THE PROFESSIONAL MAGAZINE FOR ELECTRONICS AND COMPUTER SERVICING

ELECTRONIC Servicing & Technology

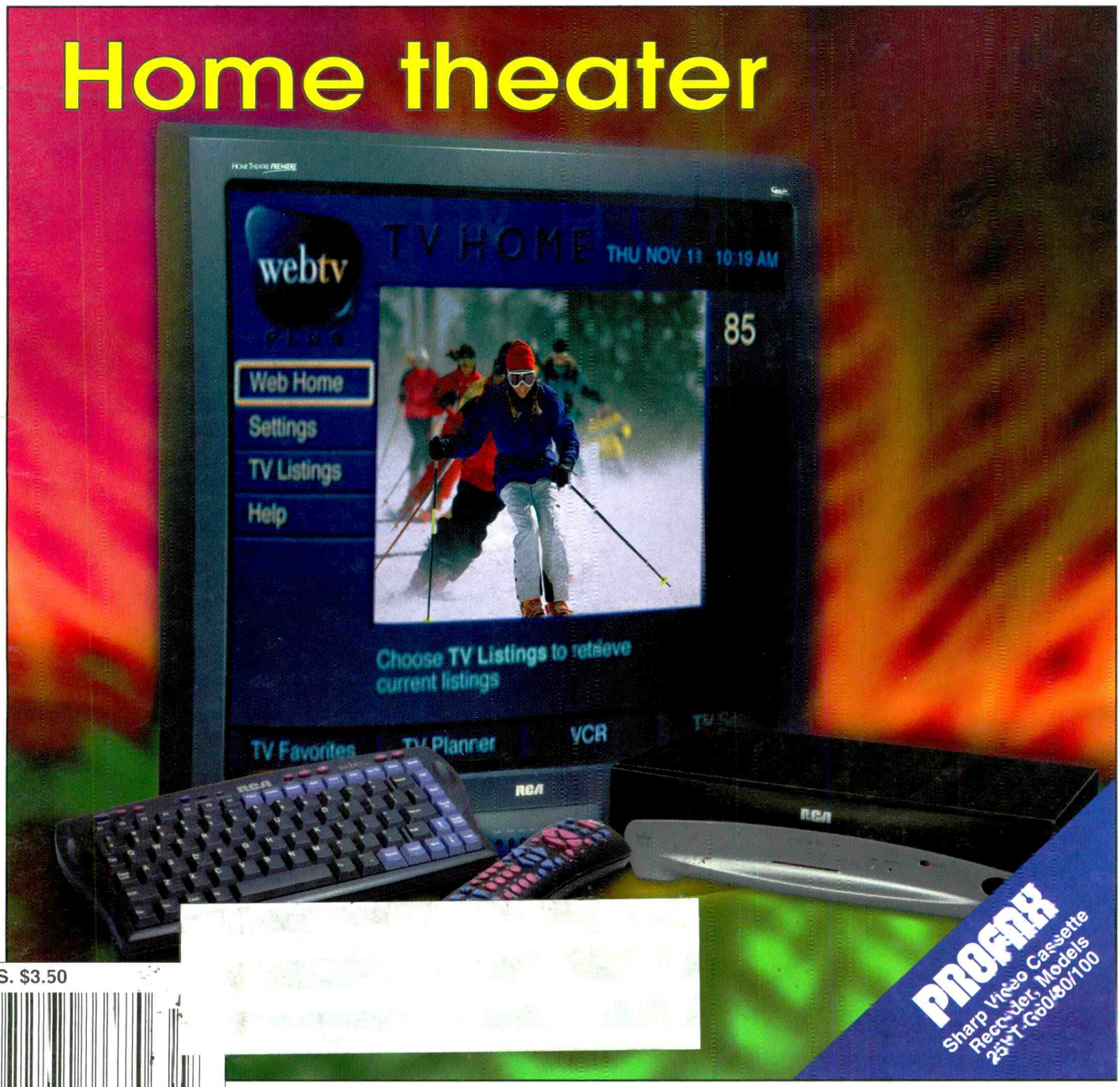
T.M.

July 2000

A Pesky vertical problem

Upgrading a personal computer

Home theater



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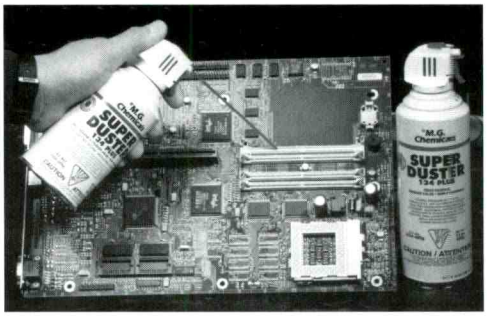

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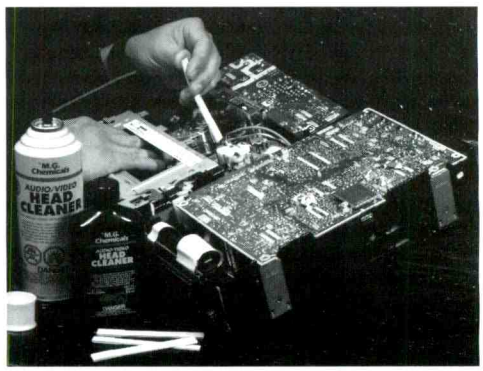

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ELECTRONIC
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Volume 20, No. 7 July 2000

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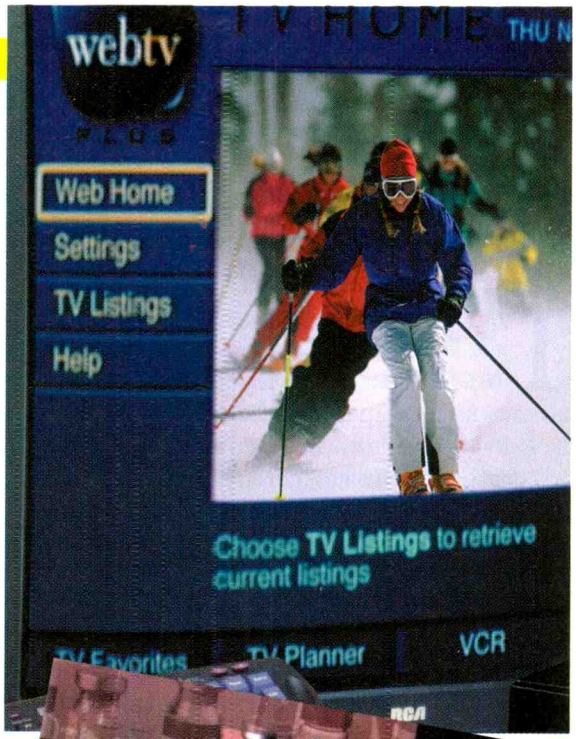

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You can't run a service center without the needed supplies. This article offers some thoughts on how to buy and store supplies, and how to make sure that the potentially toxic products don't harm the staff or the environment.

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Projection television sets present unique servicing challenges. This article describes some of the problems the author encountered, and overcame, in servicing one of these behemoths.

54 A pesky vertical problem *by Bob Rose*
Modern TV sets are designed so that they shut down when certain malfunctions occur in order to avoid excessive levels of radiation, damage to the picture tube, or other unwanted effects. But this can complicate troubleshooting, as described in this article.

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NOTE: We failed to mention the May 2000 cover was provided courtesy of Jensen Tools.

ON THE COVER

Home entertainment has changed so much in just the past few years. Manufacturers have introduced such innovations as DVD players, large-screen TVs, Web TV, and powerful accurate sound system. It all adds up to bringing the movie theater experience, and more, into the living room. (Photo courtesy Thomson Consumer Electronics)

Editorial

by Nils Conrad Persson

The CE Hall of Fame

The Consumer Electronics Association (CEA), formerly the Consumer Electronics Manufacturers Association (CEMA) of the Electronics Industries Association (EIA), has established a Consumer Electronics Hall of Fame to honor the individuals who created, nurtured, and brought to maturity, the consumer electronics industry. Among the first 50 inductees are some of the scientists who researched and defined the technologies, as, for example, the propagation of radio waves, the invention and development of radio transmitters, and receivers, and the invention and development of television. Also included are some of the individuals who had the vision to see the potential of these technologies as a consumer communication and entertainment medium when they were still in their infancy.

It's an interesting exercise to read the list. Some of the names are household names. Some of the other names are reasonably familiar to most of those who have dedicated their lives to consumer electronics service. Some of the names are completely obscure, at least to this observer.

As an example, names such as that of Alexander Graham Bell, Lee DeForest, Thomas Edison, Heinrich Hertz, Guglielmo Marconi, John Bardeen, William Brattain and William Shockley will be instantly recognized as scientists who made discoveries that advanced our understanding of radio communication, or who developed components or circuits that are used in the manufacture of radio communications products (I'm extending the idea of "radio" to include television, which does use "radio" waves for propagation).

There are also a number of names that most of us will recognize as engineering or manufacturing giants who built companies that made and sold products that advanced the state of the art of consumer electronics: Powell Crosley, Jr., Ray Dolby, Allen DuMont, Avery Fisher, Henry Kloss, John Koss Sr., James B. Lansing, Konosuke Matsushita, Akio Morita.

Then we find some of the names that we (or at least I) recognize, but can't quite say exactly what they did: Nolan Bushnell — something to do with ICs, John Logie Baird, Peter Goldmark, Jack Kilby, Robert Noyce.

Last but not least is the list of names that don't really mean anything: to me, anyway. For example, there's Benjamin Abrams. Or how about Robert Adler? Ibuka Masaru? David Lachenbruch? Perhaps you know who they are, but I sure don't. But they're among the first 50 people named to the Consumer Electronics Hall of Fame, so they've all done something important.

Last August, the Consumer Electronics Association sent out a call for nominations to the Hall of Fame.

A panel was put in place to select 50 of the 300 nominations for induction into the Hall of Fame. This initial group consists of the early pioneers, founders and inventors, who laid the foundation for the consumer electronics industry as it exists today. Current company CEOs, government leaders, bureaucrats and support staff were excluded from consideration.

We tend to think of the consumer electronics industry as consisting mostly of products and the entertainment that those products deliver to us. But as with any other industry, the really important thing is the people behind it; the people who have the vision to see what can be, and the courage to make it happen, as well as the people with the brilliant minds who can invent, design, and develop the marvelous products that bring the world into our living rooms. The Hall of Fame gives us all the opportunity to become aware of who these people are, and to understand what they have accomplished.

But even more than that, by studying the lives of the people nominated to the Consumer Electronics Hall of Fame, we can better understand the products and the technology themselves, which makes our jobs a little easier and more rewarding.

In case any of you are still in suspense about who some of those guys are who were mentioned earlier, I looked some of them up. Turns out that Nolan Bushnell is known as the "father of electronic entertainment." He is the technology entrepreneur who started the video game craze when he created the coin operated game of "Pong," and founded Atari Corp. in 1972, reportedly with an investment of $250.

Kilby and Noyce, working independently, came up with the same idea of doping semiconductors in such a manner that it was possible to fabricate a number of semiconductor components within a single tiny piece of silicon, the IC. Noyce, along with a colleague went on to found a company called Intel. You may have heard of it.

Ibuka Masaru was cofounder of Sony. Lachenbruch was a highly respected journalist who reported on developments in consumer electronics. Abrams founded The Emerson Radio and Phonograph Company in 1922. Adler was the guy who helped couch potatoes grow roots by inventing the wireless TV remote.

That fellow Baird invented a little thing called a "television," device. It was primitive, and it was mechanical, not electronic, but it was the first such device that was actually capable of producing a picture. There is still some debate as to who actually invented "television." Other technological geniuses who also have claim to that distinction are Philo T. Farnsworth and Vladimir Zworykin, but there is no question that Robert Logie Baird played a significant role in that area.

You can learn a lot about these and other people who helped create the business we all work in by visiting www.ce.org. ■

THE PROFESSIONAL MAGAZINE FOR ELECTRONICS AND COMPUTER SERVICING

ELECTRONIC
Servicing & Technology

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.

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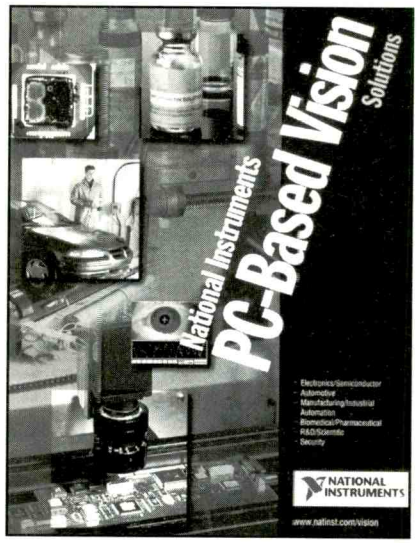
Literature

PC-based vision solutions brochure

National Instruments announces a new, free brochure for engineers and scientists seeking faster, easier, and lower cost machine vision applications development. The new "PC-based Vision Solutions" brochure describes the company's comprehensive collection of software and hardware tools for applications



ranging from assembly verification and LCD inspection to thermal imaging and semiconductor wafer thickness measurements. Brochure readers will gain valuable insight into using LabVIEW™ for machine vision, discover new tools for optional character recognition and rapid application development, learn about the latest features available on today's leading frame grabbers and more. The brochure is part #350574A-01.

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Phone: 800-258-7022, E-mail: info@natinst.com,
Website: www.natinst.com/imaq
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Computer connection catalog

A new B&B Electronics catalog shows solutions to common and uncommon computer connection problems. New in the Spring 2000 catalog are adapters to connect a CAN (Controller Area Network) bus to fiber optic cable. The catalog also shows a new optically isolated USB hub and several converters that allow use of the USB port on new PCs for legacy serial and parallel applications.

A new catalog section of Fail Safe and Redundancy products includes a Rogue Node Isolator that cuts off an RD-485 node giving spurious signals before it brings down the entire network. Other fail-safe modules can automatically disconnect locked modems, automatically transfer data to a back-up line if a main line goes down, or sound an alarm if data stops flowing.

B&B Electronics, P.O. Box 1040, Ottawa, IL 61350
Phone: 815-433-5100, Fax: 815-434-7094
E-mail: catrqst@bb-elec.com,
Circle (101) on Reply Card

Semiconductor master replacement guide

Philips ECG introduces their 19th Edition ECG Semiconductor Master Replacement Guide featuring over 6,000 additional cross-references and 81 new devices, including new product families.

With more than 306,000 crosses to U.S., Asian, and European part numbers, the 19th Edition Master Guide is a comprehensive source of replacement information for electronic equipment servicers. Expanded selector guides are also provided to simplify choosing the best replacement type for numbers that are not crossed. All components meet or exceed OEM specifications for the Entertainment, Industrial/Commercial and MRO replacement markets.

Philips ECG, 1-800-526-9354
Website: www.ecgproducts.com
Circle (102) on Reply Card

News

Thomson picture tube recycling/analysis program aids product improvement efforts

Thomson multimedia, manufacturer of RCA, PROSCAN, and GE color TVs, is launching a television picture tube analysis and recycling program to aid in product improvement efforts.

Under the program, servicing dealers who replace an in-warranty picture tube in a Thomson-made television receiver can return the old tube to Thomson's Customer Service Center in Indianapolis. The picture tubes are sent to a processor where they are dismantled and recycled. The processed glass is sold to Thomson's glass factories for re-use in new tubes.

As many as 1,300 end-of-life- picture tubes are expected to be recycled annually under the voluntary program. Upon return, the picture tubes are diagnosed as to the root cause of failure, thus providing feedback to the company's engineering and design staff for future product development and improvement.

An additional benefit of the program will be to reduce the number of TV picture tubes entering U.S. landfill sites.

"The picture tube recycling program offers several other advantages," said Charles Jost, Manager of Service Administration. "It provides dealers with a cost-effective and convenient mechanism to recycle the tubes once they have reached the end of their life cycle, it reduces the amount of waste that is disposed of in landfills, and it reduces the amount of raw material needed to make new tubes."

The cost of the recycling program is offset in two ways: using the recycled glass in new picture tube production and by utilizing returned tubes for quality inspection. Prior to the program, as many as 1,000 tubes per year were returned to Thomson for analysis. Under the new procedure, tubes for quality inspection are obtained from those returned for recycling, thereby reducing overall costs.

April video sales up in 2000

According to figures released by eBrain Market Research, a service of the Consumer Electronics Association (CEA), total video sales in April moved up 6 percent over the same period last year. Shipments from manufacturers to dealers reached 4.9 million units in the month, while the first four months' sum reached 18.2 million units, representing an increase of 17 percent over 1999.

Direct view analog TVs and analog projection TVs both showed gains of 8 percent in the month. Year-to-date sales for direct view sets are up 11 percent to 6.9 million units. Direct view televisions measuring 29 inches and larger now account for 15 percent of that figure, and the 1.1 million large screen sets represent sales levels 31 percent higher than last year. Projection television sales are up 30 percent in the year-to-date.

"Consumer interest in video technologies has never been higher and we have a great dynamic going on at retail. Shoppers are snapping up great VCR bargains, they're adopting new technologies like DVD, and of course they continue to upgrade their TVs at a record pace," noted CEA Vice President of Market Research Todd Thibodeaux.

The largest percent increase in April belongs to TV/VCR combinations. Sales in this category grew 26 percent in the month, leaving the year-to-date 20 percent higher than 1999 with shipments nearing 1.4 million units so far this year.

Camcorder sales, so far this year, are up 17 percent to 1.6 million units. And, thanks to a spectacular final week, DVD player sales in April exceeded 400,000 units, putting this rapidly growing digital category also at 1.6 million units for the first four months of the year.

CEA and NCTA reach accord on labeling digital television sets

The Consumer Electronics Association (CEA) and the National Cable Television Association (NCTA) announced that they have reached agreement on labeling information that will aid consumers in their purchase of new digital television equipment.

The CEA-NCTA agreement establishes the labeling to be used to inform consumers about the capabilities of various digital television sets to receive digital and interactive digital TV services. All digital sets will be capable of receiving both analog and digital programming from a digital cable system.

Digital TV sets with full interactive capabilities will be labeled "Digital TV-Cable Interactive." Digital sets that lack these capabilities will be labeled, "Digital TV-Cable Connect."

"We're pleased to take this further step in the transition to digital television," said NCTA President and CEO Robert Sachs. "Consumers will benefit from this agreement because they will know exactly what to look for when they purchase a new digital TV receiver. No longer will ambiguous terms like 'cable ready' cause consumers confusion."

"With this agreement, we have now passed one more milestone on the road to DTV," said CEA President and CEO Gary Shapiro. "As our industry brings new DTV products into the marketplace based on this agreement, consumers will have full access to the spectacular picture, sound and interactive features of digital television via their digital cable system." Both Shapiro and Sachs praised FCC Chairman William Kennard for encouraging industry resolution of these issues.

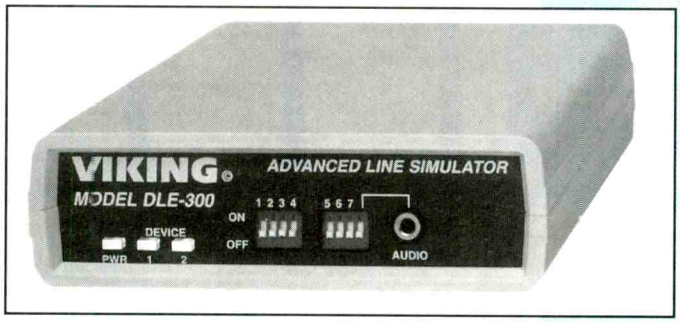
On Feb. 23, the two trade associations announced technical specifications that will permit the direct connection of digital television receivers to cable television systems. At that time, the industries also announced agreement concerning how program and system information will be transmitted over digital cable networks to digital TV receivers.

(Continued on page 26)

Products

Line simulator

Viking Electronics announces the DLE-300, advanced line simulator. The unit is perfect for field demonstration of telecommunications equipment such as modems, faxes, and phone systems. It provides talk battery, precise dial tone, ring signal and busy signals, S.I.T. tones, even caller I.D. It eliminates the need to discor nect customer premise equipment and tie up customer lines just to demo equipment.



The simulator also provides instant point-to-point communication with ring-down notification. As soon as one connected phone goes off-hook, it immediately rings the other phone.

For high-speed data transmission between two hard-wired points, the product provides a copper-to-copper connection, giving a fast transmission. Maximum wiring distance is 2.6 miles.

Viking Electronics, 1531 Industrial Street, P.O. Box 448 Hudson, WI 54016,
Phone: 715-386-8861, Fax: 715-386-4344

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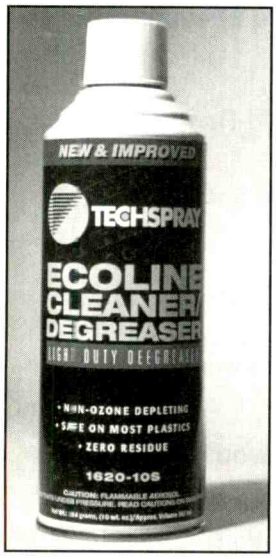
Cleaner/degreaser



Tech Spray introduces new, improved performance Ecoline cleaner/degreaser, with an innovative hydrocarbon reformulation. This new economical hexane mixture effectively cleans and removes a broad spectrum of soils and contaminants. It is rapidly evaporating, residue free, non-corrosive and safe for use on most plastics.

This cleaner/degreaser is non-ozone depleting and specifically designed for light duty cleaning and degreasing of electronic and electrical equipment, machinery and parts. It is useful for cleaning and degreasing contacts, controls, PCBs, motors, gears, generators, switches, electromechanical devices and de-energized industrial machinery.

Tech Spray, P.O. Box 949, Amarillo, TX 79105-0949,
Phone: 806-372-8523, Fax: 806-372-8750, Website: www.techspray.com

Circle (106) on Reply Card

DC power supply

BK Precision announces the Model 1620 dc power supply. Utilizing a standard 115Vac outlet as the power source, the new bench top units provide variable voltage outputs of 0Vdc to 18Vdc, and up to 5A at continuous operation. The supply is suitable for a variety of benchtop applications such as automotive and marine electronics.

The unit features a front-panel-mounted precision analog voltmeter and ammeter. Other front panel indicators and controls include an off/on switch, a power LED, overload indicator light, and voltage adjustment knob.

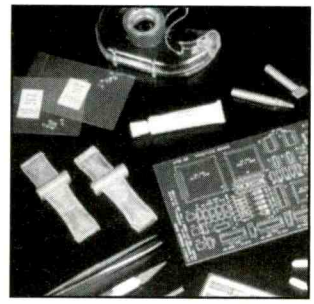
The supply provides variable output voltage of 0Vdc to 18Vdc, 0A to 5A output current, 5mV (peak to peak) ripple and noise, 5mV (+/-2% load) line regulation, 50mV (0-100% load) load regulation and utilizes a standard 120V/60Hz power source. The system features constant voltage/current operation, excellent line and load regulation and has low ripple and noise.

B&K Precision, 1031 Segovia Circle, Placentia, CA 92870-7137,
Phone: 714-237-9220, Fax: 714-237-9214, Website: www.bkprecision.com

Circle (107) on Reply Card

Circuit board repair training kits

Circuit Board Repair Training Kits for IPC-7721 Certification, available from Circuit Technology Center, contain all the necessary tools and materials to comply with IPC-7721 PCB repair procedures. They are for use in the newly-developed IPC-7721 (repair and modification of Printed Circuit Boards and Electronic Assemblies) certification training course.



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Circle (108) on Reply Card

Home theater basics: cables and speakers

by John A. Ross

During the past several years, this magazine has covered various aspects of the home theater market. Articles have discussed high definition television, DVD players, VCRs, and satellite television receivers. In each instance, however, the articles have discussed the equipment without making a direct conceptual link their use in home theater systems.

This article will acknowledge that home theater systems may include those types of equipment while taking a closer look at the foundation pieces of home theater: cabling, amplifiers, and speakers. As we discuss these topics, it becomes important to remember that home theater has several different definitions. In some instances, a home theater system may consist of a high quality television receiver with integral stereo sound, the same high quality television with the addition of external speakers, or a complete surround sound system that includes the high quality television, a VCR, DVD video player, high-power amplifiers, and a set of full-range speakers placed in strategic locations around the viewing area.

Surround sound

Home theater systems use a variety of methods to recreate the sensation of sitting in a movie theater. Going back to the 1950s, movie studios began using several audio tracks to give moviegoers the sense that they were surrounded by sound. The movie sound systems take advantage of a method that uses discrete tracks for each audio channel. Today, home theater systems using Dolby Pro Logic, Dolby AC-3 and Digital Theater Systems (DTS), rely on similar techniques.

As an example, the Dolby Pro Logic surround sound system uses two tracks that have four channels encoded within them. Using a process called steering, the processor detects the presence of in-phase and out-of-phase information in the two tracks and sends the two separate sets of information to the left and right stereo front channels, the center channel speaker, and the rear surround speakers. The first two channels include the front left and right stereo channels and playback through speakers placed at the sides of the television. A center channel carries voices and special effects sounds.

Center-channel audio is derived from in-phase signals contained in both tracks. A center-channel speaker, placed either on top of or under the television set reproduces the monophonic center channel sounds. The rear surround channel has a restricted frequency range and is derived from out-of-phase signals contained within both tracks. Rear surround speakers are located on the sidewalls a few feet above ear height either in line with or slightly behind the listener.

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Dolby Digital AC-3 offers 6 discrete channels of sound within the front left/right, center, rear left/right, and the subwoofer channel. We can also refer to the subwoofer channel as the Low Frequency Effects, or LFE, channel. Because all channels but the LFE channel have a full frequency range, the AC-3 system operates with a 5.1 channel format. While Pro Logic has a 1.5

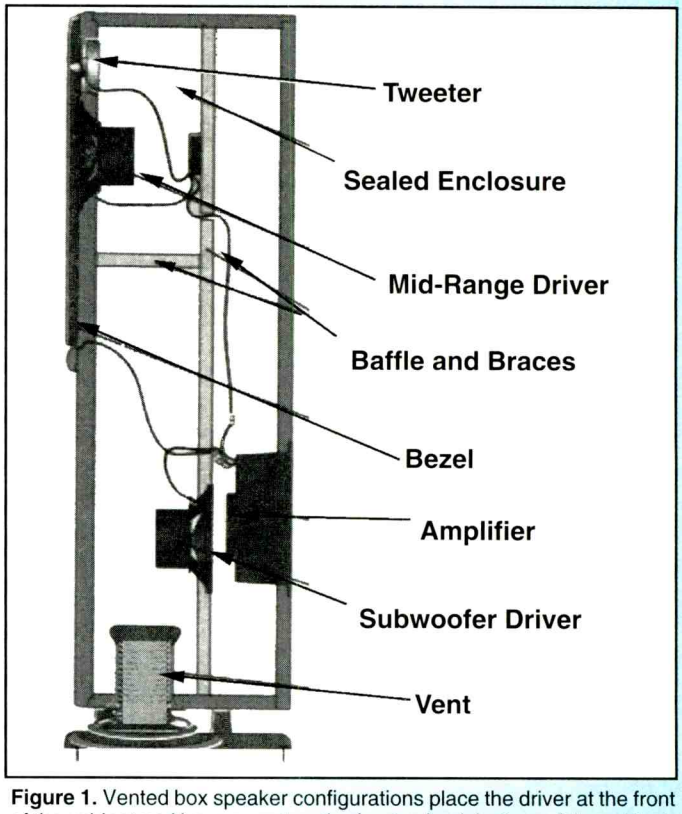

Figure 1. Vented box speaker configurations place the driver at the front of the cabinet and have a vent on the front or back bottom of the cabinet. In most instances, a speaker will feature multiple driver-vented boxes and close off the tweeter in a box located inside the main box.

