THE PROFESSIONAL MAGAZINE FOR ELECTRONICS AND COMPUTER SERVICING

ELECTRONIC™

Servicing & Technology

May 1999

Camcorder repair basics

Let's talk about tuners: the CTC187 chassis

Early history of the transistor

Hitachi Color Television Model CMT2138

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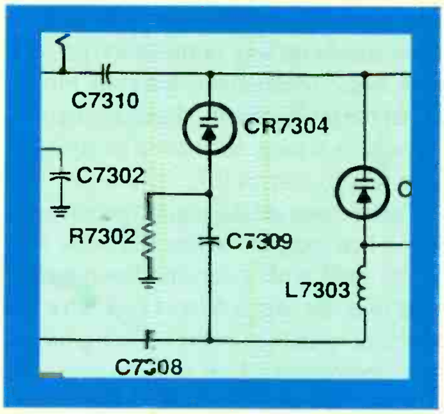

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ON THE COVER

The evolution of semiconductors, and all of the other electronics components that have become smaller and lighter in weight over the years, began with the introduction of the transistor later in 1947. Today, thousands of distributors sell millions of components to OEMs and service centers to manufacture and repair electronics products, including the camcorder. (Photo courtesy of B&D Enterprises. Taken by Falconer Printing and Design.)

EDITORIAL

Diagnosis

There's something a little bit different than other people in most service technicians. The average person faced with a product that doesn't work, doesn't care much one way or the other if the product is fixed or if they get a new one. They just want whatever that function is back again. Most technicians, on the other hand, gain great satisfaction out of taking a product that is not working, or not working properly, and restoring it to first-class, like-new operating condition. It's just a compulsion with technicians to bring their skills to bear on a faulty product and fix it.

The other characteristic that usually sets a technician apart from others, and it goes hand-in-hand with the characteristic mentioned above, is their drive to be able to figure out what's causing a problem and fix it. Again, most people when faced with a product that malfunctions just want to get it fixed one way or the other, or get a new one. Technicians have to puzzle about the problem until they have figured out what's wrong, and have a pretty good idea how to correct it.

Technicians are the kind of people who stop when someone is stranded by the side of the road with a car that has quit and look over the engine to try to see what the problem is and try to get the car going at least temporarily. Call it a sickness, call it a gift, most technicians have it, and know what I'm talking about.

I suppose that one could say, more generally, that technicians have a consuming need for knowledge about how things work. That's why they gather books, training materials, and spend time poring over schematic diagrams to puzzle over what makes that circuit operate. No doubt it's the same compulsion that leads technicians to test themselves whenever they get a chance, using tests such as the TYEK quizzes that we have in this magazine.

Diagnosis as an intellectual exercise

In short, technicians enjoy the challenge of getting to the root of a knotty problem in a TV, VCR, or CD player as much as other people enjoy the challenge of completing a crossword puzzle, putting all of the pieces of a jigsaw puzzle together, or solving cryptograms. They enjoy the process of troubleshooting, of performing a diagnosis on a piece of equipment.

It's an intellectually stimulating challenge to observe the symptoms of a problem in a product, then to mentally compare what has been observed against the knowledge the technician possesses to try to come to a conclusion as to what might be wrong. In some cases, the knowledge possessed by the technician about those products in general is not complete enough, so he must go back to the service literature and fill in the gaps in his knowledge.

In other cases, the technician's knowledge of the particular product being serviced is not complete enough, so he has to go back in and perform some more observations, some more tests to get a complete enough picture of the condition of this product so he can reach a conclusion as to what is wrong.

Sometimes a technician never is able to gather enough knowledge about either this particular product, or that class of product, in order to be entirely sure that he knows exactly what the problem is. That's when the technician starts to play the odds, and says to himself that he's almost sure that the problem is being caused by that transistor, that IC, that resistor, and changes one or a few components, then goes back and powers up the set and observes whether the actions he has taken have cured the problem.

Knowledge is gained from parts replacement

In some cases, when a technician has made an educated guess at the cause of the problem based on a thorough evaluation of the symptoms, the problem will have been cured. In other cases, of course, the ones we hate to think about, the product did not spring back to life. However, frequently, when some components have been replaced and that hasn't effected a cure, that gives the technician some more information on which to base further diagnostic steps. At other times, the replacement components have caused some improvement in the condition of the product, which again is useful in performing further diagnosis.

The meaning of "diagnosis"

While I was writing this editorial, I decided to look up the word "diagnosis," to learn its precise meaning. We all know it from its medical context of figuring out what's wrong with the patient. But how well does the actual derivation of the word describe it compared to how we use it. Interestingly, I don't think we, or at least I, think of the word exactly correctly, but pretty close. And actually, the derivation of the word is close to what is actually taking place as I described the process of diagnosis above.

"Dia-" is a prefix borrowed from the Greek. It can have the meaning of "across," or "through," as in the word "dialog," which means something like talking across. Some people have the impression that the "di-" means two, which means that dialog would be two people talking, as opposed to a "monologue," but that's not the case.

However, "dia" can also have the meaning of "complete," or "thorough." "Gnosis" is another borrowing from the Greek, and it means "knowing." Therefore, the word "diagnosis" means a thorough knowing. And when you think about it, in order to determine for sure, beyond a doubt, what's wrong with something or someone, it's necessary to have a thorough knowledge of not only that individual, but of the entire class to which that individual belongs.

So, in other words, when a technician performs a diagnosis on a product, he has a thorough knowing of the product, its operation and why it's not operating properly. No wonder why being a technician can be so very satisfying and fulfilling.

Nils Conrad Persson

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Electronic Servicing & Technology is edited for servicing professionals who service consumer electronics equipment. This includes service technicians, field service personnel and avid servicing enthusiasts who repair and maintain audio, video, computer and other consumer electronics equipment.

EDITORIAL
Nils Conrad Persson, *Editor*
(Internet e-mail: cpersedit@aol.com)
Alycia Nicholsen, *Associate Editor*
(Internet e-mail: AlyciaEST@aol.com)
Richard S. Moseson, NW2L, *On-Line Coordinator*

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ADVERTISING SALES OFFICE
Electronic Servicing & Technology
21704 SE 35th Street, Issaquah, WA 98029
Tel.: 425-557-9611 Fax: 425-557-9612

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EDITORIAL CORRESPONDENCE:
P.O. Box 12487
Overland Park, KS 66212
913-492-4857

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Circle (62) on Reply Card

Inter-industry consensus reached on IEEE-1394 digital interface specification

New standard will ensure compatibility between digital set-top boxes and digital television receivers

The consumer electronics industry and the cable television industry have reached an agreement and completed the necessary extensions to the baseline IEEE-1394 specification (the so-called "firewire") which will promote compatibility between digital television receivers and digital set-top boxes.

This inter-industry consensus represents a significant milestone for the deployment of digital television and answers the challenge from FCC Chairman William Kennard for the industries to reach accord on this important digital interface specification by November 1.

In a letter to FCC Chairman Kennard signed jointly by NCTA President Decker Anstrom and Gary Shapiro, president of the Consumer Electronics Manufacturers Association (CEMA), the two industries also pledged to continue collaborative efforts to facilitate the introduction of digital television:

"Having now completed the baseline specification for this digital interface, we believe that some consumer electronics manufacturers may produce 1394-enabled digital television receivers with content protection technology for retail distribution by November 1999. We are pleased to report that our industries are working together to jointly resolve these technological hurdles."

In addition, the two industries have committed to continue working together to complete the work that will ensure that copyrighted material sent over this digital link is protected, in recognition of the concerns of the Motion Picture Association of America (MPAA).

The work on IEEE-1394 specification was completed by CEMA's R4.8 subcommittee Working Group 1 and CableLabs' OpenCable™. The specification is now reflected in CEMA document EIA-775 and OpenCable™ document OCI-C1, both of which will now undergo the formal acceptance process required by standards setting organizations.

A special 1394 Pavilion hosted by Digital Harmony Technologies was highlighted at the International Consumer Electronics Show (CES) in Las Vegas, Nevada, January 7–10, 1999. More than 20 companies, including AMX Corp., California Audio Labs, Cirrus Logic, Escient, Go Video, Harman International, Leviton Telecom, Loewa, Madrigal, Meridian Audio, Monster Cable, Phast by AMX, Pioneer, Starmatix, and Whitejay International, were scheduled to demonstrate compelling 1394 connectivity among all types of audio, video and control products at the show.

CEMA published VSB digital TV interface standard

The Consumer Electronics Manufacturers Association (CEMA) has published a voluntary standard (EIA-762) for an interface between digital set-top boxes and digital television (DTV) receivers using vestigial sideband (VSB).

The DTV RF (radio frequency) Remodulator Interface will allow consumers to connect digital set-top boxes such as a digital cable decoder, a satellite receiver, a digital VCR or a computer to a DTV receiver.

The interface can be used to translate the cable industry's transmission language Quadrature Amplitude Modulation (QAM) into VSB, the terrestrial broadcast transmission standard accepted by the Advanced Television Systems Center (ATSC) and mandated by the Federal Communications Commission (FCC) for use with DTV.

The standard adopted by the CEMA R.4 Video Systems Committee consists of baseband input and VSB RF output specification on either channel 3 or channel 4. The input is a suggested implementation practice, as it can be done in several ways. The output details the signal levels required at the interface to operate properly with DTV receivers designed to receive terrestrial digital high-definition television (HDTV) and standard-definition television (SDTV).

Interested parties can order EIA/CEMA standards through Global Engineering Documents, 1-800-854-7179 or http://global.ihs.com. CEMA engineering information can be found on CEMA's Website, http://www.CEMAcity.org.

The research is clear says CEMA: consumers want HDTV

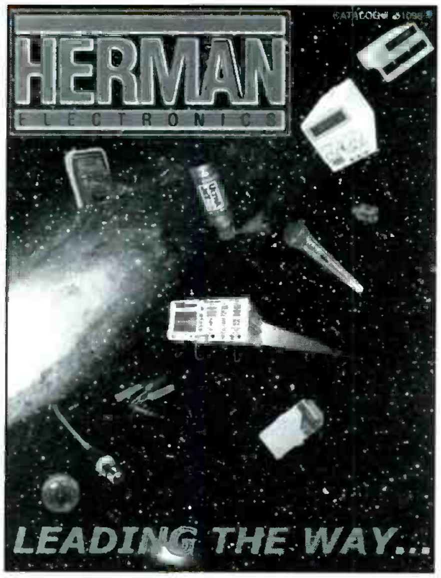
Responding to a survey released on December 7, 1998 by Forrester Research, "HDTV Dreams, SDTV Realities." Gary Shapiro, president of the Consumer Electronics Manufacturers Association (CEMA) issued the following statement:

"The Forrester research results are wrong. Forrester makes predictions in its report about what consumers want without talking to consumers. Our HDTV research is based on consumer opinion surveys and consumer focus groups that included HDTV demonstrations. The results of our research are clear: consumers want high definition TV and, in demonstration after demonstration, they express a strong preference for HDTV over standard definition TV (SDTV).

"HDTV is like ice cream. You can read about ice cream. But until you taste it, you don't know how good it is. Our research tells us that when consumers see HDTV, they are excited about the technology and willing to pay for it.

"The entire history of our industry demonstrates that Americans want the best picture and sound quality technology has to offer. And 20 million households have already invested $2000 or more on their television. Even at introductory prices, HDTV is a success with consumers. As prices of sets come down — and they will — HDTV sales will go up, making this technology the next generation of television."

CEMA estimates digital television sales of 150,000 sets by the end of 1999, and sales of 600,000 in the year 2000. CEMA projects that the first 10 million sets will be sold by 2003, the next 10 million in 2004 and 2005, and 10.8 million to be sold in 2006.



Tool, test equipment, supply, component catalog

Herman Electronics has released their latest catalog. In addition to factory authorized original replacement parts, the catalog lists the company's lines of tools, test and soldering equipment, service accessories, and just about everything that might be used by a service technician on the bench or on the road. The catalog features such major brands as Sencore, Fluke, Chemtronics, and many others with full listings of IC's, batteries, capacitors, and virtually everything in technicians aids and service accessories.

Circle (90) on Reply Card

Equipment catalog

LeCroy has released its 1998 full-line catalog containing complete technical information on the company's digital and analog oscilloscopes, other test instruments, and accessories. The 270-page catalog also contains nearly 100 pages of application notes describing how oscilloscopes can he used to solve problems in circuits, including making more accurate jitter measurements, troubleshooting intermittent faults, and making precise power supply measurements.

Circle (91) on Reply Card

Distributor's website

Mouser Electronics has a website that was recently updated with some new features, including: a user-friendly interface, product pricing, product availability, and excellent search engines. This allows searches by part number, manufacturer, product type, keyword, or catalog page. There are also links to the company's manufacturer's websites. In addition, there are complete manufacturer and product indexes with drill down capabilities. At any time in the drill down, you may view the catalog page, or check the price or availability for any product on a page. Catalog pages are viewable with Adobe Acrobat Reader 3.0, which can be downloaded from their website.

You can check out this internet site at http://www.mouser.com

Circle (92) on Reply Card

Servicing TV audio-stereo circuits

by Homer L. Davidson

The audio circuits in a TV set are comparable to those found in a large AM/FM/MPX stereo receiver. Although the stereo audio circuits in a deluxe TV chassis began with different components, the stereo results are the same. In the RCA CTC167CN chassis, the left and right stereo channels start with a stereo decoder IC (U1701). The stereo circuits take off of terminals 4 and 5 of the stereo demodulator (U1701) in the RCA CTC166 chassis and at pins 22 and 23 of the MPX/stereo (SAP) IC601 in the Goldstar CMT-2612 model (Figure 1).

RCA CTC166-CTC167 stereo circuits

The stereo circuits in the RCA CTC166 and CTC167, which will be discussed here, are similar to the stereo circuits found in more recent RCA TV chassis. IC (U1701) combines the stereo decoder and demodulator circuits. The left audio channel appears at pin 4 of U1701, and is then fed to a summer transistor, Q1703. In a similar manner, the right audio stereo channel begins at pin 5 of the same IC and is tied directly to the right summer transistor, Q1704.

The left audio channel is fed to the left-matrix IC (U1702) and to pin 15 of the audio switch IC (U1402). The right audio output is fed to a difference IC (U1402) and right-matrix IC (U1702), before being fed to pin 2 of the audio switch IC (U1402). This audio switch (U1402) switches the left and right stereo audio signals to the volume control IC (U1801). U1402 also switches in the left audio at jack J1403, and the Right/Mono Audio in at jack J1405. Switching of signals is accomplished inside U1402 and the volume is controlled inside U1801.

Volume control

The volume control IC (U1801) controls the level of audio sent to the dual audio-output IC (U1902). There are no actual volume controls, such as potentiometers, in these audio circuits. The audio level is controlled at the input terminals, pins 2 and 9, of U1801, by the microcontroller (U3101). Similarly, the manual volume control at the front of the set controls the volume via the infrared remote control receiver to the microcontroller (Figure 2).

Both the left and right audio channels are capacitance coupled to pins 4 and 6 of

Davidson is a TV servicing consultant for **ES&T**.

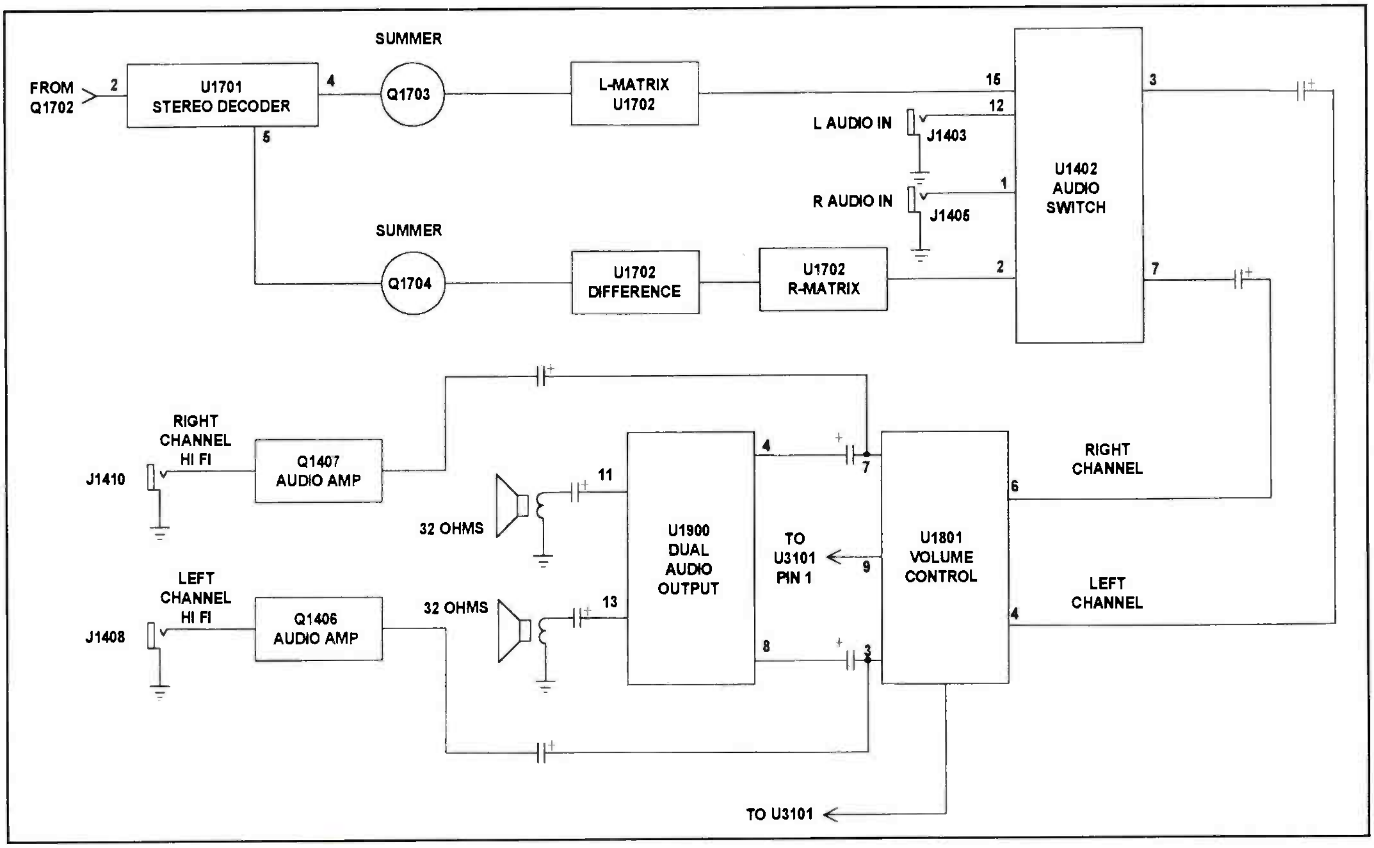


Figure 1. A block diagram of the stereo circuits in the RCA CTC166 television chassis.

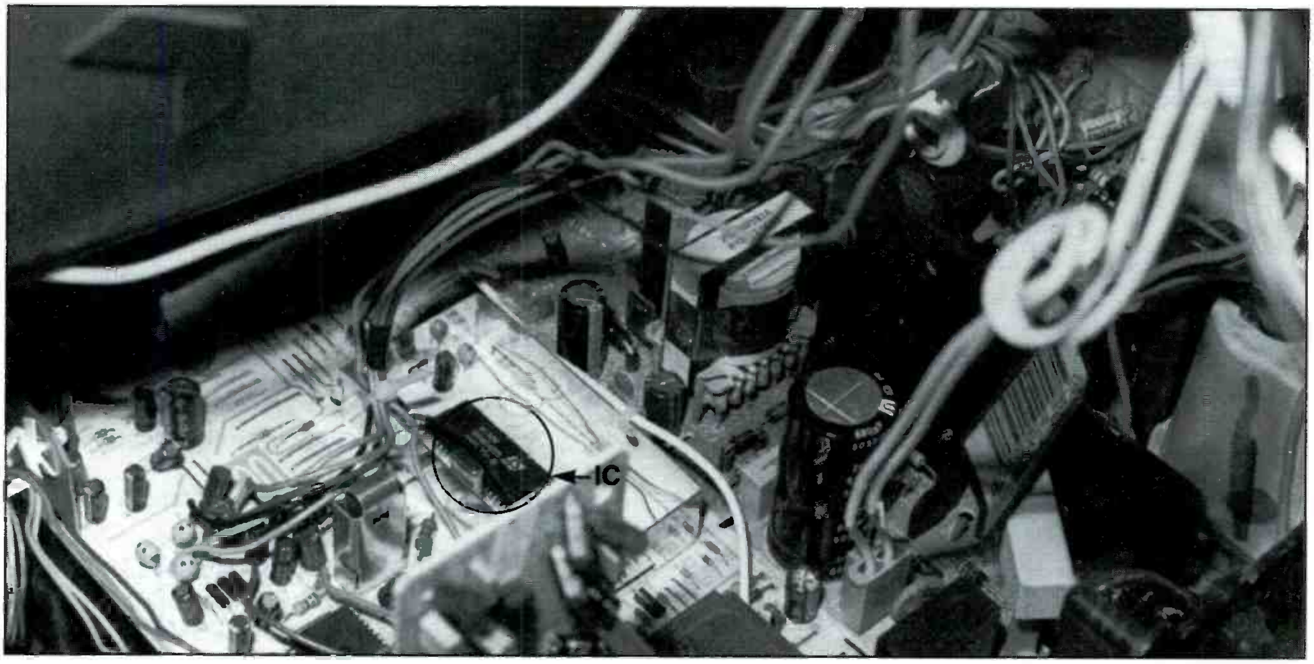


Figure 2. The stereo microcontroller, multiplex decoder, and multiplex demodulator in one of these sets might be included in a single largeIC.

the volume control IC through 1µF electrolytic capacitors. The audio outputs of both stereo channels are fed to a dual sound-output IC (U1900).

U1900 amplifies the audio level in the stereo channels and outputs the amplified audio to 32Ω PM (permanent magnet) speakers via output pins 1 and 13. In addition, both audio channels appear at Hi-Fi audio output jacks, as described in the following paragraph, where they are available to be connected to a separate audio amplifier, if desired.

The right channel audio output is taken from pin 7 of U1801, coupled through an electrolytic capacitor to audio amp Q1407, amplified, and sent to the right Hi-Fi output jack, J1401. The left Hi-Fi output is coupled from pin 3 of U1801 through an electrolytic capacitor, to Q1406, where it is amplified, then sent to J1401. Note that each Hi-Fi output jack has a separate transistor as amplifier

Signal tracing

A quick method to locate a dead, weak, or intermittent audio channel is by signal tracing the audio signal. To perform this procedure, connect an external audio generator at the input of the audio circuits, and observe the output with an oscilloscope. Start with the oscilloscope at the speaker terminals. If there is no signal, or a weak or distorted signal, on the oscilloscope screen, move the probes closer to the signal generator, one audio stage at a time until a good signal appears. The stage just downstream of the stage that shows a good signal is the defective stage.

You could, of course, perform this procedure in reverse. Initially, connect the oscilloscope probes to the outputs of the

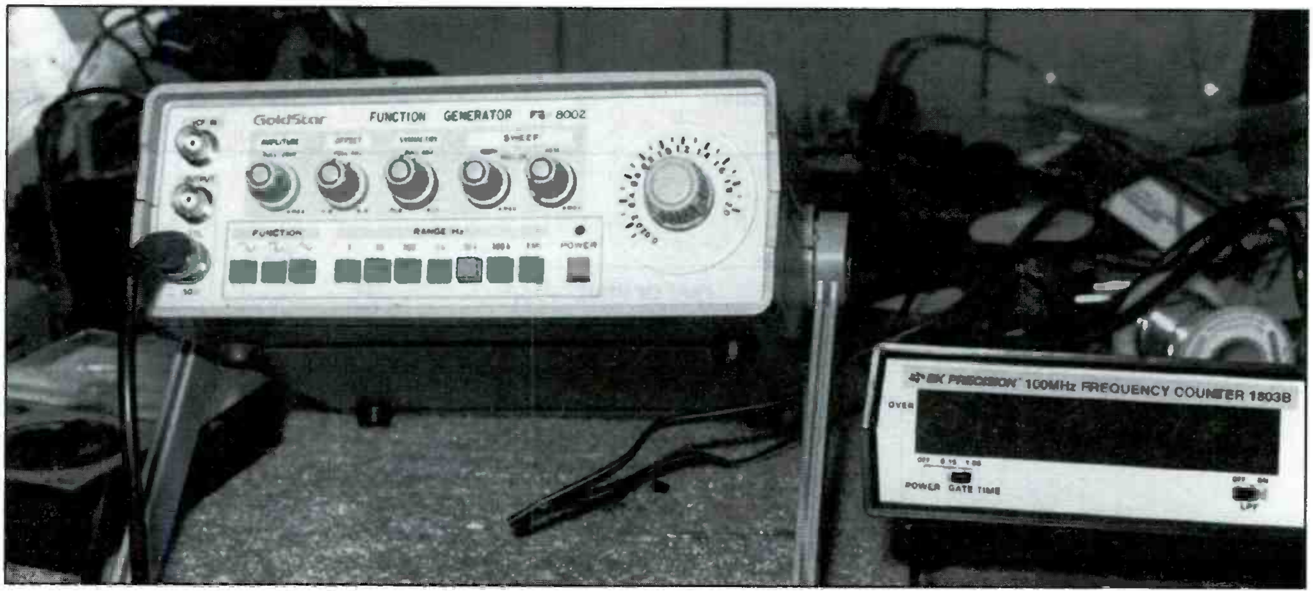


Figure 3. You can use a function generator, or audio signal generator, in conjunction with an oscilloscope and external audio amplifier to isolate most sound problems.

