THE PROFESSIONAL MAGAZINE FOR ELECTRONICS AND COMPUTER SERVICING

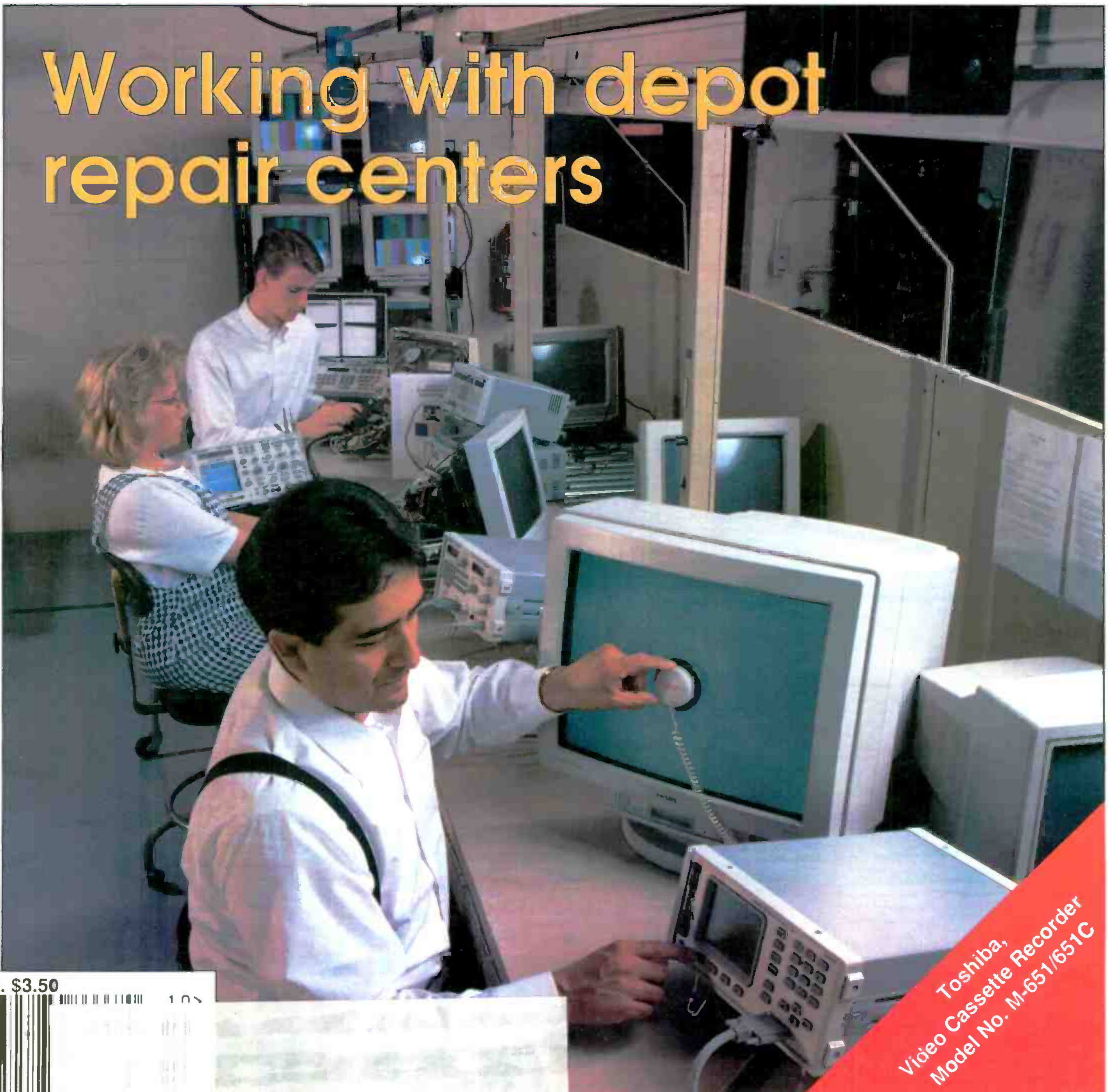
ELECTRONIC Servicing & Technology

T.M.

October 1997

Laser optical pickup devices

Servicing switching power supplies



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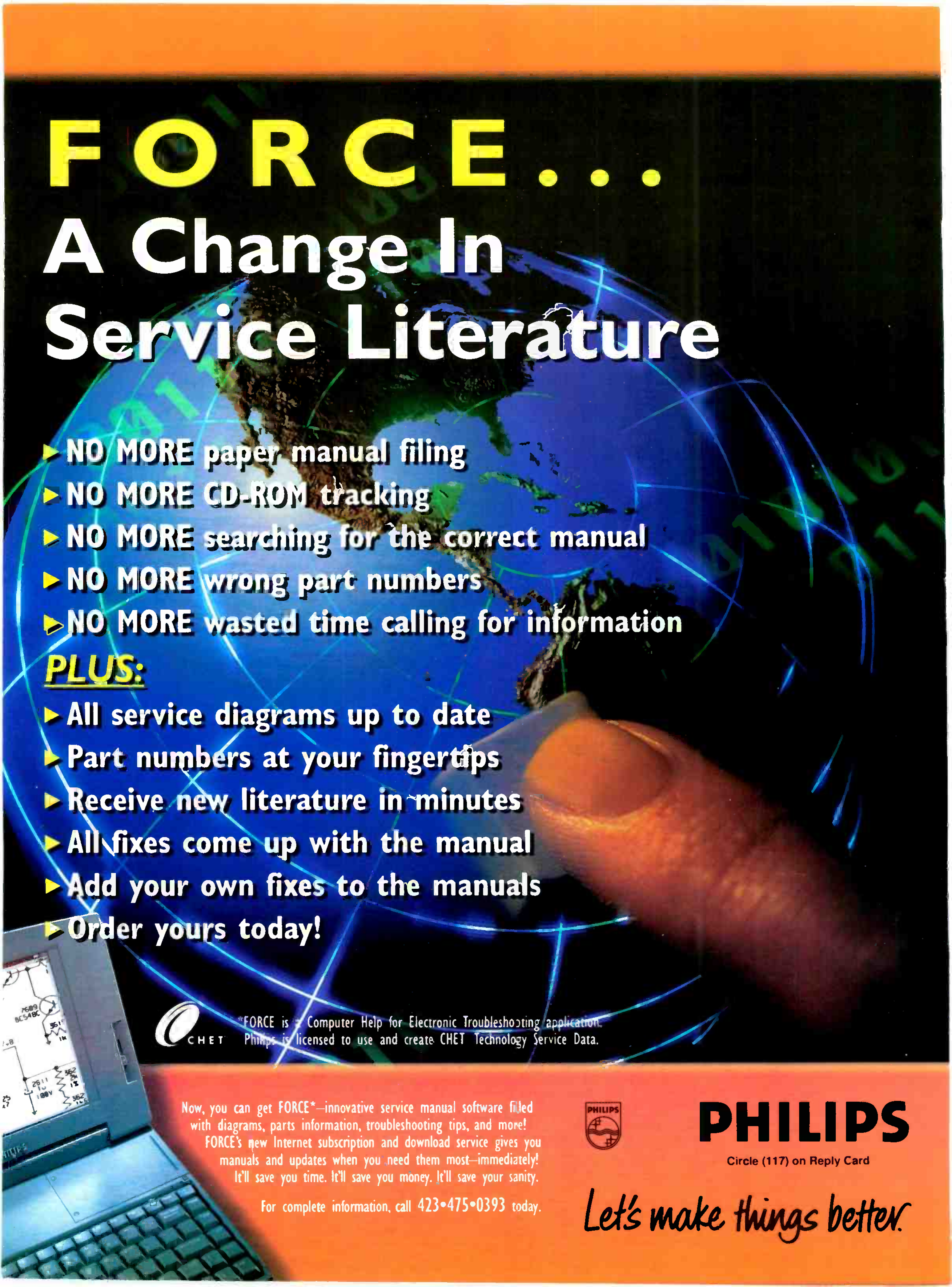
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THE PROFESSIONAL MAGAZINE FOR ELECTRONICS AND COMPUTER SERVICING

ELECTRONIC Servicing & Technology

Volume 17, No. 10 October, 1997

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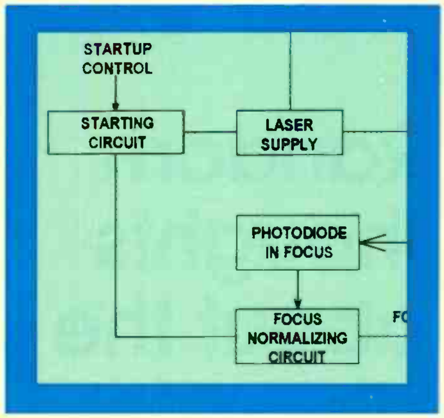
ON THE COVER

Repair depots provide service centers with a way to offer service to their customers on products that the service center is not yet equipped or otherwise prepared to handle. This allows the service center to keep business that they would otherwise lose, keep the customer satisfied, and maybe even make a profit on the transaction. (Photo courtesy Sencore.)



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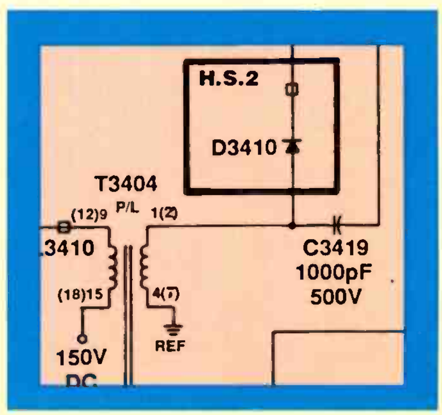

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EDITORIAL

Random thoughts about the digital revolution

The "digital revolution" has been wondrous indeed. How else can you characterize a technological advance that has resulted in such marvels as the personal computer, the compact disk, digital TV, the digital video (versatile?) disk, CD-ROM and more. But then, that's just the consumer electronics side of the digital revolution.

Just think about all of the other applications of digital electronics that we rarely think about. For example, many automotive engines are now controlled by computers. Sensors sense engine speed and temperature, the composition of the exhaust gas, and adjust the fuel-air mixture for the most efficient combustion.

Another example of the effects of the digital revolution is the application of the computer to personal banking. There was a time not so long ago when in order for me to check my bank balance to make sure that I've been keeping accurate records, I had to either wait until the end of the month for my statement, or go to the bank and request a current printout of my checking account (at the cost of a few bucks, of course).

These days I can access my account information via computer at any hour of the day or night from anywhere in the world, there's a computer on which I can load my access software, and a telephone line, and know exactly, up to the minute, which checks have cleared and which have not, and exactly what the balances are in my checking and savings accounts. As if that weren't enough, I can now pay many of my bills electronically.

The article "CD Servicing: Understanding and troubleshooting the optical pickup," in this issue, describes one of the ingenious applications of digital technology: the optical disk. Some ingenious individual, or group of individuals, came up with the idea of encoding music as digital data in the form of pits on the surface of a plastic disk, coating the surface with a reflective material such that when a laser is used to read the data, the music is detected and then decoded by a "computer" of sorts, and converted back into the music that was originally used to create the music data.

There are a couple of interesting sidelights to the story of the compact disk. For one, because of the way technology is developed these days, the individual or individuals who created this technology are quite anonymous. If we look at past technological developments, the names of the inventors are well known: the phonograph, the light bulb - Edison; the air brake - Westinghouse; the automobile assembly line - Henry Ford. But who "invented" the compact disk. We know that it was a joint venture between Philips and Sony, but who knows the names of the individuals whose minds developed this technology.

Another interesting facet of this technology is that it seems that, in this case, an application of digital technology was first conceived as a venture completely outside the realm of computers and technology: it was used to record and play back music. Then someone looked at compact disk technology and came up with the bright idea that if data that constituted music could be stored in optical form on a compact disk, why not computer data. And thus was born the concept of the CD-ROM.

Digital electronics has now been incorporated into virtually every aspect of electronics, including consumer electronics. Now with DBS satellite TV, even the TV signal is digital. The trend will continue when we see the introduction of terrestrial broadcast digital TV. It will represent a whole new world of consumer electronics. And a whole new set of challenges for service technicians.

Nils Conrad Persson

National VICA announces medalists in Skills USA Competitions

The Vocational Industrial Clubs of America (VICA) has announced the winners of the 1997 Skills USA Competitions at the 33rd annual Leadership and Skills USA Championships. The competition was held in H. Roe Bartle Hall in Kansas City, MO on June 26, 1977.

Entrants in the Electronic Products Servicing competition took a demanding written test, and were required to demonstrate manual servicing skills by building a circuit project and troubleshooting and repairing several products that had been rigged with a known fault.

The medal winners in the Electronic Products Servicing competition were:

Post Secondary: Gold Medal: Walt Kersiek, Cedar City, UT; Silver Medal: Thomas Ham, Albany, GA; Bronze Medal: Andrew Huey, Covina, CA

Secondary: Gold Medal: Dale Swartz, Richboro, PA; Silver Medal: Steven Disario, Washington C.H., OH; Bronze Medal: Chad Lloyd, Old Hickory, TN

These medalists were presented with a certificate from *Electronic Servicing & Technology* magazine for a complimentary one year subscription in recognition of their achievement.

CEMA applauds FCC DBS antenna ruling precedent setting ruling allows consumers to get DBS without local zoning approval

The Consumer Electronics Manufacturers Association (CEMA) applauded the Federal Communications Commission's decision today to strike down a local ordinance that would have the effect of limiting the placement of Direct Broadcast System (DBS) antennas.

CEMA's president Gary Shapiro hailed the decision as a precedent setting victory for the consumer. "This ruling is a clear indication that consumer interests can supersede local bureaucratic interests. This is a victory for DBS companies, but more significantly it is a victory for consumers who want alternatives to cable. The FCC has sided with consumers and we applaud their decision."

In February of this year CEMA, and others, filed comments urging the Commission to strike down local ordinances limiting the placement of DBS antennas. This announcement is the first time the FCC has issued an order striking down local restrictions and represents a major setback for localities seeking to generate revenues by limiting the use of DBS antennas.

The Federal Communications Commission's decision will prohibit local governments and homeowner associations from establishing rules and regulations limiting installment, maintenance or use of satellite dishes and wireless cable antennas that are one meter or smaller in diameter unless justified by safety or historic preservation considerations.

Skills USA Championships. Front row from L to R: Dave Ebberts; high school medalists: Silver-Steven Disario, Ohio; Gold-Dale Swartz, Pennsylvania; Bronze-Chad Lloyd, Tennessee; Deborah Gelvo, EIA/CEMA; Kendra Stanley, CEMA. Back row L to R: Jerry Ganguzza, Sharp Electronics Corporation; post secondary medalists: Silver-Thomas Ham, Georgia; Gold-Walt Kerksiek, Utah; Bronze-Andrew Huey, California; Brian Ott, EIA/CEMA; and Frank Steckel, EIA, CEMA.

Audio system sales skyrocket; portable sales rebound

With sales to U.S. dealers expanding two percent to $586 million, the audio equipment sector showed renewed strength in May, according to data released by the Consumer Electronics Manufacturers Association (CEMA). System sales are skyrocketing this year, and portable sales rebounded in May.

Among the categories driving May audio growth were compact disc (CD) headsets, home radios, CD boomboxes, and both compact and home theater systems. The rebound in monthly sales also helped to energize the audio industry's year-to-date performance. For the first five months of 1997, factory sales of consumer audio hardware totaled $2.67 billion, only fractionally below the $2.73 billion registered at this point last year.

In percentage terms, systems continued to outperform the other audio groups, soaring 30 percent in May to $141 million. Compact systems, which grew 57 percent, accounted for more than two-thirds of that dollar volume.

Barely a statistical footnote last year at this time, home-theater-in-a-box systems posted more than $100 million factory sales through May, helping to lift the overall systems category to $614 million year to date, up 17 percent over last year's first five months.

Leading the major categories in dollar volume were portable products, which topped $164 million, up seven percent over the $153 million recorded in May 1996. Home radios and compact disk headset units each reported 11 percent growth, while CD boomboxes surged 35 percent to $54 million.

(Continued on page 52)

THE PROFESSIONAL MAGAZINE FOR ELECTRONICS AND COMPUTER SERVICING

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

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Understanding and troubleshooting laser optical pickup devices

By The ES&T Staff

Based on information provided by the Consumer Electronics Manufacturers' Association

New technology such as the video laser disk and the compact disk have brought many improvements into the lives of audiophiles and videophiles. Both have resulted in better reproduction of recorded material. Both are far more convenient than previous systems. For example, in the case of a CD you simply place a CD in the player, close the drawer, and press play. And the CD plays. If you want to change the order in which the unit plays the tracks, just program that in. If you want it to skip tracks, program that in too. Or if you just want the player to play the tracks in random order, you can select that option as well.

Unfortunately, as with so many new products, the convenience for the user translates into more challenges for the servicing technician. The old turntable or record changer was little more than a turntable driven by a motor. The user would place the stylus in the groove and the groove just pulled the stylus around while the record turned.

The changer mechanism might present some challenges, and the stylus might wear out, and it was necessary to adjust the amount of force on the stylus for best music reproduction, but compared to a compact disk player, the old phonographic turntable was simplicity itself.

With a CD player, or a video laserdisk player, the music information on the disk is read by a laser beam. There is a servo system to focus the laser. The motion of the optical pickup to track the row of pits on the disk that represents music, requires not one but two servos. And conversion of the disk data to the original audio it represents requires a complex digital system. No wonder technicians need constant education.

This article is intended to provide some

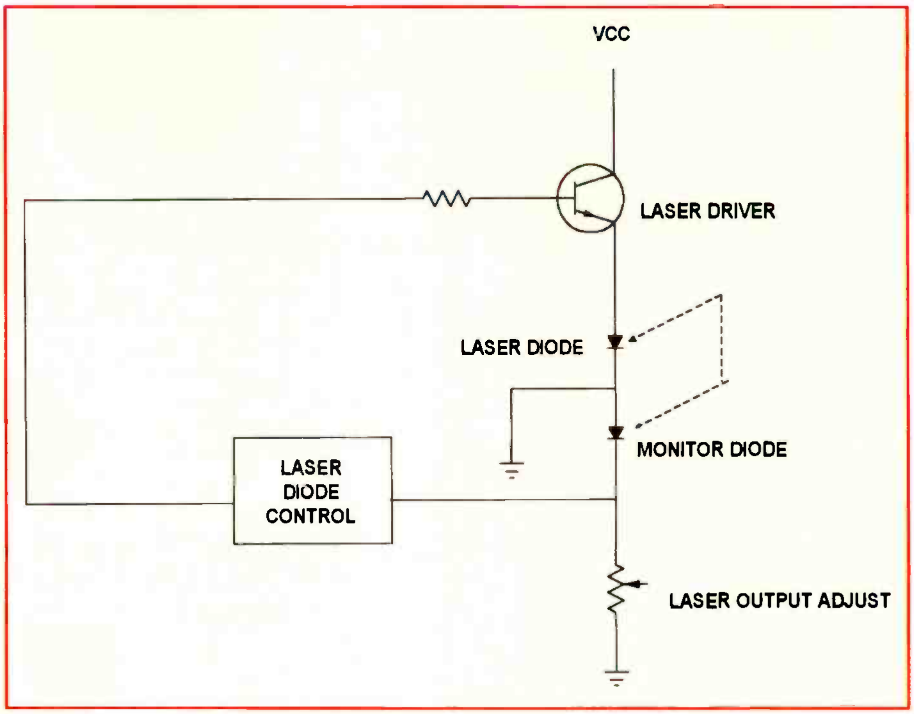


Figure 1. This simplified diagram gives an idea of the operation of an optical pickup system used in a CD player or a laser disk player.

