz. Drive, Open H.O.T or inductor in Horiz. Output.
VPP lower than normal	Low B+, Open yoke path, Insufficient Drive, Increased value-retrace capacitor or inductor.
VPP higher than normal	High B+, reduced value-retrace capacitor or inductor, Horiz. Output stage loading.
µS = - - - µS	Little or no B+ volts, No Horiz. Drive, Open H.O.T. or inductor in Horiz. Output.
µS = lower than normal	Display capable of higher resolution? Reduced value-retrace capacitor or stage inductor. Flyback shorted turn or sec. load.
µS = higher than normal	Open yoke or its series components.

Chart 2: Probable causes of the measurement results using the COLLECTOR OR DRAIN Dynamic Tests.

to positive and negative switching spikes caused by the normal switching action of the horizontal output transistor. VPP readings that are lower than the typical range likely indicate a drive signal problem. VPP readings near zero indicate that there is no input horizontal drive signal or the horizontal output transistor is shorted preventing any substantial VPP at the base or gate.

VPP readings below the typical range (less than 4 VPP) may indicate that drive is weak or missing. For questionable VPP readings (2-5 VPP) in horizontal output stages using bipolar horizontal output transistors, use the HA2500 Horiz. Driver Test to confirm normal or insufficient drive current levels.

The Base Or Gate frequency measurement tests the frequency of the horizontal oscillator. The oscillator generates a drive signal which is amplified by the horizontal driver stage to the base or gate of the horizontal output transistor. Measuring the frequency of the horizontal drive waveform provides an indirect measurement of the horizontal oscillator frequency.

For normal operation, the horizontal output stage must be driven with the proper horizontal frequency. In a multi-frequency display, the B+ voltage and mode selecting components in the output stage are chosen depending on the operating frequency. An improper drive frequency in relationship to the applied B+ and mode selected components causes improper horizontal output stage operation. Too much or too little high voltage or deflection is produced or the timing of the output stage pulse is incorrect for the video's retrace time requirements.

The normal frequency is determined by the horizontal scan rate of the video to be displayed by the monitor.

BASE OR GATE TEST RESULTS	PROBABLE CAUSES
Freq. = 0.0 kHz	• No Horiz. Drive
Freq. = lower than normal	• Horiz. Osc., Horiz. Drive Distortion, Mode Select Defect, Missing Sync
Freq. = higher than normal	• Horiz. Osc., Mode Select, Sync, Unwanted Osc/Driver Distortion
VPP = 0.0 VPP	• No Horiz. Drive, Shorted H.O.T.
VPP = lower than normal	• Missing or Weak Drive, Shorted H.O.T.
VPP = higher than normal	• Likely no fault

Chart 3: Probable causes of the measurement results using the BASE OR GATE Dynamic Tests.

In a VGA monitor, the horizontal oscillator runs near 31.5 kHz and locks to this frequency when synced to a VGA input signal. In a multi-scan computer monitor, the horizontal oscillator locks to the frequency of the input horizontal sync signal.

To accurately test the horizontal oscillator (drive frequency) and horizontal sync circuits of a display, apply the proper video test signal and frequency from a generator to the inputs of the display. The Base Or Gate kHz readout should agree with the horizontal sync frequency of the applied video signal if the display is capable of displaying the applied video format. The horizontal oscillator and sync circuits of the display are working properly if the kHz readout agrees with the generator frequency.

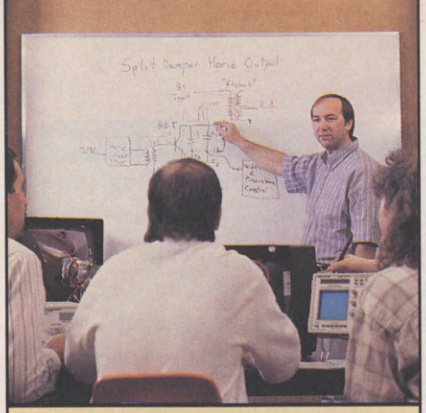
If the Base Or Gate kHz readout is considerably higher or lower than expected with no input signal to the display, check the display's horizontal frequency and resolution capabilities.

A kHz readout near the applied generator frequency (but not the same), indicates the horizontal oscillator is not being synchronized with the horizontal sync signal. You can remove the generator signal while monitoring the FREQ. readout to confirm the oscillator is not locking or changing frequency. If the frequency does not change as the generator signal is applied, the display's horizontal sync circuits or mode control circuits are suspect. If the frequency changes, but just not quite enough, the horizontal oscillator components or frequency mode control input voltage to the oscillator is suspect.

Learn More Today

The HA2500's Dynamic Tests "Meter" Dynamic Tests analyze the horizontal output stage for defects without worry of test equipment damage, without complicated setup, without probing multiple circuit points and without selecting multiple test functions. In just seconds, you determine if the horizontal output stage is functioning normal or not and identify suspect stages and components.

Start saving time and reducing the effort needed to isolate horizontal and related defects in computer monitors today! To order or simply learn more about the HA2500's Dynamic Tests or other analyzing features, call today at **1-800-SENCORE.** SN



By Glen Kropuenske
Application Engineer
Sencore Electronics

Understanding Horizontal Stages Of Multi-Frequency CRT Video Displays

Fifth In A Series Of Articles Covering Multi-Frequency Horizontal Stage Analyzing

Computer monitors and other multi-frequency displays change operating modes for higher display resolution. Changing modes increases or decreases the operating frequency of the horizontal output stage(s). Keeping the CRT high voltage and yoke current constant with horizontal frequency changes requires altering the operation of the horizontal output stage. This article looks at how the horizontal frequency impacts the high voltage and deflection produced by horizontal output stages. It further examines how multi-frequency monitors alter the operation of the horizontal output stage to regulate the high voltage and/or deflection current.

How Frequency Affects High Voltage/Deflection In The Horizontal Output Stage

To understand how energy to the flyback transformer or coil changes with frequency, consider the conduction time of the H.O.T. during the horizontal cycle. Recall that this is the time during the horizontal cycle that all the energy to produce high voltage and/or deflection is input to the output stage (see Fig. 1). When the H.O.T. is switched on, the B+ supply produces a rising current in the inductive transformer or coil winding. The rising current builds a magnetic field in the coil. The intensity of the magnetic field depends on the current buildup. The input energy (magnetic field intensity) produces induced voltage and alternating currents in the horizontal output stage during the remainder of the cycle. The level of induced voltage and alternating currents determine the high voltage and yoke deflection.

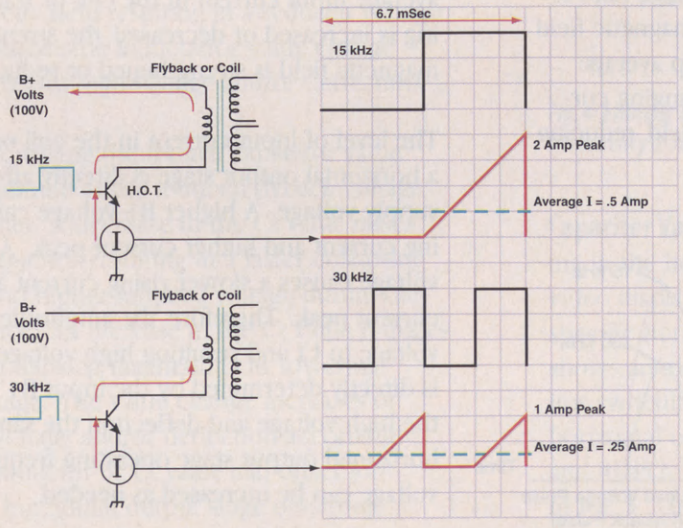


Fig. 1: Increasing the horizontal frequency reduces the average flyback or coil current and input energy to the horizontal output stage.

For ease in comparing input energy at different operating frequencies, consider the rise in current in the flyback or coil to be linear. In normal operations, the current rise is not perfectly linear due to the resistance and inherent capacity of the flyback or coil. For example, with a frequency of 15 kHz, a B+ supply voltage of 100 volts may produce a flyback primary current reaching a 2 amp peak (see Fig. 1). The H.O.T. normally conducts approximately 1/2 of the horizontal cycle. With a linear current increase and 50% conduction time, the average current in the coil calculates to 0.5 amps (50 W). A portion of this energy is transferred to the flyback secondaries and retrace capacitor Ct to produce high voltage and deflection current.

With a drive frequency of 30 kHz, the conduction time of the H.O.T. each cycle is cut in half. The reduced conduction time reduces the current buildup to a 1 amp peak with the same applied B+ voltage and inductor. In comparison to 15 kHz, the H.O.T. completes two conduction cycles, but the average current calculates to approximately 0.25 amps or an input power of 25 watts. This is determined by averaging the conduction current values and dividing the result by two for the 50% conduction time.

Because a linear current example was used, a linear relationship between frequency and input energy results. But keep in mind the current increase is not perfectly linear and therefore the relationship between frequency and input energy is not linear. However, from the example, it should be clear that an increase in the horizontal drive frequency to the horizontal output stage reduces the average current or input power to the flyback or coil. Oppositely, a decrease in the horizontal drive frequency results in an increase in the average current to the flyback or coil, increasing the input power.

It is the input energy to the flyback primary or coil that is available to produce induced voltage and alternating current in the horizontal output stage the remainder of the cycle. When the H.O.T. is switched open, the magnetic field in the flyback or coil collapses. The collapsing field produces induced voltage and charging current to the retrace or timing capacitor (see Fig. 2). The intensity of the magnetic field determines how much voltage and charging current is produced. If the intensity of the magnetic field is produced with an operating frequency of 15 kHz and 0.5 amp average current as in the previous example, the voltage rises to some voltage level. If the intensity of the magnetic field reflects the 30 kHz frequency and 0.25 amp average current, much less induced voltage and changing current results from the collapsing magnetic field, reducing the voltage or flyback pulse amplitude.

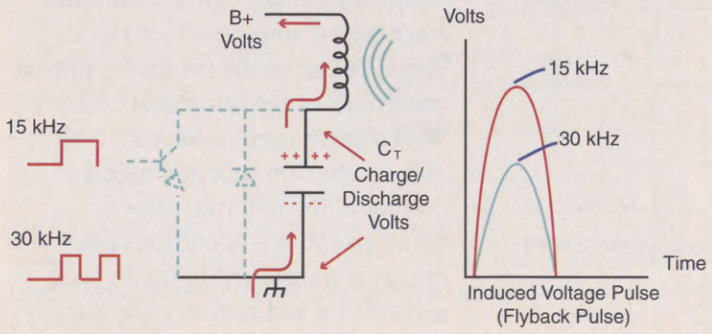


Fig. 2: The intensity of the flyback or coil's magnetic field determines the charging current to Ct and amplitude of the induced voltage pulse.

It stands to reason that if the intensity or strength of the collapsing magnetic field is about half as strong, the level of induced voltage into the flyback secondary windings is cut in half, reducing the high voltage. Also recall that Ct sources current for the deflection yoke in a single or split damper horizontal output stage. In these configurations, the voltage applied to the yoke and resulting yoke current would be reduced.

Horizontal Output Stage Changes To Regulate HV Or Deflection

For a horizontal output stage to maintain the same level of high voltage or deflection at a new operating frequency, the input energy must be sufficient and the flyback voltage pulse must reach approximately the same amplitude. A desired amplitude reflects sufficient input energy and induced voltage and charging current to Ct from the collapsing magnetic field of the coil or transformer. There are four ways to increase or decrease the induced voltage and charge to Ct at a new operating frequency. They include:

1. Increasing or decreasing the B+ supply voltage.
2. Increasing or decreasing the conduction time of the H.O.T.
3. Increasing or decreasing retrace capacitor Ct value.
4. Increasing or decreasing inductor value.

The first two methods, changing the B+ supply or conduction time of the H.O.T., are methods that affect the level of input current in the coil or transformer. If the average input current in the coil or transformer winding is increased or decreased, the strength of the magnetic field is strengthened or reduced.

The level of input current in the coil or transformer of a horizontal output stage is directly affected by the B+ supply voltage. A higher B+ voltage causes a faster rising current and higher current peak. A lower B+ voltage causes a slower rising current and reduced current peak. Therefore, the amplitude of the induced voltage to Ct and resulting high voltage and deflection is directly determined by the input B+ voltage. To keep the high voltage and deflection the same at a higher horizontal output stage operating frequency, the B+ voltage can be increased as needed.

The level of input current to the coil or transformer of a horizontal output stage depends on how long the

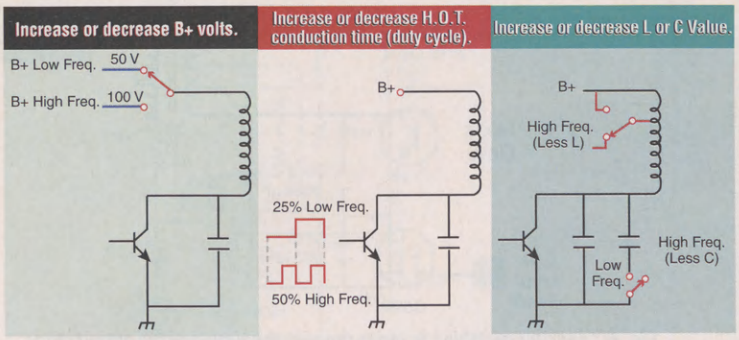


Fig. 3: Methods of altering the horizontal output stage to keep the high voltage and deflection constant at new operating frequencies or modes.

horizontal output transistor is permitted to conduct each horizontal cycle. If the H.O.T. conducts 40% of the time, the current rises to some peak. If the H.O.T. conduction time increases to 60%, the current rises to a much higher peak. The average current and input energy to the transformer or coil increases, resulting in a stronger magnetic field and larger induced or flyback voltage pulse. The high voltage and deflection can be increased or decreased by varying the H.O.T. conduction time. For example, at a higher operating frequency, the duty cycle can be widened to keep the high voltage and deflection the same.

The amplitude of the induced or flyback voltage pulse to Ct can be increased or decreased by changing the value of the inductor or the retrace capacitor. Decreasing the inductance value results in a faster rising current during the conduction of the H.O.T. and increased resonant frequency during the first and second parts of retrace. The result is a faster expanding and collapsing magnetic field and higher induced voltages to transformer secondaries and Ct. Increasing the inductance slows the rise in energizing current and the collapsing magnetic field resulting in a reduced voltage pulse. In this manner, the inductance value change increases or decreases high voltage and/or deflection.

Increasing or decreasing the retrace capacitor value changes the amplitude of the induced flyback voltage in a similar manner. A decrease in the Ct value raises the resonant frequency, resulting in a faster collapsing magnetic field and higher induced voltage during the first part of retrace. An increase in the Ct value reduces the rate of the collapsing magnetic field, lowering the induced voltage. The value change increases or decreases high voltage and/or deflection accordingly. Decreasing the inductor or Ct value can offset for increases in the horizontal output stage operating frequency to produce nearly the same high voltage and deflection.

Practical Examples Of High Voltage Or Deflection B+ Supply Regulators

Multi-frequency video display monitors use one of these methods or a combination of them to compensate the horizontal output stage(s) as operating frequencies or resolution modes change.

Inductor Value Switching – Inductor value switching is typically combined with capacitor switching in the horizontal output stage for mode or frequency changes. An example of an inductor or transformer value change in the horizontal output stage is shown in Fig. 4. B+ voltage is applied to the flyback either to pin 3 or pin 8 depending on the condition of the contacts of relay (RL458). If Q453 is switched on, the relay coil is energized and the B+ voltage is applied to pin 8 through the closed relay contacts. This reduces the number or flyback primary turns and the value of the primary winding inductance. The relay is energized in this monitor when switching from an operating mode for CGA at 15.7 kHz to EGA mode at 21.8 kHz.

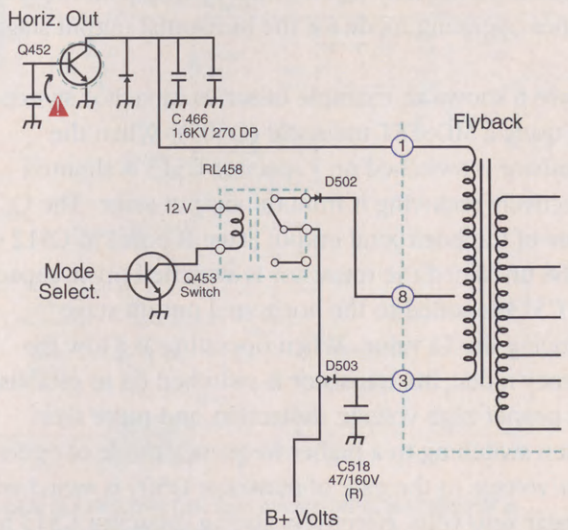


Fig. 4: Example of inductor switching in horizontal output stage for a frequency or mode change.