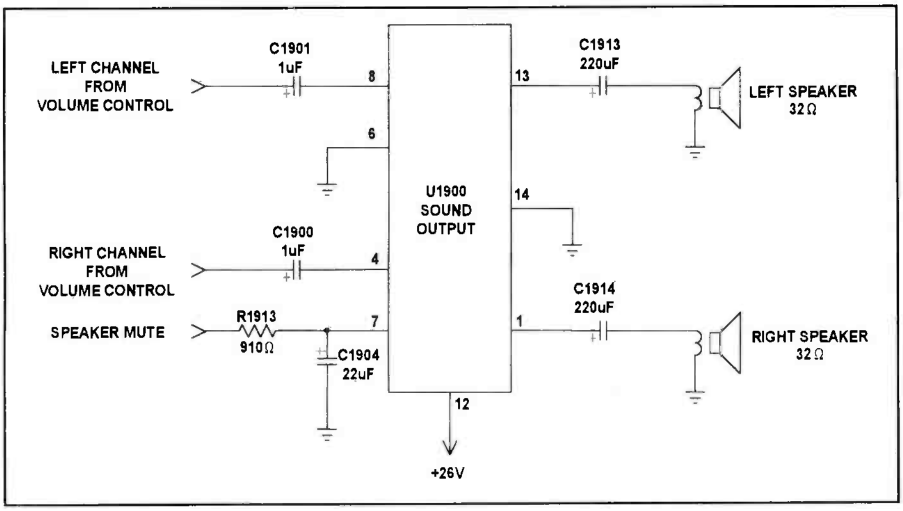


Figure 4. The dual sound output IC (U1900) can cause many different audio problems.

audio output stage closest to the audio generator, and move the probes downstream one audio stage at a time until the signal disappears or becomes weak or distorted. The stage at whose output the signal is no longer good is the defective stage.

Another, similar method of signal tracing is to locate the defective component or stage by using an external audio amplifier in place of the oscilloscope. In this procedure, inject the audio signal from the generator, or from a tuned-in TV station, and check each suspected stage with the external audio amp and speaker (Figure 3). Using the external amplifier replaces a visual indication of the situation with an audible one.

Once you have located the defective audio stage using the above signal injection tests, pinpoint the defective component within the stage by making careful voltage and resistance measurements. If the problem seems to be caused by a defective transistor, check the suspected audio transistor in or out of the circuit with a transistor tester or the diode-junction test of the DMM.

If the problem seems to be caused by a defective IC, locate the suspected IC component with audio signal in and out tests. Suspect the audio output IC when the signal is found at the input terminal but there is no signal at the output. Careful measurement of the voltages and resistances at the pins of the suspected IC can confirm if the IC is leaky or open. Very few transistors are used in these audio circuits, while IC components are found throughout the CTC166 and CTC167 audio stereo circuits.

Various audio symptoms

The most common audio symptoms are:

- dead right or left channel, or both
- weak audio
- intermittent sound
- hum
- distorted audio.

Dead audio

If the symptom is dead audio, only one channel may be dead, or it may be both. You might hear only a low hum in either channel and no audio. Common causes of a dead audio channel include an open electrolytic coupling capacitor in any audio circuit, defective or open transistor or IC, improper grounds, defective bypass capacitors, or an incorrect voltage source.

Weak audio

Weak audio might be caused by open or leaky coupling capacitors, increased resistance, leaky audio transistors and IC components, open electrolytic bypass capacitors, and incorrect source voltage feeding the audio circuits. In the CTC166 chassis, look for open 1μF electrolytic capacitors. Check the audio signal on both sides of a suspected electrolytic coupling capacitor. If it's present on one side and absent on the other side, the capacitor is bad.

Carefully measure voltages at all of the terminals of the suspected audio transistor or IC component. Test the signal into and out of any IC to locate a open or leaky component. Check the supply voltage at each IC to make sure that they're as specified. Check to see if a dried-up or open electrolytic is causing the weak audio signal. Locate the weak audio component with the scope or the external audio amplifier.

Intermittent audio problems

The weak and intermittent audio symptoms are the most difficult to locate.

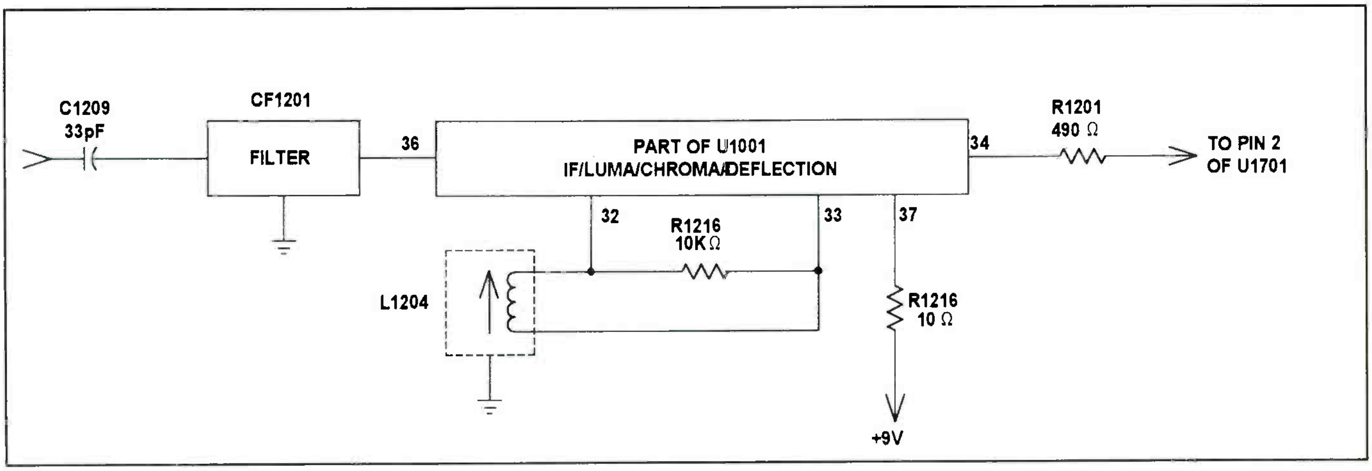


Figure 5. CF1201, L1204, and U1001 can all be causes of hum and buzzing noises in the RCA CTC166, and CTC167 chassis.

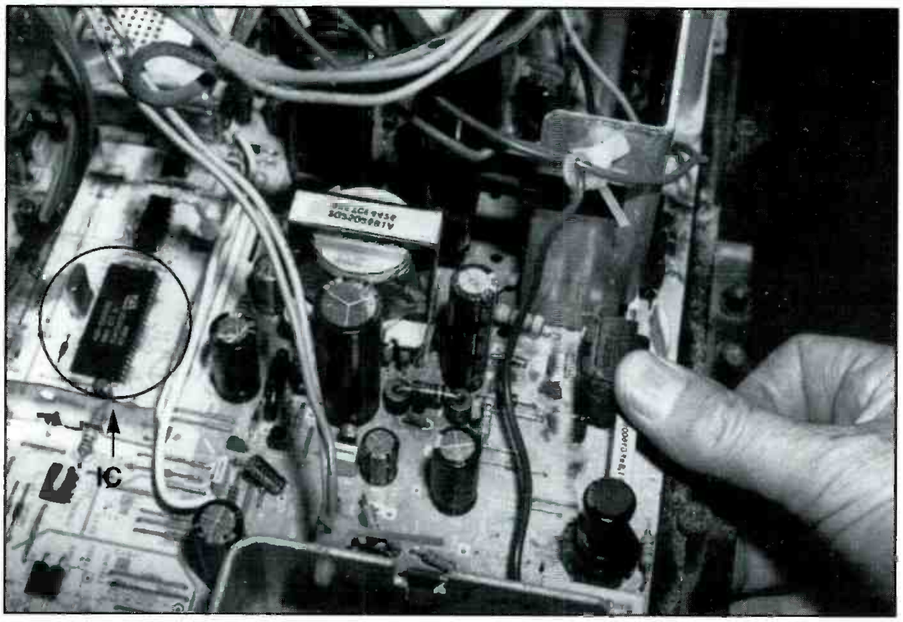


Figure 6. The sound circuits in several RCA TV chassis might be included with the chroma, luma, and deflection circuits in a single large IC processor.

Intermittent sound might be caused by open or cracked PC board foil connections, open ground connections on audio ICs, cracked PC boards, intermittent coupling and bypass capacitors, SMD (surface-mount device) end-connections, audio transistors, and IC components.

A good way to start in the diagnosis of an intermittent audio circuit is to connect the scope at the midpoint of the audio circuits to locate the intermittent component. If the scope face shows signs of intermittent problems, one of the circuit stages upstream is the likely culprit. Conversely, if there is no sign of an intermittent problem on the scope face with the scope connected midway in the audio circuits, the culprit is most likely somewhere downstream.

In the case of the RCA sets we're talking about here, connect the scope to the input volume control IC and determine if the intermittent is ahead of, or after, this audio IC. If the intermittent condition is after the volume control IC, check the signal at the output power IC. Do not overlook the possibility of a damaged speaker or voice coil in either channel.

Distortion

Extreme distortion is usually caused by a fault in the audio output transistor or IC circuits. Leakage in the dual-audio output IC can cause distortion in either channel, or in both channels. If the voltage of the power supply source that provides power to the dual-output IC is not within specification, the result may be distortion of the audio from the speakers. A leaky electrolytic coupling capacitor can produce weak sound and slight distortion symptoms. Badly soldered IC terminals can cause audio distortion and a buzzing sound in the audio system.

Hum

Hum in the audio might result from leaky bypass capacitors, misalignment of the audio discriminator or detector coil in the IF-IC circuits, open ground pins on the output IC, or cracks in the PC board. A low hum and buzzing sound can be caused by a defective ceramic filter at the input terminal of the IF-IC. The defective IF surface acoustic wave (SAW) filter might produce a popping noise after the chassis operates for several hours.

Check the adjustment and condition of the discriminator, quadrature, or detector sound coil in the audio sound IF circuits. Simply rotate the metal slug in either direction until the sound is clear.

RCA U1900 sound output problems

The U1900 dual audio output IC in the latest RCA stereo circuits can produce many sound problems (Figure 4). A leaky U1900 can cause distortion in either sound channel, or both sound channels. If the problem is absence of sound, resolder pins 6 and 14. If pin 14 is not properly soldered, the symptom may be dead sound or low hum in the audio.

U1900 can cause intermittent stereo problems. If you determine that U1900 is defective, replace it with an exact manufacturer's replacement, part number 181836. Also check C1913 and C1914 if the symptom is intermittent or weak sound in the speaker circuits.

When sound is absent, measure the supply voltage on pin 12 (26V) of this IC. If this voltage doesn't seem to be correct, disconnect the set and desolder pin 12, making sure that it is disconnected from the circuit. Now restore power to the set and again measure the voltage at the foil trace to which pin 12 was connected. If the voltage has returned to normal, or is

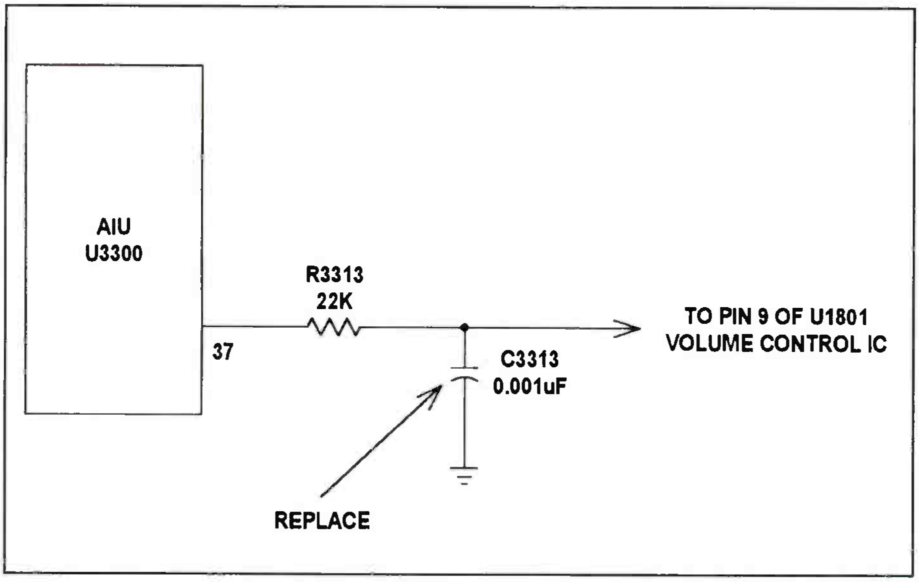


Figure 7. In the RCA CTC157, if the symptom is noisy sound, replace C3313.

a few volts higher than it was when pin 12 of U1900 was connected to it, suspect a leaky U1900 sound output IC.

If the voltage remains low, there is a problem in the supply. This 26V is developed in the scan-derived winding of the flyback transformer.

Hum and buzz in RCA CTC167 chassis

A hum and buzz sound in the audio from an RCA CTC166 or CTC167 chassis might be caused by a problem ahead of the stereo audio channels. Check the audio for hum and a buzzing noise at pin 2 of the stereo demodulator circuits (U1701), using an external amplifier, as described earlier. Go directly to pin 34 of the IF/Luma/Chroma/Deflection processor U1001 (Figure 5). If the hum is present here, suspect a defective U1001, CF201, or L1204.

Although ceramic filter networks produce very few service problems, CF1201 has caused hum and buzzing noises in some CTC166 and 167 chassis. The same symptom might be caused by a misalignment of coil L1204. Replace sound coil L1204 if the noisy distortion cannot be adjusted out of the audio circuits.

In some RCA chassis, U1001 has been known to cause hum, buzz, and dead sound (Figure 6). Measure the supply voltage at pin 37 of this IC to determine if the voltage is low. If it is low, there may be leakage in U1001. If the sound symptoms seem to be caused by these circuits, and can't be easily corrected, you might have to replace CF1201, U1001, and L1204. If you do have to replace all of these components, replace them with the exact manufacturer's replacement components.

RCA CTC157 audio symptoms

The same sound problems might be found in other RCA chassis with similar sound circuits, for example, the RCA CTC157. In this set, check C229 if the problem is extremely low sound level. Replace U1001 or U1900 in the case where there is no sound in either channel.

If there is no audio at pins 1 and 13 of U1900, check the signal at terminals 4 and 8 using the external amplifier. Replace U1900 if the sound is extremely distorted. If the audio is intermittent and you hear a low hum, resolder all pins of U1900. If the audio level is abnormally high, there is probably a bad connection at R1727. Resolder both sides of this resistor. If you hear a buzzing in the audio, check T402. Adjust L1204 if the symptom is a buzz and hum sound.

Look outside of the direct audio circuits for possible sound problems. Check the volume control circuits within the AIU (U3300) control circuits for various sound symptoms. Replace C3313 for a noisy sound problem. This capacitor is right off of pin 37 of U3300 and pin 9 of volume control IC (U1801) (Figure 7).

RCA CTC159 sound problems

Here are a few hints for dealing with sound problems in the RCA CTC159 chassis. If there is no sound, check for a leaky bypass capacitor C1205 (0.01μF) to ground on pin 34 of IC-IF (U1001) (Figure 8). Measure the voltage on pin 34 (2.3V) to determine if C1205 is leaky. This sound

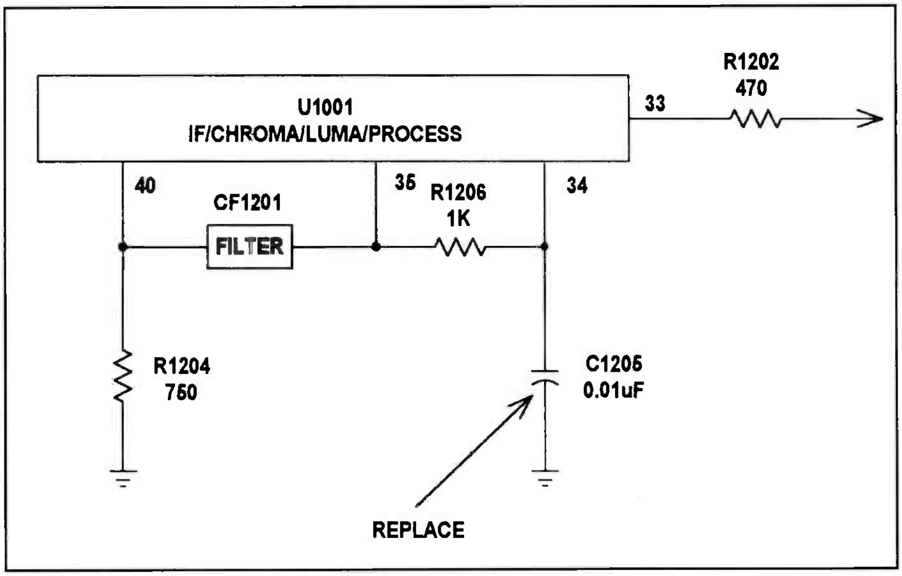


Figure 8. In the RCA CTC159 chassis, C1205 may be the cause of the symptom of no sound.

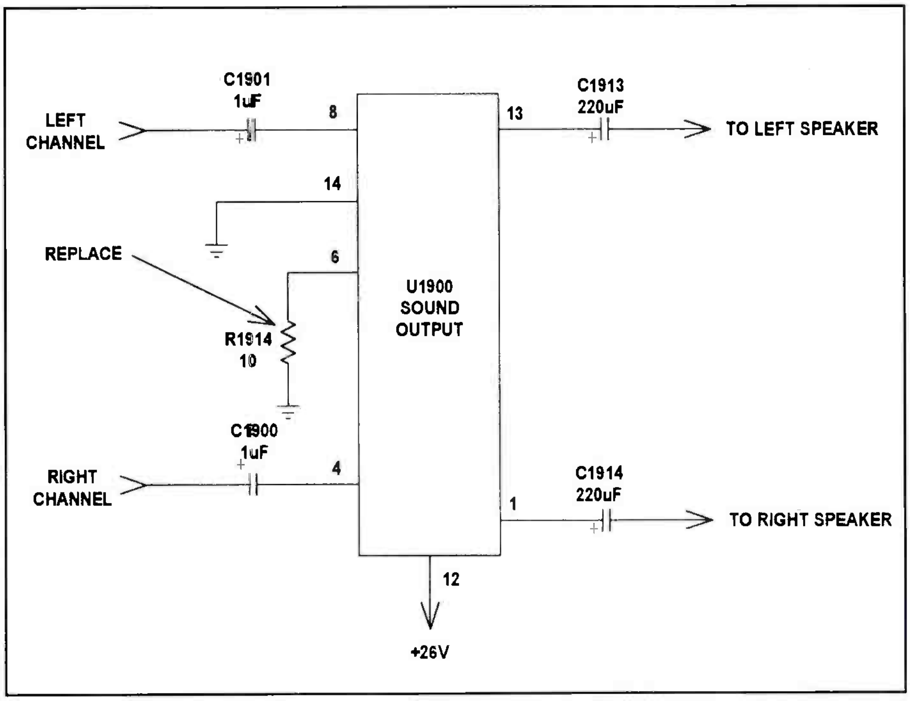


Figure 9. After replacing integrated circuit U1900 to cure extreme audio distortion, check R1914 to see if it is open or burned or otherwide damaged.

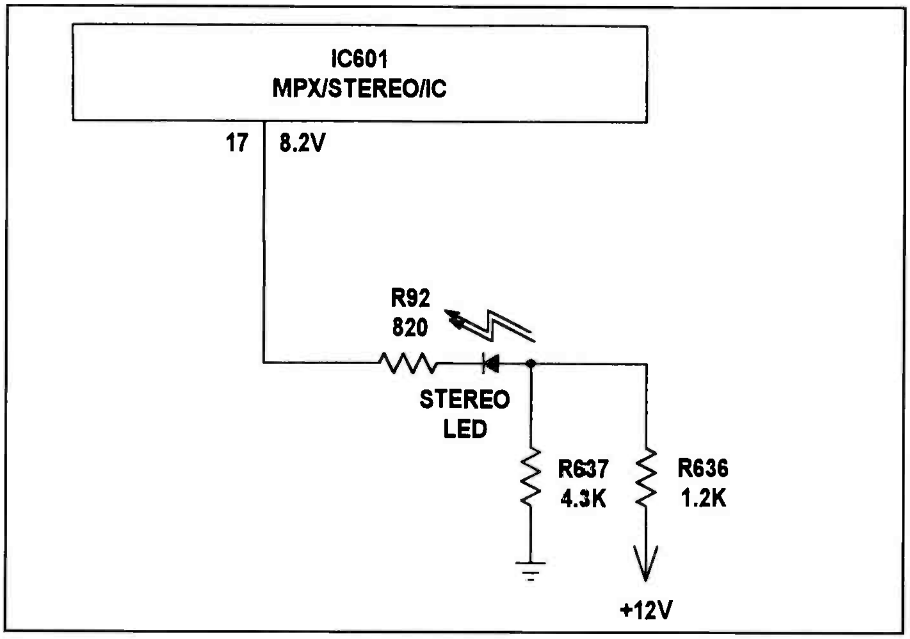


Figure 10. Replace IC601, the stereo/multiplex integrated circuit, in a Goldstar CMT-2612 when the sound and the LED stereo light cut in and out.

problem is located within the IF/ Chroma/Luma/process U1001 circuits.

Check for a cracked PC board wiring foil at the audio heat sink, under or near IC (U1001) if the symptom is intermittent sound and picture. If the symptom appears to be poor audio balance in the drain terminal of the Expanded Stereo Switch transistor (Q1408) replace coupling capacitor C1417 (0.047μF). If there's a squealing sound in the audio, install a new control IC (U3100).

If the sound from the speakers is distorted, replace U1900 and R1914. There have been cases in which U1900 has exhibited leakage, or become shorted, resulting in a burned or open R1914. Check pin 6 to ground with the low ohm range of the DMM to determine if R1914 is open or has changed in resistance (Figure 9). Another cause of poor audio in these sets is an increase in resistance of R1753 (120K) and R1752 (62K) in the matrix U1702 circuits.

Intermittent Goldstar CMT-2612 chassis

In these sets, when the LED pilot light and the sound cuts off and on in the TV stereo circuits, suspect the multiplex-stereo IC component. Go directly to the MPX IC that produces drive to the stereo LED. This LED indicates that the stereo sound is operating. Check the voltage at pin 19 of the MPX/Stereo IC, IC601, in the Goldstar CMT-2612 chassis.

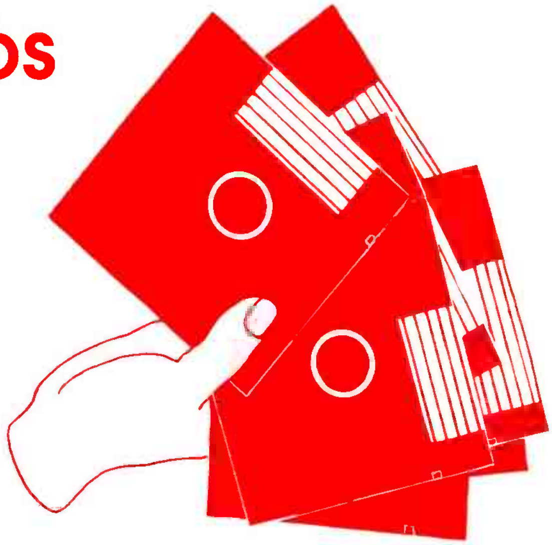
Monitor the sound output with the scope or with the external audio amplifier at pins 22 and 23 of IC601 (Figure 10). Notice if the voltage on pin 19 changes, and if there is no sound at either left or right channels when the audio becomes intermittent. Check all voltages upon each terminal of IC601 when the sound cuts out. Make a note of the voltages you measure on the schematic. If IC601 has leakage, you will measure extremely low voltage at several pins. Replace IC601 if the voltage at pin 19 drops below 2.5V. This confirms that this IC has leakage.

Conclusion

Remember, TV sound circuits are just as easy to service as those in the AM/FM/ MPX receiver. For extremely distorted audio, immediately check the audio output transistors or IC components. Use the audio signal generator and scope to identify weak sound and low distortion symptoms. The external audio amp is a handy tester to signal trace or monitor audio circuits. Do not overlook the audio amp AF transistor circuits when sound problems occur in the HI-FI amplifier circuits. ■

Troubleshooting tips software

by the ES&T Staff



The concept of troubleshooting tips goes back a long way. Troubleshooting tips provide a very useful shortcut in the servicing process. Ideally, of course, a servicing technician faced with, say, a faulty TV, would observe the symptoms, form a hypothesis of what might be causing the problem, open up the set, refer to the service literature, head directly for the area of the circuitry that is the most likely cause of the problem, take some resistance and voltage measurements, perhaps observe some waveforms with the oscilloscope, and on the basis of those measurements conclude what component or components are faulty, and replace them.

Taking a shortcut

The above approach to servicing is the classic, tried and true, way to go about troubleshooting. When the technician is skillful and familiar with the product, it can go pretty fast and end up in an economical repair. Unfortunately, in many cases, for a number of reasons, this tried and true troubleshooting just doesn't yield an economical repair. For one thing, given the variety of types and models of product available today, it's almost impossible for a technician to become intimately familiar with more than a few products. For another thing, with most consumer electronics products the cost is less than a few hundred dollars. In order to make a repair on such a product economically, the technician has to get it fixed very quickly. If he has to haul out the DMM and scope and the service literature, and then spend time making the diagnosis, it just might not be possible to repair the product economically. That's where troubleshooting/service tips come in.

Documenting problems and their cures

Some failure modes in consumer electronics products are rare; they happen once or a few times and then are never experienced again. On the other hand, there are some failures in consumer electronics products that seem to happen in set, after set, after set of the same brand and model. Every service center has had this experience, and it's very common for the service technician or service manager to document the symptoms of every product that comes in the door, and the action by the technician that corrected the problem.

Armed with that knowledge, whenever the service center takes in another product that is exhibiting the same symptom, they don't have to spend time going through diagnostic procedures. They can go directly to the circuits or components that caused the problem in other sets that have exhibited the same symptoms and cure the problem directly.

Sharing the knowledge

It's very useful for a service center to document problems and their solutions for use by the technicians within that service center, but it's even more useful if the collective experience of technicians throughout the country can be shared by everyone. The manufacturers of the products do that type of thing for the sets they sell, in the form of service bulletins that tell technicians about problems that have been found to be common and repetitive in certain sets. Local, regional, and national associations perform a similar type of service by sharing data on how their members repaired predictable, repetitive types of faults in the products they service.

This type of information can be valuable as a service tool that can save a great deal of time and make an service procedure that would otherwise have been out of the question, economical and affordable for the customer, that service centers are willing to pay for it. Accordingly, a number of companies have been formed that offer these service tips for sale. For the most part, the companies that offer service tips for sale are consumer electronics service companies that have compiled a great deal of information on their own over the years and then realize that they have created information that is of value not only to them, but to other service centers as well, and offer it for sale.

Gathering more data

Many of the companies that offer service tips software recognize that the more data they can offer to potential customers, the more valuable it is, so they have developed ways of gathering data from outside their own service centers. For example, one way they do this is to offer some kind of compensation to their customers who are willing to feed back information on problem solutions that they have developed in their service centers. Thus the databases grow in size and value. Some represent the collective experience of hundreds of technicians.