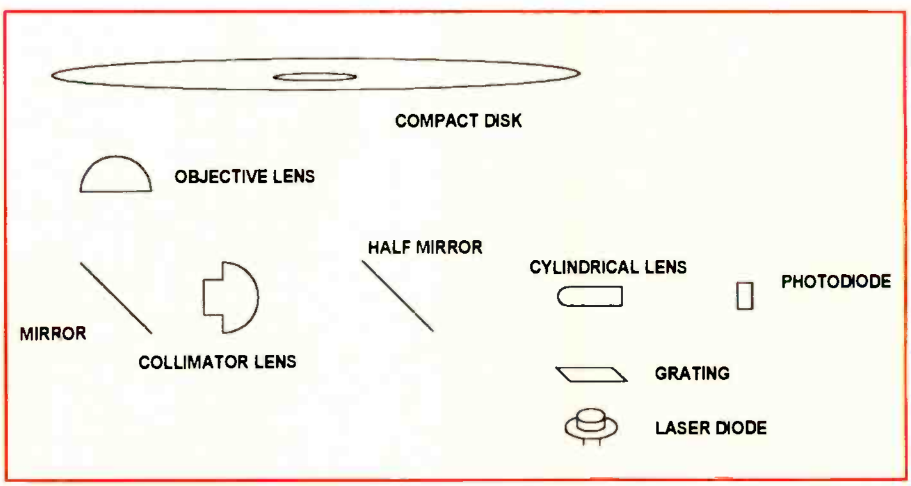


Figure 2. The elements of a three-beam optical pickup system used in a video laser disk or CD player are arranged generally as shown here in this illustration.

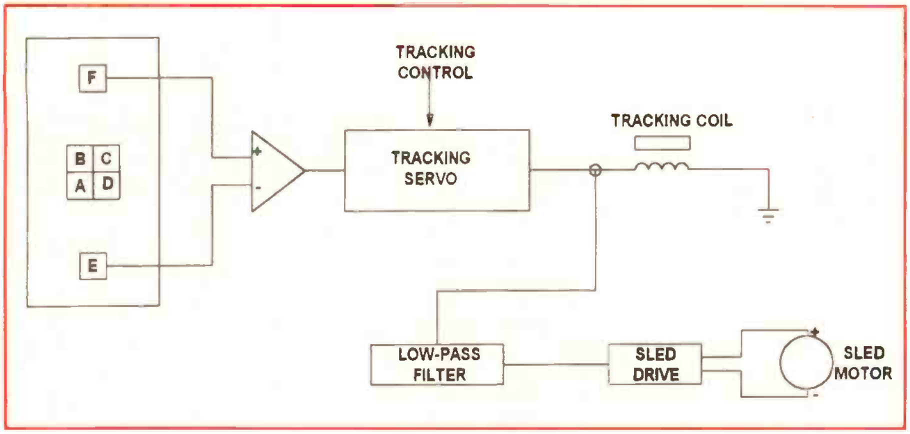


Figure 3. The photodiode array in a three-beam optical pickup system consists of an arrangement of four photodiodes and an arrangement of two photodiodes. The outer two photodiodes in the three beam system provide tracking information, and the inner four photodiodes detect focus errors at the same time as they convert the optical data from the main beam into an electrical signal for use in the player's amplification and decoding circuits.

details about the operation of the optical pickup in CD and laserdisk players, to aid readers in troubleshooting these devices.

Safety information

It is imperative that anyone working on the laser optical pickup of a compact disk or video laserdisk player observe certain safety precautions.

First, the laser beam emitted by the laser diode can cause serious damage to the eyes. Never look directly into the objective lens or directly at the laser diode while the player is turned on.

Second, the laser optical pickup is sensitive to electrostatic discharge (ESD). Always use ESD precautions, such as a grounded work mat, a grounding wrist strap and grounded equipment.

The laser optical pickup

The laser optical pickup unit in a CD player focuses on the side of the CD opposite the label. It tracks the data at the same time as it reads the data and sends it to the circuitry that decodes it and outputs it to the audio amplifier. The data encoded on the disk is recorded on the disk starting at

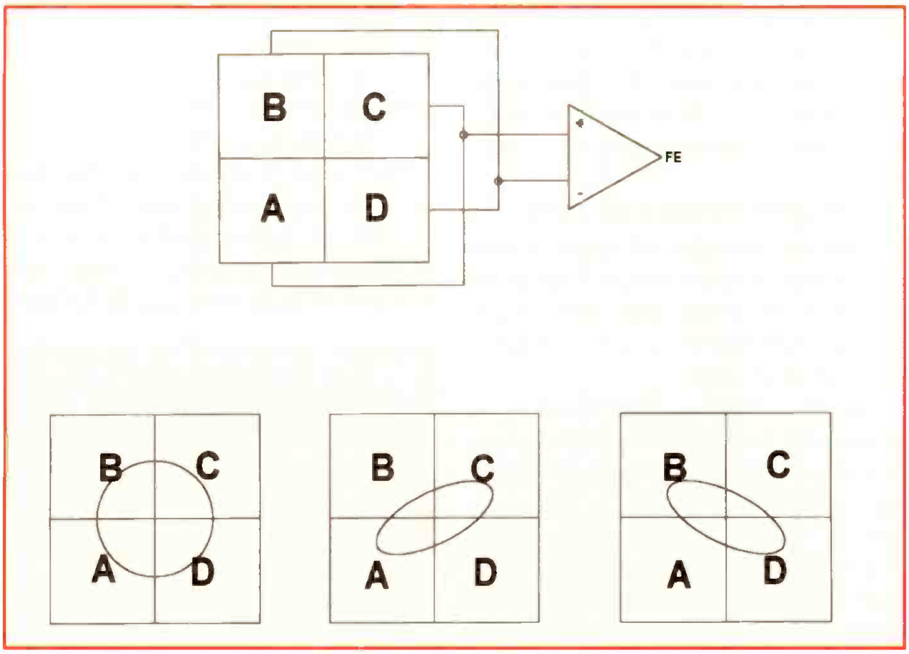


Figure 4. If the main beam falls equally on all four diodes in the focus/pickup photodiode array, as shown at the lower left, the laser optical system is in focus, and there will be no focus error signal. If the intensity of the beam is greater on one of the pairs of diodes in the four-diode array, as shown in the two lower right drawings, a focus error signal will be generated and the objective lens will be moved until focus has again been achieved.

COMING NEXT MONTH

Among the useful information in the November issue, *ES&T* will present two articles that will be of interest to anyone who could use some pointers on soldering and desoldering parts found in today's consumer electronics equipment, or handling of printed circuit boards and parts.

The soldering and desoldering update will provide details on getting enough heat to solder joints to ensure a reliable solder joint without providing too much heat, which could cause damage to the component or cause the circuit traces to lift.

An article on circuit board and parts handling will suggest products and techniques that make it easier for a technician to keep the circuit board being worked on steady, while placing and soldering those tiny, hard-to-handle parts.

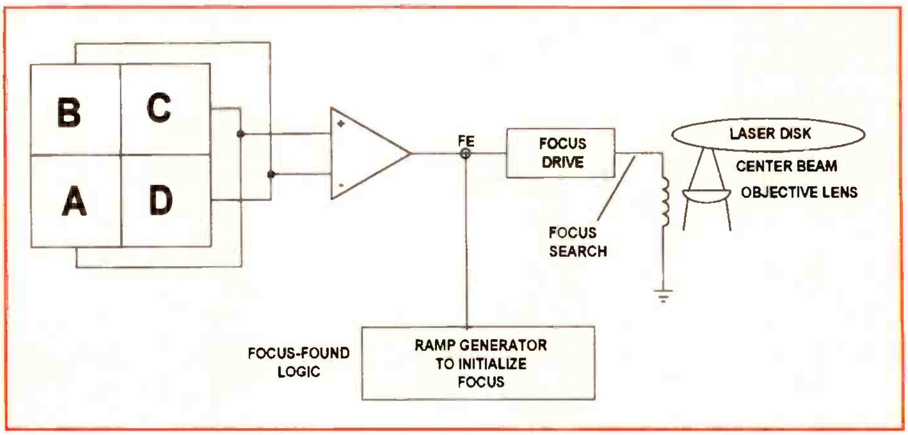


Figure 5. When the player is first turned on, the objective lens moves until the electrical signal created by the main beam on the photodiode array is falling with equal intensity on all four photodiodes, indicating to the focus servo system that the beam is in focus.

the inside edge of the disk and spiraling to the outside of the disk. As the disk turns, the data travels past the optical pickup at a constant linear velocity. Because the diameter of the disk is greater at the outer edge than at the inner edge, this means that as the disk plays, the angular velocity of the disk varies from about 500rpm at the inside, to about 200rpm at the outside, of the disk.

The optical pickup system

Figure 1 is a simplified schematic diagram of the optical pickup system. The driver transistor regulates the current to the laser diode. The current through the monitor diode is fed to the laser diode control circuit to control the amount of current through the diode. The laser output adjustment allows the technician to adjust the diode current to the specified value.

Single-beam and three-beam

There are two types of optical pickup used in laserdisk and compact disk players: single beam and three beam. These systems are highly complex electromechanical devices.

The three-beam system consists of photo sensors, a laser diode assembly and lenses and mirrors for shaping and directing the laser beam (Figure 2). In this system, the focus servo controls the up and down movement of the objective lens to focus the infrared light from the laser diode onto the surface of the disk.

The three beam optical pickup system is mounted on a "sled," which slides along a track beneath the radius of the spinning disk. As the data on the disk spirals outward, a tracking drive coil makes fine adjustments in the position of the sled to follow the data track. When the drive coil has moved as far as it can, a sled, or feed motor, makes the coarse adjustment to move the pickup to the next track.

The 3-beam optical pickup unit uses a single laser diode to emit a laser beam. A number of different optical pickup designs are used in 3-beam systems. This basic illustration serves to give a general idea of how the 3-beam system works.

The laser beam is divided into several beams by the grating unit. Only the three center beams are used in the operation of the unit. The center, strongest, beam is focused on the reflective surface of the disk by the objective lens.

As the disk spins, the laser beam is reflected from the surface and onto a sensor. One set of diodes in the sensor, a photodiode array (which will be described later), senses tracking information, and the other set senses whether the beam is in focus, and converts the laser light reflected from the disk into an electrical

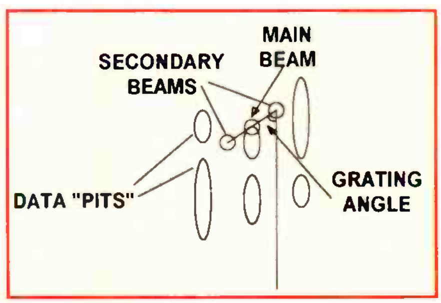


Figure 6. The relative intensities of the two reflected beams from the secondary beams tells the player if the main beam is tracking right down the middle of the data stream on the disk, or if it is straying.

signal. The less intense, second-order, sub beams, are used for tracking.

The semi-reflective half mirror reflects the three beams of light from the laser diode into the objective lens, which focuses them on the surface of the disk. The reflected beams pass directly through the semi-reflective mirror and impinge on the sensor, the photodiode array.

The photodiode array consists of an arrangement of two photodiodes and an arrangement of four photodiodes (Figure 3). The two outer photodiodes, E and F, detect tracking errors. Photodiodes A through D perform a dual function: they detect focus errors, and they serve to "pick up" the reflected main beam. That is, they convert the laser light into an electrical signal. This main beam now consists of a beam of laser light interrupted wherever a pit appeared on the disk. That is, it is a modulated data signal that contains a representation, in time, of the data that was encoded on the disk.

The reflected secondary, or radial beams used for tracking, strike the two photodiodes, E and F. The difference in intensity between the reflected beams is detected as the tracking error signal. The tracking error signal is used by the track and sled servo circuits to keep the main beam centered on the digitally-encoded track of the disk. The three beam optical pickup system is used in both laser disk and compact disk players.

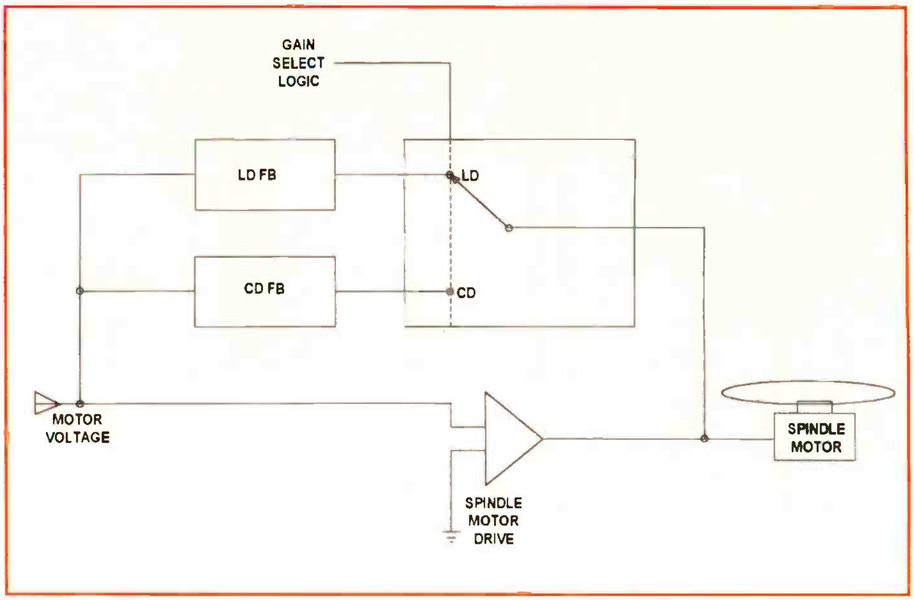


Figure 7. A video laser disk is larger in diameter and heavier than a compact disk. In a combination video laser disk/CD player, the player must determine which type of disk has been loaded in the player, and set the torque of the spindle motor accordingly.

The simplified three-beam servo block diagram for a typical video laser disk player includes the focus servo, sled or feed servo, tracking servo, spindle servo and tilt servo. The tilt and time base corrector are not required in a three-beam compact disk player.

Focus

The focus servo system for the three-beam optical pickup system (Figure 4) uses four photodiodes to develop the focus error signal. The optics in three beam systems is a focus error detection method known as astimagtic focus detection.

The focus error signal is derived by comparing the signal from two pairs of photodiodes. The shape of the reflected center beam striking the photodiode array determines the amount and polarity of the focus error. If the beam is perfectly centered among all four photodiodes, the error signal will be essentially zero. If the beam strikes any pair of the diodes with less intensity than it strikes the other pair, the difference in intensity is converted into an error signal detected in the focus servo circuit, which, in turn, outputs the focus drive signal to keep the laser beam focused on the surface of the disk.

When the CD player is first turned on, the objective lens moves until the electrical signal created by the reflected main beam on the photodiode array indicates to the focus servo system that the beam is

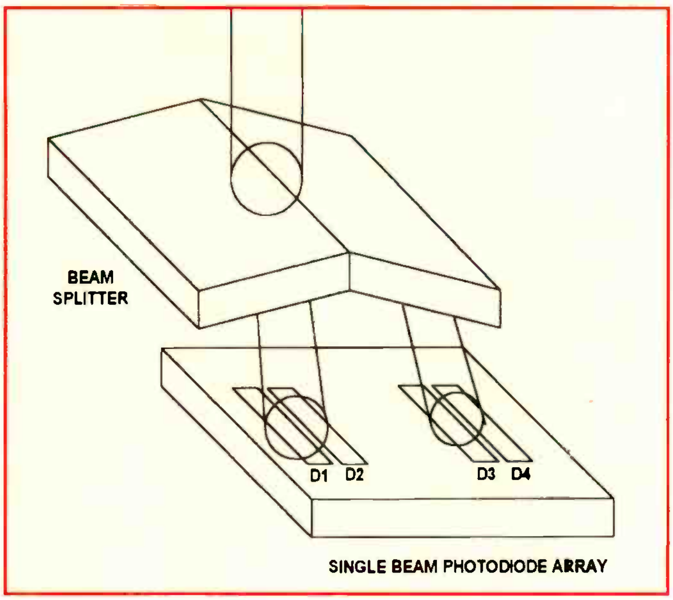
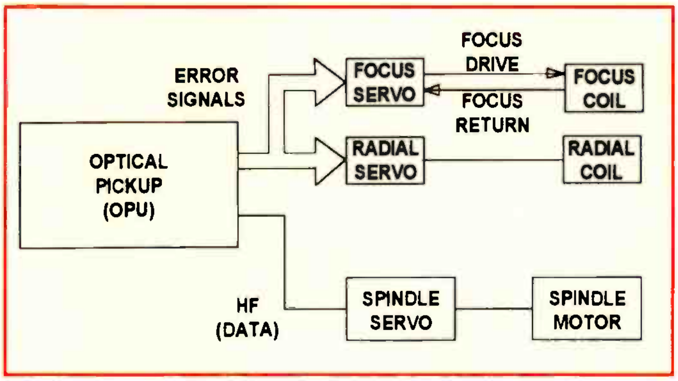


Figure 8. A single-beam laser optical pickup system employs a beam splitter to split the reflected modulated beam. These two beams are used to detect tracking and focus errors.

Figure 9. The single-beam servo system, used only in CD players, includes focus, radial, and spindle servos.



in focus (Figure 5). Thus, servo lock is achieved during the focus initialization.

Tracking

Tracking is accomplished by the tracking and sled servos. The tracking error is proportional to the difference in the strength of the signals generated by photodiodes E and F in the optical pickup, which is in turn proportional to the intensity of the reflected beam from the radial or secondary beams.

Ideally, the radial beams strike the reflective surface of the disk adjacent to the row of pits being read by the main beam, while the main beam strikes the center of the row of pits (Figure 6). If the main beam of light from the laser diode strays very far from the center of the row of pits, one of the secondary beams will begin striking the row of pits. If that happens, the intensity of that beam will be reduced, resulting in a difference in the strength of the output of one of the tracking diodes. This difference in signal strength from the two diodes is the error signal sent to the tracking servo, which is used to move the pickup back to its correct position with respect to the disk. The tracking servo thus attempts to minimize the tracking error current, which is determined by the difference in current between photodiodes E and F.

The angle of the secondary beams to the track, known as the grating angle, is very critical. If the grating angle is not properly adjusted, tracking becomes erratic, or in extreme cases, tracking is not possible at all. In the latest CD players, the grating angle is set at the factory and is not field adjustable.

