

ELECTRONICTM

Servicing & Technology

NOVEMBER 1984/\$2.25

Typical problems with RCA CTC97 • Build a digitally controlled timer

Clearing up a snowy TVRO picture • Components series

Cordless telephones

The Bar Antenna which is used for RX is located inside of Portable Unit.

Incoming Message

1.6 ~ 1.8 MHz (FM)

Outgoing Message

PORTABLE UNIT

BASE UNIT

BATTERY STANDBY TALK

1 2 3

4 5 6

7 8 9

* 0 #

MEMORY-PAUSE REDIAL

PHONE

uniden

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cord

Hz AC Po

is used for Antenna (TX)

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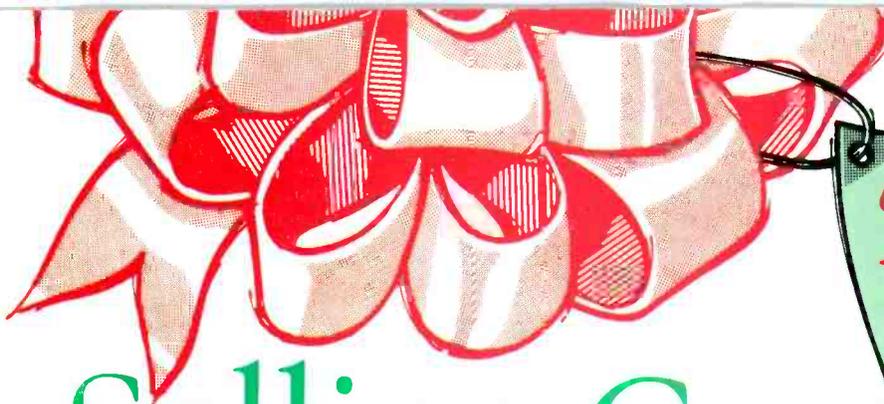
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Telephone
jack



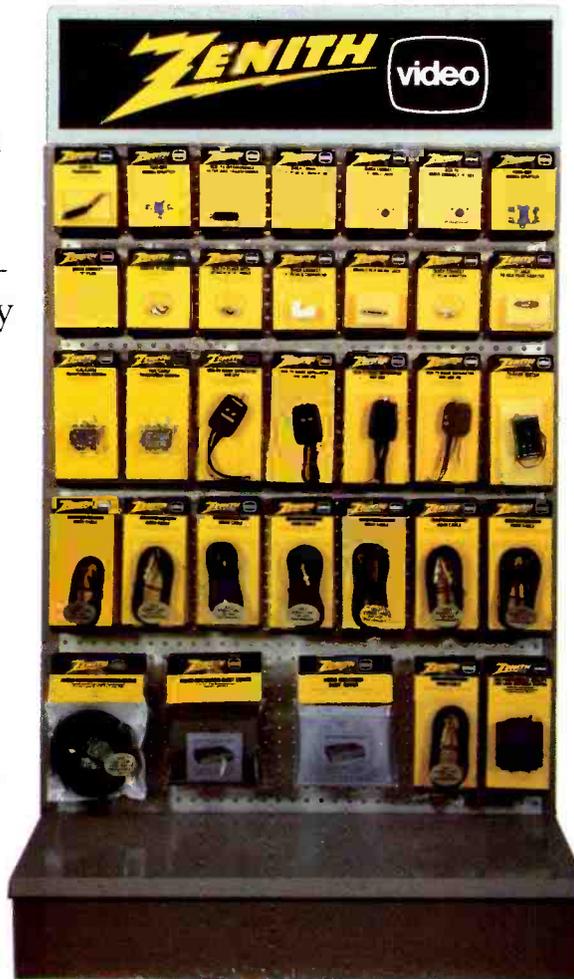
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Nick of time
for the Christmas
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Now Zenith brings you a carefully selected assortment of the fastest-moving video cassette recorder accessories, each individually packaged and labeled to sell on sight from this 54" x 36" floor display.

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Circle (4) on Reply Card

The how-to magazine of electronics...

ELECTRONIC

Servicing & Technology

November 1984
Volume 4, No. 11



Cordless telephones allow users to roam up to 1000 feet from the telephone base, unfettered by a cord. That physical freedom is bought at the cost of introducing the complexity of an FM link between the base station and handset. The article, "Operation and Servicing of Cordless Telephones", Part 1 (page 18) explains how these phones work and how to fix them. (Photograph and line drawing for composite art on the cover are presented through the courtesy of Uniden Corporation.)

8 Build this digitally controlled precision timer

By Al Gordon

A simple and fun project, this timer provides timing accuracies of better than a small fraction of a second over many hours. Complete construction instructions, illustrations, parts list and available parts sources are all included.

18 Operation and servicing of cordless telephones

By Paul Yost

With the recent deregulation of the telephone industry and the rapid flood of telephones into the marketplace, telephone servicing information has not been readily available. In the first of a 2-part series, Yost explains how the base stations of these increasingly popular cordless telephones work and how to service them.

38 What do you know about components? Neons, lasers and LEDs

By Sam Wilson

Continuing his examination of components, Wilson compares the operation of neon lamps with that of lasers and LEDs.

44 Typical problems with RCA CTC97

By Homer Davidson

Effective TV troubleshooting requires a knowledge of any unusual circuits, plus a list of the common component failures. Davidson examines these items for the RCA CTC97 chassis.

54 Clearing up a snowy TVRO picture

By Tom Moore

Finding the specific component causing a snowy picture is the key to solving problems with satellite receiver systems. This article gives some tips to help you isolate where the problem lies.

58 Test your electronics knowledge

By Sam Wilson

Do you feel overwhelmed by all the new technology today? This month's quiz reviews some basic electronics theory which relates to the new technology. Try your hand to see how much you already understand.

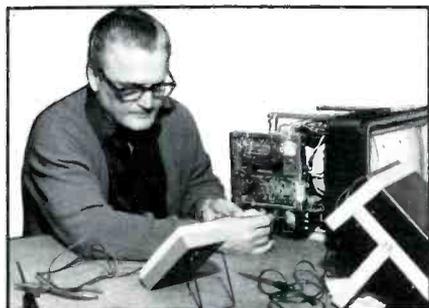
Departments



Page 8



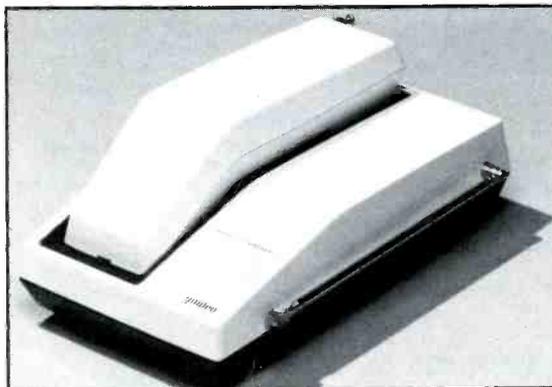
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Next month...



Part 2 of "Operation and Servicing of Cordless Telephones" will focus on the handset portion of these phones. It details the circuitry that causes the phones to ring, dial and operate at distances up to 1000 feet from the base unit. Tips for servicing the handset are also discussed.

Telephone magic

I have a wonderful instrument on my desk. I pick it up, push a few buttons, and I'm in contact with almost anyone, anywhere in the world. It's called a telephone.

But wait a minute. If I disconnect my telephone from the modular plug on the floor, it doesn't work at all, which points out a truth that we frequently fail to think about. Although the telephone, an evolutionary relative of Alexander Graham Bell's invention, is indeed a technological marvel, it's not the telephone itself but the telephone *system* that allows me to be in contact with the world.

As with so many other phenomena, both natural and man-made occurrences, most of what actually makes the telephone work lies hidden from sight. More than half of an iceberg, they say, lies underwater. The root system of a tree extends farther under ground than the limbs do above it. A modern building is supported, not by its gleaming marble facade, but by the network of steel girders hidden from sight.

So it is with the telephone. When you make a phone call, the tones or pulses you generate do nothing until they reach the telephone company exchange, where they are converted to switch positions. It's what happens once the call gets beyond the telephone exchange that is truly a marvel. Of course, if it's just a local call, it will probably just travel over another set of wires to your neighbor.

But if it's a long-distance call, that's when the magic truly begins. The call will probably be multiplexed; that is, it will be grouped together with many other telephone signals into a single, complex, broadband signal. Then that signal might be transmitted via wires, microwaves, optical fibers or satellite. And depending on how the call is routed, it might be multiplexed as part of one group for part of its distance, then demultiplexed and made part of another group for another part of its journey.

All of this happens apparently instantaneously, and the person you speak with sounds just like a next-door neighbor. Now that's magic.

Modern cordless telephones add to the magic. Now it's even possible to communicate over a distance of up to 1000 feet between the handset and the base, without a cord, via FM. And for the most part, the size of the unit is similar to a standard phone, and, to the caller, the unit operates just like a standard phone. If you're interested in having a look behind the scenes to see how these new cordless types work and how to fix 'em, turn to page 18 in this issue.

Nils Conrad Persson

ELECTRONIC

Servicing & Technology

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FLUKE®

Marriage of computer and audio technology Floppy audio disk

A home digital audio recording and playback system that stores music in digital form on a Floppy Audio Disk has been introduced by CompuSonics, a new professional and consumer electronics manufacturer and marketer.

The DSP-1000 allows consumers to make home digital recordings from any digital or analog source (such as compact discs, radio, records, cassettes and live music), storing it in digital format on a high capacity floppy disk. These recordings never encounter most of the problems inherent in analog recording equipment—wear, deterioration, drop outs, tape hiss and surface defects.

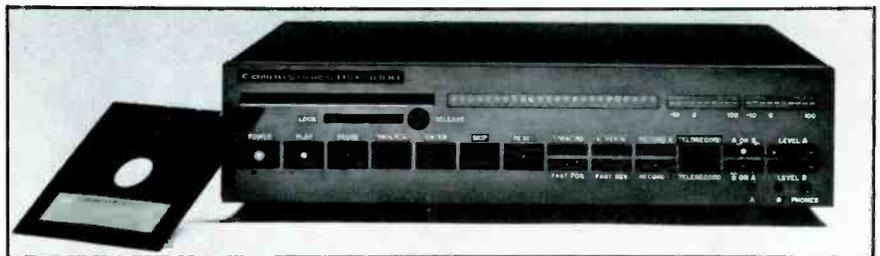
The company plans to distribute the digital recording system through high end audio dealers during the first quarter of 1985. It is compatible with all conventional stereo components, and employs features not found on analog audio cassette recorders.

The DSP-1000 will enable consumers to record up to one hour of music on a disk. Function controls include forward, reverse, fast forward, fast reverse, erase, reset, program, enter, skip, telerecord and play. The unit also features a scrolling LED text display that allows the consumer to interact with the system.

"The development of the CompuSonics System makes true digital recording capability available to the consumer market for the first time, and as such, represents a significant achievement in the history of audio," said David Schwartz, CompuSonics president. "The system heralds the arrival of a bold new era in the audio industry, one that marries computer technology and audio technology together for the first time

SYSTEM SPECIFICATIONS	
Hardware	
Single chassis containing:	
Single board computer with expansion bus	
Superfloppy disk drive with controller	
RCA jacks	
Power supply	
Computer interface	
Communications interface	
Performance	
System	floppy digital audio system
Disk	superfloppy
Head	gumball head type
Spindle speed	360 r.p.m.
Scan velocity	2.6 feet per second
Error correction	computer generated 48 bit polynomial
Numbers of channels	2
D/A conversion	16 bit linear
Frequency response	10 to 20,000 Hz \pm 0.5dB
Harmonic distortion	less than 0.007% (1kHz)
Dynamic range	more than 91dB
Signal to noise ratio	more than 91dB
Channel separation	more than 91dB
Wow and flutter	below measureable limits

Tables list the components of the DSP-1000 and show system performance factors, according to the manufacturer.



Home digital disk audio recording and playback system, the CompuSonics DSP-1000, allows consumers to make home digital recordings from any digital or analog source.

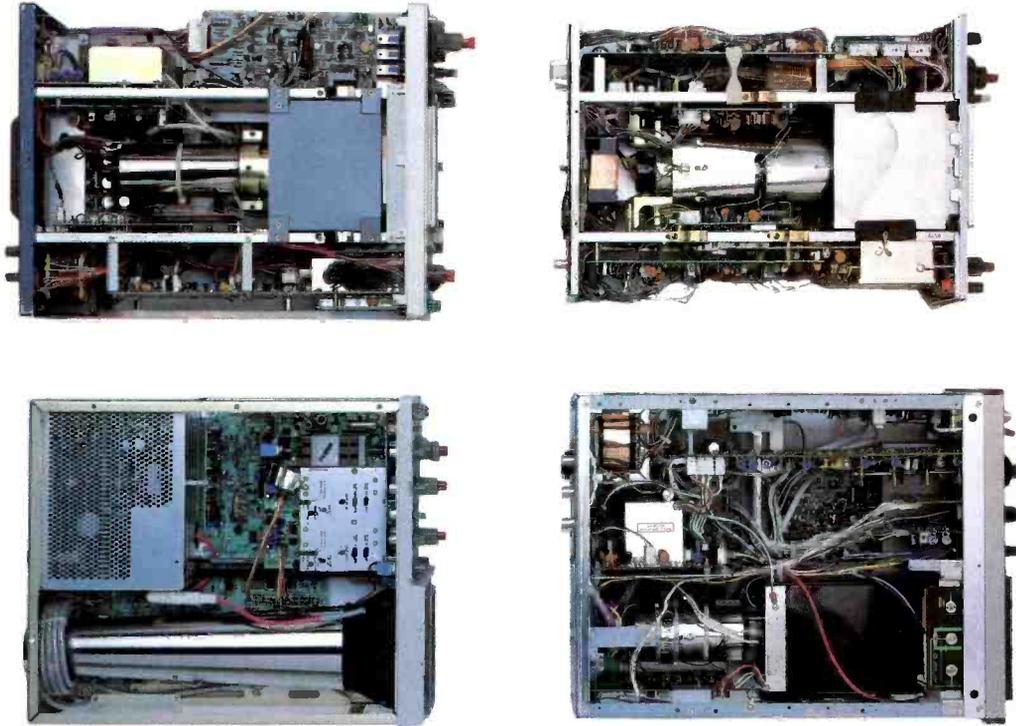
in one consumer electronics product. A product that offers both immediate and future benefits."