Automating the databases

Service tips information has always been useful, but the application of the computer to the process has made it infinitely more useful. Before computers were introduced, individuals sometimes kept notes directly on the service literature itself. Companies that offered service tips offered it on paper. Simply finding a particular tip might be time consuming.

Now, with service tips in the form of computer databases, it's possible to access any tip on any product instantaneously.

What to look for

At the end of this article is a list of companies that offer service tips software, taken from the **ES&T** Buyers' Guide database. Some of the offerings of these companies are no doubt more valuable than others. Of course, the value of a specific database would depend at least in part on how the information they contain fits in with the needs of a specific service center. For example, if you service only microwave ovens, and one of these databases has thousands of TV tips, and only a handful of microwave oven tips, it won't be very valuable to you.

Moreover, some of the databases offered by some of the vendors contain more tips than others. Some of the tips are more accurate than others. It's not within the scope of this article to rate the software offered by the vendors listed. For that, you might want to talk to another service center that has experience with a particular package. Or talk it over with fellow members of a servicer's association.

In general, though, here are a few thoughts on selecting a service tips software program.

- What is the total number of tips offered?
- Are they all unique, or are some duplicates, or nearly so?
- How accurate are the tips?
- Where do the tips come from?
- Does anyone verify the tips?
- What products are covered?
- Can the service center add its own tips?
- Is the software user friendly?
- Can you get a refund if the product is not suitable?

Service tips vendors

Following is a list of the companies of whom we are aware that offer service tips software:

A-Tech Electronics
198 Lincoln Highway
Fairless Hills, PA 19030
215-949-0400
Fax: 215-949-0403
E-mail: A_tech@juno.com
Website: Http://www.a-tech-inc.com

Anatek Corporation
P.O. Box 1200
100 Merrimack Road
Amherst, NH 03031
603-673-4342 • 800-999-0304
Fax: 603-673-5374
E-mail: info@anatekcorp.com
Website: Http://www.anatekcorp.com

Cahill Electronics
160 Main Street
P.O. Box 568
Kingston, NH 03848
603-642-4292
Fax: 603-642-7941

Electronic Software Developers
826 South Main Street
South Farmingdale, NY 11735-4152
516-221-6403
800-621-8477
E-mail: Esd@bccom.net
Website: Http://www.servicetips.com

High Tech Electronic Services
1623 Aviation Boulevard
Redondo Beach, CA 90278
310-379-2026 • 800-289-3001
Fax: 310-379-9608

Higher Intelligence Software
60 Farmington Lane
Melville, NY 11747-4019
516-643-7740 • 800-215-5081

ICM Components
1545 Sawtelle Boulevard., Suite 21
Los Angeles, CA 90025
310-268-1005 • 800-748-6232
Fax: 310-445-5003
E-mail: Icmsteve@worldnet.att.net
Website: Http://www.icmcomp.com

M.I. Technologies
3310 E. Peterson Road
Troy, OH 45373
937-335-4560 • Fax: 937-339-6344
E-mail: 335@bright.net
Website:
Http://www.mitechnologies.com

Philips Consumer Electronics
Software Development
P.O. Box 555
Jefferson City, TN 37760-0555
423-475-0393 • Fax: 423-475-0178
E-mail:
Forcesupport@knox.pcec.philips.com
Website: Http://www.forceonline.com

Philips Technical Training
Service Co.
P.O. Box 555
Jefferson City, TN 37760
423-475-0115
E-mail:
Force.support@knox.pcet.philips.com

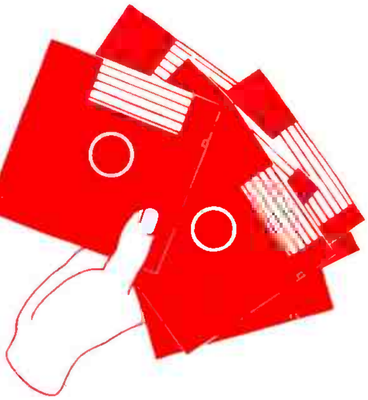
Sony Service Company
National Parts Division
8281 N.W. 107th Terrace
Kansas City, MO 64153
816-891-7550
Fax: 800-821-5662

SyncPulse Systems
P.O. Box 4503
Sunland, CA 91041
818-353-9595
Fax: 818-353-7016
E-mail: 102654,1665@compuserve.com
Website: Http://www.syncpulse.com

Tech-M
1912 Michigan Avenue NE
St. Petersburg, FL 33703
813-522-9044
E-mail: Techm@cent.com
Website: Http://www.cent.com/techm

Tech. Info. Procurement Serv.
P.O. Box 1681
Forest Park, GA 30051-1681
770-968-3715
Fax: 770-968-3715
E-mail: Tipsinc@mcenter.com
Website: Http://www.mcenter.com/tips/

TV Man Tech Tips Inc.
8614 State Road 84
Fort Lauderdale, FL 33324
954-349-2455
800-474-3588
E-mail: Tvman@safari.net
Website: Http://www.safari.net/-tvman



Early history of the transistor

by Alvin G. Sydnor

We are forever indebted to the past. It is the source of our identity and it is healthy to pause and pay tribute to the explorers, entrepreneurs, engineers, and inventors who have laid the foundation of our prosperity.

After more than 45 years as a electronic design engineer, I often marvel at the advancements I have witnessed and those that helped shape our industry and feel that its vital to know how we got to where we are today. The early history of the transistor is fascinating and it shows that its progress has not lacked continuity.

It was in the 1880s that curious experimenters created the worlds most powerful electrical-electronic industry. It is interesting to note that not one of the top ten vacuum tube manufacturers became a top ten semiconductor manufacturer.

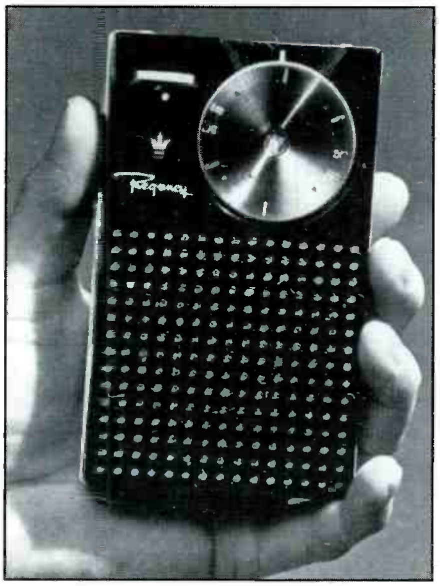


Figure 1. Photograph of the Regency TR-1, the world's first all-transistor radio.

The fundamental properties of semiconductors

In 1883, Michael Faraday found that silver sulfide had a negative temperature coefficient of resistance. This discovery set silver sulfide apart from other conductors whose resistance increased with temperature. Six years later, A.H. Becquerel observed that a photo-voltage could be produced by shining light on the surface of one electrode in an electrolyte. Soon after, it was discovered that the resistance of selenium could be reduced by shining light on its surface: a phenomenon that later became known as photo-conductivity.

About the same time, it was discovered that when contacts were placed between certain materials they would rectify depending on polarity. Some researchers at that time believed that this phenomenon was a thermal effect. It was W.G. Adams and R.E. Day who made the first photo element of the barrier layer type and in 1883 C.E. Fritts made the first large area dry rectifier.

Continuous research finally established the four fundamental properties of semiconductors; (1) negative temperature coefficient; (2) rectification; (3) photo-conductivity, and (4) photo-electromotive force.

Syndor is a retired consumer electronics servicing technician.

Detection

In 1888, Heinrich Hertz demonstrated the existence of radio waves, which created a demand for suitable detectors. In 1904, J.C. Bose was issued U.S. Patent No. 755840 and in 1906 H.H.C. Dunwoody was issued U.S. Patent NO. 837616. Both patents demonstrated that point-contact (cat whiskers) on galena, silicon carbide, tellurium, and silicon were workable detectors of radio waves. From experimenting and practical applications, it was found that silicon detectors were very stable, but were not as sensitive as galena detectors.

Amplification

In 1906, Lee de Forest introduced his Audion, the world's first triode vacuum tube and in a few years they were being used by the Navy Bureau of Equipment in Washington.

Before the invention of the triode vacuum tube, electrical communications was limited to a few miles of voice transmission and manual switching (Morse Code). Longer distances could be covered but the only amplifiers of those days were electromechanical (relays), which were very complex, costly, and consumed large amounts of power. The triode vacuum tube offered the experimenter the opportunity to design amplifiers that were much more economical and technically superior to electro-mechanical devices.

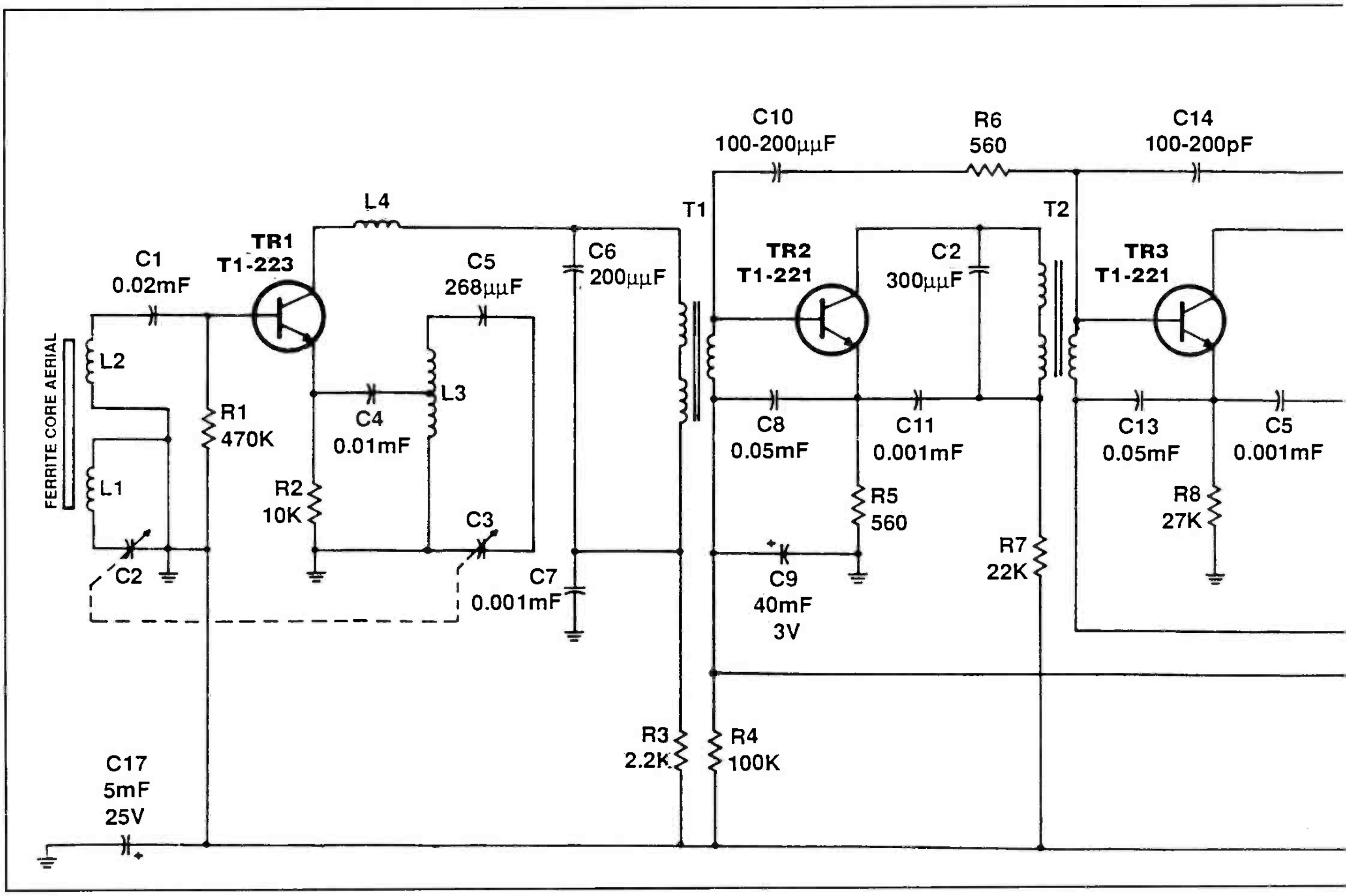
By 1914, research and manufacturing techniques of the triode had established it as a superior device in performance and reliability and it was put to work in the first American Transcontinental Telephone System. Also at this time, the vacuum tube had become the work horse in radio signal amplification and detection, and very little interest was given to research in semiconductors.

During the next few years, vacuum tube cost, reliability, and performance as measured by its power output and amplification over a wide frequency range were greatly improved. Extensive research and development went into multi-channel telephony over wires and radio broadcasting. To keep up with the rapid growth of telephone service, large automatic switching systems were developed and put into use using the triode vacuum tube.

The effects of WWII

Prior to World War II, much research was being put into extending electronics into higher frequencies beyond the broadcast bands into the microwave spectrum. During the war, this research went into improving the vacuum tube. This resulted in the development of magnetrons and klystrons which were developed for radar and other military communication systems. During the war, small digital computers using tubes and relays were used to control the firing of artillery, and other computing functions.

Beginning in 1920, barrier-layer rectifiers and photocells became commercial devices that were used in power supplies, battery chargers and photographic expo-



sure meters and, in the case of copper-oxide rectifiers, they were used as modulators and non-linear circuit elements.

Study of semiconductor characteristics

In 1925, E. Merritt demonstrated rectification between a metal point contact and germanium. There was a great deal of interest in high frequency limitations of rectifiers and why the point contact rectifiers had a much higher cutoff frequency than the larger area barrier devices, such as copper oxide or selenium. Later, these differences were recognized to be the result of differences in geometry rather than the property of the device. By 1930, researchers believed that electrical conduction within the semiconductor obeyed Ohm's Law and photoconductivity was due to an increase in the number of carriers by light excitation.

Would semiconductors amplify?

The analogy between the vacuum tube and the semiconductor diode was obvious in the 1930s. A vacuum tube diode can be operated as a negative resistance and act as an active circuit element. During this time, there were some diodes that exhibited negative resistance at frequencies as high as several MHz, but they were very unstable and difficult to manufacture.

The fundamental physics of this problem was not understood but the most widely-accepted explanation was based on thermal effects arising from the large negative temperature coefficient of resistance. The counterpart of these early negative resistance diodes are now known as negative or positive "gap" diodes.

Using the analogy of the vacuum tube, there were many researchers that were suggesting putting a grid in the semiconductor diode and the results would be an active triode with amplifying possibilities.

The solid-state triode

In 1938, R. Hilsch and R.W. Pohl in Germany were working with alkali halide crystals in which the space-charge layer was made in the order of one centimeter in thickness. They put in a grid and made a solid-state triode circuit element. The frequency cutoff of their experimental device was in the order of 1Hz.

With the beginning of World War II, research on semiconductors was set aside for what was considered at that time more important work. The situation was further set back due to the lack of the publication of what was being accomplished on semiconductor work since all countries placed strict security on the release of any scientific information. After the war, Bell Telephone Laboratories established a semiconductor research group consisting of metallurgists, physicists, chemists, and engineers. Progress from this point on at Bell Labs was due to the close cooperation within its organization and review of the developments discussed up to this point.

The birth of the transistor

It was on December 23, 1947, that John Bardeen, Walter Brattain, and William Shockley of Bell Labs showed that a small piece of germanium could be made

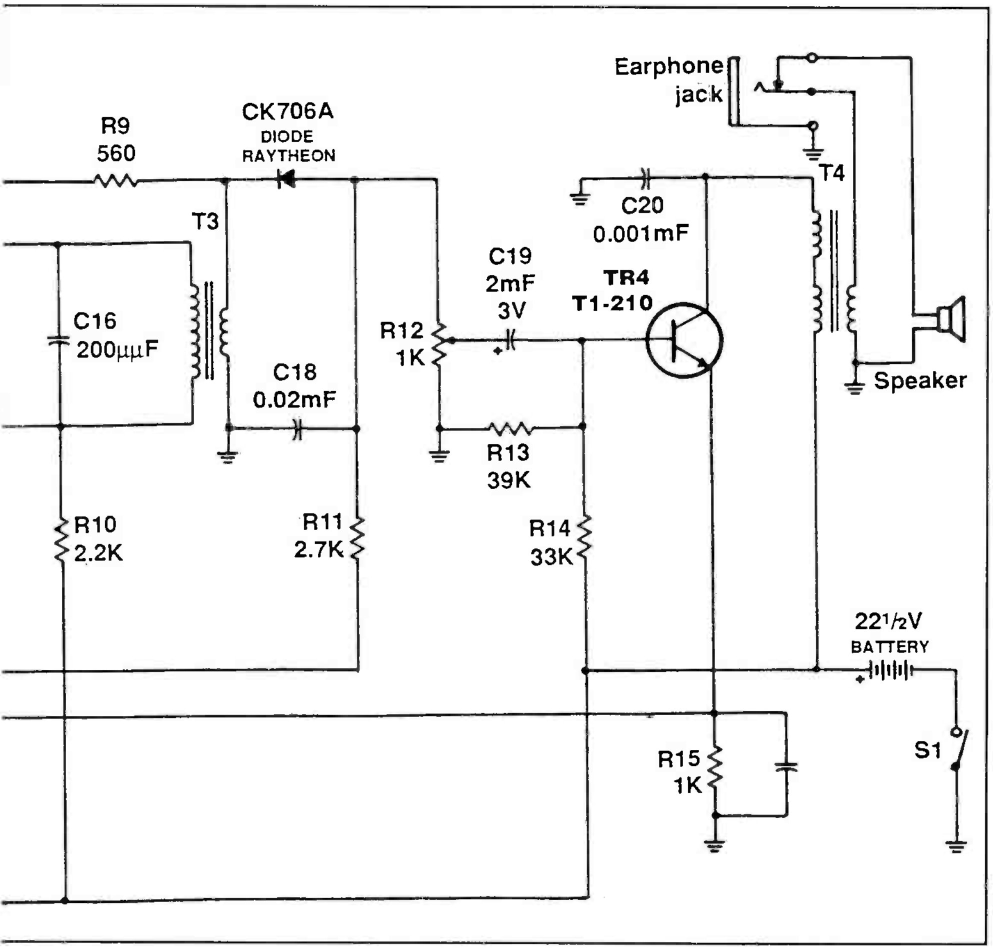


Figure 2. Schematic diagram of Regency Model TR-1. The TR-1 is a superheterodyne circuit using germanium transistors supplied by Texas Instruments. The diode detector was a germanium diode supplied by Raython (CK 706A) and in some radios Tungsol (TS 117) were used.

amplify an audio signal by 20dB. This was the birth of the transistor. Their success was achieved with a point-contact device. The original transistor was built using a germanium wafer with two closely spaced pointed-wire contacts (the old cat whiskers method) on one side and a flat metal electrode on the other side.

The resistance of one point-contact was found to depend on the current flowing through the other contact. It was John R. Pierce, a member of the technical staff at Bell Labs, who was heavily involved in vacuum tube work, who suggested the name transistor. He reasoned that the point-contact transistor was the dual of a vacuum tube, and since the resistance appeared to transfer from the input to the output, why not call it a trans(fer) (re)sistor (transistor).

A short time later, Shockley made the first grown junction transistor by eliminating the cat whiskers, which improved the extreme sensitivity to shock and temperature that the point contact transistor had. Patents were issued to Bardeen and Brattain in 1950 and to Shockley in 1951 for their respective transistors. In 1956, the three scientists received the Nobel Prize for their accomplishments, and from this point on, the semiconductor industry was off and running.

Advances in transistor technology

A continual flow of improved versions of the grown junction transistor began. Most of the innovations were due to improvements in the process, an example is the method of zone refining developed by William Pfann of Bell Labs, who made the first P-N junction.

Pfann's technique yielded pure crystals along with an improvement in the doping process. This method insured that impurities could be controlled to the point that mass production of transistors were commercially feasible.

Research conducted at General Electric, RCA, and Bell Labs led to an improved commercial process for manufacturing germanium transistors by alloying techniques. This yielded transistors with much higher switching capabilities, but limited bandwidth was a weakness in this technique and they began to work on improving the bandwidth problem.

In 1953, Philco Corporation developed the jet-etching technique in which electrochemical machining was used to fabricate the necessary thin base layers. The surface-barrier transistor, with its much improved upper frequency limit extending into the megahertz region, was the result of the jet-etching technique.

During this time, much effort was being put into improving quality and lowering manufacturing cost. This effort resulted in the introduction of the diffused-base transistor first by Motorola and then Texas Instruments. This effort led to the oxide masking technique, which played a major role in the development of the integrated circuit.

As a result of the introduction of the diffused-base transistor, Fairchild and Texas Instruments were working on the possibility of producing ICs on a single chip of silicon. Their goal was to make an IC that incorporated transistors, diodes, resistors, and capacitors, all joined into a compact packaged circuit. It was determined that the special properties needed for the various circuit elements would have to be achieved by selectively diffusing traces of impurities into the silicon or oxidizing it to silicon dioxide. Using this technique, of photolithography and selecting the regions of silicon being exposed while masking the unexposed area, was the answer.

Introduction of silicon transistors

In 1954, a small Dallas, Texas, company named Texas Instruments introduced the silicon-junction transistor, and at the same time Bell Labs developed the oxide masking and diffusion technique for fabricating transistors.

Germanium had been the primary semiconductor for making transistors, but it had one major drawback; its limited operating temperature range. With Texas Instruments' introduction of their silicon

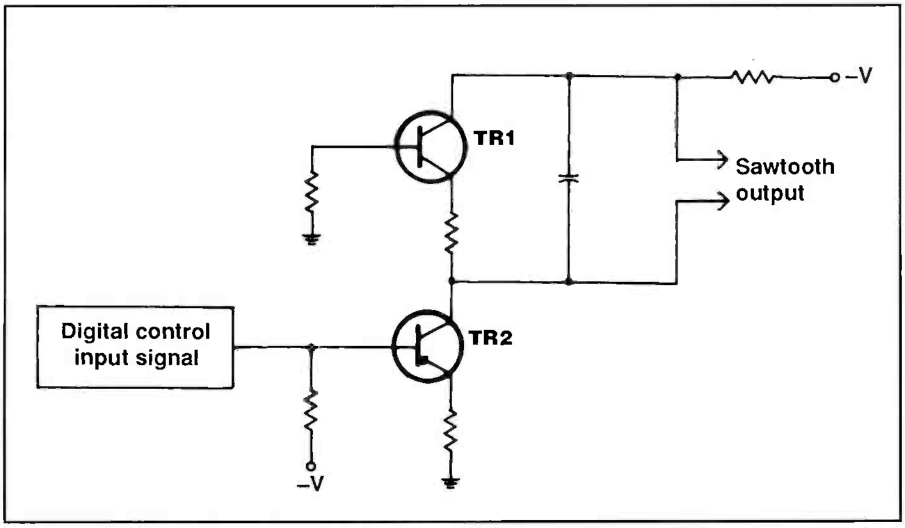


Figure 3. G.B. Herzog's frequency-controlled oscillator.

transistor types, the limited temperature range was much improved to a point that semiconductors were deemed suitable for military applications.

The introduction of the all-transistor radio

As a result of the much improved silicon transistor types available from Texas Instruments, Regency, a Division of I.D.E.A (Industrial Development Engineering Associates) Inc., of Indianapolis, IN, manufactured and marketed the world's first all-transistor radio, which became known as the Regency TR-1, shown in Figure 1. The schematic diagram of the circuit of the TR-1 is shown in Figure 2. Today the TR-1 is fetching between $300.00 and $1,000.00, depending on color and condition. Its original price was $49.95.

The TR-1 is a five-stage superheterodyne circuit using four Texas Instruments transistors. The diodes were Raytheon CK-706As and in some sets Tung Sol TS-117' were used. One of the NPN grown transistors (TI-223) had sufficient gain at high frequencies to function as a combined mixer-oscillator stage.

There are two IF stages using TI-222 transistors. The IF frequency is 262 KHz. The power supply is a single 22.5V hearing aid battery. The no-signal current drain is about 4mA. The antenna is a high-Q ferrite-core loop. The speaker, manufactured by Jensen, measures 2-3/4 inches in diameter. The output transformer was supplied by Texas Instruments.

The plastic case measures 5 inches by 3 inches by 1-1/4 inches. The radio weighs 12 ounces. There was a choice of five different colors; green, red, gray, ivory, and black. Today, the color of the case has a great deal of relevance to radio collectors because the values depend on color. The most sought after color is green. A green TR-1 radio will fetch up to $1,000, and in some cases more.

Solid-state TV

In 1954, G.B Herzog of RCA was issued U.S. patent No.2,663,800 for a frequency-controlled oscillator, shown in Figure 3. It became a key element in the world's first all solid-state television set, which was built in RCA's David Sarnoff Research Laboratories. As shown in Figure 3, the point contact transistor, TR-1, creates a pulse output that drives the horizontal output transistors via a high-efficiency complementary-symmetry pulse amplifier.

Because the experimental high-voltage power transistors of those days had so much storage delay, if the oscillator was merely locked to the horizontal sync pulse, the horizontal blanking bar appeared in the middle of the screen with half the picture on each side. This circuit was used to control the frequency via a phase-locked loop with the PNP junction transistor, TR-2, modulating the current flowing to the oscillator, thereby controlling its frequency and solving the blanking bar problem.

Other transistor applications

Near the end of 1954, Texas Instruments had increased their production volume of silicon transistors to a point where they had added two more devices (making a total of five) to their line. One of these transistors had a current amplification factor of 0.975, and the other had a cutoff frequency of 8MHz. Field experience with silicon transistors at this time indicated that they had great potential in computers, aircraft, and military applications.

By mid-1955, four more transistor radios were placed on the market. RCA introduced two models, a six-transistor type and a seven transistor model. Crosley and Emerson introduced their hybrid portables, both having two transistors and three subminiature tubes. These radios were selling at prices between $50.00 and $80.00

A new transistor manufacturing method

A new method of manufacturing transistors in, which used wire-shaped crystals rather than sliced semiconductor ingots, resulted in small-signal transistors that could be used at very high frequencies. This new method was called the "melt-back" process, which resulted in closer control of impurities because wire-shaped crystals cool much faster than the larger cigar-shaped crystals. Using the "melt-back" process produced transistors that had a greatly improved power amplification characteristics particularly at high frequencies.