Mpbs bitstream, Dolby AC-3 has a 384 Kbps data stream for all 6 channels. As a result, AC-3 relies on the lossy compression of audio data at a ratio of 10 to 1. To reproduce exceptional audio playback, Dolby utilizes Perceptual Encoding or a set of complex mathematical algorithms that place only sounds that the brain would recognize in the sound tracks.

Digital Theater Systems uses the 5.1 digital surround sound format and lossy compression. However, DTS has a lower compression ratio than does Dolby AC-3. Most high performance processors include Pro Logic, AC-3, and DTS options.

Surround sound modes

Regardless of whether the home theater system relies on Dolby Pro Logic, Dolby Digital AC-3, or the Digital Theater System, several sound reproduction modes exist. With each choice, a listener can elect to delay the signal in the center channel as well as the rear surrounds by several milliseconds. The delaying of the signal creates a better sense of audio depth.

To improve the apparent audio depth, a listener can change the center channel from the normal setting, which has a restricted frequency range, to a wide setting that establishes a full frequency range or to the *phantom* setting. In the case of the phantom setting, center channel signals are reproduced through the left and right speakers, while the center channel output shuts down. The phantom mode provides quality home theater audio without the use of a center channel speaker and corrects a problem caused when the system does not use identical speakers for the left/right stereo and the center channels.

Without the use of a center channel speaker, voices will seem to arrive from either the right or left rather than from the person shown on the television screen. In instances in which the system has an unmatched center-channel speaker, the phantom mode may offer superior audio reproduction. An unmatched center channel speaker will cause sounds that move from one side to the other to pass through the speaker as the changes occur. At times, this phenomenon may be irritating to the listener.

Digital Signal Processing provides other choices for Dolby Pro Logic, Dolby AC-3, and Digital Theater System Surround that add more ambience to the sound. These choices include various theater and hall modes and appear as Pro Logic Enhanced and Dolby Digital Enhanced. To recreate the symphony halls of Europe, churches, jazz nightclubs, rock concerts, and stadiums, designers have used special recording equipment to analyze the echoes, reflections, or reverberations that occur. From there, manufacturers place the individual ambience characteristics into the permanent memories of computer circuits in the preamplifier. The selection of different modes adds the echoes, reflections, and reverberations to existing music and creates the ambient effects.

The "THX" logo indicates that surround processors, amplifiers, and speakers meet certain high standards for home theater sound. Special surround sound features such as decorrelation of the rear channel speakers cause the speakers to sound slightly out of phase and provide more presence. THX-certified speakers have a limited vertical dispersion pattern while having a more extensive lateral dispersion. All this allows surround sound to reach a larger number of listeners who might be seated throughout the room.

Cables and connectors

The different equipment types that make up home theater systems often overshadow the importance of the cables used to interconnect the equipment. Several unique cable designs exist and each offers physical and electrical characteristics that can improve the performance of the system. Manufacturers provide flat and round cables that have different applications. The electrical characteristics of cables depend on a combination of resistance, capacitance, and inductance, and vary with the type of material used within the cable.

Because all cables have values greater than zero for all three of those factors, the cables effectively operate as filters. Regardless of whether the cable conductor consists of gold, silver, or copper, the resistance presented by a speaker remains low. As an example, most cables have a resistance that ranges from 0.1Ω to 0.02Ω for every eight feet of cable. Consequently, resistance does not have a great effect on speaker cable performance.

However, the capacitance and inductance of a cable combine to present a reactive impedance that may vary even with higher quality cables. Combining capacitance and frequency produces capacitive reactance while combining inductance and frequency produces inductive reactance. Lowering the frequency produces more capacitive reactance while increasing the frequency increases the inductive reactance. Together, the resistive impedance and reactive impedance combine to result in the total impedance.

When connecting cables between the source and pre-amplifier or between the pre-amplifier and power amplifier, low capacitance values offer the best performance. Along with the conductor, the dielectric surrounding the conductor affects the capacitance of the cable. As the electrical signal passes through the cable, part of the energy is transferred into the insulation and then released back into the conductor. The release of too much stored energy during any one period into the conductor can degrade the quality of the reproduced sound.

Different insulation materials used for AV cabling, such as polyvinyl chloride, polyethylene, polypropylene, and Teflon, produce different dielectric constants. Polyvinyl chloride, or PVC, resists the elements and most solvent compounds. Because PVC insulation has a higher dielectric constant than

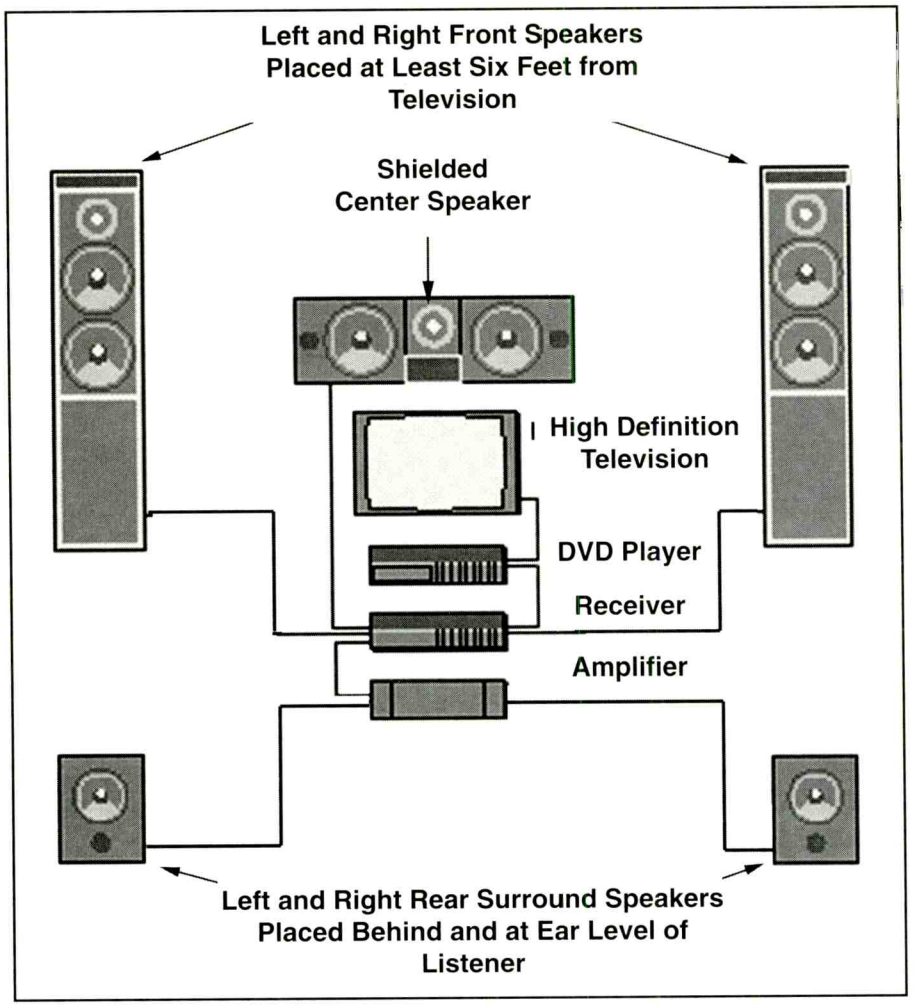

Figure 2. The selection and placement of all the speakers depends on personal preferences and the setup of the listening area.

polyethylene, it works best for audio frequency transmissions. The lightweight, water-resistant, and chemically inert polyethylene insulation offers ease-of-use. Because polyethylene insulation has a low dielectric constant of 2.5 that establishes low capacitance and low electrical loss, it works well for audio and rf applications.

Much stiffer than PVC or polyethylene, polypropylene provides excellent heat and abrasion resistance and provides very low signal loss when used with small components. Teflon insulated cables work for instrumentation/control applications. Of the listed materials, PVC has the highest dielectric constant while Teflon has the lowest dielectric constant at 2.33. Typical values of capacitance with high-end audio cables vary from 6pF/ft to 50pF/ft.

When connecting between the power amplifier and speakers, low inductance offers better performance. Going back to Electronics 101, single wires in the signal path produce a magnetic field when current flows through a wire. Coiling the wires increases the value of the inductance.

As a result, coiling an extra length of speaker cables on the floor can cause performance degradation. Because speaker cables have two leads and each conducts in the opposite direction to complete the circuit, high inductance can cause the flow of current in one lead to interfere with the flow in the other lead. As a result of this phenomenon, high frequency loss occurs. Inductance values in high-end audio cables vary from about 0.1uH/ft to 0.6uH per foot.

The combination of insulation and conductor that makes up the speaker cable can also lead to another phenomenon called "skin effect." As you know, skin effect means that as the frequency increases, the signal tends to travel mostly through the outer surface of a conductor rather than at the center of the conductor. Although thick cables may seem desirable for A/V applications, a cable that has a larger gauge conductor will have greater chances for skin effect and the smearing of high frequencies.

Connectors

For the most part, the input and output connections for the DVD video players, VCRs, decoders, tuners, amplifiers, and televisions found in home theater systems utilize RCA jacks for most applications. However, some DVD players may rely on a Toslink optical digital output jack and a coaxial digital output jack. Regardless of the type of connector used, the system should provide the capability to dub from one unit to another. As a result, the system will usually include three sets of output connections with two reserved for S-video and one set used for left/right stereo audio. One S-video/stereo audio set will connect to a television while another S-video/stereo set connects to a VCR or DVD player.

The remaining set of connectors connects to a preamplifier/processor that may have as many as five or six line-level audio outputs. Those output lines consist of the left/right front stereo, center, left/right rear surround, and one subwoofer and feed into the power amplifiers. Most integrated units usually include pre-amplifier output connectors that allow the upgrading of the system to higher quality power amplifiers. The receiver speaker connectors may consist of either binding posts, spade lugs, banana plugs, or simple spring clips.

Some preamplifiers, power amplifiers, and DVD players use unbalanced and balanced jacks as interconnections. An unbalanced jack is nothing more than the standard two-connection jack such as the typical RCA connector. A balanced jack has positive, negative, and ground connectors. Balanced connections can eliminate electrical interference that may enter longer cables that connect components together.

Home theater speakers

With our discussion of cables and surround sound modes, we have touched on the three desired characteristics of high fidelity sound system: accuracy, soundstage, and ambience. An accurate home theater system reproduces sounds precisely. In part, accuracy allows a violin to sound like a violin and a trumpet to

sound like a trumpet. In addition, accuracy distinguishes the finer points of audio reproduction. As an example, accuracy allows us to hear two violins playing a melodic line, the drumstick striking the skin of the drum, or a guitar pick touching the string.

Soundstage imaging defines the left to right and front to back placement of the instruments or voices. While one speaker can establish accuracy, soundstage requires at least two speakers and separately recorded channels. Left to right sound reproduction utilizes a microphone for each stereo channel. Front to back soundstage operates from the proximity of the microphones to the instruments and the capability of the speakers to reproduce different frequencies at relative volumes. If the speakers have a strong midrange, instruments, such as a saxophone, in that frequency range would seem forward. Without the strong reproduction of the mid-range frequencies, the saxophone will seem to play from the background. Speakers that have a strong high range will cause instruments that play at the upper audio spectrum, such as a flute, to sound forward.

A home theater system filters the original accuracy, soundstage, and ambience through the speakers. In addition, the ceiling, walls, floor, doors, windows, and furniture in the listening add to the ambience and may compensate for some loss that occurs through the speakers. We can enhance the ambience of a system by simply duplicating the front speakers with two speakers in the rear and not use a surround processor.

We can achieve more ambience by using dipolar or bipolar speakers that aim the sound in several directions and bounce the sound off numerous surfaces. Dipolar speakers have cones moving out-of-phase, that is, with one cone moving in towards the magnet, while the other cone moves out and away from the magnet. Bipolar speakers have drivers on the front and back that move in-phase, or with both speaker cones moving away from the magnet.

Crossover networks and subwoofers

Located inside the speaker cabinet, the crossover network takes advantage of the electrical characteristics of capacitors, and inductors to pass or impede high and low frequencies. Resistors are used to balance the loudness between the various drivers. The connection of a crossover network sends only high frequencies to the tweeter, midrange frequencies to the midrange driver, and low frequencies to the woofer.

If the home theater system does not feature full range speakers, the use of a subwoofer may allow the better reproduction of the lowest frequencies. Of the ten octaves in the range of human hearing, a subwoofer reproduces the lowest two octaves for a range of 20 to 80 hertz. Subwoofers may have large drivers that have 18-inch diameters. Other subwoofer types may have integrated power amplifiers while others consist of only the driver in the enclosure.

Depending on the type of subwoofer used, the system may require power amplifiers that provide three-to-six channels of amplification. The use of the phantom mode and no center channel speaker usually calls for a four-channel power amplifier. Using a center channel speaker and a self-powered subwoofer establishes the need for a five-channel power amplifier. A six-channel power amplifier works best with the use of the center channel and a subwoofer that has no amplifier.

Most commercial sub-woofers utilize self-power and servo feedback. In this type of system, a sensor located on or near the speaker cone feeds back information to the amplifier about the movement of the cone when a signal passes through the voice coil. A special circuit compares this sensory feedback with the amplifier signal sent to the speaker. Any difference between the two signals results in the modification of the signal to the speaker through the adding of electrical information that cancels out the distorted movements of the speaker cone. A servo feedback subwoofer produces the most accurate sound quality because of the cancellation of most of the even and odd ordered harmonic distortion. Although servo feedback subwoofers dominate the market, other types, such as push-pull, passive radiator, and vented enclosure subwoofers, exist.

Vented box speakers

Basic speaker designs place various combinations of drivers into enclosures or cabinets. A sealed enclosure or cabinet results in a closed-box configuration. An enclosure or cabinet that has one or more holes called vents or ports results in a vented box speaker. Typical vented box configurations (Figure 1) place the driver at the front of the cabinet and have a vent on the front or back bottom of the cabinet. In most instances, a speaker will feature multiple driver-vented boxes and close off the tweeter in a box located inside the main box.

Vented enclosures often have complicated arrangements of shelves (baffles) that direct the sound from the driver through a tunnel before it emerges from the port. A speaker with a labyrinth arrangement has parallel and horizontal shelves. A speaker with a transmission line arrangement places the shelves at angles other than horizontal. Horn loaded speakers use shelves that cause the sound to exit as if through a megaphone. These types of enclosures and arrangements allow bass extension through smaller drivers reproducing lower frequencies than normally seen with a simple vented enclosure. Vented enclosures with a labyrinth, transmission line, or horn loaded arrangement have low cabinet resonance, loud bass below 50 Hz, and low amounts of mid-bass coloration.

Passive radiator speakers

Passive radiator speakers operate as a cross between the vented enclosure and the sealed enclosure, have one or more active drivers, and one or more passive drivers. Some passive radiators are simply non-electrically connected speakers, while others are flat membranes suspended across an opening in the enclosure. The drivers for passive radiator speakers mount inside a non-vented box and face outward. Depending on the frequency, the passive driver may move in phase with the active driver or out of phase. When moving in phase with the active driver, the passive radiator increases the bass output. When the passive radiator moves out of phase with the active driver, the bass output is reduced. At the tuning frequency, the active driver has little movement and the passive driver moves substantially because each remains out-of-phase.

Push-pull speakers

Push-pull speakers use two active drivers for the pushing and pulling of the

output. One driver mounts inside a nonvented box and faces outward while the other mounts outside and faces inward. With the two drivers electrically connected out-of-phase, the cone of one driver pushes outward and away from the magnet. In contrast, the cone of the other driver pulls inward and toward the magnet. Even order harmonic distortion is reduced in this design.

Acoustic suspension speakers

Many speaker designs rely on a method called acoustic suspension. With this simple closed-box design, all speakers are active, mount inside the nonvented box and face outward. Operating in-phase, acoustic suspension speakers have all the speaker cones simultaneously moving in the same direction with respect to the speaker magnets.

Ribbon and electrostatic speakers

Some specially designed dipolar speakers do not rely on cones. Instead, ribbon and electrostatic speakers have thin foils suspended between magnets or metal sheets. Ribbon and electrostatic speakers reproduce midrange and upper frequencies with superb clarity but lack quality at frequencies below 100Hz. With ribbon speakers, the musical signal is applied to a foil ribbon. As a result, the varying electrical charge placed upon the ribbon by the music causes the ribbon to attract to or become repelled by the magnets. The attraction or repulsion of the ribbon moves air and reproduces sound. A variation on the ribbon design called planar-magnetic consists of a foil that suspends a large flat membrane.

Electrostatic speakers suspend a plastic membrane coated with powdered graphite between two perforated metal sheets. During operation, a positive voltage connects to the membrane. Increasing the voltage through the use of a transformer at the base of the speaker produces a signal that is, in turn, applied to the perforated sheets. Varying the signal in the metal sheets attracts or repels the membrane and reproduces the music.

Speaker sensitivity and damping factors

We measure the sensitivity of a speaker in terms of dB/watt/meter or dB/2.83V/meter. With this, certain decibel amounts occur with a standard power at a standard distance from the speaker. Sensitivity becomes more of a concern with low powered amplifiers than with high-powered amplifiers. Speakers with ratings above 90dB/watt/meter provide good sensitivity while speakers with ratings below 90 do not have good sensitivity.

Most home theater specialists view sensitivity from a very general perspective. For example, horn loaded speakers can reach levels above 100dB/watt/meter. In comparison, acoustic suspension speakers do not have good sensitivity because the air inside the sealed box acts like a spring and prevents the speaker cone from moving outwards and resisting the cone moving inwards. Although acoustic suspension speakers sacrifice sensitivity, the speakers gain bass tightness because of the spring-like control. In addition, sensitivity measurements depend on the impedance variations of the speaker across the audio spectrum.

The impedance of the speaker also affects the damping factor: the ratio of the speaker impedance to the output impedance of the amplifier. If the speaker has an impedance of 8Ω and the amplifier has an output impedance of 0.05Ω, the damping factor equals 8/0.05 or 160. High damping factors usually define or tighten the bass response while low damping factors result in a looser sounding bass. Because damping factors vary with the type of amplifier, the selection of the amplifier affects the selection of the speakers used in the home theater system. Tube amplifiers often have low damping factors compared to solid-state amplifiers.

Placing the speakers

The selection and placement of all the speakers depends on personal preferences and the setup of the listening area (Figure 2). The direction in which the speakers radiate their sound depends on how the drivers are lined up within the enclosure and whether there are drivers or ports on the back of the speaker. We define the decreasing levels of sound as the listener moves away from directly in front of the speakers as the *off-axis* response. Decreasing levels of high frequency sounds disclose possible problems with off-axis response. Good wide-angle dispersion occurs when speakers do not lose high frequencies regardless of whether the listener sits towards the side or directly in front.

After purchasing the speakers, experiment with placement before mounting the speakers permanently. Speakers not designed for home theater front channels radiate sound vertically. As a result, the sound will bounce off the ceiling and the floor. Home theater speakers designed for the front channels radiate the sound side to side and allow the listener to sit anywhere in the room and hear the sound clearly from all the speakers. However, side to side radiating speakers produce less room ambience than vertically radiating speakers.

Speakers designed for rear channel surround sound radiate in numerous directions and emphasize ambience. Rear surround speakers have drivers only on the front and should be aimed in the desired direction. With digital surround sound, the use of matched speakers in the rear and in the front works well.

Going back to Figure 1, place the front left/right stereo speakers at least 6 feet apart and on either side of the television. The center channel speaker should have magnetic shielding and fit either on top or underneath a direct view television. Rear surround speakers may install on the floor, on the wall, or tuck into corners near the ceiling. Most installers recommend placing the rear speakers at a few feet above ear level.

Sound is a big part of the home theater experience

Over the last few years, it has been demonstrated that good sound, along with the large screen, can make the movie-going experience more realistic. One of the reasons people like to go to movie theaters to see a movie is the powerful experience that good sound can create.

Today, consumer electronics manufacturers offer amplifiers, speakers, and audio signal processing equipment that can enhance the realism of the home theater experience. We hope that this article helps readers understand these systems so they can better create the home theater experience for their clients. ■

Test Your Electronics Knowledge

by J.A. Sam Wilson

Here is a review of some low-frequency technology.

1. Sound frequencies above the range of frequencies that humans can hear are called:
A. Infrasonic frequencies
B. Intrasonic frequencies
C. Ultrsonic frequencies
D Intersonic frequencies

2. Of the following radio signals, which occupies the least band space?
A. PM
B. FM
C. AM
D. SSB

3. Two basic kinds of transmission media are used in industry to convey control and status signals. They are:
A. AM and FM.
B. Audio and RF.
C. IF and RF.
D. Hardwire and wireless.

4. Which of the following is a variable resistance taper that should be used as an audio volume control?
A. Logarithmic taper.
B. Linear taper.
C. Reverse taper.
D. Square root taper.

5. A square wave can be constructed by using a sine wave at the base frequency and:
A. Sine waves having odd multiple frequencies with decreasing amplitudes.
B. Sine waves having even multiple frequencies with increasing amplitudes.
C. Sine waves at all frequencies.
D. Cosine waves at the fundamental frequency with decreasing amplitudes.

6. The telephone is an audio device that transmits and receives audio signals at a level of around:
A. –3dBm
B. 0dBm
C. 5dBm
D. 13.6dBm

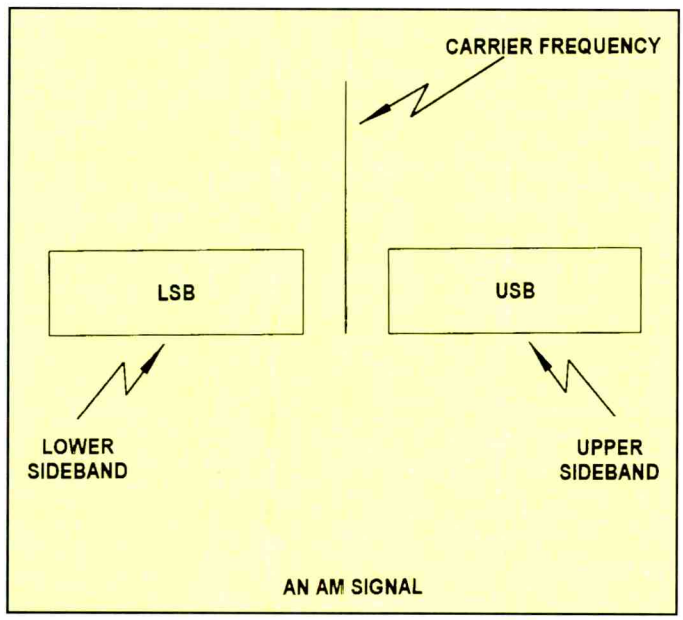

Figure 1

7. Which of the following might be used as a source of light in a fiber-optic communications system?
A. Incandescent lamp
B. Xenon lamp
C. Halogen Lamp
D. Laser light

8. There is a basic rule in communications: the higher the rf frequency,
A. The greater the losses.
B. The wider the bandwidth.
C. The higher the heat generated.
D. The higher the cost.

9. The advantage of infrared communications is:
A. Lower frequency operation.
B. Higher frequency operation.
C. No FCC license required.
D. Only state codes apply.

10. Which of the following can be used to sense infrared light?
A. PIN diodes
B. LeClanch Cells
C. Point contact diodes
D. Germanium diodes

(Answers on page 62)

Servicing home office products: Upgrading a personal computer

by Sheldon Fingerman

There are many old Pentium computers out there, and you, or one of your company's clients, may have one. Those computers sure seemed fast when new, but now they can't handle newer applications, and productivity is suffering as the user waits for things to happen. One possible answer to this problem is the purchase of a new computer and transfer of all existing software and data. Another, possibly better, solution is a major upgrade. An upgrade might take less time than the time it would to transfer everything to a new machine, and everything will be the same as it is now, only a heck of a lot faster.

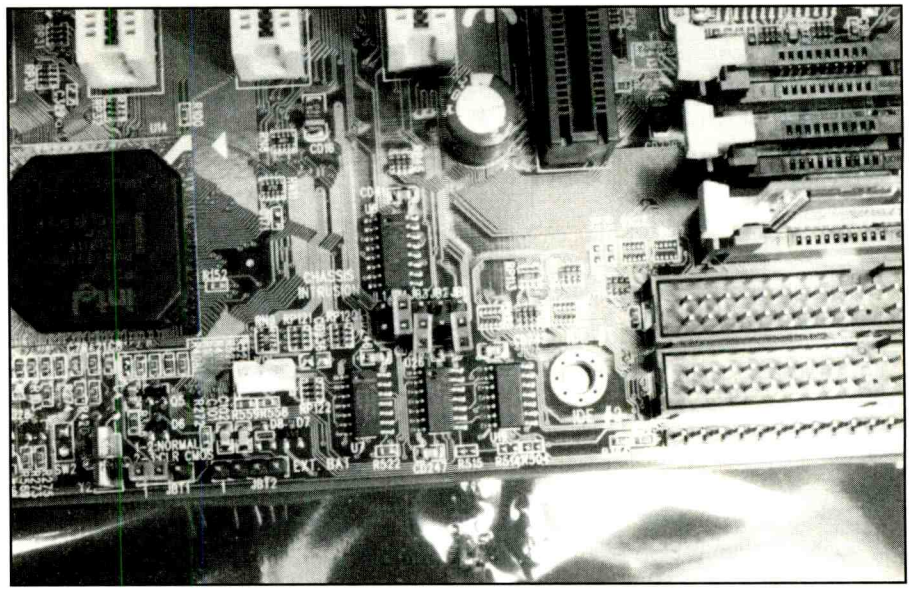

Figure 1. In the foreground are the jumpers for setting the CPU Core/Bus ratio. This setting must match the CPU speed.

Upgrading motherboard, processor, and RAM

This article explores upgrading the motherboard, processor, and memory (RAM). Although it's possible to get more speed by just adding memory or getting one of those "upgrade" processors, you will still be dealing with the limitations of the original motherboard. Those old boards run at bus speeds of 66MHz, while new ones are rated at 100MHz and 133MHz. This gives the system a huge boost, transferring data at much faster rates, and allows the computer to take advantage of modern CPUs, hard drives, and RAM. It can also be quite cost effective.

Evaluating the existing system

Before undertaking this task, you must evaluate the present system. After all, you don't want to wind up with a faster computer full of problems. Is hard drive space running low? If so, a bigger drive may be in order, regardless of whether you upgrade or not.

Is the computer buggy? These problems should be straightened out before any upgrade, or the bugs will just pop up faster than before.

Are there any obsolete components? Any CD-ROM in the 20x category should be fine for most purposes, and it's easy to upgrade to a 56k modem at any time. If the present peripherals are working fine, they should easily transfer over.

Sound cards and speakers aren't a big deal. Most businesses don't use sound cards, or don't care much about sound quality. If games are important, a new computer with the latest graphics, awesome sound, and lots of whistles and bells may be a better option. Keep in mind, however, that you can get a new motherboard with up-to-date integrated video and sound.

What kind of power supply does the computer have?

Does the computer use an AT or ATX power supply? This is important. At AT, power supply is connected directly to the power switch. On an ATX system, the power switch is connected to the motherboard, and the motherboard actually turns the power supply on and off. This allows for shutdown and power saving options. Some ATX power supplies have a master AC switch, not to be confused with the on/off switch on the front panel. This switch is usually mounted directly on the power supply, accessible at the back of the computer.