The DSP-1000 has the built-in capability to receive the digital transmission of music from remote data bases. In other words, it would be possible with this product to call up your local music store and have the latest rock music album sent to you via telephone line, right to your blank floppy disk. In addition, the unit has the capability to interface with the IBM Personal Computer, giving

the user the capability to become involved with home music editing, music synthesis, restoration of noisy source material and high capacity data storage.

Blank disks for the system will be available at the same time the hardware unit is delivered at retail, and through the same distribution outlets. Although prices have not yet been finalized, it is expected that the recorder will carry a suggested retail price of \$1200, and individual disks will retail for \$6.

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The industry's first three-year warranty† is testimony to 2200 Series dependability. Adding value to value are a variety of optional service plans that can economically extend this coverage to five years.

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now in downtime, in service, in back-up scopes. On the bottom line, a Tek 2200 Series scope will save you money, time and trouble now and in the years to come.

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Circle (6) on Reply Card

Tektronix
COMMITTED TO EXCELLENCE

Build this digitally controlled precision timer

By Al Gordon

RC-controlled IC timers are useful. That is, until timing tolerances of better than about two percent, or long timing periods are required. Capacitor leakage, tolerance variations, dielectric absorption, and temperature variations for both timing resistors and capacitors, in addition to inherent IC problems, such as threshold and discharge pin bias currents and power supply changes during the timing interval, all play a role in reducing the timing accuracy of these RC configurations. And even with precision components, two percent accuracy translates to a 72-second error in just one hour. What to do? One solution is to go crystal-controlled digital.

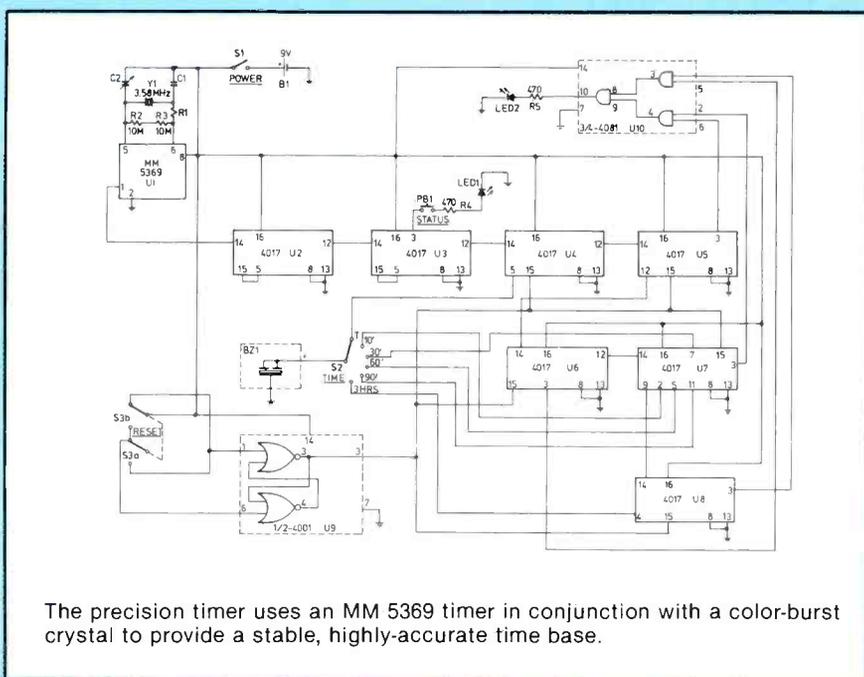
This project provides timing accuracies of better than a small fraction of a second over many hours; and if you are near a Jim-Pak distributor or a Radio Shack store, you should have little trouble in obtaining the parts to build it. Furthermore, the project can be easily modified to provide alternate selectable timing periods and the output can be used to drive relays, incandescent bulbs, or other logic in addition to the piezo buzzer used in this project. The precision timer is readily usable for many applications, such as in a darkroom, as an amateur radio/CB ID or repeater timer, in the kit-

chen, when studying, or in many other situations which require a specified timing duration.

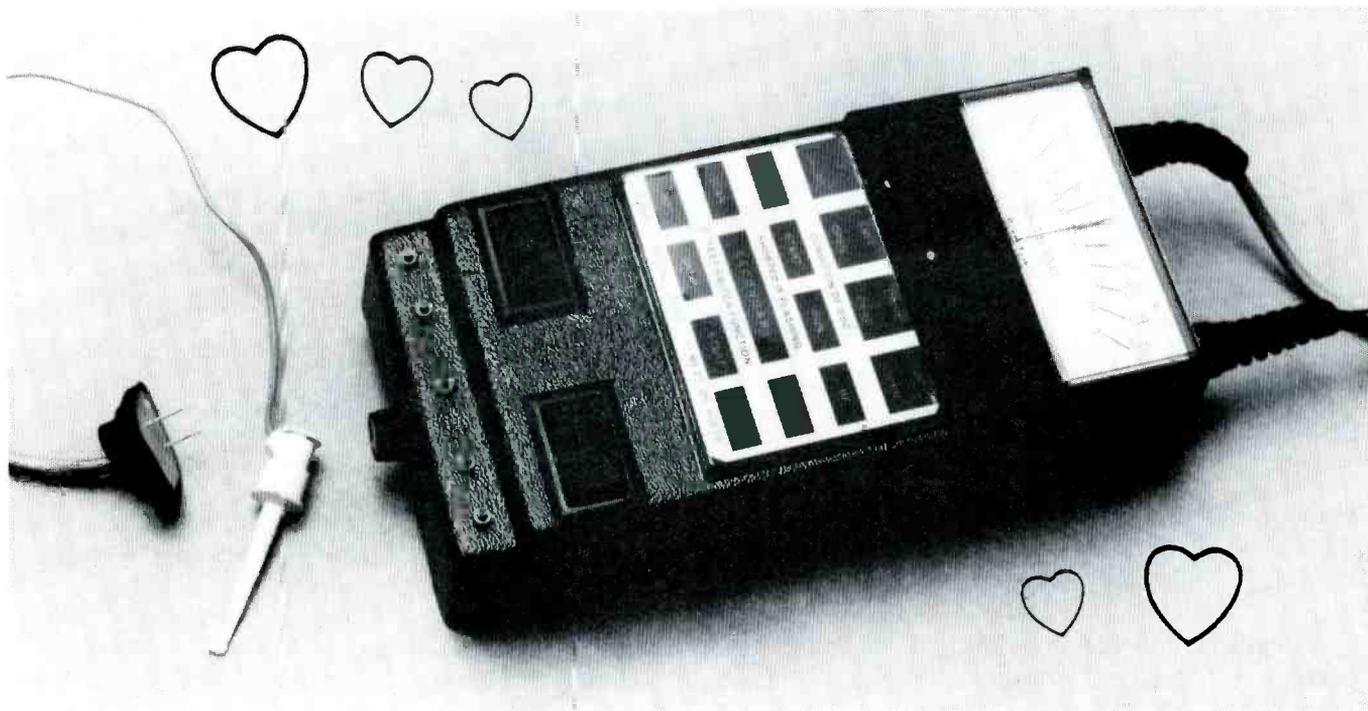
Refer to Figure 1. The heart of the precision timer is U1, a type MM5369 combination oscillator/divider. Y1 produces a 3.579545MHz reference for the oscillator that is trimmed by variable capacitor, C2. Internal to U1 is a module 59,659 divider which produces a 60Hz, 50 percent duty-cycle square wave at pin 1. Asynchronous counters U2 through U8 are 4017 divider/counters and are ripple configured: the carry output of one (pin 12) sequencing the clock input of the next one (pin 14) in cascade. U2 and U3 are divide-by-6 counters while U4, U5 and U6 are pure decade counters. Division is further accomplished by U7 and U8, and the decoded outputs are brought out to S2, which selects the appropriate pin that directly drives BZ1.

U9 is a 4001 Quad 2-input NOR gate chip, half of which is wired as an RS latch debouncer for S3, which pulls the reset inputs of U4 through U8 low when the switch is actuated. Confirmation of this reset occurs via U10, a Quad 2-input NAND gate in which three gates over two logic levels light LED2 for five seconds, confirming the zero setting on the counters.

During the course of the timing interval, proper functioning of the



The precision timer uses an MM 5369 timer in conjunction with a color-burst crystal to provide a stable, highly-accurate time base.



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(FOR START UP, SHUT DOWN OR ANY HV RELATED PROBLEM)

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Remove the TV set's Horiz Output Transistor, install Super Tech's Interface Plug in the now empty socket then, make one ground connection. Hook up is universal, no other connections are required.

WHAT HAPPENS NEXT WILL ASTOUND YOU

(Con't. on Page 10)

(Con't from Page 9)

SUPER TECH MARK IV

TAKES LESS THAN 30 SECONDS

TO ACCURATELY

CHECK OUT THE ENTIRE CIRCUIT !

This includes the Primary LV Supply, Regulated LV Supply, Horiz Osc and Driver, Horiz output Circuitry, Initial Start Up Circuit, B+ Resupply or "Run" Circuit, HV Multiplier, Entire Flyback (every aspect), The Yoke, Each and Every Scan Derived B+ Source, and all Shut Down Circuits.

After checking the above circuits, it will then "power up" the TV set and allow you to visually observe the operation of all other circuits on the set's CRT. (Even in cases where a Shut Down, Start Up, Osc Driver, LV Regulation, or B+ Run Supply Problem, or combination of problems exist, it will still power up the TV set). This allows you to verify tuner, audio, Video, Chroma, AGC, ABL, etc. for accurate estimates !

In the process, it will light up the title of those circuits that are working in green and, indicate the circuit or circuits that are not working with either a red or an unlit green light.

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Super Tech is so totally accurate, it will spot such things as a Dynamic Short in the 2nd Anode of a CRT. If a circuit that relies on Scan Derived B+ is shorted, Super Tech will tell you so. In most cases, it will also tell you which of these circuits is shorted. Its Flyback test is so sensitive and accurate it will even spot Hi-Voltage Arcs. Flybacks with integrated Triplers pose no problem for Super Tech. In less than five seconds, the Mark IV Super Tech will spot any type of a shut down problem, even those that are being caused by a shorted CRT, Vertical, Video, or Color Output circuit, and tell you which circuit(s) are causing the set to shut down. From beginning to end, the entire test sequence takes less than 30 seconds.

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It will arrive in less than ten days. The very same day as it does, locate a working TV set to use for test purposes.

(RCA CTC 85 thru CTC 125 Chassis are good candidates but any set that uses a Horiz Output Transistor will do just fine.)

NEXT, SIMULATE THE FOLLOWING PROBLEMS BY USING CLIP LEADS.

- Short the 2nd Anode to Chassis Ground.
- Short the LV Regulator (E to C or A to K).
- Short some (or all) of the Flybacks Secondary Windings to Chassis Ground.
- Disconnect the B + "Run" Supply for the osc / driver circuit.
- Disconnect the Emitter to Ground Circuit for the Horiz Output Transistor
- Open the Primary LV Supply
- Disable the Driver Circuit for the LV Regulator.
- Disconnect one side of the Damper Diode.
- Short out the Initial Start Up Circuit
- Short out the Horiz Driver (E to C).
- Short Across the Horiz Yokes Discharge Capacitor.
- Short across the Fail Safe, Shut Down or X-Ray Protect Transistor or Zener (E to C or A to K).
- Short across the Primary of the Flyback.
- Short out a Vertical Output Transistor.
- Short out a Color Output Transistor.

Do all of the above simultaneously or create each of the above problems one at a time

— it won't make any difference to your Super Tech. Because of Super Tech's inherent design, neither the TV set nor the computer can be damaged even when all of the above problems exist. Just hook it up properly and follow the simple step by step instructions.

Once these problems have been simulated, spend just two hours with your Super Tech practicing how to troubleshoot them. If you have any problems or questions call us for assistance. We will explain to your satisfaction exactly what you are doing wrong.

If at the end of just two short hours of practice, you are unable to diagnose any of the above problems **one at a time** in less than 20 seconds or, all of them **at the same time** in less than 60 seconds, don't even bother to keep your Super Tech overnight. Super Tech is easier to use than any other piece of test equipment including scopes, analysts, generators, flyback ringers and even most meters. Most technicians are all but totally familiar with using their Super Tech in only fifteen minutes. If you haven't learned to use yours in two hours - - - perhaps you never will. If this is the case, put your Super Tech right back in its box and return it immediately. We will very promptly refund all of your money including postage both ways. All we ask is that you hook it up properly and follow the simple step by step instructions that come with your unit. If you do, you will immediately fall in love with your Super Tech ♡♡ sigh !

Super Tech sells for only \$995.00. If you consider the amount of time, effort and headaches it will save you, then add those savings to the amount of additional profit it will earn you, Super Tech is truly the greatest bargain in test equipment today.

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If you have any doubts as to whether Super Tech can do what we have stated, if you have any reservations as to whether or not you could learn to use one, if you think that our claims are exaggerated or overstated in any way, we will be happy to send you an actual instruction manual. This in itself will convince you.

To order your Super Tech call (806) 359-1824

For an instruction manual circle (8).