Capacitor Value Switching Example – Capacitor switching in the horizontal output stage is common among video display monitors designed to operate at several specific horizontal scan frequencies or modes. Figure 5 shows an example of a multi-mode monitor with capacitor switching. Capacitors are switched into the horizontal output stage by relay contacts of relay RL451 and RL452. These relay contacts are shown as switches in Fig. 5. The addition of capacitance values of parallel capacitors C466, C467, C464, and C465 determine the Ct value of the horizontal output stage.

When the monitor is operating at a CGA frequency or mode of 15.7 kHz, relay RL452 is energized and the contacts are closed, placing C465 into the circuit. Capacitor C465 has a relatively large value 7800 pF compared to the other capacitor values. The Ct value is increased, lowering the induced voltage pulse with the same applied B+ voltage to the output stage. The added Ct value also widens the time of the flyback voltage pulse to that required for proper retrace and blanking for CGA operation.

When the monitor increases in operating frequency to EGA, relay RL452 is switched open, removing capacitor C465 from the output stage. Relay RL451 is energized to switch C464 into the horizontal output stage. The capacitance value of C464 is 2700 pF, which decreases the total Ct value compared to CGA operation. This narrows the flyback pulse time and keeps the amplitude of the flyback pulse nearly the same as it was for CGA operation to maintain the needed high voltage and deflection. A narrow flyback pulse time is also needed for faster blanking or retrace during EGA operation. Capacitor C464 may be switched open, permitting yet a higher operating mode for the horizontal output stage.

Figure 6 shows an example of series capacitor switching using a MOSFET transistor (Q509). When the transistor is switched on, capacitor C513 is shunted effectively removing it from the output stage. The Ct value of the horizontal output stage is equal to C512 or .0068 uF. When the transistor is switched open, capacitor C513 is added to the horizontal output stage, reducing the Ct value. When operating at a low frequency mode, the transistor is switched on to establish the proper high voltage, deflection, and pulse time. When switching to a higher frequency mode of operation, voltage to the gate of transistor Q509 is switched to near zero volts, effectively adding capacitor C513 to the output stage.

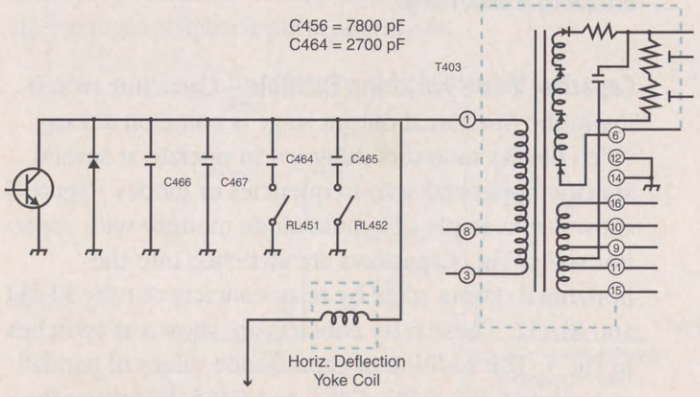


Fig. 5: Switching capacitors in parallel increase the C+ total value to reduce the flyback pulse amplitude at low frequency modes.

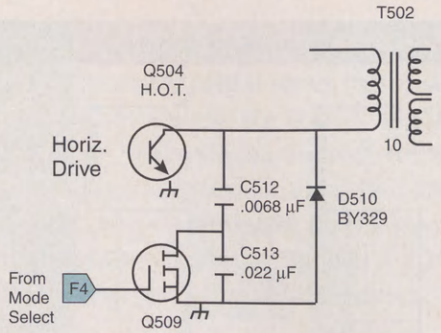


Fig. 6: Capacitor switching in series changes the timing of the output stage for proper high voltage and/or deflection at a different frequency.

H.V. Or Deflection B+ Regulator – Varying the B+ voltage to the horizontal output stage is a common method used by multi-frequency video monitors to maintain normal high voltage and/or deflection as horizontal frequencies or modes change. The B+ can be varied as needed with either a linear pass regulator or a switching type regulator. The regulator is placed in the monitor circuitry between the regulated B+ output of the monitor's main power supply and the B+ input to the flyback or coil of the horizontal output stage. The regulator is commonly called the high voltage or deflection regulator.

A linear regulator is shown in Fig. 7. The regulated 80 volts from the main power supply is applied to the input of IC501, the linear series pass regulator IC. The regulated output voltage from IC501 is applied to pin 3 of the flyback transformer through R510. IC501 is shunted by resistor R507 to produce some start voltage and current to the output stage and reduce the power dissipation of IC501 during normal operation.

Control, or the voltage output of the linear regulator IC501 is determined by the conduction of Q502. Voltage pulses induced into the flyback secondary winding at pin 15 are rectified and filtered into a DC voltage. The voltage provides feedback to the regulator as to the amount of magnetic energy (induced voltage) in the flyback and resulting high voltage. The voltage is divided down by resistors R511, VR501, and R512 and applied to the base of Q502. VR501 adjusts the conduction of Q502 and the output B+ voltage to flyback pin 3 to establish normal high voltage and deflection.

During normal operation, the B+ voltage is varied only slightly to regulate the high voltage and deflection. For example, CRT current from the flyback varies as scene brightness levels vary. When the operating frequency of the horizontal output stage changes, the high voltage

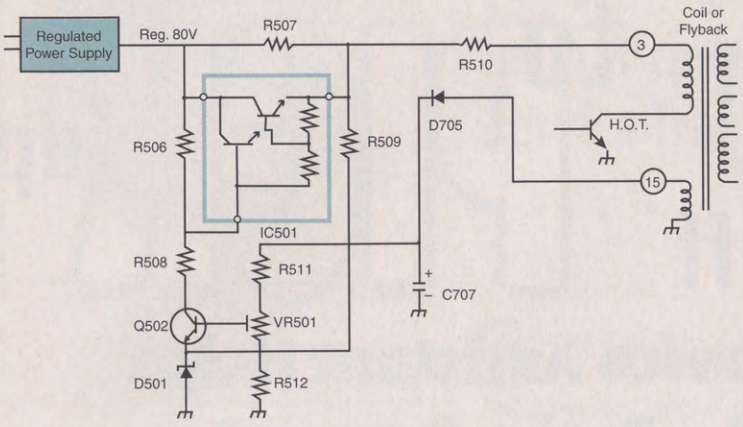


Fig. 7: Example of a linear high voltage/deflection B+ regulator in a multi-mode computer display monitor.

and/or deflection increases or decreases. The regulator automatically increases or decreases the B+ voltage to the output stage to keep the high voltage and/or deflection the same. For example, if the frequency of the horizontal output stage is increased, the input energy to the flyback decreases, lowering the high voltage and feedback voltage to Q502. Q502 conducts less, increasing the conduction of the transistors within IC501. The output B+ voltage increases until the feedback voltage returns to near normal returning the high voltage and/or deflection to near normal.

A linear B+ regulator has the disadvantage of added power dissipation, especially at low horizontal output stage frequency modes. A switching type regulator can provide a wider range of output B+ voltage with less power dissipation. The most common switching high voltage and/or deflection regulator is shown in Fig. 8. The switching regulator commonly uses a power MOSFET (Q5G6). This switching regulator is commonly called a "buck converter."

The switching MOSFET has the regulated output voltage from the monitor's main switch mode power supply input to the drain lead. The gate lead has an on/off drive signal applied to it. The drive signal originates from a separate output from the horizontal oscillator so it is locked to the horizontal frequency. The drive signal is varied in duty cycle (pulse width modulated) by the regulation control circuits, amplified, and coupled to the gate lead.

The DC output voltage from the regulator to the horizontal output stage is produced across C583. As Q5G6 is switched on by the gate drive signal, current flows from the B+ supply, producing current to the output stage and energy stored in L5G1 and L5G2's magnetic field. When the MOSFET switches open, current ceases and the magnetic fields of the coils collapse causing current to flow through D5G7 charging capacitor C583. A DC voltage is developed across C583 relative to the conduction time of Q5G6. The duty cycle of the gate drive to the MOSFET switching transistor determines the B+ voltage to the output stage and resulting high voltage.

The regulation control circuit shapes the horizontal signal into the proper duty cycle. The duty cycle of the gate drive is determined by the regulation control circuits with feedback voltage derived from the flyback transformer. Flyback voltage pulses are rectified and filtered into a DC feedback voltage. The feedback voltage is compared to a reference voltage with a comparator inside the regulation control circuits. The comparator alters the trigger level of a ramp generator which is also part of the regulation control circuits to develop a shorter or longer duty cycle for the drive signal.

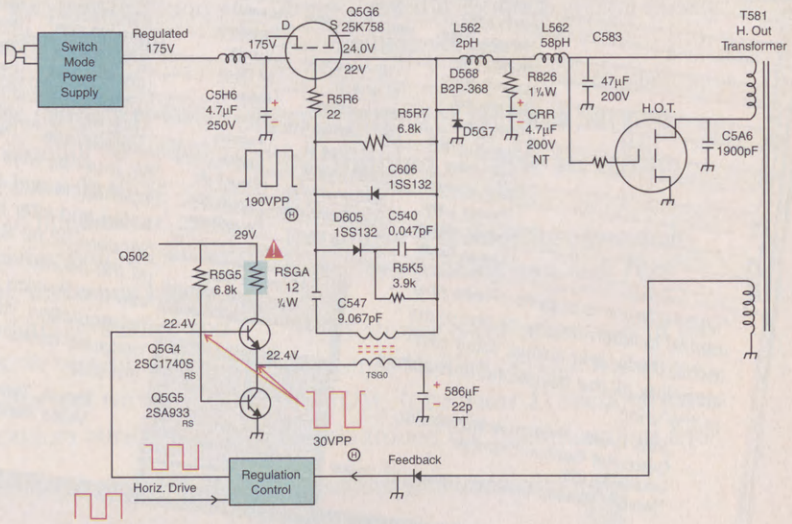


Fig. 8: Example of a switching type high voltage/deflection regulator in a multiscan computer display monitor.

The switching B+ regulator provides a tightly regulated high voltage to the CRT during CRT brightness changes. It further changes the B+ voltage as needed to keep the high voltage or deflection the same as different modes and horizontal operating frequencies are selected. As higher resolution, higher frequency modes are selected, the level of high voltage and/or deflection decreases. The regulation control circuit senses the drop in feedback voltage and increases the duty cycle and B+ voltage to the output stage. The increased B+ voltage returns the high voltage and/or deflection to their normal levels. SN

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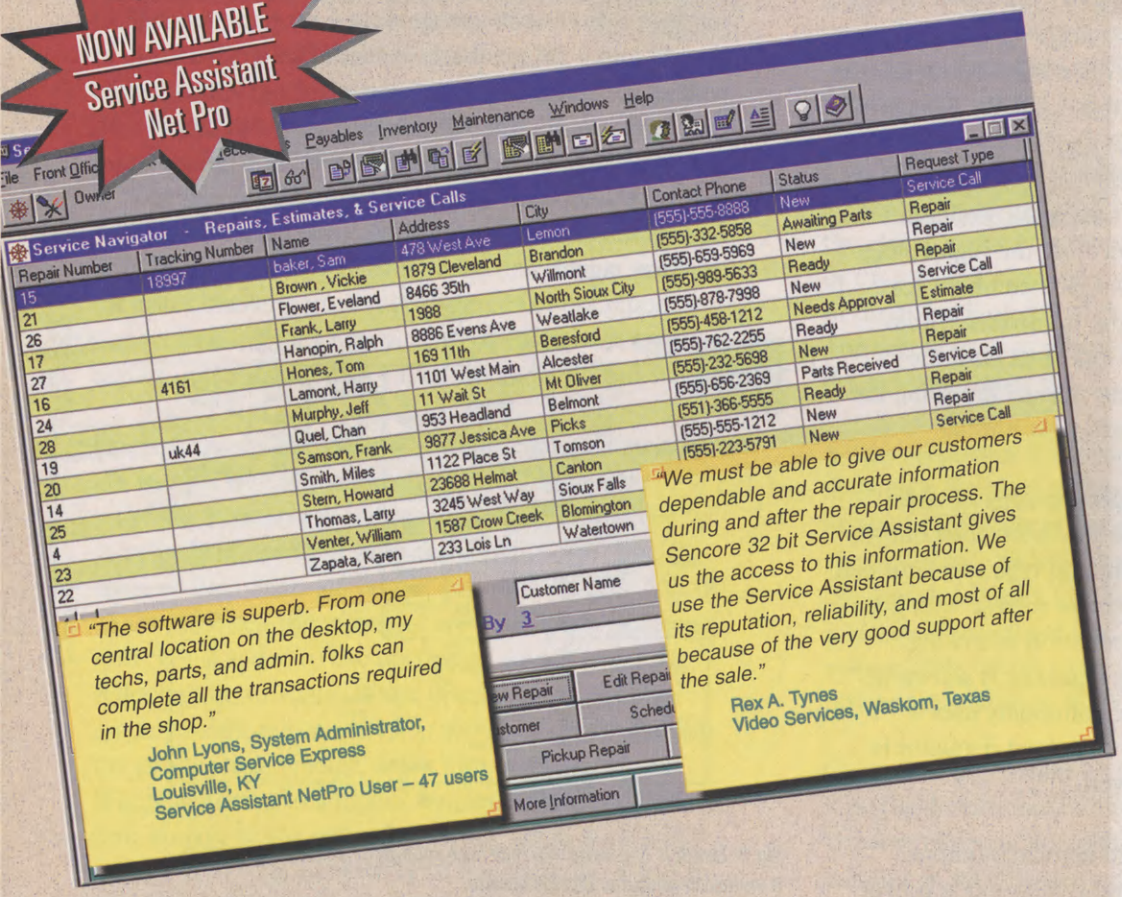

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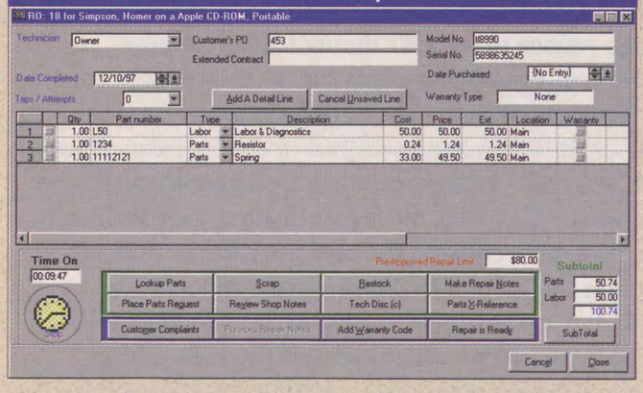

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Introducing The New Computer Monitor Service Training Course On CD-ROM

By Stan Warner
Application Engineer
Sencore Electronics

Computer monitor repair continues to be one of the best and most profitable business opportunities for service centers in the nineties. Computer monitors are used everywhere and they have the highest failure rate of all of the components in the computer system. And end-users, especially commercial accounts, are willing to pay what it takes to get their monitor back up and running - fast.

In the past 10 years, Sencore has been at the leading edge for providing innovative service solutions for monitor technicians with our Computer Monitor Analyzer test instrument line and our Computer Monitor Servicing book and hands-on class. In these years, we've talked to hundreds of monitor service technicians about their servicing challenges; we've purchased new monitors and dutifully studied and tested their circuits; we've visited service centers like yours; and we've repaired a lot of monitors ourselves.

Through advances in computer technology and the magic of computer based training, we are now able to provide our collective knowledge of computer monitor servicing through the new Computer Monitor Service Training CD-ROM. This course will help you and your technicians become more efficient and profitable at computer monitor repair. The Computer Monitor Service Training on CD-ROM gives you the information you need to service computer monitors faster - not the stuffy classroom theory you might never apply.

Computer Monitor Service Training - Course Structure

The course is divided into two main parts: Tech Training and Tech Tips.