You can open the computer up — you're going to have to do this anyway — and see exactly where the power switch on the front panel goes, but you can often tell which power supply your system has without opening the case. A momentary on/off switch means you're working with an ATX system, and you may be able to use the current case and power supply. If the computer's power switch clicks on and off like a light switch, you probably have an AT power supply. Another sure sign that this is an ATX system is if the computer automatically shuts itself off when you follow the Windows shutdown procedure. To upgrade to a modern motherboard and

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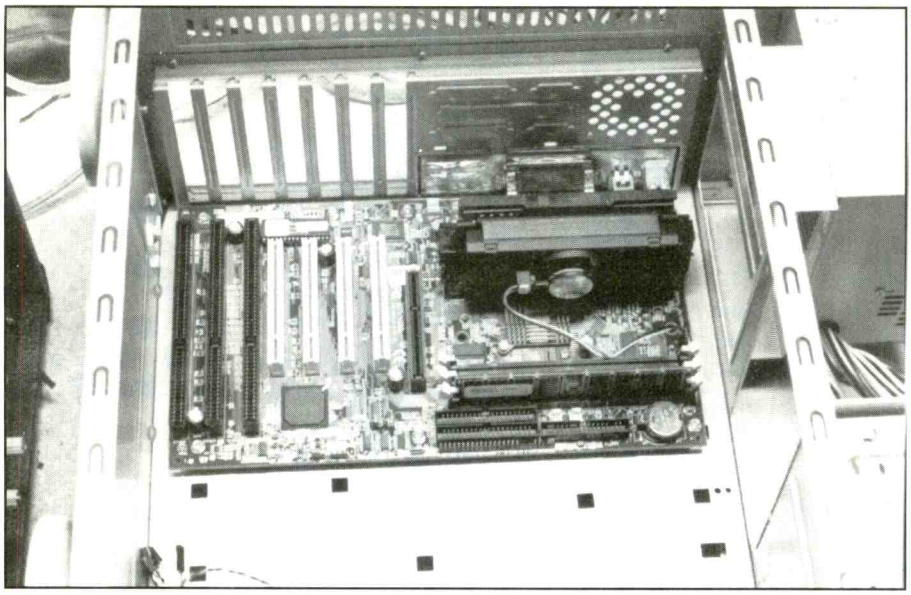


Figure 2. The motherboard along with the CPU and memory installed in the new case. Note the vast amount of room in this case, and the extra mounting holes for various motherboard configurations. This board has three ISA slots (one shared), four PCI slots, and one AGP slot for video.

CPU, you may need an ATX power supply, and possibly a new case.

Upgrading my Pentium

My old system was a Pentium 133 with 64MB of RAM. I was using Windows 98, and there was still plenty of room on the hard drives (yes, I have two). I don't care much about sound, so my old SoundBlaster card and cheap speakers were fine. The CD-ROM drive was 24x, so that was okay, too. Except for bogging down and running extremely slow, all of the programs and operating system were extremely "tight," causing no problems. This system was ripe for a motherboard/CPU upgrade.

The processor

My first decision was deciding what processor to use. I chose an Intel Pentium III 550 (slot1). This was a compromise between cost, availability, and performance. I could have easily gone with an AMD CPU, but did I mention that I own stock in Intel?

Intel ships CPUs two ways: boxed retail and OEM. Retail chips come with a fan and a three-year warranty from Intel. OEM chips are exactly the same, except they have no fan, a limited warranty from the seller only (usually a replacement if DOA), and tend to be a bit cheaper. Since this was the heart of my system, and the most expensive part, I opted for the retail version. Prices on CPUs can vary wildly based on availability at any point in time.

Next came the motherboard. You must match the motherboard to the CPU, or the CPU to the motherboard. Intel CPUs

are made for motherboards with bus speeds of 66MHz, 100MHz, and now 133MHz. You can mix and match in some cases, but the CPU will run much, much slower if you get it wrong. I selected a SuperMicro, slot 1, 100MHz motherboard for my new CPU.

The motherboard

There are many motherboards and manufacturers, and the choice must be made carefully when upgrading. I chose SuperMicro because many of their motherboards are manufactured in the U.S., and they have good documentation and support. In my case, I needed enough ISA slots to handle some of my older cards (sound, modem, NIC). Some new motherboards offer only PCI slots, and maybe only one ISA slot, so I had to scrutinize SuperMicro's catalog and Website.

Be especially careful if your distributor tries to sell you a mismatched motherboard and CPU. It is possible to put a newer Intel chip into a slot 1 motherboard using what's called a "slocket" adapter. Intel does not support these adapters, and they must be approved by the motherboard manufacturer. In many cases they work fine, but caution is advised. Obviously, if you choose to make an AMD CPU the heart of your system, you must get a motherboard compatible with that processor.

RAM

RAM must also match the motherboard and CPU. You will need memory that runs at the speed your motherboard will be set at, which, again, could be 66MHz, 100MHz, or 133MHz. Just ask your distributor or dealer what the proper RAM is for the system you are planning to put together. If you don't feel like you're getting a good answer from your distributor, call or e-mail the motherboard manufacturer. Also, make sure the RAM you buy is not only guaranteed against failure, but for compatibility with the system as well. I often get RAM that doesn't work with a particular system, and my suppliers are only too happy to make things right.

Ordering the materials and getting started

I went ahead and ordered a new case and power supply. Why? My old system was using an AT power supply and a case which was not compatible with my new motherboard. I also wanted more available drive bays for future internal RW-CD-ROM drives, Zip drives, and whatnot. I ordered a server-grade, tower case with a 300W power supply. It's really nice, has plenty of available external bays, lots of room to work in, and swing-out, removable side panels.

Once all the parts arrived, it was time to begin. First, I carefully placed the motherboard on my bench, taking all necessary antistatic precautions. I then installed the CPU and memory. Since some degree of pressure is necessary to install these components, it's easier to do this on a hard, flat surface before installing the motherboard in the case.

Following the instructions supplied with the motherboard, I installed the CPU fan connector to the proper pins. Next, I set the jumpers to match the CPU clock speed (Figure 1). This is very important, since a wrong setting here will cause major problems. You may also have to set the bus speed on the motherboard. My motherboard came set at "Auto," and I just left it there. After double-checking all the jumper settings, it was time to install the motherboard in the case (Figure 2).

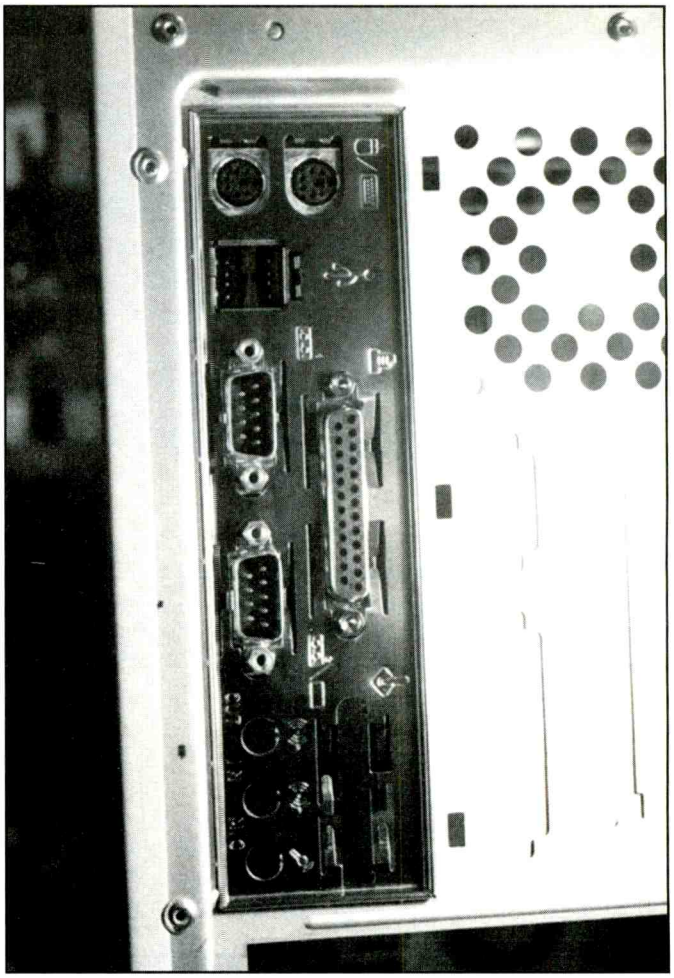


Figure 3. The PS-2, parallel, COM, and USB ports protrude through the back of the case. It's important that you punch out these openings before installing the motherboard.

Modern ATX motherboards have ports (parallel, COM, USB, etc.) attached directly to the board, and they stick through the back of the case. This was another reason I needed a new case. You must make sure all the appropriate holes in the back of the case are punched out before installation (Figure 3).

"It's very important to add the appropriate number of mounting standoffs to the case, lining them up with the mounting holes in the motherboard."

It's very important to add the appropriate number of mounting standoffs to the case, lining them up with the mounting holes in the motherboard. Simply hold the motherboard in place, being extremely careful not to damage the board, and figure out where to place the standoffs. This is done by trial and error, but is a simple procedure. Use as many of the metal standoffs as possible, as they are used for grounds. Start with all the screws loose, and don't overtighten when finished.

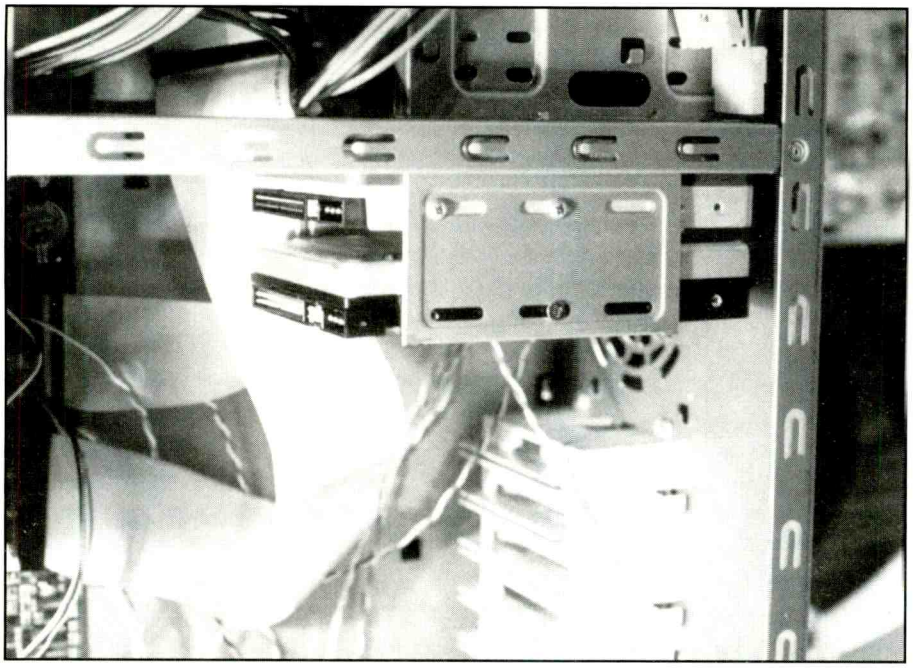


Figure 4. This bracket holds two hard drives. This is nice because it leaves available drive bays vacant for other peripherals.

You're installing a delicate piece of electronic equipment, not a set of lug nuts on a car wheel.

Now it was time to attach the power supply to the motherboard, along with the power switch, speaker, and LEDs. All of this information is in the documentation that comes with the motherboard, and if any of the LEDs don't light it's almost always due to reversed polarity.

Testing the upgrade

I wanted to test these new components as soon as possible, so I immediately installed a spare video card and monitor. I pushed the power button, watched my 128MB of memory count up, and was thrilled to see a bunch of error messages. After all, the computer wasn't going to go much farther without an operating system, but at least I knew the CPU, motherboard, and memory worked before continuing. The power light didn't light, so I reversed the plug to solve that, and lined up the plugs from the other LEDs to match.

Switching over components from the old system

Finally, I was ready to switch over all the components from my old system. Before I did, however, I first ran Scandisk on my old computer to clean things up a bit, and also went to the Windows Device Manager to check for problems and conflicts. This probably isn't necessary, but I like to make sure my system is really "tight," especially before any upgrades.

"If you use screws that are too long, you could impede operation of the device, or damage it."

I moved the hard drives (Figure 4), floppy drives (not all motherboards will accept two floppies), CD-ROM, sound card, video card, and modem. The swing-out panels on the case and all that extra space in there really helped. All the necessary hardware to mount the motherboard and all the components are supplied with the case. Always be careful when installing any type of drive in a computer. If you use screws that are too long, you could impede operation of the device, or damage it.

Even if you do everything correctly, you will probably have a lot of hardware left over. Not to worry. This is perfectly normal, and those parts may come in handy later, or if you work on computer systems in general.

The last installed component was the supplied, optional CPU overheat fan. This large fan mounts on the case just above the CPU, and plugs into a special socket on the motherboard. If the CPU rises above a certain temperature, the fan will start automatically, and a warning light on the case will come on. All this is controlled from the motherboard.

The big test

Now it was time for the big test of the completed upgraded computer (Figure 5). I attached all the external peripherals, took a deep breath and hit the power switch. The memory counted up, and the motherboard found all of my hard drives and CD-ROM drive automatically. Soon, I was looking at the Windows splash screen and then the Desktop, but the screen resolution looked very strange. Was I going to have a video problem?

The computer threw a few fits as it found this device and that device. After all, the new motherboard not only had new controllers for the drives, but integrated USB ports. The new system requested my Windows 98 CD to load some drivers, and I obliged. When the system restarted I was again treated to

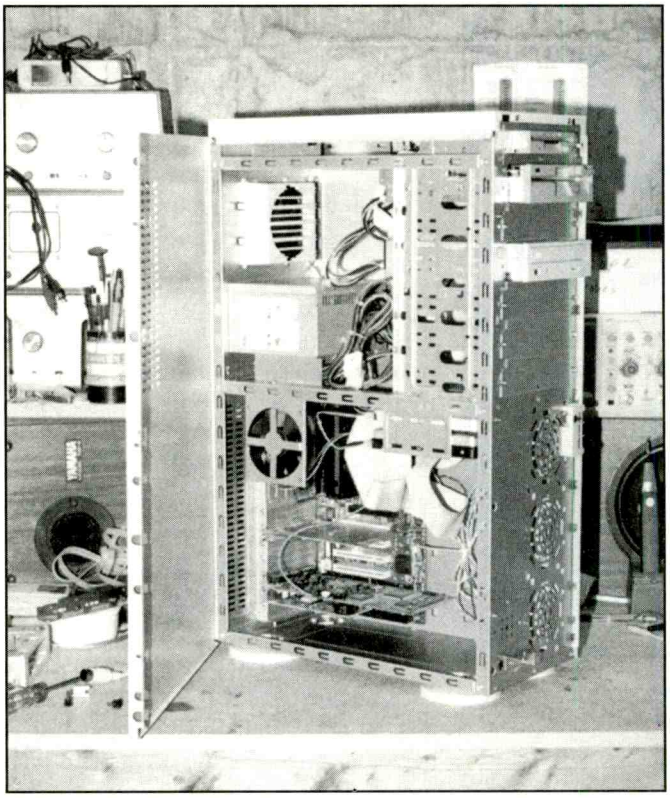


Figure 5. This is what the final project, with all the components and auxiliary CPU cooling fan installed, looked like.

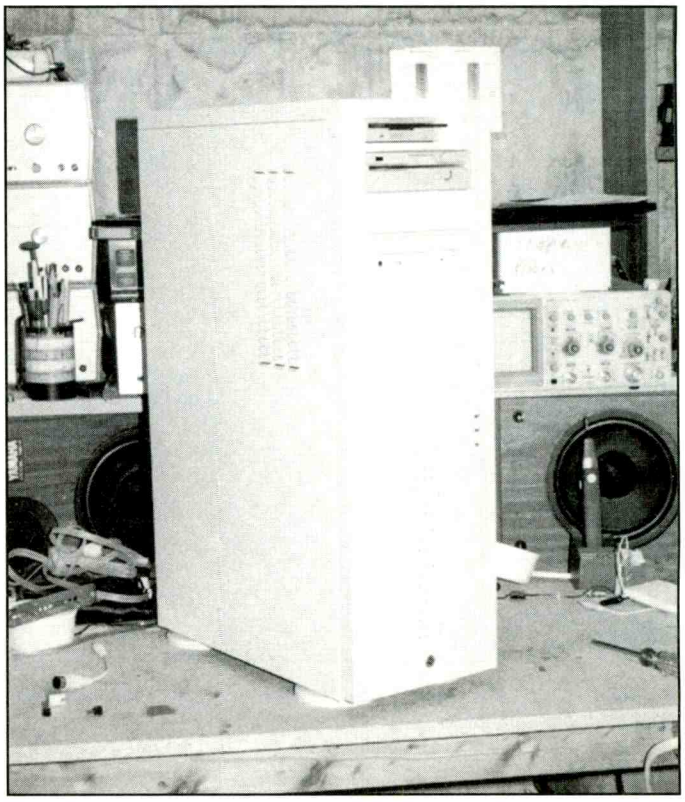


Figure 6. The upgraded computer with panels closed and the front cover in place. With six available height bays, this case leaves a lot of room to grow.

seeing all that memory, and this time the video looked perfect as the Desktop appeared. Whew!

My serial mouse didn't work, but I had it plugged into the wrong port; an easy fix. I also had to go into the BIOS and change the settings so the computer would recognize my second floppy drive. Another restart and all was well.

Problems and conflicts

I went to Device Manager to check for problems and conflicts, but there were none. This was too easy. My understanding is this process works better with Windows 98 than it does with Windows 95, partly because 98 contains drivers compatible with modern motherboards. Be prepared for glitches regardless of which operating system that's used, however. It might be wise to have any disks that came with your peripherals handy. Don't start unless you have the Windows CD nearby.

Now everything runs faster and smoother, and frequently run programs snap back quickly. The best part is that I didn't have to reload any of my software or data, and all of my menus, including the Desktop, are exactly as they were on my old system. I also picked up two integrated USB ports, so now I can shop for a new scanner, digital camera, and a plethora of other USB devices.

Total cost of the project (Figure 6 shows it with the panels closed and the front cover in place) was about $600, and there's no way I could have bought a machine of this caliber for that price. If I could have used the old case and/or power supply, the cost would have been $130 less. Even if you can't use the old case and power supply, you can get a case and power supply for a lot less than I paid, and you could go with a Celeron or AMD processor to save even more.

Since I work with computers for a living I can only compromise so much, but most business users can easily pull off this metamorphosis for a lot less. I estimate you can upgrade an older Pentium computer for just over $200, including the case and power supply. That would get you a low-end system, but still much faster than your current computer.

"I estimate you can upgrade an older Pentium computer for just over $200, including the case and power supply. That would get you a low-end system, but still much faster than your current computer."

None of these figures include labor, but that's where being a technician comes in. Anyone reading this magazine probably has the skills necessary to do this. The hardest part is deciding how fast you want to go, and how much you, or the client, want to spend on the upgrade.

The downside

There is one downside to all this. When you build your own system, or upgrade a system for one of your clients, *you* become technical support. Personally, I like the challenge and educational opportunities of solving computer problems on my own. Who knows? This could be the start of a new career. ■

Servicing A Philip's DVD Player: The Video And Audio Paths

by Bob Rose

The time has come to wrap up this series of articles on the Philips' DVD400/420. If you have been following along, you will recall that Part 1 examined the power supply, and Part 2 took an in-depth look at the servo and system control circuits. This article will lead you through the video and audio processing circuits.

The video signal path

The video signal begins, of course, with information that the pickup assembly has garnered from the spinning disk. At this point, the information is imbedded in an RF (radio frequency) signal that is transferred from the pickup assembly to the main circuit board by a ribbon cable identified by connector CN501 on the main board. The signal comes in on pins 16 and 17 and and from there scoots along to pins 54 and 55 of IC502 (Figure 1).

Do you recall your encounter with IC502 in the discussion of the servo circuits? IC502 serves as an RF amplifier, boosting the tiny signal to a level the other circuits can use. After amplification and equalization, the signal exits at pin 35 on its way to IC201. At this time, let me point you to TP502, which is a very important test point. If the disk is spinning and the circuits are working properly, you may use your scope to observe the familiar RF "eye pattern" at TP502. The presence and shape of the RF waveform should tell you a great deal about the health of the unit you have on your bench.

The amplified and equalized RF signal enters pin 52 of IC201, which serves as a data slicer, a 16-to-8-bit decoder, and an error correction circuit. The data slicer retrieves the data imbedded in the signal. Because the bit rate varies, the retrieved data is temporarily stored in a 4Mbit DRAM (IC202) and sent along to the 16-to-8 demodulation inside IC201 as it is needed. After it has been demodulated, the signal undergoes error correction to restore any bits of data that may have been lost between the disk and its present location.

After the error correction circuits have done their work, the signal goes to IC207 (Figure 2, the so-called data processor 2) in an eight-bit MPEG data stream. "MPEG" stands for "moving picture experts group" and refers to the scheme used to compress the data. The first thing IC207 does is detect the region code. If the code matches the region code of the player, the IC proceeds to process the signal and route it on to IC304, which is the actual MPEG decoder (Figure 2). If, however, the region codes don't match, the disk won't play, and the player will display the "region code error message" on the screen of the TV.

The DVD 420

The eight-bit MPEG data stream enters IC304 at pins 121 through 128. You may be a bit ahead of me by realizing the data enters the decoder at a varying rate and thinking, "What happens to the data if it comes in faster than IC304 can process it?" You are correct in assuming that the data enters IC304 at a varying rate. Because the rate varies, the system requires a means of storing the "to-be-processed" data. Enter IC305, a 16Mbit DRAM that has the job of storing the data until IC304 can handle it.

IC304 separates the audio and video bit streams and performs the job of

Rose is an independent consumer electronics business owner and technician.

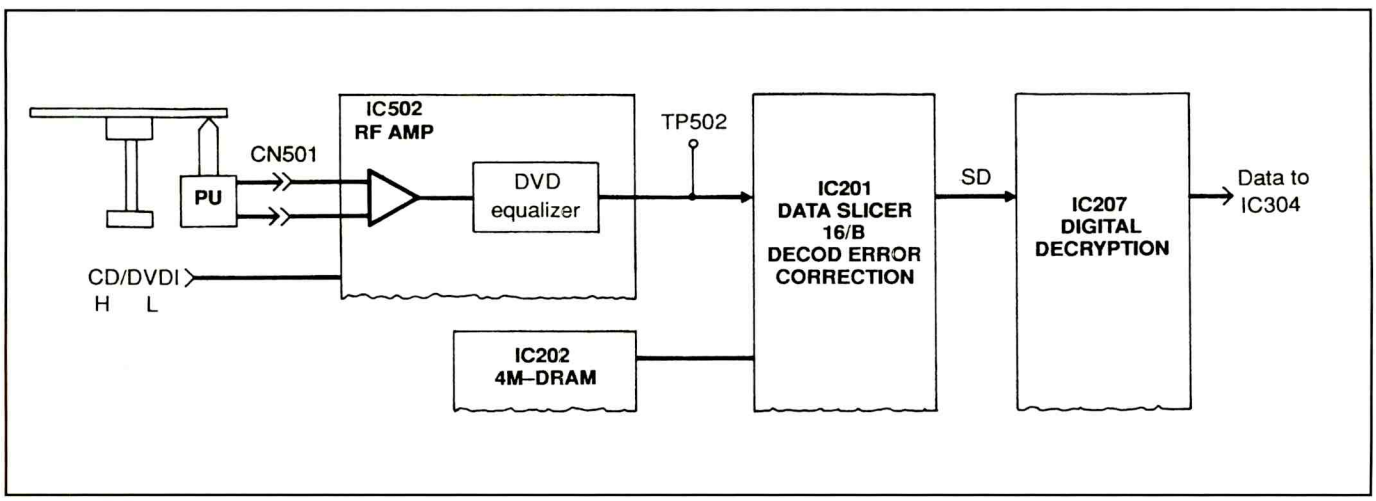


Figure 1. The video signal begins, when the pickup assembly retrieves data from the spinning disk. It is then processed by the circuitry in the DVD player.

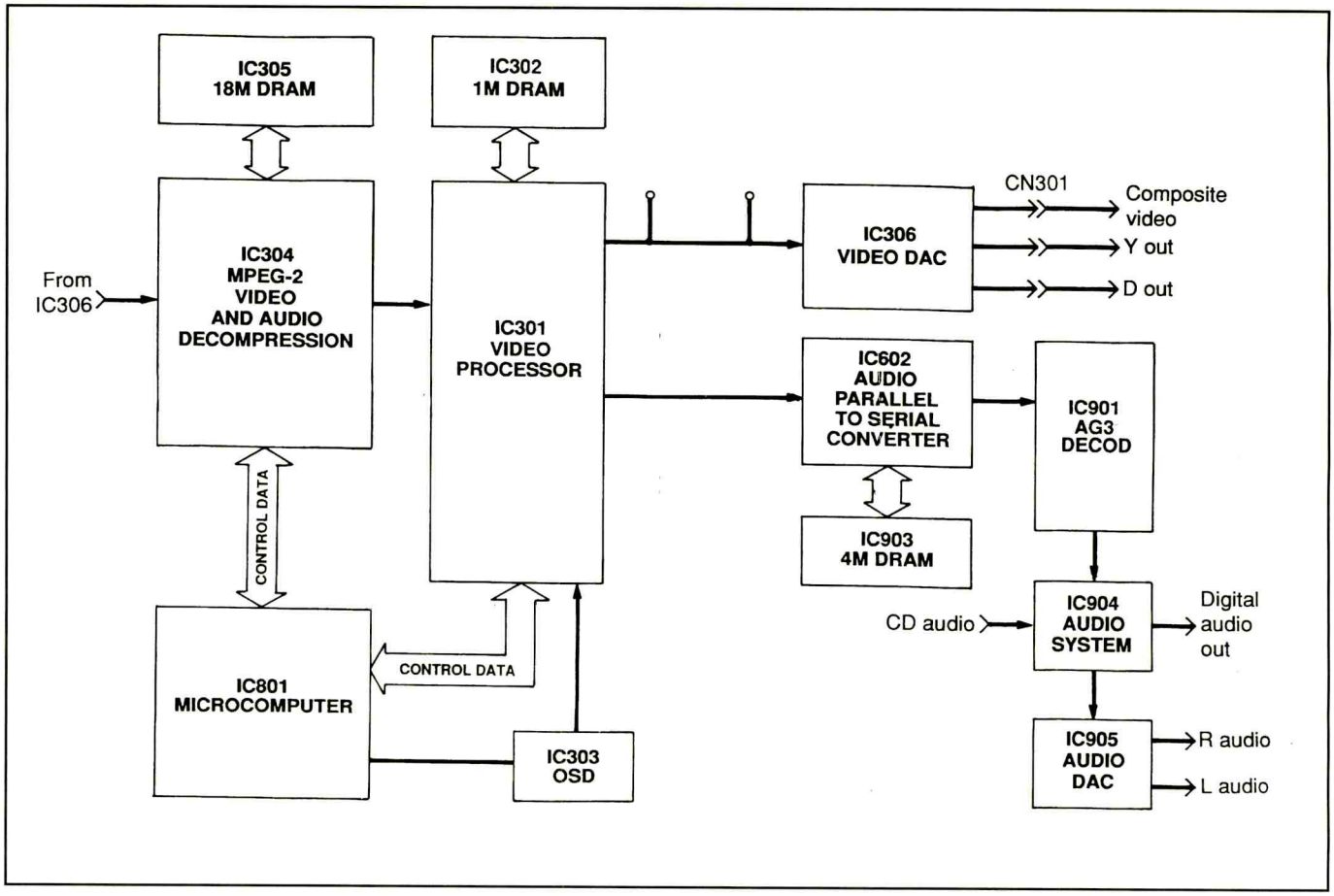


Figure 2. The video path for the DVD400 is the same as the path for the DVD420 up to IC301, but it changes from that point on. The DYC output of IC301 is fed to a second video processor, which adds "Macrovision" to the digital video if the software on the disk requires it.

decompression. The decoded eight-bit digital video data stream, YCI, is nudged along to the video processor (IC301) while a separate eight-bit data stream, SDA, containing audio and sub-picture information is also sent to IC301. Since the signal is to be displayed on an NTSC television, we must have sync. Therefore, horizontal and vertical sync information make their way out of IC304 at pins 79 and 80 respectively to enter pins 133 and 134 of IC301.