Build this digitally controlled precision timer

oscillator and the divider chain is confirmed through U3 by test light LED1 which flashes at a 1.75Hz rate when PB1 is depressed. R4 and R5 limit the current through these monitor LEDs.

Constructing the timer

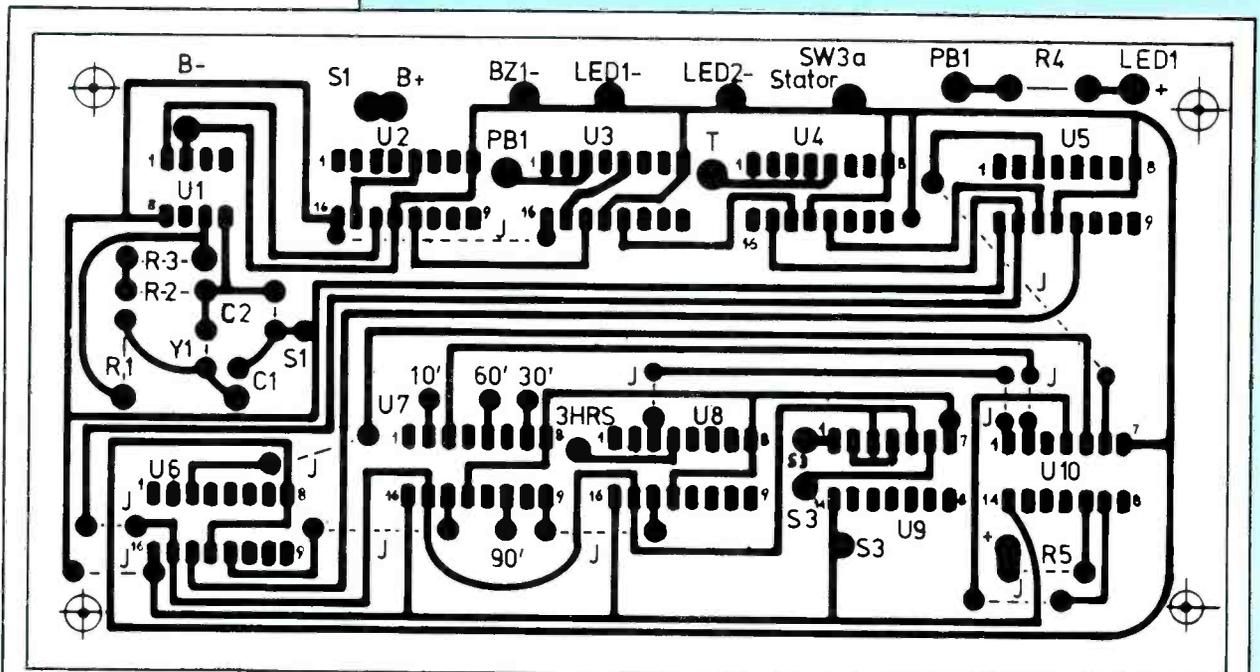
Construction is not critical. The PC layout indicated in Figure 2 is only a suggestion, as practically any arrangement is acceptable. If you choose to follow the layout exactly, transfer the PC pattern onto a 3" x 6" single-sided board. After preparing the board, mount the resistors, IC sockets, fixed capacitor C1, crystal and trimmer capacitor C2 onto the board. Then solder the required jumpers on the top side of the PC board and one end of several-inch lengths of hookup wire from the top of the PC board onto the alphanumerically designated pads. The free ends of the wires will be connected later to B-, B+, S1, BZ1, LED1, LED2, SW3, PB1, S2, as well as the T, 10, 30, 60, 90 and 3 hour terminals of S2. Don't forget the ground return wires for LED1, LED2, BZ1 and S3a. Figure 2 shows the connections on the board for these wires. Install all ICs in their sockets, taking precautions not to generate any electrostatic discharges, as they are all

CMOS devices.

The case for this project prototype is the LMB CR-632, although any suitable plastic or metal container may be used. Holes should be drilled in the case for mounting the PC-board spacer screws, S1, S2, S3, PB1, LED1, LED2, screws to mount BZ1, and the screw holes for the 9V battery holders. Holes should also be drilled so that the leads from BZ1 may enter the case interior from the outside, preferably through a grommet. The panel markings may then be applied and the switches, LEDs, buzzer, and battery holders may be mounted to the case. The PC board should be installed on 1/4-inch spacers in the bottom of the case.

Starting it up

Connect the 9V batteries and turn the power on. Turn S2 to T. BZ1 should sound for about one second at about four-second intervals. This confirms the proper operation of the buzzer. Turn S2 to the 10-minute position and actuate momentary toggle switch S3. LED2 should light for about five seconds and then go off, indicating that the counters have reset to zero. Press PB1. LED1 should flash at about 1.75Hz rate, indicating that the oscillator and



PC board layout is not critical, as even point-to-point wiring may be used successfully. Component and jumper notations show where the board connections are made for the various switches and indicators.

"CONIFER IS THE TOP OF THE LINE OF OUR HOME SATELLITE TV SYSTEMS"

During the Past Year 85% of Wes Hunter's Home Satellite TV Systems Sales Have Been Conifer Packages.

Wes Hunter, owner of Hunter's TV and Satellite, Inc., and Dave Cottrell, general manager, selected the Conifer Home Satellite TV System to replace the existing equipment they had been selling. Today, Conifer's DE-2001 System is their top-selling home satellite TV system.

WHAT DO YOU LIKE ABOUT CONIFER'S DISH?

Cottrell: I liked the Conifer mesh antenna when I first saw it. I like the way the screen is attached to the petals...all you have to do is assemble the petals to each other. It's lightweight and aesthetically, it looks very good. It comes in several colors so you can blend the dish into any surrounding, plus, it has a low wind factor. The average installation of the antenna for two of our men is two hours, excluding concrete work.



LEFT
WES HUNTER

RIGHT
DAVE COTTRELL

HUNTER TV
Muscatine, Iowa

HOW DO YOU MARKET THE CONIFER DISH IN YOUR AREA?

Cottrell: Today there's a lot of confusion in the marketplace. Some people are selling low priced satellite systems with claims of crystal clear reception. The average consumer doesn't know what he's buying. We have a lower priced system on display and we show the consumer the quality of the pictures of that system compared to Conifer. Conifer shows the best picture. 85% of our customers buy the Conifer system!

WHAT DO YOU THINK OF CONIFER'S DEALER READY CONCEPT?

Cottrell: It's unique. Everything comes to us in one package, the dish, feedhorn, 100k LNA, cables, motor drive, receiver, it's all right there. The receiver incorporates the motor drive control and power supply. And, with the one piece cable, everything plugs together, you don't have to worry about connecting separate wires.

WHAT DO YOU THINK OF CONIFER'S RC-2001 RECEIVER?

Cottrell: The most popular receiver feature is the satellite A or B switch which allows the consumer to push either button and select his favorite satellite. It's very popular among the buyers. The receiver is a good looking piece with everything built right in.

WHAT ABOUT CONIFER'S SERVICE?

Hunter: We really can't say enough about how well the people at Conifer treat us. They're a service oriented company. They give us a two to five day turnaround in repair service. I've never dealt with a company that has given us such consideration. Their one year warranty policy is top notch.

WHY DO YOU RECOMMEND CONIFER?

Hunter: We get literature from a lot of TVRO companies. You don't know if these people are working out of their garage or if they really are a legitimate TVRO company. We've seen a lot of TVRO companies come and go the past five years. Conifer is in the business for the long run. We've seen their facility. We've seen their antenna manufacturing operation. As far as we're concerned Conifer is going to be around for a long time.

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Circle (9) on Reply Card

Build this digitally controlled precision timer

first dividers are functioning. Successful completion of the above tests indicate that the timer is operating normally.

Next, the crystal oscillator should be calibrated, although a non-calibrated oscillator will provide fair accuracy. Attach an accurate frequency counter to pin 7 of U1. Turn both the counter and the precision timer on and allow about a 30-minute warmup. Make certain the counter is grounded to the common of the timer (the grounded center connector of S3 is a good place). Adjust C2 with a non-metallic alignment tool until the counter reads 3.57954MHz.

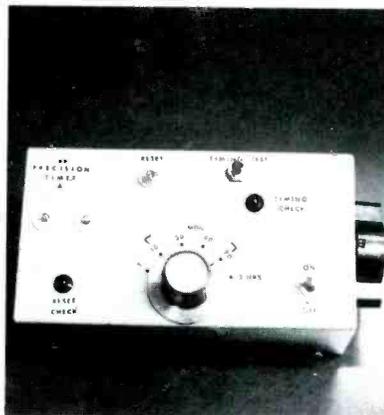
Operation

The rotary switch selects the piezo sounder mode. In the *T* (for *test*) position, BZ1 will sound for about 3.5 seconds to verify proper operation. The other positions select the timing intervals from 10 minutes to three hours. To actuate

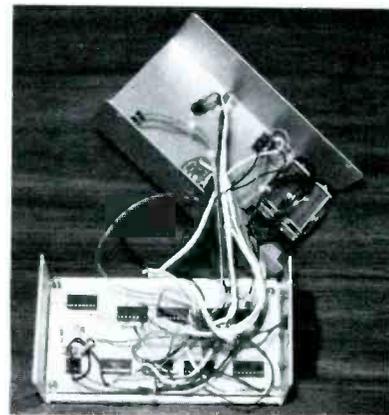
TIME	IC, PIN #
20'	U7, pin 4
40'	U7, pin 10
50'	U7, pin 1
6 hrs	U8, pin 10
9 hrs	U8, pin 5
12 hrs	U8, pin 9

Optional times besides those shown on the schematic may be programmed by connecting different IC pins to the rotor of S2 by using this table.

the timer, throw the *reset* toggle switch S3 to its momentary position. Timing begins upon release of the switch. While S3 is actuated, and for about five seconds after its release, the *reset check* LED2 will light to verify zeroing of the counters. During the timing interval, proper counting operation can be verified by pressing the *timing test* push-button PB1 which causes



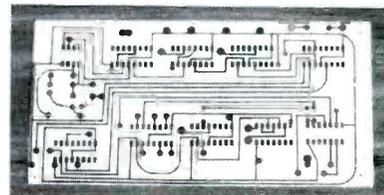
The precision timer provides accuracy to within a few parts per million using readily available parts.



Two 9V batteries were used in the prototype, although a single battery will provide operation for a long time. Current draw is 10mA when the buzzer is sounding, and less than 1mA while timing.



Drill all the holes in the cabinet prior to lettering and coating with a protective Krylon coating.



The PC board shown is ready for removal of the etch resist. Either direct or photographic methods may be used for the timer project.

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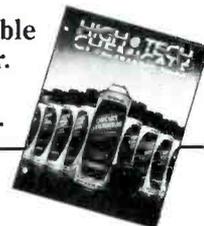
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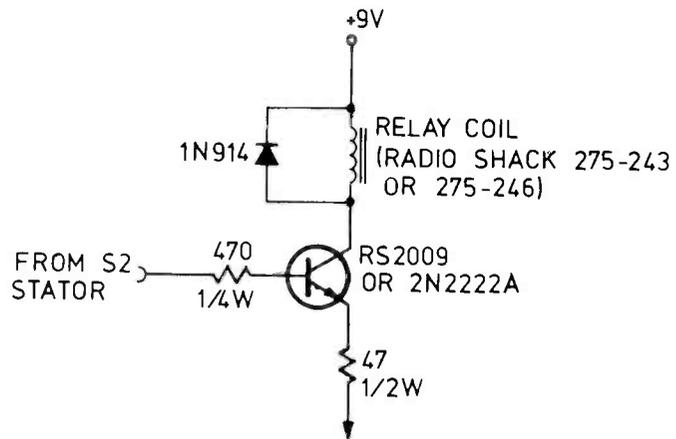
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Build this digitally controlled precision timer



Besides a piezo buzzer alarm, other devices may be triggered by the precision timer such as this 5V relay which may control high current devices.

DESIGNATOR	PARTS LIST DESCRIPTION	AVAILABILITY CODE
R1	1K Ω , 1/4W resistor	all
R2,R3	10 M Ω , 1/4W resistor	2,3,6
R4,R5	470 Ω , 1/4W resistor	all
C1	47 pF disc capacitor	all
C2	5-60 pF trimmer capacitor	1,2,3,4
U1	MM5369 oscillator/divider	3,4,5
U2-U8	4017 decade counter/divider	all
U9	4001 Quad 2-input NOR gate	all
U10	4081 Quad 2-input AND gate	2
S1	SPST toggle switch	all
S2	6-position rotary switch	2,3,4
PB1	SPST push-button switch	all
S3	DPDT momentary toggle switch (Alcoswitch MTA-206R; C/H JMT-226; Calectro 35-014; Sprague QSP-1119-01, or equivalent)	4
BZ1	Piezo buzzer	1,2,3,5,6
LED1, LED2	Standard LED and holder	1,2,3,5,6
Y1	3.579545 MHz Crystal	2,3,4,5,6

Miscellaneous Items: 9V battery holders and snaps, case (LMB CR-632, or equivalent), knob, IC sockets, grommet

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- Mail sources**
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415-592-8097
 - 4 Circuit Specialists
P.O. Box 3047
Scottsdale, AZ 85257
800-528-1417
 - 5 Digi-Key Corporation
P.O. Box 677
Thief River Falls, MN 56701
800-346-5144
 - 6 Edlie Electronics
2700 Hempstead Turnpike
Levittown, L.I., NY 11756-1443
516-735-3330

the *timing check* LED1 to flash on and off. The buzzer will sound at the end of the timing interval.