Tech Training is the main body of the Computer Monitor Service Training CD-ROM. It contains 11 sections partitioned around the main functions and

Fig. 1: The Computer Monitor Service Training CD-ROM is divided into 11 main sections.

major circuits of a computer monitor. Each section delivers theory information, defect symptoms, practical troubleshooting guides and tips, plus alignment procedures. The material is geared specifically for monitor service technicians and can be immediately applied in the bench troubleshooting experience.

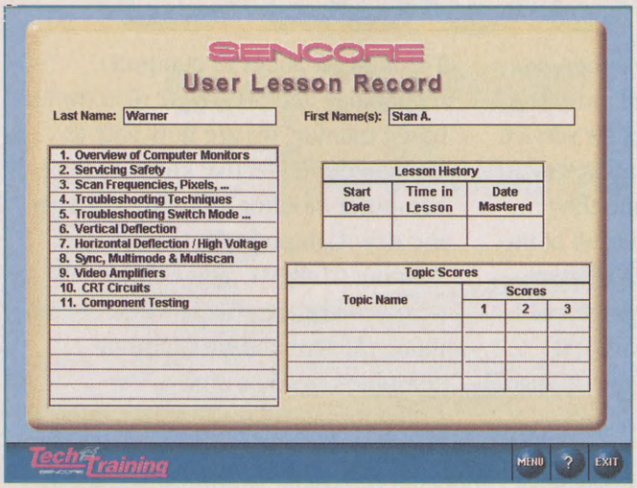

Fig. 2: The Computer Monitor Service Training CD-ROM tracks the learning progress of all the technicians in your service center.

After completion of the Tech Training portion of the CD-ROM, you can use the Tech Tip section as a bench reference tool. Tech Tips provide nuggets of general monitor information, testing and troubleshooting procedures, and alignment procedures that you can quickly access when you need them on the bench. The material in the course is presented using high-resolution digital photographs, video, audio, animated graphics, and live troubleshooting simulations. This keeps the learning experience interesting and holds the attention of you and your technicians. Throughout the course material are activities to complete that reinforce the study material.

Learning Is Tested And Progress Charted

Entering the Computer Monitor Service Training CD-ROM requires a log-on and a password. This lets you track the learning progress of all of the technicians in your service center.

At the end of each subsection, the Computer Monitor Service Training CD-ROM gives you and your technicians the opportunity to check your progress. If you are having problems with a particular topic, you can go back and review the pertinent material.

At the end of each section, there is a Lesson Test. The test checks your knowledge of all of the material presented in the section. If any questions in the Lesson Test are missed, the program highlights the subsection that contains the information you missed and provides the opportunity to go back and study the material.

A View Progress feature in the Computer Monitor Service Training CD-ROM lets each individual and service center management trainer track the learning progress through each of the computer monitor servicing sections. The amount of time each technician spends in a section is logged as well as section test scores. A technician can take a section test up to three times and all three scores are displayed to show learning progress and highlight areas that need training reinforcement.

Use The Computer Monitor Service Training CD-ROM With Other Sencore Computer Monitor Servicing Products

The Computer Monitor Service Training CD-ROM can be used in conjunction with other Sencore computer monitor products.

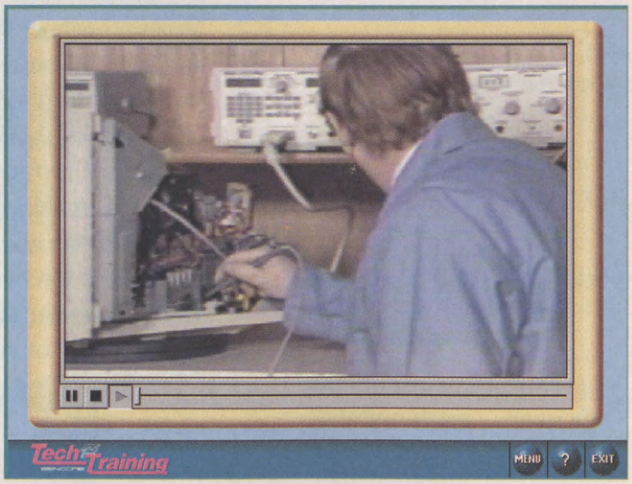

Fig. 3: Use the Computer Monitor Service Training CD-ROM to become more proficient on your CM2125 Computer Monitor Analyzer.

The Computer Monitor Service Training CD-ROM features the use of the Sencore CM2125 Computer Monitor Analyzer. If you've recently invested in a CM2125 or have new technicians starting on the CM2125, the Computer Monitor Service Training CD-ROM will help them become proficient on its use faster.

Note: *You are not required to own a CM2125 to benefit from the training CD-ROM.*

The Computer Monitor Service Training CD-ROM also acts as a support piece for the TC100T Hands-On

Benefits Of The Computer Monitor Service Training CD-ROM

- Teaches fast, efficient computer monitor troubleshooting
- Delivers practical troubleshooting knowledge you can immediately apply
- Brings new technicians up to speed on monitor repair quicker
- Increases the efficiency of experienced technicians
- Provides insightful reference information while you're on the bench
- Teaches the use of the CM2125 Computer Monitor Analyzer
- Section checks and tests track the learning progress of your technicians
- Interactive computer based training makes learning interesting and fun
- High resolution photos, live videos, audio, and animated graphics brings the monitor servicing expert to your service center

Computer Monitor Servicing Class held at Sencore. You and your technicians can attend the 4½ hands-on training class in Sioux Falls and then take the Computer Monitor Service Training CD-ROM back to your service center to use as a reference tool.

The Computer Monitor Service Training CD-ROM Teaches Service Theory And Practical Troubleshooting Procedures

Here are several samples from the Computer Monitor Service Training CD-ROM from ***Lesson 7: Horizontal Deflection/High Voltage***.

The first section delivers an operational overview of the horizontal output stage. Animated current flows and beam action make learning the operation of the horizontal circuit easy to understand. Troubleshooting notes are provided on the critical components in the horizontal circuit.

The next section shows typical horizontal output section defects. The monitor symptom is shown as well as the voltage waveform that you can expect to see produced from the defective circuit. Insights are provided on the critical components that generally cause the defective symptom.

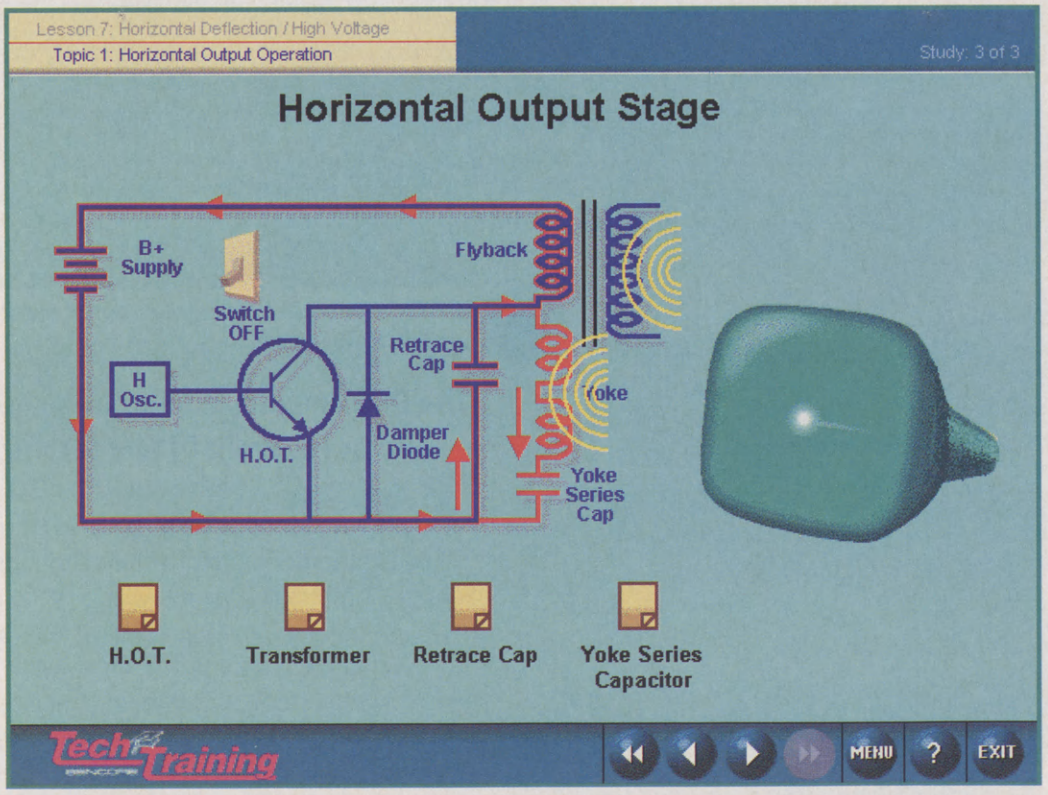

Fig. 4: Animated graphics make learning the operation of the horizontal output stage easy.

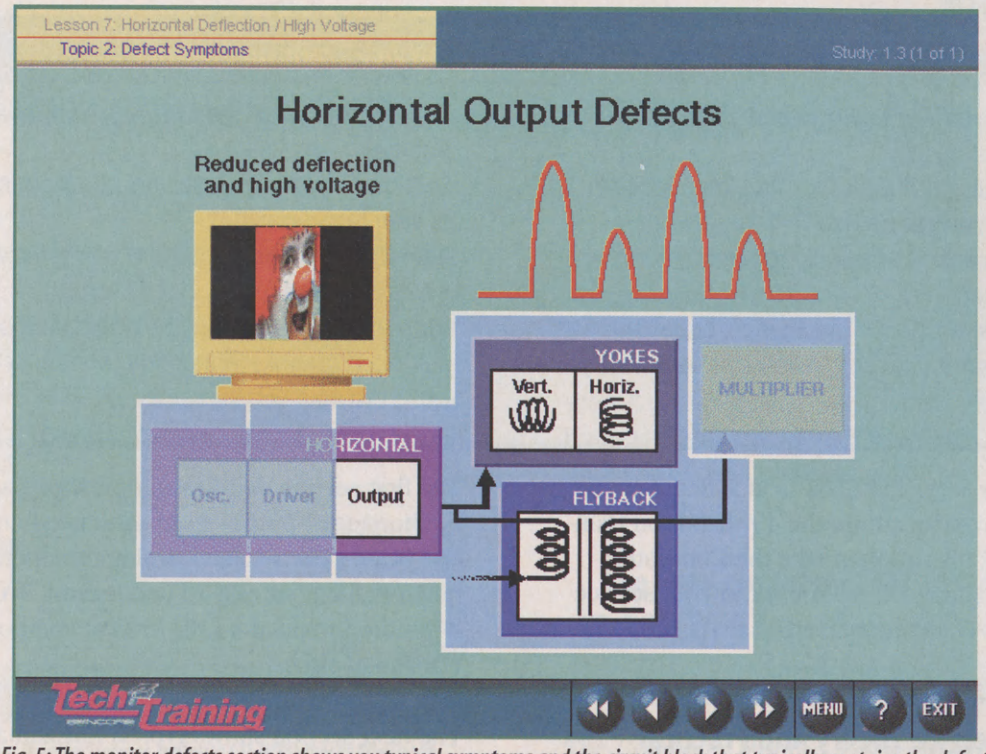

Fig. 5: The monitor defects section shows you typical symptoms and the circuit block that typically contains the defect.

The third section teaches troubleshooting and alignment procedures. Trouble trees are provided to teach a technician a systematic approach to monitor troubleshooting. Practical troubleshooting pointers are provided that you can immediately put to use. Critical test points are highlighted so you can move effectively from the training CD-ROM to defective monitors on the bench.

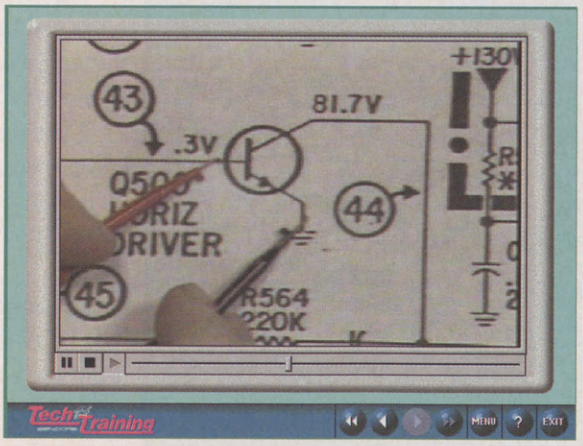

Fig. 6: The troubleshooting section provides information you can immediately put to use on the bench.

Each lesson contains a test to chart your progress. The questions are interactive and present live troubleshooting situations to make even test taking interesting and fun. If questions are missed, the program highlights the section where the questions were missed allowing you to go back to study the section.

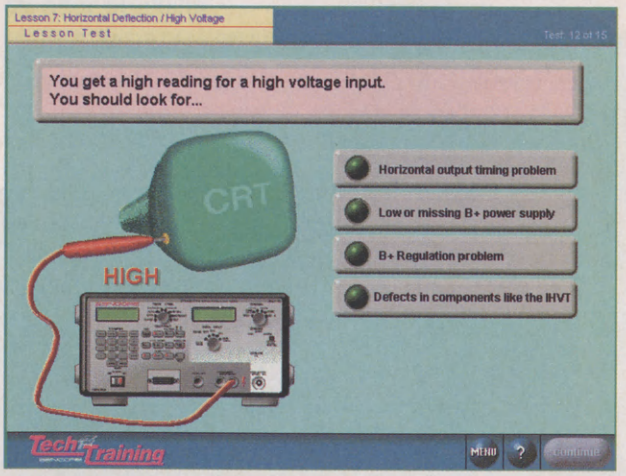

Fig. 7: The lesson tests are interactive and present questions on practical, live troubleshooting situations.

Use The Computer Monitor Training CD-ROM To Boost The Profit Of Your Service Center

The Computer Monitor Training CD-ROM teaches fast, efficient computer monitor troubleshooting and delivers practical troubleshooting knowledge you can immediately apply. It is a long-lasting service center asset that you can use to bring your new technicians up to speed faster on computer monitor repair and improve the efficiency of your experienced technicians. The Computer Monitor Training CD-ROM makes learning exciting. Call **1-800-736-2673** for more information. SN

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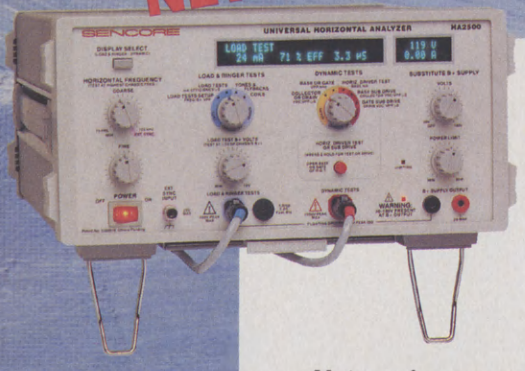

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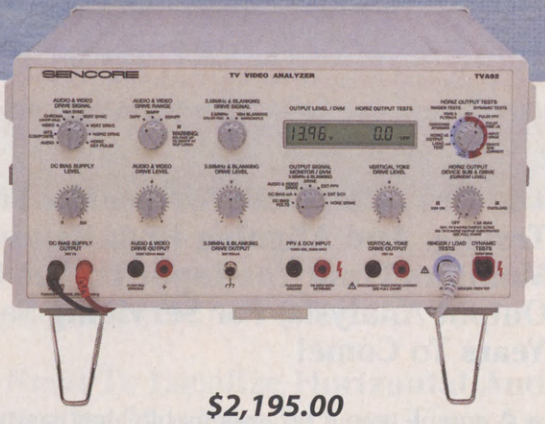
- Spare video output and exclusive interconnect design that permits future updates or expansion
- Portable and easy-to-use

TVA92 TV Video Analyzer*

Patented *On GSA Contract*



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Now You Can Isolate TV Defects, Troubleshoot Startup/Shutdown Problems, Test Expensive TV Components, Plus Accurately Estimate TV Repair Costs In Minutes!

- Exclusive "TV OFF" horizontal output load test
- Dynamic tests through a simple 3 lead hook-up to the horizontal output transistor
- Horizontal output transistor sub and drive
- Universal substitute TV signals
- Patented Ringer Test to quickly pinpoint shorted turns in flybacks, IHVTs, yokes, and switching transformers
- An exclusive yoke drive signal
- DC biasing supply
- Built-in monitor for all sub-signal results and making DCV and PPV measurements

* *The TVA92 is a companion unit to the VG91 Universal Video Generator*

VC93 All Format VCR Analyzer

Patented *On GSA Contract*

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Isolate Any Playback Or Record Problem In All VCRs, In Less Than Half The Time It Presently Takes... Now And In The Future, Or Your Money Back!