Laserdisk, compact disk combos

In a product that combines a video laserdisk player with a compact disk player, the type of disk being played must be detected before any other actions are taken by the player. During startup in one of these units, the optical pickup is positioned via the sled so that it can detect which type disk has been loaded. The system first checks for the presence of a laserdisk by attempting to focus outside of the diameter of a typical compact disk. If the disk in the player is a laser disk, the laser beam will be reflected onto the photodiode array (focus is found), and the system sets up to play a laserdisk.

If the laser beam is not reflected onto the photodiode array, there will be no electrical output from it (focus is not found), and the optical pickup will then

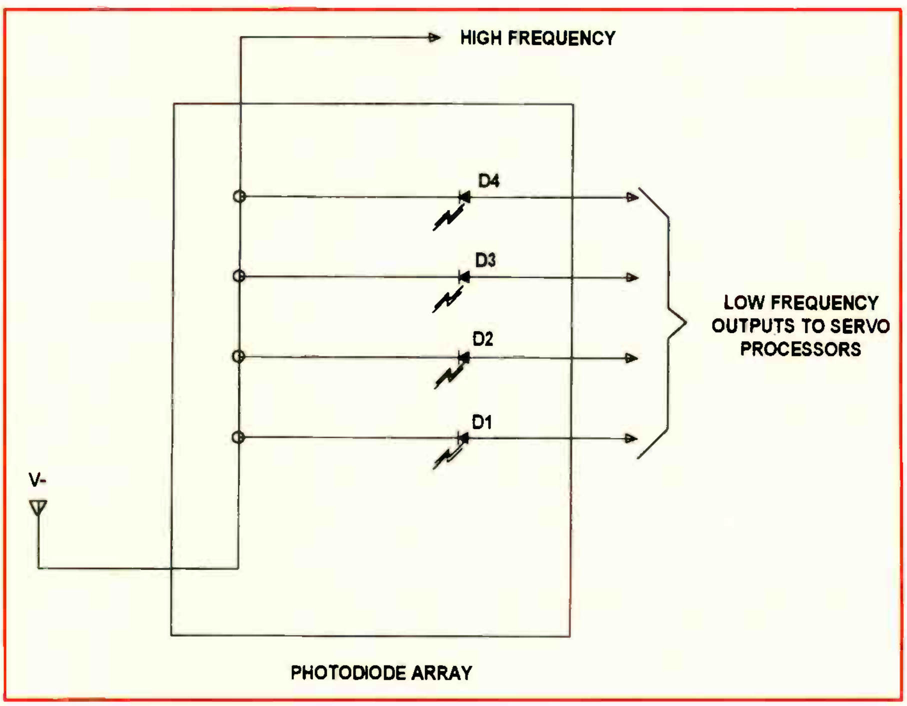


Figure 10. In a single-beam optical pickup system, the pickup outputs several signals as a result of reading and tracking a spinning disk, including the HF data signal and the LF radial error and focus error signals. These signals are used to recreate the music from the CD and for tracking.

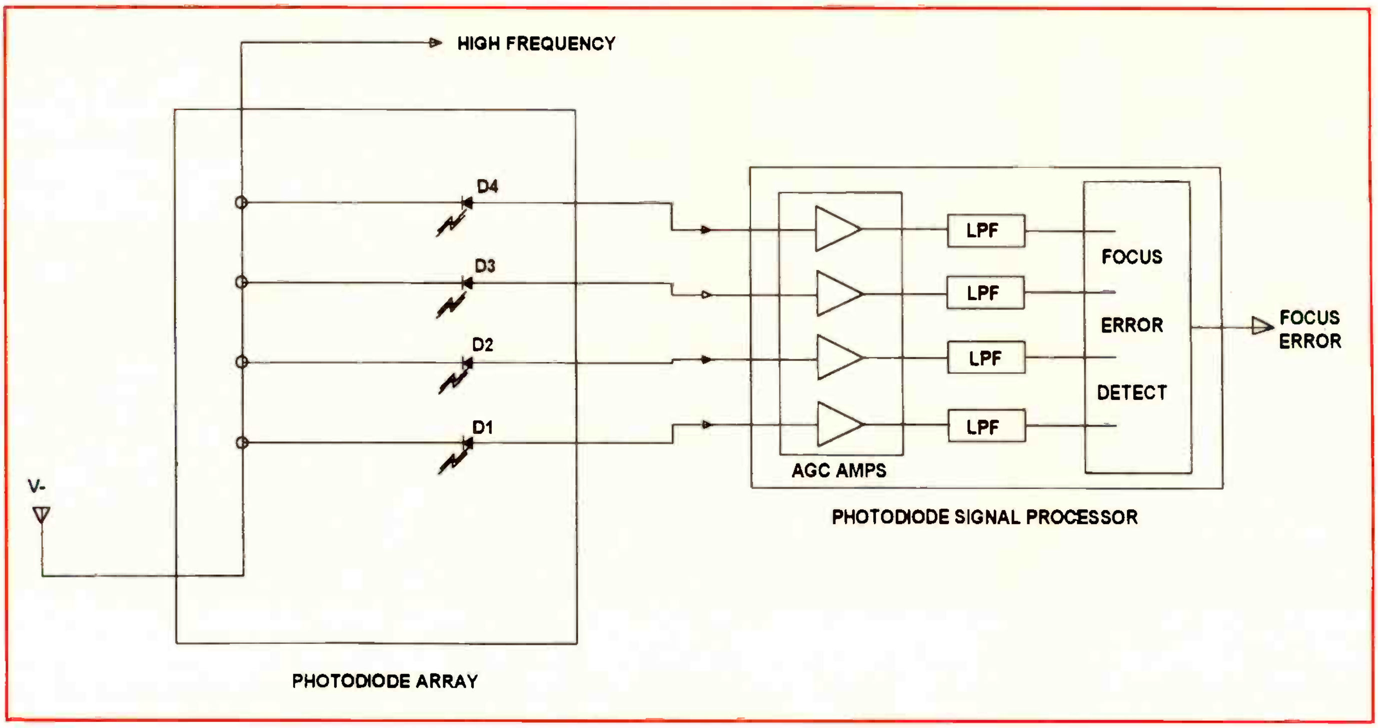


Figure 11. In the single-beam optical pickup system, the photodiode signals are applied to AGC amplifiers followed by low-pass filters.

be positioned to detect a compact disk.

The microcomputer sets the gain of the spindle servo and the torque of the spindle drive motor according to which type of disk has been loaded (Figure 7). The greater mass and size of the 12-inch video laser disk requires greater torque than does a 3-1/2-inch compact disk.

The spindle motor starts to rotate according to the type of disk detected, and the sled drive positions the optical pickup to the lead-in tracks. The table of contents (TOC), located in this area of the disk, is read from the disk. At this point, tracking servo lock is achieved.

The fine tracking is accomplished via the tracking coil. The LF sled drive signal is used to control the forward or reverse drive to the sled motor.

In normal play, when the tracking coil current reaches a certain designated level, the sled motor drive momentarily kicks on to step the sled forward to the next track.

Logic from the microcomputer provides direct control of the tracking servo to advance or reverse the sled mechanism for track jumping when required, for example during search forward or reverse.

Tilt servo

The larger-diameter video laser disk tends to sag toward its outside edges. If some means were not provided to compensate for this, the laser beam reflected from the disk would not strike the photodiode array properly, resulting in failure of the player to operate properly, or at all. Thus, in video laser disk players, a tilt servo is used to adjust the angle of the laser beam from the pickup so that it is always perpendicular to the surface of the disk.

In combination video laserdisk/CD units, normally, the tilt servo is only active when playing the larger video disks.

The tilt servo consists of two photodiodes and an LED to correct tilt as the disk plays. A tilt-neutral circuit is used to place the tilt servo in its neutral position for smaller diameter disks.

The single-beam system

The single beam optical pickup unit uses only one laser beam to read data and to achieve focus and to perform tracking. In this system there is no grating element. The single beam is reflected by the half mirror into the objective lens.

The single-beam system tracking and focus are accomplished by splitting the reflected modulated beam in half using a "beam splitter" (Figure 8). These two beams are used to detect tracking and focus errors. While the single-beam system uses a photodiode array as a sensor to perform focus and tracking and data pickup, it is a different type of array. In the single-beam system, four photodiodes pick up modulated data and detect both tracking and focus errors. Single-beam systems are used in compact disk players only.

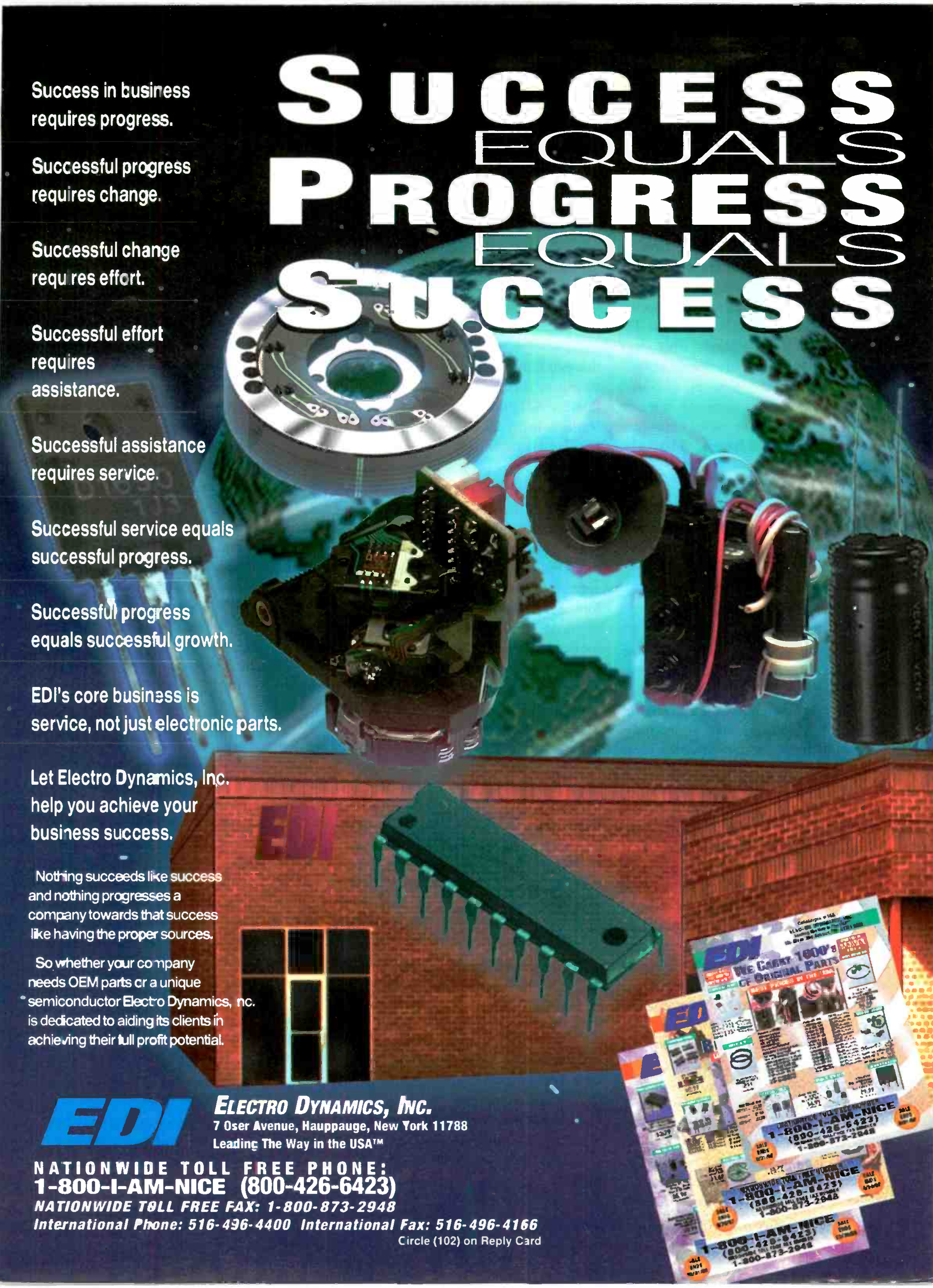
The single beam servo block diagram for a single-beam CD player (Figure 9) includes the focus servo, radial servo and spindle servo. The optical pickup outputs several signals as a result of reading and tracking a spinning disk, including the HF data signal and the LF radial error and focus error signals (Figure 10). The photodiode signals are applied to automatic gain control (AGC) amplifiers followed by low-pass filters (LPFs) (Figure 11).

The focus error is generated by detecting the difference in signals between two photodiode pairs. The focus error is derived from the four low-frequency photodiode signals.

In this system a focus initializing circuit controls the focus startup to initiate focus servo lock. Focus initialization is controlled by the servo microprocessor. The focus drive signal reveals the condition of the focus initializing and the focus error servo signals.

The focus drive signal controls the focus movement of the objective lens via the focus coil. In the single-beam system, the optical pickup is mounted on a radial swing arm, rather than on a sled. The

(Continued on page 54)


SUCCESS
EQUALS
PROGRESS
EQUALS
SUCCESS
Success in business requires progress.
Successful progress requires change.
Successful change requ res effort.
Successful effort requires assistance.
Successful assistance requires service.
Successful service equals successful progress.
Successful progress equals successful growth.
EDI's core business is service, not just electronic parts.
Let Electro Dynamics, Inc. help you achieve your business success.
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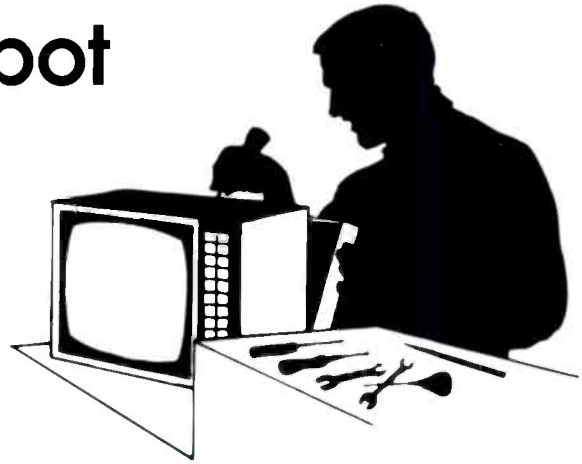
Working with depot repair centers



By The ES&T Staff

The definition of consumer electronics, and therefore of consumer electronics service, continues to broaden. Remember the good old days when a sign up over the storefront that said "Al's Radio and TV Service" accurately reflected what went on inside? Those days are gone forever.

Just imagine the size of the sign required for a service center to describe everything that is now called consumer electronics. It would have to read "Al's Radio and TV and VCR and compact disk, and video laser disk, and satellite receiver, and personal computer and monitor and ...." OK, it's getting a little ridiculous, so we'll stop here. But think about it; the list could have actually continued for a while. Whew!

Diversification for success

Because of the vast broadening of the definition of consumer electronics over the past couple of decades, service centers that service consumer electronics products have felt pressure to diversify. For one thing, with television sets increasingly reliable and less expensive, the percentage of sets that will ever be candidates for service has shrunk dramatically. And those sets that are candidates for service barely make it economical for either the owner or service center to fix. So the service center has to look elsewhere for other products to service.

Moreover, a more and more common occurrence is that one of Al's stead customers brings in a camcorder or monitor and says "Al, you've been fixing my TVs for years. Do you know anything about these things." Al has a couple of choices: he can turn this steady customer away and hope that although he's gone elsewhere for the service of his monitor or camcorder, he'll come back to old faithful Al the next time his TV set needs to be serviced. He might come back. Or if he finds that the place he brings his monitor for service is in a more convenient location, or has a very personable, friendly staff that puts him at ease about his product servicing, or perhaps looks more competent than his old faithful service center, he may begin to bring all of his service work to Modern Electronics Servicing.

Using depot service

Let's say that Al has only two other technicians working for him. One of them is young and has taken some courses in digital electronics, but he's not competent enough to service computers and monitors. Still, without special training, the required service literature, and special tools and test equipment, Al's is not going to be servicing any computer-related products for a while. What does Al do to keep from letting that precious, steady, long-time customer walk out the door.

One answer is that he might be able to avail himself of the services of a depot service center. If he could find the right depot that services the type of product that the customer has brought in, he could use an express package service to ship it to the depot, have it serviced by experts who possess the correct tools, test equipment and service literature, have it back within a few days, mark up the depot's cost of service and return it to the customer.

Using one or more service depots in this way, Al could gauge how much of this business he's likely to do, and, on that basis, make decisions as to which of the many types of products he may have the opportunity to service that he should gear up to service himself.

Depot service is nothing new

Service centers have historically used some type of "depot" service center to help them service certain portions of some products. For example, service on mechanical TV tuners requires equipment and skills that the average service center does not wish to acquire. Therefore, when a TV being serviced needed a new tuner, the service center sent the tuner to a tuner service specialist and received a refurbished tuner in return to install in the set.

From the point of view of the service center, this was merely exchanging a faulty but repairable subassembly for a refurbished one. But it was in fact a form of depot repair. The same thing was true of replacing a TV picture tube with a rebuilt one. While the faulty tube was replaced with another, refurbished, one, in effect, the service center had dealt with a service "depot."

It's a common way of doing business

Some service centers seem reluctant to contract out work, but it does make sense in many cases, and it is standard practice in other businesses.

For example, if you bring your car in to the auto service shop for some work, and the work includes damage to the body that will require some straightening, filling, sanding and painting, the chances are very great that the service center will perform the mechanical work, but will send the car out to a body shop with whom they have an arrangement and get the body work done there. It just doesn't make sense for them to maintain the skills, specialized equipment and supplies for body work when they don't do much of it.

A list of depots

For the convenience of readers, following is a partial list of depots that provide service for consumer electronics products and for personal computers and peripherals.