Variations

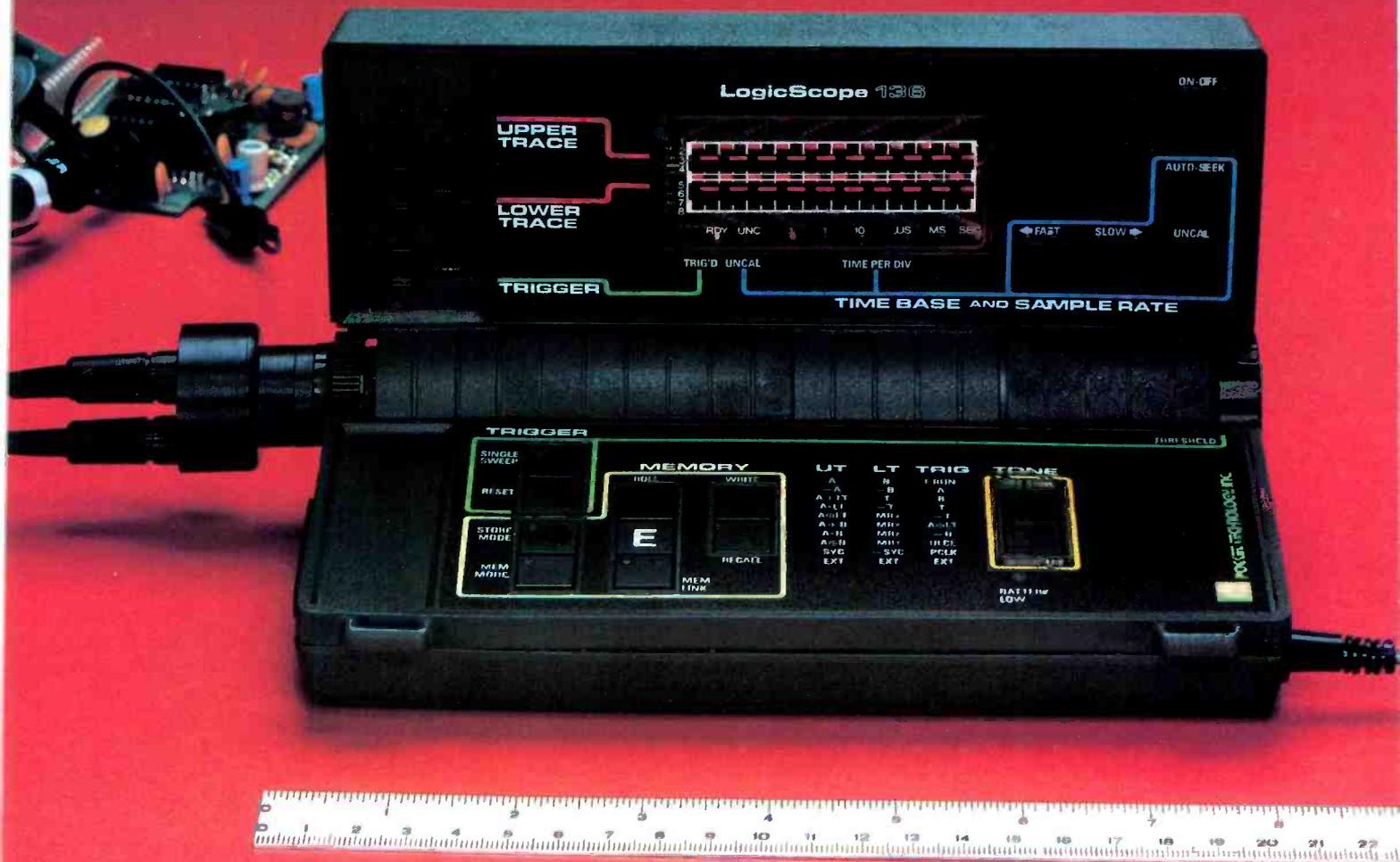
Other options are available for the timer. Figure 3 shows a table which lists optional time periods and the IC and pin numbers, which should be brought to S2 in the event that different times are desired. Another possible modification is the use of a 12-position rotary switch (such as a Radio Shack 275-1385) for S2 to provide more available time options. Also, the timer output can be used to drive LS (low power Schottky) TTL loads, a transistor

switch or any other output which draws 12mA or less. As an example, Figure 4 shows a transistor switch driving a relay if higher current control is desired. Also, if the piezo buzzer is used and is to remain on for long periods of time, a 100 Ω resistor should be placed in series with BZ1. If BZ1 is not on for long time stretches, a single battery may also be used instead of the two-battery arrangement of the prototype.

This project has a wide variety of uses, limited only by the imagination of the builder, and provides yet another example of improved accuracy and resolution by going digital.

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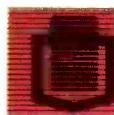
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Operation and servicing of cordless telephones

Part One

By Paul Yost

For many decades, if you wanted telephone service in your home or business, you had to lease your telephone. You had no choice because ownership wasn't allowed. Also, selection and style were extremely limited. Wall or desk-mount in basic black was just about it.

Then a few years ago, the FCC deregulated the telephone industry, allowing consumers to own their telephones. This opened up a whole new industry for both manufacturers and services. Many new types and styles of telephones came into being. Everything from sophisticated, hi-tech telephones with microcomputer control to decorative Mickey Mouse telephones appeared. Perhaps the most interesting and innovative of the new phones to appear is the cordless telephone.

What is a cordless telephone?

A cordless telephone is a modern communications device that offers telephone service with the added convenience of wireless portability. It consists of two main parts: a base unit that connects directly to the incoming telephone line and a

handset, or portable unit, that the user talks and listens with. (See Figure 1.) It is a *cordless* telephone because there is no interconnecting cord between the two units. They are instead *connected* via a low power, duplex FM carrier system that allows both parties to talk and listen at the same time (the way a normal telephone conversation occurs).

The most surprising thing about cordless telephone servicing is the amount of test equipment you don't need.

Because there is no cord, the user is free to move about his home or neighborhood up to a range of 1000 feet. And, because cordless phones are classified as low power, an operator's license is not required by the user.

Most cordless telephones produced until this year operate on frequencies in the 1.7 and 49.8MHz bands. Today, there are more than 10 million in use in the United States, with about two million additional ones being sold each year. Recently the FCC allocated additional spectrum at 46 and 49MHz, but because most cordless telephones currently in the field are 1.7 and 49MHz, this discussion only covers these.

Getting started

The most surprising thing about cordless telephone servicing is the amount of test equipment you *don't* need. Although there is a multitude of test equipment available to aid the cordless telephone servicer, (some pieces made specifically for cordless telephone servicing) you really only need four pieces of equipment to properly do the job:

- 50MHz oscilloscope
- volt-ohmmeter
- frequency counter (50MHz minimum)
- FM deviation meter

I want to stress here that the oscilloscope *must* be of 50MHz bandwidth minimum. You will not be able to get by with a 10, 20, or 30MHz bandwidth. Also, the VOM must have a minimum isolation impedance of 1M Ω . Anything less may load down some of the more sensitive circuits and give you an inaccurate reading.

Of the four pieces of test equipment needed to service cordless phones, three of them are general purpose test equipment commonly found on a test bench. The only exception is the FM deviation meter.

Basically, an FM deviation meter is a modulation meter. It measures the amount of FM modulation on a carrier. This meter is used to set the modulation levels of both the handset and base, making

Editor's note: This is the first installment of a 2-part article that describes the theory of operation and some adjustment and servicing procedures for today's cordless telephones. This first segment deals primarily with the circuitry of the base unit. The portable handset portion will be treated in detail next month.

Operation and servicing of cordless telephones

(10.695MHz and 10.240MHz) and one output (the audio). If the two inputs are present, but there is no output, the IC is defective and should be replaced.

TR3, TR4, and TR5 are the audio amplifiers. The audio from pin 9 is amplified in turn by each of them, then inductively coupled through transformer T1 to the telephone line to be heard by the other party.

In many ways, the receiver circuitry is similar to most types of superheterodyne FM receivers.

In many ways, the receiver circuitry used in this and other cordless phones is similar to most types of superheterodyne FM receivers. It is straightforward and simple in design and layout, yet still well-engineered and reliable.

Receiver alignment

Receiver alignment for this unit is easy to perform. Just follow these steps:

1) Take the handset unit (once you have verified that it is operating properly), turn it to the *talk* mode, then set it next to the base receive antenna.

2) Connect the oscilloscope probe to the input (pin 16) of IC1.

3) At this point, you should see the 10.695MHz IF signal on the oscilloscope screen. It should be 0.1 to 1V peak-to-peak in amplitude. Actual signal strength depends on the current base alignment and

proximity of the handset.

4) Adjust L2, L3, L4, and L9 for maximum signal indication at pin 15. (Note: The local oscillator, TR6, may be unstable at maximum signal. When adjusting L9, adjust for maximum indication, then back up 1/4 turn for stability.

The FM discriminator used in IC1 is the quadrature type (the same type used in many TV sets) and the quadrature coil is L5, located on pin 8. The best way to set L5 is by monitoring the audio output at pin 9. All handsets on the lower frequency cordless phone models transmit a constant pilot tone in the audio range. For Uniden phones, this tone is at either 5.3, 6.0 or 6.7kHz, depending on the unit's security or P code. At the output on pin 9 should be the detected pilot tone. On your oscilloscope screen, it will be approximately 0.2V peak-to-peak. Adjust L5 to where the pilot tone looks most like a sine wave (least distortion) at maximum amplitude. This completes the receiver alignment. (If it sounds easy to do, that's only because it is.)

Pilot tone

As mentioned earlier, the handset not only transmits voice audio to the base, it also transmits a pilot tone. The pilot tone serves two purposes. First, it provides access security for the base, and second, it is used in the dialing process.

The pilot tone is processed and demodulated the same way the voice audio is by IC1, except that it does not continue on to the telephone line. It is stopped by a 3.5kHz low-pass filter network (L6, C19, C20, and C21) between TR3 and TR4. The voice frequencies are below 3.5kHz and pass through the filter with little or no attenuation. However, the pilot tones are approximately twice the cutoff frequency and do not pass through.

The reason the pilot tone is stopped or filtered out is because we do not want it to be heard on the telephone line. Because the pilot tone is in the audio range, it would easily be heard as a loud, annoying, high-pitched whistle in the background of the conversation if

it got through. This would be undesirable. Instead, the pilot tone is directed to the input (pin 3) of IC2, the *tone decoder*.

A tone decoder is an IC circuit that has gained a lot of popularity in the last few years with both hobbyists and professionals for use in remote control applications. A tone decoder is designed to react to one, and only one, input frequency. The frequency it *listens* for is known as the *capture frequency* and is variable over a range from a few cycles up to 500kHz. The capture frequency is determined by the resistor/capacitor values connected to pins 5 and 6. On this model, VR2 controls the value of capture frequency listened for, which in our case, is the frequency of the pilot tone.

When the proper pilot frequency is received, this causes pin 8 to go from a logic 1 condition (+8V) to a logic 0 (0V). Pin 8 provides the base bias or turn-on voltage for TR8. When pin 8 goes low, TR8 shuts off. While it is conducting, TR8 along with R45, 46, 47 and 48 creates a voltage divider network that provides the proper base bias to turn on TR9. So when TR8 shuts off, this bias is lost and TR9 shuts off also. When TR9 shuts off, this turns off TR10. TR10 controls TR11 in the same manner TR8 controls TR9, so when TR10 shuts off so does TR11.

While it is on, TR11 provides an emitter-base short across TR12. This keeps TR12 off. When TR11 shuts off—which it does when the proper pilot tone is received—TR12 is no longer shorted out and starts to conduct. The emitter of TR12 goes to +Vcc and its collector connects to the relay coil of RL1. TR12 turns on the relay to connect the base unit up to the telephone line and activate the rest of the base circuitry.

To briefly reiterate, when the proper pilot signal is received by the tone decoder, pin 8 goes low. This turns TR8, TR9, TR10, and TR11 off which then turns TR12 on. TR12 then activates the relay and the rest of the base circuitry.

This is the security feature for this device. Not only must a cordless phone base receive a transmis-

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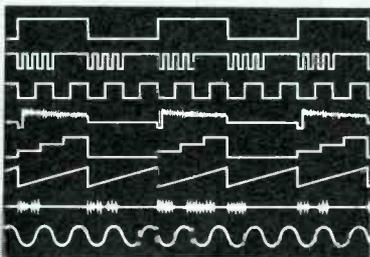
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Operation and servicing of cordless telephones

sion on the proper channel frequency, the carrier must also contain a pilot tone at the correct frequency. Both of these must be present to access the base.

At first glance, it may seem rather unusual and wasteful to turn four transistors off just to turn one on. The base of TR12 could be directly connected to the output (pin 8) of IC2 and give the

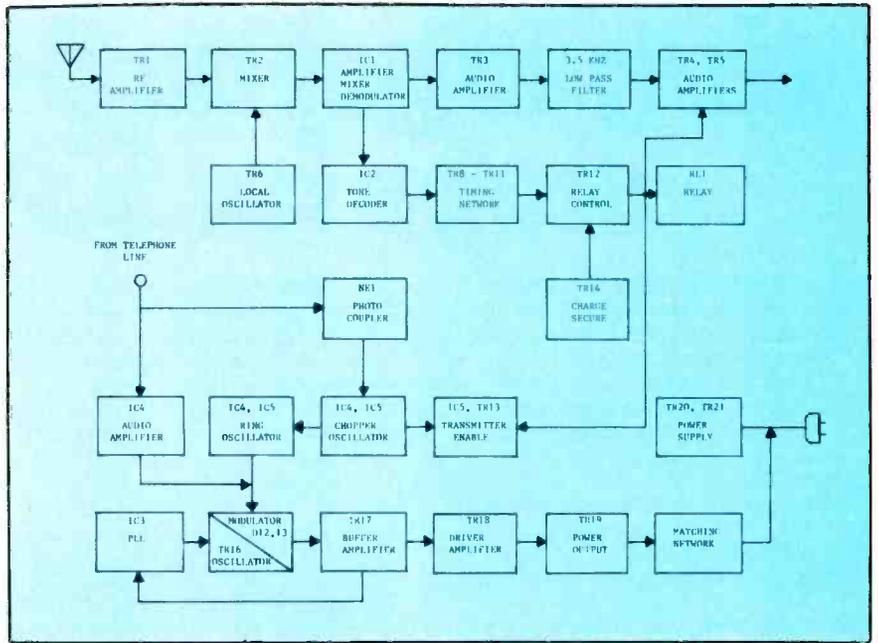


Figure 2A. Block diagram illustrates signal processing in the cordless telephone base unit.