The all-transistor auto radio

In 1955, Delco Radio Division of General Motors announced their all transistor automobile radio. It would be available for the first time on a production car, the 1956 Corvette. Although transistors did not replace all tubes in the Corvette radio, it was the beginning of transistors being used in the auto industry. It is interesting to note that today about 20% of a new car's cost is in its electronics.

Integrated circuits

The first Texas Instrument IC used very fine wire to bond the various elements into a functional circuit. The Fairchild IC achieved the same results but they evaporated a thin film of aluminum over the circuit elements and etched it selectively, thus leaving a two dimensional network. This technique, invented by Fairchild, resulted in what became known as planar integrated circuits, and is now known as the "planar process."

Later, Fairchild commercially introduced the first metal-oxide silicon (MOS) transistor. In 1957, Texas Instruments introduced the first monolithic integrated circuit and in 1958 J.S Kilby developed a phase shift oscillator using a single silicon bar. Kilby's oscillator did not use any interconnections from one component to another since all electrical connections were through the silicon.

SCRs, zeners, and PIN diodes

The silicon-controlled rectifier (SCR) was a Bell Lab invention. In 1956, General Electric Company introduced the first commercially available SCR; the solid-state replacement for thyratron tubes that were being used in control and switching systems. As a result of the work at Bell Labs, there were many other devices that became commercial successes, such as zener and PIN diodes.

The first commercial zener diode was introduced by National Fabricated Products, which later National Semiconductor. The double base diode, which became known as the unijunction transistor, was the result of research at the General Electric Research Laboratories. This development was announced in 1953.

In 1958, General Electric affiliate CFTH in France announced the first commercially available field-effect transistor (FET). Soon after, a U.S. company, named Teledyne Crystalonics, announced their FET. There were many spin-offs from research laboratories and manufacturing processes that gave us new devices, such as the tunnel diode and the Gunn diode. Many technical advances were being made world-wide.

New semiconductor materials and techniques

In early 1950, Siemens in Germany had discovered gallium-arsenide during their research work on semiconductors and IBM was the first to announce the use of gallium arsenide by introducing the Gunn diode. During this same year, IBM also announced the first microwave gallium-arsenide FET, also known as the Schottky barrier transistor.

The Esaki diode, better known as the tunnel diode, was first built in 1957 at the Sony Research Laboratories in Japan. At that time, there were some who believed that the tunnel diode would replace the transistor. As we all know now, this never happened, but it did play a vital role in the replacement of special purpose tubes being used at high frequencies.

In 1965, Bell Laboratories introduced TRAPATT (Trapped Plasma Avalanche Triggered Transit) diode circuits in which the mode of operation of the device is characterized by high efficiency and their ability to operate at frequencies well below the transit-time.

More power, higher frequencies, more functions

Soon the rush was on to increase power handling capabilities and go for higher frequencies with silicon and germanium transistors. Increasing power handling capabilities required an increase in the size of the transistor die. Increasing the size of the die lowered the frequency at which it could operate. It was possible to achieve both increased power handling and frequency, but the cost per transistor would increase tremendously.

In the 1960s, ICs took over the spotlight and the functions available grew endlessly and prices kept dropping. At the beginning, resistor-transistor logic (RTL) seemed to be the way to go.

In 1962, Signetics introduced the first diode-transistor logic (DTL) and in 1963 Sylvania announced their transistor-transistor logic (TTL) IC.

In early 1964, the overlay geometry in producing high-power high-frequency transistors was developed by RCA and they introduced the first commercially produced overlay transistor, the 2N3375, which produced 10W output at 100MHz, and could handle 4W at up to 400MHz.

The important feature of the overlay process was that part of the emitter metal was layered over the base instead of being placed next to it and the emitter and base were insulated from each other by a silicon dioxide layer.

Higher density, more capability

In 1967, RCA brought out the first MOS memory 64 bit ROM and Texas Instruments introduced the worlds first handheld electronic calculator. In 1970, Intel introduced the first 1-Kbit DRAM and in 1974 came Motorola's 6800 microprocessor. In 1975, the first PC was on the market. In 1978, Texas Instruments brought out their Speak and Spell speech synthesis technology and Intel introduced their microprocessor. In 1986, DRAM density was 4Mbits and rose to 16 Mbits in 1988. In 1993, Intel introduced their Pentium and in 1994 Digital Equipment Corporation introduced Alpha.

In 1996, Hitachi announced that their laboratory had integrated 300,000 components into a single chip that requires very little power and they also had developed a 390,000 pixel imaging chip.

No end in sight

Here we are today in 1999 and we hear researchers saying they foresee us reaching the ultimate limit of miniaturization where motors, machinery, electronic materials, and complete systems will be assembled from scratch, atom by atom, and molecule by molecule. Even in 1948, no one foresaw us working with picosecond timing and the small system packages we have today.

The beat goes on. Years from now, continuing microminiturization, and the introduction of more new technology, will result in electronic marvels that no one living today could possibly foresee. ■

A tool for diagnosing SCSI problems

by Philip M. Zorian

An article in the January 1999 issue of this magazine, introduced the use of SCSI (pronounced "Scuzzy") Small Computer System Interface devices by describing the advantages, and the drawbacks, of using them. SCSI tends to be more expensive, and somewhat more complicated to install than other interface schemes.

But the decision to upgrade to a SCSI Hard Drive, or a SCSI Scanner, is usually based on one overriding factor: the need for greater performance. With the ability to transfer data at a rate of 80 MB/sec. (Adaptec, Inc's new 3950U2 SCSI Host Adapter Card is capable of moving data at 160 MB/sec.), the SCSI interface is well-suited for non-linear (computer based) video editing, computer graphics, high-resolution scanners, CD-recorders, data backup, and more.

While SCSI offers a number of performance benefits — it also supports up to 15 devices on a single port — it can be difficult to troubleshoot. This article introduces an important piece of test equipment: The SCSI Vue Active Diagnostic Terminator from Granite Digital. This inexpensive — and easy to use — tester provides critical information on the status of the SCSI Bus, providing the technician with a useful tool when troubleshooting SCSI devices. The Active Diagnostic Terminator is a combination of SCSI Bus analyzer, SCSI Bus monitor, and an "active" terminator. (All SCSI Buses require termination at both ends of the bus.)

What is termination?

The SCSI terminator is a small electric circuit that prevents reflection of the signals as they reach the end of the bus. The simplest form of terminator, passive, consists of a 220Ω resistor, and a 330Ω resistor. The passive terminator scheme, although less expensive, has one disadvantage: fluctuations in the termination voltage can show up on the data lines of the bus and cause errors.

Active terminators, however, include a voltage regulator to reduce the effect of fluctuations in termination power. The scheme provides a more stable SCSI signal and fewer data errors. A more advanced scheme uses diode clamps to force the termination to the correct voltage, eliminating signal reflection even further. Active termination is the minimum required for faster-speed SCSI buses.

Zorian is the director of the video/audio department at the school for international training in Brattleboro, VT and is the owner of Phil's VCR Repair.

The SCSI Bus

The SCSI Bus consists of two parts: the data lines and the control lines. The data lines carry computer data, while the control lines carry timing, device selection, and control signals.

Figure 1 is a pin-out diagram of a 50-pin SCSI Bus. Notice that more than half of the lines are referenced to ground: pins 1 through 25, 35, 36, 39, 40, and 42. Notice that pins 26 through 34 provide the eight lines for the eight bits wide SCSI Data signal, plus one parity bit. This is the SCSI Data Bus.

The SCSI Vue Diagnostic Terminator monitors four control lines:

- Line #38 Termination power
- Line #44 Acknowledge
- Line #47 Select
- Line #49 Request

The diagnostic terminator

As shown in Figure 2, the analyzer has four LEDs that are used to monitor four control lines on the SCSI Bus. By "reading" the LEDs, the analyzer provides the technician with information on the status of the SCSI Bus. The LEDs monitor the bus during the following operations:

- When transferring data to a peripheral device
- When transferring data from a peripheral device
- When no data is being transferred
- During initial boot-up

Pin	Signal Name	Pin	Signal name
1	Ground	26	-Data Bit(0)
2	Ground	27	-Data Bit(1)
3	Ground	28	-Data Bit(2)
4	Ground	29	-Data Bit(3)
5	Ground	30	-Data Bit(4)
6	Ground	31	-Data Bit(5)
7	Ground	32	-Data Bit(6)
8	Ground	33	-Data Bit(7)
9	Ground	34	-Data Bit(P)
10	Ground	35	Ground
11	Ground	36	Ground
12	Ground	37	Ground
13	Not Connected	38	TERMPWR (Fuse)
14	Ground	39	Ground
15	Ground	40	Ground
16	Ground	41	-Attention
17	Ground	42	Ground
18	Ground	43	-Busy
19	Ground	44	-Acknowledge
20	Ground	45	-Restart
21	Ground	46	-Message
22	Ground	47	-Select
23	Ground	48	-Data/Control
24	Ground	49	-Request
25	Ground	50	-Input/Output

Figure 1. This is a pin-out diagram of a 50-pin SCSI Bus. Notice that more than half of the lines are referenced to ground: pins 1 through 25, 35, 36, 39, 40, and 42. Notice that pins 26 through 34 provide the eight lines for the eight bits wide SCSI Data signal, plus one parity bit.

Therefore, it is important for the technician to become familiar with the LEDs by connecting the analyzer to a working system. Again, referring Figure 2, the LED indicators are defined as follows:

- Termination Power (TRM-Green LED): This indicator must always be on or active. It monitors the presence or absence of Termination Power on the SCSI Bus. If it is not lit, the Bus will not operate properly.
- Select Line (SEL-Yellow LED): A blinking light indicates that a device has been selected, and data is being transferred, either to a peripheral device or from a peripheral device.
- Request Line (REQ-Red): A dim light indicates that a peripheral device is requesting a response from the host.

Figure 2. The SCSI bus analyzer has four LEDs that are used to monitor four control lines on the SCSI Bus. By "reading" the LEDs, the analyzer provides the technician with information on the status of the SCSI Bus.

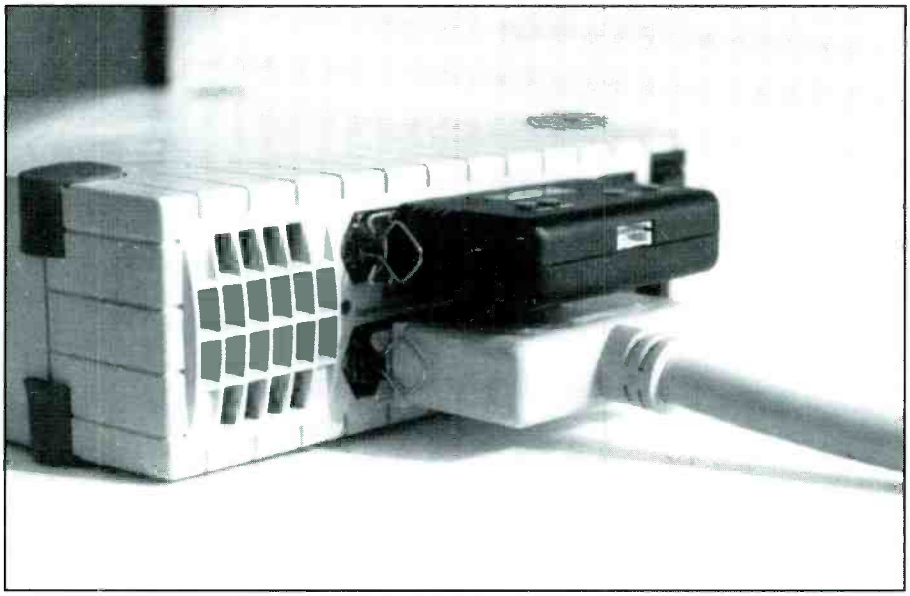


Figure 3. When you encounter a problem on a SCSI bus, always first inspect, and then test the cables, since they are the easiest part of the Bus to test. Check the cables for cracks and breaks, especially around the strain relief.

• Acknowledge Line (ACK-Red): A dim light indicates that the host computer is responding to the request from a peripheral device.

Note: A "dim light" indicates the presence of a high frequency signal. It is dim because the LED is turning ON and OFF.

It is the host adapter card, the connecting cables, and the peripheral device(s) that make up the SCSI Bus. Therefore, when a problem occurs, one must identify which component of the Bus is faulty.

Consider, for example, the situation where the SCSI peripheral is an external hard drive. (The icon for the external SCSI hard drive is found by opening the "my computer" icon — perhaps labeled as the 'E' drive.) If the icon for the SCSI drive is visible, you must be able to save a file by dragging and dropping a file to it. Once you save a file to the external SCSI drive, you must be able to "open" the drive and verify that the file has been saved there. If the file is there, you must be able to open the file. (For instance, if the file originated as an Excel spreadsheet, it should open as an Excel spreadsheet.)

In order to accomplish the preceding steps, the SCSI Bus must perform to the degree that you are able to write data to the SCSI drive, and read data from the SCSI drive. Typically, when a fault occurs in any component of the SCSI Bus, you lose the ability to transfer data to the hard drive, or from the hard drive. Or, the system locks up when you try to use the device.

By observing a combination of LED indicators during the read/write operations, the technician can determine where the problem originates. Each of the following six combinations provides critical information when a peripheral is not working, or the computer locks up.

1. All four LEDs are OFF. First, this indicates there is no termination power. This condition also indicates that there is no activity on the Bus.

2. All four LEDs are ON. This indicates that the target device is faulty and is hanging up the SCSI Bus.

3. The SEL, TRM, and REQ LEDs are ON, but the ACK LED is OFF. This indicates that the host adapter card is faulty and is hanging the SCSI Bus.

4. The SEL, TRM, and ACK LEDs are ON, but the REQ LED is OFF. This is another indication that the host adapter card is faulty and is hanging the SCSI Bus.

5. The SEL and TRM LEDs are ON, while the ACK and REQ LEDs are OFF. This is an indication that the target is either waiting for the next command from the host, or the target is reconnecting and hanging the SCSI Bus.

6. The TRM LED is ON, while the ACK, REQ, and SEL LEDs are OFF. This indicates the host is faulty, since peripheral is waiting for the next command.

Test the cables

It is always important to rule out the simple things. One should always inspect, and then test the cables since they are the easiest part of the Bus to test. Check the cables for cracks and breaks especially around the strain relief (Figure 3). When troubleshooting the Bus, remove each cable and visually inspect it to make certain the contacts are all straight and clean. If you observe oxidation or tarnishing on the contacts, clean them gently with an eraser or a good contact cleaner. The final step is to simply verify the integrity of a cable by replacing it with a known good one.

Conclusion

Since the SCSI Bus is difficult to troubleshoot with a number of peripherals connected, the logical approach is to disconnect everything external to the computer. This will allow you to verify, or rule out the possibility, that the problem originates from the computer itself. Of course, you may even want to remove the host adapter card. This is an important step, since you want to be certain that the problem is located somewhere on the SCSI Bus. The next step is to re-install the host

"Since the SCSI Bus is difficult to troubleshoot with a number of peripherals connected, the logical approach is to disconnect everything external to the computer."

PHOTOFACTS

EMERSON
TC1973D (Version A) 4135

FISHER
G5K-36S800 4136
PC-36S80 4136

GE
CTC187AB 4138
25GT539FE1 4138
25GT539YX1 4138
27GT621FE1 4138
27GT621YX1 4138

ORION
TV1319 4130

PANASONIC
AEDP311 4133
CT-32G23CW 4133
CT-32G23UW 4133
CT-32G23W 4133

RCA
CTC185AA2 4142
F25209BCTX1 4142
F25209WTTX1 4142
F25211BCTX1 4142

SANYO
DS19380 4132
DS19580 4139
VHR-M107 ....VCR-309
19380-01 4132
19580-00 4139

SHARP
CK32S40 4141
CK36S40 4141
32K-S400 4141
36K-S400 4141

SONY
KV-20V80 4134
KV-27S40 4131
KV-29SL40 4131
KV-29XL40M 4131
KV-29XL40P 4131
SCC-S01D-A 4134
SCC-S01H-A 4131
SCC-S02D-A 4131
SCC-S03B-A 4134
SCC-S03E-A 4131
SCC-S04R-A 4131
SCC-S04X-A 4131

ZENITH
A09P02X 4137
A27A74R 4140

adapter card, and then hook up one peripheral a time.

For those who want to learn more . . .

The following are a number of organizations that can provide more information about SCSI:

The SCSI Trade Association

A group of industry leaders supporting the use and development of Small Computer Systems Interface technology in storage and peripheral applications — <http://www.scsita.org/>.

SCSI Experts

If you have technical questions about SCSI, submit them to a panel of SCSI experts at <http://www.scsita.org/expert/index.html>.

The T10 Committee

The committee responsible for the SCSI technical standard. This is the place to find more information about I/O Interfaces, especially SCSI, SCSI-2, and SCSI-3 — <http://www.symbios.com/t10/Welcome.html>.

SCSI in the News

If you're looking for breaking developments, especially good for news about Ultra3 SCSI — <http://www.scsita.org/press/ scsinews.html>.

Internet News Group

If you have access to News Groups, check out: < news:comp.periphs.scsi>.

SCSI FAQ

A thorough and comprehensive list of questions on using SCSI. (Vol. I & II) Currently maintained by Gary Field, posted to Usenet during the first week of each month — <http://www.cis.ohio-state.edu/hypertext/faq/usenet/scsi-faq/top.html>.

The PC Guide to SCSI

A very thorough overview of the SCSI interface. It covers Standards, Protocols, Host Adapters, and Configuration and Cabling — <http://www.pcguide.com/ref/hdd/if/scsi/index.htm>.

Companies that can provide useful information on SCSI. Each company site has information on SCSI Technology.

Granite Digital
<http://www.scsipro.com>
Advansys
<http://www.advansys.com>
Adaptec
<http://www.adaptec.com> ■

ES&T Calendar

Electronic Distribution Show:
EDS '99
May 18–20, 1999
Educations Programs — May 17th
Las Vegas Hilton Hotel
Las Vegas, NV

Electronic Distribution Show Corp.
222 South Riverside Plaza, Suite 2160
Chicago, IL 60606
312-648-1140 • Fax: 312-648-4282
Website: http://www.edsc.org
E-mail: eds@edsc.org

National Professional Service Convention
August 2–7, 1999
(Trade Show August 4 and 5)
Hotel Intercontinental
Dallas, TX

NESDA
2708 W. Berry
Fort Worth, TX 76109-2356
817-921-9061 • Fax: 817-921-3741
Website: http://www.nesda.com

PCS '99
September 22–24, 1999
New Orleans, LA
703-739-0300

Consumer Electronics Manufacturers Association (CEMA)
2500 Wilson Blvd.
Arlington, VA 22201-3834
703-907-7600
Website: http://www.cemacity.org

Let's talk about tuners: the CTC 187 chassis

by Bob Rose

This article is the second part of a two-part article. Part one attempted to explain how a typical, electronic tuner works with particular reference to Thomson's tuner-on-board technology. In this installment, I will build on the theory expounded in part one by dealing with some typical tuner problems in the CTC187 chassis. I suggest you have part one available as a reference as you read this installment.

Preliminary observations

Before getting into the article itself, here are a few preliminary observations.

1. The information I am about to convey is applicable, though in modified form, to any chassis with the tuner-on-board (TOB), including the CTC175/176/177/187, the CTC185, and the CTC195/197. I say "in modified form" because the latest chassis use a different microprocessor, omit the summing amp, utilize a new tuner controller IC, and employ and modified tuner wrap/shield.

2. Thomson says troubleshooting the tuner is best accomplished using a digital multimeter. Their engineers believe that the average technician can isolate tuner failures in a reasonable amount of time by making voltage and resistance checks. I reply, "yes and no." I still stumble upon an occasional chassis that, for a variety of reasons, I have to pull and send to a repair depot. In most instances, I just don't have the time to chase down the problem because other jobs are demanding attention. I do agree that a good DMM is your best troubleshooting tool, but I will add that you will need a scope to make a few of the measurements, such as checking the 4MHz crystal.

3. *Never* repair these tuners without first checking and resoldering the tuner wrap, if it is necessary. I know Thomson says, "The tuner wrap problem has been solved." I agree, because I almost never see the problem in the newer chassis, but I see no need to take unnecessary chances. The "wave soldering" used in manufacturing isn't one hundred percent reliable. It can and does leave certain areas unsoldered, which means somebody has to finish the job. Therefore, inspect the tuner shield and solder it if you think it needs it. Be safe; don't be sorry.

4. If any of the varactor diodes have to be replaced, all the diodes in the respective (VHF or UHF) circuit must be replaced. These diodes are matched for capacitance characteristics and come as a set. If you replace one without replacing the others, the tuner will not work properly. The diodes in the VHF circuit are: CR7106, 7107, 7108, 7111, 7111, 7302, and 7305. The diodes in the UHF circuit are: CR7101, 7103, 7114, 7301, and 7304. The Thomson stock number for the diode kit is 215494.

5. Before you even think about changing a part or parts, check the supply voltages. I know I am stating the obvious, but I have seen technicians miss this step before. I still remember the CTC175 that I just knew had a defective controller chip. I changed it, and the tuner still didn't work. I had failed to check the +33V tuning voltage. These tuners must have four voltages to work: +5V, +12V, -12V, and +33V.

6. Keep your solder connections clean and smooth, and don't use more solder than you need.

7. Never tinker with the coils on the top of the circuit board and underneath the tuner shield. If you move one or more of the windings, or reposition a coil, you may have to go through a painstaking coil alignment procedure to get the tuner to work properly again.

8. Remember EEPROM problems can lead you to believe you have a tuner problem when you don't. If you encounter a "slick raster" and no audio, check the EEPROM by replacement before you troubleshoot the tuner. I have written so much about the EEPROM and the trouble it causes, I hesitate to say anything about it here. Let me refer you to an article in the July, 1997 issue of **ES&T**, "Servicing EEPROM Problems in RCA Televisions," if you think you need additional information.

9. Ninth, give the tuner a thorough performance test. Does the tuner tune channels on all bands but one? If it does, then U7501, U3101, U3201, U7401, and at least part of U7301 are working. Will it tune low band VHF but not high band? If it does, you can limit your troubleshooting to the appropriate circuitry. Thorough performance testing will tell you a lot about where the problem is and save you time over the long haul.

10. Don't trust an off-the-air signal for tuner troubleshooting or alignment. Use a good signal generator. If you can't afford one of the major brands sold today, consider getting one RCA developed as a tuner alignment aid, the TAG001. It makes a fairly useful addition to your test equipment collection.

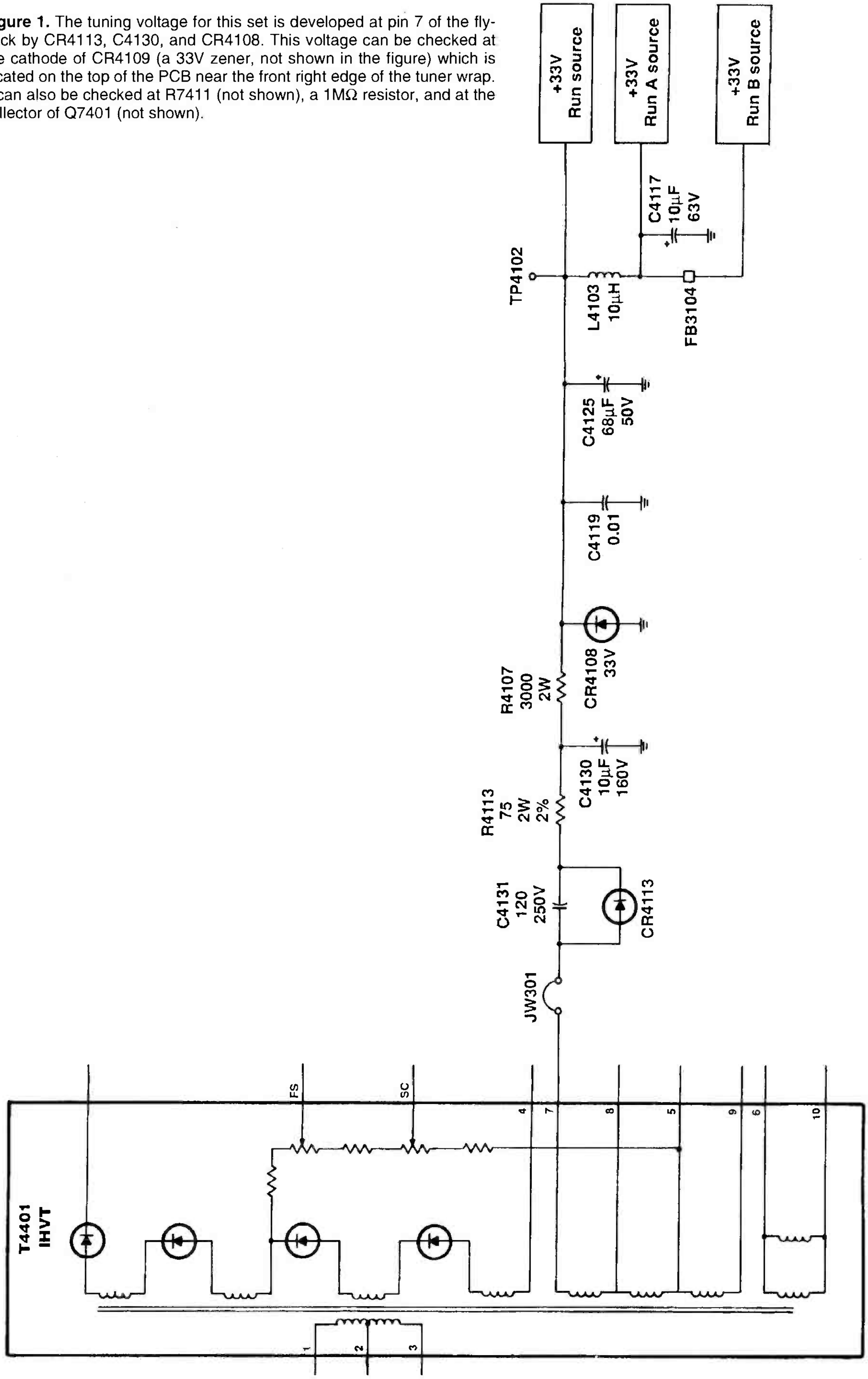
Some useful reading material

You might be interested in applicable literature. If you are, I suggest a booklet I have recommended in the past, CTC 177/187 Troubleshooting Guide. It has a lot of useful information packed into 41 pages. Even if you use Sam's Photofacts, I suggest that you obtain a copy of Thomson's service literature for the CTC187 chassis. The factory literature adds the alignment procedures, a troubleshooting chart for the tuner, an operating guide, and a comprehensive parts list to the usual schematic data.