Now, let's make IC301 the focus of attention (Figure 2). IC301 strips the sub title and audio sub picture control data from the SDA line and adds it to the digital picture information after processing. The IC also receives on-screen display data from the microcomputer (IC601) by way of IC303, the OSD generator, and mixes that information with the digital video information.

Again, the data may come faster than IC301 can process it. Therefore, IC302, a 1Mbit DRAM, has been put into the circuit to store the sub-title information until it can be processed.

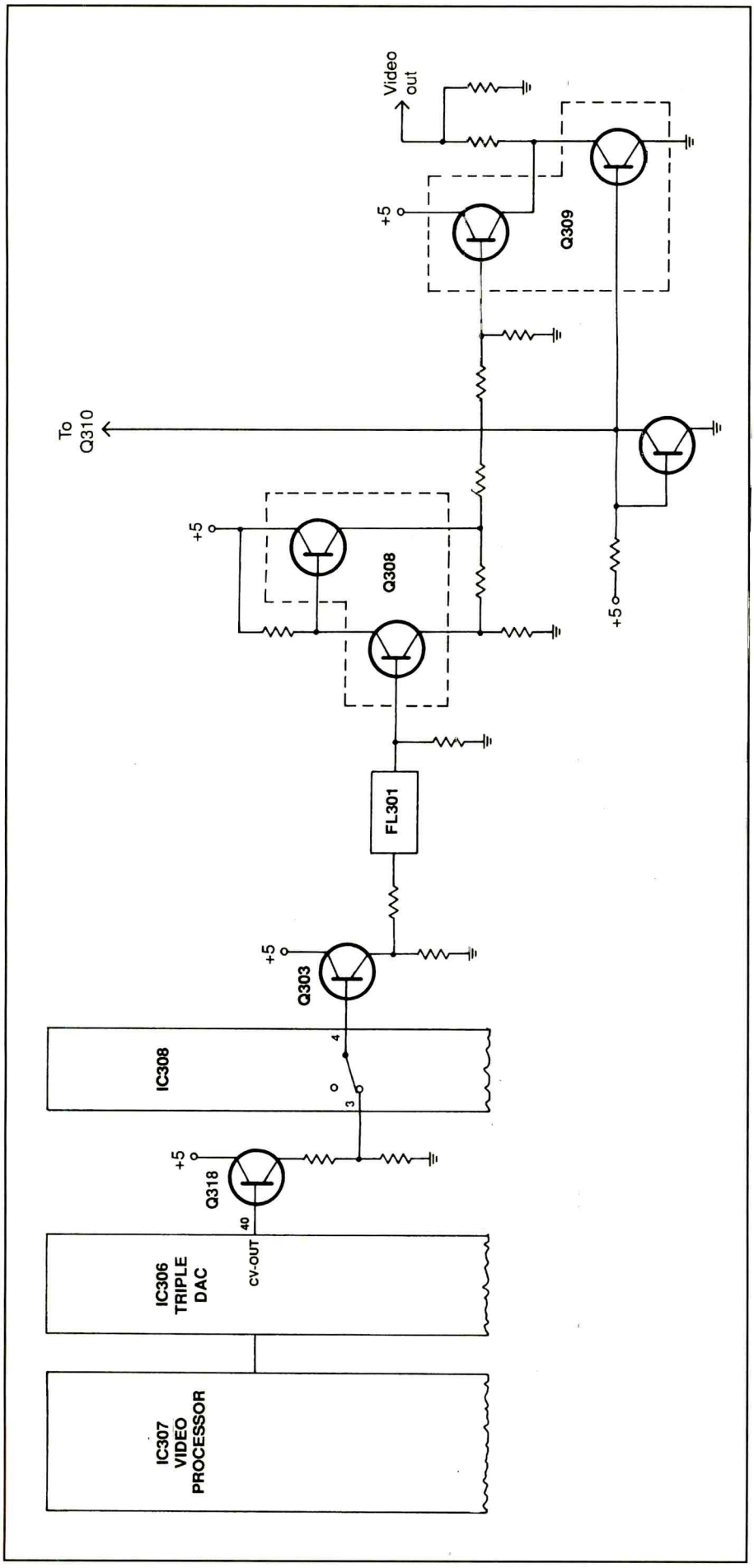
The next stage in the journey is IC306, the video DAC (digital to analog converter). The signal leaves IC301 and enters it on eight, eight-bit data lines. IC306 changes the video from an eight-bit data signal to an analog signal and outputs composite video, luminance, and chrominance to the output board.

Once the sub-title and control data are stripped off, the eight-bit audio bit stream is fed into IC902, which is the audio parallel-to-serial converter. The data moves from IC902 to IC901, the IC that performs the AC-3 decompression. The signal leaves IC901 at pin 52 and goes directly to pin 54 of IC904, the audio system processor. This IC has two digital outputs, one at pin 17 for data that goes directly to an external digital terminal that can be connected to an external AC-3, 5.1 channel decoder and another output at 11 that goes to pin 8 of IC905 which is the audio DAC. IC905 produces the right and left analogue signals and feeds them to the output board.

The DVD400

The video path for the DVD400 is the same as the path for the DVD420 up to IC301, but it changes from that point on. The DYC output of IC301 is fed toa second video processor (Figure 2), which adds "Macrovision" to the digital video if the software on the disk requires it. The bit stream then goes to IC307, video processor three, which separates the data into three, eight bit streams (Figure 3). The DY stream contains luminance information; the DC stream, chrominance; and the DCV stream, the digital composite video.

The three bit streams enter IC306, which is just a triple DAC used to convert each data stream into an analog signal. The composite video exits pin 40 of IC306, is buffered by Q318, input into pin 3 of IC308, and exits on pin 4. The signal is buffered by Q303 and filtered



← **Figure 3.** From the second video processor the bit stream goes to IC307, video processor three, which separates the data into three, eight bit streams.

by FL301 to remove high frequency noise. It is amplified by Q308, passes through an impedance matching network (Q309), and then is routed to the video input jack of an NTSC television.

The luminance and chrominance signals follow a similar path.

Troubleshooting tips

Troubleshooting a video and/or audio problem is a matter of taking voltage measurements and checking data inputs and outputs. However, (do I need to say this?) you must not only have a good scope but also know how to use it. Your DMM simply isn't sufficient for the task.

How you proceed depends on whether the disk you inserted into the player is spinning. If it isn't spinning, consult the information Part 2 of this series of articles in the June issue.

If it is spinning, begin your checks at the output of IC304, the MPEG decoder. The literature says if the input to IC304 is *not* correct, the disk will stop its rotation, and system control will write a "check disk error" to the screen of the television. You may, therefore, assume that the data is getting into IC304 if the disk is spinning.

Follow the data from the output of IC304 through to each of the DACs making certain that data is present on each and every pin of the eight-bit data bus.

The CD audio path

The final leg of our journey involves the path taken by the signal when the user asks the DVD400/420 to play an audio CD. Use Figure 4 as reference.

Assume I have just inserted an audio CD into my DVD420. The microprocessor detects its presence and sends a command that causes the lens to switch from the DVD to the CD position (Figure 2 in Part 2, June). Do you remember that these Philips products are able to use the same pickup assembly for DVD and CD functions because they incorporate a feature that permits the use of a pick up assembly that has two lenses?

The laser reads the information off the disk and, as in the DVD function, feeds

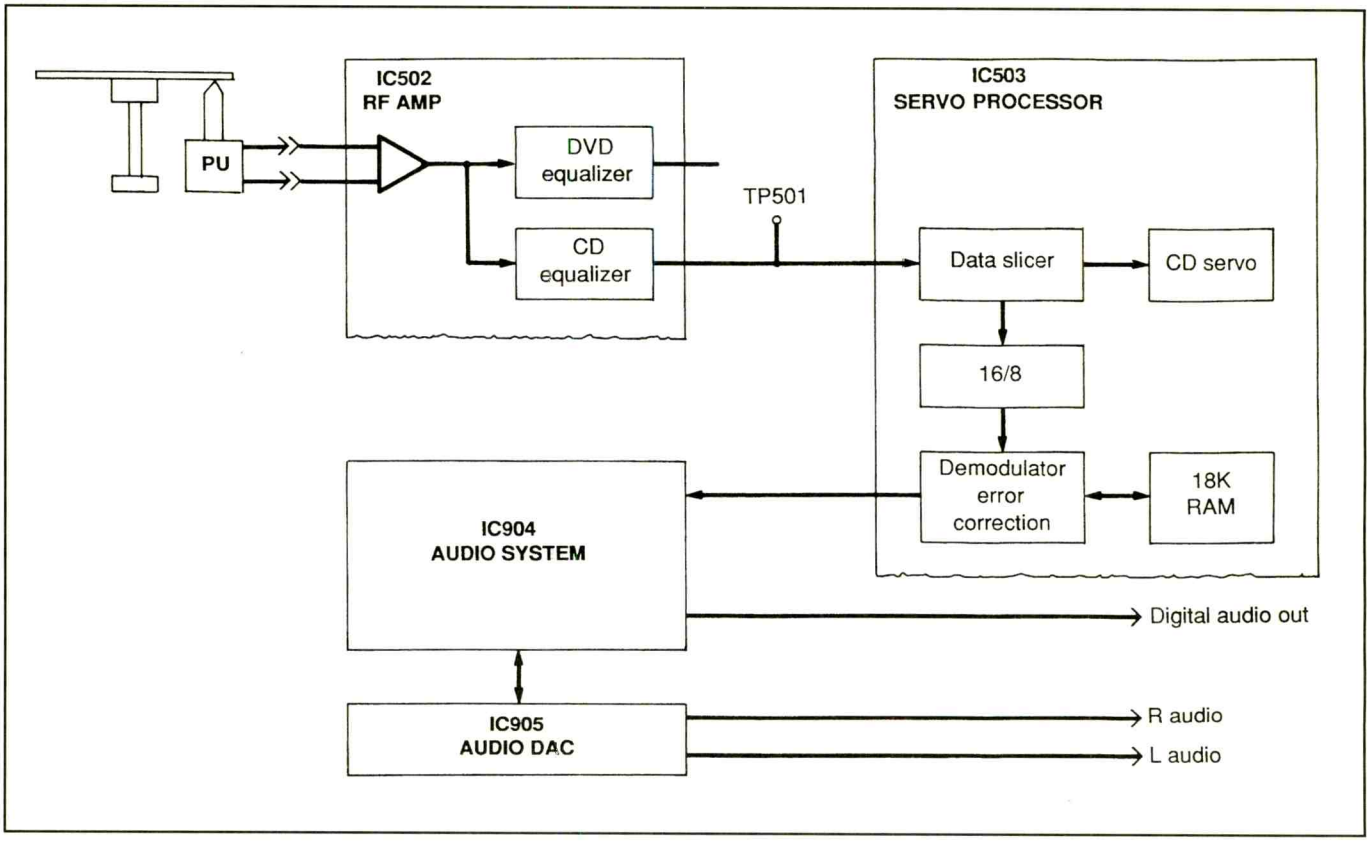


Figure 4. This is the path taken by the signal when the DVD400/420 plays an audio CD.

it into pins 54 and 55 of IC502. After it has been amplified and passed through the CD equalizer, the signal exits at pin 39. Remember pin 39 because it has been designated as "TP501" and, like TP502, is a convenient place to check the RF signal. It is the same type of signal as the DVD signal at TP502 except that it is lower in frequency.

The signal leaves IC502 and goes to pin 38 of IC503 and the CD data slicer. It then makes its way to a 16-to-8 decoder and from there to the CD demodulator and error correction circuits. Since the data rate varies, the system needs a means of storing data until it can be processed. The circuit therefore includes a 16K RAM memory chip that receives the data overflow and feeds it to the demodulator as it is needed.

The data signal leaves IC503 on the D-out and A-out, LRCK, and BCK pins on its way to IC904. IC904 outputs the same kind of signal it does when the player is playing a DVD. In other words, digital audio leaves on pin 17 and can be used to drive an external decoder while the data that leaves on pin 11 goes directly to IC905, the audio DAC.

If the disk doesn't spin or spins and then stops, check the servo IC (IC503). Make a note of the fact that if a DVD plays, you know the disk and feed motors are working correctly and the problem will more than likely be in and/or around IC503. If the disk spins, check for a proper "eye pattern" at TP501. If it is present, proceed to check every line of the eight-bit bus for a signal.

General service notes

1. Before you remove any connectors, unplug the unit from the ac outlet. If you don't unplug it, you will severely damage parts of the player.

2. Before you take the player apart, thoroughly check its operation and make a note of all symptoms. For example, if it won't play an audio compact disc, will it play a DVD?

3. Check the menu settings before you dig into the electronics. For instance, if the AC-3/PCM audio select in the setup menu is in the AC-3 position, expect to get AC-3 audio and no left and right analog audio. If it is in the PCM position, expect to get left and right analog audio but no AC-3 audio.

4. Check the cable connections next. Did you know that if the color difference cables are reversed, you will have picture information but with a blue tint and that putting the luminance cable into the wrong connector causes a very visible sync problem?

5. A dirty disk may cause play problems. If the customer complains that the player won't play certain disks, ask to see those disks and inspect them for dirt and/or damage before you do anything else. I have a handout that I give a customer after I have serviced his/her CD player. The handout discusses the problems dirty CDs cause and offers suggestions about how to clean them properly and keep them clean.

How to check the laser

I argued with myself about where to put this information and decided that here is about as good a place as any. The manufacturer suggests that you follow the procedure I am about to outline when you suspect a problem with the laser.

1. Check the DVD RF signal at TP502 You should look for a normal eye pattern with a peak-to-peak voltage level of 2.7V or higher. The voltage level will vary from player to player and will decrease as the player ages.

2. Check the differential RF signals at pins 16 and 17 of CN501. Expect to find signals of about 0.5V peak to peak.

3. If the signals appear to be weak and/or distorted, clean the objective lens with a cotton swab and alcohol before you even think about replacing the pick-up assembly. If you are new to CD player repair, you will probably be surprised by the good a thorough cleaning does. Recheck the RF signal after you have cleaned the lens. If it is still low, replace the laser slide assembly. Of course, you may use a laser power meter if you have one. The literature says that a new laser should put out signal about 0.2mW.

4. Check the RF CD signal at TP501. As I pointed out in the text, it looks like the DVD RF signal except that it is lower in frequency. Expect to find it at about a 1.6V peak-to-peak level.

Thank you for staying with me through this series of articles. I hope you will find them helpful as you make your journey into this new technological jungle. Good servicing! ■

Books

***Audio Systems Technology III,* by NSCA, PROMPT Publications, 320 pages, $34.95**

Audio Systems Technology Level III is an essential for the library of the advanced technician who has several years of job experience and an associate's degree or the equivalent. While each book in this series contains its own information, there is an overlap from one level to the next, providing repetition on the most important, fundamental points. This intentional dovetailing also allows the entire series to be used as a systematic, progressive course of study from the basics through intermediate and advanced topics.

Some of the many uses of this book include:

- A study and preparation guide for those seeking National Institute for Certification in Engineering Technologies (NICET) certification in audio systems.
- A training manual for installer and designer of audio systems.
- An overview of the fundamental things a good audio technician should know.
- A reference guide for installers and engineers seeking a one-stop source for practical technical audio information.

The chapters are organized loosely around work elements, or the subjects encountered on the NICET exams. All of the core elements and most of the general work elements are represented here and each chapter begins by stating that the work element descriptions that apply to that chapter's content. Special work elements that deal with special systems or subjects that are an elective part of NICET exams are discussed briefly in this book, and a list of these elements can be found in the appendix. This book also includes a description of " The NICET Audio Certification Program."

If you are an experienced sound contractor, and want to further your education with the NICET Level III Certification, this book is an essential part of your preparation.

PROMPT Publications, 2647 Waterfront Parkway East Drive, Indianapolis, IN 46214-2041,
Phone: 1-800-428-SAMS. Website: www.samswebsite.com

***Manufacturer to Manufacturer Part Number Cross Reference*, by Howard W. Sams & Company, PROMPT Publications, 320 pages, $29.95**

Desperate to get that replacement part? Wondering if that two-week wait for one part is worth it? Have a workshop full of parts you aren't sure are the right replacement parts? With the *Manufacturer to Manufacturer Part Number Cross Reference* you have the source for finding all the possible alternative replacement parts. The engineers at Howard W. Sams, using years of hands-on experience, have put together this cross reference guide.

Created from the Howard W. Sams database that was developed through the production of PHOTOFACT® service documentation, this guide gives you the knowledge to use electrically compatible parts already in stock. A reference tool this important saves time and money, making it a wise investment for anyone servicing consumer electronics devices.

Manufacturers include:
- Hitachi
- Samsung
- Sanyo
- Sears
- Sharp
- Sony
- Thomson
- Zenith
- And More

Parts include:
- Semiconductors
- Resistors
- Controls
- Capacitors

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Electronics servicing supplies

by Conrad Persson

When most of us think of a consumer electronics center, we picture the technician with the product to be serviced on the bench, scratching his head over the schematic diagram, probing it with the DMM or the oscilloscope, removing the defective component, or installing the replacement component. We seldom think about all of the supplies that a service center consumes in the course of a year just to restore all of those TVs, VCRs, CD players, and more to proper operation.

But we should think about those supplies. For starters, they cost money. And they have to be purchased, stocked, and inventoried. If any of those supplies contain toxic materials, and many servicing chemicals almost certainly do contain toxic materials, they need to be properly disposed of, and may cost the service center money to dispose of.

Another reason to think about supplies is to make sure that the service center maintains an adequate stock of these important service aids at all times, and to make sure that the service center staff is aware of all of the supplies that are available to make the tasks involved in servicing easier and more efficient.

There's yet another reason to keep supplies at the top of our awareness. As we alluded to earlier, some chemicals are toxic. But frequently, there are equivalents that are either non-toxic, or less toxic. These replacement products might cost a little more, or not do quite as good a job as the toxic chemical it replaces, but it might be worth a little extra cost, or a little lower efficiency, to keep the workplace worker friendly.

Categories of supplies

Consumer electronics supplies fall into a number of categories and subcategories. We'll do our best to list everything, but hope readers won't be too disappointed if we miss a few.

- Chemicals
- Cleaners
- Degreasers
- Defluxers
- Lubricants
- Freeze sprays
- Dusters
- Label and adhesive remover
- Rubber rejuvenator
- Glass cleaner
- Contact cleaner
- Tape head cleaner
- Fiber optic cleaner
- Adhesives
- Soldering/desoldering products
- Solder
- Desoldering braid
- Fluxes
- Swabs and wipes
- Static control products
- Printed circuit board repair/rework supplies
- Conductive ink pens
- Insulating material pens
- Miscellaneous supplies
- Membrane switch restorer

Ordering supplies

How does a service center determine what quantity of supplies it should order at one time? That becomes a fairly complicated procedure, and the mechanics of it are beyond the scope of this article, but here's some of the thinking that it entails.

The simplest way to buy, say, chemicals, is simply to buy them in small quantities (packages, cans, etc.) and take a package off the shelf when it is needed. But as we all know, buying a small quantity is always more expensive than buying a large quantity. Maybe. You can buy cans, for example, of cleaning solvent by the case. They're cheaper that way. But then you have a case of cans sitting on the shelf that represents money that could otherwise be invested somewhere. And the cans might be gradually losing pressure, so that when they're put to use, they don't spray.

Or, you might think of buying in bulk, that's usually a money saver. If you have a large service center you might buy a gallon, or five gallons, or a 55-gallon drum of whatever chemical you need. That might be a good idea for some service centers, but not so good for others.

Look at all of the ramifications. You would save a huge amount of money up front buying in bulk; the larger the quantity, the greater the savings. But now, again, you have money tied up in the product, and you have to have a safe place to store the product. Whenever you need to use some of the product, you risk spillage. And the manufacturer might come along with a superior product and you're stuck with a less effective product. Moreover, the larger the quantity of a product that you have on hand, the greater the problem with a spill.

Safety

The entire world has become increasingly aware of the safety of materials, and their impact on the environment. The most obvious example of the environmental impact of products is the harm to the earth's ozone layer caused by chlorofluorocarbons (CFCs). That turned out to be a real shame. CFCs (notably Freon) were perfect for the applications for which they were used. Nothing works better as a refrigerant. And as an almost universal solvent for consumer electronics servicing applications, they were close to perfect.

CFCs cleaned up dirt and grease, they were totally inert, they evaporated without any residue, they were safe with any material, they were wonderful coolants for use as freeze sprays. Unfortunately, when released into the air, they slowly traveled upward without undergoing any chemical change until they reached the ozone layer, where they caused damage to this layer of our atmosphere, which is so valuable in filtering out harmful ultraviolet rays from the sun. This environmental impact of CFCs was unacceptable, despite their multitude of beneficial uses, so they were outlawed.

Chemical manufacturers have responded with a number of replacement products that are either as effective or nearly so, and that don't have CFCs

deleterious effects. However, some of these replacements are not compatible with some materials used in electronics product manufacturing, so it is important that service centers read directions on such products very carefully so that they don't damage or destroy the very products they're trying to repair.

Moreover, many of these products, while generally quite safe, may have harmful effects if not used properly. For example some solvents may cause at least short term health effects in users if they're not used with proper ventilation.

Read the label

Manufacturers of chemical supplies offer both product specification sheets and material data safety sheets (MDSSs). Every individual who uses these products should read both of these documents before using the product. Here's an example of some of the wording of an MDSS for a cleaning solvent that is used quite extensively in servicing.

"*Emergency Overview:* Clear, colorless liquid with strong ethereal odor. This product is nonflammable. Liquid will irritate eyes and skin under repeated or prolonged exposure. Breathing high concentrations of product vapors may produce drowsiness and a headache.

Potential Health Effects:

Eyes: Liquid, aerosols, and vapors of this product are irritating and can cause pain, tearing, reddening and swelling accompanied by a stinging sensation.

Skin: Contact causes skin irritation.

Ingestion: Harmful if swallowed. Irritating to mouth, throat, and stomach. May cause vomiting.

Inhalation: Harmful if inhaled. High concentrations of vapors in immediate area can displace oxygen and can cause dizziness, unconsciousness, and even death with longer exposure. Keep people away from such vapors without self-contained breathing apparatus.

Pre-Existing Medical Conditions Aggravated by Exposure: Heart, lung, skin, eye."

Then at the bottom of the MDSS, the manufacturer adds the following caveat:

"To the best of our knowledge, the information contained herein is accurate. However, all materials may present unknown hazards and should be used with caution. In particular, improper use of our products and their inappropriate combination with other products and substances may produce harmful results which cannot be anticipated. Final determination of the suitability of any material is the sole responsibility of the user. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that may exist."

Do your homework

Perhaps the most efficient way to purchase supplies is to monitor use of these products over a period of time; a month, a quarter, a year, develop numbers that describe the quantities used in that time, and work with a supplier to get their advice on how best to buy and in what quantities. After that, it's important to take precautions to make sure that neither the employees nor the environment are exposed to any of the adverse effects of those supplies. ■

A yet-to-be-resolved copy protection issue involving parties in addition to CEA and NCTA is the subject of a current FCC rulemaking proceeding on which comments are to be filed today.

Today's agreement acknowledges that every digital TV set will not need to include a 1394/5C connector allowing reception of the full range of cable interactive services. However, all sets will be packaged with consumer information describing the features and functions of television sets with and without the 1394/5C connector. The descriptive information will appear in consumer electronics product manuals and brochures.

Sets labeled "Digital TV-Cable Connect" — those without the 1394/5C connector — will be capable of receiving analog basic, digital basic and digital premium cable programming from any cable system that offers digital service. "Digital TV-Cable Interactive" sets — those with the 1394/5C connector — will be able to receive those services and other programming, including impulse pay-per-view, video-on-demand, enhanced program guides and data enhanced television services with a digital set top box. CEA and NCTA have agreed to continue discussions and expect to reach an agreement on the labeling of digital set-top boxes that will work with the "Digital TV-Cable Interactive" DTV sets.

With approximately 68 percent of U.S. households receiving television programming via cable, these agreements mark an important point in the U.S. transition to digital television. CEA estimates that the first digital TV receivers bearing the new labels will reach market by the fourth quarter of 2001.

CEA is a sector of the Electronic Industries Alliance (EIA). CEA represents more than 600 U.S. companies involved in the development, manufacturing and distribution of audio, video, mobile electronics, communications, information technology, multimedia and accessory products, as well as related services, that are sold through consumer channels. Combined, these companies account for more than $60 billion in annual sales. CEA also is the producer, manager and sponsor of the International CES, the world's largest showcase for consumer technologies.

NCTA is the principal trade association of the cable television industry in the United States. Its members include owners and operators of cable television systems serving over 90 percent of the nation's cable television households and over 100 program networks. Its membership also includes cable equipment suppliers, and others interested in or affiliated with the cable television industry.

CEA and SAE to develop IDB standards

The Consumer Electronics Association (CEA) and the Society of Automotive Engineers International (SAE) have finalized an agreement to develop vehicle standards for the Intelligent Transportation System Data Bus (IDB). The agreement formalizes a working relationship between industry organizations to standardize the way consumer electronics products connect and communicate in automobiles.

"CEA is pleased to contribute the experience gained from more than 75 years of setting consumer electronics standards to this historic collaboration," said Gary Shapiro, CEA president and CEO. "Standardizing the way mobile electronics products communicate will allow the automotive and consumer electronics industries to offer consumers the latest technologies in their cars. The relationship outlined in this agreement will create new profit opportunities for these industries in adding value to consumer products."

Under the terms of the agreement, the parties will form a steering committee to establish goals for the development of standards and assign responsibilities to each of the organizations. The committee also will provide a forum to exchange information, relay information on industry and organization needs, and resolve any differences that surface in the process.

"We look forward to working with SAE and other organizations and groups to get the standards written. As this technology begins to come to market, it is important for the standards development organizations like CEA and SAE to work in partnership to build strong consensus in the industry," said Shapiro.

IDB is a serial communication bus that supports an open, non-proprietary standard architecture to allow multiple electronic devices to be installed easily, cost-effectively and safely in any vehicle. New IDB devices plug-and-play, letting car owners rely on a pre-configured bus, ready to accommodate compliant devices. These standards will promote consistent installation, minimizing the need for device or vehicle-specific customizing. There is no complicated wiring and no intensive installation time is needed.

SAE performs a role as a global leader in Intelligent Vehicles (IV) and IDB technology. The SAE IDB Committee developed the architecture and the IDB protocol specifications with the input of automakers, automotive suppliers, electronics companies, consulting firms and research companies. The IDB and some of its applications were first displayed at Convergence '98. In October 2000, SAE will return to Convergence with the latest developments in IV and IDB. SAE is administering the National Intelligent Vehicle Initiative Meeting being held in Washington, DC on July 19–20 by the Department of Transportation and will hold its own IV Congress in Fall, 2001.

SAE is a non-profit educational and scientific organization dedicated to advancing mobility technology to better serve humanity. More than 70,000 engineers and scientists, who are SAE members, develop technical information on all forms of self-propelled vehicles including automobiles, trucks and buses, off-highway equipment, aircraft, aerospace vehicles, marine, rail, and transit systems. SAE disseminates this information through its meetings, books, technical papers, magazines, standards, reports, professional development programs, and electronic databases. ■

An encounter with a Magnavox PTV

by Bob Rose

Some repair jobs go easily and quickly. Others are like climbing a ladder; if you keep at it, you eventually get the job done. And then there are those that are like a bad dream because they just go on and on. I illustrate the latter point by telling you about a Magnavox PTV (projection television) that we brought into the service center for repair. It looked innocent, even harmless, sitting on the floor. The repair tag read, "Customer turned it off when he went to bed, and it wouldn't come on the next morning."