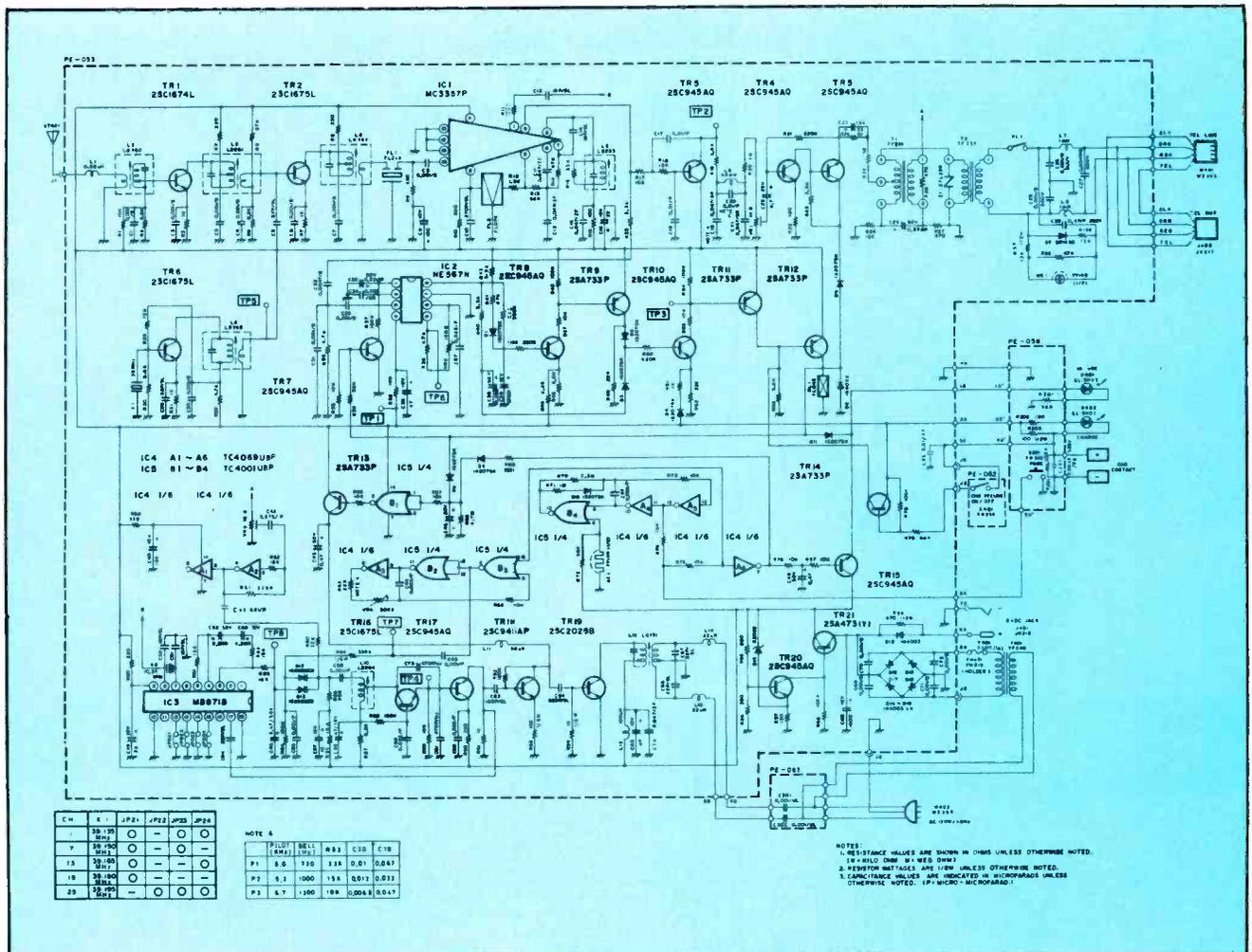


Figure 2B. Because much of the signal processing is done by integrated circuits, the cordless telephone base unit schematic is relatively straightforward in spite of all of the functions it performs.

"Thanks a lot RCA, for this useful tool. SK is super!"

Bob Lucas, TESA NEWS of St. Louis

In a 35-year electronic servicing career, Bob Lucas has seen many components come and go. Too many. That's why he recommends the RCA SK Guide to Reliable Replacement Semiconductors. The Guide not only clears up the confusion, but also offers hands-on advice to technicians when and where they need it.

Bob Lucas calls the SK Guide's Cross Reference Directory "a very important reference." He points out that even without a schematic diagram, a technician can find a suitable replacement for a defective part just by cross-referencing a part number. (2,300 RCA SK devices replace over 193,000 industry types.)

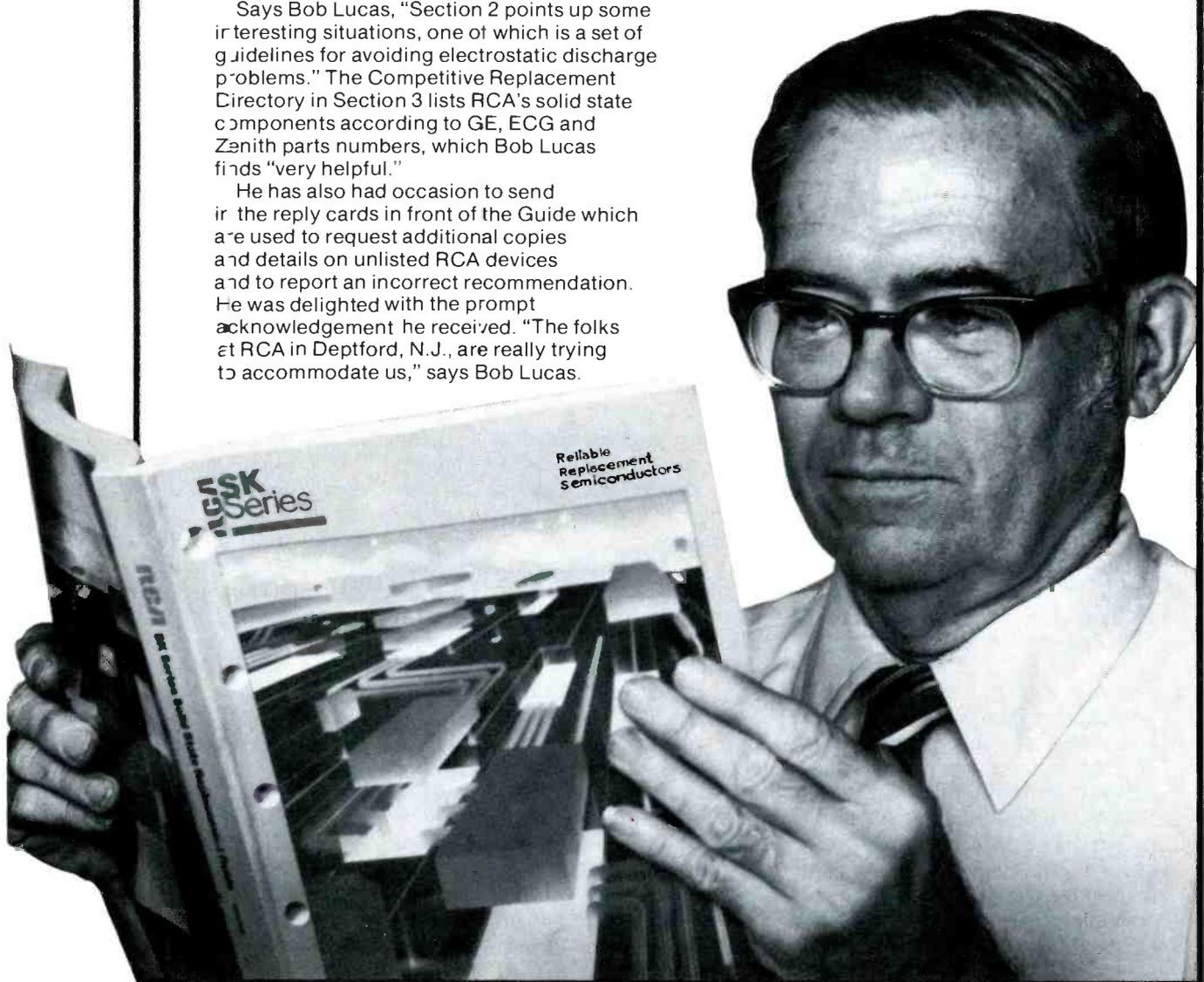
Says Bob Lucas, "Section 2 points up some interesting situations, one of which is a set of guidelines for avoiding electrostatic discharge problems." The Competitive Replacement Directory in Section 3 lists RCA's solid state components according to GE, ECG and Zenith parts numbers, which Bob Lucas finds "very helpful."

He has also had occasion to send in the reply cards in front of the Guide which are used to request additional copies and details on unlisted RCA devices and to report an incorrect recommendation. He was delighted with the prompt acknowledgement he received. "The folks at RCA in Deptford, N.J., are really trying to accommodate us," says Bob Lucas.

Pick up a copy of RCA's SK Guide to Reliable Replacement Semiconductors (SKG202C) at your local RCA SK Distributor or write to Sales Promotion Services, RCA Distributor and Special Products Division, 2000 Clements Bridge Road, Deptford, N.J. 08096. Who knows? Maybe we'll ask you to write our next ad!

RCA

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Operation and servicing of cordless telephones

same result of turning the relay on during the reception of the pilot tone. So why are four additional transistors used? The answer: for timing!

In the earlier days, all telephone dialing was accomplished by mechanical switching. Inside the old-style rotary telephones, there are a pair of switch contacts, located across the telephone line. When a number was dialed, as the dialer unwound, this switch pair opened and closed across the line. The number of times it did this corresponded directly to the value of digit selected (i.e. dial a 7, the switch opens/closes seven times).

At the telephone company, there was a 10-position stepping relay connected to the line (See Figure 2B). The center contact of this relay steps through to the next position each time the telephone's switch opens and closes across the line. If the digit seven is dialed, the relay will step through to the seventh position, then the next relay will come on-line for the next digit. This sequence will continue until the entire number is dialed.

The cordless telephone dials in much the same manner. During dialing, the handset pulses the pilot tone on/off corresponding to the value of digit selected. If a seven is dialed, the pilot tone is pulsed seven times. This opens and closes the base relay switch across the telephone line seven times, which dials the digit seven.

The timing of these dialing pulses is critical. A few milliseconds too fast or too slow could cause the phone to either misdial or hang up. If you have ever taken apart an old rotary telephone, you probably noticed how well made it

was. The dialer speed was governed by a strong set of gears and springs. The switching contacts were also durable. This design was partly for longevity, but more importantly, for dialer timing. It always unwound at the same rate, even after years of service.

Timing is the purpose of the four transistors, TR8 to TR11. Together, they, along with the associated resistor/capacitor values, form a timing network for the dialing pulses that make the phone dial properly. If one of the circuit components were to fail, the phone may or may not stop dialing. If it did continue to dial, the timing would be off and it would constantly misdial.

The tone decoder

A tone decoder consists of an internal oscillator, a phase comparator and a switching circuit (see Figure 4). The most common types are NE567, LM567 and 1R3N05.

The phase comparator compares the oscillator's frequency to the incoming signal's frequency. If the two match ($\pm 100\text{Hz}$), the output (pin 8) is switched low.

Determining the capture frequency of a tone decoder is easily accomplished. Just connect the frequency counter probe up to pin 5 (labeled as TP6 on the schematic). The frequency found at this point is the internal oscillator signal, which will be the same as the capture frequency. This means the readout on the counter is the same as the capture frequency.

To realign or change the capture frequency, merely adjust VR2 until the desired frequency is read on the counter. The frequency will probably fluctuate some, but as long as it remains within the 100Hz range, the circuit will function properly. (Note: If you do change the unit to a new capture frequency, you *must* also reset the pilot tone in the handset to the new frequency as well. The two must always match.)

If a base unit is receiving properly, but will not turn on, chances are the problem is either in the tone decoder or the timing cir-

cuitry. A quick and easy test is to jump pin 8 of IC2 to ground. If the relay does not turn on, the problem is in the timing circuit and must be traced out. If the relay turns on, the problem may be the tone decoder.

To test the tone decoder, inject an audio signal at the pilot tone frequency into pin 3, the input, of IC2 (the demodulated handset signal works fine for this). If the circuit is operating properly, pin 8 will go low. If it does not, the IC is probably defective and should be replaced.

The transmitter

The base transmitter is composed of five stages: the phase lock loop, the oscillator, the buffer amplifier, the driver and the power output. The major components of these stages are IC3, TR16, TR17, TR18 and TR19 respectively.