List of Depots

3E Corp.
Monitor Repair
165 Front Street
Chicopee MA 01013
413-594-2772
Fax: 413-594-7283

Air 1 USA Inc.
Micro Services Division
PO Box 3035
Pueblo CO 81005
719-566-0018
Fax: 719-566-0024

AMCOR
373 Route 46 West
Fairfield NJ 07004
201-575-5900
800-542-6267
Fax: 201-575-8469

Analog Technology Center Inc
62 Route 101A
Amherst NH 03031
603-673-0404
Fax: 603-673-4526

Cerplex Group, Inc
1382 Bell Avenue
Tustin CA 92780
714-258-5600
Fax: 714-259-1944

Datatech Depot, Inc.
1371 North Miller St.
Anaheim CA 92806
714-996-7500
Fax: 714-970-1670

Depot America
1345 Campus Parkway
Neptune NJ 07753
800-648-6833
Fax: 908-919-1929

Dot Shop, The
12025 NE Summer St.
Portland OR 97220
503-256-7585
800-487-6025
Fax: 503-256-7588

Electrohome
181 Cooper Ave, Suite 100
Tonawanda NY 14150
716-874-3630
Fax: 716-874-4309

Electroservice Laboratories
6085 Sikorsky St.
Ventura CA 93003
805-644-2944
Fax: 805-644-5006

Fessenden Technologies
116 3rd Street
Ozark MO 65721
417-485-2501
Fax: 417-485-3133

General Disk Svcs, Inc.
1530 Montague Expwy
San Jose CA 95131
408-432-0537
Fax: 408-434-1015

Genicom Corporation
1 Genicom Drive
Waynesboro VA 22980-1999
800-535-4364
Fax: 703-949-1500

Guardian Computer Support, Inc
1177 Quarry Lane, Suite F
Pleasanton CA 94566
510-846-3649
800-752-8733 X102
Fax: 510-846-4596

HI-TEK Services, Inc.
1595 Crocker
Hayward CA 94544
510-489-8909
800-285-3508
Fax: 510-489-5908

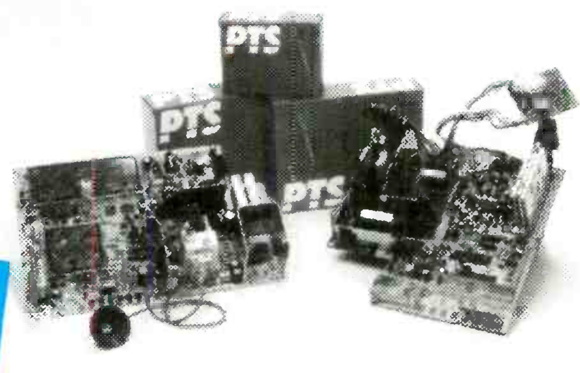
C. Hoelzle Associates, Inc.
17321 Eastman Street
Irvine CA 92714-5523
714-251-9000
Fax: 714-251-9291

Hy Tec Dealer Service
4548 Parkbreeze Ct
Orlando FL 32801-1045
407-297-1001
Fax: 407-297-4310

LaserImpact
10435 Burnet Rd Suite 114
Austin TX 78758
512-832-9151
800-777-4323
Fax: 512-832-9321

Laser Wizard
705 General Washington Ave.
Valley Forge Business Ctr.
Norristown PA 19403
610-539-4708
Fax: 610-539-1096

Mac Shack
28 Willow Pond Way Suite LL3
Penfield NY 14526
716-377-9230
Fax: 716-377-9573



Magnetic Data Inc.
6754 Shady Oak Road
Eden Prairie MN 55344
800-328-3441

Main Source Electronics
9260 Owensmouth Ave
Chatsworth CA 91311
818-882-7500
800-882-1238
Fax: 818-882-7785

Man & Machine, Inc.
3706 West Street
Landover, MD 20785
301-341-4900
301-341-4078

Matrix Components
13581 Pond Springs Rd Ste 315
Austin TX 78729
512-258-7590
800-411-2967
Fax: 512-219-0021

Meltek, Inc.
227 Technology Circle
Scotts Valley CA 95066
408-438-4986
Fax: 408-438-3459

Mesa Systems, Inc.
420 Leisure St.
Livermore CA 94550
510-443-9491
Fax: 510-443-9499

Micro Medics
6625 Jarvis
Niles IL 60714
847-647-1010
800-678-5300

Module Exchange
706 Space Way Drive
Duncanville TX 75137
972-298-1212
800-632-6637
Fax: 972-283-1778

NorthStar MatrixServ
7101 31st Avenue N
Minneapolis MN 55424
612-593-4500
800-969-0009
Fax: 612-591-0029

The Peak Technologies Group
9200 Berger Rd
Columbia MD 21046-1602
410-312-7660
800-950-6372

Peripheral Computer Support
Division of Cerplex
2219 Oakland Road
San Jose CA 95131
408-428-6420

Pre-Owned Electronics
125 Middlesex Turnpike
Bedford, MA 01730
617-778-4600
Fax: 778-4848

Princeton Computer Support
5 Crescent Avenue
PO Box 787
Rocky Hill NJ 08553
609-921-8889
800-682-5168
Fax: 609-921-7691

PTS Corporation
5233 South Highway 37
PO Box 272
Bloomington IN 47402
812-824-9331
800-844-7871
Fax: 812-824-2848

Reset, Inc.
49 Strathearn Place
Simi Valley CA 93065
805-584-4900
Fax: 805-583-2900

Service Electronics Inc.
682 Passaic Avenue
Nutley NJ 07110
201-284-1200 X524
Fax: 201-284-1550

SMH Electronics Co., Inc.
21 Pattersons Brook Rd.
West Wareham MA 02576
508-291-7447
Fax: 508-291-7449

TEKSERV
127 Riverneck Road
Chelmsford MA 01824
508-459-9480
Fax: 508-453-6336

Trilogy Magnetics Inc.
424 N. Mill Creek Rd.
Quincy CA 95971
916-283-3736
800-873-4323
Fax: 916-283-3122

Unicomp, Inc.
800-359-5092
800-275-1901

Uptime Service Association
14450 NE 29th Place #116
Bellevue WA 98007
206-869-6668
Fax: 206-869-6229

Valtron Technologies
28309 Avenue Crocker
Valencia CA 91355
805-257-0333
800-2-VALTRON
Fax: 805-257-0114

Voltura Enterprises, Inc.
Matrix Components
744 Main Street, #1
Winchester MA 01890-2713
617-721-4920
Fax: 617-721-7316

Whitaker Repair Corp
1106 Commercial Street
Athens TX 75751
214-675-3552 • 214-677-3188

Test Your Electronics Knowledge

By J. A. Sam Wilson

1. In a televised picture frame there are two fields and ________ active lines.

2. In which direction does an isotropic radiator send out signals?________

3. How many picofarads are there in a microfarad? ________

4. If ten and a half pieces of candy cost four and a half cents, how much would one piece of candy cost you?________

5. In a television receiver the even-number lines are scanned first. Then, the odd-numbered lines are scanned. Where in the receiver are the even - then odd - lines selected?

6. The outside coating of a fiber optic cable is called ________.

7. When you magnetize an iron rod it becomes shorter. That is called ________.

8. If you want to decrease saturation you should add (black or white) paint.

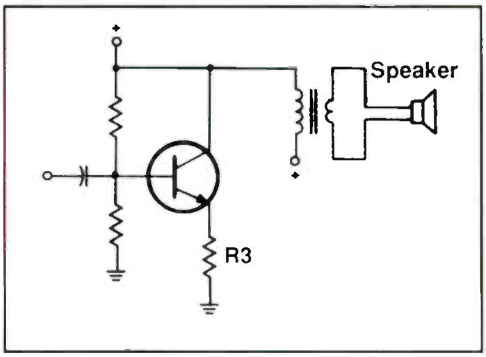


Figure 1. What component would you add to this amplifier to increase sound volume?

9. Add a component to the audio power amplifier in Figure 1 to increase the output sound from the speaker. This is a ________.

10. A superheterodyne receiver is tuned to 1100kHz and the local oscillator frequency is 1555kHz. The if frequency is ________ kHz and the image frequency is ________ kHz.

Wilson is the electronics theory consultant for **ES&T**.

(Answers on page 52)

Servicing switching power supplies: A five-step approach

By Bob Rose

A technician friend of mine recently said to me, "I'm having trouble getting a Magnavox TV set to start up. It has power supply problems, and the power supply is one of those switch mode things."

I think all of us can identify with what this technician said. Switch mode power supplies can be difficult, exasperating, and often downright intimidating. But they are a fact of life, and we technicians have to learn to service them or find another line of work.

I have been working with switch mode power supplies for ten years. In that span of time, I have read a host of books and articles dealing with theory of operation and methods of troubleshooting, and I have attended several workshops on the same topic. The combination of reading-schooling-experience has led me to conclude that most of our difficulty stems from a lack of troubleshooting methodology. You just don't "jump" into a SMPS and start replacing parts. Sometimes such "hit-and-miss" (replace parts until it begins to work) servicing works. Most of the time, however, it is both time-consuming and expensive.

In this article I am going to suggest a five-step approach to servicing these power supplies because I am convinced that a systematic approach to troubleshooting is the key to conquering our servicing problems. So, use my method or use yours, but use something other than the "replace parts until it works" method.

Necessary test equipment

First a word about some very necessary test equipment. At the top of the list is a good multimeter for taking voltage and resistance readings. I use a Simpson 260 to check diodes and transistors. The new DMM's are excellent, but they will "lie" about certain pn junctions. In some cases, my trusty DMM has told me that a certain npn transistor is good, but if I use the Simpson on the Rx1000 (or the Rx10,000) scale, the transistor actually shows a healthy leakage.

Rose is an independent consumer electronics business owner and technician.

For example, I remember the day I worked most of an afternoon on a Philips C-8 chassis. Every component checked good, but the power supply just would not start. Out of exasperation I removed Q402 for the second time to check it out of circuit. The DMM said it was good, but the Simpson told me it was leaky, base to emitter. Replacing Q402 fixed the set. The same situation occurred in another case, and from then on, I reach for the Simpson to check transistors and diodes.

You will also need a good scope and isolation transformer/variable transformer. A good DMM is important. So is your oscilloscope. There is no other way to evaluate the waveform at the base and collector or drain of the switching device. With these few pieces of test equipment, you will be able to repair almost all SMPS that come into your service center.

I use a five-step approach to servicing switch mode power supplies, asking a series of questions as I go.

Question one: Is there B+?

The first question is the most obvious. If the power supply is dead, do you have B+ on the appropriate terminal of the switching transistor (either collector or drain)? If B+ is absent, look for a blown fuse or an open fusible resistor (Figure 1). The B+ voltage is routed to the switching transistor through the "primary winding" of a transformer (actually a choke). An open winding in this component will also account for absence of B+ voltage, but in my experience a defective transformer is extremely rare (except in the case of lightning damage).

A blown fuse or fusible resistor almost always indicates shorted components, usually at least the switching transistor and sometimes the bridge rectifier. Routine troubleshooting will enable you to spot and replace such defective components. A good rule of thumb to follow is: if the switching transistor is shorted, replace it and its control transistor (Q1 and Q2 in Figure 1).

Remember, because of the full-wave bridge rectifier, these supplies have a both hot and a cold ground. When you are checking for the presence of B+ voltage, measure it with reference to hot ground. I usually use the negative terminal of the main filter capacitor as a hot ground because it is an unmistakable point from which to take these measurements.

Question two: Is there start-up voltage?

Take my word for it, this is an easy one to miss! The presence of B+ does not mean that the supply will start. It has to have a voltage-current source to kick-start it. Once started the voltage to sustain it is generated by the supply itself.

Figure 2 is the schematic of a power supply that Zenith has been using for years and is the standard power supply for many of its current TV sets. I serviced one not long ago that was completely dead. All of the components looked good and checked good except one, namely RX3404. RX3404 is a 180k resistor the sole purpose of which is to provide ICX3431 with start-up voltage and current. Once the supply is up and running, base drive comes via the transformer and RX3407 and RX3408.

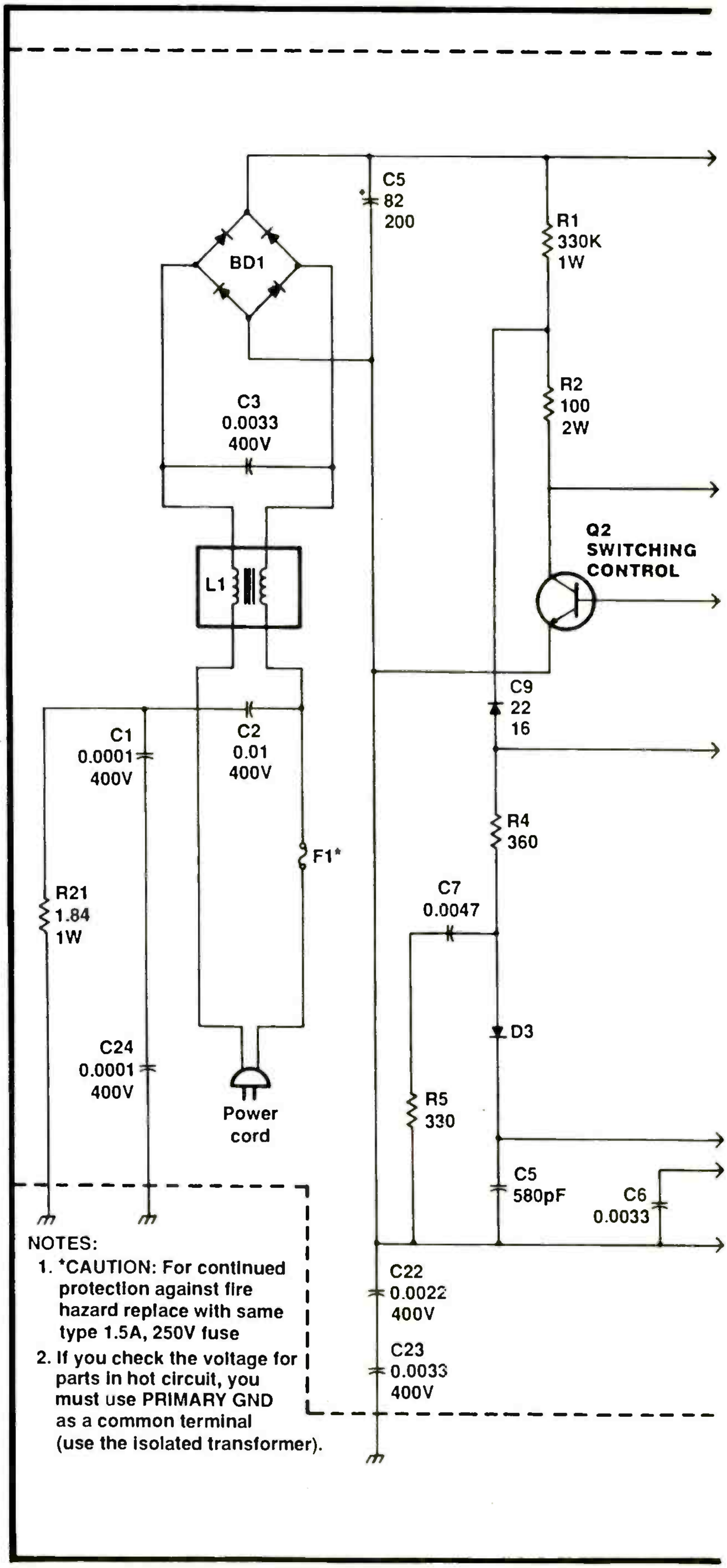
Figure 3 is the schematic for the SMPS for RCA's CTC 176\77 chassis. R4104 is a 1/4W, 1.5MΩ resistor that ties pin 4 of U4101 to the 150V supply. It's purpose is to provide start-up voltage. I have seen quite a few of these resistors open for no apparent reason. The result is no start-up. Amazing, isn't it, a seven-hundred-dollar TV shut down by a quarter-watt resistor!

Every switching power supply must have a means to get it started. Most start-up voltages are generated across one or more high-resistance resistors. If you are servicing a no-start supply, make the second item you check the start-up voltage.

Question three: Is there drive\oscillation?

Let us assume you have B+ and start-up voltage. The next step is to use your scope to confirm oscillation. Begin by

Figure 1. If you are faced with a TV set in which the power supply is dead, the first question to ask is do you have B+ on the appropriate terminal of the switching transistor (either collector or drain)? If B+ is absent, look for a blown fuse or open fusible resistor. →



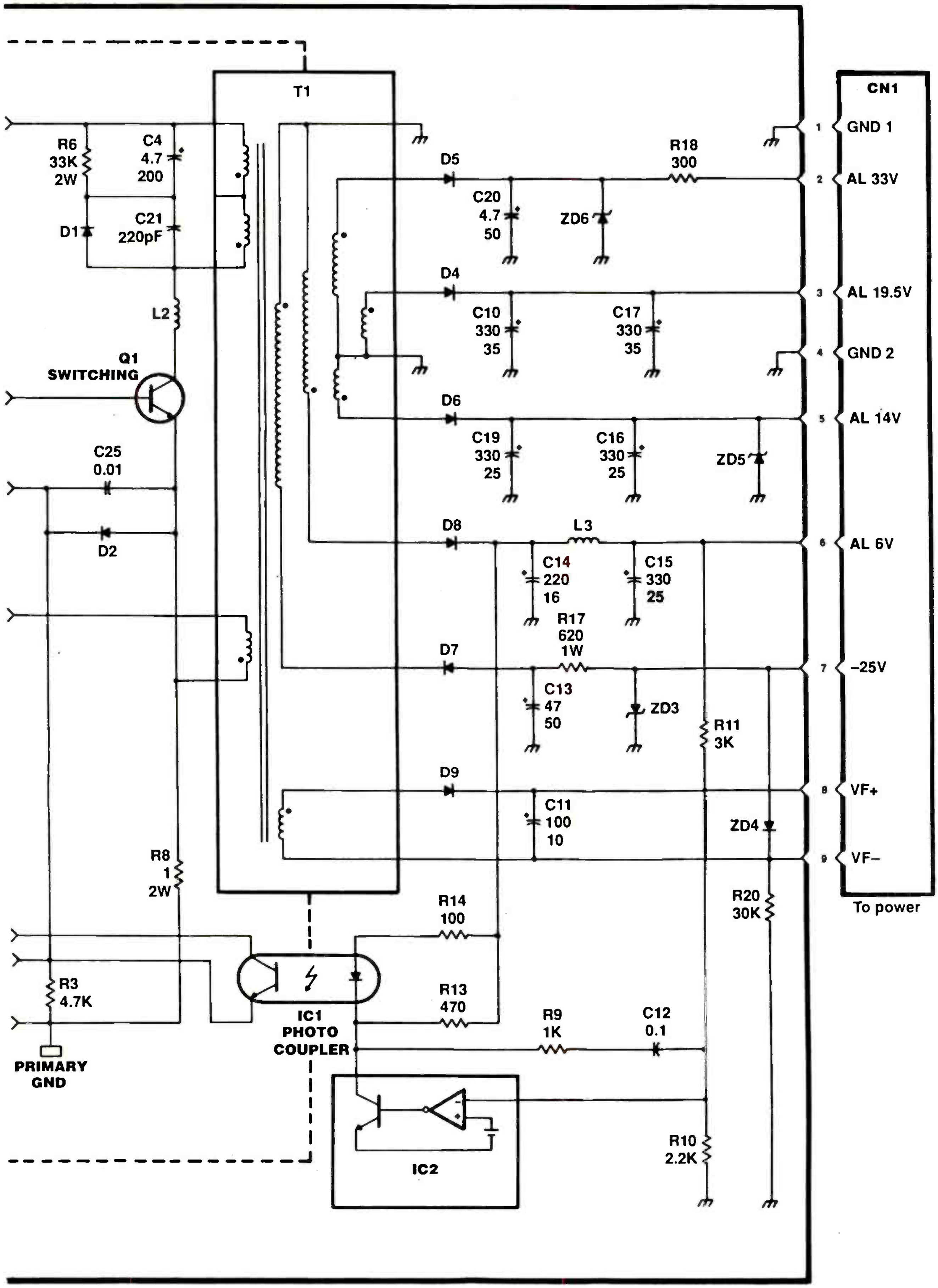
setting your variable transformer at 0Vac. Remember you are still working on "the hot side" of the power supply. Put the probe of your scope on the collector\drain of the switching transistor and slowly increase the acV as you check for a waveform. The shape of the waveform will vary from SMPS to SMPS, but once you have seen one good waveform, you have a fairly good pattern for those that follow. While you increase the acV, listen for atypical noises (like squealing). If you hear an atypical noise, shut the supply down immediately because you have additional problems. You should get some indication of oscillation with as little as 20V input. One supply I worked on had full output at 10Vac input!