If you care to read further, I suggest issues #170 and #171of Sencore News. The former has a helpful article on tuner repair, "Quality Repairs for 'On the

Rose is an independent consumer electronics business owner and technician.

Figure 1. The tuning voltage for this set is developed at pin 7 of the flyback by CR4113, C4130, and CR4108. This voltage can be checked at the cathode of CR4109 (a 33V zener, not shown in the figure) which is located on the top of the PCB near the front right edge of the tuner wrap. It can also be checked at R7411 (not shown), a 1MΩ resistor, and at the collector of Q7401 (not shown).



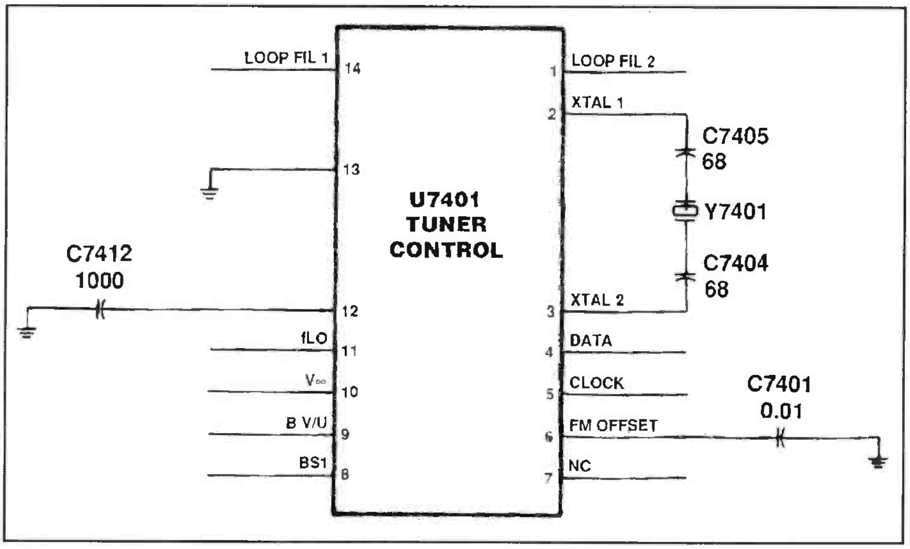


Figure 2. Crystal Y7401 develops the reference signal for the tuner controller IC, IC7401. Look for a 4MHz signal at about 1V_{PP}. A defective crystal will cause one of two problems: a completely dead tuner or one that drifts off frequency.

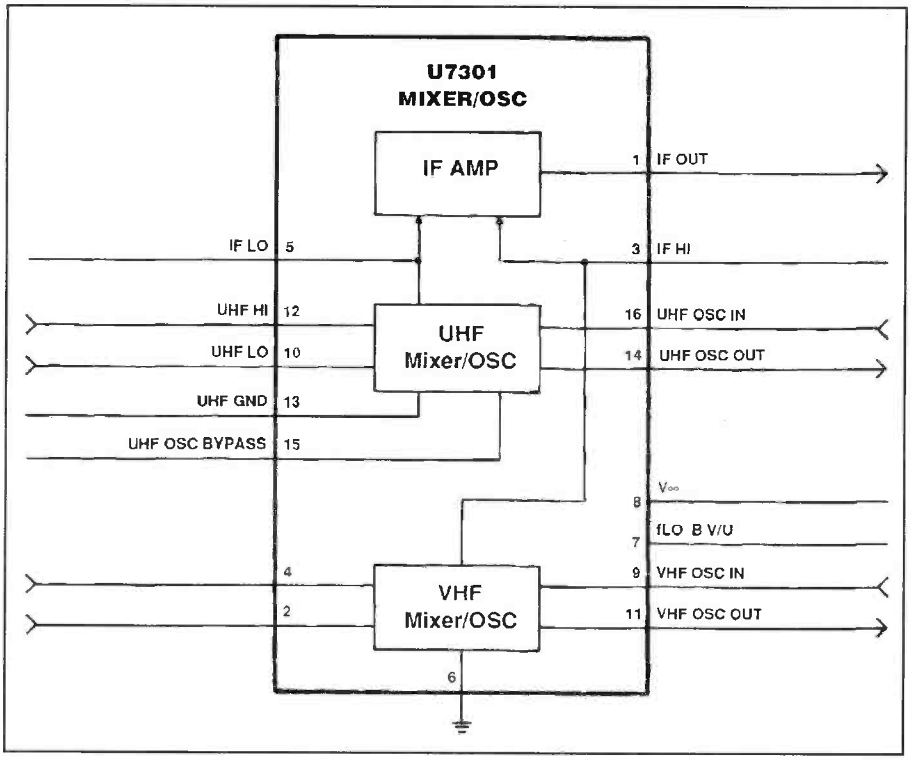


Figure 3. If you encounter a CTC187 for which the tuner is inoperative on all cable channels, try tuning UHF channels. If you get good picture and sound, you know that at least a part of the tuner is working and that the problem will be in the oscillator-mixer, or the tuner controller, or related circuitry.

Board' Tuners." The latter deals with alignment procedures: "Service Alignment of the RCA/GE CTC175/176/ 177 Chassis. Both are worth your time.

Four common problems

I always hesitate to talk about common problems because I doubt there is a "common problem" in the world of electronics. You know what I am talking about if you have been in the service business for a long time. With this reservation, let me share four problems I have serviced more often than others.

Loss of the +33V tuning supply

The tuning voltage is developed at pin 7 of the flyback by CR4113, C4130, and CR4108 (Figure 1). This voltage can be checked at the cathode of CR4109 (a 33V

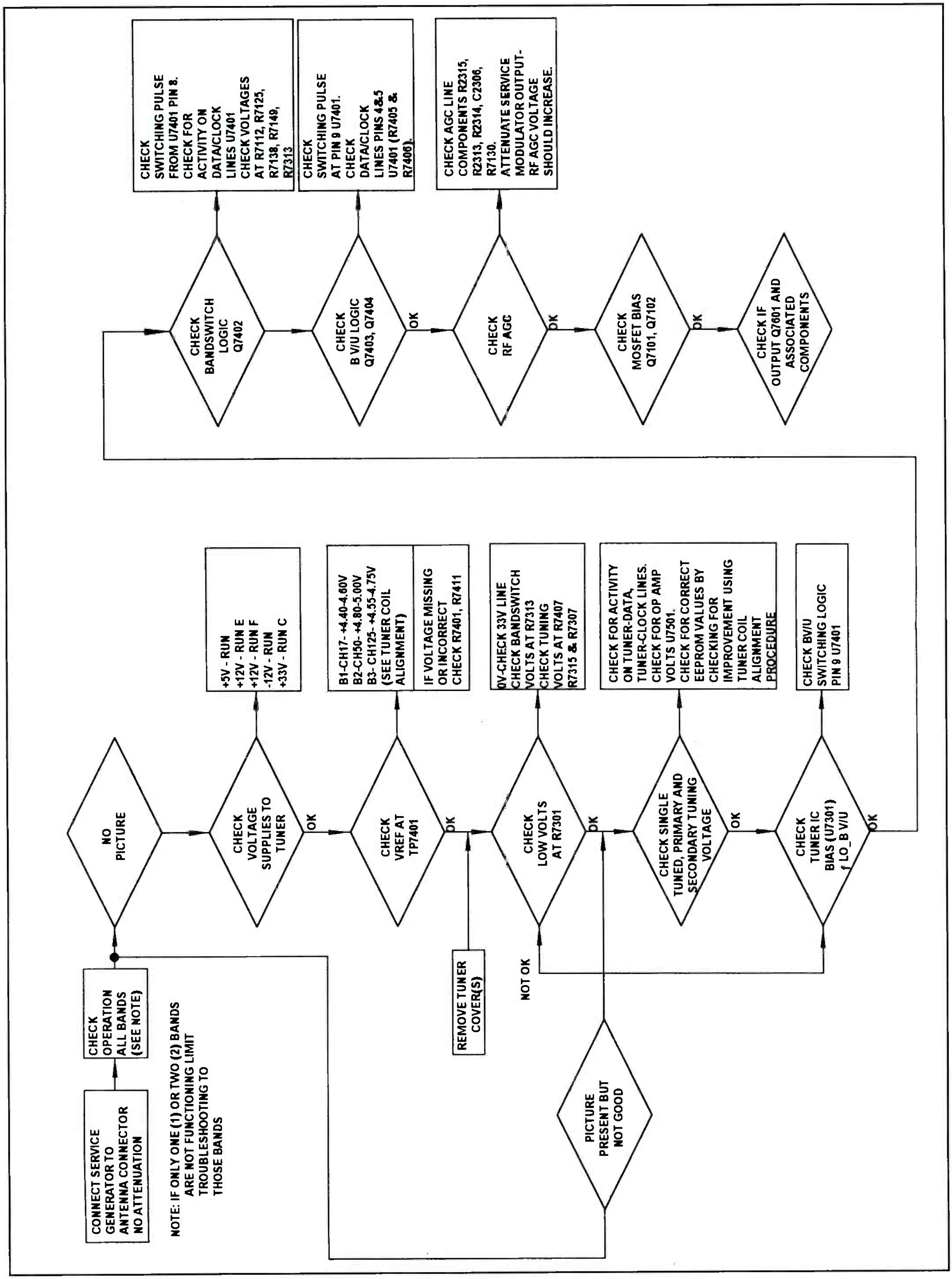


Figure 4. Following this flow chart may help you diagnose problems in the tuner on board (TOB) circuits.

zener, not shown in the figure), which is located on the top of the PCB near the front right edge of the tuner wrap. It can also be checked at R7411 (not shown), a 1MΩ resistor, and at the collector of Q7401 (not shown). Lightning often damages the zener, which removes the tuning voltage, rendering the tuner inoperative. I have also known of three instances in which R7411 opened.

A defective Y7401

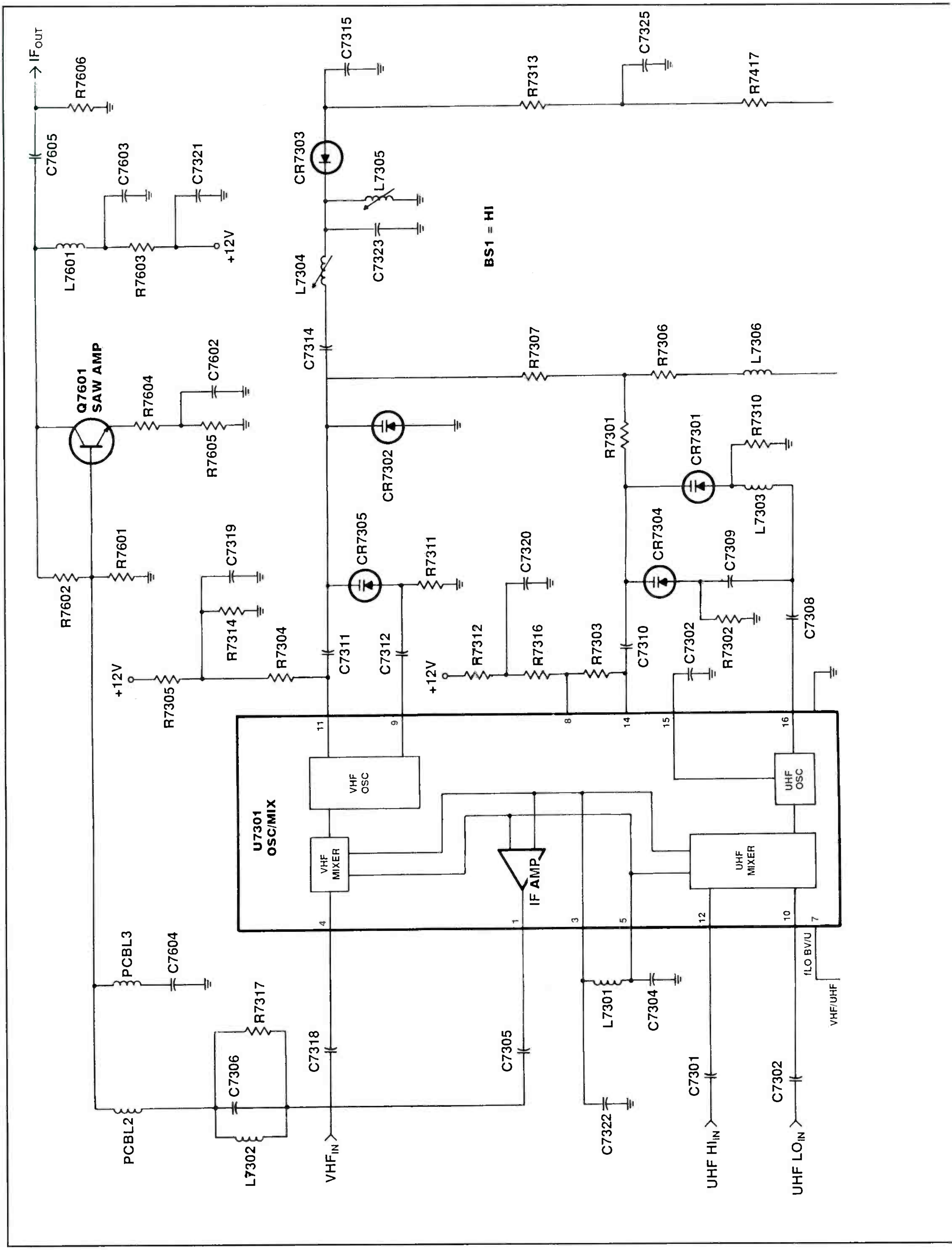
Crystal Y7401 (Figure 2) develops the reference signal for the tuner controller IC, IC7401. Look for a 4MHz signal at about $1V_{PP}$. A defective crystal will cause one of two problems: a completely dead tuner or one that drifts off frequency. If you service a set that drifts off frequency when it warms up, try spraying the crystal with freeze spray. If the frequency corrects itself, you know you are dealing with a defective crystal. You can also use a scope to check the frequency. Early production models of the CTC175/76/77 had a similar problem. After the set warmed up, the picture would fade to snow, and the audio would fade to "white noise." RCA issued a technical bulletin instructing the technician to spray the crystal with coolant to see if video and audio returned. If both returned, the tech was instructed to replace the crystal.

I serviced a CTC187 just last week that had, I guess you could say, the problem in reverse. The customer complained, "The picture is snowy until the TV has been on for about ten minutes." He was correct. The TV had to be on for about ten minutes before video and audio appeared. I used a scope to check the crystal and found that it did not begin to oscillate until the chassis had warmed up.

The oscillator-mixer, U7301

Let's assume you accept a CTC187 for service, and when you check it, you find the tuner inoperative on all cable channels. You want to be thorough, so you instruct the microprocessor to tune UHF channels. Lo and behold, you get good picture and sound. You now know that at least a part of the tuner is working and that the problem will be cause by a fault in the oscillator-mixer, or the tuner controller, or related circuitry.

Using the information I will shortly give, check pin 7 (Figure 3) for 3V for


IF OUT
R7606
C7605
C7603
C7321
L7601
R7603
+12V
Q7601
SAW AMP
R7604
C7602
R7605
R7602
R7601
C7319
R7314
R7304
R7305
+12V
PCBL3
C7604
R7317
C7306
PCBL2
L7302
C7318
VHF IN
C7315
CR7303
L7305
C7323
L7304
C7314
CR7302
CR7305
R7311
C7311
C7312
C7320
R7312
R7316
R7303
+12V
C7305
R7313
C7325
R7417
BS1 = HI
R7307
R7306
L7306
R7301
CR7301
R7310
L7303
CR7304
C7309
C7310
C7302
R7302
C7308
U7301
OSC/MIX
VHF OSC
VHF MIXER
IF AMP
UHF OSC
UHF MIXER
L7301
C7304
C7322
C7301
UHF HI IN
C7302
UHF LO IN
ILO BV/U
VHF/UHF

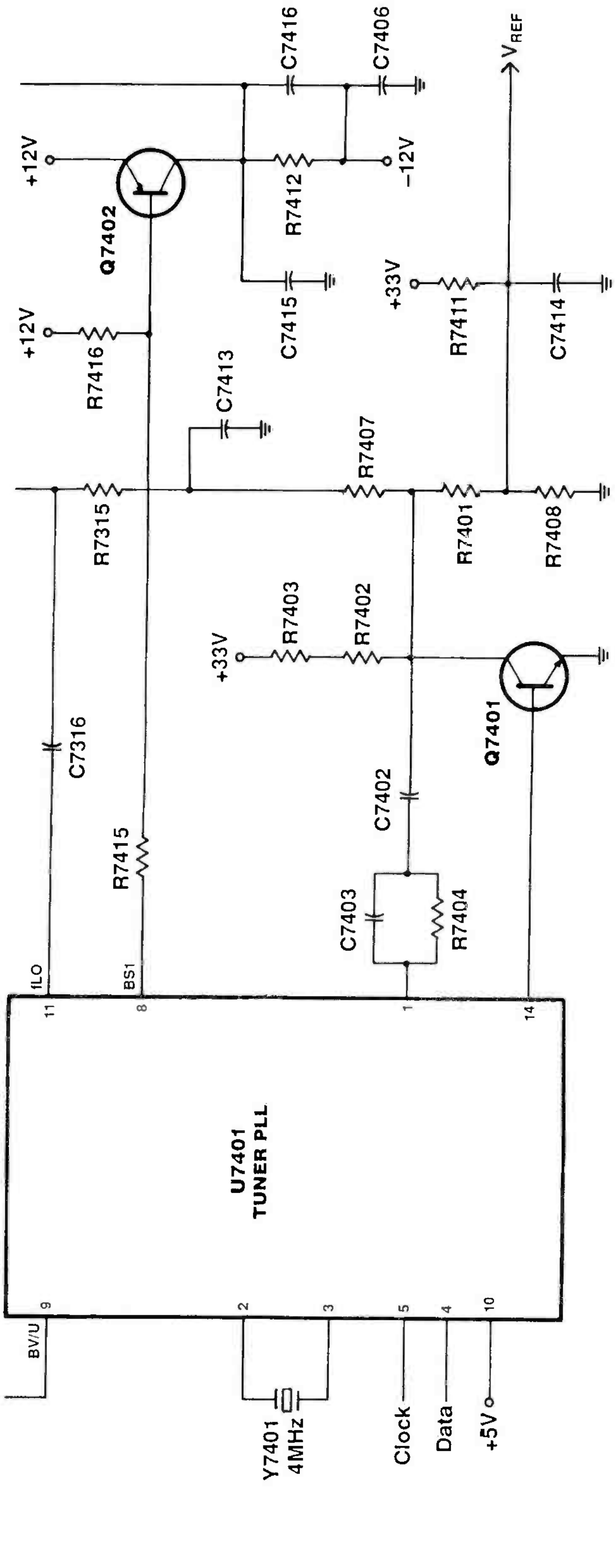


Figure 5. As you can see from this schematic diagram, there are a number of components between the tuner and the if input into the T Chip, for example Q7601 (the SAW amp).The T Chip itself could also be the problem. Remember to rule out IF problems before you plunge elbow deep into the tuner.Don't forget to check the tuner voltages: +5V, +12V, -12V, and +33V.

VHF and 0V for UHF. If the voltage is correct, check for the appropriate band switching voltage at pin 9 of the controller IC. If that voltage is also correct, you have probably isolated the problem to the oscillator-mixer. You can confirm the diagnosis by attempting to inject a VHF signal of the appropriate strength into U7301 at pins 2 and 4. If you get good picture and sound, you know the problem lies elsewhere. If picture and sound do not appear, you should change U7301. I have seen the problem so often, I keep at least one of these IC's in stock at all times.

The tuner controller, U7401

A CTC175 I recently repaired illustrated the kind of problem U7401 causes. The TV sort of received channel four when I asked it to tune channel four. It also received channel four on all low band VHF channels and completely lost picture and sound on high band VHF channels. Don't let the fact that this is a surface mount chip intimidate you into not changing. It's easier than you think. I use an exacto knife to cut the leads off as close to the body of the chip as possible, then I lift it off the circuit board and use desoldering braid to remove the leads I just cut. I complete the removal process by using a swab moistened with alcohol to clean the pads. A product called "Chip Quik" is a great aid in chip removal. It's relatively inexpensive and very easy to use. If you are interested in learning about it, I suggest you look it up in one of the distributors' catalogs.

Troubleshooting the tuner on board

Some technicians may prefer to work with a flow chart, something I find rather tedious. But each his/her own, as the old saying goes. If you like flow charts, you should be delighted with Figure 4. I took it directly from RCA's service literature for the CTC187. It is more detailed than the procedure I am about to give you and, I think, a bit cumbersome to work with, but it does work. Since it is cumbersome, I prefer to use a different technique. The approach I am about to suggest divides tuner problems into one of three categories:

1. one band inoperative,
2. picture present but not good, and
3. no tuning.

Like any tuner, the TOB on the CTC187 can cause a variety of problems. I can't give you a "one chart fixes all," and I won't attempt it. But I do hope the following procedure gives you an idea and an approach that will lead you to solve at least most of the tuner problems you encounter.

One band is inoperative

If one band is inoperative, begin troubleshooting by checking for the presence of -12V and +12V.

If the problem is "no VHF" but good "UHF" (or vice versa), reread what I have written about problems with U7301. If U7301 checks good when you inject a VHF signal into it, check the biasing on Q7101 (UHF RF amplifier) or Q7402 (VHF RF amplifier.) If you find that the appropriate RF amplifier is not turning on, don't automatically condemn it. Remember Q7403 and Q7404 from part one of "Let's Talk About Tuners"? These transistors receive band-switching information and turn on/off the RF amplifiers. If you find that the appropriate RF amplifier is not turning on, don't forget to check these transistors and the switching action that controls them.

If the problem is, let us say, no low band VHF channels but good high band VHF channels, check the band switching voltage at transistor Q7402. The collector should be at about -14.9V to tune channels 2 through 6 and at about 11.1V to tune channels 7 through 13.

Obviously, other components in the tuner can cause the loss of one band. Since I cannot cover every scenario, I trust these

Varactor Diode Tuning Voltage Chart			
CABLE CHANNEL	CR7106, CR7107	CR7108	CR7111
2	0.69	1	1.1
6	4.37	5.7	6.3
14	14.92	14.5	14.9
17	26	25.5	23.5
18	1.6	1.3	1.9
13	5.7	5.5	6.7
34	11	10.5	12.8
37	12.8	12.2	14.7
48	22.8	23.1	26.2
50	24.1	24.3	26.6
	CR7101, R7114	CR7102	CR7103
51	0.6	0.64	0.69
57	1.7	1.81	1.98
63	3.06	3.28	3.68
76	6.88	7.09	7.76
83	8.92	9.08	9.83
93	11.45	11.63	12.3
110	14.43	14.73	15.61
117	16.54	17	18.2
125	19.6	21.6	26.5
Note: Voltages are approximate cathode voltages only and will vary from set to set. This chart is supplied as a basic guide for typical voltages on the alignment channels. DO NOT USE THESE VOLTAGES AS A BASIS FOR TUNER ALIGNMENT.			

Figure 6. If it becomes necessary, check the single tuned, primary and secondary tuning voltages per this table.

	Band 1		Band 2		Band3		
Pin No.	2	17	18	50	51	75	91
1.	1.36V	4.63V	1.30V	5.52V	1.20V	2.21V	2.86V
2.	1.36V	4.63V	1.30V	5.52V	1.20V	2.21V	2.86V
3.	1.36V	4.63V	1.30V	5.52V	1.20V	2.21V	2.86V
4.	33.0V	33.0V	33.0V	33.0V	33.0V	33.0V	33.0V
5.	1.06V	3.62V	1.16V	4.68V	0.99V	1.90V	2.54V
6.	1.06V	3.62V	1.16V	4.68V	0.99V	1.90V	2.54V
7.	1.07V	19.8V	1.78V	27.6V	0.54V	7.20V	11.9V
8.	0.69V	24.2V	1.30V	25.3V	0.86V	7.63V	12.5V
9.	1.01V	4.22V	1.10V	4.38V	1.01V	1.96V	2.62V
10.	1.01V	4.22V	1.09V	4.38V	1.04V	1.96V	2.62V
11.	0V	0V	0V	0V	0V	0V	0V
12.	1.06V	4.36V	1.07V	4.76V	0.99V	1.86V	2.66V
13.	1.06V	4.36V	1.07V	4.76V	0.99V	1.86V	2.66V
14.	1.02V	25.2V	1.12V	28.1V	0.54V	6.91V	12.7V

Figure 7. These are the voltages you should find at the various pins of U7501.

	Band 1		Band 2		Band 3		
Pin No.	2	17	18	50	51	75	99
1.	5.44V	5.40V	5.41V	5.40V	5.30V	5.28V	5.48V
2.	2.99V	2.96V	2.96V	2.96V	3.18V	3.17V	3.00V
3.	7.80V	7.78V	7.77V	7.75V	7.57V	7.57V	7.89V
4.	2.99V	2.96V	2.96V	2.96V	3.18V	3.17V	3.00V
5	.7.82V	7.78V	7.77V	7.77V	7.57V	7.57V	7.89V
6.	0V	0V	0V	0V	0V	0V	0V
7	3.06V	3.04V	3.05V	3.05V	0V	0V	3.08V
8.	9.02V	9.01V	8.98V	9 00V	8.84V	8.83V	9.14V
9.	3.01V	3.01V	2.98V	2.98V	3.36V	3.35V	3.01V
10.	3.26V	3.23V	3.22V	3.23V	2.88V	2.88V	3.28V
11.	4.96V	5.04V	5.07V	5.16V	9.62V	9.60V	5.14V
12.	3.26V	3.23V	3.22V	3.23V	2.88V	2.87V	3.28V
13.	0V	0V	0V	0V	0V	0V	0V
14.	9.05V	9.00V	8.98V	9.00V	5.43V	5.42V	9.13V
15.	3.43V	3.41V	3.42V	3.41V	2.88V	2.87V	3.46V
16.	3.41V	3.41V	3.41V	3.41V	2.87V	2.89V	3.47V

Figure 8. This table will give you an idea about the voltages that you can expect on the pins of U7301. Note that these voltages are typical voltages and that the readings will vary slightly from set to set because each set has its own alignment parameters.

few hints will get you into "the ball park" and help you solve your problem as efficiently as possible.