Fixing such a PTV700 series projection unit usually goes quickly and easily, and I thought it would make a nice start for the day. As it turned out the PTV occupied space in the shop for almost two weeks, and I began to think that I would never get it fixed.

A certain oriental culture has a saying that seven years of good luck are followed by seven years of bad luck. That television set paid me back for all the easy jobs I've ever had.

An overview of the PTV 700 Series

Philips put the PTV700 series on the market around 1996. I can't be certain about the exact date because the training material was issued in 1996, meaning the TV could have come out in 1995. But that is beside the point. It broke new ground for its time because it represented one of the first attempts at what is called "digital convergence," an innovation that is now an industry standard. My partner said when he heard about it, "Even you can converge one now."

Convergence really is a snap on these products: (1) take the protection screen off; (2) tape a template over the screen; (3) enter the convergence mode and select green geometry; (4) use the remote control to move an icon (a small cross) from one point on the template to the next; (5) remove the template; and (6) center the red and blue crosses over the green one. Presto! You're done. The whole process might take thirty minutes. More about "digital convergence" later.

Philips even reduced the number of major "panels" we servicers had to deal with to three: the large signal panel or LSP (Figure 1), the small signal panel or SSP (Figure 2), and the digital convergence panel or DSP (Figure 3). Take an interconnect diagram and DMM, and you ought to be able to find the panel that is causing the trouble in almost less time than you took to remove the back. Once you find the defective panel, replace it, do a few minor adjustments, and go your merry way. That was the hype, and it worked that way lots of times, especially if you were doing warranty service on the unit. We'll talk about how to navigate those panels in a few paragraphs.

Of course, the 700 series has more in it than just three panels. Those are the major ones. It could have up to eight smaller panels: red CRT panel, green CRT panel, blue CRT panel, combo block (high voltage distribution block), front jack panel, remote locator panel, timer locator panel (early production runs only), and customer assembly panel (front panel controls).

Moreover, there are no mechanical controls to tweak. The small signal panel retains in electronic memory (an EEPROM) all the information the set needs to operate. This means that servicing a PTV700 might require tinkering with either the software or the hardware, or both, which is what the little beauty sitting in the shop on that fateful morning eventually needed.

Electronic adjustments

Let's take a stroll through the electronic adjustments before getting into the more traditional aspects of these units. You must enter the "service mode" to gain access to them. To get into the service mode, using the remote control, enter the code 0, 6, 2, 5, 9, 6, Menu. Since the display tends to be unstable unless the TV has been tuned to an active channel, may I suggest you select an active channel before you enter the service mode?

If you don't select an active channel before you get into the service mode, simply use the channel up/down buttons on the hand unit until you come across an active channel. You must, however, highlight the channel number before you can change channels once you are in the service mode. Read on to find out how to do that. If you scan across or select Registers 74 or 75 while you are in the service mode, the video will blank. Don't panic if this happens. Select any register between 02 and 06, and the video will reappear.

The information pops up on the bottom of the screen. The register number appears in the lower left hand position to the right of the channel number. The register data appears on the lower right hand side of the screen. Use the menu left and right buttons to select register number, channel number, or register data. Your selection appears as a highlighted item on the screen. After the item has been highlighted, use the menu up/down keys to change the register data. You may also use the number pad on the remote control to select a register or to change its data once it has been selected. But the number pad cannot be used to enter hexadecimal values above 9 such as A through F. By the way, there are seventy-six registers in the typical PTV700 series unit (Table 1).

Register number, channel number and register data are the parameters with which you are mostly concerned. If you look below these items to the next line, you will see the factory number for the microcomputer, IC300 (613085-3, for

Rose is an independent consumer electronics business owner and technician.

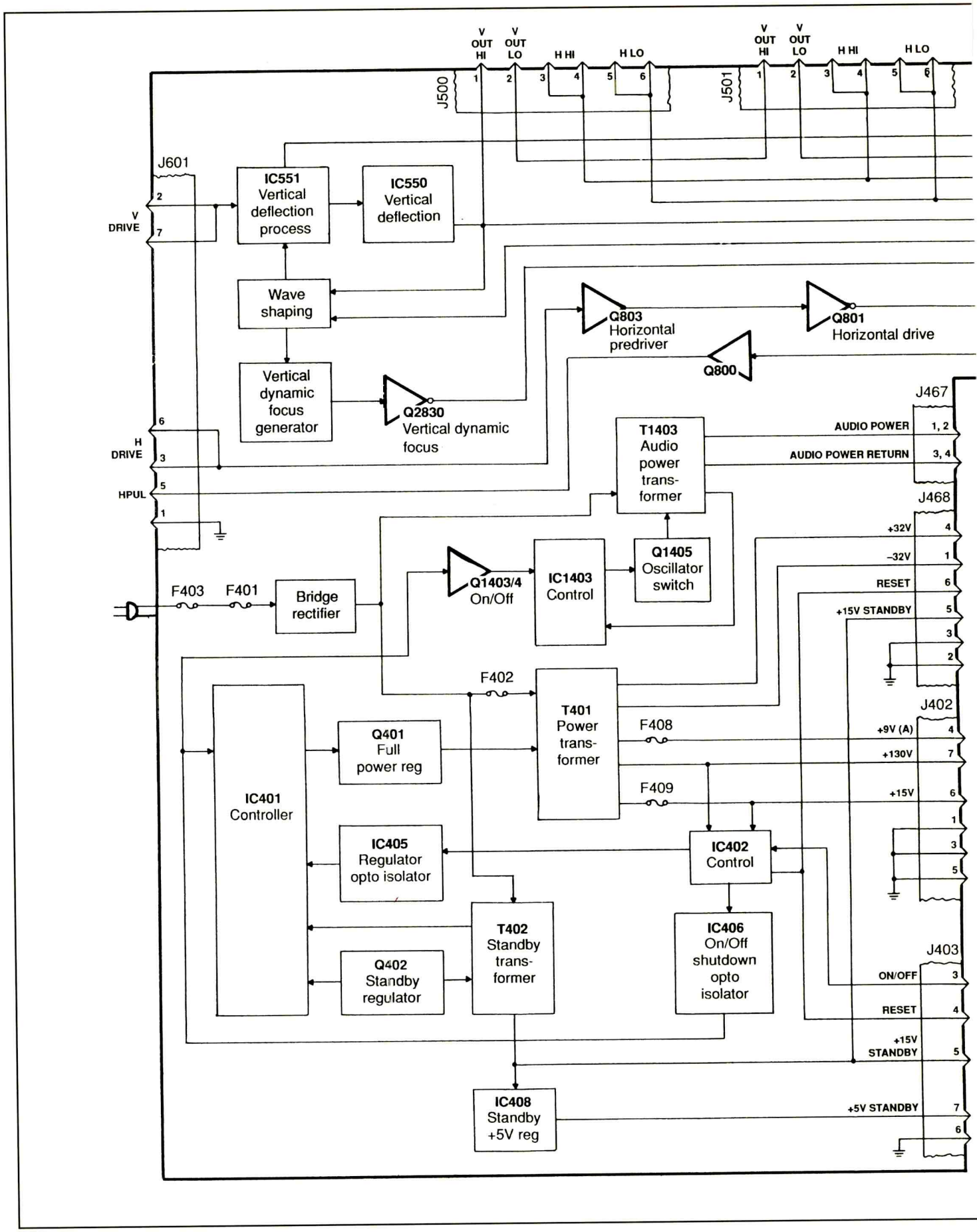
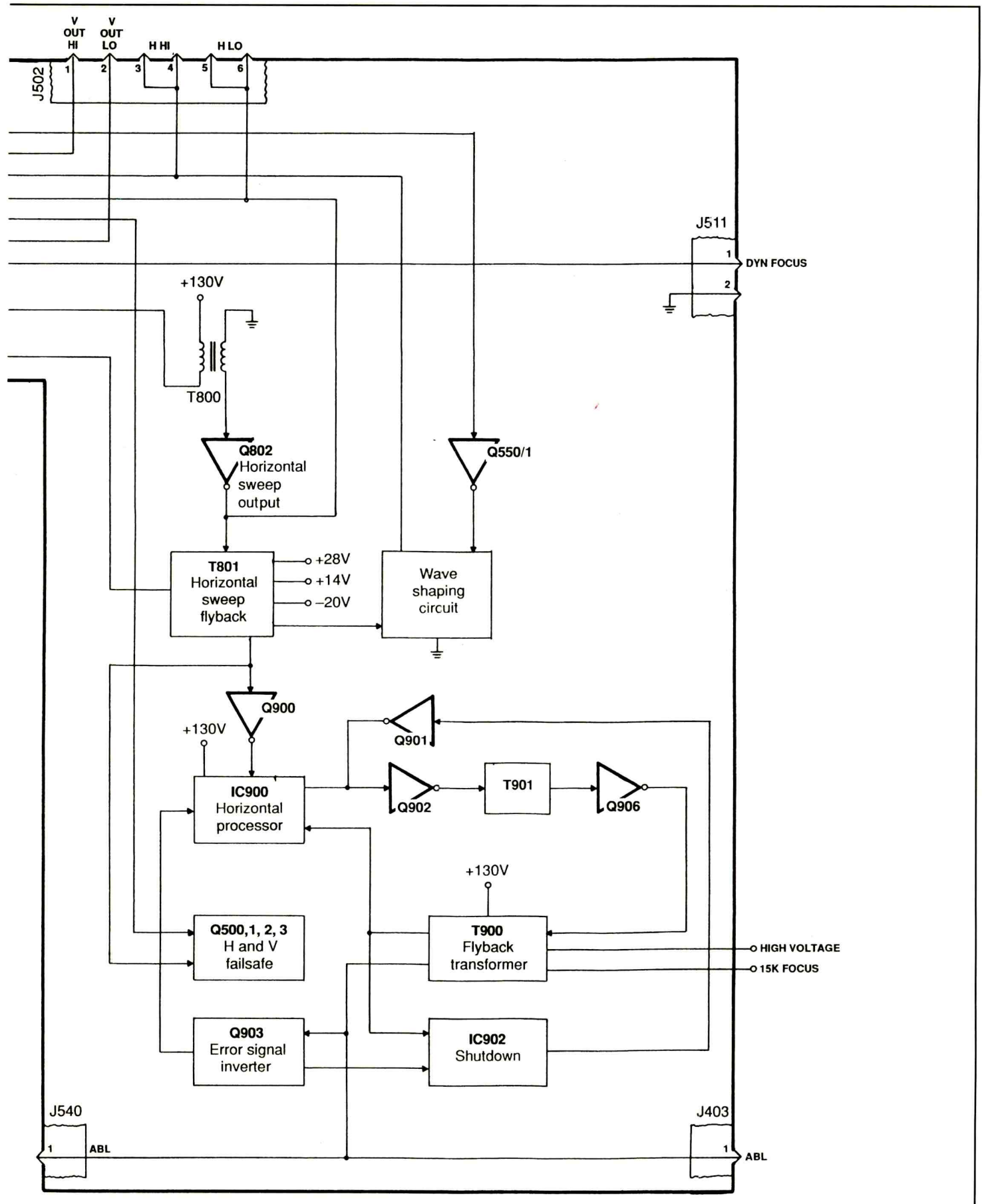


Figure 1. This is a diagram of the large signal panel or LSP.


V OUT HI
V OUT LO
H HI
H LO
J502
1
2
3
4
5
6
J511
1
DYN FOCUS
2
+130V
T800
Q802
Horizontal sweep output
Q550/1
T801
Horizontal sweep flyback
+28V
+14V
–20V
Wave shaping circuit
Q900
+130V
Q901
IC900
Horizontal processor
Q902
T901
Q906
+130V
Q500,1, 2, 3
H and V failsafe
T900
Flyback transformer
HIGH VOLTAGE
15K FOCUS
Q903
Error signal inverter
IC902
Shutdown
J540
1
ABL
J403
1
ABL

Reg.	Description	Value	Reg.	Description	Value	Reg.	Description	Value
00	EXIT	1A	26	P READ POS	OF	52	BLUE CUT-OFF	80
01	EXIT DEFAULTS	1A	27	P WRITE POS	4C	53	GREEN DRIVE	40
02	RIGHTNESS	1F	28	COLOR DLY	14	54	BLUE DRIVE	40
03	PICTURE	2F	29	BACK BURST	11	55	CHROMA	FA
04	COLOR	1F	30	RED HORIZ	1F	56	VID CTRL 1	07
05	TINT	1F	31	RED VERT	1F	57	VID CTRL 2	C3
06	SHARPNESS	1F	32	BLUE HORIZ	1F	58	DEF CTRL	20
07	BASS	1F	33	BLUE VERT	1F	59	SETUP	1A
08	TREBLE	1F	34	PICTURE HEIGHT	20	60	SUB BRIGHT	5F
09	BALANCE	1F	35	LINEARITY	0F	61	SUB TINT	3F
10	SF LAG 00	24	36	VS CORECT.	0E	62	SURROUND LEVEL	FF
11	SF LAG 01	00	37	V SHIFT	00	63	AUDIO CTRL 2	70
12	SF LAG 02	23	38	V COMP	00	64	AUDIO CTRL 3	03
13	SF LAG 03	00	39	PICTURE WIDTH	28	65	AUDIO ALIGN 1	17
14	RL ADDRESS	05	40	E-W PARAB	10	66	AUDIO ALIGN 2	93
15	FEATURE ID	03	41	E-W CORNERS	00	67	AUDIO ALIGN 3	08
16	DEMO ID	00	42	TRAPEZOID	39	68	DOLBY MODE	82
17	CLOCK CAL	10	43	H COMP	00	69	GRAPH EQ 4K	05
18	OSD VERT	21	44	VSS CORRECT.	00	70	GRAPH EQ 12K	05
19	OSD HORIZ	22	45	HORIZ.PH	10	71	GRAPH EQ 1K	05
20	PIP COLOR	1F	46	RGB BRIGHT	40	72	GRAPH EQ 225	05
21	PIP TINT	1E	47	RGB CONT.	40	73	GRAPH EQ 59	05
22	PIP X1 POS	00	48	SUB COLOR	EA	74	ADDRESS	6A
23	PIP Y1 POS	05	49	SUB CONT.	E7	75	DATA	00
24	PIP X2 POS	3F	50	RED CUT-OFF	80	76	BANK	00
25	PIP Y2 POS	21	51	GREEN CUT-OFF	80			

Table 1. This table shows the number of each of the registers in this TV set, along with the function it controls and the value you should expect to find in that register.

example) followed by a series of characters (like GR5X3.0) that identify the current software version. If you press the status button, even more information scrolls onto the screen. The top line tells you in hexadecimal format the hours the set has been one (00B7, for instance, equals 183 hours.) The second line from the top consists of a string of letters (like EFKLMNO) that identifies the subsystems that could be present but did not respond to the microcomputer's request for a handshake via the I-Squared-C bus when the service mode command was first executed.

Let me restate that for emphasis. The presence of a letter identifying a subsystem that did not respond does not mean that the subsystem is present. Before you begin to troubleshoot, make certain the subsystem is in fact an integral part of the hardware. I won't go into those subsystems here, but you may look them up in the service menu for the TV on which you are working.

Some of the registers ought not to be changed by the servicer unless he or she has been instructed to do so, which is to say, "Know what you are changing before you change it." However, some do have to be changed whenever you replace the small signal panel, specifically Feature ID, Demo ID, Height, Vertical Linearity, Width, Parabola, Corner, Trapezoid, SubBrightness, CutOff, and CRT Drive. I don't recall ever having to adjust all of them, but I invariably have to write adjustments to some registers whenever I change out a small signal panel.

The registers

Let's go through and consider the registers one at a time.

Feature ID. Select register 15, and set the register value to the correct value from this list: PTV700/725, 01; PTV705/706, 06, PTV710/711, 03; PTV715, 04; and TV720, 05. I don't know all the problems a set can have if the feature ID isn't set correctly, but I do know that a "no audio" condition is one of them. I suggest you check register 15 for the correct value when you run across one that doesn't have audio.

Demo ID. Access register 16, and set it for 01, for Magnavox models only, and 00 for all other brands.

The geometry registers

The following registers are called "the geometry registers." If these registers are set incorrectly, they adversely affect convergence. Make absolutely certain they are correct before you attempt to do convergence. I almost never have to adjust them, but I always check them for proper register values.

Picture Height. Go to register 34 and set the data for about three-fourths of an inch overscan at both the top and bottom of the picture.

Vertical Linearity. Go to register 35 and set the value for the best overall vertical linearity.

Picture Width. Select register 39 and set the value for approximately three-fourths of an inch overscan on both sides of the screen.

Parabola. Register 40 is used to straighten the vertical lines in the left and right sides of the picture. I suggest you use a crosshatch pattern to make the adjustment.

Corner. Register 41, the EW Parabola adjustment, is used to remove any tilt in the vertical lines in the left and right sides of the picture.

Trapezoid. Select register 42 and set the data to remove any tilt in the vertical lines in the left and right sides of the picture. Again, use a crosshatch pattern to achieve the best results.

The picture quality registers

The following registers have to do with picture quality and usually have to be tweaked when you change the SSP.

Subbrightness. Go to register 60 and set the data so that the scan lines in the darkest part of the picture are just barely visible to the eye.

Cutoff. PTV710, 711, and 720 have AKB (auto kine bias) and do not need this adjustment. If you are servicing one of these, go to the next adjustment. For the PTV700, 705, 706, and 725, proceed to register 04,the color register, and set the data to 00 to turn the color off. Then set the registers 50 (red cutoff), 51 (green cutoff), and 52 (blue cutoff) to a value of 80. Finally, adjust them to obtain gray in the low light areas of the picture. The literature says that one of the registers should remain untouched.

CRT Drive. Select register 04 and set the data to 00. Adjust the drive registers to obtain white in the light brightness areas of the picture. Begin by setting register 53 (green) to 40, register 54 (blue), and proceed till you have obtained the desire results.

Finally, go back to register 04 and restore its data to 1F.

Exit the service test mode and save the results, turning the unit off using the power control button on the front of the set. Turn it back on to confirm that the adjustments were stored in memory and are in fact correct.

The interconnect scheme

If you have never had the back off one these units, you will get a jolt when you

Photofacts

DAEWOO
CN-200A....4320
DTQ-25S2FC....4320
DTQ-26S1HC....4320
DTQ-27S2FC....4320
DTQ-29S1HC....4320

PANASONIC
CT-13R4A....4313
CT-13R5B....4313
CT-27SF26A....4319
CT-27XF26CA....4319
D323....4319
MBP328....4313
MQP328....4313
PORTLAND CN-001A....4315
PT1301....4315

QUASAR
ADC331....4316
RC330....4323
SP2723B....4323
SP2723UB....4323
SP3233B....4316
SP3233UB....4316

RCA
CTC187AB....4324
E0901BTC03....4317
E0901BTF03....4317
E0901BTF24....4317
E13205BKF24....4321
F27638BCFE1....4324
F27638BCJX1....4324
F27641BCYX1....4324
TX825QC....4317
TX825TD....4321

SANYO
DS27890....4312
27890-00....4312
27890-01....4312

ZENITH
A25A11D4....4322
A25A11D64....4322
A25A12D4....4322
A25A23W4....4314
A25A23W6....4314
A25A23W64....4314
A25A74R7....4318
A25A74R8....4318
A25A76R7....4318
A25A76R8....4318
LGA26A11DM4....4322
LGA26A11DM64....4322
LGA26A23WM....4314
LGA26A23WM6....4314
VRC4165....VCR-323
VRC4195....VCR-323

ES&T Calendar

September 6–10, 2000
CEDIA Expo
Indianapolis Convention Center
Indianapolis, IN

Custom Electronics Design and Installation Association (CEDIA)
9202 N. Meridian #200
Indianapolis, IN 46260-1810
800-669-5329
www.cedia.org

COMDEX
September 26–28, 2000
Miami Beach Convention Center
Miami Beach, FL

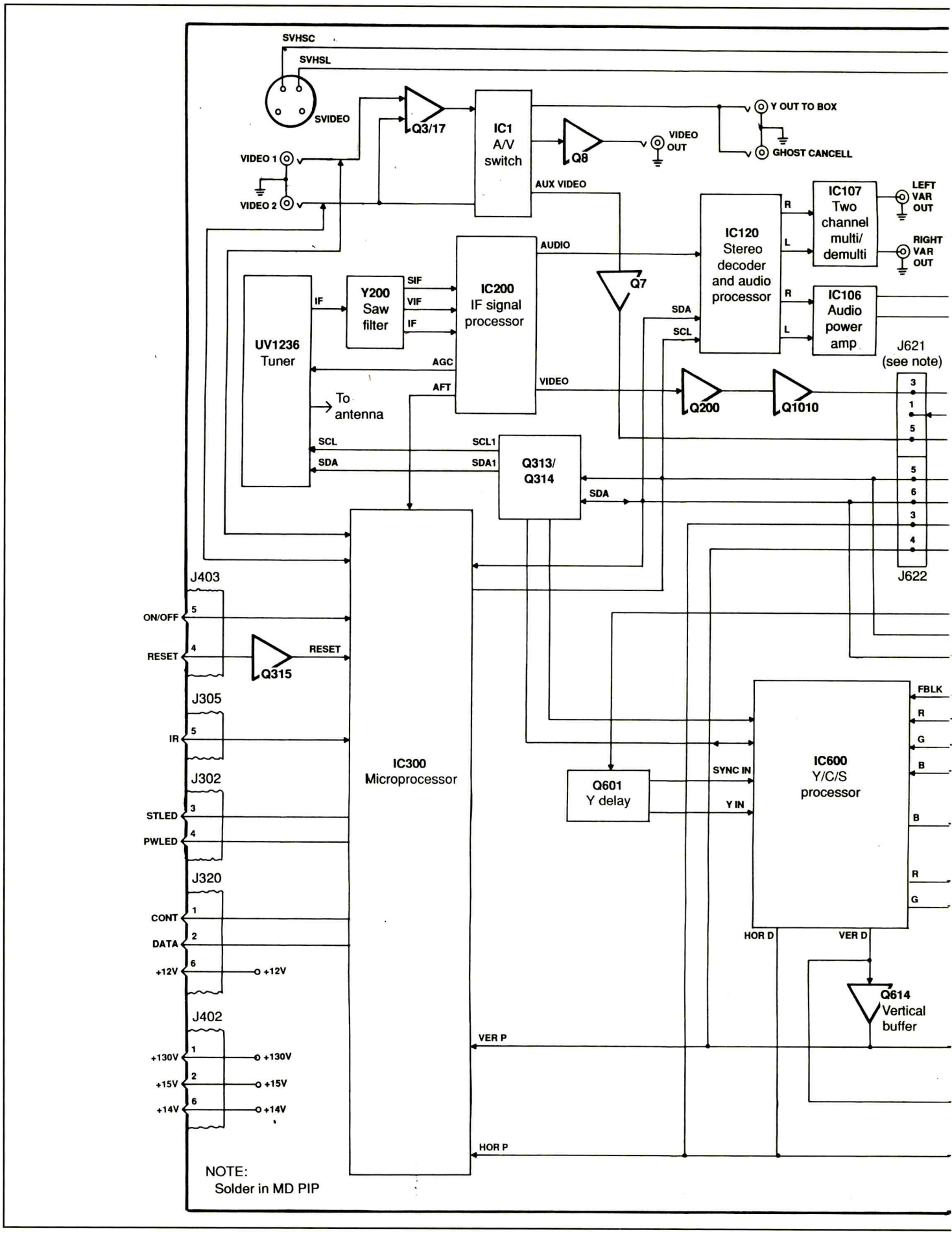
COMDEX
300 First Avenue
Needham, MA 02492-2722
781-433-1500
www.zdevents.com/comdex

August 7–12, 20000
NPSC (National Professional Service Convention)
John Ascuaga's Nugget Hotel
Sparks (Reno), NV

National Electronics Service Dealers Association (NESDA)
2708 West Berry St.
Ft. Worth, TX 76109

January 6–9, 2001
International Consumer Electronics Show (CES)
Las Vegas Convention Center, Sands Convention Center and various hotels
Las Vegas, NV

Consumer Electronics Association
2500 Wilson Blvd.
Arlington, VA 22201-3834
703-907-7600
Fax: 703-907-7602
www.cesweb.org


SVHSC
SVHSL
SVIDEO
VIDEO 1
VIDEO 2
Q3/17
IC1
A/V
switch
Q8
VIDEO
OUT
Y OUT TO BOX
GHOST CANCELL
AUX VIDEO
IC107
Two
channel
multi/
demulti
LEFT
VAR
OUT
RIGHT
VAR
OUT
IC120
Stereo
decoder
and audio
processor
R
L
IC106
Audio
power
amp
AUDIO
Q7
SDA
SCL
J621
(see note)
UV1236
Tuner
IF
Y200
Saw
filter
SIF
VIF
IF
IC200
IF signal
processor
AGC
AFT
To
antenna
VIDEO
Q200
Q1010
SCL
SDA
SCL1
SDA1
Q313/
Q314
SDA
J622
J403
ON/OFF
RESET
Q315
RESET
J305
IR
J302
STLED
PWLED
J320
CONT
DATA
+12V
+12V
J402
+130V
+15V
+14V
+130V
+15V
+14V
IC300
Microprocessor
Q601
Y delay
SYNC IN
Y IN
IC600
Y/C/S
processor
FBLK
R
G
B
B
R
G
HOR D
VER D
Q614
Vertical
buffer
VER P
HOR P
NOTE:
Solder in MD PIP

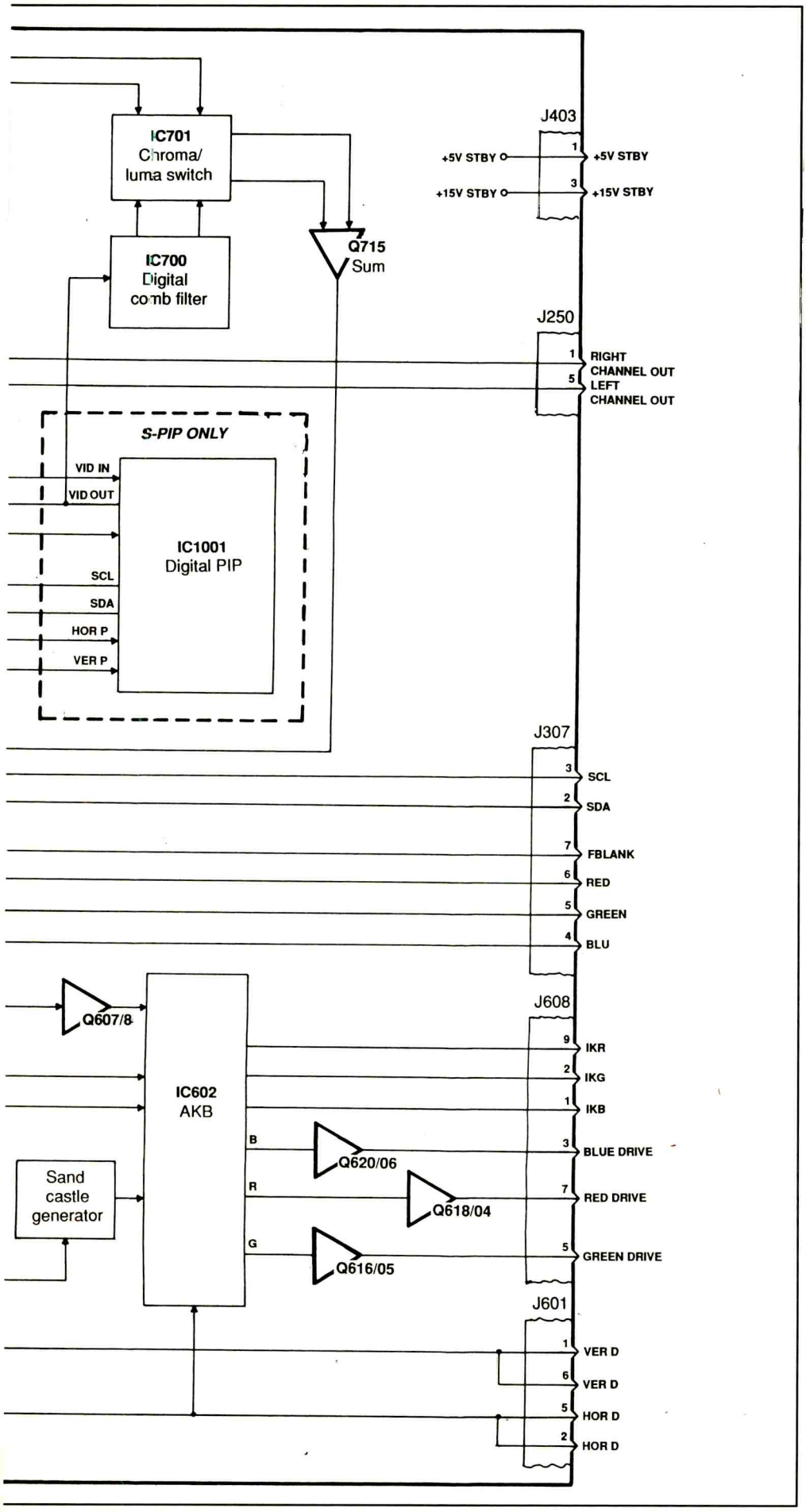


Figure 2. This is a diagram of the small signal panel or SSP.

do because the number of cables closely resembles a spider web. Don't let it befuddle you. Use an interconnect diagram such as the one found in the information packet stapled on the back of the TV as a roadmap. Using it, you should be able to navigate the interconnect maze with little difficulty.