Let us assume you have no indication of oscillation. Depending on the SMPS, you will need to go in one of two directions. The trend in TV design today is to include the driver IC and the switching transistor in one package. The Panasonic GL 7, 8, 9, and 10, RCA\GE, Philips, and Zenith are among the manufacturers using a single chip. The cure may be as simple as replacing the chip.

If the power supply has a separate chip to provide drive to the switching transistor (like the CTC 169 or one of several Philips' chassis) you will need to troubleshoot the chip. RCA, Philips, and Panasonic are among the manufacturers that have excellent literature to help you do just that. This, however, is a subject I plan to cover in a future article.

Suppose the power supply uses discrete components, which is how most VCR supplies are built. You will then need to go in a different direction. Look at Figure 4. This power supply and certain variations thereof have been, and are, used in a host of VCRs: Quasar, Panasonic, RCA, GE, Magnavox, etc. What do you do if you have no oscillation?

Virtually any component on the primary side can cause a no oscillation problem. Some are more likely than others to be the problem: R1023, D1002, D1003, and Q1002. In rare instances the problem can be IC1001 (voltage measurements will help here) and transistor T1001 (usually as a result of lightning damage).


T1
CN1
GND 1
AL 33V
AL 19.5V
GND 2
AL 14V
AL 6V
–25V
VF+
VF–
To power
R6
33K
2W
C4
4.7
200
C21
220pF
D1
L2
Q1
SWITCHING
C25
0.01
D2
R8
1
2W
R3
4.7K
PRIMARY
GND
D5
D4
D6
D8
D7
D9
C20
4.7
50
ZD6
R18
300
C10
330
35
C17
330
35
C19
330
25
C16
330
25
ZD5
L3
C14
220
16
C15
330
25
R17
620
1W
C13
47
50
ZD3
R11
3K
C11
100
10
ZD4
R20
30K
R14
100
R13
470
IC1
PHOTO
COUPLER
R9
1K
C12
0.1
IC2
R10
2.2K

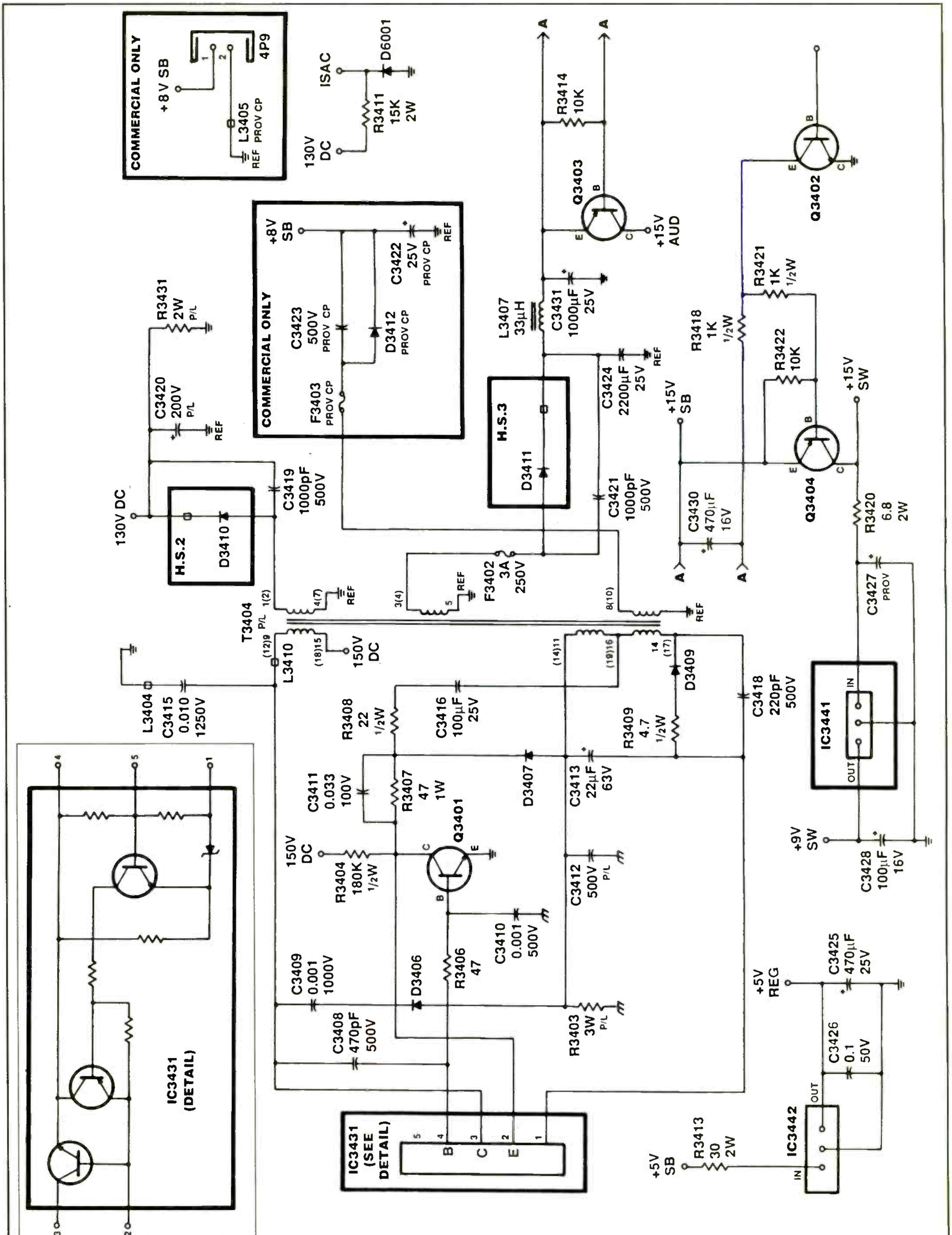
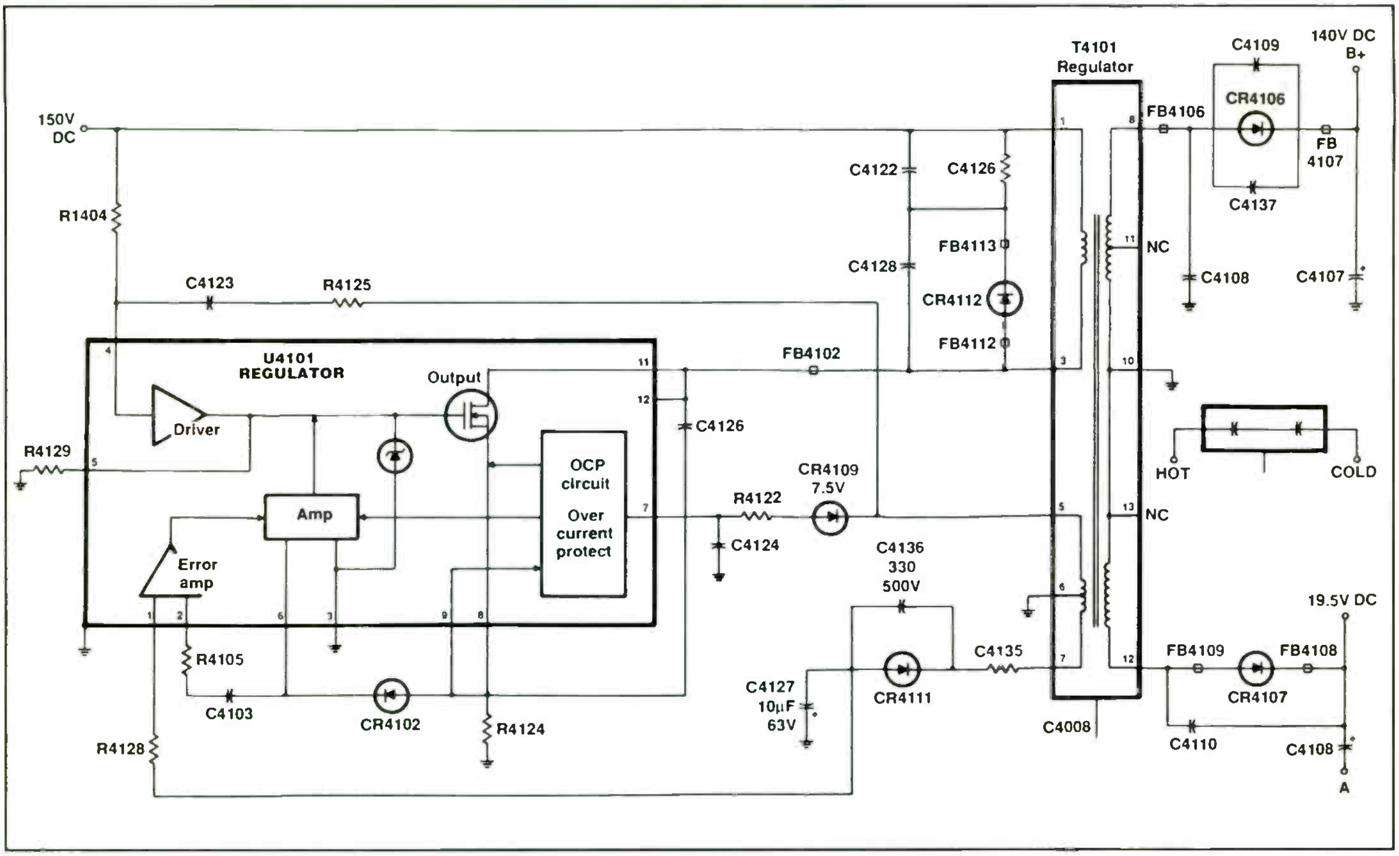


Figure 2. This is the schematic diagram of a power supply that Zenith has been using for years and is the standard power supply for many of its current TV sets. In one dead set, RX3404, a 180k resistor whose sole purpose is to provide ICX3431 with start-up voltage and current was bad.



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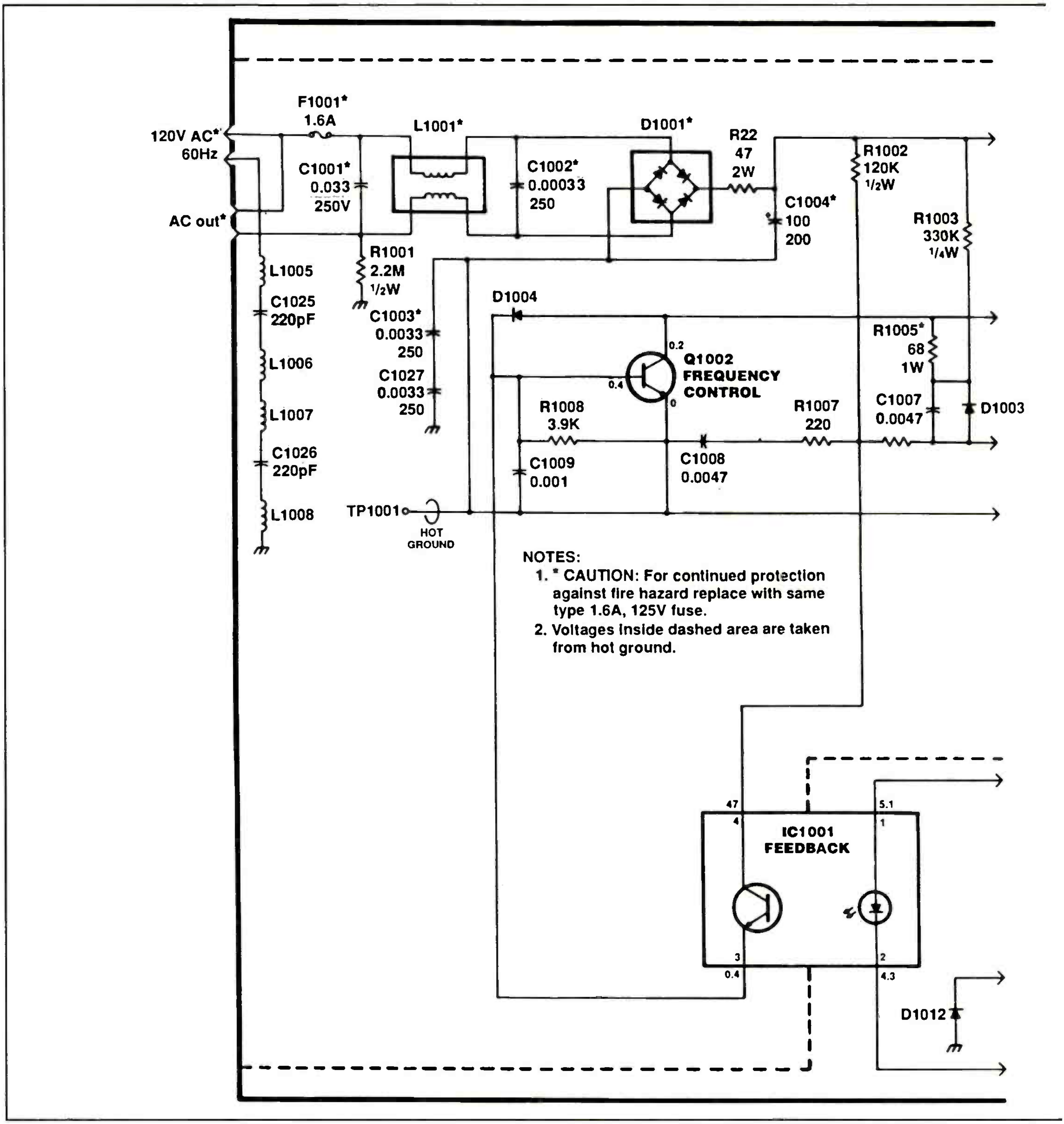
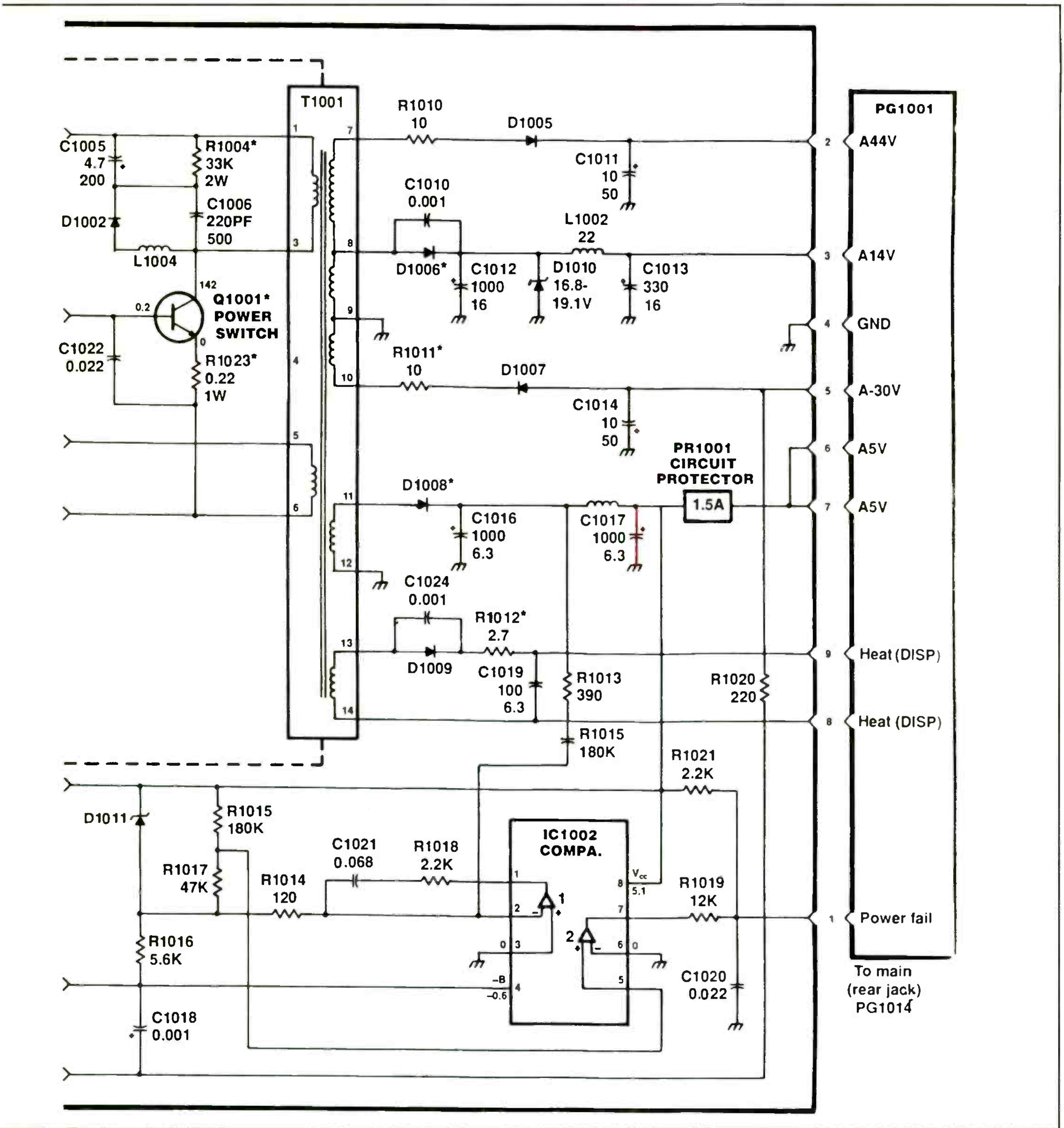


Figure 4. If the defective switch mode power supply uses discrete components, which is how most VCR supplies are built, check all the components on the primary side of transformer T1001.

Again, a good rule of thumb is to take about one minute (it might take that long) and check all the components on the primary side of T1001.

Now look at a more complicated power supply (Figure 1), one Samsung has used extensively in its VCRs and the VCRs it has vended for others. Besides Q1 and Q2 what can cause the no-oscillation symptom? The most logical suspects are: R08, D01, D02, and D03. IC1 can also be a culprit. Please note that this supply is a little different. Any time you service it and the components test good but the supply just won't work, replace C09. Samsung has issued a service bulletin on the problems that may be caused by a defective C09.

Finally, look again at Figure 2. If you have B+ and start-up voltage but no oscillation, check especially DX3406 and DX3407. I recently serviced a Zenith TV that used a 9-911 module. The power supply was completely dead. It had the necessary start-up voltages, and all components except one checked good. The culprit was an open DX3406.



Question four: Is there good output?

Let us suppose the answer to questions one through three is, "yes." The next question is, "Is there appropriate voltage output in the secondary of the supply?" I usually monitor the voltage source used to provide the feedback for regulation. This is the 5V line in Figure 4 and the ever 6V line in Figure 1. You will need to change grounds when you monitor these voltages because you are moving from hot ground to cold ground.