The picture is present, but it is not good

Begin by checking the AGC voltage that is applied to gate 2 of the RF amplifiers. As AGC voltage rises, drain current increases, increasing the output of the RF amplifier. As AGC voltage decreases, drain current decreases, reducing the amplitude of the RF signal. If you suspect an AGC problem, you can use an external power supply to control the RF amplifier. If you discover an AGC problem, check R2313, R2314, R2315, C2306, and R7130 in the AGC line. The problem could even be located inside the T Chip.

Somewhere near the beginning of the troubleshooting procedure, I like to inject a good IF signal at pin one of U7301, the output of the IF amplifier. If I get a good picture on the CRT, I know I have a tuner problem. If I do not, I begin to suspect the problem lies outside the tuner. Look at Figure 5, and you will see a number of components between the tuner and the IF input into the T Chip, for example Q7601 (the SAW amp). The T Chip itself could also be the problem. Remember to rule out IF problems before you plunge elbow deep into the tuner.

Don't forget to check the tuner voltages: +5V, +12V, -12V, and +33V.

If it is necessary, check the single tuned,

Q7403

E	0V	0V	0V
B	0.70V	0.70V	0V
C	0.10V	0.10V	11.3V

Q7404

E	11.4V	11.2V	11.3V
B	11.0V	10.9V	10.6V
C	0.11V	0.11V	11.3V

Figure 9. These are the voltages you should expect to find on the pins of Q7403 and Q7404.

primary and secondary tuning voltages per Figure 6 and U7501 per Figure 7. You might want to check for the correct EEPROM values by varying some of the data stored in the EEPROM. Take a hint. Record — that is, write down — the value in a particular register before you change it. If varying the parameter does not improve the picture, you can restore the data to their original values without trusting your memory.

The tuner will not tune any channel: it is completely dead

Before you go any further with your troubleshooting, check to see if the channel numbers change on the screen as you scroll up and down the channel list. If the on-screen display does not respond to channel change commands, you have a system control problem, not a tuner problem. Then, guess what? You'll want to check all supply voltages.

Q7401

	Lo V	Hi V	UHF
E	0V	0V	0V
B	0.6V	0.6V	0.6V
C	2.06V	3.85V	17.8V

Figure 10. These are typical voltages you may expect to find on the pins of Q7401.

Q7402

E	11.4V	11.2V	11.3V
B	11.3V	10.5V	10.6V
C	-14.9V	11.1V	11.2V

Figure 11. These are typical voltages you may expect to find on the pins of Q7402.

Q7102

	2	7	14
G1	4.64V	4.58V	4.61V
G2	5.32V	6.85V	7.19V
D	11.3V	11.2V	11.4V
S	4.08V	4.20V	11.3V

Figure 12. These are typical voltages you may expect to find on the pins of Q7102.

If the OSD responds correctly and if the tuner voltages are present and accounted for, proceed to the oscillator-mixer, U7301. Figure 8 will give you an idea about the voltages that you can expect on its pins. Please note that these voltages are typical voltages and that the readings will vary slightly from set to set because each set has its own alignment parameters.

Pin No.	Lo V Chan. 2	6	Hi V Chan 7	13	14	UHF Chan. 40	69
1.	5.43V	5.42V	5.38V	5.38V	5.30V	5.22V	5.30V
2.	2.93V	2.98V	2.95V	2.95V	3.18V	3.16V	3.18V
3.	7.80V	7.81V	7.75V	7.69V	7.56V	7.51V	7.56V
4.	2.99V	2.99V	2.96V	2.97V	3.18V	3.16V	3.18V
5.	7.82V	7.81V	7.75V	7.71V	7.56V	7.51V	7.56V
6.	0V	0V	0V	0V	0V	0V	0V
7.	3.06V	3.06V	3.04V	3.01V	0V	0V	0V
8.	9.06V	9.03V	8.97V	8.89V	8.84V	8.80V	8.84V
9.	3.02V	3.02V	2.98V	2.98V	3.36V	3.33V	3.36V
10.	3.25V	3.25V	3.22V	3.19V	2.88V	2.87V	2.88V
11.	4.94V	5.00V	5.06V	5.02V	9.62V	9.58V	9.62V
12.	3.25V	3.23V	3.22V	3.19V	2.87V	2.87V	2.88V
13.	0V	0V	0V	0V	0V	0V	0V
14	9.05V	9.04V	8.97V	8.90V	5.43V	5.39V	5.46V
15.	3.43V	3.43V	3.40V	3.37V	2.88V	2.84V	2.88V
16.	3.44V	3.43V	3.40V	3.38V	2.89V	2.89V	2.89V

Figure 13. These are voltages you may find on the pins of U7301 when the set is tuned to an off-the-air signal.

Pay particular attention to the B+ supply. I have seen instances when the B+ was a little below normal. When I wicked out the B+ supply pin, the B+ supply came up to normal. Out of curiosity, I injected the +9V to bring the supply up to normal. When I did, the picture cleared up. However, if I turned the TV off and back on, the B+ dropped to its original level. The chip was defective.

If the B+ is normal, check for correct band switching voltages on pins 8 and 9, per Figure 8. Then check pin 7 for correct voltage, the collector of Q7402 (Figure 9), and the collectors of Q7403 and Q7404 (Figure 9).

If everything checks okay, check the tuning voltage on the collector of Q7401 and compare your readings to the table in Figure 10 as you scroll through the channels. This is important. If the tuning voltage is stuck HI or LO (if it doesn't change), suspect a problem in the PLL loop. The most likely cause is Y7401. Depending on the quality of your test equipment (bandwidth of your scope and nature of your probe), you should find a peak-to-peak signal of about 1V. If you don't, change the crystal. As I have indicated, Y7401 has a history of causing problems.

By the way, you can manually control the tuning voltage. RCA suggests connecting a 100k potentiometer from the collector of Q7401 to ground, after turning it off by shorting its base to emitter. By varying the setting of the pot, you vary the tuning voltage, permitting you to check the rest of the tuner for proper operation.

Pin No.	Band 1 2	Band 2 18	Band 3 51
1.	1.74V	1.74V	1.74V
2.	2.11V	2.11V	2.11V
.3.	2.11V	2.11V	2.11V
4.	4.78V	4.78V	4.78V
5.	4.71V	4.71V	4.71V
6.	0V	0V	0V
7.	NC	NC	NC
8.	11.5V	0V	0V
9.	7.47V	7.42V	0V
10.	4.85V	4.85V	4.85V
11.	2.31V	2.31V	2.31V
12.	2.31V	2.31V	2.31V
13.	0V	0V	0V
14.	0.60V	0.60V	0.60V

Figure 14. I have never really needed the voltage readings for the pins of U7401, but it is good to have them just in case you do.

A few more steps

I write on the basis of my experience. Having said that, I will assume that you probably will have solved your tuner problem by now. If you haven't, there are a few more steps to take.

Check the local oscillator voltage at R7301 (Figure 5). The voltage should increase as the channel numbers go up and decrease as the numbers go down. If the voltage is missing, check for an open in the voltage path between R7401 and R7301. The problem might also be caused by a shorted diode, so check CR7301, 7302, 7304, and 7305.

Check the single tuned, primary and secondary varactor diodes per Figure 6.

Check the band switch logic (BS1) at Q7402 (Figure 11).

Check the B V/U logic on Q7403 and Q7404 (Figure 9).

RCA suggests, as a kind of final check, that you check the biasing on Q7101 and Q7102, per the chart given in Figure 12. If you read this article before you do any troubleshooting, I hope you make it a point to check these RF amplifiers first, when you check the AGC voltage. I put the check here because the chance of having a bias problem is slim, but possible. If you suspect a problem with an RF amplifier and aren't really sure how to proceed,

CABLE CHANNEL	VOLTAGE
2	1.6
6	5
14	12.7
17	22.7
18	1.8
13	5.6
34	10.8
37	12.7
48	26.2
50	31
51	0.7
57	2
63	3.8
76	8
83	10.1
93	12.6
110	15.9
117	18.3
125	23.5

Figure 15. This chart completes the available information. It lists the readings you should find at various points as the tuner operates over its rather extensive range. The channels under "cable channels" are the "data channels" used to set the tuning parameters for the tuner. As you know, this data is stored in the EEPROM.

use a signal generator to inject a signal of appropriate strength into the amplifier's input and output and observe the results on the screen.

Concluding remarks

I will tidy up my discussion by giving you a few more charts.

The values I gave you for U7301 in Figure 8 are for cable channels. If you want or need them, the values for an off-the-air signal are listed in Figure 13. I have never really needed the voltage readings for the pins of U7401, but it is good to have them just in case you do (Figure 14). Figure 15 completes the information I have. It lists the readings you should find at various points as the tuner operates over its rather extensive range. The channels under "cable channels" are the "data channels," used to set the tuning parameters for the tuner. As you know, this data is stored in the EEPROM. ■

BOOKS

***Complete Projection TV Troubleshooting and Repair*, by Joe Desposito and Kevin Garabedian, PROMPT Publications, 336 pages, paperback $29.95**

Complete Projection TV Troubleshooting and Repair covers everything from the basics of projection circuits, tools and test equipment, TV types, safety procedures and measurements, to the finely detailed repair techniques. This book also shows how to troubleshoot audio circuits, video circuits, high-voltage circuits, microprocessor circuits, CRTs, projection TV controls, and remote control circuits. Lastly, it contains a case study for the Mitsubishi Model VS-458RS complete with step-by-step instructions through the repair process using written instruction, helpful photographs, and detailed schematics.

PROMPT Publications, 2647 Waterfront Parkway E. Drive, Indianapolis, IN 46214-2041

***Component Identifier & Source Book, Second Edition*, by Victor Meeldijk, PROMPT Publications, 432 pages, paperback, $34.95**

The Component Identifier & Source Book, Second Edition is a vital tool for anyone who wants to make the process of identifying and locating components easier and faster. According to the publisher, there is not another book on the market that lists as many manufacturers of such diverse electronic components.

This source book was written to:

- Assist technicians and system designers in identifying components from prefixes and logos.
- Find sources for various types of microcircuits and other components.
- Aid in cross reference of component types to manufacturers.
- Provide cross reference of trade names, abbreviations, and part number prefixes to the manufacturer.
- Provide listings of the worldwide manufacturing and sales office addresses.
- List manufacturers who provide replacement devices and vendors who specialize in stocking and locating discontinued devices.

Victor Meeldijk is a reliability/maintainability manager at DRS Photronics in New Jersey. He is a member of IEEE, the Authors Guild, and is listed in Who's Who. Meeldijk has been published in **ES&T**, Hands on Electronics, Electronics Now, Radio Electronics, and others. He has also published several books. Meeldijk earned his BEE from the City College of New York in 1975.

PROMPT Publications, 2647 Waterfront Parkway E. Drive, Indianapolis, IN 46214-2041

***Semiconductor Cross Reference CD-ROM*, by Howard W. Sams, PROMPT Publications, $29.95**

Newly revised and updated, *Semiconductor Cross Reference CD-ROM* is the most comprehensive guide to replacement data available for engineers, technicians, students, and those who work with semiconductors. With more than 490,000 part numbers, type numbers, and other identifying numbers listed, technicians will have no problem locating the replacement or substitution information needed.

The Semiconductor Cross Reference CD-ROM covers all major types of semiconductors, including bipolar transistors, FETs, diodes, rectifiers, ICs, thermal devices, SCRs, LEDs, and modules. It also features replacements for NTE, ECG, Radio Shack, and TCE, making this CD-ROM four cross references in one. This reference includes an up-to-date listing of all original equipment manufacturers, making it easy to find all necessary parts.

Built to be simple to use and understand, the CD-ROM gives users the advantage of an excessively speedy search. It also features a cross reference of similar type numbers that have the same semiconductor replacements, something the paper version does not contain. The CD-ROM will run on PC platforms using Windows® 95, 98, or Windows NT.

The Howard W. Sams Semiconductor Cross Reference CD-ROM was produced by the engineers and technicians of Howard W. Sams & Company.

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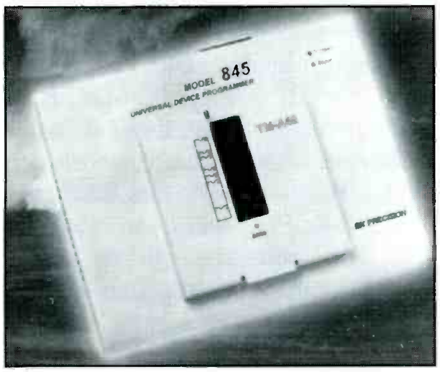


Universal device programmer with logic memory test

B&K Precision, announces the Model 845 Universal Device Programmer with Logic/Memory Test Function.

This product delivers an extensive library supporting in excess of 2800 devices. The software is Windows 95 and NT compatible and written for expandability. This design includes the capacity to add an emulator module and 8-gang programming adapter.

The programmer allows testing of logic and memory chips, in addition to programming both standard and low voltage devices. It has a built-in power supply operating from either 115Vac or 230Vac 50/60 HZ and can be used to program EPROMS, Flash, PROMS, PLDS, and Microcontrollers.

The programmer uses a parallel interface and can be used with either a desktop computer or a laptop computer.

Circle (100) on Reply Card

Regulated dc power supply

B&K Precision Corporation announced the addition of Models 1785, 1786, and 1787 cost-effective, high-reliability, programmable regulated dc power supply systems to their growing product line. All three supplies offer easy-to-use 9-user programmable preset memory recall, 10-step user programmable output routine and RS-232 communications to a PC via DOS or Windows-95.

These direct key-in digital regulated dc power supplies provide 0.02% +5mV line and load regulation, clean and reliable output with low 1mV ripple and noise (RMS), operating voltage of 120V, 60Hz and dc outputs of 0 V to 18V, 5A (1785), 0V to 30V, 3A (1786), and 0V to 60V, 1.5A (1787), and instant retrieval of preset outputs.

Circle (101) on Reply Card

T-shape DMM with backlight

Wavetek introduces the 220, the lowest cost meter in the company's new series of T-shape DMMs. The Digi-Glo backlight is bright and evenly lighted. The "T" design allows for an oversized display area and larger characters.

The meter features eight measuring functions in 27 ranges, including dc and ac voltage, dc and ac current, resistance, logic and diode test and continuity beeper. Other features include autoranging, overload alert, 4300-count oversized display characters and front panel button selection of features like Probe Hold, min/max, relative, and range lock.

Circle (102) on Reply Card

PCB repair tool kit

The TP-10 Tech-Pro Tool Kit from Circuit Technology Center features specially designed tools crafted from surgical quality chrome steel, with tips hardened to withstand the rigors of demanding detailed work. The potential for operator fatigue is reduced by tufted foam grips on each tool. Each kit includes a burnisher for burnishing scratches in gold contacts, and for blending solder joints, among other uses; a pick to mark or scribe surfaces, or to punch holes in thin materials; a scraper to scrape away burned material or excess epoxy, or to cut circuits and other thin materials; and a wire guide that is used to form bends in wires and to hold wires during soldering.

Circle (103) on Reply Card

Plug card converts PC into 20 Ms/S DSO

A newly developed, PC based DSO card, which plugs into any PC expansion slot enabling a computer to be used as a 2 channel, digital storage oscilloscope, is now available from HC Protek. The Model 220, complete with CD ROM software and probes, works with Windows '95 and will capture and display waveforms by an easy-to-use, point-and-click graphics interface. The CD ROM software can support up to 8 DSO cards to permit simultaneous display of 16 waveforms. Key DSO features include: sweep speeds to 50 nsec. per div.; sample rate to 20 Meg samples per channel; scroll mode sweep time to 60 mm.div.; memory to 32K per channel; and deltaT and deltaV cursors.

Circle (104) on Reply Card

Electronics servicing chemicals

Cortec offers their series of "E" Products for electronic repair and maintenance. Electricon VCI-238 is a non-conductive corrosion inhibitor that cleans and protects exposed contacts. E-205 Contact Cleaner cleans and restores electronic components. E-215 Flux Remover removes activated fluxes and other ionic contaminants and also cleans and restores relays, switches, and other components. E-220 Dust-A-Way is an inert gas that removes dust, lint, and particles from any surface. E-225 Super Freeze is a non-flammable inert gas that lowers the temperature of components sprayed to -60F (-51C). E-230 Antistatic Glass Cleaner cleans dust, grease, ink, and soot from glass and plastics.

Circle (105) on Reply Card

Heavy-duty multimeter

Wavetek introduces the HD110B. It is resistant to damage from water, dust, chemicals and voltage transients and spikes, and drop-proof to 10 feet. Features include an oversized character display and a new patented ergonomic shape. A Safety Tester feature quickly checks for live circuits, and indicates the presence of common power supply voltages with a series of LEDs. This feature does not use the meter's internal battery; so live voltage levels can always be detected even if the meter's battery is dead.

Measuring functions include 1500Vdc/1000Vac voltage range, current to 10A, resistance to 20M, continuity, diode test, and data hold.

Circle (106) on Reply Card

Extended reach lighting arm

Waldmann Lighting's fully rotational Omnivue magnification light now offers a 43-inch extended reach arm. The Omnivue "Max" version is useful for production benches and workstations, or longer length inspection and assembly applications. The standard arm reach is 35 inches, for shorter work surfaces.

The light uses three 9W compact fluorescent lamps, which provide two light levels: 27W of light from the top and both sides of the magnifier, or 18W of side-to-side lighting. The unit also features a three diopter optical quality glass magnifying lens, which tilts independently of the light source for optimum positioning. This feature reduces glare from overhead lighting by allowing the lens to be positioned precisely where it's needed. Two optional lenses are available that increase magnification up to 7 and 15 diopters.

Circle (107) on Reply Card

Single output dc power supply

The new Model 1337 offers continuously variable voltage (0Vdc to 60Vdc) and current (0A to 2.5A) output, as well as constant voltage and constant current modes to suit a wide range of applications. The unit is accurate to within 0.5%, and features a digital readout with separate displays for current and voltage.

Circle (108) on Reply Card

DC power supplies

Global Specialties introduces a single-output dc power supply. The new Model 1335 offers continuously variable voltage (0Vdc to32Vdc) and current (0A to3A) output, as well as constant voltage and constant current modes to suit a wide range of applications.

Circle (109) on Reply Card

Magnification light

Waldmann Lighting's fully rotational Omnivue magnification light now offers a 43-inch extended reach arm. The Omnivue "Max" version is ideal for production benches and workstations, or longer length inspection and assembly applications. The standard Omnivue arm reaches 35 inches, ideal for shorter work surfaces.

The OmnivueMax uses three 9-watt compact fluorescent lamps which provide two light levels; 27 watts of light from the top and both sides of the magnifier, or 18 watts of side-to-side lighting. Either light level is available with a simple touch of a three-way switch. UV "black lights" are optional.

The Omnivue Max also features a three diopter optical quality glass magnifying lens which tilts independently of the light source for optimum positioning. This feature reduces glare from overhead lighting by being able to position the lens precisely where it's needed. Two optional "ADD-X" lenses are available that increase magnification up to 7 and 15 diopters.

The light includes an industrial-grade clamp for traditional worksurface mounting. Additional mounting options include a table base and portable stand for easy mobility, or pin mount for production workstations.

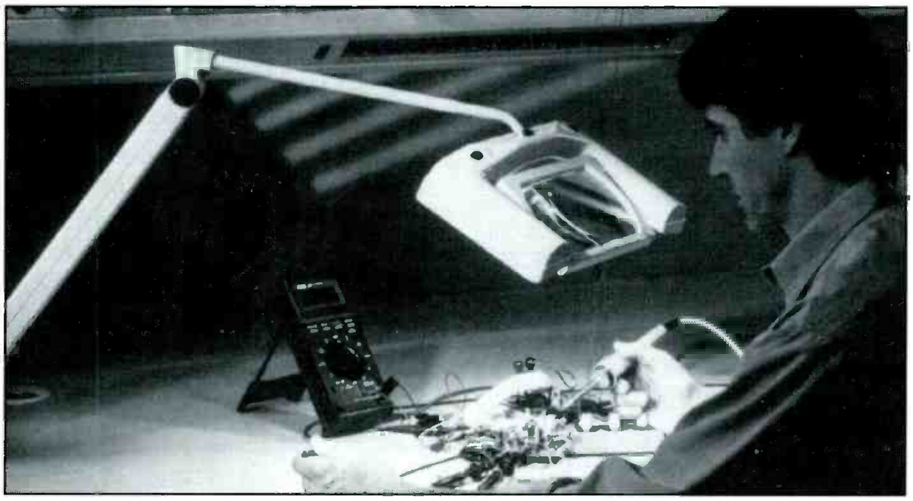
The Omnivue and OmnivueMax are ideal for enhancing the visual performance for inspection and assembly applications where high or varying light levels are needed. Both models include a 10-year warranty.

Circle (110) on Reply Card

Electronic components database

Hearst Business Communications, Inc./IUTP Division, announces release of the new 1999 EEM/Electronic Engineers Master on the Internet at http://eemonline.com together with the release of the 1999 EEM CD-ROM for Windows and the publication of the 1999 EEM/Electronic Engineers Master printed catalog.

Circle (111) on Reply Card



Repair basics for camcorders

By John A. Ross

The popularity and versatility of camcorders has pushed service centers to gain increased knowledge about the functionality and serviceability of the devices. However, many service shops shy away from servicing camcorders because of the inherent complexity of both the mechanism and the electronics. After all, a camcorder consists of both a VCR and a camera. When considering the mechanical assemblies, we can draw on our knowledge of VCRs when servicing a camcorder.

In addition, we must also remember that the mechanical assemblies of a camcorder also control optical adjustments such as zoom, focus, and autofocus, in addition to the VCR functions.

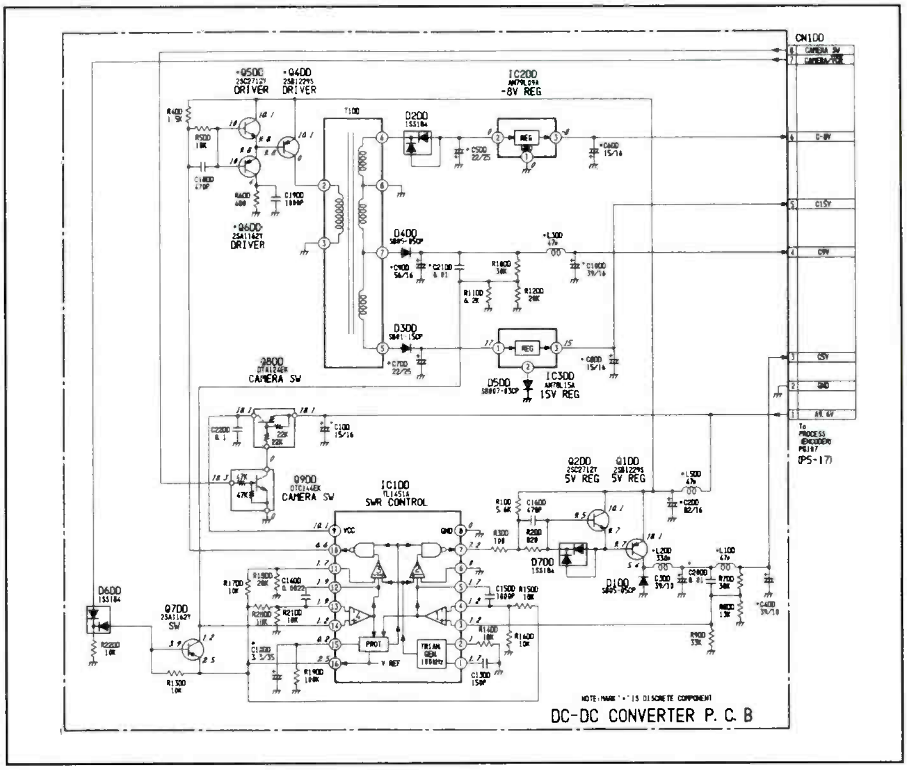


Figure 1. A camcorder, which is portable, is different from a VCR in that it needs a dc-to-dc converter to convert the battery voltage into the various voltages required by the circuitry.

Special features

Most modern camcorders offer special features that enhance the functionality of the device. Some of those features are:

• *Remote control* for easy playback of recorded video images;

• *A 1/3-inch CCD imager* that provides clear, high resolution (270,000 pixels) pictures during even light low conditions;

• *Real-time tape counter with memory* that allows a customer to mark and return to specific locations on the tape;

• *A multi-angle viewfinder with variable focus* that allows the customer to monitor the picture during recording and playback of the scene;

• *An 8-to-1 power zoom lens* that allows a transition from wide-angle to telephoto shots at the press of a button;

• *Digital zoom up to X16* that increases the magnification of the image up to two times greater than is possible with the extreme telephoto position;

• *Automatic focus* that constantly adjusts for the optimum picture sharpness;

• *Macro focus* that allows the recording of close up shots from as little as 3/8-inch away from the object;

• *Auto iris* that adjusts for low lighting;

• *Automatic white balance* that ensures natural color reproduction in any setting;

• *A high speed shutter* that generates sharper fast-motion recordings;

• *A title superimposer* that allows the insertion of title text during recording;

• *A clock/calendar character generator* that allows the display of the time and date on the viewfinder and the recording of the information on the tape; and

• *A built-in microphone* that automatically records audio during recordings.

Camcorder electronics

As with the mechanical assemblies, camcorders are based on electronic circuits comparable to those found in a video cassette recorder. However, because of the increased functionality given through the special features, camcorders contain additional complex circuitry. As we service camcorders, though, we should remember that, as with all products, the electronic system found within a camcorder consists of a power supply, a series of circuits, and a load.

Circuits and components in the lens assembly and sensor circuit board convert an image captured by a camera lens into an electrical signal. The process circuit board contains the circuitry needed to manipulate the electrical signals and recover the luminance and chrominance signals. Within the process circuit board, the signals travel to the luminance/chrominance IC for additional separation and processing. From there, the signals travel to the main circuit board where synchronization, along with chroma and burst deemphasis, occur. The main circuit board also contains the electronics needed for the tape motor drive and pre-amplifiers and amplifiers needed to drive the signal to the video heads.

Camcorder power supplies

Because camcorders are meant to be portable, they have no need for ac line rectification and regulation. Instead, a camcorder functions through either a charged battery or through some type of external dc power supply. Power supply adapters

Ross is a technical writer and microcomputer consultant for Ft. Hays State University, Hays, KS.