If I went into detail about the interconnection, the description for the power distribution alone would go like this, "Power from the standby power supply leaves the LSP on the following plugs: 15V SB on P/J403, pin 5, going to A/J403 pin 3 on the SSP. Five volts SB source leaves on P/J403, pin 7, going to A/J403, pin 1 on the SSP." The power distribution scheme itself would take up several paragraphs. Then I could devote space to the control, video, sweep, and audio interconnections. But why do it? You are certainly capable of reading an interconnection diagram and following the signal flow without my help.

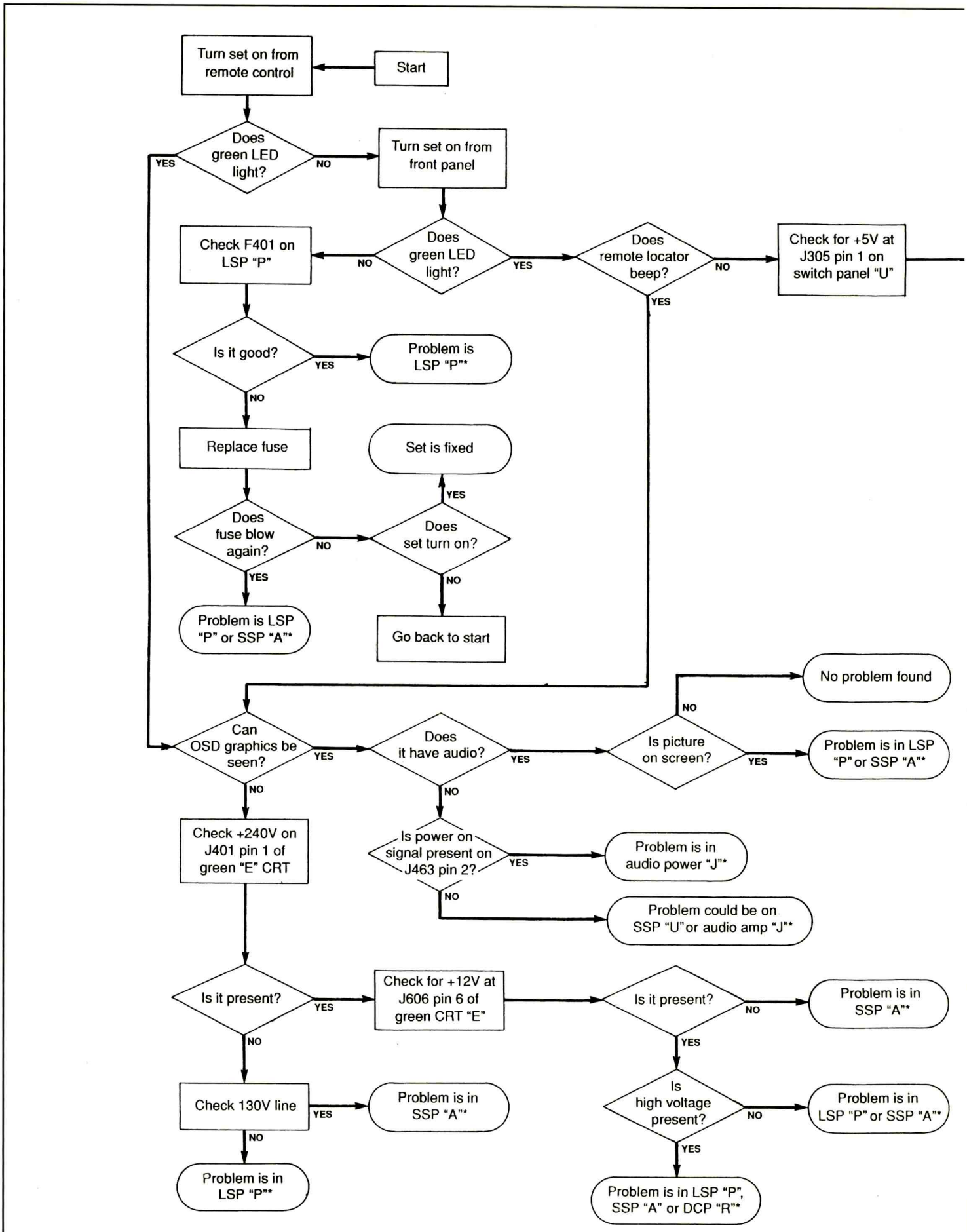
Let me, therefore, use my time with you to illustrate what the literature calls "interconnect troubleshooting."

Interconnect troubleshooting

Before you even touch a test instrument, poke your head inside the unit and use all of your senses while you take in the scene. Is the fuse blown? Do you see any burned components? Do you smell anything unusual? Use your sense of touch and examine the panels, especially the LSP (large signal panel), for a liquid spill. These sets have a history of the blue tube cracking and causing coolant to spill on the LSP.

Use a flashlight as you look things over. Be certain to look at the necks of all three tubes, especially the blue one (the one tube on your right as you are looking inside the unit from the back), for evidence of a coolant leak. If you detect coolant inside the neck of a CRT, you know that the tube is de facto bad and must be replaced. It's hard to miss once you have seen one.

If coolant has spilled onto the LSP, consider it totaled. The coolant is highly conductive and does major damage to whatever it touches. I had been told that once the liquid gets onto the board, the board has to be scrapped. Of course, I


Start
Turn set on from remote control
Does green LED light?
YES
NO
Turn set on from front panel
Does green LED light?
NO
YES
Check F401 on LSP "P"
Does remote locator beep?
NO
YES
Check for +5V at J305 pin 1 on switch panel "U"
Is it good?
YES
Problem is LSP "P"*
NO
Replace fuse
Does fuse blow again?
NO
YES
Problem is LSP "P" or SSP "A"*
Does set turn on?
YES
NO
Set is fixed
Go back to start
Can OSD graphics be seen?
YES
NO
Does it have audio?
YES
NO
Is picture on screen?
YES
NO
Problem is in LSP "P" or SSP "A"*
No problem found
Check +240V on J401 pin 1 of green "E" CRT
Is power on signal present on J463 pin 2?
YES
NO
Problem is in audio power "J"*
Problem could be on SSP "U" or audio amp "J"*
Is it present?
YES
NO
Check for +12V at J606 pin 6 of green CRT "E"
Is it present?
NO
YES
Problem is in SSP "A"*
Check 130V line
YES
NO
Problem is in SSP "A"*
Problem is in LSP "P"*
Is high voltage present?
NO
YES
Problem is in LSP "P" or SSP "A"*
Problem is in LSP "P", SSP "A" or DCP "R"*

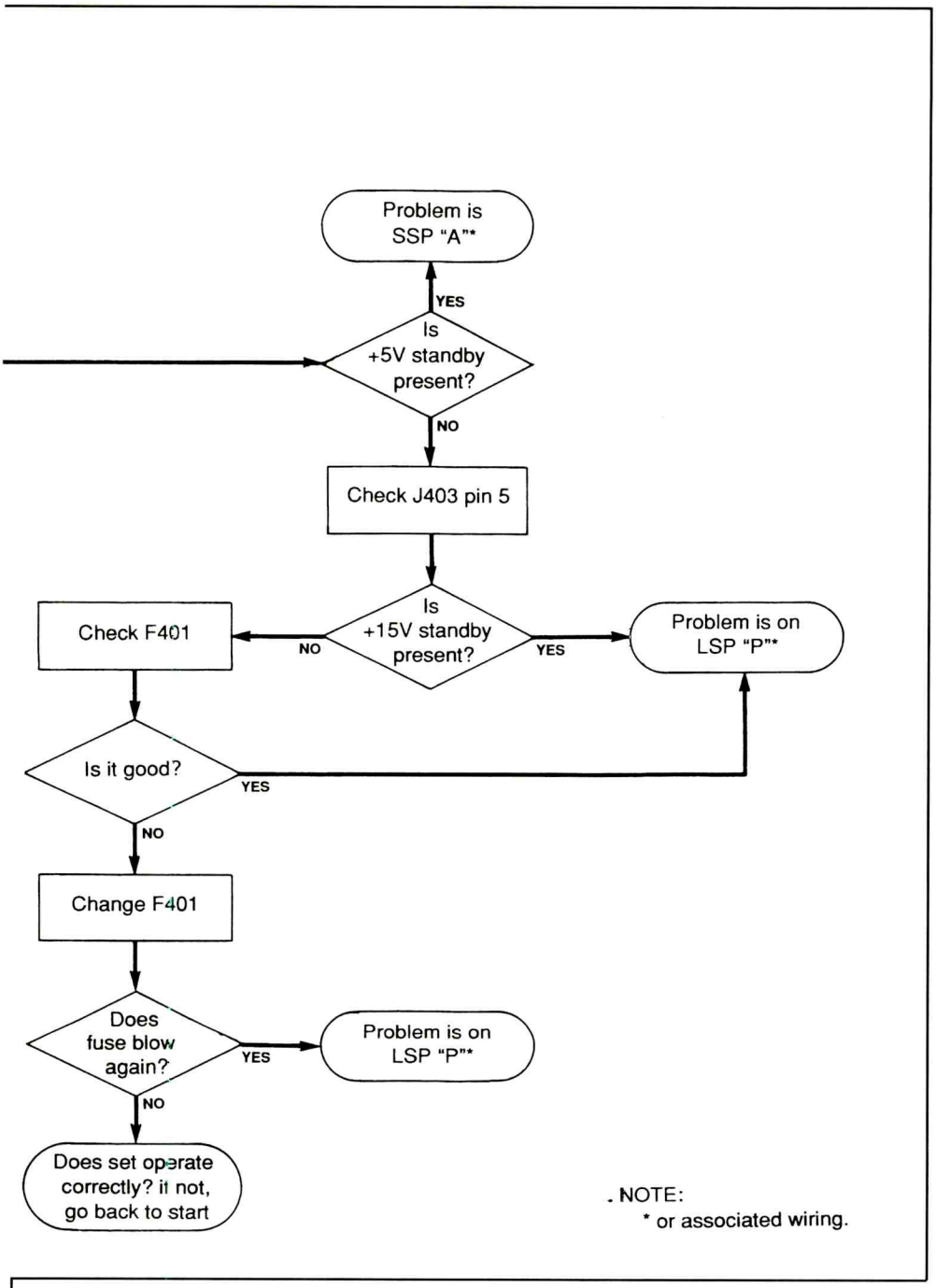


Table 2. This is a trouble tree for this set taken from a Philips Service Reporter publication.

didn't believe that and tried to effect a few repairs on my own. Guess what? They were right.

Now that you have carefully looked the set over, see what happens when you issue an on command. Did the power on LED light up? Is there audio? Is there even the hint of a raster? Did you hear the high voltage come up? Do you smell something burning? Did anything at all happen in the unit?

After you have processed the information, you may now get your interconnect diagram and at least a DMM and begin to sort out what failed. Did I mention that the interconnect cables are labeled and the information each cable carries is etched onto the circuit boards, meaning you can check quite a few parameters without touching a diagram?

Using a trouble tree

I include in Table 2 a trouble tree taken from a Philips' Service Reporter. I personally don't care that much for trouble trees, having had limited success with them. However, your experience may be different. I present it here on the chance you might find it useful.

Assume the unit is completely dead

Here's a trouble-tree type analysis if you think the set is completely dead.

(1) Is the fuse blown?

(2) Are the standby voltages present?

(3) Is the microcomputer receiving an on command?

(4) Is the microcomputer being reset? Check pin 4 of A/J403 on the LSP for 5V. If it is good, check the voltage going to the SSP on pin 4 of A/J403.

(5) Are the other B+ voltages present? If one is missing, check the source panel and connecting plugs and cables.

Using such a procedure, you ought to be able to localize the problem to either the SSP or LSP in a few minutes.

No picture/good audio?

Assume the problem you are facing is a no picture but good audio condition. If a dead set is the number one cause for service, then this one is number two.

(1) Do you have high voltage?

(2) Are filaments lit? You may need to darken the room to see their glow.

(3) Have the protection circuits been activated? Horizontal and vertical pulses go into the "horizontal and vertical fail-safe" circuit, Q500, Q501, and Q503. The vertical pulse comes from IC550, the vertical output IC, and the horizontal pulse comes from T801. If either pulse is missing, the error signal inverter, Q903, enables an output to the shutdown IC, IC902. It also sends information to IC900, the horizontal processor, to reduce horizontal drive. The result is no horizontal deflection. By the way, these components are located on the LSP.

(4) If you have high voltage and the filaments are lit, do you have: (a) screen voltages going to the CRTs, (b) proper video drive exiting the SSP, (c) +12V going to the CRTs, and (d) vertical sync to the convergence panel? Don't overlook the convergence panel because it can cause the video to blank. I haven't seen it happen often, but I do know a no video condition can be traced to it.

Good picture no audio

Assume this time that you have good picture but no audio. Begin by making certain that the speakers are connected

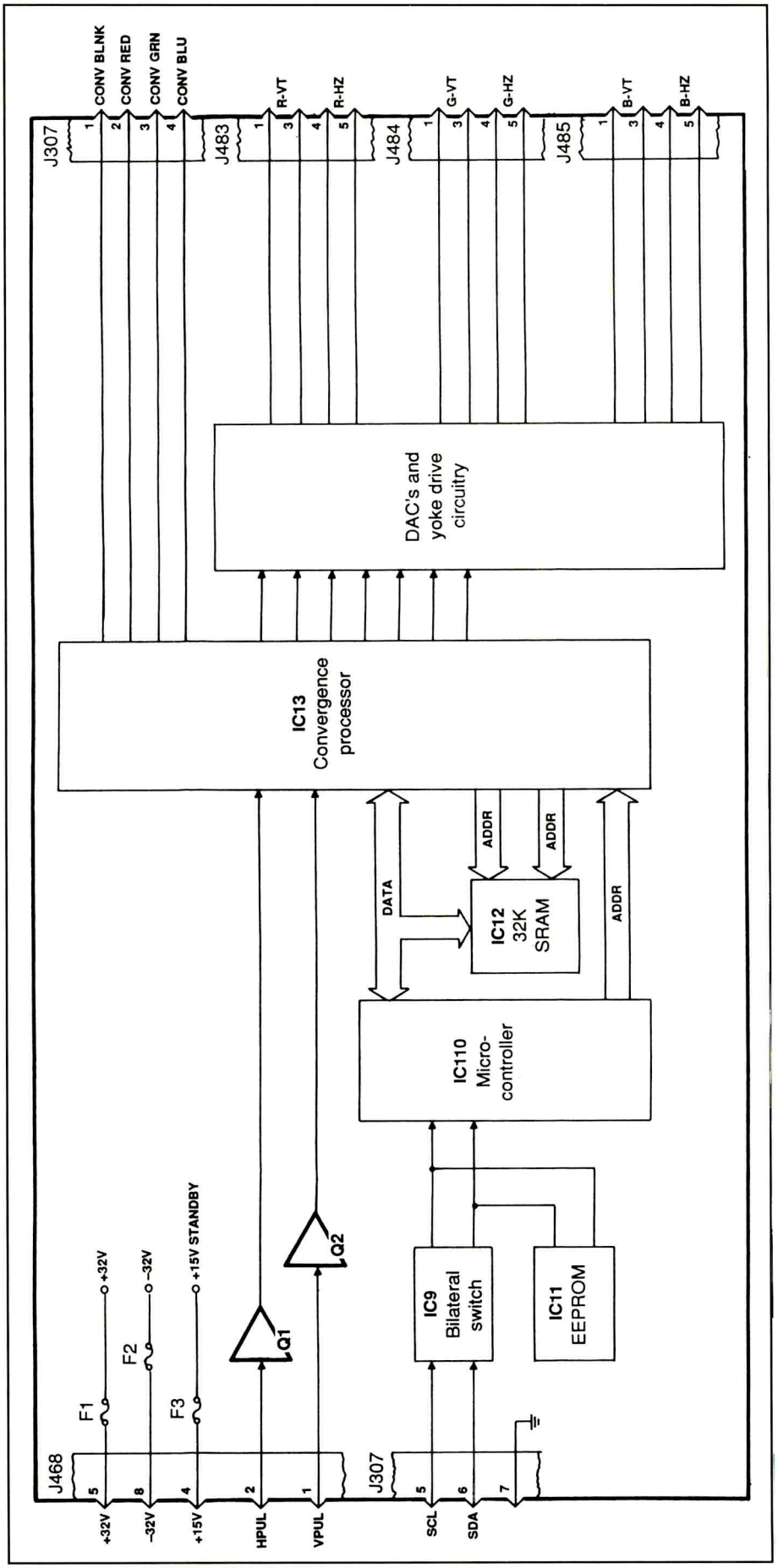


Figure 3. This is a diagram of the digital convergence panel or DSP.

and that they are turned on via the menu. It is possible that the customer has accidentally turned them off or has selected "center channel input." Then access the service menu and confirm that the "feature word" is correct. When you have done all of this, you have probably traced the problem to an audio failure on the small signal panel.

I have obviously failed to mention other problems the PTV700 series can have, such as retrace lines and extremely bright picture, a dim picture, bad convergence, etc. I can't deal with everything in a limited space, but I can give you an idea about how to use basic information like an interconnect diagram to arrive at a reasonable solution to the problem confronting you.

Repairing the SSP Or LSP?

Once you have traced the problem to, let us say, one of the two major panels, do you attempt to fix it yourself? I intend to give you a few quick fixes at the end of the article and trust they prove to be profitable. However, I must confess that I have had limited success repairing these modules, especially the LSP. Part of the difficulty fixing them lies in the fact that the components are difficult to access. You'd think an object as large as a projection TV is easy to troubleshoot, but it isn't. I often have to remove the board, make a few cold checks, install a component or two, put the board back into the set, and make a "hot" check. That's one problem.

Another problem is finding a source for parts. I have found that Philips doesn't sell certain parts, like an IFT, because they say when the IFT fails a few modifications probably need to be made to it and this modification must be made only by factory personnel.

A depot, on the other hand, will rebuild an IFT for about $175.00 (if the price for this type of refurbishment hasn't increased). If I can't fix the problem, I usually opt to pull the board and send it to a depot.

The up side is there are certain problems you can fix. More about those later.

Convergence

It's now time to talk about convergence. Limitations of time and space won't permit me to go through the entire procedure, but I expect to provide you

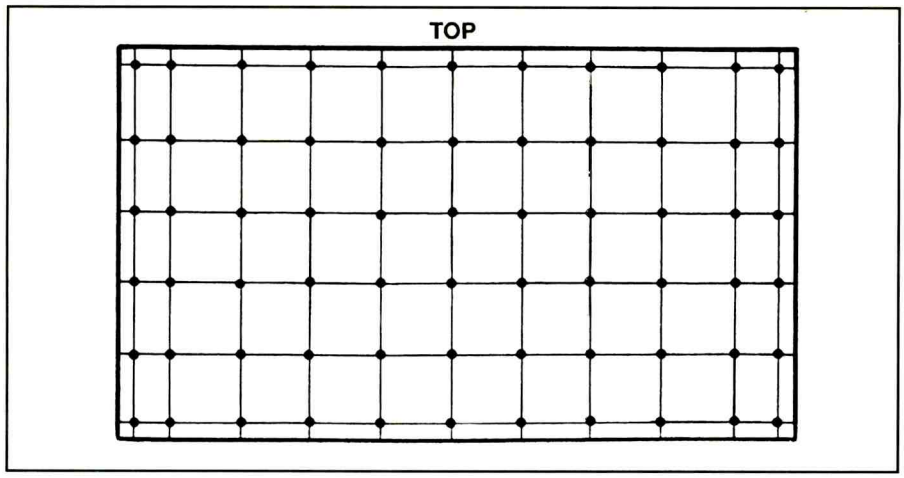


Figure 4. You will need a template like this; a plastic sheet with what looks like a crosshatch pattern printed on it that is large enough to cover the entire screen, to perform convergence on these sets. There are templates for each screen size.

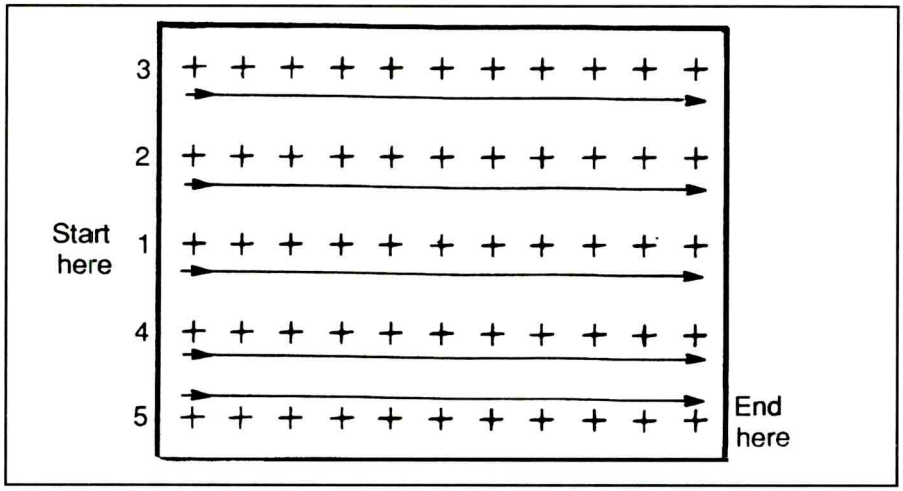


Figure 5. To perform convergence on one of these sets, you start and end as shown in this diagram.

enough information to give you a feel for how it is done. I mentioned that you need a template; a plastic sheet with what looks like a crosshatch pattern printed on it that is large enough to cover the entire screen (Figure 4). There are templates for each screen size. For example, the PTV730 that sat in my shop had a 46-inch screen and required template ST4130-46. I ordered it from Philips at a cost, I believe, of about $14.95 plus shipping. Fortunately, convergence instructions come with the template. Follow the instructions that are packed with the template as opposed to those that come in the service manual because they are easier to follow.

Preliminary observations

Before you begin, let the set warm up for about 20 minutes. Sit at least five feet from the screen, ensuring that your eyes are level with the area of the screen you are adjusting. Remember that the adjustments are interactive and will probably require repeating several times. Don't worry if the cross that appears on the screen is misshapen because a severely misadjusted convergence board won't project a perfect icon.

First things first

Before you begin your journey into electronic convergence, check the geometry settings in the service menu, specifically, picture height, linearity, VS correction, vertical shift, vertical comp, picture width, EW parabola, EW corners, trapezoid, H comp, VSS com, and H phase. The instruction sheet that accompanies the template gives you the register numbers and their values.

Then perform screen centering. Remove the protective screen and tape the template onto the outer screen if you haven't already done so. When you have correctly installed it, the template gives you a center reference. If you still aren't sure where the center of the screen is, place two strings diagonally across the viewing area from corner to corner. The point where the strings intersect is the center of the viewing area.

Use the remote control to enter the convergence mode by pressing in sequence 0, 6, 2, 5, 9, 7, Menu. Select an active channel using the channel up/down buttons or by inputting a signal from a signal generator. (I prefer to input the active signal before I begin the convergence procedure.) Select "M" to begin convergence.

From the menu on the screen, select "1" for green geometry. An internally generated green icon (a green cross) may or may not become visible on the left side of the screen toward the middle of the viewing area. Move it toward the center of the viewing area by pressing "M" on the hand unit. *Do not use the arrow keys for this procedure.*

Don't panic if you don't see the icon. Simply press "M" slowly until it appears, and then scoot on toward the center of the screen.

Next, place a jumper wire into the plug coming from the convergence board. The plug is sticking out into the free space around the CRT sockets above the small signal module and originates at TP4. If the plug and its wire are missing, simply place a jumper across the points at PT4. The jumper causes the screen to display lines that are bowed toward the center. It also removes all dc offset voltages that are generated by the convergence panel.

Use the centering taps on the yoke to position the green icon as close to the center of the viewing area as possible, keeping in mind that it may not go all the way toward the center. Then, center the red and blue using the same procedure you used to center the green.

Exit the convergence mode by selecting "Status Exit" on the hand unit. Do not remove the jumper at PT4 just yet.

Geometry adjustments

Enter the service mode and make a final check of picture height, linearity, horizontal phase, horizontal width, parabola, corner, and trapezoid.

Instructions about how to make these adjustments come with the template. It is possible that you may have to make one or more adjustments. I have found that if I set their values according to Table 1, I usually don't have to make additional adjustments.

Oh, yes, Remove the jumper at TP4 after you check or adjust register 42 (picture width) and before you adjust registers 38 (vertical linearity), 44, 45, 46, and 47.

The register data given in the service manual may not be entirely accurate. Therefore, depend on the information given to you in the instructions that accompany the template.

Getting on with convergence

Okay, let's finish the job.

Reenter the convergence mode (0, 6, 2, 5, 9, 7, Menu). Then cover the red and blue tubes with pieces of cardboard. Confirm that you are receiving an active signal either from a signal generator or antenna. If you aren't receiving a signal, and you proceed with convergence, you'll have to do the actual convergence all over again (I speak from experience.).

Select "1" for green geometry. The green icon should pop up near the left edge and about half way between the top and bottom of the screen. If it isn't visible, use the right arrow key on the hand unit until it becomes visible. Then use "M" to move the icon to the next horizontal point of the convergence adjustment sequence (those points on the template where the vertical and horizontal lines intersect).

Let me repeat for emphasis what I have just said about moving the icon. Use the arrow buttons (left- right, up-down) to center the icon at the point where the vertical and horizontal lines on the template intersect. Then use the "M" button to move the icon to the for one adjustment point to the next.

When you reach the "End Here" notation on the template, select "M" to go back to the convergence menu. Select "Repeat Convergence" by selecting number "2." Repeat the process until the icon is as centered on the convergence adjustment points as you can get it. Figure 5 should give you an idea about where the starting and ending points are. You are now ready to remove the template because it is no longer needed.