Begin by setting your variable transformer to 0Vac. Use a DMM or an oscilloscope to monitor the output voltage. Slowly increase the ac voltage while you monitor your meter and listen for abnormal sounds from the switching transistor. If there is no squeal, if the waveform at the collector/drain looks normal, and if the voltage regulates at or very near what it is supposed to (Figure 1 at slightly less than 6V and Figure 4 at slightly more than 5V), increase ac to the full 120V. If everything still looks good, congratulate yourself because you have completed the repair.

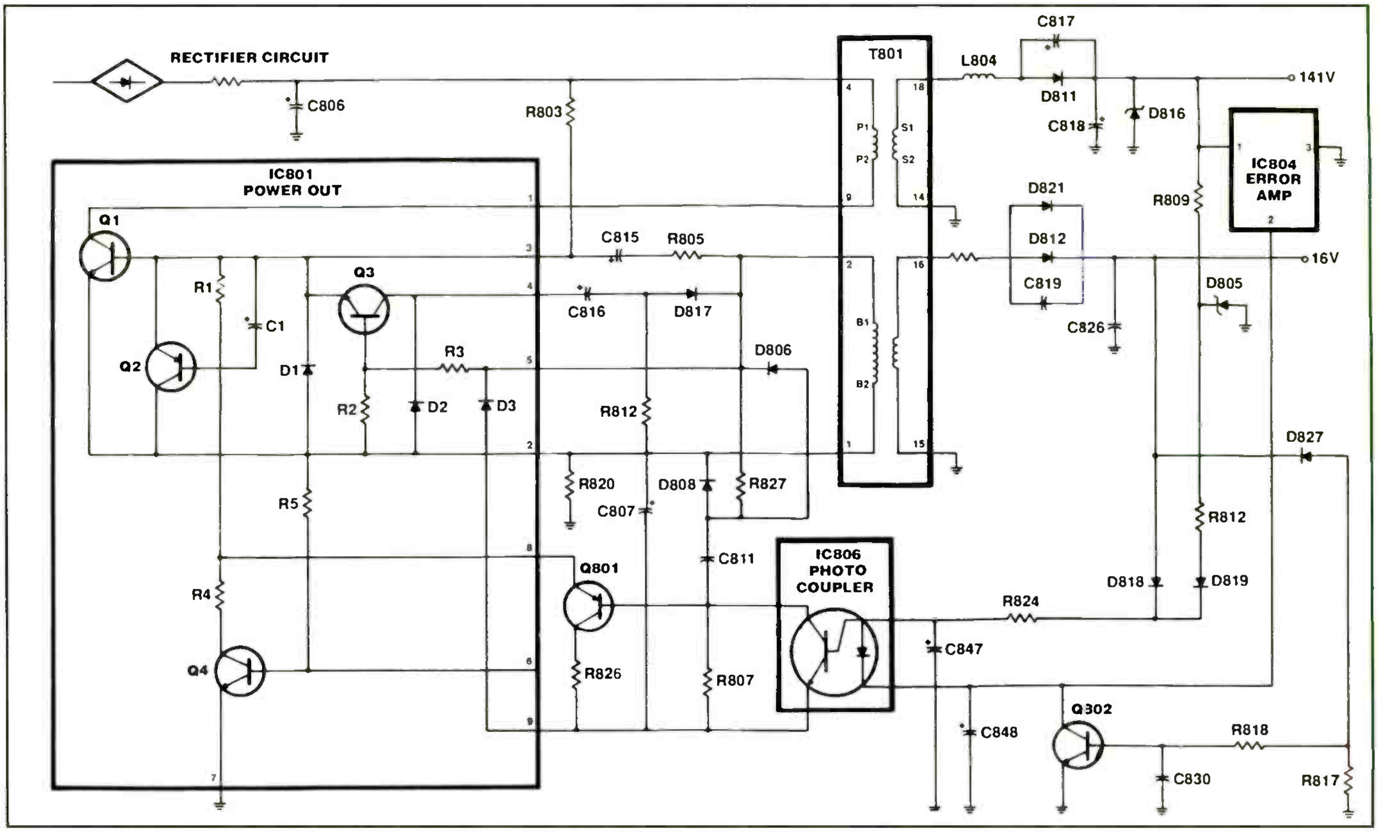


Figure 5. This is the basic schematic diagram for Panasonic's GL 7-8 supply. If the voltage at D811 does not regulate at about 140V, the regulation has failed. Key components of the regulation circuit are integrated circuits IC804, IC806, and transistor Q801. These and associated resistors and diodes will need to be checked, and, often, replaced.

If the voltage does not rise to the expected level, if you hear a squeal and/or if the waveform looks abnormal, turn the variable transformer off. You have additional problems.

What can cause absence of output or very low output? Usually a shorted component in one or more of the secondary sources. Take another minute and check the components in the secondary voltage sources. Most of these kinds of problems will be caused by shorted diodes, especially zener diodes. This applies whether you are troubleshooting a VCR or a TV SMPS. The last Samsung supply I worked on (Figure 1) had two shorted diodes in the secondary: ZD4 and ZD6. These diodes often short when the supply experiences catastrophic failure (like lightning) or loses regulation. Remember that shorted diodes in TV supplies (like CR4106 in Figure 3) also cause very low or no output. Sometimes a shorted diode like CR4106 will cause the regulator IC or transistor to fail. The last CTC177 I worked on had a defective U4101 because CR4106 had shorted.

I guess I should to remind you that defective filter capacitors in one or more of the secondary sources can also cause problems. Bad caps crop up when a VCR, for example, has been in service for several years. The symptoms may vary: no display, erratic capstan-lower drum rotation, color that flashes in and out, etc. Matsushita VCRs are quite prone to such failures. It seems that the capacitor that fail most often are in the 5V lines and are rated at or near 6.3V.

A problem in the regulation circuit of the power supply can also cause poor output. It can be a case of which comes first, the chicken or the egg. Sometimes determining if the regulation is causing poor output or poor output is causing poor regulation causes the technician to become prematurely bald (I am mostly bald)! I hope to deal with this problem in some depth in a future article.

Question five: Is there regulation?

Suppose you are monitoring the output and as you increase the ac, the output voltage continues to rise beyond the point where it should stop. Shut the power supply down because you have a regulation problem. If you continue to increase the voltage, you will damage other components in the supply, components such as zener diodes and filter capacitors. Take my word for it. It will happen!

Look again at Figure 1. If you are monitoring the ever 6V line and the voltage goes beyond 6V and continues to rise, the regulation circuit has failed. Several components can cause the "no regulation" problem. D02, D03, IC1, IC2, and R14 stand at the head of the list. I have had to replace all of these components on many occasions in older power supplies in Samsung TV sets.

Figure 5 provides another illustration. It is a basic schematic for Panasonic's GL 7-8 supply. If the voltage at D811 does not regulate at about 140V, the regulation has failed. Key components of the regulation circuit are IC804, IC806, and Q801. These and associated resistors and diodes will need to be checked, and will often times, need to be replaced.

Use a systematic approach

That about covers it. In order to troubleshoot switching power supplies effectively, you will need to develop a systematic approach. I suggest asking these five questions: (1) Is there B+? (2) Is there start-up voltage? (3) Is there oscillation? (4) Is there output voltage? (5) Is there regulation? I find asking these questions puts me onto the circuit that is causing the problem. Once into the problem circuit, the fix becomes relatively easy. If this system doesn't work for you, perhaps it will stimulate you to find one that does work. ■

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By The ES&T Staff

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Ontrack Data International Inc
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website:
http://www.parts-express.com

PC Service Source
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Fax: 972-406-9081
website: http://www.pcservice.com

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617-665-1400
800-996-3837
Fax: 617-665-0780
website: http://www.fotronic.com

3M Electrical Specialties Div
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800-665-7862
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Test equipment

Computer & Monitor Maintenance, Inc. announces the "Checker TV Pro" and the "Checker TV Jr.". The "TV Pro" is an ac or battery operated television test pattern generator, designed for bench or field operations. The Jr. is small enough to fit in your pocket, but can help set-up and test the largest television. They are both NTSC, RS 170- video compatible, with complex sync.

The "Pro" features include split field color bars and Gray scale. It also has S-video output, RF output, and 1V video. It has stereo processor and tone generator that will allow the testing of the stereo detection and audio portion of the receiver. The patterns include a cross hatch with dots and white screen. The Red, Green, and Blue signals are push-button selectable, as is stereo signal and the audio tone.

The "Jr." has color-bars, White, Red, Blue, Green, Black screens, and cross-hatch with dots. Its output is 1V RS170 NTSC color video. It is a small unit (1" x 2" x 3") that can fit in your pocket or tool box and operates on a 9V battery. The various patterns are selected by a single push-button.

Circle (80) on Reply Card

Video pattern generators

Fully field upgradable, the *Klein* VPG series video pattern generators have a larger memory, over 700 stored timings and an interface to a PC running in Windows. With a larger (4 line) LCD display, scrollable timing groupings, light weight 9 pound box, FCC approval and CE certification, this new product is low cost and high performance according to the manufacturer. The VG170, VPG210 and VPG250 are affordable to large and small depots, manufacturers, engineers and test technicians.

Circle (81) on Reply Card

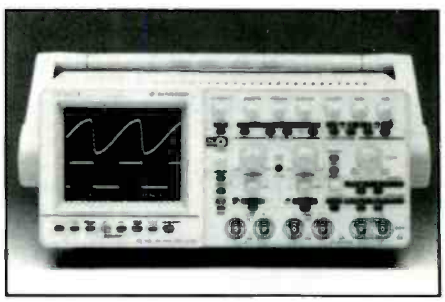
Microprocessor controlled oscilloscopes

B&K Precision's Model 5034 and 5024 differential input analog/digital oscilloscopes combine analog and digital technologies to provide ease of use and parameter manipulation.

The Model 5034 has 30MHz bandwidth, the Model 5024 has 20MHz bandwidth, and both models feature a 40MS/s sampling rate. Unlike many digital storage oscilloscopes, the bandwidth specifications are achieved independently of the digital sampling rate and are not subject to aliasing or interpolation problems. The autoset and store functions allow the time base, v-axis and trigger parameters to be easily entered and stored for retrieval.

The two models are Lab View/Lab Windows compatible and have built-in RS-232 interfaces. Both scopes feature cursor/readout, autoset and 8K memory. A set of safety leads is included with each model and the leads and differential inputs allow the direct measurement of signals at different reference levels.

Circle (82) on Reply Card



BOOKS

***Build Your Own Home Lab*, By Clement S. Pepper, PROMPT Publications, 224 Pages, $24.95**

Learn the joy of having your own home electronics lab!

For electronics enthusiasts, a home lab is a place where learning can take place. All of the lab details; work space, equipment, parts, library; are necessary for a working facility. With your own home lab, the basics of electronic devices from A/D converters to computers become simpler and more accessible, and the world of electronics offers more opportunities for success on both a professional and hobbyist level.

Build Your Own Home Lab shows you how to assemble an efficient working home lab. Learn how to create an ideal lab inexpensively, and how to make it pay its own way through years of growth and use. *Build Your Own Home Lab* includes many projects for creating your own instruments, such as a multichannel oscilloscope switch and a 100-minute timer/stop watch; instruments designed to help the reader learn more about electronics while you save money by creating them yourself.

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

***Electronic Circuit Guidebook, Volume 1: Sensors*, By Joseph J. Carr, PROMPT Publications, 288 Pages, $24.95**

Electronic instrumentation today is largely computer-based. The use of the digital computer has greatly improved the design of electronic instruments, control systems and related devices. Many texts are available that discuss electronic instrumentation and computer interfacing. A topic usually lacking in these texts, however, is extensively covered in *Electronic Circuit Guidebook, Volume 1: Sensors*; namely, the analog interface.

Most sensors are inherently analog in nature, so their outputs are not usable by the digital computer. Even if the sensor is supposedly a "digital output" design, it is likely that an inherently analog process is paired with an analog-to-digital converter. In *Electronic Circuit Guidebook, Volume 1: Sensors*, you will find information you need about typical sensors, along with a large amount of information about analog sensor circuitry. Amplifier circuits are especially well covered, along with differential amplifiers, analog signal processing circuits, and more.

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

***Electronic Circuit Guidebook, Volume 2: IC Timers*, By Joseph J. Carr, PROMPT Publications, 256 Pages, $24.95**

Timer circuits used to be a lot of trouble to build and tame for several reasons. One major reason was the fact that DC power supply variations would cause a frequency shift or slow drift. Modern timers are designed to permit a wide variation in the DC supply voltage without affecting the output frequency or single-pulse duration. Another reason is that the equations determining the frequency or timing were little more than approximate, despite the appearance of great precision in the textbooks. Modern timers will work very closely to the way the textbooks say they do. *Electronic Circuit Guidebook, Volume 2: IC Timers* will show the reader how it is done.

Part 1 of this book is organized to demonstrate the theory of how various timers work. This is done by way of an introduction to resistor-capacitor circuits, and in-depth chapters on TTL and CMOS digital IC timers, the LM-555 and other IC devices, operational amplifier timer circuits, retriggerable timers and long duration timers. Through simplified equations and detailed graphics, the information presented is useful for both technician and hobbyist.

Part 2 presents a variety of different circuits and projects. Some of the circuits are standalone, while others are for incorporation into other circuits. Examples of some of the circuits included are: touch-plate trigger, missing pulse detector, analog audio frequency meter, one-second timer/flasher, relay and optoisolator drivers, two-phase digital clock, 100kHz crystal calibrator and many more. *Electronic Circuit Guidebook, Volume 2: IC Timers* will teach you enough that you will not only be able to rework and modify the circuits covered in the book, but also design a few of your own.

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

What Do You Know About Electronics?

Digital TV

By J. A. Sam Wilson

Several **ES&T** readers have tried to send me e-mail. Unfortunately, I do not have any provision for receiving/sending computer mail! No e-mail, no www dot, no anything via computer. In those cases where someone sends computer-generated mail through the **ES&T** office the noble editor forwards it to me, but I cannot answer because it has no mailing address. So if you want to reach me, please either send your comments via regular mail, or include a postal address if you correspond with me through the **ES&T** editorial via e-mail.

While I'm at it, I still have boxes to unpack from my move to a new address. So, I can't answer letters like the following: "In the July, 1986 issue you said. . ." That issue is in one of those boxes.

"My company makes widgets and we use things that look like this . . . (There is a drawing that looks like two seagulls fighting over a minnow.) Please explain."

I think the answer to this question may be in one of those boxes.

I do like receiving letters from readers. I have a stack of letters I'm going to try to answer this week. It may take some time, but I *will* answer.

Digital TV

Are you starting to collect articles on digital TV? Here is some good news. Not everything is going to change. For example: high voltage and CRTs are still going to be used - at least at first. Low-voltage power supplies will still be based on the same principles.

There are new terms and circuits you should start reviewing. I'll review a few with you here. Also, there are some old digital terms and circuits we haven't looked at for years. We will eventually need to review some of them too.

If you are on a cable or satellite dish there may be some good news. Companies that own those systems are threatening to convert digital programs to analog for your present TVs. (Sorry, there's no good news about the programs.)

We will start this series of digital TV articles by putting together a digital monochrome television system and go to color later. As we go along we will note some differences with color.

We will divide the CRT screen into tiny pixels. Each pixel is one of many tiny rectangles. They are arranged in rows and columns with no spaces between them in a row, but, the rows are separated vertically into lines. The only difference between this system and the analog scanning system is that each line of the picture is divided into pixels.

When you add color and more levels of brightness for each pixel you can see that the HDTV system would never fit into the currently allowed 6MHz. However, there is a statistical method that can save the day.

Huffman coding

The statistical method is called "Huffman coding". With this method, different word lengths are assigned to pixels. The word lengths are proportional to the number of times the pixel occurs. For example, in a picture of a red barn there will be a lot of red side-by-side pixels. As another example, a picture of blue sky will contain a lot of side by side blue pixels. The Huffman code allows for reducing the total number of bits required for each pixel.

We break up an analog line into pixels and the process is called sampling. In other words, at each pixel we will sample the picture. At a given point the pixel can be any shade from black to white in our monochrome system.

Although an analog TV screen does not actually have pixels, the screen can be considered to be made up of slightly over 215,000 pixels. (There are 448 pixels per line multiplied by 480 active lines.)

Each pixel has a horizontal and vertical position on the screen, and, a brightness.

When you quantize the scanning line you assign a number that determines the brightness of a pixel. The greater the range of numbers you use for pixel brightness the more shades of brightness it has. For example, you could use only two numbers for brightness - one number for black and one for white.

Using only two numbers for pixel brightness would give a rather unpleasant black and white picture with no shades of grey. More about that later.

What's in a digitally-coded TV line?

Let's look at one line of digital coding. Each line starts with a "header" that gives information about the line. For example, the header may tell you where the data begins, the number of pixels and the number of bits per pixel.

Remember, in our monochrome system the number of bits per pixel determines the number of shades of white-to-grey that are possible. The digital system may also give the total number of bits in a line and tell where the line ends and the next line begins. The digital system can count millions of bits in one line.

You can think of the header for a digital line as something that takes the place of horizontal sync pulses.

Troubleshooting a digital TV

This is a good place to talk about troubleshooting in a digital TV system. In today's color TV receiver you may be working down at the component level. Digital television receivers are so complex that you will spend almost all of your time working at the IC signal level. In other words, you will be looking at signals rather than volts, amps and ohms.

Screen aspect ratio

Of course, the aspect ratio of a frame (two fields) is of interest. For the NTSC (National Television Systems Committee) system it is 4 to 3. That is, a ratio

Wilson is the electronics theory consultant for **ES&T**.

of 4 wide to 3 high. The plan for HDTV is to use an aspect ratio of 16 wide to 9 high. It is sort of a wide screen. (Maybe we will be able to see all of the stuff at the edges we have been missing?)

People are being told (in the newspapers) to expect HDTV (High Definition Television) pictures to be amazingly clear in details. The present analog NTSC TV system has 525 lines of video of which 480 lines are active - that is, 480 lines are actually used to display a picture.

The proposed HDTV system will have 1125 lines of which 1080 are active. That means there will be more than twice as many vertically-spaced lines used to make a picture.

No one seems to notice this, and/or, no one seems to care - however, if you did nothing else but increase the present 480 active lines to 1080 lines you would get a remarkable increase in picture clarity.

Some digital TV terms

Here are some terms (related to digital TV) that we have discussed so far. A few new terms are added.

ASPECT RATIO - This is the ratio of screen witdth to height. In the proposed HDTV system the aspect ratio will be 16:9. It will show up as a wider screen so that it will be an easier matter to convert today's movies for television viewing.

HDTV - High Definition Television.

HEADER - An identification code - in digital form - which is given at the beginning of each line of video. It describes the characteristics of the data stream that follows on that line.

HUFFMAN CODING - A method of assigning digital codes to pixels. It is a statistical method that assigns code numbers to pixels. The lengths of the code numbers vary with the number of times the pixel occurs. By using this coding method the bandwidth of the system is greatly reduced.