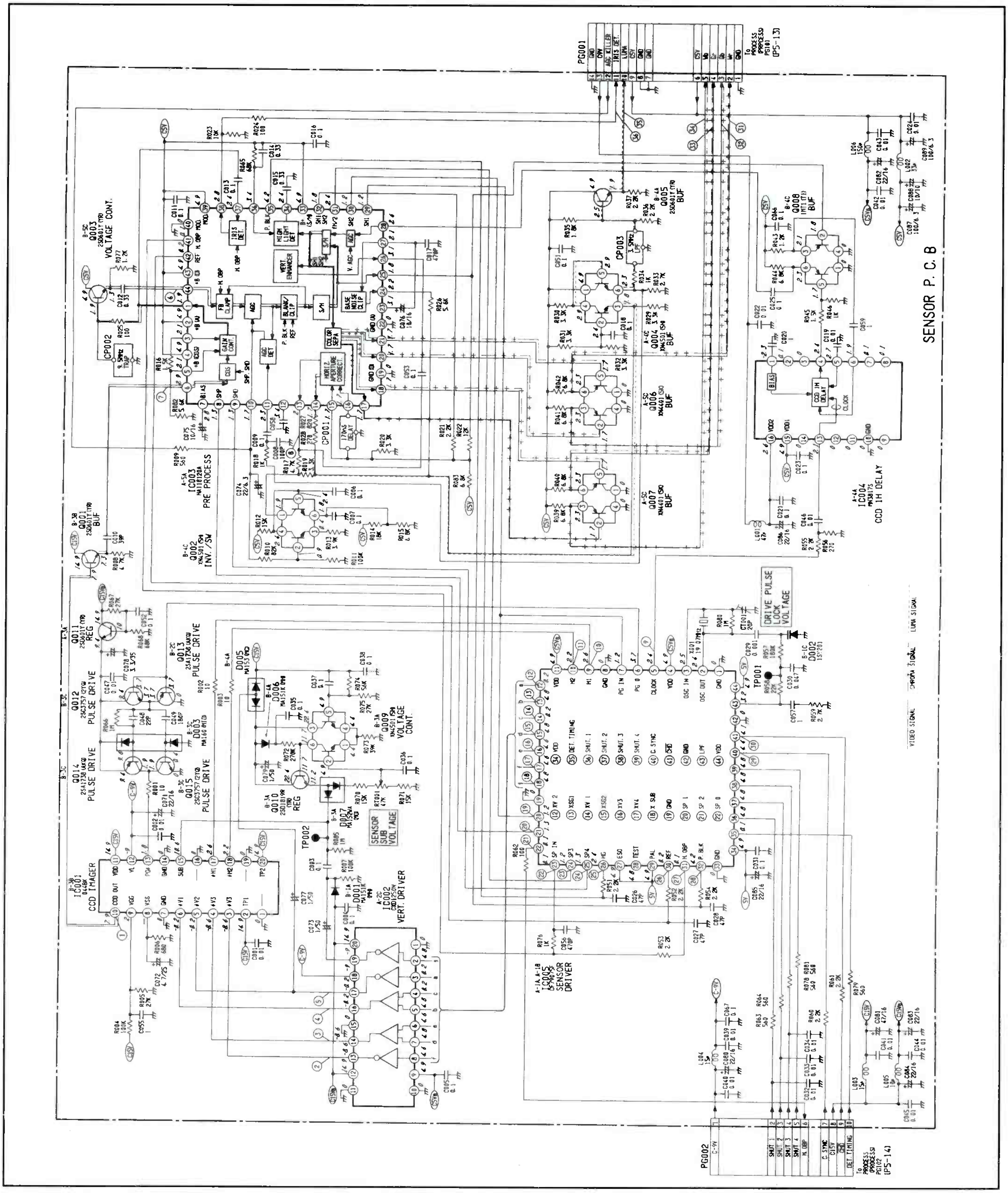


Figure 2. A camcorder has a sensor, circuit shown here, that converts the image of the scene formed by the lens into an electrical signal.

used with camcorders contain the transformer and circuit that change ac voltage into pulsating dc; rectify the dc; and then provide a regulated supply voltage.

Most camcorders depend on a switching regulator that applies several regulated voltages to areas such as the system control board, the capstan, and the cylinder. A switching regulator circuit uses a control device, such as a bipolar transistor, a field-effect transistor, or a silicon-controlled rectifier, to switch the supply power in and out of the circuit and regulate the voltage. Switching occurs because of the ability to send the device into either

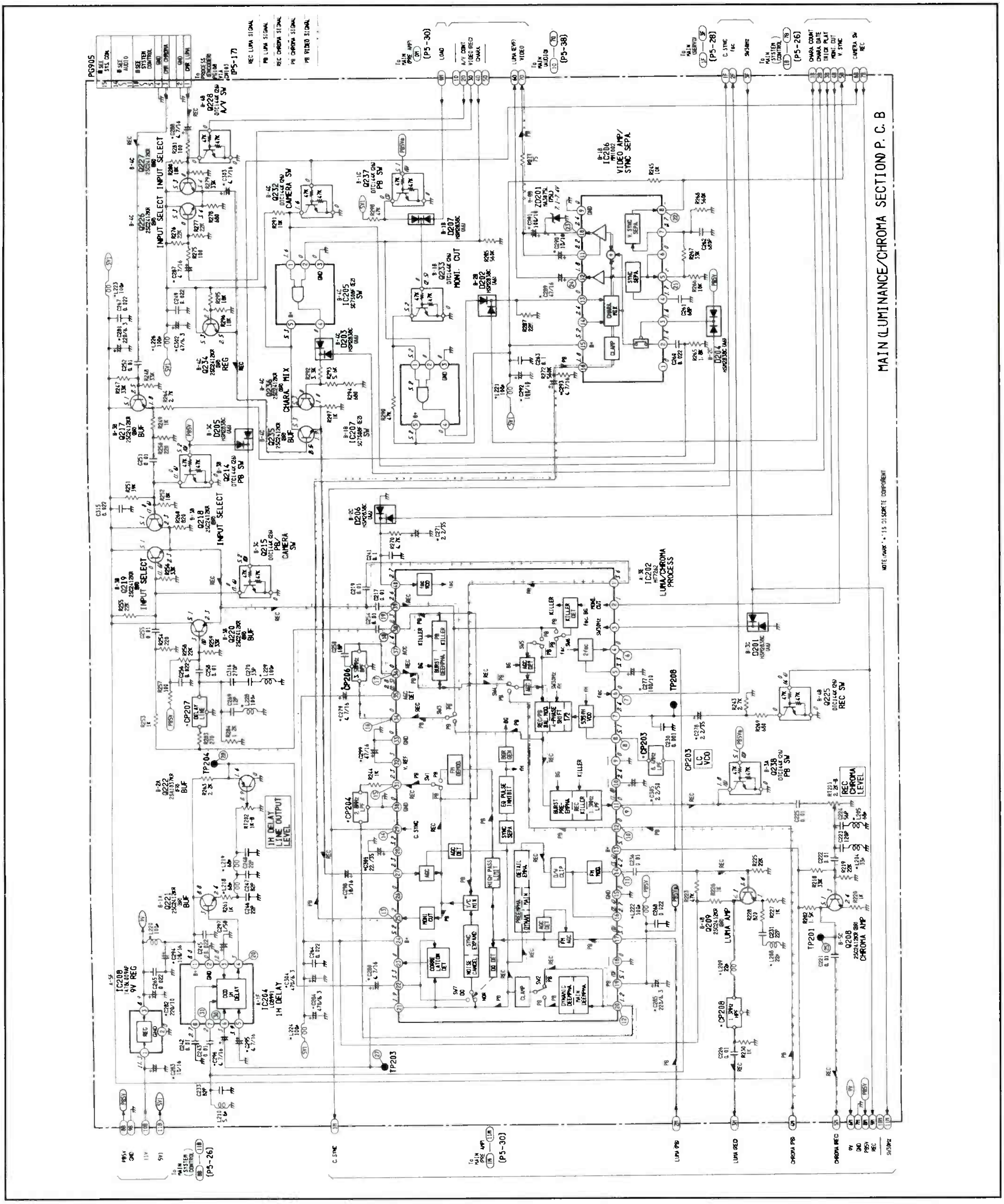


Figure 3. The amplified luminance and chrominance signals travel to the main circuit board. On this circuit board, the luma/chroma process IC, IC202, provides pre-emphasis and de-emphasis, additional AGC, and color killer circuits. IC204, a CCD delay line, provides comb filtering.

saturation, the completely-on state, or into cut-off, the completely-off state.

Figure 1 shows the schematic of a typical camcorder dc-to-dc converter. If you trace through the schematic, you'll see that the supply voltages route through several areas of the camcorder. Raw B+ in the form of the A9.6V line is applied from either the battery through the dc light control PC board and a 2A fuse to the system control board, or from a dc voltage input jack found on the system control board and then back to the dc light control board, through the 2A fuse, and to the system control board.

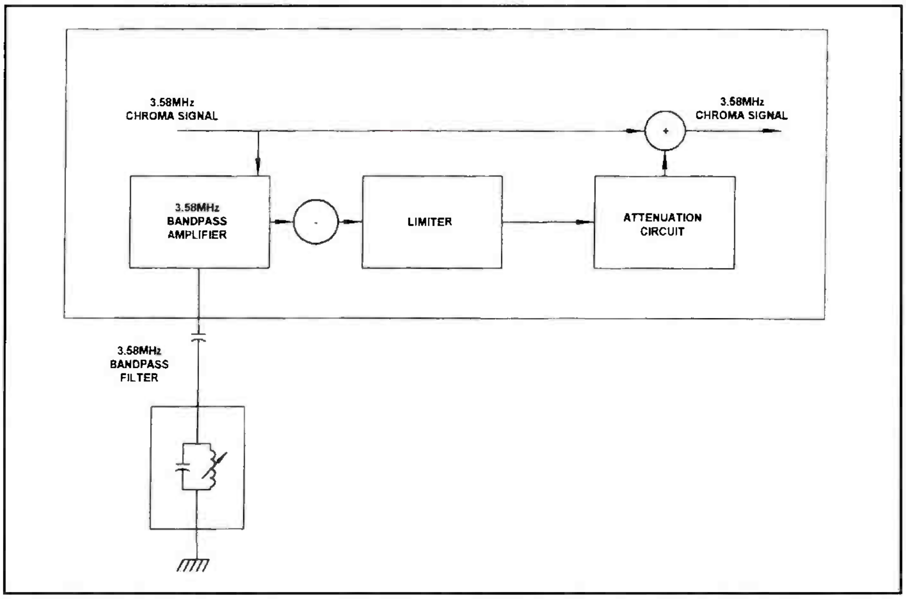


Figure 4. Chroma circuits in camcorders contain preemphasis circuits that give little emphasis to frequency components close to the 3.58MHz center frequency and higher amounts of emphasis to frequency components at the upper and lower ends of the band. As shown here, the 3.58MHz signal feeds directly toward the summing point while also branching to the 3.58MHz bandpass amplifier. The output signal from the bandpass amplifier is the 3.58MHz center frequency.

The unregulated A9.6 dc voltage line also works as the source for the switching regulator. In addition, the A9.6 line also connects to the trouble sensor board, the process encoder circuit, and the dc-to-dc board. Referring to the dc-to-dc converter schematic shown in Figure 1, the unregulated +9.6Vdc also becomes the source voltage needed to generate the +8Vdc, +15Vdc, +9Vdc, and +5Vdc voltages for the camera system. Because of the various interconnections between the voltage supplies and the circuits, power supply problems often occur because of bad connections.

Camcorder image processing circuitry

Much of the camcorder functionality centers on the ability of a camera lens to capture an image and the ability of circuits and components to convert the captured image into an electrical signal. The lens focuses reflected light from a scene onto the light-sensitive surface of a CCD pick-up device. A mechanical service adjustment between the lens and the CCD device maintains the ability of the camera to maintain image focus as the customer changes from wide-angle to telephoto zoom settings. *Automatic focus* occurs through the operation of a small motor and a servo control circuit mounted in the lens assembly. The motor adjusts the focus lenses for proper focus, as the distance between the camera and object change as it receives information from an infrared or LED distance ranging sensor.

Along with adjusting for distance, the autofocus control circuit also emphasizes high frequency information in the video signal so that the optimum focus occurs. Adjusting the autofocus circuit sets the camera optics for the best focus at the telephoto setting. This occurs as the camera user operates the zoom switches and causes another motor in the lens assembly to move the internal zoom lenses.

The *auto-iris circuit* controls the amount of light passing through the lens assembly. To accomplish this task, the auto-iris circuit uses a small motor to open or close the iris diaphragm. As with the focus motor, a servo control circuit monitors and controls the auto-iris operation. Control of the auto-iris circuit occurs through the sampling of the video signal generated by the camera and the determination of the amount of light falling on the charge-coupled device in the sensor circuit.

The sensor board

A camcorder also includes a small circuit board assembly, called the sensor circuit board, which consists of a CCD imager; a sensor driver; pre-processing circuits; and support circuitry. Most camcorders utilize a two-dimensional CCD, or charge-coupled device, array that can generate thousands of pixels. *Charge-coupled devices* are solid-state transducers that rely on large numbers of photodiodes that respond to light energy. The CCD converts the visual image by outputting an electrical signal when light falls on the device.

During operation, the CCD relies on

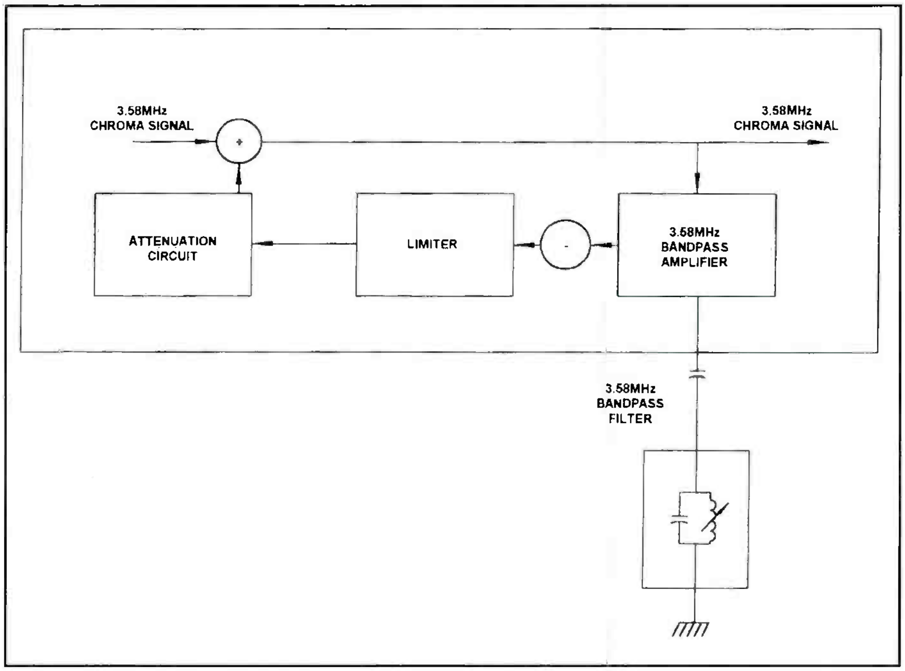


Figure 5. The chroma deemphasis circuit in a camcorder provides an equal and opposite effect on the chroma signal as that caused by the preemphasis circuit.

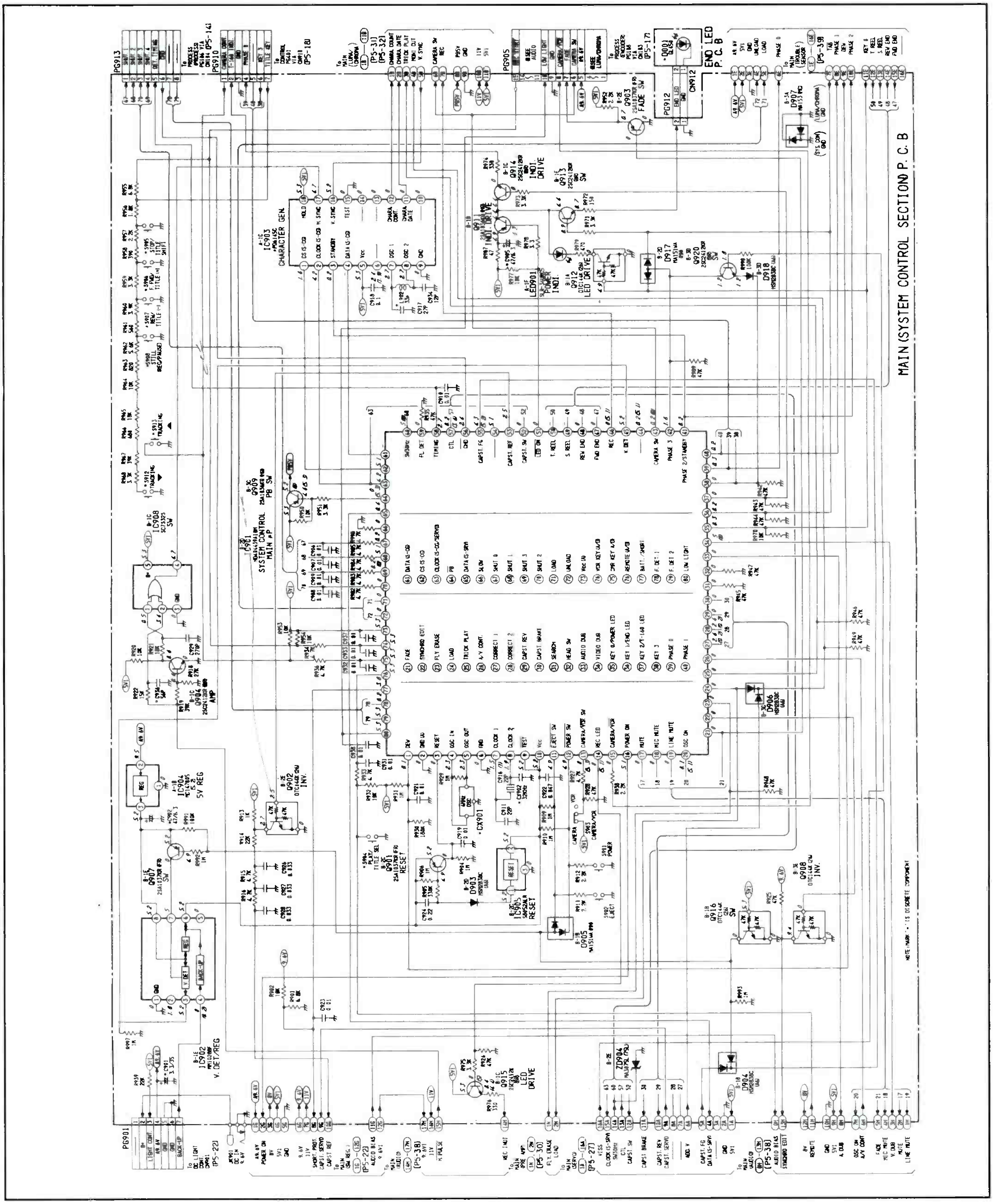


Figure 6. This is the system control section of the main printed circuit board. Integrated circuit IC901, an 80-pin system-control microprocessor, controls the camera assembly; the VCR operation; the power supply; and the power distribution circuitry of the camcorder.

vertical and horizontal frequency drive pulses that remain synchronized to the master sync generator. The master sync generator, located on the main circuit board, controls the raster scanning process by using the drive pulses as control pulses. As the CCD scans the raster, the drive pulses control the collection of charges obtained from the photodiodes within the CCD. The field-by-field, line-by-line, sequential collection of the charges produces a luminance signal that

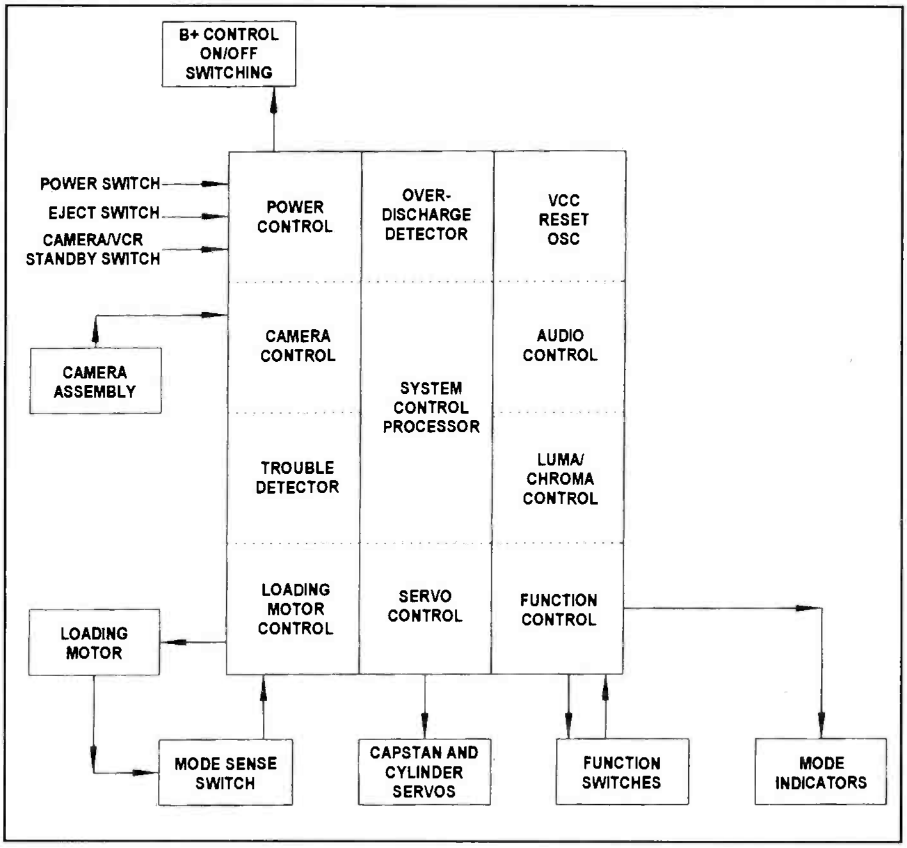


Figure 7. As shown in this block diagram, different parts of the control processor maintain the functions of the VCR and camera assemblies. With the VCR portion of the control system, the loading motor control area drives the motor and circuitry that engages levers and gears that control the mechanical operation of the video cassette recorder.

contains all the information to create a monochrome picture. However, the signal lacks the chroma, sync, and burst reference signals that are parts of the composite video signal.

Because this digitally-sampled video signal results from the collection of charges, it has a choppy appearance that requires smoothing through the use of sample-and-hold circuit. To accomplish this smoothing effect, the circuit includes an optical black clamp that ties the signal to a black reference level found at the end of each vertical and horizontal scan. As a result, the circuit can clamp the blanking period to a fixed level with respect to the black level. During the retrace period, the camera adds the blanking levels to the video signal. The signal then serves as a reference for voltages found in the remainder of the video signal.

Camcorder AGC and luminance/chrominance circuitry

Figure 2 is the schematic diagram of the sensor circuit. In this circuit, IC001 functions as the charge-coupled device, while IC003 contains pre-processing circuits that include the AGC detector and AGC circuits. In addition, IC003 separates and amplifies the luminance and chrominance signals. Buffer amplifiers in the luminance/chrominance circuitry establish output isolation as the sensor board circuitry pass the signals onto the luminance/chrominance circuitry.

The AGC detector and amplifier respond to white signal levels as those levels fluctuate due to changes in the iris. Low light levels cause the iris to open fully and the white signal levels to drop below 714mV. As a result, the AGC detector provides a control voltage that forward biases the AGC amplifier to the point at which additional AGC amplification occurs. In addition to the AGC circuit action, another circuit, the aperture correct circuit, sharpens the received picture signal by adding spikes to the signal transition points as the picture detail changes from black to white and vice versa.

One of the final stages in this process also involves adding the horizontal and vertical sync signals to the video signal at the sync adder stage in IC003. The adding process results in a composite luminance and sync signal.

Luminance signal processing

The amplified luminance and chrominance signals travel to the main circuit board. The Luma/Chroma Process IC, IC202 (Figure 3) contains pre-emphasis and de-emphasis circuits, additional AGC circuits, and color killer circuits. IC204, a CCD delay line, provides comb filtering. The composite video signal couples into the comb filter circuit and divides along three paths. While one signal path travels through the charge-coupled device and is delayed by 63.5usec, another path goes through the amplified luminance processing channel. The third path goes through the amplified chroma processing channel.

As part of the signal travels through the luminance processing channel, the signal is amplified and applied to the input of a summing circuit. The portion that travels through the charge-coupled device also reaches the summing circuit but, because of the delay, arrives one horizontal line later. With the luminance information appearing the same to the summing circuit, the circuit doubles only the in-phase components of the input signals. Because the input signal information contains both in-phase luminance and 180-degrees out-of-phase chrominance information, the circuit cancels the phase shifted chroma signal. As a result, only luminance information travels to one of the outputs of the comb filter circuit.

Chrominance signal processing

The chroma signal produced by a camcorder has the saturation and hue levels found at each point in the original scene, as well as the luminance signal that corresponds to the total brightness at each individual point in the scene. Moving back to the charge-coupled device in the sensor circuit, a multi-colored filter etched onto the face of the CCD allows the device to sample the brightness of individual colors of light found in each area of the picture. A high-frequency 5MHz to 10MHz chrominance signal exists at the output of the device and contains information about the color of light reflected from each area of the recorded scene.

At the chroma processing channel, the luma/chroma process IC converts the high frequency chroma signal obtained from the output of the CCD into a usable NTSC-standard format chroma signal. The beginning of this process separates the chrominance signal from the remainder of the video signal through the use of sample-and-hold circuits with the separated signals consisting of R-Y and B-Y signals.

The balance section of the luma/chroma process IC controls the balance between the red and blue signal levels so that white pictures will not include any color tinting. In addition, the balance circuitry compensates for any differences in color that may be caused by different illumination sources. Auto white balance circuitry monitors the color of light arriving at the camera by checking the level of the output signals found at the R-Y/B-Y separator circuit. Compensation occurs through the averaging of the signals and the application of a gain correction signal to either channel.