Go to the "Converge Menu," and select "Red To Green Convergence." Remove the cover from the red tube only. Find the red icon, and use exactly the same procedure you used with the green to place the red cross squarely onto the green. Repeat the process as often as necessary.

Next, select "Blue To Green Converge" from the menu. Uncover the blue tube and re-cover the red. Place the blue icon onto the green. When you are satisfied with your efforts, save the data you've entered by selecting "1" from the convergence menu.

Finally, check electrical and optical focus for the unit.

I know it sounds like a big, complicated deal, but it isn't. I did the whole procedure in less than forty-five minutes the first time around. After I had a couple under my belt, I found I could do them in about 20 minutes. Let the records show that I cannot do a convergence using the old-fashioned "turn a pot" method. I have to get somebody else to do it. My partner is right. Here is a convergence I can do. I am proud of me.

Back to my problem job

It's time to finish the story with which I began. I plugged the set in and noted that the "power on" indicator came on, but the screen didn't light (no raster), and no sound came out of the speakers. I popped the back off and took a brief look around while I made a few voltage checks. Yep, I had standby voltages, and I even had the +130V to the deflection/high voltage sections, but the set was basically dead.

Having serviced several of these sets that had blue tube problems (the face of the tube cracks and causes the neck to fill with coolant that also gets onto the LSP), I checked it next and saw no apparent liquid spill in it or around it. Not satisfied with the inspection, I pulled the panel out to take a closer look, and then I saw the problem: several burned components and a large charred spot right in the center and underneath the board. But how did it happen? The area around the blue tube, which is right above the LSP, seemed dry. However, I felt a little wetness when I ran my hand over the high voltage lead. The PTV had indeed been victimized by a fluid leak. Because there was no fluid inside the neck of the tube, I felt that it was okay.

My partner called the customer to give him the bad news. The owner said that the unit was slightly more than two years old, had some naughty words to say about the situation, and told us to fix it. Since it was just over two years old, my partner called our Philips field service engineer, who is one of the best in the business, and told him about the situation. He said Philips would provide the parts at no charge if the customer would pay the labor. Should I tell you that the customer was elated?

Replacing the tube

I pulled the blue tube and noticed coolant leakage around the area where the reservoir attaches to the face of the tube. The coolant had leaked onto it and gravity had pulled it down onto the high voltage lead and from there onto the circuit board. The leak had to be around the gasket that seals the face of the tube against the reservoir or from the rubber diaphragm inside the expansion chamber. It turned out that the diaphragm had a slit in it almost an inch long, the result of its constant expansion and contraction. I replaced the rubber diaphragm (part number 3135 013 01060), replaced the coolant (about three tablespoons full), and thoroughly cleaned the tube. I let the tube sit outside the TV for about a day, rechecked it, and then put it back into the TV. By the way, keep that part number handy because a split diaphragm isn't an uncommon problem.

Perhaps I ought to say that you should use a good quality fluid when you replace coolant that has leaked or when you have to change it completely Some use mineral oil, which works great in the older sets except that it eventually causes the rubber seals to get mushy and leak. You will get away with for a while, but if you persist in using mineral oil, you will have problems. I don't recommend it. We have chosen to use the coolant we get from Philips. It costs far more than mineral oil or fluid we get from other sources, but I am comfortable with its quality.

The LSP came in a few days later. You would be terribly mistaken if you

assumed the story has a happy ending, as if to say, "I installed the LSP and had TV." The TV came on without even the hint of audio and displayed a raster that had the shape of an egg that was lying on its side. I have seen distorted rasters, reduced rasters, shrunken rasters, but never an egg-shaped raster. To complicate matters, when I disconnected the digital convergence panel, the raster filled out but had no video in it.

(Remember I told you that a defective convergence panel can create a "no video" situation?)

Thinking I had missed something, I called Philips' technical service. The tech suggested I order a new LSP and, just to be safe, a convergence panel because he felt one of the two "had" to be the problem. I ordered both, and neither helped. Slightly more than a week had passed. The TV was still taking up space, sitting in the shop and laughing at me (I was getting a bit paranoid by this time) from time to time.

An inspiration

It was then that I had a "light bulb" moment, the kind of occasion when you get a bit of inspiration that the author of a comic strip conveys by drawing a light bulb above a character's head. The set had no audio, a condition that might be caused by an incorrect setting of the feature word in the service menu. Even though the raster was grossly distorted, I could just read the menu when I called it up. I managed to find the setting for the feature word (register 15 in table one), and it was indeed wrong. The audio popped in when I reset it. "If the feature word (or Feature ID) was wrong, is it possible that the vertical height setting is wrong?" I asked. I found the picture height register and was delighted to see the raster fill out as I incremented the register value upwards. I entered its correct value, skipped over to the vertical linearity register and adjusted it, and saw to my great relief that the raster had filled out perfectly. It seems that voiding the picture height and vertical linearity registers at the same time caused the egg-shaped raster.

Convergence

I wasn't through yet because the picture was terribly misconverged. I let this little jewel play until I located and installed the proper template. Then I went through the convergence procedure in abbreviated form because it didn't require a full convergence.

We played the TV for about a half a day and sent it home. The owner was glad to get it back in his living room. I was relieved just to get it out of the shop.

Module level repair

As I said, these modules are difficult to repair because getting to the components to make "live" checks makes a contortionist out of you. I have been able to fix a few, but the really serious problems usually go to a depot that has the jigs necessary to make those repairs. The information I am about to give you comes from my notes, which I gleaned from personal experience, factory service bulletins, and Philips so-called "notes from the field." I hope they help.

(1) The unit is either dead or tries to come on and shuts down. Check D902 on the LSP and if that is leaky or shorted, replace with Philips part number 4835 116 57321. Please make a note of the fact that the green power-on LED might come on and stay on when the TV receives an on command.

(2) The set exhibits a "no picture" symptom. Check pin 11 of IC600 for a horizontal pulse. If it is missing, suspect resistor R660.

(3) The TV has good audio but a dark picture and poor video. Check C30 on the SSP. It was installed backwards in some early production runs (Make sure the negative lead goes toward pin 28 of IC1.). In later production runs, it may have become leaky.

(4) The set comes on bright blue, red or green picture and shuts down. IC602 on the SSP may have shorted.

(5) Horizontal bars move through the picture when the customer uses either the tuner or the video input. Suspect poor filtering of the +32V line, and check C459, C474, C409, and L804.

(6) The picture is subject to vertical roll, loss of vertical sync, and an on-screen display that won't lock into place. The problem may be caused by corrupt data written into the EEPROM. Check the registers in the service menu, and be prepared to reset them. I advise you to purchase the service menu and follow its instructions for resetting the registers.

(7) The unit is dead because it has no high voltage. Check R818 on the LSP, which should measure 1ohm.

(8) The set has good audio but no raster. Check vertical deflection IC for B+. If B+ is missing, check for an open resistor in the B+ line.

(9) When the set comes on, the picture has red images in it because the red is out of convergence. Reconverge the TV. If the problem recurs, get ready to replace the digital convergence board.

(10) The set has scrambled channel captioning after you replace the SSP. You haven't written the default values into the registers. Enter the service mode, and set register 1 to "00." The TV will then write the factory default values into the EEPROM and shut off.

(11) You hear snapping and popping while the set is playing. Look for high voltage leaks around the anode caps on the CRT. You will more than likely have to pull the tubes and reseal the anode caps using RTV (room-temperature vulcanizing) sealant. ■

A Pesky Vertical Problem

by Bob Rose

A customer walked in the front door and asked my partner if we worked on TV/VCR combinations. When he said we did, she replied, "Well, I've got one, and I can't get it to stay on. It won't work as a TV, and I can't use the VCR either. Will you see what's wrong with it?" He lugged it into the shop for her and placed it with the other units waiting for repair. In due course, I set the combi, a nineteen-inch Funai (Model F3819C), on the bench and checked the actual performance against the complaint and found that the customer was correct. I could turn it on, hear the high voltage come up, and almost immediately die. The combi was shutting down.

It was late in the day, and I thought to myself, "Why couldn't it have had another problem?" As you will find out, few troubles are more tedious to track down in these units than a shutdown. The job is further complicated by the fact that getting to the appropriate test points to make critical voltage and waveform checks is a chore. When you get there, you have to contend with surface mount components and test leads and magnifying glasses. But griping never helps. I took the back off the combi, pulled the literature, and got on with the job.

Rose is an independent consumer electronics business owner and technician.

A similar unit

I propose to illustrate how the shutdown circuits in a lot of the newer products work by using a similar product, a Magnavox CCX092.

Shutdown circuits in today's electronic equipment are becoming more and more difficult to troubleshoot because of the methods used to effect a shutdown and the circuit areas that are monitored. Without an understanding of their operation, troubleshooting and repairing the new shutdown circuits is almost impossible.

For purposes of discussion, I shall divide the shutdown circuits into two parts. The first involves the

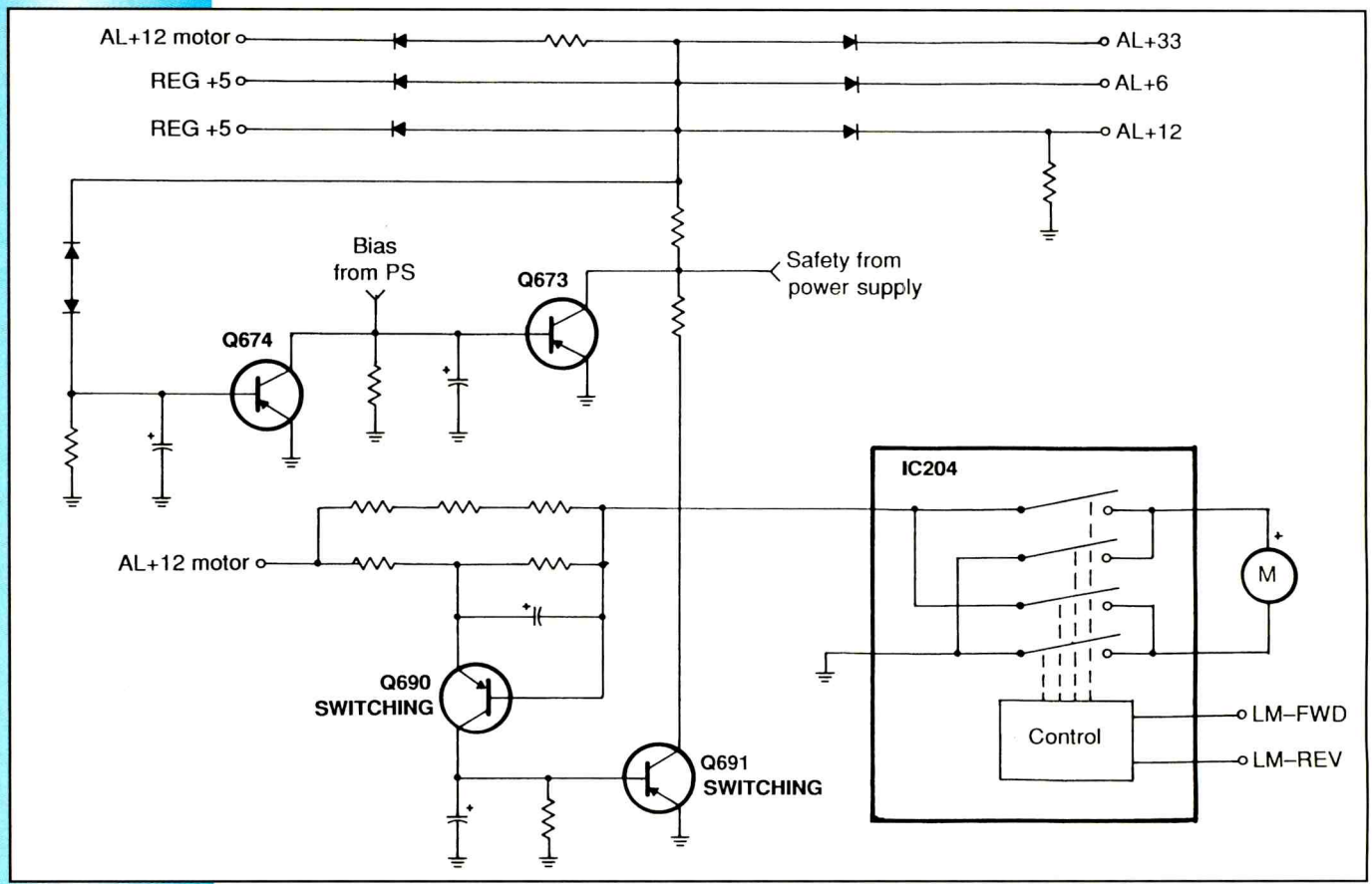


Figure 1. The safety shutdown circuit in these sets has two branches. Both branches protect the power supply from damage by turning it off when certain other circuits fail.

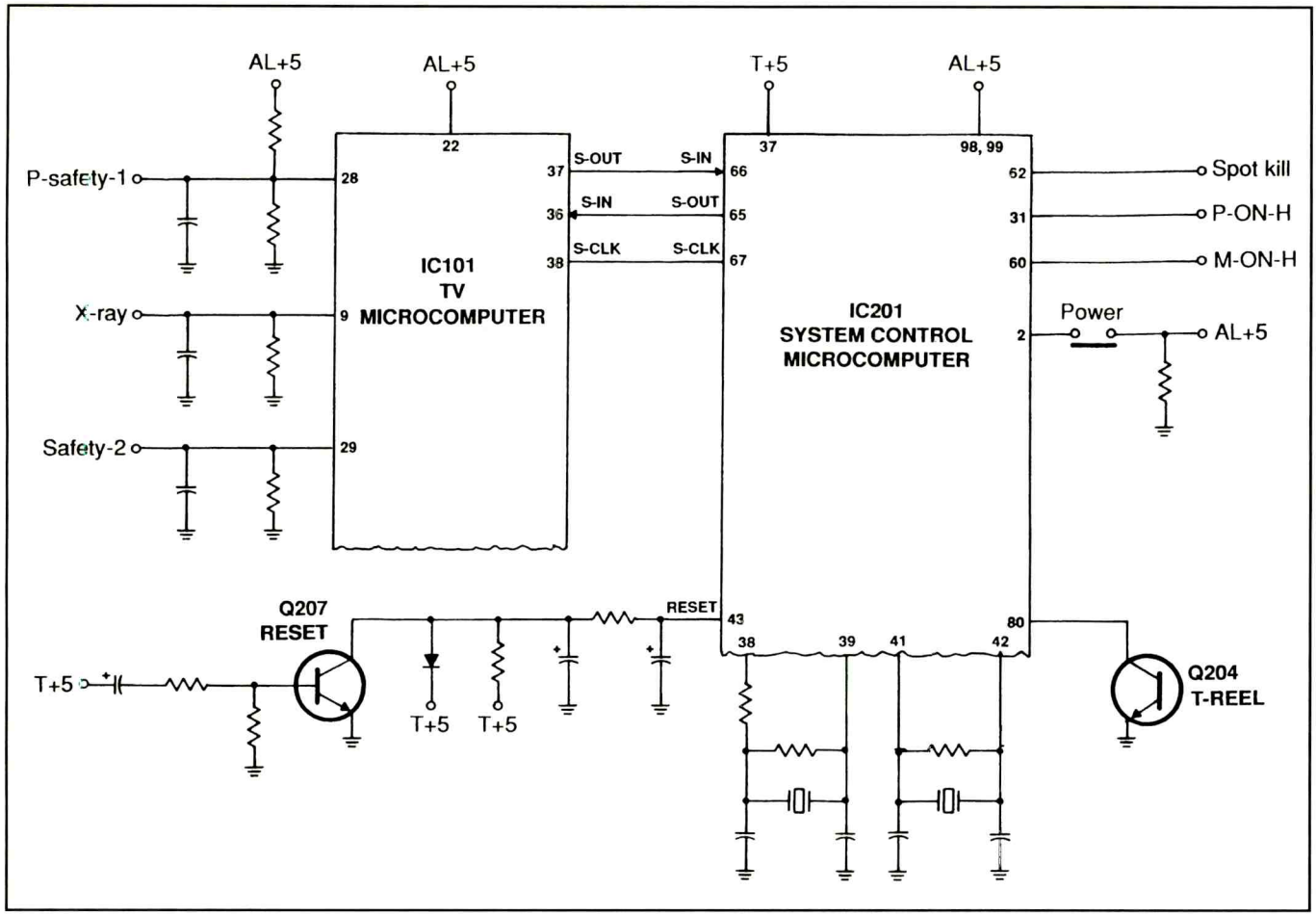


Figure 2. The system control shutdown circuits. System control shutdown occurs when system control senses a problem and takes the form of either turning the unit off if it is up and running, or keeping it from turning on.

power supply while the second centers around system control. Following the industry's nomenclature, let's label the circuits "safety shutdown" and "system control shutdown."

Safety shutdown

The safety shutdown circuit in the CCX092 and the Funai F3819C has two branches (Figure 1). Both branches of this circuit protect the power supply from damage by turning it off when certain other circuits fail.

Since a failure in the power supply or a failure in other parts of the unit might cause shutdown, we servicers need a method for determining which area to investigate. Checking the voltage on the collector of Q673 is a good place to begin because the voltage levels there help you determine if the shutdown is caused by problems in the power supply or system control. As I will point out, if it is in the power supply, an additional measurement enables you to determine which branch of the safety circuit has been turned on. During normal operation, the collector voltage measures slightly over 6V. If the voltage goes high and then low, you can be reasonably sure one of the safety circuits that protect the power supply has tripped.

Because there are two, you must now determine which shutdown circuit has become active. Fortunately, there is another test to help you determine which one has turned on. After you have checked the collector voltage on Q673 and found it to be low, move your probe to the base. If it goes high and stays high as ac is applied, safety circuit one is turning the power supply off.

Safety circuit one

Safety circuit one monitors the AL 33V, AL 6V, both AL 12V lines, and the regulated 5V and 6V sources via diodes D681, D680, D674, D679, D672, and D673 (Figure 1). If all of the voltages are present at the cathodes of these diodes, the diodes are reverse biased because the voltage at the cathode is higher than the voltage at the anode. In normal operation, a voltage divider network consisting of R686, D676, D678 and the base-emitter junction of Q674 supplies the anode voltage for the diode matrix. The biasing arrangement holds Q674 on, meaning that the base of Q673 is held low keeping it from conducting and holding the safety line connected to the collector of Q673 to about 6.2V.

If one of the supply voltages fails, the diode monitoring the source becomes forward biased and conducts. D676 turns off because the voltage on its cathode has dropped. Having lost its bias voltage, Q674 turns off as soon as capacitor C677 discharges permitting Q673 to turn on and pull the safety line low. A low on the safety line disables the regulator feedback reference (the voltage on the collector of Q673), and the power supply turns off.

I need to digress for just a moment. I have made a reference or two to a few components that aren't shown, like the reference to the regulator feedback loop

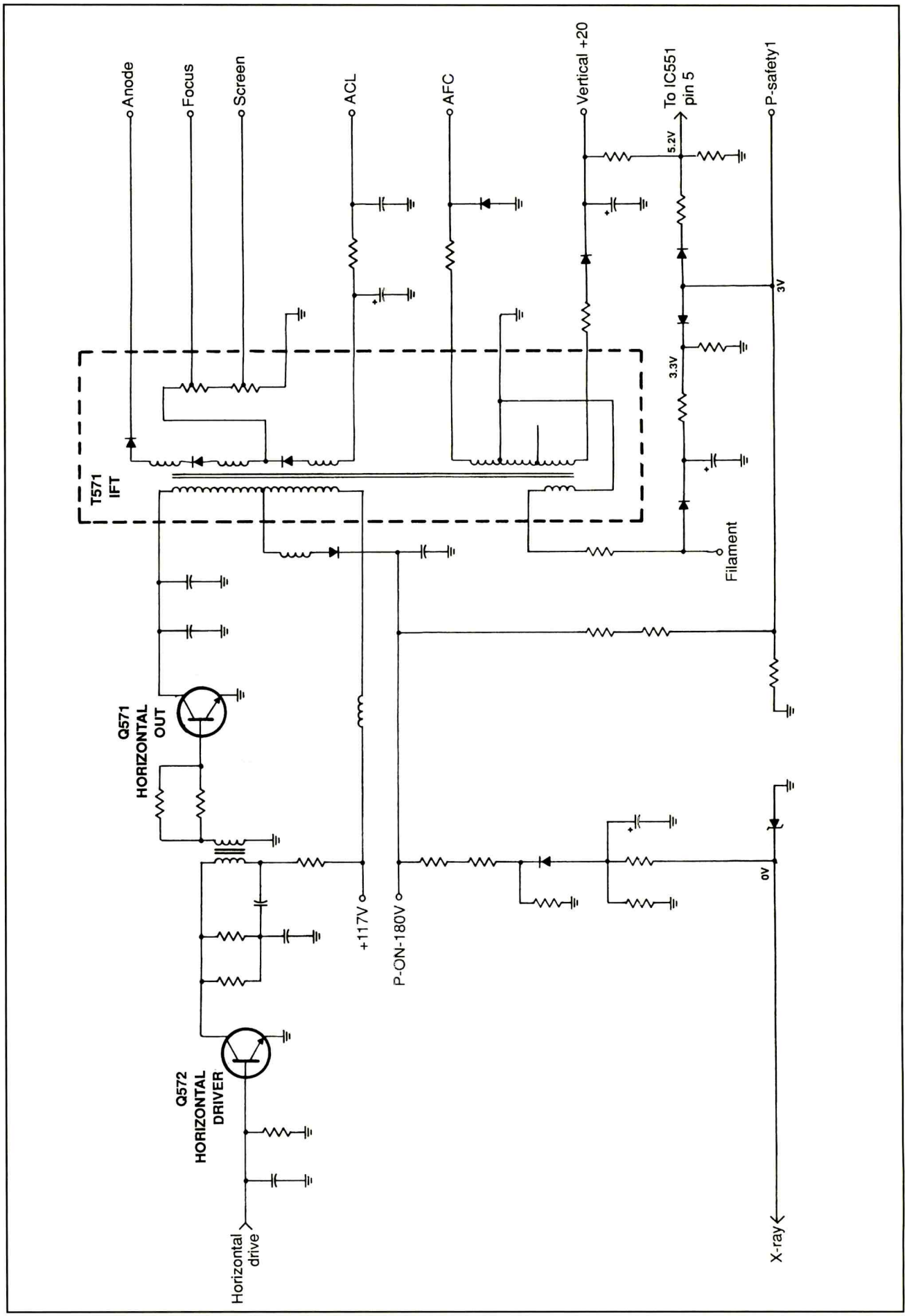


Figure 3. The x-ray sensing line monitors two different sets of voltages. The first one has the ability to keep the unit from turning on while a failure in the second one results in the unit shutting off shortly after it turns on.

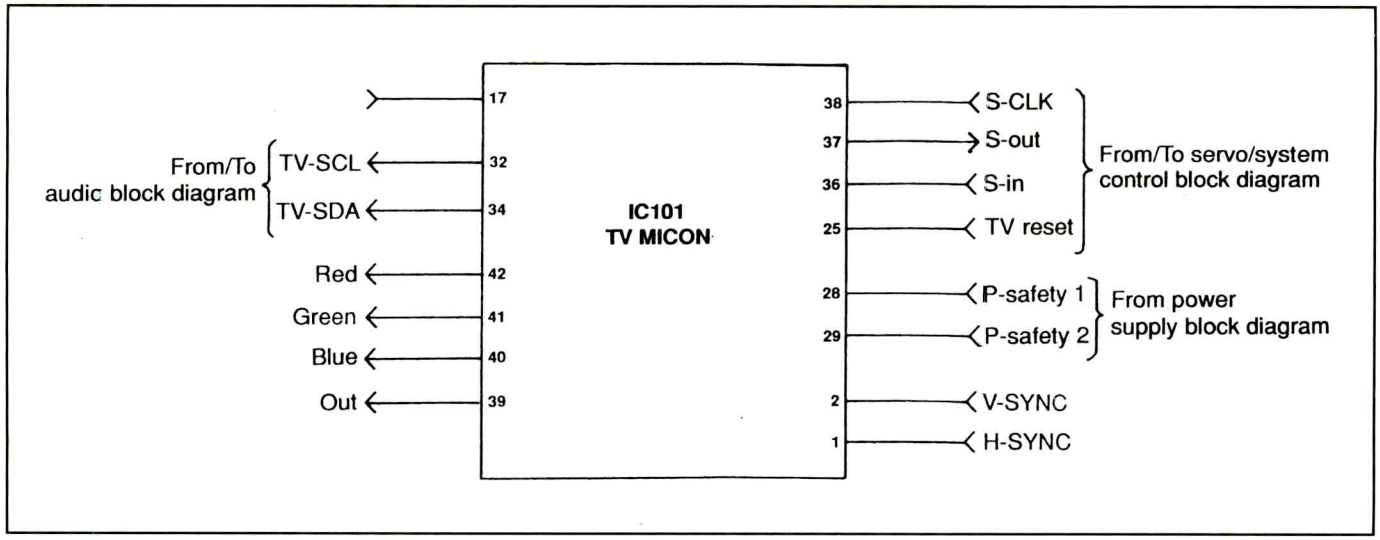


Figure 4. IC 101 monitors critical voltages at several points in the set, and if they are not correct, reports the fact to the circuitry that shuts the set down.

in the power supply. I haven't duplicated all of the schematics for these units because some take up the equivalent of four sheets of paper, are printed in color, and are intricate in design, making them very difficult to duplicate. I hope you will forgive me for not including them.

Now back to the topic at hand. Your nose for trouble immediately sniffs out a number of things that could go wrong, but for the moment let's focus on the diode matrix. If you suspect a safety one shutdown, monitor the voltage on the cathode of each diode in the matrix with a dc-coupled scope while you turn the combi on. When you find the one that goes low and stays low, you have found the voltage that is failing. Use conventional troubleshooting techniques to find out why that is the case.

Safety circuit two

If, however, the base of Q674 goes low and stays low when the safety line goes low (i.e. when the collector goes low), you must look for the source of the shutdown in the second safety circuit. So let me call your attention to the circuit that monitors the loading motor voltage supply, namely Q690, Q691, and their associated components. If the +12V line to the loading motor drops below a certain point, the base voltage of Q690 (a PNP transistor) goes low, turning it on, which causes Q691 (an NPN transistor) to turn on. The low at the collector of Q691 pulls the safety line low, and the power supply turns off.

How do you determine when the circuit activates? Use your dc-coupled scope to monitor the base of Q691. If the voltage reaches about 0.6Vdc and stays there when power is applied, look for the problem in the 12V source, IC204, or the loading motor itself. Don't automatically conclude that you have a major problem; a simple thing like a jammed cassette in the VCR has the ability to trip the circuit. As a matter of fact, I have never serviced a combi for a safety circuit two shutdown that *wasn't* caused by a jammed cassette up unit (or carriage).

Nuisance trips

You may be wondering, "What keeps minor power fluctuations from tripping these circuits?" That's a good question. Look again Figure 1 and find capacitors C677 and C676. These capacitors have been placed in the circuit to provide a time delay between a voltage drop (or sag) and the time the circuit activates. Without them, the unit would indeed be subject to nuisance shutdowns. While you are studying Figure 1, locate capacitors C690 and C691. They perform a similar function in the second safety shutdown circuit.

System control shutdown

Okay, the first series of shutdown circuits disables the power supply. Let's move on to the second series that involves the microprocessor. Use Figure 2 as a reference. System control shutdown occurs when system control senses a problem and takes the form of either turning the unit off if it is up and running, or keeping it from turning on. Unlike the safety shutdown circuits, a system control shutdown does not affect the power supply.