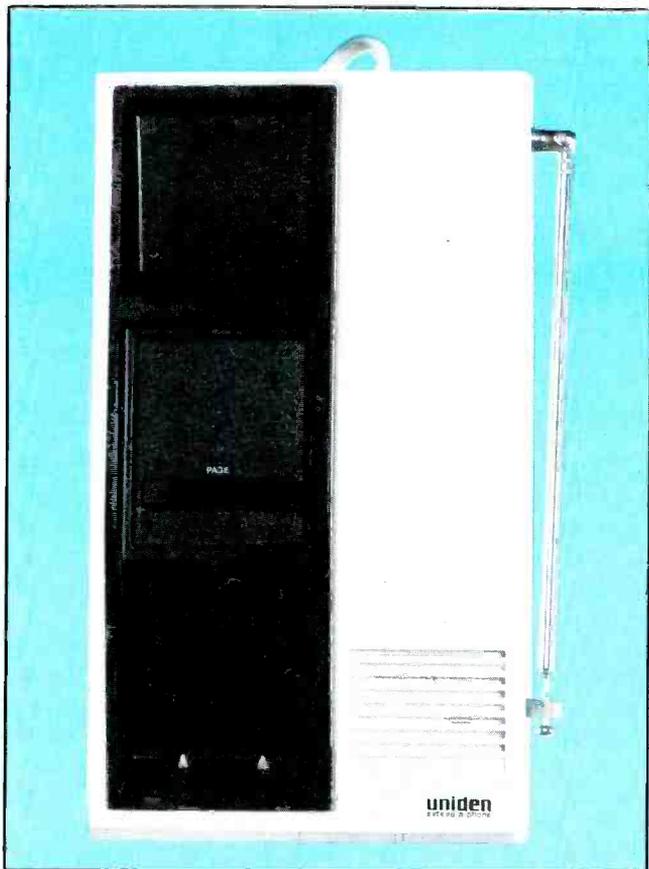
The oscillator, TR16, is set to oscillate in the 1.7MHz band. Its tank or tuned circuit is composed of L10, C59, C56 and the varactor diodes D12 and D13. The varactor diodes are used in the FM modulating process.

A varactor diode is one of those rare things in life that has all advantages and no disadvantages. They are small, lightweight, inexpensive and require no power supply to speak of. They also do a great job. To properly understand how a varactor works, let's examine diodes in general.

The basic diode is a PN junction device consisting of an anode and a cathode. It can be thought of as a 1-way gate for electricity. When the diode is forward biased, the PN junction provides little impedance to current flow. When the junction is reverse biased, it provides an infinite impedance (theoretically).

When the diode is reverse biased, it also acts like a capacitor, that is two conductors (the anode and cathode) separated by an insulator (the reverse biased junction). The amount of capacitance there may be small, but it is there nonetheless.

Every diode has this effect. A varactor diode is special because it is made or doped to have as much



The cordless telephone base unit plugs into the ac line for power and into the phone line for access to the telephone system. Telescoping antenna is for receive only — the ac line is used as the transmit antenna.

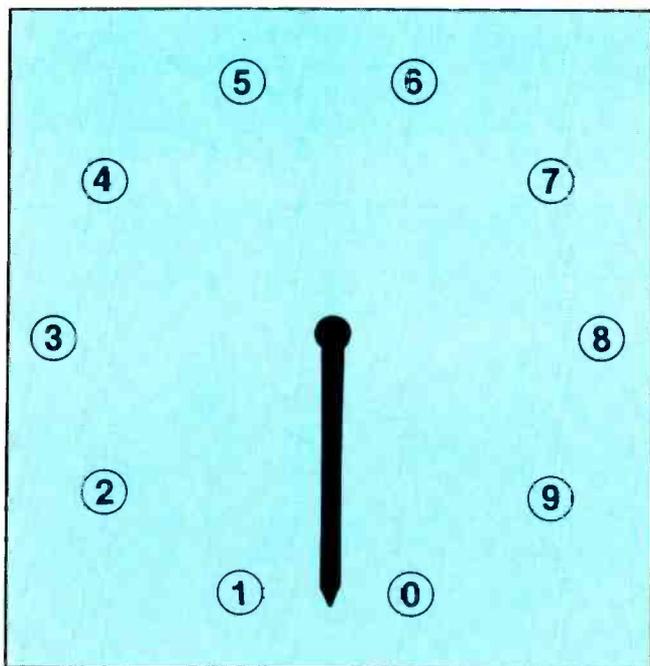
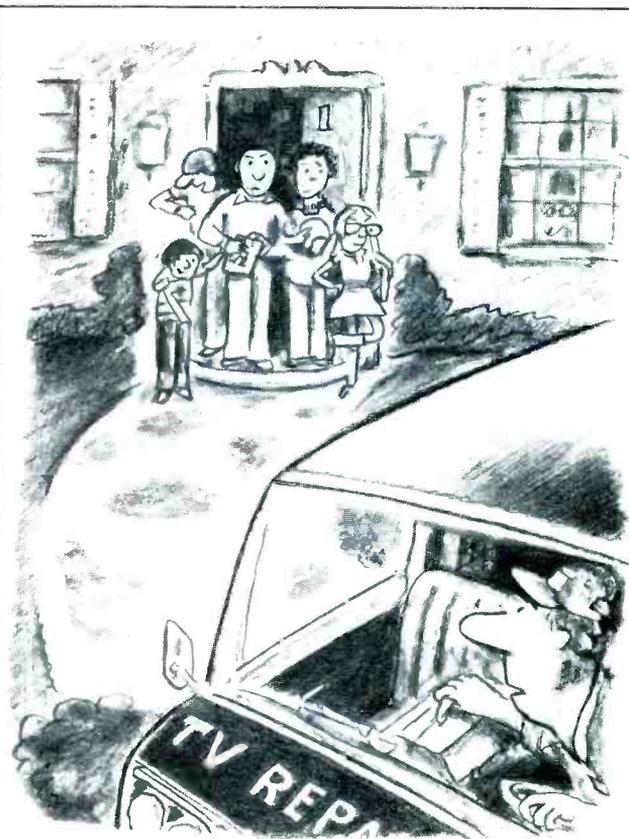


Figure 3. A conceptual illustration of a telephone stepping relay. Each pulse from a rotary telephone dial steps the relay to the next position. One stepping relay was needed to record each digit dialed.



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Operation and servicing of cordless telephones

capacitance as possible. Usually it only ranges from 2pF to 15pF depending on the bias, but this is a significant amount.

Because these two varactor diodes are located in the oscillator's tuned circuit, their capacitance affects the frequency of oscillation. The amount of capacitance the varactors contribute is determined by the amount of reverse bias applied to them.

The incoming telephone line audio is tapped off pin 1 of transformer T1 (this point is labeled A on the schematic). This audio goes through the control VR3 (the second A labeled on the schematic) then into the input, pin 3, of the amplifier, A2. This audio is amplified by A2, then coupled through C41 and R60 to the varactor diodes.

The audio at this point is a varying voltage waveform. As the waveform voltage varies up and

down, it changes the amount of reverse bias on the varactors. This in turn varies their capacitance, which then varies the frequency of oscillation. Because the bias is changing at the audio rate, the frequency is changing at the audio rate and this, of course, is our FM modulation.

Because the amount of capacitive change is relatively small, the frequency doesn't vary that much. Approximately ± 0.3 percent is typical, but that translates into ± 5 kHz and that is all that's necessary for narrowband FM applications.

The output of the oscillator is applied to the base of TR17, the buffer amplifier. TR17 amplifies the signal then sends it on to TR18 and TR19, the driver and power output. From the power output, it is coupled through L12, the output transformer, and the matching network to the ac power line.

The ac power line is the transmit antenna for this cordless telephone's base unit.

The wavelength of 1.7MHz is 176m. A good $\frac{1}{4}$ -wave antenna for this frequency is 44m or about 145-feet long. This is an impractical length to work with. This is why the ac power line is used. It's long, goes everywhere the user normally goes, and cordless phones are short range anyway (up to 1000 feet). It also works reasonably well.

This method of transmission is called carrier current transmission

and has been around for years. Many private FM radio stations (like those found in some universities and businesses) employ this technique, as do many of the wireless intercoms.

The last section of the transmitter is the phase lock loop (PLL for short). The PLL is a modern communications circuit used to keep transmit oscillators locked on frequency via correctional feedback.

The PLL chip, IC3, is composed of many sections. A reference oscillator, two divider networks and a phase comparator. (See Figure 5.)

The 10.242MHz crystal, on pins 7 and 8, is for the reference oscillator. Its frequency is divided down by a factor of 2048 into a 5kHz signal (The 2048 is two to the eleventh power).

A portion of the transmit oscillator signal is fed back from TR17, the buffer amplifier, to pin 17 of IC3. It also is divided down to a frequency of 5kHz. The division ratio for it, though, depends on the channel of operation.

These two 5kHz signals are compared by the phase comparator. If they are in phase with each other, or both on the same frequency, all is in order. If the two are not in phase, a correction voltage is developed and sent out pin 3 of the PLL chip to varactor diode D13. This brings the transmit oscillator back on frequency.

The reason PLL control is so accurate and stable is not only

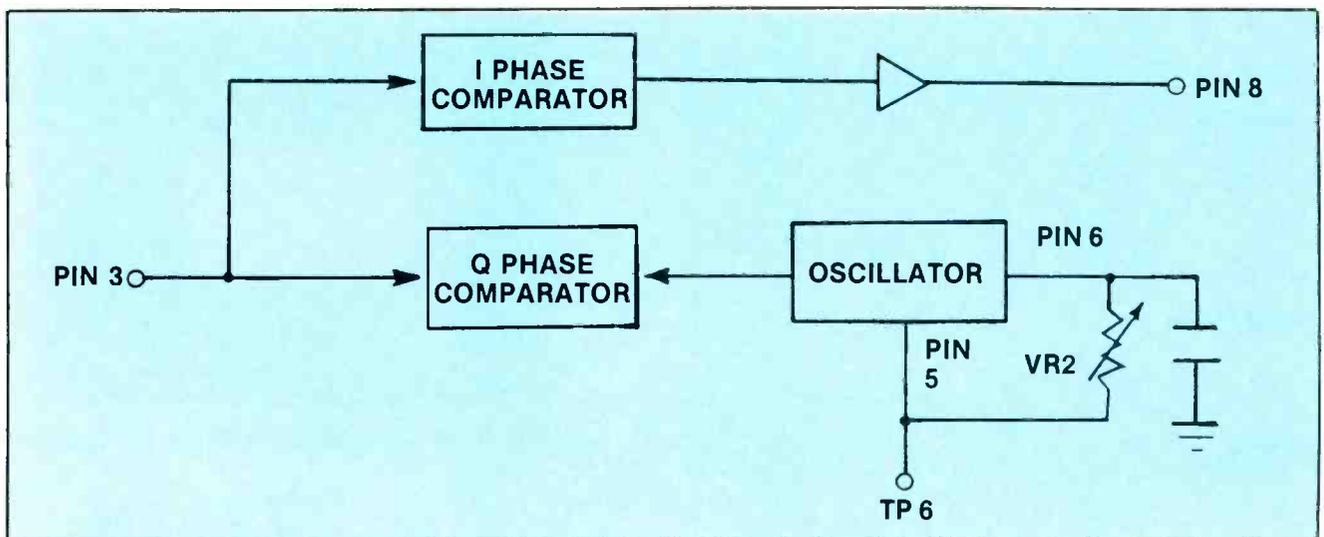


Figure 4. A tone decoder consists of an internal oscillator, a phase comparator and a switching circuit.

because it is referenced to a crystal oscillator, but any frequency error present is reduced down by the division process. For example, if the 10.240MHz oscillator was off by 10kHz, i.e. 10.250 or 10.230MHz, then the 10kHz error will be divided down by a factor of 2048 to an error of just less than 5Hz. And a frequency error of only 5Hz is indeed a small error.

The frequency or channel of transmit operation is determined by the PLL or more accurately, by the division ratio of the second divider circuit. The division ratio is selected by the binary programming on pins 12 through 15 of the IC. It is the jumper configuration on these pins that determines the ratio and ultimately the frequency of operation.

The channel/jumper reference chart is located in the lower left corner of the schematic. The first column shows the channel numbers of 1, 7, 13, 19 and 25 (the only channels used by Uniden) and the specific jumper configuration for that channel. A circle means the pin is jumpered to ground. A dash means the circuit is open.

For a unit on channel 1, pins 12, 14, and 15 are connected to ground and pin 13 is open. For channel 7, only pins 12 and 14 are grounded. And so on for each channel.

The other column on the chart (the one labeled X1) lists five different values of 39MHz crystals. These are used in the first local

oscillator, TR6, in the receiver section. To perform a channel change on this unit, all you need do is re-jumper the PLL pins and change the first local oscillator crystal to the appropriate frequency. Once you have reset the PLL, there is one more adjustment that must be made. The PLL reference voltage off pin 3 (labeled TP8 on the schematic) must be reset. To do this, monitor the voltage on TP8 and adjust L10, the transmit oscillator coil, for a reading of 4V dc \pm 0.2V. Once this is done, the channel change is complete.

Ringing

Unlike a standard or corded telephone, the cordless phone does not have a mechanical ringer. Although it is the handset that rings, the ring is actually generated by the base unit.

The ring signal generated by the telephone company is a 20Hz signal, in amplitude between 50 and 150V peak-to-peak. The amplitude depends on what else is connected on the line and how far away the central office is from the phone.

Across the telephone line input of the base unit is a neon bulb. This neon bulb is one half of the photocoupler circuit (labeled as NE-1 on the schematic). The incoming ring signal will ionize the neon bulb and cause its light to strike the second half of the photocoupler, the photo-resistor. When this occurs,

that device's resistance drops from several million ohms of impedance to almost 0 Ω . The photo-resistor is connected between ground and pin 9 of NOR gate B4 (part of IC5). This means that the ringing signal is pulsing pin 9 of B4 to ground at a 20Hz rate.

The circuit configuration of B4, A4 and A5 is an oscillator. Pulsing pin 9 to ground turns it on and off. Its output is taken off pins 11 and 12 and is applied to the input (pin 6) of NOR gate B3. B3, B2 and A3 form another oscillator circuit, the *ring oscillator*. Its output comes off pin 4 of B3 and is coupled through C45 and R64 to varactor diode D12 to modulate the transmit carrier. This signal is then transmitted out to the handset to make it ring.