- All format VCR analyzer
- Dynamic head substituter for all formats
- Exclusive Hi-Fi Stereo all format head signal substituter
- Innovative VCR luminance, chroma, and audio analyzer
- Automatic servo analyzer (patented)
- Stand-alone analyzer or companion to the VG91 Universal Video Generator
- Complete all format troubleshooting tool includes:
  - Servo bias supply
  - Standard video & audio line outputs
  - Autoranging DCV/PPV meter
  - Output signal monitor

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CVA94 "Video Tracker"™ Camera Video Analyzer

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Quickly And Accurately Analyze Camera Video Signals With Time-Saving Digital Measurements, Waveform And Vector Displays, And Exclusive Special Tests Designed For Fast Camera Servicing And Alignment!

- Digital waveform measurements for fast signal troubleshooting
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All The Accurate Reference Signals You Need For Camera Servicing!

- An industry standard source of indoor light allowing you to properly service and align all cameras
- A manufacturer specified source for reliable test results with uniform, even illumination of all test patterns
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SC3100 "AUTO TRACKER"™ Automatic 100 MHz Waveform & Circuit Analyzer

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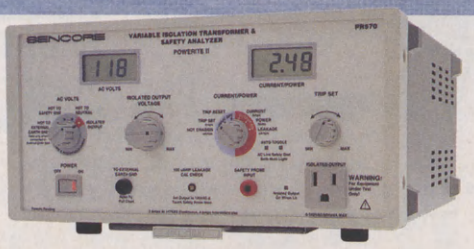
Now Touch And Test Any Circuit Test Point And Make Autoranged Error-Free Measurements In A Fraction Of The Time!

- A complete waveform and circuit analyzing system in one instrument
- Auto-Tracking™ digital readout of waveform voltage and frequency with one probe connection
- Integrated measurements of all circuit parameters provides fast troubleshooting answers
- Full performance, 100 MHz dual trace oscilloscope
- Exclusive autoranged timebase and vertical attenuators eliminate wasted time
- Digital delta measurements to analyze every portion of any waveform
- All functions microprocessor integrated for ease-of-use

PR570 "POWERITE II"™ Variable Isolation Transformer & Safety Analyzer

Patent Pending *On GSA Contract*



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Identify And Troubleshoot Virtually Any AC Supply Problem Fast... With The PR570 "POWERITE II"!™

- Insure your safety and the safety of your test instruments whenever servicing electronic products
- Conquer AC power source problems plus startup, shutdown, and regulator failures with a digitally accurate and variable 0-140 volt AC supply
- Have complete confidence your AC line is right with the AC line monitor
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- Watch voltage levels and current draw with simultaneous current and voltage displays
- Test AC outlets with an exclusive receptacle checker to ensure correct earth grounding for the highest level of safety
- Protect your customers from electrical shock and protect your business from lawsuit with an automatic, auto-toggling AC line and safety ground leakage test (leakage to 10 microamps)

New PR570 Safety Leakage Promotion Kit ... Call 1-800-SENCORE For Info!

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Easily Test And Restore CRTs With The Most Complete Tests Available For Added Profit And Security!

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- The easiest to use CRT tester on the market
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SG80 AM Stereo – FM Stereo Analyzer

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Pinpoint Any Receiver Problem From The Antenna To The Output With The Only Fully Integrated AM Stereo - FM Stereo Analyzer!

- Every signal you need to troubleshoot and performance test any AM Stereo or FM Stereo receiver
- Rock-solid digital tuning gives you fast, accurate, channel-by-channel control
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- Exclusive tunable IF sweep system allows you to dynamically analyze the latest FM IF stages
- Isolated audio drive signal lets you troubleshoot from the stereo decoder to the audio amplifier
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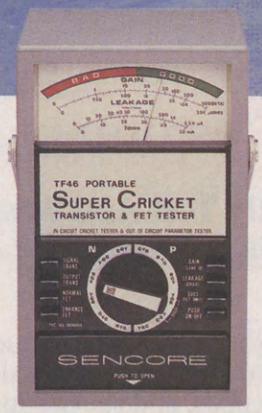

TF46 Portable Super Cricket™ Transistor/FET Tester

Patented *On GSA Contract* *NSN 6625-01-058-9564*

$495.00

Test Any Transistor Or FET With 99% Reliability In Less Than 15 Seconds – In Or Out Of Circuit!

- Patented in-circuit "go/no go" transistor/FET test
- Automatically identifies transistor leads
- Tests for all possible leakage paths
- Dynamic gain test for thorough analyzing
- Portable operation with auto shut-off to save your batteries
- Needs no set-up book or instructions

LC102 "AUTO-Z"™ Automatic Capacitor/Inductor Analyzer

Patented *On GSA Contract* *NSN 6625-01-278-3878*

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The Only Dynamic Capacitor/Inductor Analyzer Guaranteed To Help You Quickly Find Any Defective Capacitor Or Inductor That Other Testers Miss, Without Calculations, Look-Up Tables, Or Error!

- Analyzes capacitors for:
  - Value from 1 pF to 20 F
  - Leakage with up to 1 kV applied
  - Dielectric absorption
  - Equivalent series resistance (ESR)
- Analyzes inductors from 1 uH to 20 H for opens, shorts, value, and even one shorted turn
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- Makes all tests, compares results to EIA standards, and shows "GOOD" or "BAD" – automatically
- Portable; 9-hour battery operation for remote sites - AC operation for your bench

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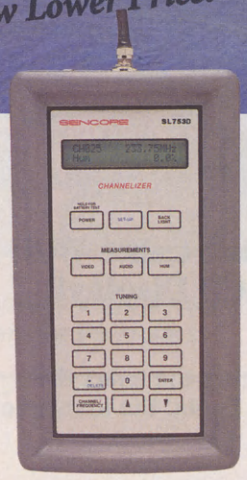

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SL753D Hand-Held "CHANNELIZER"™ Digital Signal Level Meter

A Rugged, Easy-To-Use, Hand-Held, Weatherproof, Signal Level Meter That Can Measure Analog And Digital Signals For Quick And Accurate Testing And Troubleshooting

- All channel/frequency tuning from 5 to 863 MHz including UHF and optional sub-band
- Auto attenuation across the entire -35 dBmV to +60 dBmV measurement range
- Easy-to-use, one button operation with a digital display of video, audio, and hum
- Pre-programmed with standard cable channels, IRC, HRC, VHF, and UHF
- Hand-held, rugged, and weather-proof design makes the unit ready for any environment
- Smart power - over six hours of continuous use on a single charge and fully rechargeable in less than three hours

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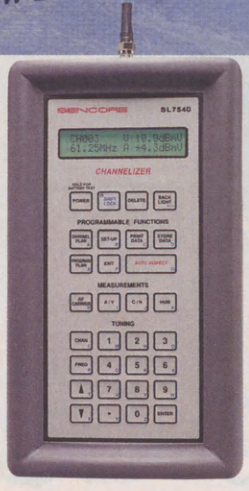

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SL754D Auto "CHANNELIZER"™ Digital Signal Level Meter

A Rugged, Hand-Held, Weatherproof Signal Level Meter That Measures Both Analog And Digital Signal Levels With One Button Data Collection For Superior Ease-Of-Use

- All channel/frequency tuning from 5 to 863 MHz (including sub-band and UHF)
- Auto attenuation across the entire -35 dBmV to +60 dBmV measuring range
- One touch Auto Inspection and data collection for quick and reliable system testing
- Easy-to-use, one button operation with a display of video, audio, A/V, C/N, pilot test, and hum
- Eight pre-programmed channel plans including IRC, HRC, VHF, UHF
- Portable, rugged, and weatherproof design that is ready for any environment
- Smart power - over six hours of continuous use on a single charge and is fully recharged in less than three hours
- Capable of measuring dBmV or uV/M

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CA780 "Cableizer"™ Metallic Cable Analyzer

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Quickly And Easily Locate Defects In All Metallic Cable With A Highly Sensitive Analyzer And Easy-To-Read LCD Display!

- Minimize downtime by accurately pinpointing cable faults or shorts
- Automatically determine the length of a buried cable or spools for accurate documentation and verification
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- Positively identify the exact distance to cable faults, the first time, every time
- Store all types of cable signatures for system documentation and future system troubleshooting reference
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SL750A "CHANNELIZER"™ TV-RF Signal Analyzer

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Pinpoint RF/Video Problems And Performance Test Any Headend, Trunk, Or Line Equipment In Any RF Distribution System More Accurately Than With Any Other Signal Level Meter On The Market...Guaranteed!

- On-channel and off-channel C/N measurements provide true picture quality measurements
- Sensitivity to -40 dB provides greater range for C/N and leakage measurements
- On-channel and off-channel Hum measurements provide true picture quality measurements and testing flexibility
- Multi-line LCD display provides more information with fewer keystrokes
- Standard 5 to 810 MHz tuning range including CATV/VHF/UHF/FM
- RF tracking generator tests passives and actives in the field
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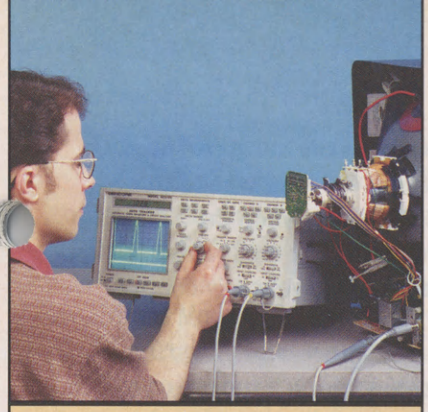
** Shown with optional VM4S ($900)*



By Application Engineering
Sencore Electronics

Learning To Use The SC3100 "AUTO TRACKER"™

The SC3100 "AUTO TRACKER" Is More Than Just A Scope

The SC3100 "AUTO TRACKER" has many powerful features to speed your waveform viewing and measuring. This article will help you get started using the SC3100 and its features.

To better understand the SC3100's features, let's review what is needed to fully analyze any waveform. Fig. 1 illustrates these waveform parameters:
1) waveshape, 2) average DC level,
3) peak-to-peak amplitude, 4) frequency,
5) average RMS (sine wave signals),
6) peak-to-peak of a waveform portion,
7) time of a waveform portion,
8) equivalent frequency of a waveform portion, and 9) instantaneous DC level at a given point on the waveform.

You can get an approximate measurement of these parameters using an oscilloscope's CRT, but this method is time consuming and inaccurate. The SC3100 Waveform & Circuit Analyzer, however, integrates the waveform viewing capabilities of a high performance oscilloscope with the speed and measurement accuracy of a digital meter. This saves you time and frustration on every measurement you make.

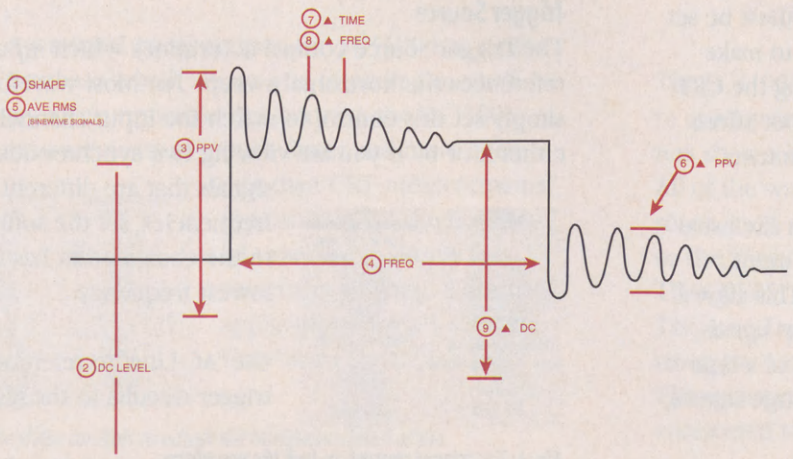


Fig. 1: Nine parameters are needed to completely analyze a waveform.

To make the SC3100 easier to understand, we've divided this article into two parts. Part 1 covers the oscilloscope section and Part 2 covers the digital analyzing features.

Part 1 - Oscilloscope Section

CH A&B

Press this button to view the signal on both channels simultaneously.

A+B ADD

A few special applications require that two signals be added or subtracted. Press the "A+B ADD" button to add the signals applied to the CH A and CH B inputs together into a single waveform. Pull the CH A VERTICAL POSITION control out to display the difference (A-B) of the signals.

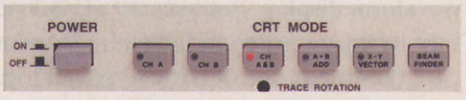


Fig. 2: Use the CRT Mode buttons to select the CRT display.

X-Y VECTOR

Press this button for an X-Y vector display. The signal applied to the CH A input produces vertical deflection, and the CH B signal produces horizontal deflection.

Applying Signals

Two, 10X Lo Capacity probes are supplied with your SC3100. The CRT and vertical circuits provide a proper amplitude CRT display when these 10X probes are used. You simply read the Volts/Div control directly when using the supplied 10X probes. The 10X probes allow you to view waveforms up to 2,000 volts.

Each probe has its own separate ground lead. Always connect each probe ground

to the circuit ground using the shortest ground lead possible to prevent ringing and noise pickup.

You can use the optional DP270 direct probe to take full advantage of the SC3100's 2mV/div vertical sensitivity. If you use a direct probe, you will need to divide the numbers on the Volts/Div control by ten to determine the actual waveform amplitude displayed by the CRT. The digital readings are automatically corrected, and are read direct.

Vertical Controls

The SC3100's vertical controls, shown in Fig. 3, are used to adjust the vertical (amplitude) characteristics of the displayed waveform. Two identical sets of controls are provided - one for the channel A input and one for channel B.

Input Coupling

This switch determines how the signal is coupled to the SC3100's vertical amplifiers. In the "DC" position, the DC component of the signal is applied to the vertical circuits and will deflect the CRT trace. In the "AC" position, the DC component is blocked from deflecting the CRT trace.

Volts/Div

The Volts/Div control determines the amplitude of the waveform display. Because the SC3100's digital measurements are faster and much more accurate than the CRT, the role of the SC3100's Volts/Div control is greatly diminished compared to conventional oscilloscopes. Set the Volts/Div control for the desired size of the waveform displayed on the CRT.

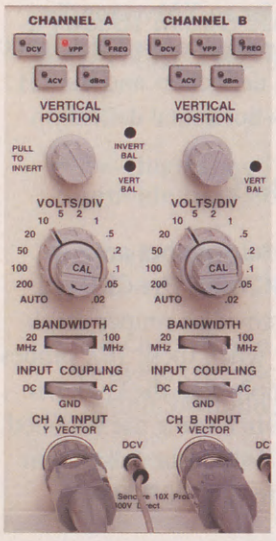


Fig. 3: Use these controls to adjust the vertical display.

The variable "cal" control (smaller inside knob) fine tunes the waveform's amplitude. This control must be set to the "Cal" detent to make measurements using the CRT display, but it will not affect the digital measurements.

The SC3100 has an exclusive 2 mV to 2000 volt input measuring range. This allows you to measure tiny signals, such as the output of a tape playback, or very large signals, such as the pulse at the collector of the horizontal output transistor. The input circuitry is protected against damage from voltages up to 2500 volts when the supplied 10X Lo Capacitance probes are used. This protection applies to all settings of the Volts/Div control.

Autoranging

An exclusive, timesaving feature of the SC3100 is its fully autoranged vertical attenuator. Simply set the Volts/Div control to "Auto," and the SC3100 automatically ranges to the Volts/Div range that produces a waveform display that is between 2 to 4 divisions high. (Signals larger than 800 VPP will be greater than 4 divisions).

The CRT will continue to autorange and follow the signal as you move between test points, or as the signal changes. Be sure to select "AC" coupling to prevent the DC component of the input signal from shifting the waveform off the CRT.

Bandwidth

The Bandwidth switch limits the frequency response of both the CRT and digital measuring circuits. Select "20 MHz" to reduce interference from high frequencies. This is especially important when using the lowest Volts/Div control (.02 & .05 & .1) settings. You will want to use the "100 MHz" position for most applications to take advantage of the full bandwidth.