The circuit works as follows. Integrated circuit IC101 monitors what the designers call "the analog condition of the unit" and digitally converts the information for use by IC201, which, as you have already seen, controls most of the functions of the unit. "The analog condition of the unit" translates into IC101 monitoring the unit for excessive high voltage (x-ray or overvoltage sensing), loss of scan-derived voltages, or power supply overvoltage.

X-ray protection

If the voltage on pin 9 of IC101 increases above 2.5V, the safety circuit assumes that the high voltage has increased beyond acceptable limits. It responds by sending the information via the data bus to IC201, which responds by toggling the power-on (pin 31) and monitor (pin 60) lines low, and the combi promptly turns off.

The x-ray sensing line monitors two different sets of voltages. The first one has the ability to keep the unit from turning on while a failure in the second one results in the unit shutting off shortly after it turns on. Since the power supply runs continuously, the +117Vdc for the horizontal deflection circuit is present all of the time. According to the schematic

(Figure 3), the +117V is also present on the +180V line. If the x-ray sensing circuit develops a problem that permits the x-ray safety line to rise about 2.5V, the unit cannot turn on. In other words, it won't respond to an on command.

The question naturally pops up, "How can I troubleshoot such a convoluted problem?" It turns out that you simply need to measure the voltage on pin 9 of IC101. If it is above 2.5V, concentrate your attention first on the power supply to see if the +117V really is high and second on the x-ray circuit to see if a component in it has failed.

The x-ray sensing line monitors a second voltage. Look again at Figure 3, and you will see that the x-ray circuit monitors the +180V line when the set comes on. If the +180V source goes high, the circuit responds by turning the set off shortly after horizontal deflection comes up. If the +117V is stable, look for C580 and C581 as the likely culprits. Simply monitor the x-ray line with a dc-coupled scope as you power the unit up. If the voltage on pin 9 of IC101 rises above 2.5V and if the +117V remains stable, immediately suspect C580 and C581.

P-safety line one

IC101 also monitors what the manufacturers call the "p-safety-1" line which is a circuit designed to protect the picture tube by monitoring three scan-derived voltages (Figure 4). These voltages are the +20V source used to power the vertical deflection IC, the +180V source that powers the video output transistors, and the CRT filament voltage. If one of the sources fails, IC101 reports the failure to IC201, which responds by turning the combi off.

The circuit (Figure 3) has been designed to maintain about 3.0V at pin 28 of IC101. Once again, the designers opt to use a diode matrix consisting of D581, D583, and D584 to monitor the scan derived voltages. If one of the monitored voltages fails, the corresponding diode becomes forward biased and pulls the p-safety-1 line below 3V. IC101 interprets the voltage drop and conveys it digitally to IC201, which responds by pulling lines 31 and 60 low, turning the power to the combi off.

Troubleshooting it isn't as daunting as you might think. First, reduce the G2 voltage to protect the picture tube. Second, connect the p-safety-1 line to the +5V regulated source in the unit to keep the voltage above 3V. I suggest that you use a small resistor to effect the hook up. Third, use your scope or DMM to find the missing voltage. Finding the problem isn't as daunting as you thought, is it?

Let's take a simple illustration by supposing resistor 580 in the +20V line has opened because the vertical output chip has shorted. D581 becomes forward biased and pulls the p-safety-1 line below the voltage level necessary to keep the set operating. IC101 informs IC201 that the voltage on pin 28 has dropped below the acceptable level of +3VDC, and IC201 responds by turning the unit off.

P-safety line two

P-safety-2 routes the voltage on the collector of Q673 (Figure 1) to pin 29 of

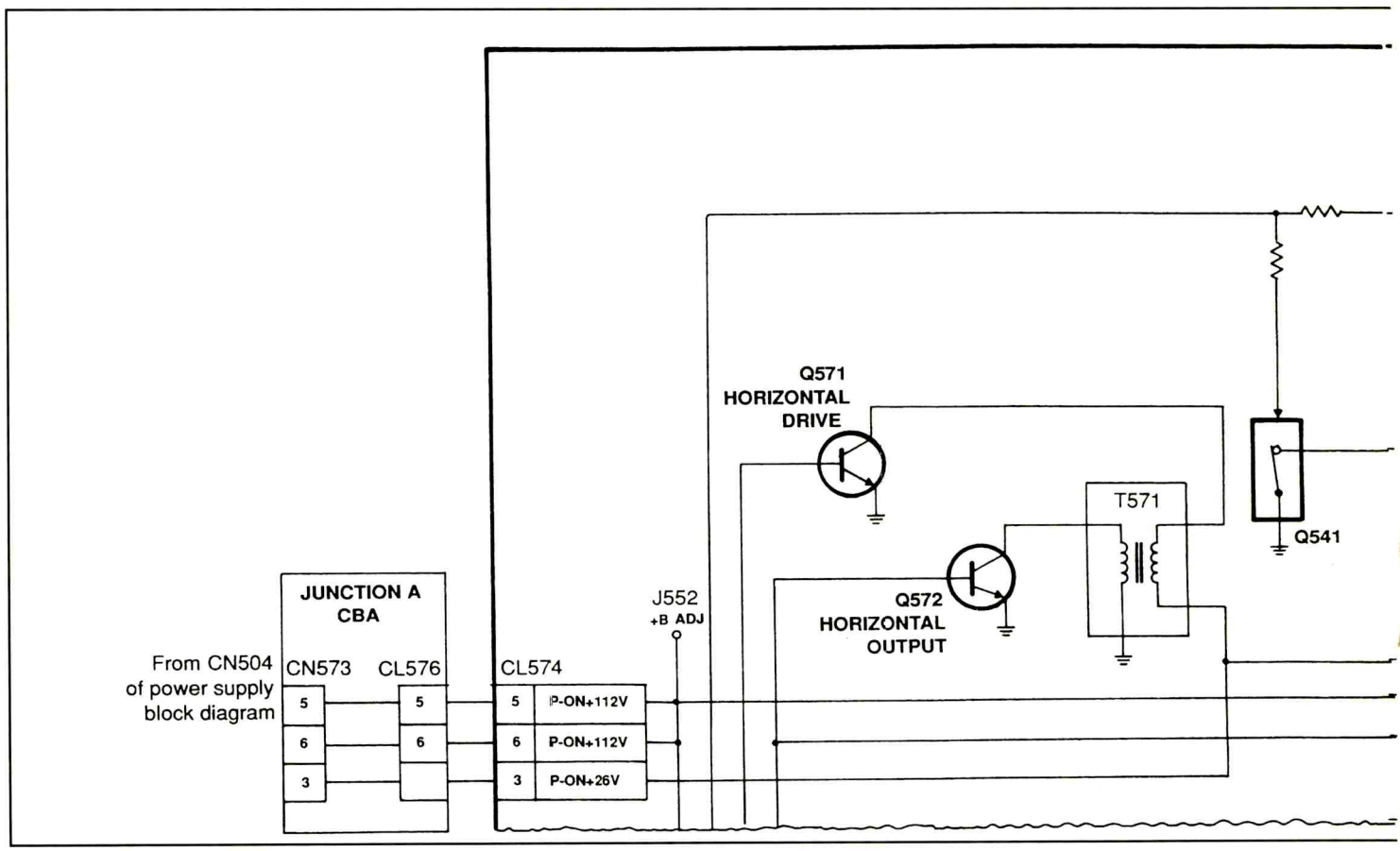


Figure 5. Here is a bare-bones diagram of the part of the deflection circuits that are of concern.

IC101. When the unit is operating properly, the voltage at that point should be on the order of 6.2Vdc.

A practical exercise

Now let's suppose that you have put one of these units on your bench, turned it on, and heard it die just a few seconds later. What do you do next? Just to be safe, you might want to monitor the voltages on Q673 (Figure 1). If the collector goes high and stays high, you can be reasonably sure that the problem is not the voltage sources monitored by Q673. In other words, the power supply isn't responsible for the shutdown. You might consider monitoring the voltage at pin 9 of IC101 next. If it doesn't rise above 2.5V, you know the circuits that the x-ray protection circuit monitors aren't responsible for the shutdown.

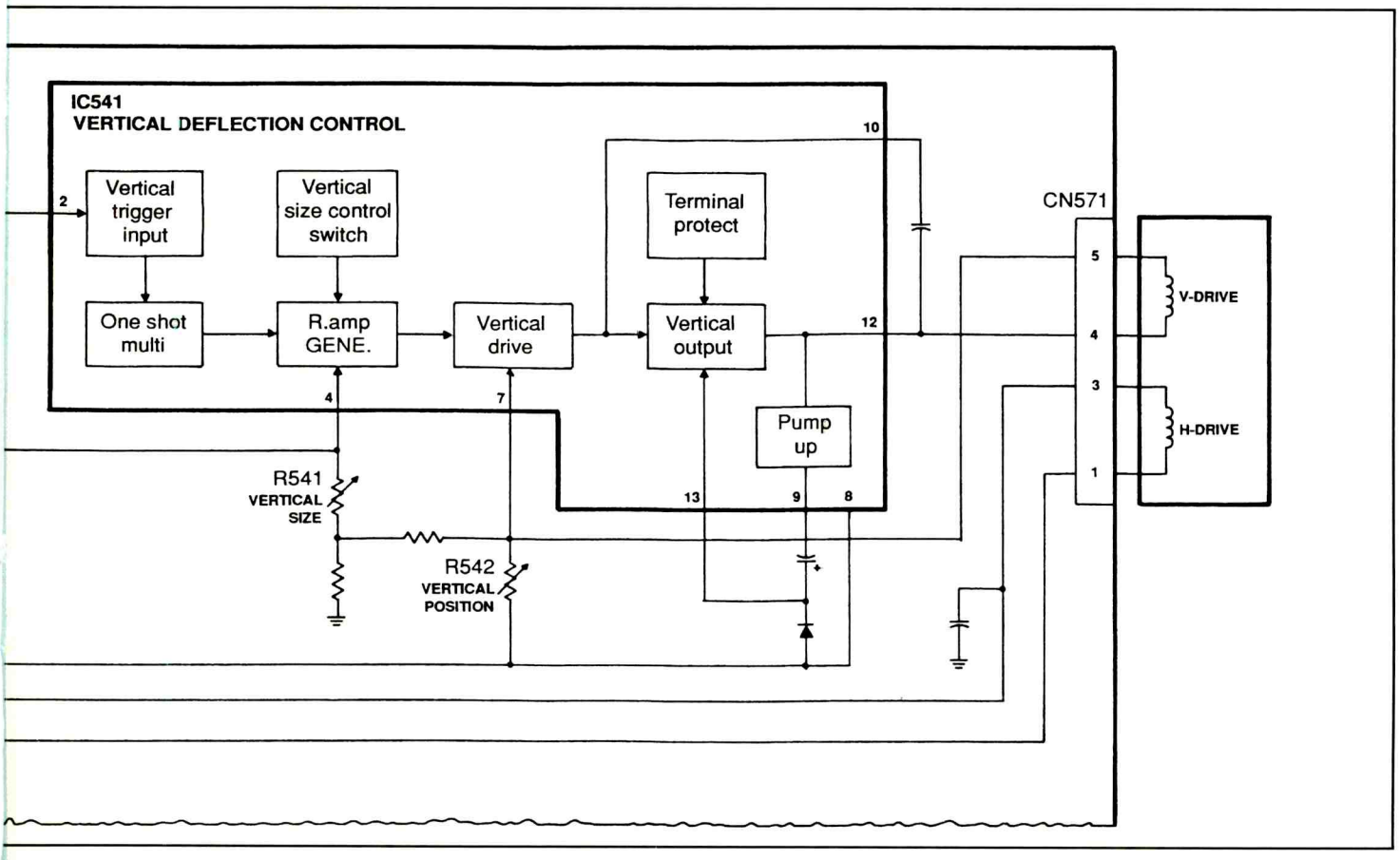
That leaves the p-safety-1 line. When you monitor it, you notice that the voltage doesn't rise to the expected 3V, which means one of the circuits the p-safety-1 line monitors is causing the shutdown. You have now isolated the problem to a particular circuit, and it's now time to find which scan-derived voltage has failed.

Begin by using a small value resistor to connect the AL +5V line to pin 28 of IC101. Then turn the G2 voltage down to protect the picture tube and use a scope to check the +180V line, the filament voltage, and the +20V line. When you check the +20V line, you find basically 0V. You set your scope probe aside, and using your DMM you discover that R580 has opened. Additional checks reveal that the resistor opened because the vertical output chip shorted.

Back to the Funai that wouldn't stay on

Now back to the combi that prompted this discussion. I put it on my bench, pressed the power button, and heard the high voltage come up and die about two seconds later. I cannot reproduce the full schematic because it would take up far too much space and be practically unreadable, but I believe I can convey the necessary information by using block diagrams. IC 101 in Figure 4 does the same job that IC101 in the Magnavox combi does; Figure 5 lays out the bare-bones of part of the deflection circuits that are of interest; and Figure 6 is the part of the block diagram of the power supply that shows the outputs. If you look closely at Figures 5 and 6, I believe you'll discover rather quickly the fact that the main power supply develops B+ for the vertical output chip. In other words, power for the vertical deflection IC doesn't come from a scan-derived voltage source.

I tackled the Funai combi near the end of a day filled with tedious problems. You, I am sure, know how it goes. You fight your way through a series of problems and find that the last one of the day is the most vexing of all. Because I like to have the day's work tidied up before I leave the service center for home, I decided to have a go at the combi. Besides I really didn't want to have nightmares about it when I went to bed; and that's the truth.



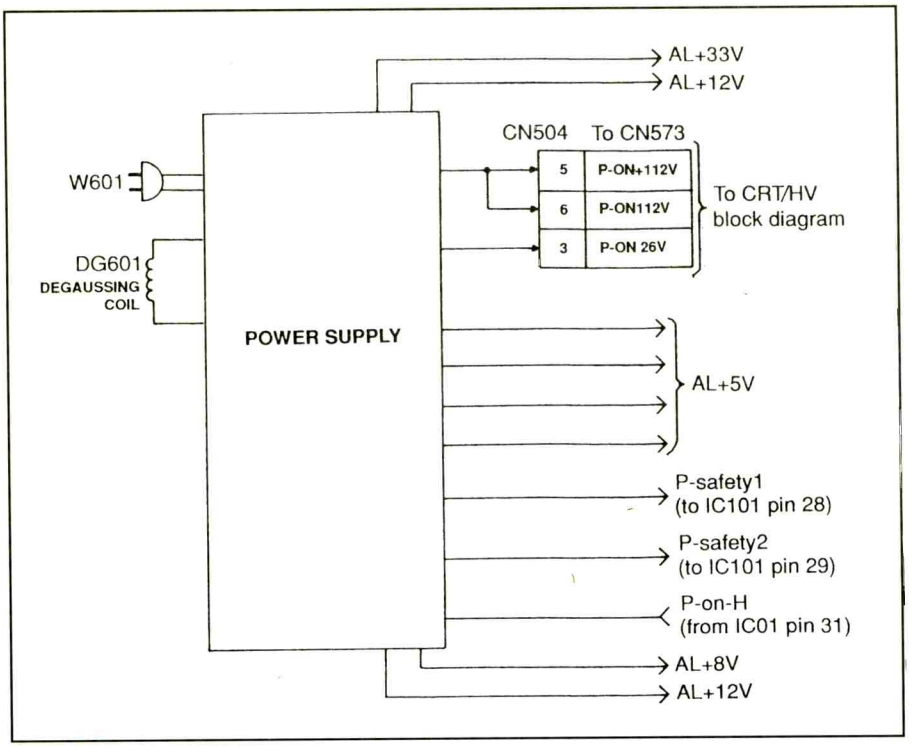


Figure 6. This part of the block diagram of the power supply shows the outputs. This drawing, along with Figure 5 shows that the main power supply develops B+ for the vertical output chip. In other words, power for the vertical deflection IC doesn't come from a scan-derived voltage.

I took the back off the set and noticed that the deflection circuits were mounted on a small circuit board located to the left and above the picture tube (looking at it from the back). For some reason I still don't understand, I put my scope probe on pin 13 of the vertical output chip (IC 451 in Figure 5). When I turned the set on, I didn't see the trace on the scope deflect. The voltmeter also registered 0Vdc. My heart skipped a beat. Had I lucked out on this one?

I promptly located pin 3 of connector CN504 and confirmed that power supply was producing the +26V. Since I had the voltage at CN504 but not at IC451, I correctly assumed that a fusible resistor had opened. I located and replaced the resistor and replaced IC451 with a new LA7873 just to be safe. Then I crossed my fingers and fired the unit up. When I turned the G2 voltage up, I had a perfect picture on the screen.

You know the rest of the story. I put that fellow back together, wrote the bill, and went home and slept well that night. ■

What Do You Know About Electronics?

by J.A. "Sam" Wilson

You may have noticed that I have been slipping a few college basic subjects into "WDYKAE?" I think some readers may be thinking about going for that two-year associate's degree because it's showing up in the want ads. You need a college degree for fixing a VCR like a fish needs a bicycle, but as the doctor replied when he was asked "Will eating chicken soup help cure a cold?," — "couldn't hurt."

Here's another way to write a matrix:

$$(abc)\begin{vmatrix} x \\ y \\ -z \end{vmatrix} = ax + by - cz$$

Many of the very good **ES&T** articles that are in each issue are written by technicians. They describe methods of troubleshooting and repairing electronics equipment. That is, they are written about a concentration of consumer equipment and industrial electronics equipment.

Well, since I'm not a practicing technician any longer, what am I? You can think of me as a teacher (actually, a professor). I teach technology. That includes the mathematics and scientific information that supports all of the subjects that helps technicians in their understanding of newer technology (that was not taught in the courses you took).

Have you observed that it is getting more and more difficult to understand the newer technology? Take a romp through a book on DSP (digital signal processing) and get a good hold on your chair. In the near future, I will fathom the depths of that subject. I say it is well within our grasp.

It's the law

Let's look at the word "discipline." I'm not talking about teaching your little boy not to pour honey in his little sister's hair. In my dictionary, the word also means "a branch of instruction in education," or a branch of knowledge or instruction. So, physics and chemistry are disciplines in science.

An important feature of science or math is a set of basic laws that govern the truth behind each discipline. For example, Newton formulated the three laws of motion (often called the rules of motion). Those laws are the basis of studies of the motion of bodies. They have an impact on the study of all motion. Let's take a look at those three laws.

Law #1 (sometimes called the law of inertia): When a body is at rest it will tend to remain at rest, and if it is in motion it will tend to remain in motion along a straight line, unless acted upon by an unbalanced force.

Law #2 (sometimes called the law of acceleration): An unbalanced force, when acting on a body, will cause the body to accelerate in the direction of that unbalanced force. The acceleration will be directionally proportional to that force, and inversely proportional to the mass of the body.

Law # 3: For every force on a body at rest, there is an equal and opposite force in opposition to that force.

That law has always been a source of confusion to me. It means that if you push on a large tree and it does not move, the tree has to be pushing back at you with an equal force(?)

You should be aware of the fact that there are laws (or rules) that govern most disciplines. As you progress through different disciplines, you would do well to memorize the related laws (you may want to put them on memory cards) because they are the foundation of the disciplines. The laws of motion can be written as math equations. For example, the second law can be written as:

Force = Mass x Acceleration, or

$F = MA$

As we go along in "WDYKAE?," I'm going to write laws for the various disciplines. It would be a good idea to put them on memory cards. Here are some laws of algebra for you to put in your exponent section.

Q. What is the value of 7^0, that is, 7 to the zero power?

A. Any number raised to the zero power is equal to one: by definition.

Q. What is the value of $64^{3/2}$?

A. This can be written as $^2((64)^3$ (the 2 as shown to the left of the radical sign is usually understood in the case of square root). So, $(((64)^3 = 8^3 = 512$. You get the same result if you square 64 first and take the square root of that result.

A review

Once in a while I like to review older material to make sure I'm not losing anything. So I pulled out this test from 1990 and retook it. I missed one of the questions. I hope that's not a sign that I'm getting old. You try it. If you get a grade of 100% you will have done better than me.

1. What is the unit of measurement for the reciprocal of a sine wave?

2. What is the unit for the time rate of doing work or expending energy?

3. What do you get when you divide the center frequency by the bandwidth (it is more commonly called Q)?

4. Two components of the power triangle are "true power" and "apparent power." What is the third component?

5. The number of amps per volt is called conductance. In what units is conductance measured?

6. In the U.S., it is called decibels, and it is based on logarithms to the base 10. In other countries it is based on log to the base epsilon, and it's called _____?

7. This three-terminal thyristor won't conduct until its emitter is a certain decimal part of the power supply voltage. What is that decimal part called?

8. In what temperature scale does all motion of atoms stop at 0 degrees?

9. What kind of interrupt is impossible to ignore in a microprocessor?

10. What is the reciprocal of reactance?

Answers to the questions

1. Frequency is the reciprocal of the period (f = 1/T) and it is measured in Hz.

2. Watts. The time rate of change of doing work or expending energy is called power.

3. Quality factor (Q). It is used as a measure of tuning sharpness.

4. VARs. It stands for "reactive volt amperes."

5. Siemens. At one time it was called mhos, which is ohms spelled backwards.

6. Nepers.

7. Intrinsic standoff ratio, or ISR.

8. Kelvin.

9. NMI, or non-maskable interrupt. This type of interrupt can be caused by an impending power failure.

10. Susceptance. The reciprocal of resistance is conductance. The reciprocal of impedance is admittance. The reciprocal of reactance is susceptance.

I missed number 3. I just called it Q.

Test Your Electronics Knowledge

Answers to the test (from page 11)

1. (C) Ultrasonic sound is sound generated at frequencies above 20KHz.

2. (D) All of the useful intelligence in an AM signal is in the sidebands. With single sideband transmission, only the upper or the lower sideband is transmitted. See Figure 1. The carrier may not be transmitted.

3. (D) Hardwire and wireless are the only ways to convey intelligence of any kind.

4. (A) The human ear has a logarithmic response to sound volume. A logarithmic taper matches the response of the ear to changes in sound volume.

5. (A) This is in accordance with Fourier analysis.

6. (B) By definition.

7. (D) A strong light is needed to overcome the losses in fiber optic cable or conductor of light.

8. (B) Actually, a wider bandwidth can be tolerated with a high RF frequency.

9. (C) I'm not sure that the requirement of an FCC license is a disadvantage, but that is the answer required on an FCC test.

10. (A) The word PIN refers to the three layers in the diode: Positive, Intrinsic, Negative.

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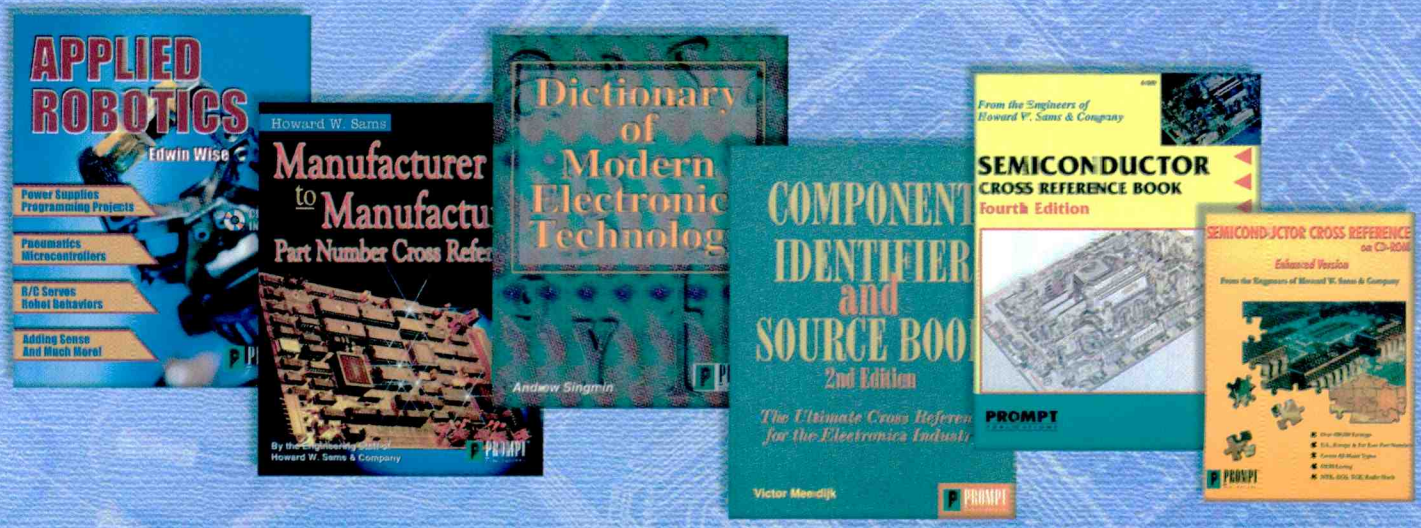

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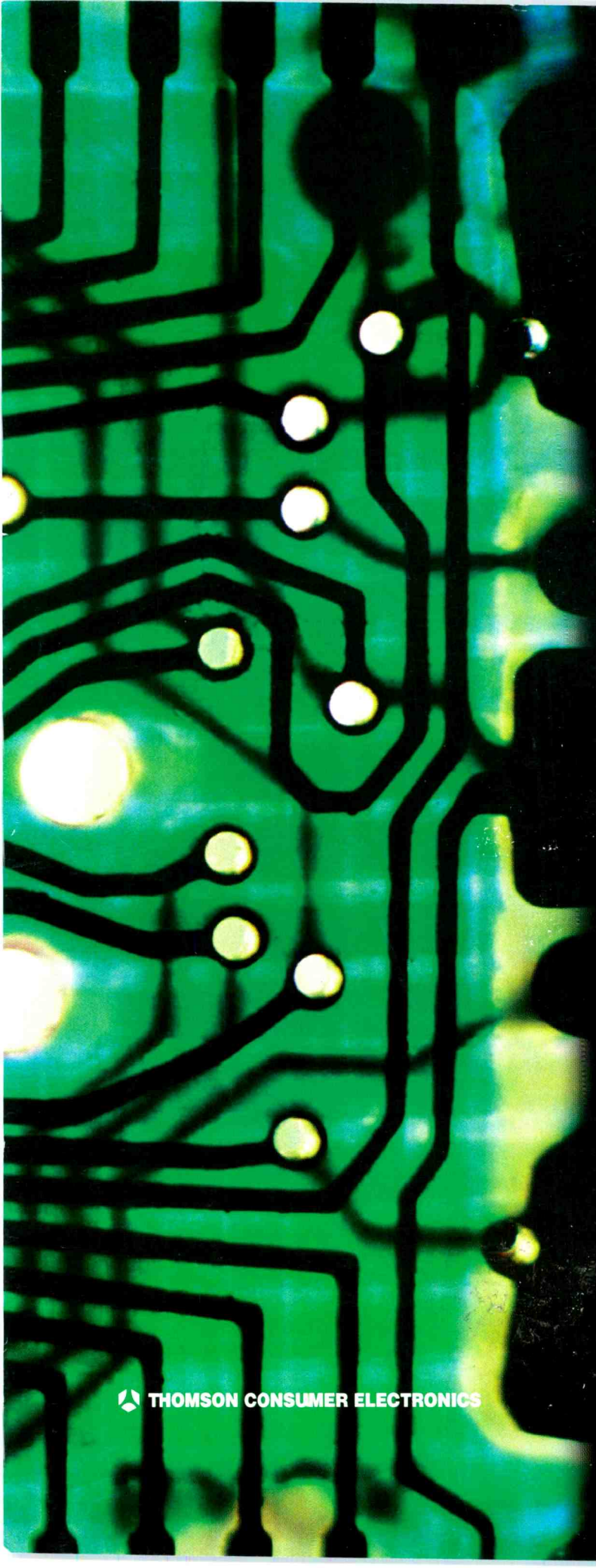

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