The output of the ring oscillator looks like Figure 6. It is roughly square wave in shape with a damped oscillation riding the peaks.

Although the frequency of the ring oscillator is adjustable by VR4, it is not something to be set indiscriminately. Uniden cordless

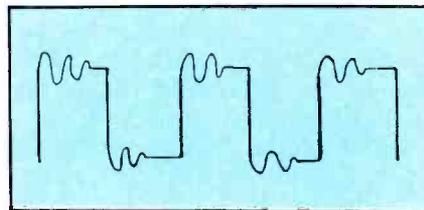


Figure 6. Output of ring oscillator.

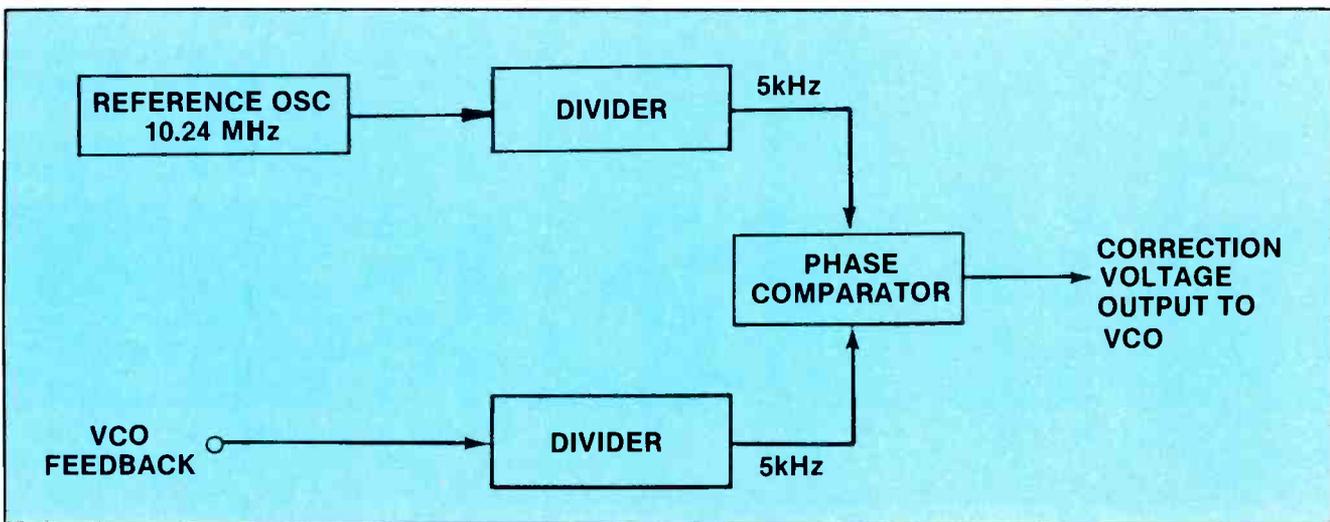


Figure 5. The phase lock loop (PLL), made up of a reference oscillator, divider network and a phase comparator, keeps the transmit oscillator locked on frequency through corrective feedback.

Operation and servicing of cordless telephones

telephones are set to ring at one of three specific frequencies: 730, 1000 or 1300Hz. This is the second half of the *P* code discussed earlier (see chart bottom left of schematic). The receiver in the handset is designed to respond to only one of those three frequencies. If the ring oscillator was off frequency, the handset would not ring.

The purpose of the first oscillator (B4, A4, and A5) is to interrupt or *chop* the output of the ring oscillator. This makes it sound more like a bell ringing. For this reason, the first oscillator is known as the *chopper oscillator*.

The chopper oscillator performs two other functions besides activating the ring oscillator. It also flashes the *In Use* light and activates the base transmitter.

Some of the chopper oscillator signals also go right through

amplifier A6 to two other circuits. First, to TR15 and then to the Transmitter Enable circuit, B1 and TR13. TR15 controls D401, the *In Use* LED. While TR15 is being pulsed on/off by the oscillator signal, it flashes the LED.

The B1 NOR gate is being used as an inverter. Because its input is normally a logic 0 or low state, its output is normally a logic 1 or +8V, which is applied to the base of TR13. Because TR13 is a PNP transistor, the logic 1 turns it off. When a ring signal is received, the B1 output is alternately switched low, which in turn pulses TR13 on. When TR13 conducts, +Vcc is switched through it to turn on TR13, the transmitter driver, and thus enables the transmitter. Now that the transmitter is enabled, it



Cordless telephones have greatly enhanced the convenience of using the phone by making it possible to walk as far as 1000 feet from the base unit unfettered by a cord.

can transmit the ring signal out to be heard at the handset.

(It was not mentioned earlier, but when the handset is *In Use*, B1 is enabled via D8 by TR12, the relay control. TR12 also turns on the *In Use* light via D11 and the audio output amplifiers TR4 and TR5 via D5. Many people mistakenly believe the relay activates the base unit. This is not so. The relay only connects the base up to the telephone line. It is actually TR12 that activates the base circuitry when it is in use.)

Other features

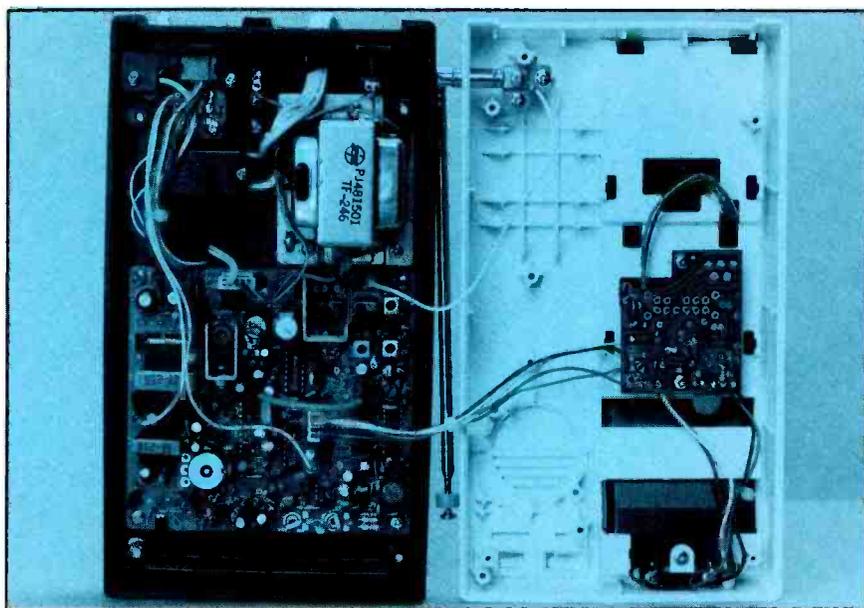
This particular model has a base-to-handset page feature. When S201, the page button, is pushed, it activates the ring oscillator directly, completely bypassing the chopper oscillator. Because the ring oscillator is not being chopped, the page is heard as a steady tone. This allows the user to differentiate between a ring and a page. One is chopped and the other isn't.

The unit also has a feature known as Auto Secure. This feature prevents the base unit from being accessed (either intentionally or accidentally) whenever the handset is recharging in the base cradle.

When the Auto Secure switch is turned on, TR14's base is connected to the positive charging terminal. When the handset is in the base charging, TR14 conducts and keeps a constant positive potential on the base of TR12, the relay control. Because TR12 is a PNP transistor, it will not be able to turn on, even if the base unit receives the proper pilot tone. This, of course, adds to this model's security.

The last section of the base is its power supply. The output of the bridge rectifier is +16Vdc. This is reduced down to +8Vdc by the regulator circuitry of TR20, TR21, and zener diode D14. The +16V enters into the emitter of TR21 and is regulated down to +8V at its collector.

In the event of a power failure, there is an optional 12V battery jack (J401) located in the back of the unit. The incoming battery voltage is regulated down to +8V in the same manner as previously described.



Modern microcircuitry allows cordless telephones to pack a large number of functions in a compact unit. This is a view of what the base station looks like when it is opened for servicing.

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Troubleshooting Tips

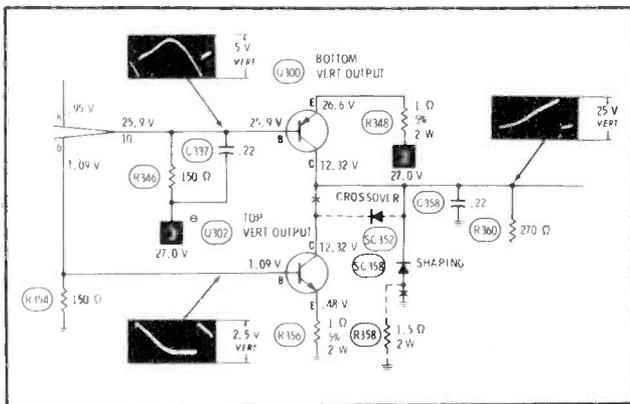
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When first examined on the test bench, the color receiver was totally dead, without any dc power. Resetting the breaker restored dc power, but the breaker tripped after a few seconds, indicating a serious overload. I removed the horizontal-output transistor, reset the breaker and applied ac power again. The breaker did not trip, proving the overload was in the horizontal-sweep section.

I tested the output transistor, found it was not defective and re-installed it. Next, I removed the connection between the T400 flyback and the HVT401 tripler and applied ac power. The breaker again tripped, showing the tripler and the picture tube were not the problem. I restored the tripler connection.

Diode rectifiers were the next suspects. SC450 (for the +77V boost) checked normal, SC510 (of the +163V source) also was normal, but SC530 (for the +27V source) was shorted. I replaced SC530 and reset the breaker. A meter at the +27V source showed only a few volts before the breaker tripped again.



What do you know about components?

neons

lasers

leds

By Sam Wilson

A little girl was assigned the task of writing about alligators. As the time approached for handing in her paper, it became obvious she was going to need extra help. So, the teacher gave her a book on the subject.

The next day the little girl returned the book. "Did it help you?" asked the teacher. "No," replied the little girl. "It told a lot more about alligators than I wanted to know."

I know just how she feels. I own a book on lasers that only has about five sentences. The rest of the book is devoted to math equations. It tells everything about lasers except how they work.

If you want to design a laser, you'll need that book. In this article, I will concentrate on the subject of how the laser works. A good way to understand how the laser (and LED) works is to go back to the theory of the simple neon lamp.

The neon lamp

The basic construction of the neon lamp is illustrated in Figure 1. It shows two metal electrodes inside a glass envelope filled with neon. Other gases may be in there to get a desired color, but they have no effect on the theory of operation.

A minimum voltage, called the *firing potential*, is needed to get the lamp into operation. If a dc voltage is used, only the negative electrode appears to glow. If an ac voltage is used, both electrodes appear to glow.

When no voltage is applied, a few free electrons are moving around in the gas. When a dc voltage is applied, these free electrons start to move rapidly toward

the positive terminal. They collide with atoms, knocking other electrons loose which, in turn, collide with more atoms. The result, as shown in Figure 2, is called *avalanching*. It occurs when the voltage across the electrodes is at least as high as the firing potential.

The atoms that have lost their electrons move toward the negative electrode because these atoms are positive. When they get close to the surface of the negative electrode, they pull electrons off its surface. As shown in Figure 3, these electrons accelerate rapidly toward the atom.

When the fast-moving electron combines with the atom, it must give up some of its energy. *That energy of motion is given off in the form of light energy.* That is what makes the negative electrode appear to be glowing.

If you look closely at the negative electrode from the top, you will see there is a dark space between the surface and the glow. That is the space the electron moves through when it is accelerating toward the positive atom.

The most important thing to remember about this information is that the electron gives off light when it goes from a high energy level to a lower energy level.

The laser

Because the electrons recombine with atoms in a random manner, the resulting light waves are out of synchronization. *Coherent* light, on the other hand, occurs when the light waves are in phase. That type of light has a very high energy. If you can get a lot of electrons to change from a high energy level to a lower level at the same instant,