Trigger Controls

The trigger controls, shown in Fig. 4, lock the horizontal sweep circuits to the incoming signal to provide a stable, "locked-in" waveform. If the trigger controls are set incorrectly, the waveform display will jitter and not stand still. Unlike many other oscilloscopes that have numerous trigger controls, the SC3100 requires only four trigger adjustments.

Trigger Source

The Trigger Source control determines which input references the horizontal sweep. For most waveforms, simply set this control to match the input channel, either A or B. If you are viewing two synchronous signals that are different frequencies, set the source to the channel that has the lowest frequency.

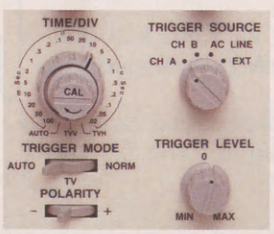


Fig. 4: The trigger controls to lock the waveform.

Use "AC Line" to reference the trigger circuits to the AC

power line when troubleshooting AC power supplies or isolating ripple. Use the "EXT" position to reference the trigger circuits to a signal applied to the EXT TRIG INPUT jack.

Trigger Mode

The Trigger Mode switch sets the trigger circuit operation to meet the requirements of the signal you are viewing. Use "Auto" to view most waveforms, except video or low repetition rate signals.

Use "TV" to view video waveforms. This mode enables a sync separator circuit which easily locks to composite video signals. The trigger circuits are automatically referenced to the vertical sync pulses when the TIME/DIV control is set to the "mSec" positions, and to the horizontal sync pulses when the TIME/DIV control is set to the "µSec" positions.

Use the "Norm" trigger mode to lock onto low repetition rate signals that are unstable when viewed in the "Auto" trigger mode.

Trigger Polarity

The Trigger Polarity switch determines whether the trigger circuits respond to the rising or falling edge of the reference signal. Except for composite video signals, most waveforms will lock in either the "+" or "-" polarity. Set the Trigger Polarity switch to match the polarity of the sync pulses when viewing video signals.

Trigger Level

The Trigger Level control determines the point on the waveform that triggers the trigger circuits. For most applications, set the Trigger Level control near the "0" reference mark. Adjust the level control if necessary for a stable waveform display.

Horizontal Timebase

Like conventional oscilloscopes, the SC3100 has a calibrated timebase which allows you to make time and frequency measurements. But, because the SC3100's digital measurements are much faster and more accurate than CRT measurements, the main use of the horizontal timebase is simply for waveform viewing. For most applications, simply set the Timebase (Time/Div) and vernier (Cal) controls for the desired amount of waveform detail. Pull the HORIZONTAL POSITION control outward to activate the 10X expand function to see more detail.

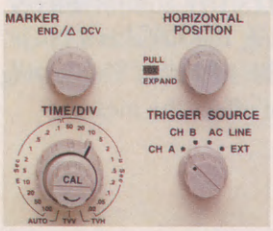


Fig. 5: Use these controls to adjust the horizontal detail of the displayed waveform.

Autorange

As with the vertical Volts/Div control, the horizontal timebase has an exclusive, timesaving autorange position. Set the timebase control to "Auto" to allow the "AUTO TRACKER"™ to automatically choose the necessary sweep speed to display 2 to 5 cycles of the waveform. (Frequencies higher than 25 MHz will result in a display of more than 5 cycles). Neither the 10X expand or the horizontal vernier are controlled by the autorange function. You can use these controls with "auto" to fine tune the waveform display.

In order for the timebase to autorange correctly, the waveform must be properly locked with the Trigger circuits. For most waveforms, set the LEVEL to "0" and set the SOURCE to match the input. The timebase will not autorange when the TRIGGER MODE switch is set to "TV". Instead, use the video presets to automatically view a video waveform.

Video Presets

The TVV and TVH positions of the timebase control are called the video presets. These presets provide a quick way to view video waveforms because they automatically set the sweep speed and trigger circuits to view a composite video signal. "TVV" displays two vertical fields (1 frame) of the video signal, while the "TVH" position will display 2 lines.

You do not need to select "TV trigger" when using the TVV or TVH presets. However, you must set the TRIGGER "Polarity" control to match the sync polarity of the video signal.

Part 2 - Digital Analyzing Functions

The SC3100's digital measurement functions allow you to quickly and accurately measure the waveform parameters shown in Fig. 1 without counting CRT graticules. All of the waveform parameters, except for the waveshape itself, are measured with either the Auto-Tracking or the Delta digital functions. Additionally, the AUTO TRACKER™ provides several circuit parameter tests. The Auto-Tracking and Delta measurements are made using the same probe that applies signals to the CRT. The parameter tests are made using the DVM probes connected to the OHMS/DC AMP INPUT jacks.

Auto-Tracking Measurements

The Auto-Tracking tests, shown in Fig. 6, measure the entire waveform. Unlike other digital readout oscilloscopes, the SC3100 readings are independent of the CRT circuits and are accurate for all CRT settings.

Auto-Tracking DC Volts

Simply press the "DCV" button for the corresponding channel and read the DC level of the signal. You will obtain the correct DC measurement no matter where the INPUT COUPLING or VOLT/DIV controls are set.

This DCV function measures average DC voltage which is the value that is indicated on schematics and measured by a DVM. If you need to measure the absolute or DC level at a single point on the waveform, such as to determine a logic level, you will need to use the Delta DC function.

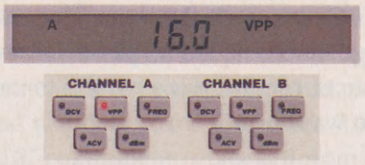


Fig. 6: The digital Auto-Tracking tests measure the entire waveform.

Auto-Tracking Volts Peak-to-Peak

Press the corresponding "VPP" button to measure the peak-to-peak amplitude of the signal. The VPP function is semi-autoranged and the VOLTS/DIV control selects each of the four digital VPP ranges. If the digital reading shows flashing "8888", turn the VOLTS/DIV control counter-clockwise; if the digital readout shows very little resolution, turn the control clockwise. If you place the VOLTS/DIV control in the "Auto" position, both the CRT display and digital reading will fully autorange.

Auto-Tracking Frequency

Pressing the corresponding "Freq" button displays the frequency of the applied signal. The frequency function is fully autoranged for all settings of the TIME/DIV control.

Auto-Tracking ACV

The ACV function measures the true RMS value of sine wave signals. This reading compares directly to values listed in service literature and to true RMS reading DVMs.

Auto-Tracking dBm

Audio service literature often lists the signal levels in dBm. The SC3100's dBm function provides the industry standard signal measurement of 0 dBm = 1 milliwatt into 75 ohms (.7746 volts RMS).

Delta Measurements

The Delta tests, shown in Fig. 7, allow you to measure just selected portions of the waveform. Although you manually set the area to be measured, the Delta Measurements provide a much more accurate measurement than can be made by counting graticules on the CRT for two reasons. First, each measurement is made using the same high accuracy circuits that are used for the Auto-Tracking digital measurements, rather than the less accurate CRT circuits. Secondly, the Delta Bar, which is used to highlight the measured waveform portion, is part of the CRT trace which virtually eliminates parallax and interpretation errors.

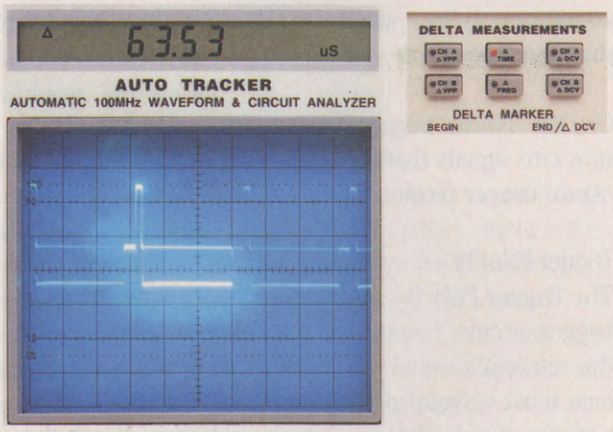


Fig. 7: The Delta functions allow you to measure a selected portion of the waveform.

Delta Bar

Each of the Delta measurements uses a highlighted portion of the trace to indicate the portion that is being measured. This highlighted area is called the Delta Bar. The area selected by the intensified Delta Bar is adjusted using the DELTA MARKER "Begin" and "End" controls. (The Delta DCV functions use a bright dot on the trace which is only adjusted with the "End/Delta DC" control). The Delta Bar appears on both traces.

Delta Volts Peak-to-Peak

Press either of the Delta "VPP" buttons to measure the amplitude of the intensified portion of the corresponding trace. The setting of the VOLTS/DIV control selects the range of the Delta VPP reading, the same as it does for the Auto-Tracking peak-to-peak function. The setting of the vernier, however, does not affect the measurement resolution or accuracy.

Delta Time

The Delta time function allows you to measure any waveform time relationship. This includes pulse width,

and rise and fall times on individual signals, and time delay or phase between two signals. The Delta Time measurement is not affected by the setting of the 10X expand or the horizontal vernier control.

Delta Frequency

The Delta Frequency function converts the Delta Time reading to the approximate frequency. The main application of this function is to determine the frequency of a signal that is part of another signal. The Delta Frequency measurement is less accurate than the Auto-Tracking measurement because it relies on how closely you estimate the beginning and ending point of one cycle. However, the Delta Frequency measurement is far more accurate than a measurement using the CRT.

Delta DCV

The Delta DC volts function allows you to measure the absolute or instantaneous voltage at any point on a waveform. This instantaneous voltage is the voltage level that the circuit responds to, such as a logic "high" or "low". Use the DELTA MARKER "End/delta DCV" control to set the location of the highlighted marker on the waveform.

Circuit Parameter Tests

The SC3100 Automatic Waveform & Circuit Analyzer allows you to completely analyze a circuit. The parameter tests include an ohmmeter, continuity tester, and a DC current meter. These tests are completely separate from the CRT, and the Auto-Tracking and Delta digital tests.

Summary

The SC3100 "Auto Tracker" is an easy-to use, high performance oscilloscope. Its Autotracking digital functions provide fast, error-free digital measurements of all waveform parameters, and its parameter tests make it a complete circuit analyzer.

For further information on any of the SC3100's operation or features, call your Area Sales Engineer at **1-800-SENCORE**. We'll help you get started with the only waveform analyzer in the industry. SN

Introducing The CM2250-PC Computer Monitor Analyzer...

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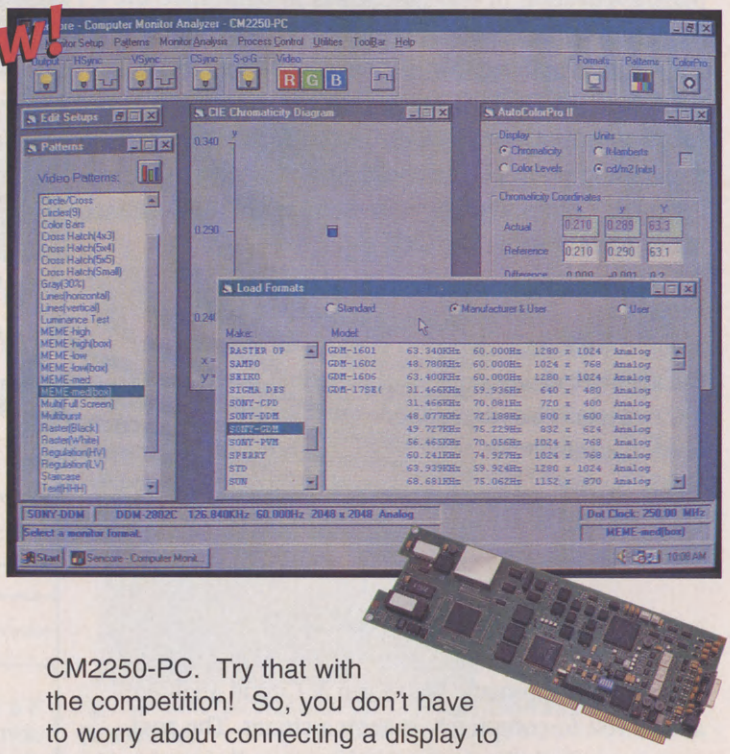

The all new CM2250-PC plug-in module for your personal computer is a fully programmable RGB video generator, offering NTSC, PAL, Analog, TTL, and ECL video outputs. The Windows Graphical User Interface is innovative, and easy to use, placing all the built-in features just a mouse click away. Take a look at the exclusive features offered by the new CM2250-PC.

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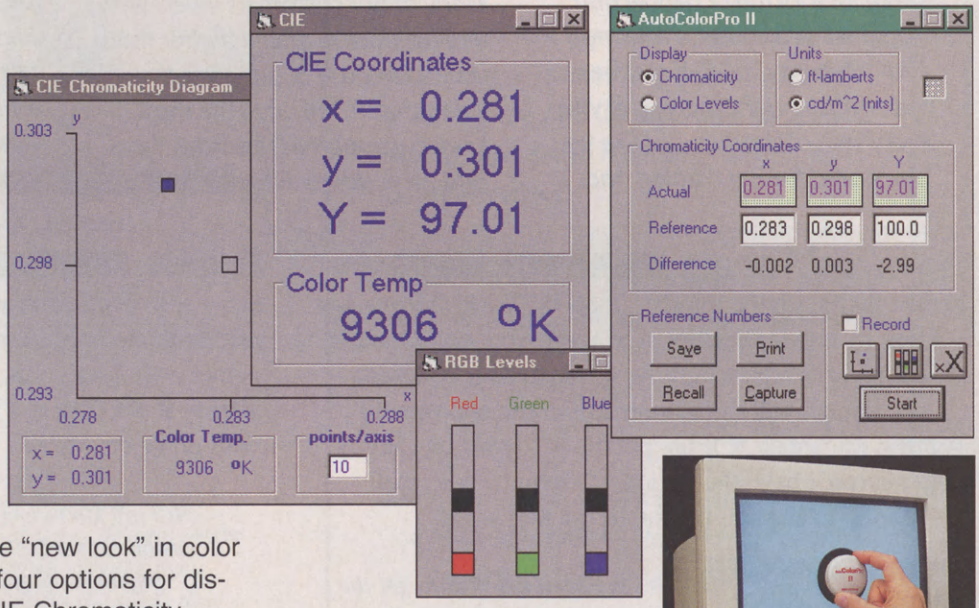

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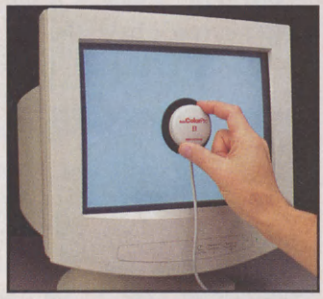
Industry standard measurement units and display modes. The CP288 displays readings in Yxy, RGB, and color temperature in degrees Kelvin. Luminance units are selectable between foot-lamberts and cd/m2 (nits). These are the most commonly used units in the industry, in fact, all manufacturers spec their displays this way.

Programmable reference data. The CP288 comes with the 9300 Kelvin reference built-in. References may be entered and stored by the user, and is limited only by the amount of memory available on the host system.



Accuracy that an engineer would require. The CP288 has the specs necessary to do a complete white-balance alignment, so you can be sure you match display manufacturer specifications. The CP288's calibration is traceable to N.I.S.T. standards.

Tracking data is made easy with the CP288. You can record a series of measurements over a period of time, and then print the document to attach to the monitor for tracking purposes. The printed form will contain the manufacturer's name, model number, serial number, and measured data.

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Teresa East
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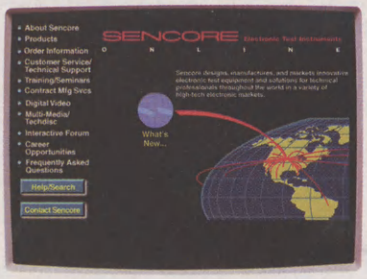

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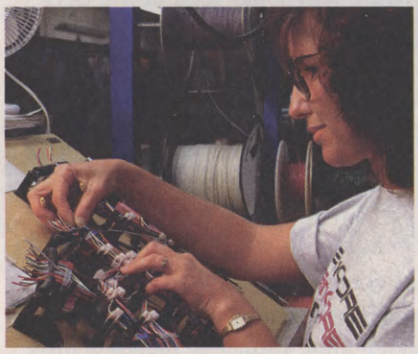

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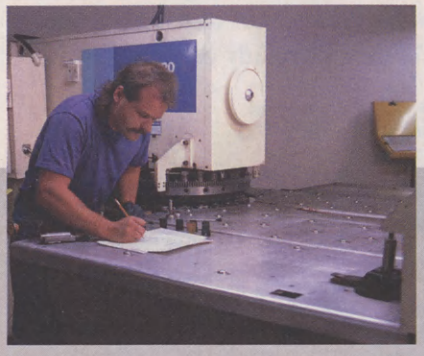

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By Randy Fromm
Technical Writer
Play Meter Magazine

From "Play Meter" Magazine - August 1997

Sencore Blows Away CRT Failures With The CR7000 "BEAM-RITE" And How CRTs Fail

A Play Meter Monthly Exclusive!