Chroma and burst preemphasis and deemphasis

When considering audio and video signals or any reproduced signal, the higher frequency components have less amplitude than the lower frequency components. As a result, the signal-to-noise ratio for any frequency is lower for a high frequency voltage and higher for a low frequency audio voltage, if the noise level remains constant. If the noise level increases at higher frequencies, then an even lower signal-to-ratio results. Given this characteristic, the quality of any high frequency signal reproduction suffers unless the signal-to-noise ratio improves.

A pre-emphasis network improves the signal-to-noise ratio of transmitted high frequencies by boosting high frequencies and attenuating low frequencies. In other words, the values of resistance and inductance in a pre-emphasis network must provide a 75usec time constant. The time constant affects how the circuit responds to certain frequencies.

A chroma signal generated by the video camera section of a camcorder consists of a range of frequencies 500kHz above and below the chroma signal frequency of 3.58MHz. Components of that signal closest to the center frequency have a larger amplitude than the components of the signal that range above and below 3.58MHz. At either 500kHz above or 500kHz below the center frequency, the signal has an amplitude of zero. Because of this, the components of chroma signal at the upper and lower ends of the band remain susceptible to noise.

Chroma circuits in camcorders contain preemphasis circuits that give little emphasis to frequency components close to the 3.58MHz center frequency and higher amounts of emphasis to frequency components at the upper and lower ends of the band. Referring to Figure 4, the 3.58MHz signal feeds directly toward the summing point, while also branching to the 3.58MHz bandpass amplifier. The

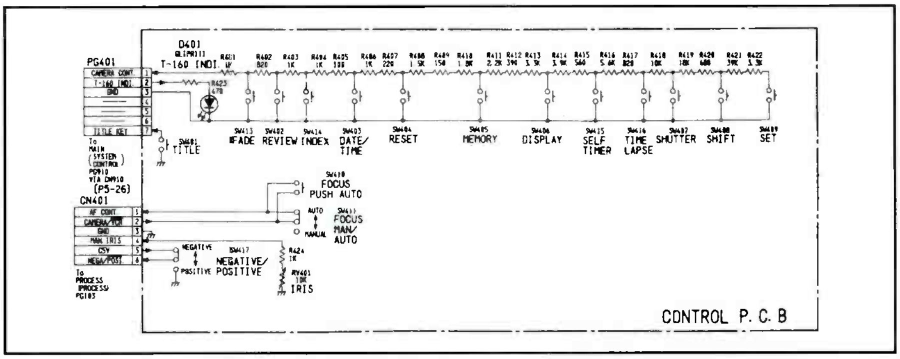


Figure 8. The system control processor and the function switches are shown in this schematic diagram. The VCR portion of many camcorders uses a keyboard input matrix system that applies through pins 11, 15, 29, 47, and 48 of the system control microprocessor.

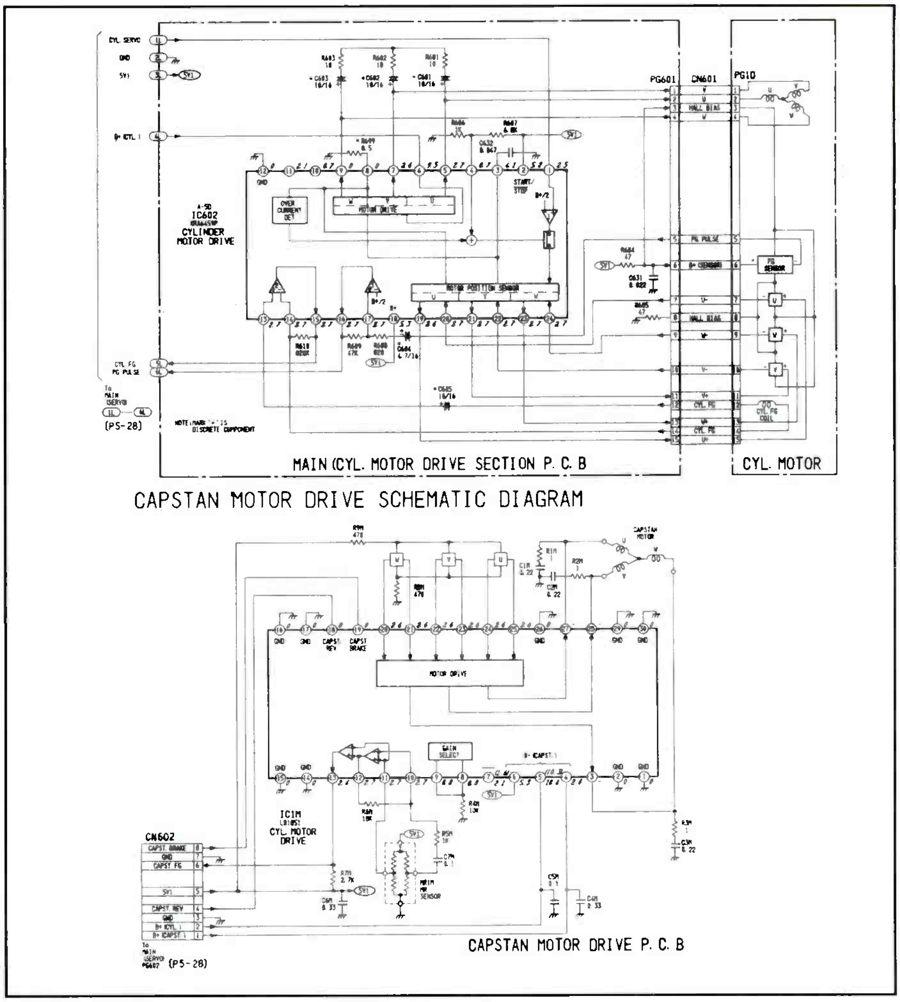


Figure 9. Called a mode motor in some camcorder designs, the capstan motor establishes the tape movement in the play, record, rewind, fast forward, and search modes. Typically, the motor will drive mechanical assemblies through either gear or belt-driven mechanisms. The circuits that provide the drive signals for the capstan motor are found in this circuit, and the capstan motor drive section of the main circuit board.

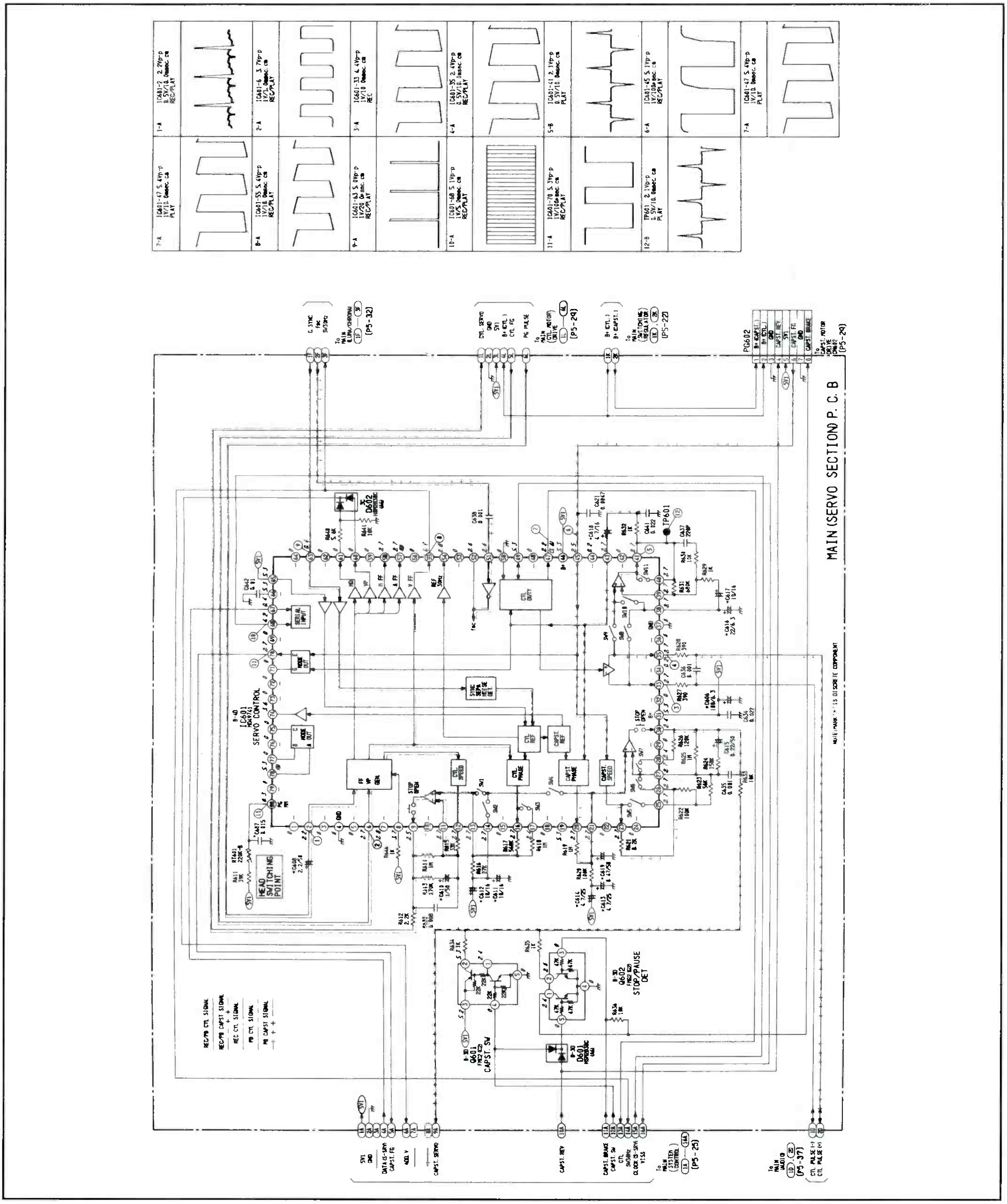


Figure 10. In the cylinder motor drive circuits, IC601, the servo control IC, controls the phase and speed of the cylinder motor through pins 20 and 23. The switching regulator also develops the regulated B+ for the capstan, the cylinder, the main servo, and the cylinder motor drive circuits.

output signal from the bandpass amplifier is the 3.58MHz center frequency.

In addition to feeding to the summing point and the bandpass amplifier, the 3.58MHz signal also feeds to the subtracting point, where it subtracts from the chroma signal spectrum. Here, only the sideband components remain and feed to a limiter, an attenuator, and then to the summing circuit. At this point, the limited and attenuated sideband components add to the original signal and complete the emphasis of the chroma signal.

Along with using preemphasis to boost components of the chroma signal, camcorders also rely on preemphasis to boost the level of the burst signal. With this, the circuit uses the burst flag to key the amplifier. As a result, the amplifier increases its gain during the burst period.

A deemphasis circuit compensates for the preemphasis applied to the transmitted sound signal. The removal of the nonlinear component from the signal allows the output signal to have an amplitude in proportion to the amplitudes of other signals. Deemphasis occurs after the modulation of a signal, reduces the higher frequency noise voltages, and establishes a desired signal-to-noise ratio. With all this, deemphasis restores a balance between the higher and lower frequencies contained in any signal transmission. The combination of preemphasis and deemphasis improve the signal-to-noise ratio of the reproduced signal.

Deemphasis circuits in the chroma and burst sections restore the chroma and burst signals to original levels. Deemphasis has an effect equal and opposite on the chroma and burst signals as that seen with preemphasis. With the burst signal, the circuit lowers the level of the burst relative to the rest of the chroma signal by reducing the gain of the amplifier during the burst signal period. Figure 5 shows a block diagram of the chroma deemphasis circuit.

System control

Figure 6 is the schematic for the system control section of the main circuit board. IC901, an 80-pin system-control microprocessor, controls the camera assembly; the VCR operation; the power supply; and the power distribution circuitry. Referring to the block diagram of the processor shown in Figure 7, different parts of the control processor maintain the functions of the VCR and camera assemblies. With the VCR portion of the control system, the loading motor control area drives the motor and circuitry that engages levers and gears that control the mechanical operation of the VCR. In addition, the loading-motor control area also controls the mode-sense switch: the device that reports the position of the levers and gears back to the microprocessor.

The first part of this article described how voltage supplies obtained from either the battery pack or the power supply adapter are routed through the camcorder. The system control microprocessor controls the switching within the VCR/camera sections of the camcorder. Moving back to Figure 1 for a moment, pins 1G through 12G attach between the dc-dc converter and the main circuit board and allow the application of the regulated B+ voltage source to the main board.

Pressing the power button on the front panel of the camcorder forward biases Darlington transistor Q581 and allows IC581 to switch. With this switching and the subsequent biasing of IC582 and Q587, the microprocessor has the B+ and RESET voltages needed for operation and begins to monitor the input pins for mode instructions. Because the start-up mode occurs quickly, IC901 senses the logic condition caused by the pressing of the power-on switch and applies a pulse that turns on Q909, the PB SW transistor.

At the same time, the switching regulator system, consisting of IC902, the voltage detector-regulator, Q907, a switch, and IC904, a +5Vdc regulator, establish the standby +5Vdc for the camcorder circuitry and the regulated B+ for the capstan motor system. Once the power-on function finishes, the power supply provides the four regulated voltage sources for the camcorder.

Function switch operation and modes

Figure 8 is a schematic drawing of the system control processor and the function switches. The VCR portion of many camcorders uses a keyboard input matrix system that applies through pins 11, 15, 29, 47, and 48 of the system control microprocessor. The matrix system operates when clock pulses received at pins 7 and 8 of the processor have an active LOW state. During operation, the VCR control system also monitors various inputs from the camera mode switches, such as start/stop. An active LOW signal input to the system control processor from either the stop/start switch on the side of the camcorder, or from the external stop/start switch, toggles from the record-pause mode to the record mode, or vice-versa.

Another input from the front panel review button causes the system control processor to place the VCR into reverse-playback for four seconds, forward-playback for four seconds, and then returns back to the record-pause mode. An additional signal from IC903, the character generator, also can control the record period of the camcorder. With the camcorder in camera mode, the character generator sends an active HIGH signal to the processor, initiates a time-lapse control and inhibits the stop/start input of the processor. When the pre-programmed period ends, the resulting active LOW signal from the character generator to the processor enables the stop/start switch.

The tape transport mechanism

The tape transport mechanism of a camcorder closely resembles the transport mechanism commonly found in VCRs. Even with the older, bulkier VHS camcorders, however, a few differences occur. For one thing, the video head cylinder in a camcorder is smaller. Moreover, the head cylinder spins faster. Nearly all camcorders use four heads because of the need to duplicate the performance of standard VCRs. The use of four heads and standard designs ensures that the signal recorded on the tape will remain compatible with VCRs.

The capstan motor

Called a mode motor in some camcorder designs, the capstan motor establishes the tape movement in the play, record, rewind, fast forward, and search modes. Typically, the motor will drive mechanical assemblies through either gear or belt-driven mechanisms. Take a look at Figure 9 and the capstan motor drive section of the main circuit board. IC1M functions as the cylinder motor drive IC, and controls the rotation of the capstan motor in the forward and reverse modes. Pins 4, 5, and 6 of the IC provide the B+ voltages for the capstan motor, while pins 13, 18, and 19 provide the capstan forward, capstan reverse, and capstan brake signals.

Cylinder motors

As with VCRs, the video head cylinder of a camcorder consists of an upper and lower drum assembly, and depends on motor speed control, recording phase control, and motor control. The cylinder motor rotates the video head cylinder at a high rate of speed and is controlled by servo circuits. Looking at Figure 10, IC601, the servo control IC, controls the phase and speed of the cylinder motor through pins 20 and 23. The switching regulator also develops the regulated B+ for the capstan, the cylinder, the main servo, and the cylinder motor drive circuits.

Troubleshooting typical camcorder problems

The following paragraphs provide some suggestions for troubleshooting some typical camcorder problems.

Power supply problems

If the camcorder has power but some or all functions, such as zoom or autofocus, do not operate, begin your troubleshooting sequence by checking the dc-to-dc converter. In many instances, a poor connection at the regulator board will cut off the unregulated A9.6Vdc source voltage from the remainder of the camcorder circuitry. Referring to the dc-to-dc converter diagram, check for the presence of the A9.6 source voltage at pin one of connector CN1DD. The presence of voltage at this pin will point toward either a broken connection or a faulty component on the dc-to-dc converter board. With no voltage at this point, trace through the A9.6Vdc circuit until you find a point where the voltage appears.

If only one function does not operate, begin your troubleshooting by checking the motor that controls that function, along with voltage paths for the motor control circuit. A check of the input voltage to the motor will confirm whether the motor has become defective or whether a problem with the supply circuit has surfaced. In most cases, you can simply trace the supply voltage line back to its source in an attempt to find a solution for the problem.

If the camcorder will not switch on, always take a quick check of the battery supply. Then, confirm the presence of the regulated B+ at IC904 and the +5Vdc regulator, with the power button depressed. If there is no B+ voltage at this point, check the power switch and Q909. If B+ is present, check for the presence of +5Vdc at pin 5 of IC908 on the main board. The absence of B+ voltage at this point indicates that the turn-on pulse for Q909 is missing, or the RESET pulse for the microprocessor is missing voltage.

Function-mode problems

If a malfunction occurs with the function-mode operation of the camcorder, confirm the presence of the clock pulses at the system control processor. If the clock pulses are present at this point, check for the operation of each of the function switches of the VCR key input matrix system by monitoring the presence of phase pulses. In addition, confirm the operation of the camera-mode buttons, the stop/start buttons, and the review switch. Finally, check the input port for the character generator input.

Motor problems

If you suspect a motor failure, always measure the dc voltage at the motor terminals to determine whether the problem exists at the motor or the motor control circuits. The presence of the correct voltage at this point suggests that the problem is a defective motor. Before replacing the motor, check the motor winding for continuity. If the voltage level at the motor terminals is not as specified in the service literature, the problem is most likely in the motor drive IC.

In this case, the first step in the troubleshooting process involves checking for the proper voltage at the motor B+ pins of the IC. Then, check each pin of the IC to ensure that the pins have the correct voltage levels. The absence of a voltage at the motor terminals, and a supply voltage that is lower than normal at the IC usually indicates that the IC has become leaky. In addition to checking voltage levels, use an oscilloscope to check that the waveforms at the servo control circuit are of the proper amplitude and shape. Incorrect signals at the servo circuit will affect both the capstan and cylinder drive circuits.

If the tape will not load, eject, or unload, consider that the loading motor or loading motor drive circuit has become defective. After checking for the proper dc voltage at the motor terminals, check for the presence of a control signal obtained from the system control IC. The signal should travel from the system control IC to the motor drive IC. ■

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Zenith modules 9-605-01, horizontal sweep, $25.00. 9-840R main chassis, $50.00. 9-914R main chassis, $25.00, 9-1753, $150.00. *Contact: Patrick Willie, 520-871-2139.*

Sencore PR570 Powerite II, Sencore SC61 waveform analyzer, Sencore SG165 AM/FM stereo analyzer. Best offer. *Contact: Tom DeMuth, P.O. Box 202, Creighton, NE 68729 or e-mail rayselec@bloomnet.com.*

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B&K Model 707 dyna-jet mutual conductance tube tester with book. Precision series CR30 CRT tester. Best offer. *Contact: Richard Gilman, P.O. Box 633, King City, CA 93930, 831-385-9248.*

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Sams Photofact 1500-3187, $350.00. *Contact: Duane Conger, 4321 Herrick Lane, Madison, WI 53713, 608-238-4629.*

Sams Photofact 1100-2486. Mircofiche reader. *Contact: Shirley, 702-435-5610 or E-mail electro@doitnow.com.*

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Sherwood model S-7700II AM/FM stereo receiver, $50.00. Sherwood S-8900A AM/FM stereo receiver, $50.00. Also assorted electronic parts. *Contact: Mike Jobe, 618-997-3482, 7333 Norris Drive, Marion, IL 62959.*

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Riders perpetual troubleshooters manuals, Vol 1–14, 23 Sams sets from '40s, 1941 Rider manual on record changes, manufacturer's service tips/schematics from '30s and '40s. TV, VCR and combi schematics on microfiche—RCA/GE (15), Maganavox (47). Zenith (3). *Contact: Bob, 570-226-6840.*

Leader oscilloscope LBO-501, $750.00. Hitachi oscilloscope V-152F, $750.00. Huntron Tracker 1000, $295.00. *Contact: Rick Standifier, 903-785-7332.*

Sencore VC93 analyzer, like new w/leads, manuals, schmatics, original box. $750.00 plus shipping. *Contact: Gerald, 252-745-5707, 252-745-4493.*

Sencore SG165 AM/FM stereo analyzer, with service manual, schematics and test leads, $400.00. *Contact: Mark, 541-888-4601.*

B&K 1249 NTSC generator, mint condition in box, $300.00. *Contact: Robert Salamy, 8 Boyer Ave., Tupper Lake, NY 12986, 518-359-9552*

Sams Photofact 1-1000, Sams transistor radio 24-158, Sams auto radio 240-317, CK 3000 Sylvania test jig. *Contact: Les Blanchard, 309 E. 6th, Alta IA 51002, 712-284-2422.*

Sencore VA62 w/VC63 plus HP200, $900.00. All probes, manuals, schematics, excellent condition, original boxes. *Contact: Frank: 727-392-0230.*

ES&T magazines from November 1984. Would like to sell as a set. Best offer. *Contact: Joe Sanfilippo, 715-356-6004, (fax) 715-356-9562.*

Sencore Model VG-91 and TVA-92 test equipment. Excellent condition, all manuals, cables, boxes, $2500.00 for both plus shipping. *Contact: Bert Mercer, 361-771-2984 or E-mail bbcomp@ykc.com*

WANTED

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Wen Model 75 soldering pistol solder gun tips, Part #75B7, looking for several and another Wen 75 solder pistol. *Contact: Harlan, Rt. 4 Box 281H, Montevideo, MN 56265, 320-269-5249 or E-mail hpgarbe@maxminn.com.*

Magnavox model CRN 130 AT 01 and Zenith model SL2753 schematics. Manuals or copies ok. *Contact: Jim, 815-398-7446.*

Professional studio recording equipment, tube limiters, Ampex tape decks, Technics SP10-MK3 table, Hickok tube tester, EPA tonearms. *Contact: Kim, 612-869-4963.*

Dictaphone "dictabelt" recorder. Uses magnetic belt for recording/playback. *Contact: Robert Kramer, 6275 Parks Rd., Alliance, OH or E-mail rfk3721@cannet.com.*

Mitsubishi HS-U80VCR video head. Mitsubishi stereo amplifier DA-U111 schematic. Sencore PR-57 "powerite." *Contact: Joe Sanfilippo, 715-356-6004, (fax) 715-356-9562.*

Reverse convertor. Will take input on Channel 3 or 4 and output onto any TV channel. *Contact: Frank Fixer, 6057 Providence Rd., VA Beach, VA 23464.*

AKAI Model AA-V301 schematic/service manual. Will buy or copy. *Contact: Don Schaefer, 6131 S. 19 Ct., Milwaukee, WI 53221, 414-761-0662.*

Zenith VCR Model VR520HF service manual. *Contact: John Phipps, 1412 Navaho Trl., St. Charles, MO 63304-7325*

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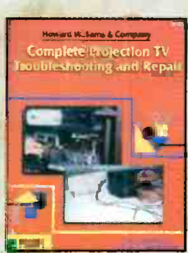

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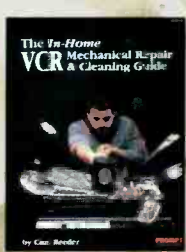

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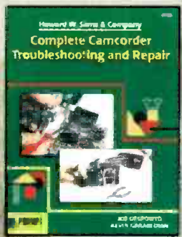

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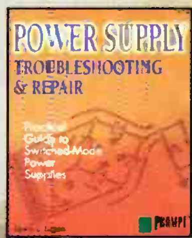

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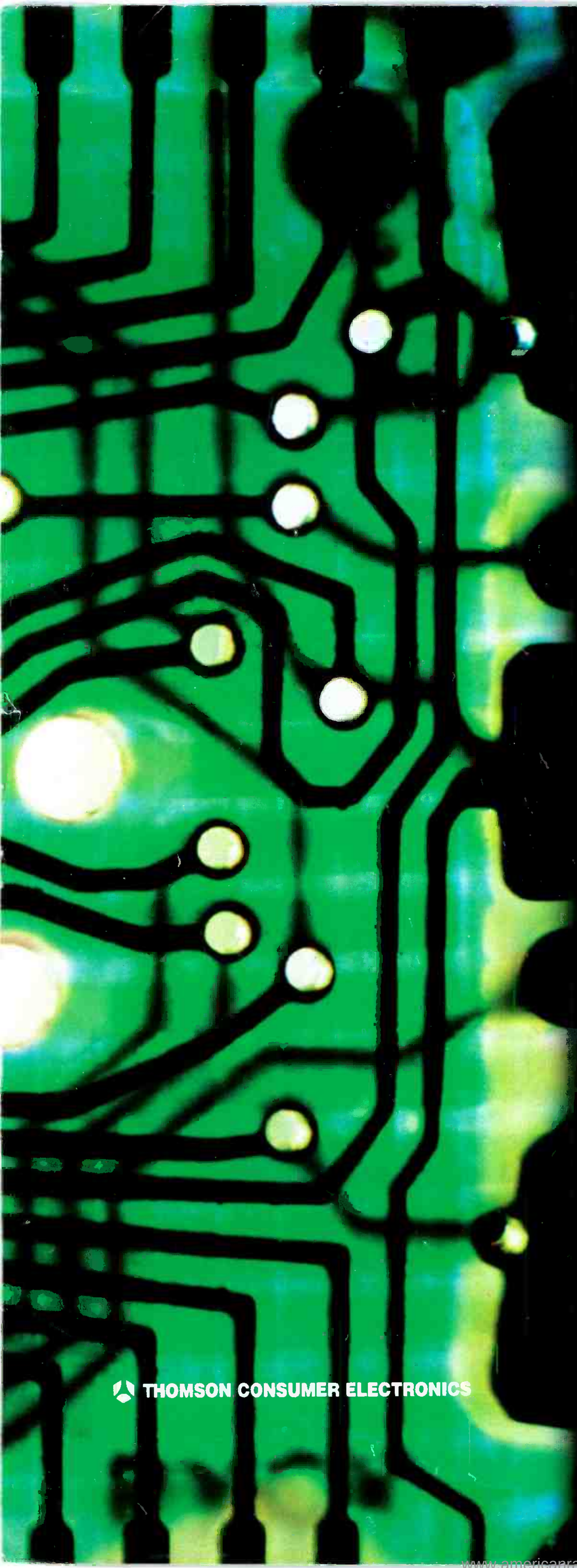
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