LINES - There will be more scanning lines and more active lines in High Definition Television pictures.

PIXEL - Although a monochrome screen is not actually made up of pixels, you can consider it to be so. Each rectangular pixel is described by the following features: its horizontal position on the screen, its vertical position on the screen, and, for monochrome TV, its brightness.

In addition to those things, pixels in color TV must also be described by the color. That will greatly complicate the description of pixels.

Horizontal and vertical positions are determined by the sweep system. In one proposed HDTV system interlaced scanning will be used. If that format is accepted your biggest job in designing a monochrome TV will be to describe (digitally) the brightness and color of the pixels.

QUANTIZING - For digital television. The characteristics of each pixel must be converted to digital numbers. That process is called quantizing.

SAMPLING - This is the first step in quantizing a video signal. It involves taking readings for each pixel. Analog-to-digital conversion is used here. ■

"Consumers continue to agree that portable music players are a great value and the best way to enjoy their favorite music anytime, anywhere," said Mark Viken, senior vice president, Personal Audio/Video Division of Sony Electronics, Inc. "This, combined with advances in digital technology and increased battery life are driving increased sales volumes."

Components and aftermarket autosound remained in negative territory, both for the month and year to date. Component sales slipped 12 percent in May to $117 million, and for the January-May period were off 15 percent. Autosound products declined in May as well, dropping ten percent to $164 million, yet on a cumulative basis remain within striking distance of last year's totals.

CEMA is a sector of the Electronic Industries Association (EIA), the 73-year-old Arlington, Virginia-based trade associations representing all facets of electronics manufacturing. CEMA represents U.S. manufacturers of audio, video, accessories, mobile electronics, communication equipment information products and multimedia products.

Large screen TV set sales see double digit growth posting all-time records, VCRs & camcorders set pace for first-half video equipment sales

Large screen television set sales grew 12 percent and unit sales of consumer video equipment rose two percent overall during the first half of the year, due in large measure to the strength of VCR decks and camcorders, according to data compiled by the Consumer Electronics Manufacturers Association (CEMA). The trade association also reported solid first-half performances by color TV/VCR combinations.

In the direct-view color TV category, despite reports to the contrary on digital television, receivers 30-inches and larger grew a strong 12 percent. Six-month sales of all TVs slipped four percent to 9.06 million units, but CEMA President Gary Shapiro explained that "the trend within that trend is the continuing strength of color TV models 25-inches and larger, which increased a solid three percent, including the 12 percent jump in models 30-inches and larger. Home theater remains the dominant force in the home video marketplace, and we expect that growth in the large-screen categories will keep overall direct-view color sales on a high plateau this year."

For the January-June period, VCR deck sales to Unites States dealers increased ten percent to more than 7 million units. On a year-to-date basis, hi-fi stereo models accounted for 43 percent of total VCR sales. First-half camcorder sales expanded five percent to 1.7 million units. TV/VCR combinations posted a 15 percent growth on first-half sales of more than a million units.

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Test Your Electronics Knowledge

Answers *(from page 18)*

1. 480 active lines that actually make a picture.The remaining lines are used for vertical blanking.

2. An isotropic radiator sends out signals equally in all directions.It is an imaginary antenna that cannot be built.However, it is used in the mathematical analysis of antennas.

3. $10^6/10^9 = 10^3$

4. Divide ten and a half by four and a half and get 2.33333 cents. Then, since we don't have fractions of a cent, you will have to pay 3 cents. By multiplying the numerator and denominator by 2 you find that 21 pieces cost 9 cents exactly and you avoid paying the fractional cent.

5. The equalizing pulses on top of the blanking pedestal.

6. cladding.

7. magnetostriction.

8. Add white paint.

9. Add a bypass capacitor around R_3.

10. The if frequency is equal to the oscillator frequency minus the rf frequency: if frequency = 1555 kHz - 1100 kHz = 455 kHz.

The image frequency is equal to the oscillator frequency plus the if frequency.

Image frequency = 1555 + 455 = 2010 kHz

While they slipped five percent in June, year-to-date sales of projection TVs were almost precisely what they were a year ago. For the first six months of 1997, projection TV sales totaled some 336,000 units; the figure for January-June 1996 was 339,000. Shipments of DVD players continued to impress, with cumulative unit sales of 125,000 through the end of June. Sales of laserdisc players, by contrast, continued to plummet,falling 75 percent in June and 63 percent during the first half of the year.

The Fiber Optic Association to study fiber competitiveness in premise cabling

The Fiber Optic Association, the professional society of fiber optics, has initiated a study of the competitiveness of fiber optics in premise cabling. The purpose of the study is to understand why fiber has been successful in many applications in the premise cabling market but has not been accepted in others.

While fiber optics has overwhelmingly become the medium of choice in outside plant cabling with almost all telecom networks based on fiber and most CATV systems in the process of converting to hybrid fiber-coax (HFC) architectures, fiber is still limited to backbone applications in premise cabling.

The reasons for fiber's lack of success in premise cabling are many and varied, real and perceived. The Fiber Optic Association, the professional society of fiber optics, is undertaking a study to determine the status of fiber optics and why it has achieved the success it has in some markets and failed in others.

The purpose of this study is to state the reasons for fiber optic's successes and failures, examine the validity of them, and consider ways to improve products, practices, standards, and perceptions within the marketplace.

Many studies of these problems have been made and some have been publicized. Most, however, have been proprietary to organizations, either to set policies for their own marketing strategies or to sell for the purpose. Several have been done by organizations of fiber optic companies to try to better understand the issues and implement promotional or educational institutions.

The result of the study will be a position paper on the future of the use of fiber optics in premise wiring systems. Included in the paper would be recommended standards that would enhance the competitiveness of fiber with respect to copper wire. The results of the study, which should be finished early in 1998, will be made public for comments.

Anyone interested in participating in the study should contact The Fiber Optic Association, by phone at 617-469-2FOA, fax 617-396-6155, e-mail fao@world.std.com. The survey questionnaire will be available on the FOA website when ready (http://world.std.com/~foa/). All participants, no matter what their involvement in fiber optics are welcome. ■

Circle (68) on Reply Card

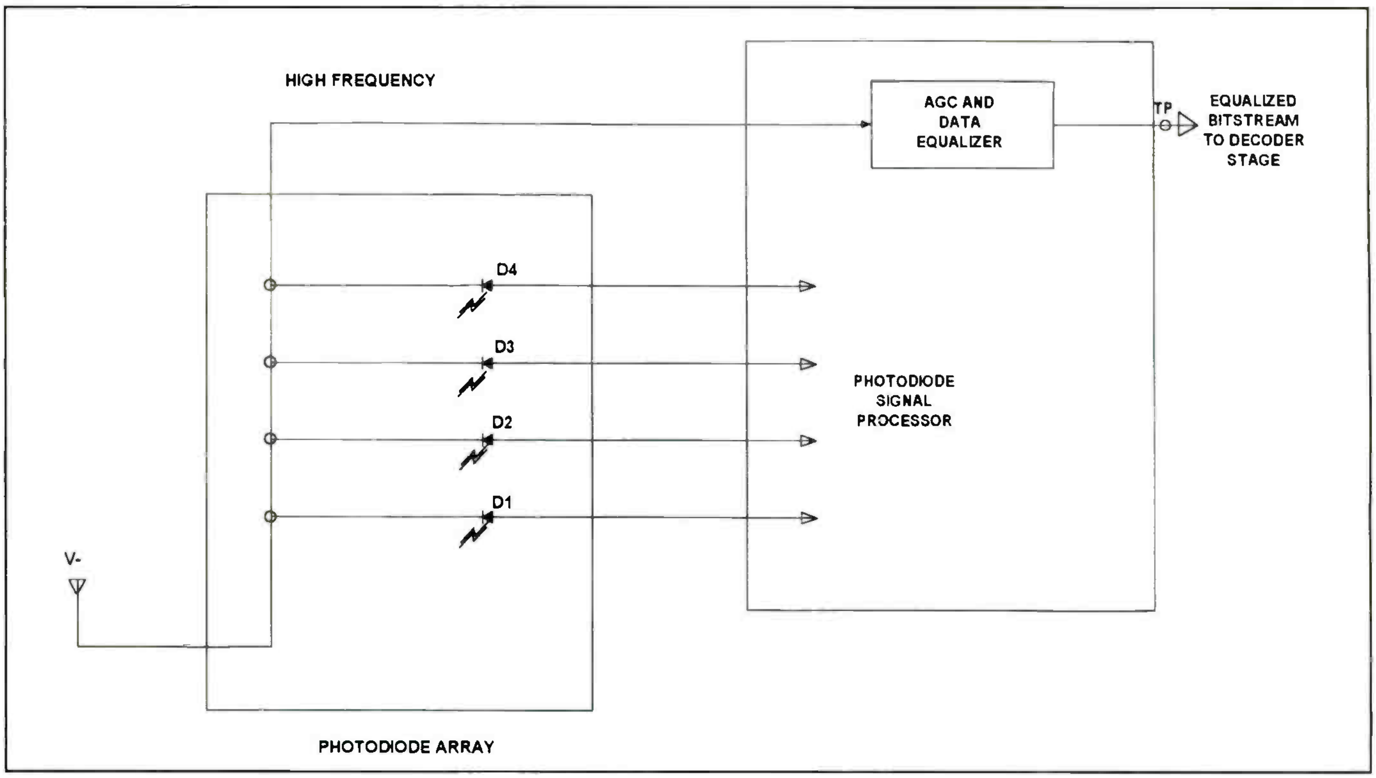

Figure 12. In either a single-beam or three-beam optical pickup system, the HF data signal is processed by an AGC circuit and data equalized to provide an equalized data bitstream to the decoding circuits of the video laser disk or CD player. Because of its appearance on the screen of an oscilloscope, the equalized HF signal is commonly referred to as the "eye" pattern.

motion of the radial swing arm to track the data on the disk is controlled by a radial servo. The radial swing arm pivots on an axis located at a point outside of the diameter of the disk. While three-beam tracking systems use both tracking and sled servos, the single beam optical pickup uses only the radial servo to follow the disk's spiral track.

The radial error signal which drives the swing arm is derived from the photodiode currents in the photodiode signal processor stage. The radial error signal processor controls the radial drive signal. When the operator selects a function such as track search, fast forward or reverse, the microcomputer logic takes over to control the radial servo lock and track jumping functions.

In the single-beam radial tracking system, the optical pickup pivots as it tracks, thus changing the angle between the objective lens and the disk. This results in differences in the strength of the reflected laser beam. This system thus requires gain and phase compensation.

Another difference in the single-beam system is that it requires an additional signal to achieve radial servo lock. A "wobble" signal is injected into the radial servo loop to provide radial servo lock. In the absence of the wobble signal, the radial system does not track properly.

Signal processing

Processing of the HF (high frequency) signal is very much the same in both the single-beam and the three-beam optical pickup systems. The HF signal is processed by an AGC circuit and data equalized to provide an equalized data bitstream to the decoding circuits (Figure 12). The equalized HF signal is commonly referred to as the "eye" pattern. The equalized HF eye pattern signal is applied to the decoder where the bit clock is regenerated and the EFM (eight to fourteen modulation) is demodulated. Another circuit may also be included to detect the HF signal (Figure 13).

The detection circuit detects the loss or reduction of the HF signal, which may be caused by dirt, or dropouts in the data stream due to damage on the disk's surface. The detection circuit develops logic control signals to indicate the condition of the HF signal.

If the circuitry in the player experiences a momentary total loss of data, such as might be caused by severe damage to the disk, or a shock to the player, a "track loss" logic level is used to notify the microcomputer of this condition. If such an event occurs, the servo loop may be opened and the microcomputer momentarily controls the tracking position of the optical pickup.

System control

A feature of any video laser disk player or CD player is a control circuit. The microcomputer-based control circuit controls all of the functions of the system and provides an interface between the user and the CD player. When the operator presses a button such as open or close tray, play, etc., the microcomputer generates an output to perform the function. This system control block diagram (Figure 14) is typical for CD players.

The microcomputer controls and monitors all aspects of the servo system. When a disk is loaded into the player, for example, the microcomputer initiates the disk startup procedure. During startup, the system detects and decodes the table of contents (TOC) in the lead-in area of the

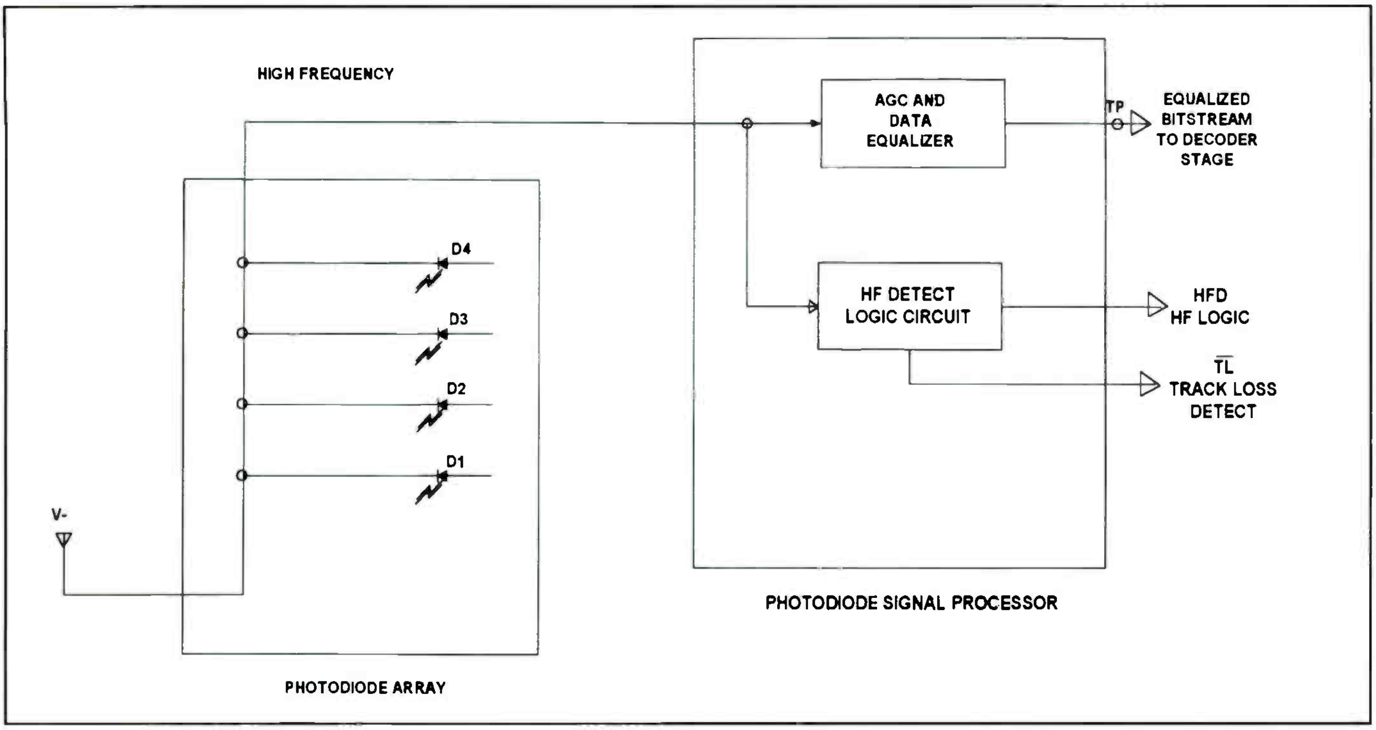

Figure 13. The detection circuit in a video laser disk player or CD player detects any loss or serious reduction of the HF signal that may be caused by dirt or dropouts in the data stream caused by damage on the surface of the disk, or a complete loss of data caused by a severe shock to the player or severe damage to the surface of the disk.

disk. The TOC contains information such as catalog number, total number of tracks, total time and other information pertinent to the disk that has been detected. After a disk has been identified, player functions are enabled.

It is a great help in troubleshooting to recognize that some faults may be caused by the system control or signal processing circuits (Figure 15).

The system control microcomputer generally detects error conditions in the CD processing circuits and controls the unit's functions, such as programming the play sequence of a disk, or tray open/close. The CD processing functions normally include such actions as focus, tracking, spindle, feed, decoding. However, these functions are monitored and controlled by the system control block of circuitry.

The condition of the unit, and the cause of a particular symptom, can be isolated using the diagnostic and test modes and by checking sensor inputs and control outputs between the system control microcomputer and the processing circuits.

Startup sequence

Obviously, disk startup must occur before the player can perform any other functions on the disk. When the operator places a disk in the loading tray and closes the tray, the microcomputer initiates startup. The startup procedure varies from model to model, but this discussion of the basic startup principles applies to all systems (Figure 16).

First, the laser diode turns on and the objective lens moves up and down to detect the presence of a disk. In some products, the optical unit is first positioned to seek the rest position, and the spindle motor begins to spin during the focus initiation procedure.

If there is no disk in the player, the focus search occurs more than once. If the presence of a disk is not detected, an error is indicated by the system, and the startup procedure is terminated.

If there is a disk in the tray, and the laser is in good condition, focus will be established on the first pass of the focus search. If there is a good disk in the tray, but the system searches for focus more than one time, the unit may be in need of adjustment, or the laser diode may be weak.

Once a disk is detected, the spindle motor turns on to rotate the disk, and the control circuit provides drive to position the objective lens to the area of the lead-in tracks to retrieve the table of contents. The TOC is decoded and its data is sent to the microcomputer.

If the unit is a CD player, the data from the TOC is displayed on the front panel display of the player. The number of tracks and total playing time are typically displayed. The unit is now ready for the play mode. In some players, the unit automatically enters play after a CD has been loaded and detected.

Adjustment procedures vary from one unit to another. With some units you will make adjustments digitally, using a computer. Some of the players you will encounter are self adjusting. Before you attempt any adjustments, consult the manufacturer's service literature for that unit.

Ordinarily, adjustment is not necessary unless you have replaced a faulty component. Even then, in some cases, the test point for the adjustment procedure may only need to be checked for verification of the correct waveform or signal level. In many cases, these test points may be used when troubleshooting the unit to verify proper performance.

Troubleshooting

During troubleshooting, you may find it helpful to conduct some preliminary checks to get a general idea of where the problem may originate. If the optical pickup system is not functioning, for example, the problem may be in that system, or it may be caused by a power supply fault.