I got the call again today. It comes about once a week now. It goes something like this:

"I can't adjust the color on this monitor. It looks real dim. If I try to turn up the pots on the neck board, the picture just smears to the right. If I try to turn up the brightness on the remote adjustments board, the picture smears to the right. If I try to turn up the contrast, the picture smears to the right. I have the screen pot turned up as high as it can go without seeing raster and vertical retrace lines washing over the whole screen."

Then, as if a sudden revelation has come over the call, he perks up and queries "Hey! Could it be a bad picture tube?"

The answer, of course, is yes. To verify, I ask the age of the CRT. After three or more years in operation, many CRTs begin to fail. With so many CRTs in the world today, the ability to test and repair (yes, repair!) CRTs can be pretty darned handy. Testing and repairing CRTs will save you time and money.

But how can you fix a bad picture tube and what the heck fails, anyway? Those are good questions! As video games get converted and reconverted, the monitors can easily log tens of thousands of hours of operation. As a result, picture tube or CRT (cathode ray tube) failure has become increasingly more common.

Anyway, the answer to the question is yes. Sometimes, kinda sorta. Maybe. But before we get into repairing picture tubes, let's take a look at some different types of picture tube failures. More specifically, we're going to look at the electron gun assembly that's located in the neck of the picture tube.

Each of the three electron guns in the electron gun assembly uses a heated cathode as a source of electrons. The heater is the element that you see glowing when you look at the neck of a picture tube. The heater must fit closely inside the metal cathode, but it must not touch it. If the heater shorts to the cathode, the gun will be stuck ON and the screen will appear a super bright color (red, green, or blue - depending on which of the three guns is affected) with vertical retrace lines visible throughout the screen. Vertical retrace lines appear as diagonal lines that run from lower left to upper right across the screen.

If you believe you might have a heater-to-cathode short, try unsoldering and removing the associated video output transistor from the neck board of the monitor. Fire up the monitor with the transistor removed. If you still have a brightly colored screen

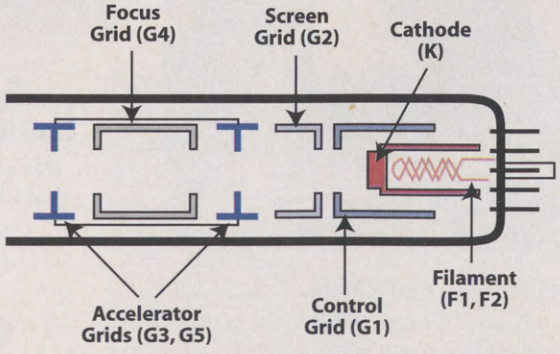

Fig. 1: The electron gun is the source of most CRT failures.

with vertical retrace lines, there's a good chance the CRT has a heater-to-cathode short.

You should be able to verify this with an ohmmeter. With the neck board removed from the CRT, you should have an infinite resistance between heater to cathode of the picture tube.

Although there are many different types of CRTs, you will often find the red cathode at pin 8, the green cathode at pin 6, and the blue cathode at pin 11. Pins 9 and 10 for the heater.

It is also possible that one of the cathodes might become shorted to the control grid. This can cause a similar symptom as a heater-to-cathode short. If the cathode is shorted to the control grid, you should be able to verify it with your meter. The control grid will often be found at pin 5.

If the cathode has become damaged due to a buildup of oxides and other crud, you will experience a loss of one color (partial or total). Try grounding the collector of the associated video output transistor. If the color comes on clear and bright (a brightly colored screen with vertical retrace lines), the CRT is OK. If the color does not come on or it is not as bright as the other two colors, the picture tube is bad.

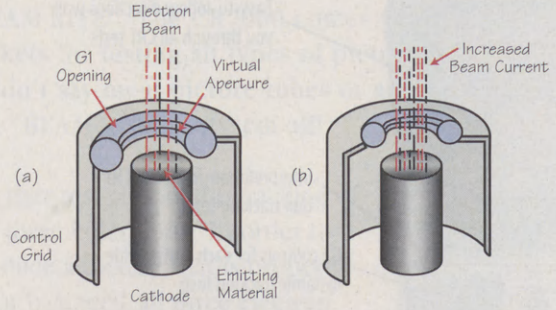

Fig. 2: Only a small portion of the cathode emits electrons when high G1 bias closes the virtual aperture (a). Reducing the bias results in more beam current because more of the cathode's surface emits electrons (b).

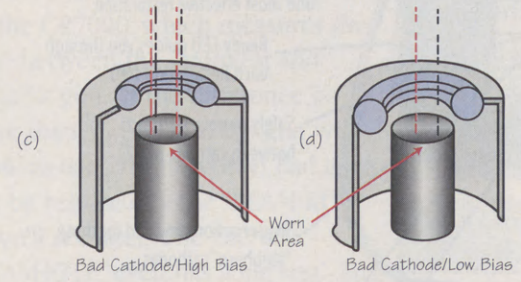

Fig 2: (continued) A CRT with a worn cathode center area (c) still produces good light output at low bias, but cuts off far too soon at higher biases (d).

Another type of electron gun failure is a short between the control grid and the screen grid. This will cause an extremely dark picture (even with the screen control at maximum) or no picture at all. Measure the voltage at the screen grid (often pin 7) of the CRT. You should be able to run it through a range of 250 to 750 volts DC using the screen potentiometer. If the voltage is not high enough, pull the neck board off the CRT and measure the voltage at the CRT socket again. If the voltage is now normal, you probably have a short between the control grid and the screen grid. Use your ohmmeter to verify.

Fixing Bad Tubes

Is it really possible to fix a bad CRT? I have had a fair bit of success using some simple techniques. Shorted electron guns are often caused by small flakes of cathode material that have sloughed off and found their way into the electron gun. This type of failure is common in games with face-up mounted monitors (table games, gun games that use mirrors, etc.) because any crud in the CRT will naturally fall right into the electron gun. By turning the picture tube face down and tapping lightly and repeatedly on the neck with the plastic handle of a screwdriver, the flakes can sometimes be dislodged.

Do not hit the convergence ring assembly and for goodness sake don't hit the glass neck hard enough to break it! Naturally if you manage to shake the shorting particle out of the neck of the CRT, you do not want to use this picture tube for a table game again, EVER!

There is another trick that you can use to save a shorted CRT. Commercial CRT service equipment uses a technique known as "rejuvenation" to remove shorts from electron guns. The rejuvenating circuit uses a capacitive discharge to blow away any little shorting particle. We'll look at the CRT rejuvenator later, but here's a cheap and dirty way to repair some shorted CRTs using just a clip lead or small piece of wire.

Cathode-to-grid shorts and grid-to-grid shorts can often be removed with this technique. Heater-to-cathode shorts are another story as the thin filament of the heater can blow out before the short circuit does. I have had about 25 percent success removing heater-to-cathode shorts this way.

The Right Way To Test And Restore CRTs

Now, let's look at the correct way to test and restore CRTs using a remarkable piece of test equipment, the CR7000 "BEAM-RITE" CRT Analyzer & Restorer. Before I begin to describe what the "BEAM-RITE" does and how it works, let me say that I have repaired and restored dozens of bad video game picture tubes using the predecessor to the CR7000, the CR70 "BEAM BUILDER". I have taken old CRTs that were dim and virtually

CAUTION: The procedures described herein involve potentially lethal voltages and must be performed by qualified personnel or at the very least by a mechanic with a decent sense of self-preservation.

1. Remove the video output transistor associated with the bad color. If in doubt, remove all three video output transistors. I usually remove all three just to be sure.

2. Locate the screen voltage pin of the CRT socket (often pin 7, but check the schematic to be sure.) This pin is often labeled G2.

3. With the neck board installed on the CRT (without the video output transistors installed), turn on the monitor and adjust the screen potentiometer fully clockwise in order to obtain maximum screen voltage.

4. Touch one end of a wire or clip lead to the screen voltage pin of the CRT socket.

5. Momentarily touch the other end of the wire to the shorted cathode pin (red, green, or blue) of the picture tube. With luck, you will see a small blue arc in the neck of the CRT as the short is blown away.

6. Use your digital multimeter to verify that the short is gone. You should now read an infinite resistance. If not, repeat steps 1 through 6.

Fig. 3: Features of the Sencore CR7000 "BEAM-RITE" CRT Analyzer & Restorer.

unusable and turned them into beautiful, bright displays that look as good as the day they were manufactured. In the process, I have saved operators and arcade school students hundreds of dollars in CRT replacement costs. I saved $400 just by restoring one high resolution CRT!

What Is It?

First of all, Sencore's CR7000 "BEAM-RITE" will test all types of picture tubes. Individual tests are made for short circuits in each of the three electron guns. Tests are made for heater-to-cathode (H-K) shorts and cathode-to-grid (G1) shorts as well. The electron guns are also tested for proper cutoff (the level at which the gun stops emitting electrons, producing black on the screen) and emission (sufficient beam current to produce a bright color on the screen).

Each of the tests closely duplicates the normal operation of the CRT, so you're testing it under typical operating conditions. By the way, you do not need the entire monitor in order to test the picture tube. The CR7000 will test any CRT as a stand-alone unit. Naturally, you do not need to remove the picture tube from the monitor to test it. You simply remove the CRT socket (the neck board) from the monitor in order to connect the picture tube to the "BEAM-RITE". The CR7000 comes with adapter sockets for testing all types of picture tubes. Notice I didn't say most picture tubes or all popular tubes. The "BEAM-RITE" tests 'em all!

Another test checks the tracking of the three color guns. In order to produce a picture that is properly color balanced, all three electron guns have to be alike. The emission guns have to be alike. The emission levels of all three guns are compared by the CR7000, which measures the ratio between the strongest and weakest gun. If the difference is more than 55 percent, the gun will show as bad. Don't worry! Bad guns can be restored by the "BEAM-RITE" as we'll see later. The CR7000 "BEAM-RITE" even has a life test. The life test will tell you how much usable life you can expect from your picture tube.

Removing Shorts

Heater-to-cathode shorts are caused by contact between the CRT heater and the cathode. The CR7000 is not designed to correct this fault as the surge current provided by the "BEAM-RITE" will often blow out the filament completely.

Control grid (G1) shorts are often caused by flakes of material that have become lodged between the cathode and the control grid. A G1 short can cause loss of control of the CRT beam, resulting in a bright screen with visible retrace lines.

G1 shorts also result in CRTs that cannot be controlled by the brightness control or the incoming video or blanking signals. The CR7000 REMOVE G1 SHORT function will vaporize most shorting particles, resulting in normal CRT operation.

Cutoff Related Failures

In order to understand the cutoff test, let's take a closer look at the way the cathode works. The cathode is the source of the electron beam. It is coated with a material (such as barium or thorium) which gives off large numbers of electrons when it is heated by a filament. Believe it or not, there is a finite amount of this electron emitting material and it gets used up or stripped after years of extended use. Once the barium is used up, the picture tube cannot be completely restored.

Test Result	Restore Function
G1 Short	Remove G1 Short
H-K Short	Do not attempt to remove
Bad Cutoff	Re-Activate, step to next level as needed
Bad Lo Tracking (all guns adjust to Cutoff)	Re-Activate gun with highest Cutoff Level control setting
Bad Emission (Good or Bad Hi Tracking)	Re-Activate, step to next level as needed
Good Emission all guns; Bad Hi Tracking	Re-Activate gun with lowest emission
Bad Emission Life (Emission drops to Bad)	Re-Activate
No current in any Restore function	REJUV

Fig. 4: This chart shows the recommended restore functions to use for each CR7000 "BEAM-RITE" test result.

The hot cathode emits electrons, which form a cloud around the cathode until they're attracted toward the front of the screen by a positive voltage on the screen grid of the electron gun assembly. Between the cathode and the screen grid lies the control grid. In most video game monitors, the control grid is grounded, giving the control grid a negative bias with respect to the cathode. The video signal modulates (changes) the voltage of the cathode. It is the voltage difference between the cathode and the control grid that controls the beam current and the brightness of the color.

The entire surface of the cathode is not always used to supply the electrons that make up the electron beam. When the electron gun is only partially turned on, just the center part of the cathode is used. This means that the emitting material at the center of the cathode is used up faster than the material at the edges. The outer areas only supply electrons during peak brightness periods. When the center part becomes worn, the CRT screen still lights brightly during peak brightness, but the beam cuts off too soon because the brightness drops and the worn-out center of the cathode is the only part being used. This results in a picture that's a combination of overdriven, smearing color and black, with no intermediate shades of color. Many technicians call this a gassy tube. Actually, the tube is exhibiting poor gamma; the ability to correctly reproduce shades of gray or color.

The CR7000 tests for proper cutoff. The cutoff test, combined with the emission test that follows, indicate the next steps to be taken in the restoration process.

Emission Test

The emission test indicates if the edges of the cathode are poisoned. Poisoning occurs when positive ions coat the emitting material on the cathode. The ions are a result of a minute amount of air that's left inside the CRT during manufacturing. These ions react with the hot cathode surface over a period of time and reduce (in some cases completely shut off) the number of electrons emitted by the CRT. Cathode poisoning is similar to rust on a piece of steel.

If the tube fails both the emission test and cutoff test, the entire surface is poisoned or stripped of emitting material. An emission life test reduces the filament voltage to detect cathodes that are overly temperature dependent, indicating short life expectancy.

CRT Rejuvenation And Restoration

The CR7000 uses a number of different methods to fix picture tubes. The method used varies from tube to tube, depending on the nature of the CRT failure. The "BEAM-RITE" uses a progressive restoration technique that allows you to carry out CRT restoration one step at a time, using just the right combination of voltage, current, and heater voltage to get the job done while avoiding the tendency to overdo it that many technicians have when restoring a CRT. The process of restoring a CRT is often referred to as shooting the tube.

After removing any shorts and testing each gun for cutoff and emission, you're ready to try restoring any weak

FUNCTION	FILAMENT VOLTAGE	CURRENT LIMIT	TIME DURATION
Re-activate	50% boost	1 mA	30 sec.
Low	normal	40 mA	2 sec.
Normal	normal	80 mA	2 cycles (3 sec. on/3 sec. off)
High	50% boost	100 mA	3 cycles (4 sec. on/2 sec. off)
Extended	50% boost	100 mA	15 sec.
Remove G1 Short	removed	self-limited surge	20 sec. cool down before active; self-limiting

Fig. 5: This chart shows the level for each CR7000 "BEAM-RITE" restoration function.

Introducing A New Way To Test & Restore CRTs!

Easily Test And Restore CRTs With The Most Complete Tests Available For Added Profit And Security!

New! CR7000 "BEAM-RITE"™
CRT Analyzer & Restorer

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- The easiest to use CRT tester on the market
- The most accurate and thorough tests of any CRT tester
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- Newly designed sockets allow easy connection to hard-to-reach CRTs

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guns. The CR7000 does this by boosting the CRT heater voltage. This makes the cathode super hot. Then, a 40 to 100 milliamp current is passed through the cathode. The combination of high temperature and high cathode current removes the cathode poisoning, exposing fresh cathode material.

Restoration

The CR7000 "BEAM-RITE" offers four automatic CRT restore functions to return near-normal performance to the CRT cathode. The four functions are progressive levels of current and current durations including Low, Normal, High and Extended. Progressive restoration allows you to use only what the gun needs to restore its operation.

The CR7000 Re-activate function safely activates the existing cathode emitting material with little or no threat to the CRT gun. Re-activation also works well on some CRT guns that have aged causing minor cathode contamination or poisoning. You can use the Re-activate function repeatedly with little threat of damaging the CRT cathode.

The Low Restore function uses a brief two second current, limited to 40 mA, to heal the contaminated cathode surface. The Low Restore function uses a much lower current and shorter current duration than offered by any other CRT tester. On many weak cathodes, this is enough to be effective while eliminating the cathode damage that would result from other testers and higher levels of restore currents.

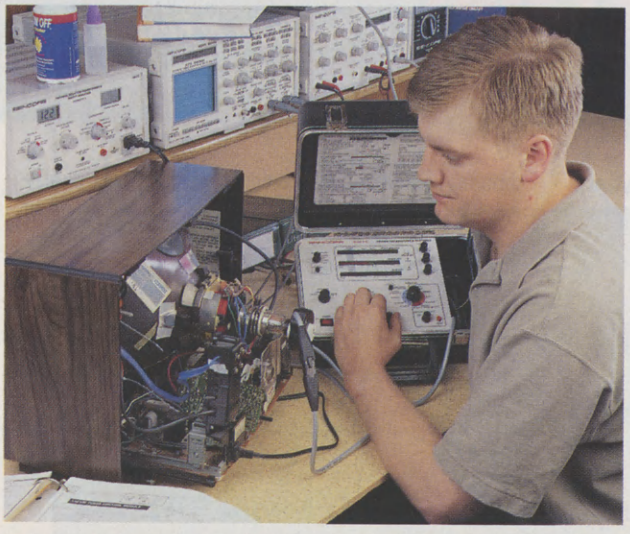


Fig. 6: The CR7000 "BEAM-RITE" tests all types of CRTs and restores them with safe amounts of restore current.

The Normal Restore function offers additional restore current, limited to 80 mA, and two automatic cycles lasting three seconds each. The higher current and duration removes the contamination more aggressively from the cathode while permitting a three second pause between current cycles. The High Restore functions boost the filament voltage to superheat the cathode while increasing the maximum current to 100 mA. The High Restore function is effective in removing thicker cathode contamination. For tougher cathode contamination, the Extended Function draws continuous restore current up to 15 seconds.

This has worked like a charm every time I've used it.

If you cannot get any cathode current to flow due to complete poisoning of the cathode, the CR7000 has a rejuvenate function. The rejuvenate function is used when the CRT cathode is so totally encrusted that no restore current can be drawn by any of the other restore functions. In the rejuvenate function, a charged capacitor is connected between the cathode and the control grid (G1). When the sudden positive voltage from the capacitor is applied to G1, the electrons under the poison crust break free, essentially cracking the layer of contamination. Once the layer of contamination has been cracked, the other restore functions can be used successfully.

Other CRT Gun Problems And Tests – G1 & H-K Short Tests

When testing a color CRT gun, the G1 Short and H-K Short tests are performed simultaneously on the red, green, and blue electron guns. The three-bar graph display indicates the resistance of the respective guns simultaneously. You know at a glance if any of the color guns has an inter-element short.

G1 Shorts Test: These common shorts are automatically tested with the CR7000, and the display shows which elements have the short. In the Remove G1 Short function, the cathode (K) and G2 grids are connected together. The filament voltage is removed to cool the cathode and prevent filament or cathode damage. After a delay, pressing the Press To Restore button discharges a 350 volt capacitor through the short path between the G1 and the K/G2 connection.

Cutoff Test: The CR7000 simulates cutoff bias conditions relating to the manufacturer's specified range and circuit bias conditions.

Lo Tracking: The Lo Tracking test compares the level of G2 voltage needed by each gun to produce cutoff current. It is automatically performed while testing cutoff of all three guns of a color CRT. The good GUN TRACKING LED lights when all three guns are conducting within the Cutoff area of the display and the G2 voltages are within a ratio of 1.25:1.

Emission Test: First the CR7000 measures true beam current or the current passing from the cathode through the opening in G1 and on to G2. This provides the best representation of the actual CRT beam current that strikes the phosphor screen. A second and exclusive feature of the CR7000 is a sliding good/bad scale for testing emission to manufacturer specifications.

The CR7000's Emission Life Test cools the cathodes slightly by decreasing the filament voltage by 25 percent. A cooled cathode produces less emission, but most good cathodes are capable of producing more current than is needed for full beam current (white picture level).

Hi Tracking: The CR7000's Hi Tracking test compares the peak emission levels of each gun of the color CRT. The Hi Tracking test automatically calculates the tracking ratio as it simultaneously displays the emission readings for all three guns. The good GUN TRACKING LED lights when all three guns have emission currents resulting in a ratio within 1.55:1.

Free Video Tape And Technical Newsletter

A very informative video tape on CRT failures is available from Sencore. Ask for Tech Tape #861A. The tape is free. Sencore's toll-free number is **1 (800) SENCORE**. The address is 3200 Sencore Drive, Sioux Falls, SD 57107. They have a Web site (http://www.sencore.com). Ask to be put on their mailing list and you'll receive a free subscription to Sencore's technical newsletter on troubleshooting monitors and VCRs. Please tell them Randy Fromm at Play Meter Magazine recommended you call.

Reprinted from Play Meter Magazine, a monthly publication covering the coin-operated entertainment industry for 24 years. To order a sample issue ($5) call 504-488-7003 or fax 504-488-7083. Address: PO Box 24970, New Orleans, LA 70184 SN

Make More Money! Fix 'em Faster!

Sencore's 1998 Hands-On Troubleshooting Seminars

The key to making money in the service business is productivity.

Enhance your troubleshooting skills and slash the time you spend troubleshooting today's complex electronic circuits!

Sencore is committed to providing unrivaled technical training that opens the door to new and profitable service opportunities (such as computer monitor service) as well as upgrading your technical skills to handle today's demanding circuits.

Our unique blend of lecture and hands-on troubleshooting activities provides the theory and "real world" experience you need to apply your new knowledge and skills with confidence.

Look at what we have to offer and give us a call before the seminars nearest you fill up. See you soon!

TS100 One Day "Hands-On" Computer Monitor Troubleshooting Seminar
****UPDATED!!****

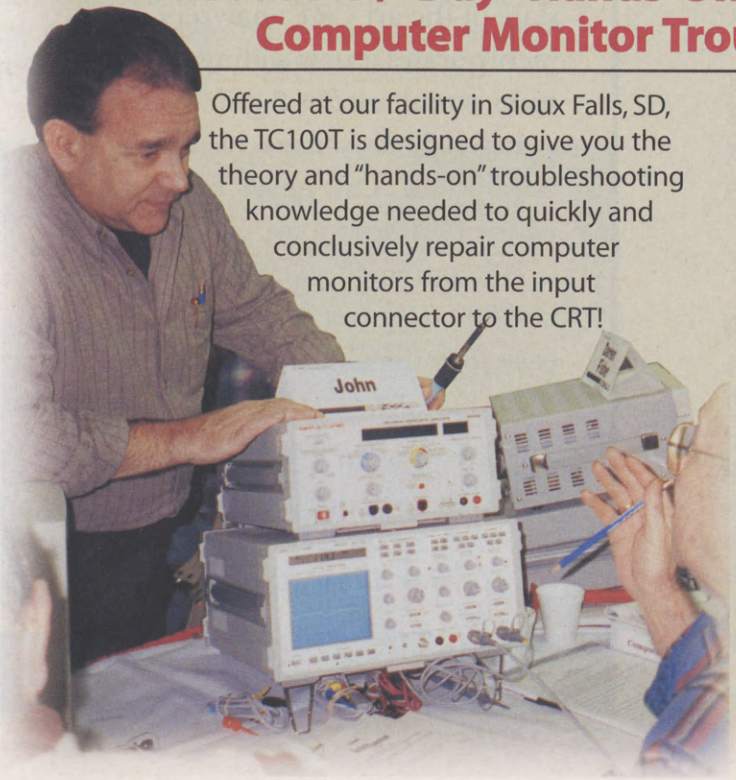
Cash in on computer monitor service with Sencore's one-day "hands-on" computer monitor servicing seminar. This course is designed to provide you with the knowledge and skills you need to successfully service computer monitors. You'll learn how to dynamically troubleshoot any computer format from CGA to high-resolution in three easy steps.

Course topics include:

- Computer monitor familiarization
- Troubleshooting signal processing circuits
- Troubleshooting sync, mode switching, and power management circuits
- Troubleshooting deflection and high voltage regulator circuits
- And much more!

Spend a week with Sencore...

TC100T 4½ Day "Hands-On" Computer Monitor Troubleshooting Seminar



Offered at our facility in Sioux Falls, SD, the TC100T is designed to give you the theory and "hands-on" troubleshooting knowledge needed to quickly and conclusively repair computer monitors from the input connector to the CRT!

Course topics include:

- Switch mode power supply troubleshooting
- Multi-sync/multi-scan horizontal deflection circuit troubleshooting
- Vertical deflection circuit troubleshooting
- Computer monitor performance testing
- Video, sync, and mode circuit troubleshooting plus much more!

Call 1-800-736-2673 for pricing and additional details on this exclusive servicing course!

TC100T Schedule

- April 13 - 17
- June 15 - 19
- September 14 - 18
- December 7 - 11

TS300 One Day "Hands-On" Television Troubleshooting Seminar

****NEW!****

Today's TV technician is faced with troubleshooting more complex circuits, both on the bench and in the home. Sencore's TS300 one day "hands-on" television troubleshooting seminar is designed to improve your TV troubleshooting skills and enhance your ability to service TVs in the home.

Course topics include:

- Troubleshooting horizontal and vertical deflection circuits
- Conventional TV troubleshooting methods
- Troubleshooting and isolating defects without a schematic
- In-home troubleshooting methods

TS400 One Day "Hands-On" Switch Mode Power Supply Troubleshooting Seminar

Without a doubt, today's electronic products are becoming more complex, and, for the unprepared technician, much more difficult to troubleshoot. In particular, modern switch mode power supplies (SMPS) represent one of the most difficult circuits technicians are called upon to troubleshoot and repair.

Sencore's one day "hands-on" SMPS troubleshooting seminar will give you the working knowledge necessary to quickly and accurately diagnose SMPS defects. You'll learn how to identify common SMPS types and experience "hands-on" troubleshooting of actual power supplies.

Course topics include:

- Conventional power supply basics
- Common SMPS circuit configurations
- Troubleshooting Pulse Width Modulation SMPS
- Troubleshooting Pulse Rate Modulation SMPS
- Analyzing SMPS components

Tuition

Any single class = $199
Any 2 classes = $358 ($179 each)
All 3 classes = $477 ($159 each)

- *Schedule (all seminars start at 8:00 A.M. and finish at 4:00 P.M.)*

Date	City	TS400	TS100	TS300
March	Los Angeles, CA	3/16	3/17	3/18
	San Diego, CA	3/23	3/24	3/25
	Phoenix, AZ	3/30	3/31	4/1
April	Los Angeles, CA	4/6	4/7	4/8
	San Francisco, CA	4/20	4/21	4/22
	Portland, OR	4/27	4/28	4/29
May	Seattle, WA	5/4	5/5	5/6
	Vancouver	5/11	5/12	5/13
	Calgary	5/19	5/20	5/21
June	Winnipeg	6/1	6/2	6/3
	Chicago, IL	6/8	6/9	6/10
	Indianapolis, IN	6/22	6/23	6/24
	St. Louis, MO	6/29	6/30	7/1
July	Cincinnati, OH	7/13	7/14	7/15
	Detroit, MI	7/20	7/21	7/22
	Cleveland, OH	7/27	7/28	7/29
August	Buffalo, NY	8/3	8/4	8/5
	Boston, MA	8/17	8/18	8/19
	New York, NY	8/24	8/25	8/26
	New Jersey	8/31	9/1	9/2
September	Philadelphia, PA	9/14	9/15	9/16
	Washington D.C	9/21	9/22	9/23
October	Charlotte, NC	10/5	10/6	10/7
	Atlanta, GA	10/12	10/13	10/14
	Tampa/Orlando, FL	10/19	10/20	10/21
	New Orleans, LA	10/26	10/27	10/28
November	Houston, TX	11/2	11/3	11/4
	Fort Worth, TX	11/9	11/10	11/11
	Kansas City, KS	11/16	11/17	11/18

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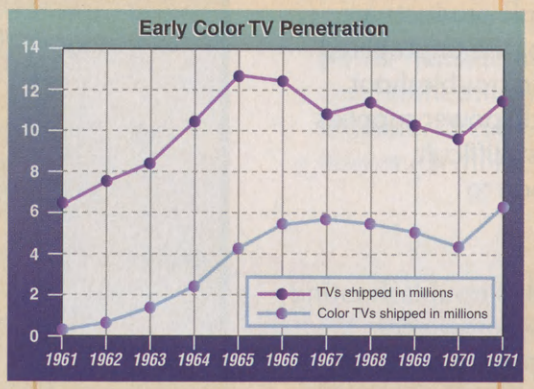
By Larry Schnabel Sencore News Editor

The Truth About DVD

You've probably already heard of DVD - the latest, greatest technology to hit the home entertainment market since the compact disc. DVD, correctly called digital versatile disc, or digital video disc, is the new, megastorage format for prerecorded movies. Unlike VHS tape, DVD never needs rewinding, virtually never wears out, and offers picture and sound quality nearly equal to that in theatres. DVD players can even play your current audio CDs, although you can't load more that one disc at a time on the current market models.

DVDs, which look like compact discs, pack enough data to hold a feature film or full-motion interactive video program. Most titles cost $20-$30, while players are available for $500 to $1,500, depending on features. The sound quality on the digital recording is clearer than on VHS; it has greater dynamic range, and less background noise. DVD movies can also be produced in Dolby Digital surround sound, providing six separate channels of sound for a theatre-like listening experience. Up to three different formats are recorded on a DVD disc, so you can watch a DVD movie in standard television format, wide-screen format (if you have a wide-screen TV), or letterbox – with the top and bottom of the screen blacked out.

Here's the catch. The current DVD players on the market aren't designed to record. In fact, a recordable DVD format consumers could potentially use in place of their VCRs could still be a long way off. There are at least two formats competing for industry dominance over who's format will become the standard for recordable DVD. Until that battle is complete, DVD will not be able to record "Days Of Our Lives" everyday like a VHS VCR can. So at this point, DVD is at the same point of laser disc, a superior quality product that might not meet the needs of the mainstream consumer until recording becomes a reality.



If you remember when color television was the latest "hot" technology, consumers didn't exactly rush out and invest in a new product (see graph above). Since what they had in their homes still worked, most consumers waited until they were more secure with the technology and/or until their present set needed to be replaced. Although the future of DVD is unknown, you can bet that most consumers won't be chomping at the bit to replace their VHS VCR with an expensive disc player that can't record. And maybe most importantly, how will a baby boomer couple watch their wedding video on DVD when it's preserved on VHS? This alone may make for a slow transformation.

Introduction of DVD in the United States has been greeted with a less than spectacular reaction. Customers are more informed and appear to be more cautious about the new format. Reports from the field indicate that consumers have three important questions that need to be addressed before the marketplace accepts DVD.

1. Does it record?
2. Will my DVD player be compatible with the recordable units when they are introduced.
3. How many DVD titles are available in the stores?

DVD won't quickly replace the VHS VCR, if for no other reason than the early machine's lack of recording capability. Nor are compact discs going to disappear immediately, because of the huge number of CD players that have been sold. So you can plan on VCRs eating tapes and wearing out video heads for some time to come. DVD may be the next "hot" technology, but don't expect it to replace the VCR anytime soon. SN

By Brian Phelps
Product Marketing Manager
Sencore Electronics

How To Build Business In VCR Analyzing

Cash In By Using The VC93 All Format VCR Analyzer

There are more VCRs in use today than ever before. They have become as common in homes as the TV, and many have two VCRs or more. With that kind of penetration and the sheer amounts of precious footage on VHS tape, you're going to have customers looking for quality VCR repair for some time to come.

Now, consider that consumers today are expecting (and paying for) a superior quality picture from their "hi fidelity video systems." With the new designs that are appearing with better picture reproduction, better sound quality, and a seemingly endless list of features, customers will be more willing to have their VCRs repaired rather than replace them.

This all means that more VCRs than ever will need to be serviced as each day passes. So it's easy to see why VCR service is a profitable and growing market for the servicing professional who sees it as a big opportunity and has the proper tools and technical knowledge to handle it.