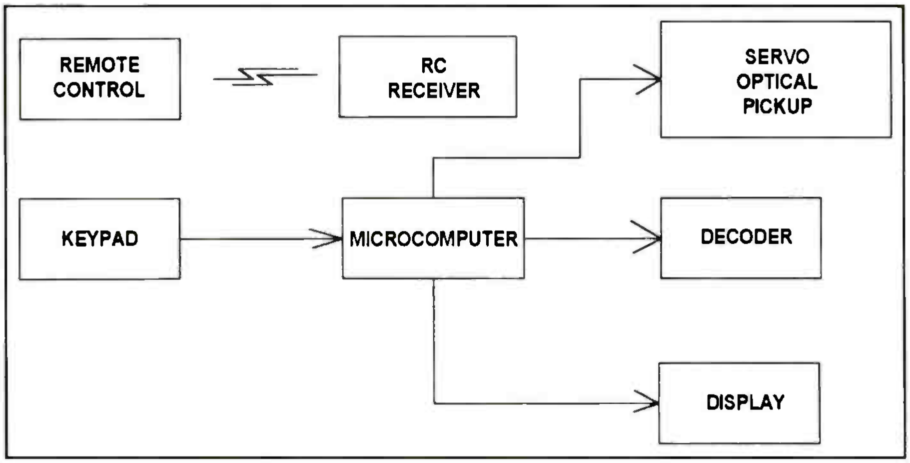

Figure 14. The microcomputer-based control circuit in a video laser disk or CD player controls all of the functions of the unit and provides an interface for the user.

Another possible cause of failure of the startup of the optical pickup system is a fault in the system control circuit.

If you have no audio, but the display on the front panel of the player is showing elapsing time and track information, you know that the problem is not caused by servo faults. This condition points to a problem in the later stages of the unit such as the DAC or analog filters.

If you're troubleshooting a combination video laser disk/CD player, try operating the unit with different disk types (Figure 17). If the unit operates with a compact disk in it, even if does not work with a video laser disk, you have determined that the optical pickup system is not the source of the problem. This problem may be caused by a fault in the spindle servo circuit or signal processing circuit.

The operation of the processing circuits differs depending on which type of disk is loaded in the player. Diagnostic tools are available to aid in the servicing of these players. You will find that there are test disks, jigs and service aids available for performance tests and diagnostics. The service manual will list any special test fixtures and disks that may be useful to the technician in servicing the product.

Test modes

The manufacturers of most compact disk and video laser disk players have built test modes into the products. The service literature will include instructions for using these test modes. In most cases, the test modes allow the service technician to isolate the cause of the fault to a specific circuit. In some cases, the product has to be in one of the test modes to perform adjustments. This is especially true in the case of video laser disk players. Some test modes you may find in various players include modes for checking the laser, focus, tracking and spindle servos.

For example, when you implement the focus test mode, the laser diode in the optical pickup turns on and the objective lens continuously moves up and down. This test mode allows the focus servo to be tested while the other servo circuits are not functioning. This mode allows troubleshooting of the laser control and focus startup, with and without a disk. The focus signal can be monitored when troubleshooting the focus servo circuit. The technician can also check the laser output while the player is in this test mode.

In another test mode, the spindle motor turns on and the focus servo is locked. A low from the $\overline{TL}$ signal indicates focus servo lock. If focus does not lock, as indicated by a high $\overline{TL}$ signal, continue to troubleshoot the focus servo loop.

If one of the photodiodes in the photodiode array is defective, for example, focus lock could not be achieved. A LF signal has to be present at each input of the photodiode signal processor in order to develop the focus error signal. If the focus test mode reveals no problems in that system, implement the next test mode. In this case, the next step is to go to the spindle servo test mode.

If the spindle servo circuit is operating properly, you have learned a lot about the condition of the unit. For one thing, the decoder stage for regenerating the bit clock must be operating (Figure 18). If the spindle servo does not lock, the cause may actually be in the decoder stage.

Error indications

If you put a disk in the player and it does not play, it will help in your diagnosis of the problem if you have a knowledge of the startup procedure. A good place to look first for clues is the player's display. Most players display an error condition if a disk is not detected.

Let's say that even though there is a disk in this player, the display indicates no disk. There are several conditions that may cause this condition:

- the optical pickup is not emitting a laser beam,
- the modulated beam is not being picked up,
- focus can't be achieved or is poor,
- startup was not initiated,
- radial error,
- some mechanical fault is preventing positioning of the optical pickup into the lead-in area required for reading and detecting the TOC,
- failure to read and detect data .

The first step in isolating the cause of

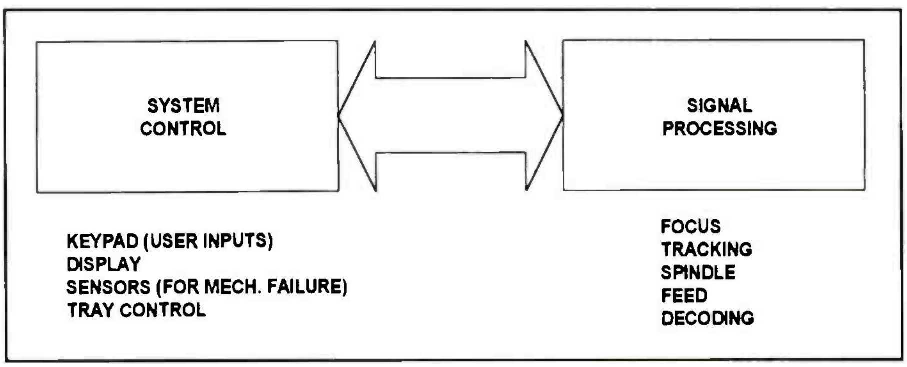

Figure 15. Some faults in a laser disk player or CD player may be caused by either the system control or signal processing circuits.

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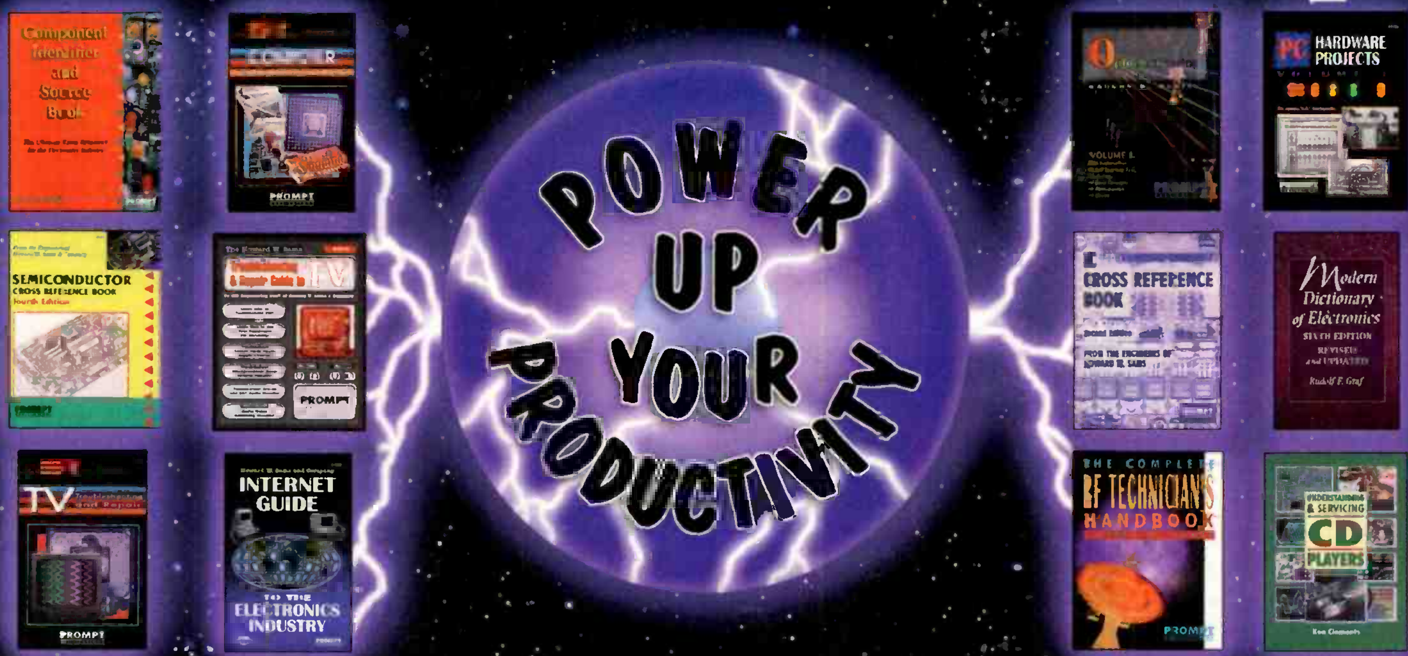

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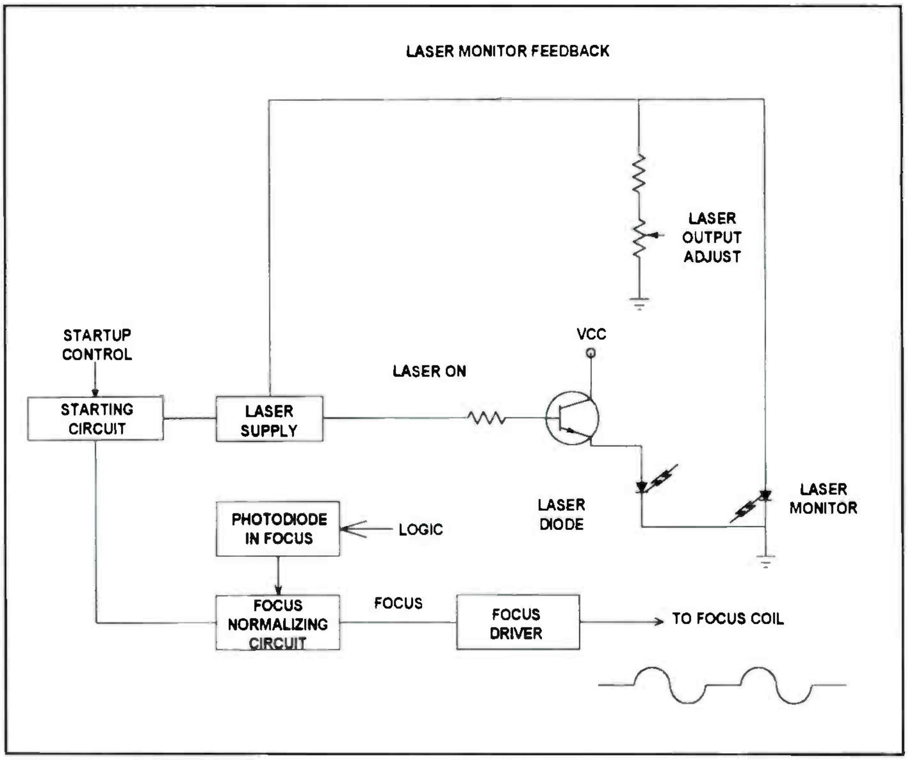

Figure 16. Once a disk has been loaded into a player, the player must go through a startup sequence, as described in the text, before the disk can be played.

this problem is to place the player in the service position. You may find it necessary to obtain extension cables in order to position the unit for service. Additionally, you may find it necessary to defeat an interlock or close the tray switch to simulate a tray-closed condition so that the optical pickup will function.

With the CD player in the service position, look at the objective lens without a disk when the unit is powered. (Again, do not look into the lens, and keep a respectful distance from it). When the tray is closed, the control microprocessor in most players initiates startup to check for the presence of a disk. Ordinarily, if there is no disk in the tray, the search function will occur two or more times. If you see the optical pickup perform its search function, it's safe to assume that startup is operational.

Next, place the unit into the service mode that turns the laser diode on. In this mode, focus search may occur several times. Even though the focus search is operating, the display indicates an error; i.e. no focus servo lock.

The cause for this problem could be that the focus servo is not functioning properly, or that the laser diode is not turning on. Check the laser output with a laser power meter or other laser detection device.

If you do not detect any laser output, the problem may be caused by a defective laser diode or it may be a laser drive circuit fault. The next logical step is to check the laser drive circuit.

If the drive voltage is correct, it is most likely that the laser diode in the optical pickup is defective. However, double check to make sure that there are no openings in the connector or flex cables before replacing the optical pickup.

Symptoms

Evaluating the symptoms of a video laser disk player or CD player that is not functioning properly can help a service technician determine where to start in performing the diagnosis/service. Following are some typical symptoms that a technician might encounter, and some suggestions as to the nature of the problem that might be the cause of that symptom.

Poor or intermittent playability

If a player won't play, the cause of the problem is usually fairly easy to isolate. Some problems, however, are not quite as easy to find. For example, if the symptom is poor playability or intermittent playability, the technician may have to bring all of his resources into play to solve the problem. For example, the player may fail to play a CD to the end, or startup may be intermittent. Another example of this type of problem is skipping.

Disks that are designed to test the performance of the player may be helpful in diagnosing such conditions. For example, let's say that the player you're servicing doesn't want to play a disk to the end. If you load in a maximum diameter test disk you'll be able to test playability at various tracking positions.

Some test disks are designed for tracking and error correction performance checks. These disks contain known faults such as scratches and smudges which can be used to test the unit's ability to correct for such errors.

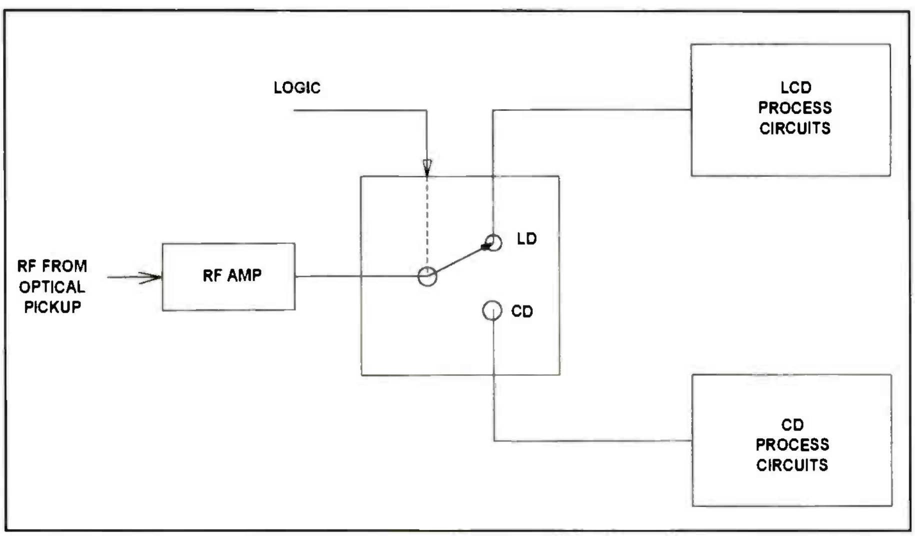

Figure 17. If you're troubleshooting a combination laser video disk/CD player, try operating the unit with different disk types in it. If the unit operates with a CD, even though it will not work with a laser disk, you have determined that the optical system is functioning properly.

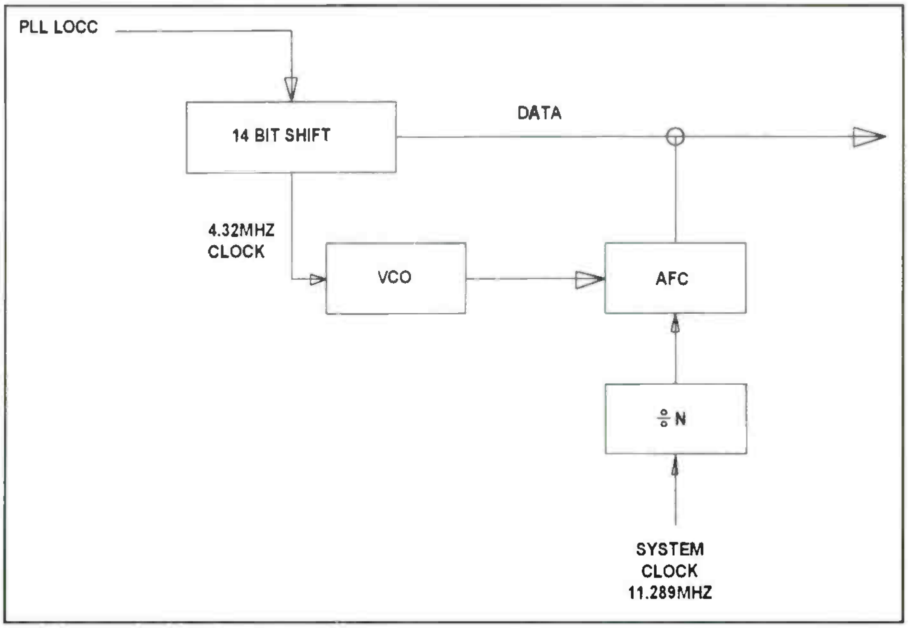

Figure 18. If the spindle servo circuit in a player is operating properly, you have learned a lot about the condition of the unit. For one thing, you know that the decoder stage for regenerating the bit clock is operating, so that can't be the cause of the problem.

It is also helpful to use the diagnostic modes to help troubleshoot such conditions. In addition, use an oscilloscope to check the condition of the signals of the servo circuits.

A look at the eye pattern on the oscilloscope screen will also help you to determine the condition of the laser pickup device and servo circuits. Jitter and distortion in the eye pattern may indicate poor tracking.

Turn the player off and inspect the optical pickup system closely. This can sometimes reveal a fault. If the objective lens is dirty, it can reduce the laser output from the objective lens, causing skipping or intermittent play.

If the lens is dirty, clean it according to the manufacturer's instructions. The optical pickup and objective lens are sensitive devices. Use only recommended lens cleaning products, and exercise extreme care in performing the cleaning to prevent damage.

Close visual inspection of the tracking mechanism may reveal a mechanical fault. Placing the unit in the tracking servo test mode may be helpful in locating a mechanical problem. Moreover, moving the tracking mechanism by hand may reveal a mechanical fault.

Poor playability may also occur if the angle of the laser beam with respect to the reflective surface of the disk is incorrect. This problem may be caused by a fault in the tilt servo in units that employ a tilt servo circuit. Implementing the tilt servo test mode may reveal the fault.

CD players generally don't have a tilt servo. If the reading angle of the laser beam in one of these units is not correct, you will usually find that the manufacturer has made some type of adjustment provision for correcting it.

A bad laser diode

A laser diode in the optical pickup that is weakening may be the cause of playability problems. If you suspect that this is the case, thoroughly troubleshoot the rest of the unit first to make absolutely sure that the problem isn't being caused by a fault elsewhere. If you don't do this, you may find that you have replaced the optical pickup unnecessarily.

Moreover, if you install a new laser diode, it may even appear that that has restored the player to proper operation even though the pickup was not the cause of the problem in the first place. A new diode, operating at highest efficiency and brightness may allow the player to operate even though the player is otherwise in less than perfect condition and there are other faults still present. If this is the case, after just a little aging of the diode, the unit may revert to the same symptoms it exhibited when it was initially brought into your service center.

Tracking faults

Poor playability or poor tracking may also be caused by faults in the tracking system. If poor tracking is the symptom in a single-beam CD player, check to see if the wobble signal is present in the radial servo loop. If the wobble signal is not present, check the radial servo circuit. In a three-beam system, performing tracking servo adjustment procedures can reveal the location of a fault.

Checking out the system after service

After completing any service, to make sure that the unit will operate properly once its owner takes it home, perform all of the adjustment check procedures to verify the unit's performance.

Finally, after completing all repairs and verifying the performance of the player, complete all of the performance and safety test procedures that are contained in the manufacturer's service manual. ■

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