How To Cash In On This Big Profit Potential

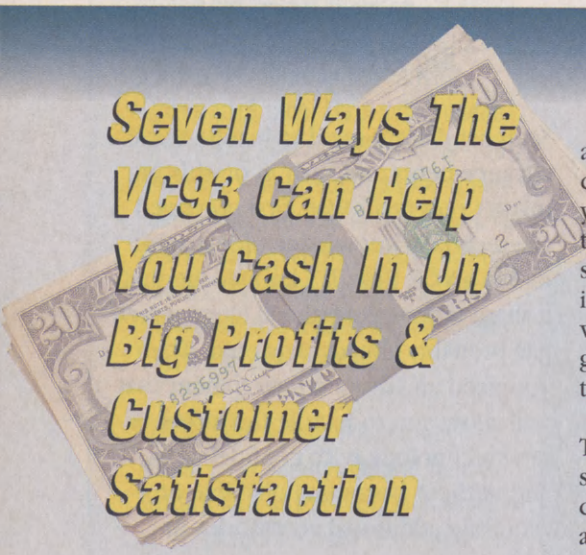
So, what do you need to handle these advancements and cash in on this big market potential? Well, first you need the technical knowledge of just what makes a VCR tick. It's knowledge that a sharp video professional like yourself has probably already mastered. Then you need an advanced instrument that will allow you to handle the influx of new technology with confidence - and without becoming obsolete or requiring additional accessories or add-ons.

This advanced instrument will need to have the versatility to check the multitude of VCRs you'll be seeing - from BETA to VHS to 8mm. And, most importantly, this advanced instrument will need to be one you can use with confidence, without worrying about damaging the instrument or the VCR you're servicing. Is such an advanced instrument available, you ask?

Here's How The VC93 Can Help You Cash In On The Big VCR Servicing Market!

The VC93 Is Guaranteed To Help Troubleshoot Every VCR You'll Ever Want To Test - Have you ever been caught short in front of a customer? You'll never be embarrassed by not being able to accept a VCR format because your test equipment wasn't designed to be operated with the particular format.

The point is, if you're interested in providing complete customer service for all of your customers' VCRs, then you need to be ready for all the various formats that may come into your service center. The VC93 All Format VCR Analyzer matches the signals found in all consumer VCRs and camcorders as well as any other formats using a "color under" scheme. Even though each format has major signal variations compared to the others, you don't need to worry about them when you use the VC93. Selecting the correct format with the VCR Format switch converts every signal and every



Seven Ways The VC93 Can Help You Cash In On Big Profits & Customer Satisfaction

The successful service centers typically don't look at an investment in test instruments as an expense, but as a profit building investment. Quality test instruments are essential just like the delivery/service vehicle you use every day, and the more you use it, the more money or profits your business is making. We've listed seven of the many ways you can use the VC93 All Format VCR Analyzer to help add profits to your service center. This information is simply a brief explanation of the techniques used by several successful service centers and ways that Sencore and the VC93 team to help the service business.

#1 - Accurate Efficient Repairs

How much profit you make on a VCR repair is directly related to the amount of time you spend troubleshooting or analyzing the machine. The quicker you can get in and get out, the more profit you actually make. Equally important is the accuracy of the analyzing time. You simply cannot afford quick troubleshooting that proves to be inaccurate. This will cause you to order parts incorrectly, give wrong estimates, and perhaps lose the customer in the long run.

The VC93 All Format VCR Analyzer is specially designed to prove the condition of a VCR before you order any parts. It does this by verifying which circuits are working and which are not working. And by using signal injection and functional analyzing, you can quickly step through a VCR and isolate the true defects as well as determine if there are multiple defects.

#2 - Like-New Certification

What if we showed you a way that you could make money by guaranteeing your service work has returned the VCR to like-new condition? You'd probably think we were crazy, wouldn't you? Well a number of our video servicers charge a nominal $5 for a "Proof Of Performance Guarantee" and come out way ahead with big profits in the cash register. Here's how it works: You test the VCR with the patented Servo Performance Tests and record the results on the stickers offered by Sencore, then attach the test results to the VCR. This does several things for your service center:

1. Certifies your repair has returned the VCR to like-new condition
2. Verifies the VCR is working correctly when it leaves your service center
3. Ensures repeat business because you've put your name on the VCR
4. Provides valuable test information if the VCR does come back in for service

No matter how you look at it, you're coming out ahead. In fact, if you look at the simple math behind the "Proof Of Performance Guarantee" you'll see your investment quickly pays off.

5 VCRs service per day average
x $5 added income from "Proof Of Performance"
$25 extra profit per day
x 20 working days per month
$500 profit added to your business per month

#3 - Trade-Ins Boost Sales

Many new VCR dealers offer a trade-in value on older models to increase new VCR sales. One service center owner told us about two VCRs that were traded in on new models. The dealer gave each customer $25 for their old VCRs. The machines naturally did not perform to like-new condition. But with the VC93, the service center owner was able to repair the VCR in less than 15 minutes per machine. The VC93's servo testing

Fig. 1: The VC93 All Format VCR Analyzer is the only total answer to analyzing all VCR formats.

test to the correct type needed for the deck you are servicing. This makes every test work the same, no matter which VCR you want to test or repair.

The VC93 prepares you for whatever format that enters your service center. Simply set the VCR Format switch to match the VCR type, and the VC93 will properly match all the luminance, chroma, and Hi-Fi audio signals that you need for proof-positive troubleshooting. Now your customers can count on you to be their one stop service center for all their needs. After all, isn't that what you want to be to your customers?

Guaranteed To Be The Most Versatile/Complete VCR Analyzer On The Market - The VC93 ensures your capabilities quickly isolate symptoms to capstan or cylinder servos with two connections and in less than five minutes. The repairs consisted of a pinch roller and a sticky capstan shaft. The VCRs sold for $100 each and net profits (excluding the pinch roller cost and labor time) was $150. Not bad for a half hour of work.

#4 - Advertise To Bring In Business

Have you been watching TV commercials lately? What about newspaper advertisements from some of the larger organizations in your area? What are they doing to help bring them business? For example, do you remember the "Mr. Goodwrench" commercials? These commercials were advertising the fact that the service technicians were fully trained and had the proper tools for servicing GM products. It's all in marketing your business and services. You're probably already advertising in various formats, yet you may not have the edge to sway the customers to come to your service center.

You'll have the edge you need with the VC93 All Format VCR Analyzer. Advertise that you have the latest in diagnostic equipment to bring the VCR to like-new condition. Advertise that you have a complete service facility to properly handle all VCR defects in a timely manner. And advertise that you can work on all formats.

#5 - Contact Schools & Hospitals For Added Revenue

Schools and hospitals can be an untapped resource for profits. The number of electronic products used by these facilities can be quite large and are typically used very frequently. You can lock in your business as the servicer for these potential customers by simply making a contact, offering a token discount to ensure the business, and providing quality service. However, once you've landed these accounts, you'll want to ensure you keep them by servicing the account and providing them with priority customer service. The VC93 can help in this area as well.

Perhaps you can negotiate a routine maintenance agreement. Use the VC93 to go on location and check the operation of all the VCRs in use. Your time investment is minimal, yet your profits can be high.

#6 - VCR Repair Clinics With Same Day Estimates

Advertise a quick-check repair clinic. Let potential customers know that in less than five minutes, you'll provide them with an estimate or repair the product the same day. Invite people to bring in the VCRs that have been sitting in their closet, VCRs they may want for a spare, or to have their VCR checked before they go buy a new one.

You'll be spreading your business name, meeting potential customers, and adding potential profits to your business. You can come out looking like a hero if you can save the customer from buying a new VCR, as well as setting yourself up as the servicer for other products the customer may need to have repaired in the future.

#7 - Offer Free Estimates

Pull in those "closet VCRs" with a free estimate promotion. You know most defective VCRs in the closet, basement, or garage are there because the customer feels it will cost too much to have it repaired. Most customers think the heads are bad because they've heard that they fail and can be expensive to replace. With the VC93, you can quickly verify if the heads are defective, the servos are causing the problem, or if there is no defect at all.

Try saturating your local neighborhoods with ads or door hanger cards. It's inexpensive advertising, but it pays off in your business name recognition.

*Now's the time to cash in on VCR testing. Call **1-800-SENCORE** today and let us put a VC93 All Format VCR Analyzer on your bench risk free for 30 days. Let the VC93 become your newest avenue to more efficient troubleshooting and increased profits.*

capability to accurately and quickly test all stages of a VCR. The patented Servo Analyzing Tests quickly identify if there is a servo (capstan or cylinder) defect in less than five minutes. Combined with the exclusive signal injection troubleshooting signals, the VC93 will become your best confidence builder for all VCRs.

Are the heads really bad? Or is it the tape path, preamps, modulator, or another part that is causing the snowy picture? If the modulator were receiving a good signal, would it work correctly? Is the signal coming into the IC correct, and if it were, would the IC function correctly? How you answer these questions could be the difference if the new part stays in the VCR or ends up on your parts shelf.

One sure fire method of isolating defects is through signal injection. For those of you who are not familiar with signal injection as a troubleshooting tool, here's a quick and easy example. Imagine if you had an extra set of video heads you could use to see if the heads in any VCR were bad. Well that's what signal injection is. You simply inject a known-good signal for the suspect bad signal.

The VC93 All Format VCR Analyzer is the instrument that supplies signal injection for troubleshooting VCRs. With the VC93, you can signal inject into every circuit inside the VCR, from the heads to the output jacks. This includes the head circuits, luminance, video, color, audio, and servo circuits. And the beauty of the VC93's signal injection capabilities is that you don't need to disconnect any components or use fancy test jigs. Simple, easy-clip connections to existing test points or directly to components is all it takes.

The other beauty of signal injection is that it makes all VCR makes and models look the same. All of your troubleshooting will follow the Universal Block Diagram approach. This approach simplifies your troubleshooting because you'll be working with standard signals and test points that are common in every VCR. For example, every VCR will have a head switcher, luminance circuit, chroma input and output, and baseband audio stages. Also, the inputs and outputs of these stages are the same in every VCR. By injecting at the inputs and outputs, you'll easily isolate the defect between the injection points - typically an IC, transistor, or reactive component.

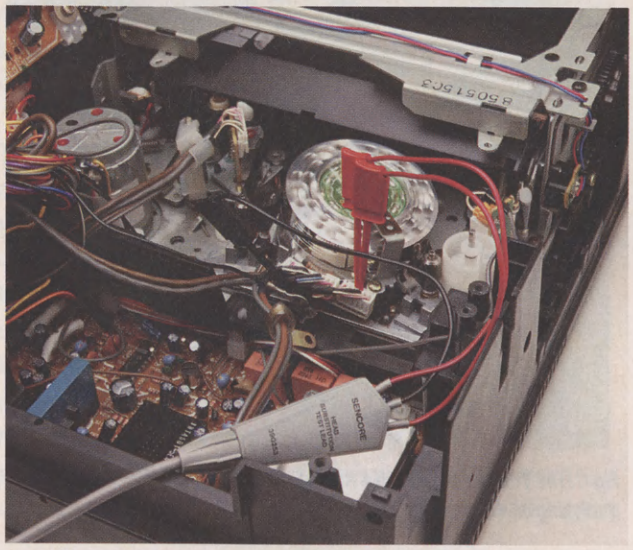


Fig. 2: The VC93 lets you substitute signals in any format to isolate problems in any circuit in the VCR.

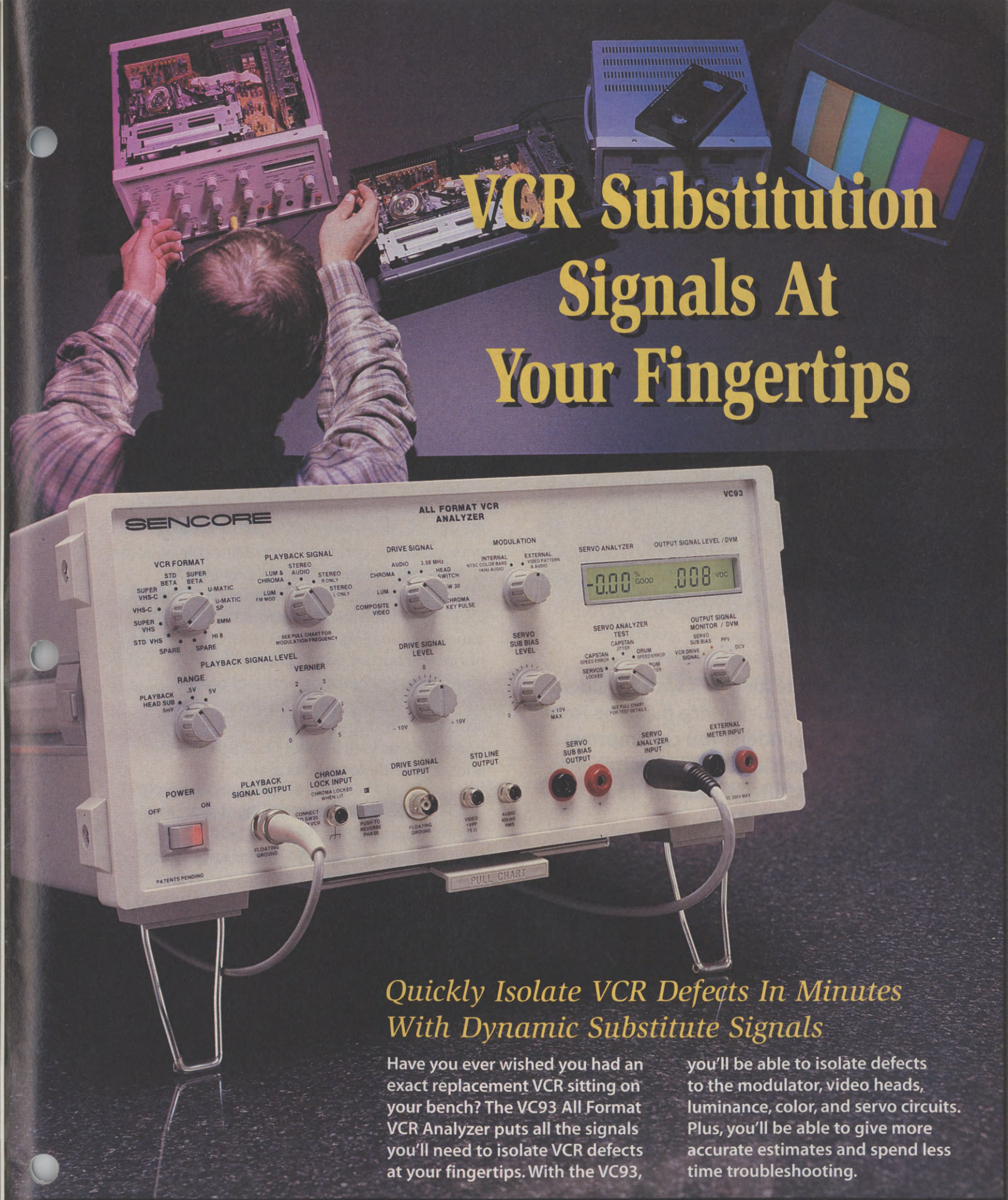
Only the VC93 All Format VCR Analyzer allows you to prove the condition of expensive VCR components before ordering new ones. With the VC93, you can reduce inventory while decreasing your analyzing time, which adds profits to your business.

Guaranteed To Eliminate Guesswork With Dynamic VCR Head Signal Substitution For All Consumer Formats - Remember the last time you spent hours servicing a suspected servo defect, with an invoice that would have amounted to about $125, only to find that when the idler tire went bad, it took the heads out also by allowing the tape to come in contact and snagging the heads? Will the customer go another $60 for a new set of heads? Chances are they won't.

With the VC93 All Format VCR Analyzer, you actually have another set of heads available at your fingertips that you can use to verify the condition of the existing heads. The VC93's exclusive signal injection capabilities allow you to substitute for the signal being picked up by the video and audio heads. This allows you to quickly identify if the heads are not picking up the signal or if the remainder of the circuits are not processing the signal correctly. Only the VC93 offers this capability on all consumer formats - you'll never again be caught short, no matter what VCR format comes into your service center. SN

TECH CHOICE SYSTEM

VCR Substitution Signals At Your Fingertips



Quickly Isolate VCR Defects In Minutes With Dynamic Substitute Signals

Have you ever wished you had an exact replacement VCR sitting on your bench? The VC93 All Format VCR Analyzer puts all the signals you'll need to isolate VCR defects at your fingertips. With the VC93, you'll be able to isolate defects to the modulator, video heads, luminance, color, and servo circuits. Plus, you'll be able to give more accurate estimates and spend less time troubleshooting.

Discover More About The Patented VC93 All Format VCR Analyzer.

Call 1-800-SENCORE(736-2673)

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