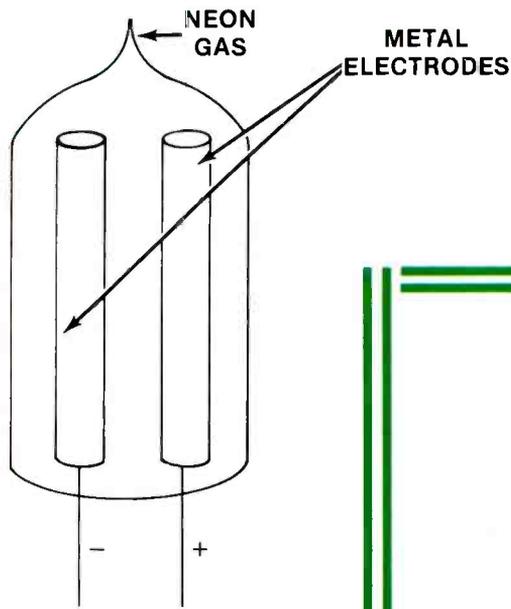
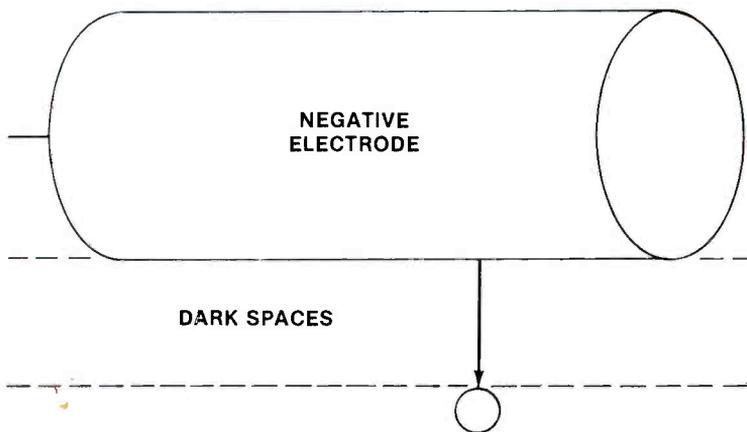
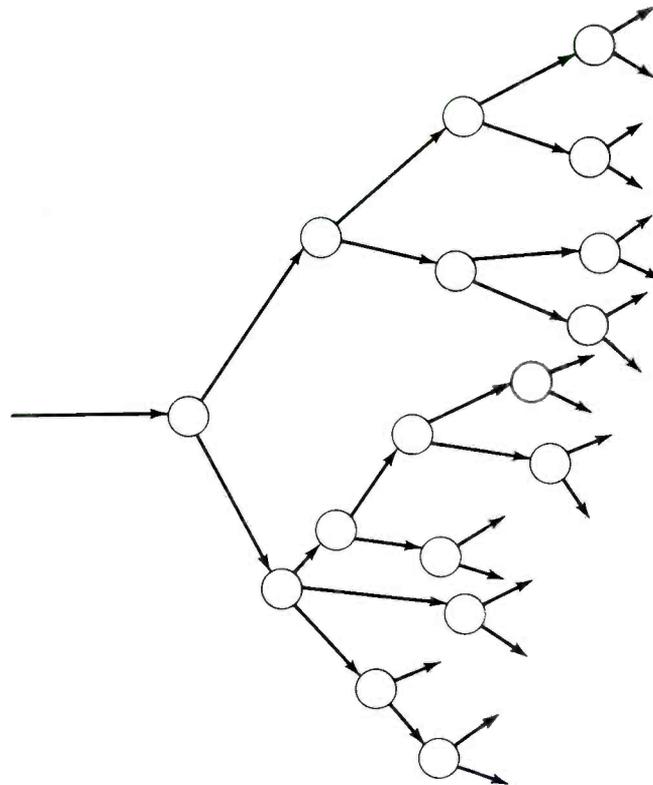
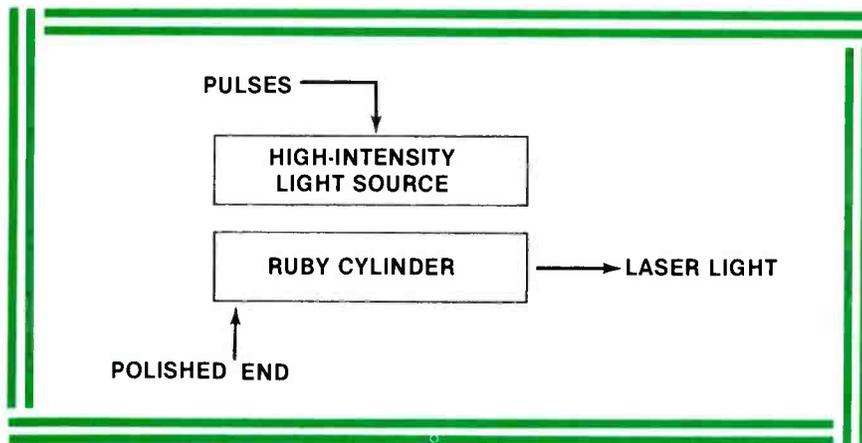


Figure 1. In a neon lamp, when high-energy electrons combine with positively charged atoms, they give off energy in the form of light.

Figure 2. When the voltage is applied across the terminals of a neon lamp, free electrons begin to move rapidly, collide with neon atoms, and knock other electrons loose, which in turn collide with other neon atoms. This is termed *avalanching*.

Figure 3. Electrons pulled from the negative electrode travel through space to the positively charged atom where they combine, emitting light.





they will produce coherent light. That is the secret to the high power in a laser beam. Figure 4 gives an idea of how it is done.

A high-intensity light source is needed. It is important that this light source can be shut off instantaneously. As shown in the illustration, this light source is placed near a ruby cylinder. One reason ruby is used is because it allows the light to pass through it. The electrons in the ruby will be used to produce the laser light, but they do not leave atoms, as in the case of

Figure 4. In a ruby laser, a high-intensity light source raises the energy of electrons in a ruby crystal. When the electrons return to a lower energy state, simultaneously, they give off energy in the form of *coherent* light.

the neon lamp. However, as they move around the nucleus, they can be excited to a higher energy level by adding heat energy or light energy to the atom.

When the high-intensity lamp is turned on, its light waves pass through the ruby. That raises the energy level of the electrons.

Then, the light source is shut off abruptly. That means that the electrons, which are no longer being excited by the light, will return to a lower level of energy. Because the light goes off instantly, they all return to a lower level simultaneously, giving off coherent light.

One end of the ruby rod is highly polished, so it reflects almost all of the light generated within the ruby. The other end is partially polished, and it reflects about 95 percent of the light and passes the rest through to the outside world. As a result, the light is bounced back and forth. This reflected light further stimulates the electrons to higher energy levels. The high-intensity light source is repeatedly turned on and off to protect the ruby from its heat, so the output light energy is in the form of pulses.

The coherent light of the laser beam can be focused to a very narrow beam, so the energy can be concentrated into a very small region. I'm sure everyone is aware of some of the important applications of the laser, so I won't fill four to five pages with that type of information. However, the one that intrigued me most, when the scientists were trying out their new toy, was when they lighted the dark side of a half moon by shining the laser on it from earth. Now, that's what I call a flashlight!

The original laser was made with ruby, but now they use gasses and many other kinds of materials, such as semiconductors. We'll review the principle of the diode lasers after taking a look at the LED.

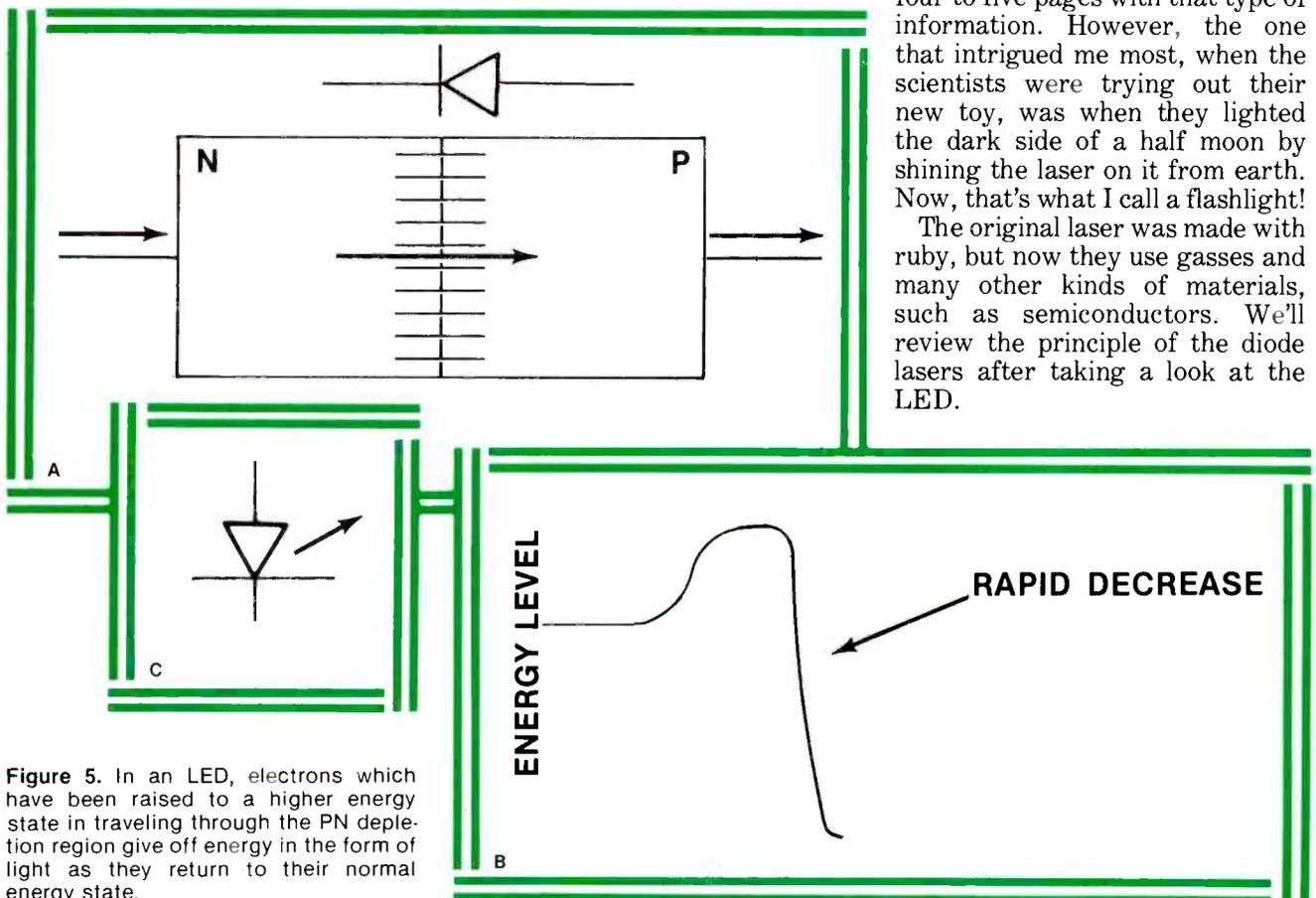


Figure 5. In an LED, electrons which have been raised to a higher energy state in traveling through the PN depletion region give off energy in the form of light as they return to their normal energy state.

The LED

When a semiconductor diode is manufactured, a *depletion region* is formed at the junction of the P and N regions. This is a region where the resistance to the flow of electrons is higher than in the P and N regions. As a result, the energy level of the electrons must be raised to get them across this section of the diode. Figure 5A shows the junction and the shaded part of that drawing represents the depletion region.

Just below the diode, in Figure 5B, a graph shows the energy level of the electrons as they move through the diode. Note that they are raised to a higher level as they move through the depletion section; but, as soon as they pass through, they drop to a lower level of energy. As described in the discussion of the laser operation, these electrons must give up their extra energy. In the real world, the extra energy must be converted to some other form.

As you might expect, the extra energy may be converted to light, if the conditions are just right (as in the neon bulb and the laser). It turns out that the conditions are very good if the diode is made out of Gallium Arsenide. One reason is that it takes about 1½V to move the electrons across the junction, they reach a higher level before they drop back.

One slight problem exists. When the diode is made out of Gallium Arsenide, the light produced is in the infrared region of the spectrum. But, if they put a little phosphide material in with the Gallium and Arsenic, the light is in the visible spectrum. They add other stuff to get other colors too. The symbol for this electronic marvel is shown in Figure 5C.

Light-emitting diodes should never be operated without a series current-limiting resistor! In some types, the resistor is already built into the diode case. Don't let that mislead you into thinking the diode can be operated without the resistor. It's there whether you can see it in the circuit or not.

The diode laser

The diode laser works on the same principle as the LED.

However, to get a laser beam the electrons have to be raised to a higher level. This is accomplished by polishing the end surfaces of the diode.

The light is bounced back and forth in the diode, between the polished surfaces, just the same as it was in the ruby laser. That raises the energy level of the electrons so they can produce the laser light.

In both the LED and the diode laser, a small window in the diode case allows the generated light to get to the outside world.

The diode laser doesn't have the destructively high energy of the ruby (and other) types. So, it is sometimes referred to as a soft laser. This component is used as a stylus for video discs and compact audio discs.

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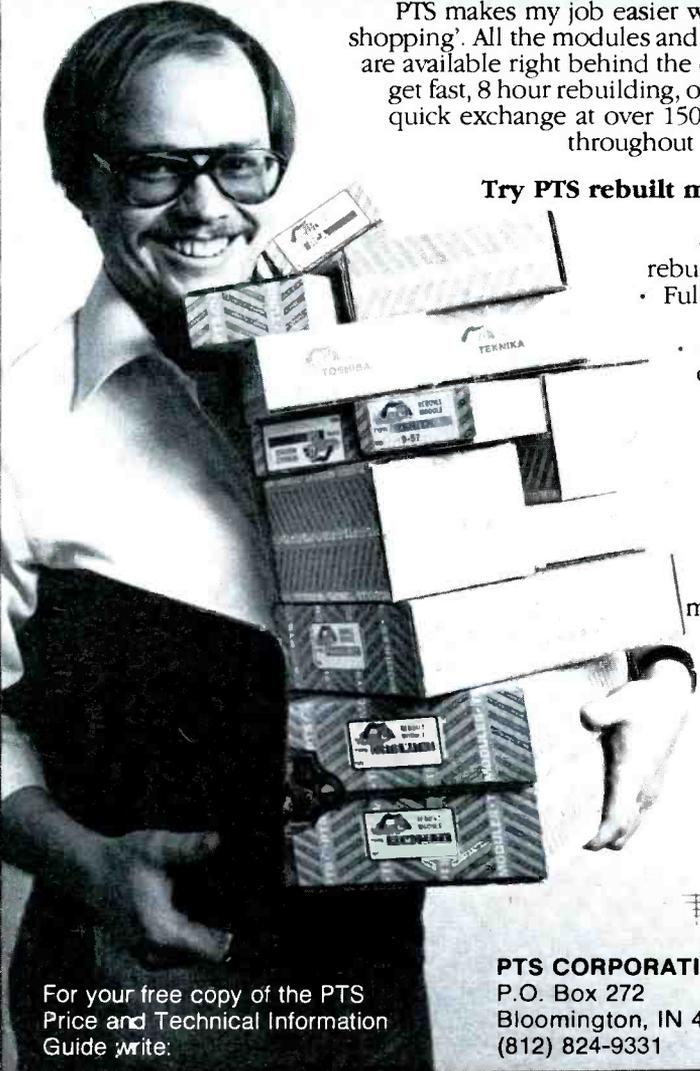
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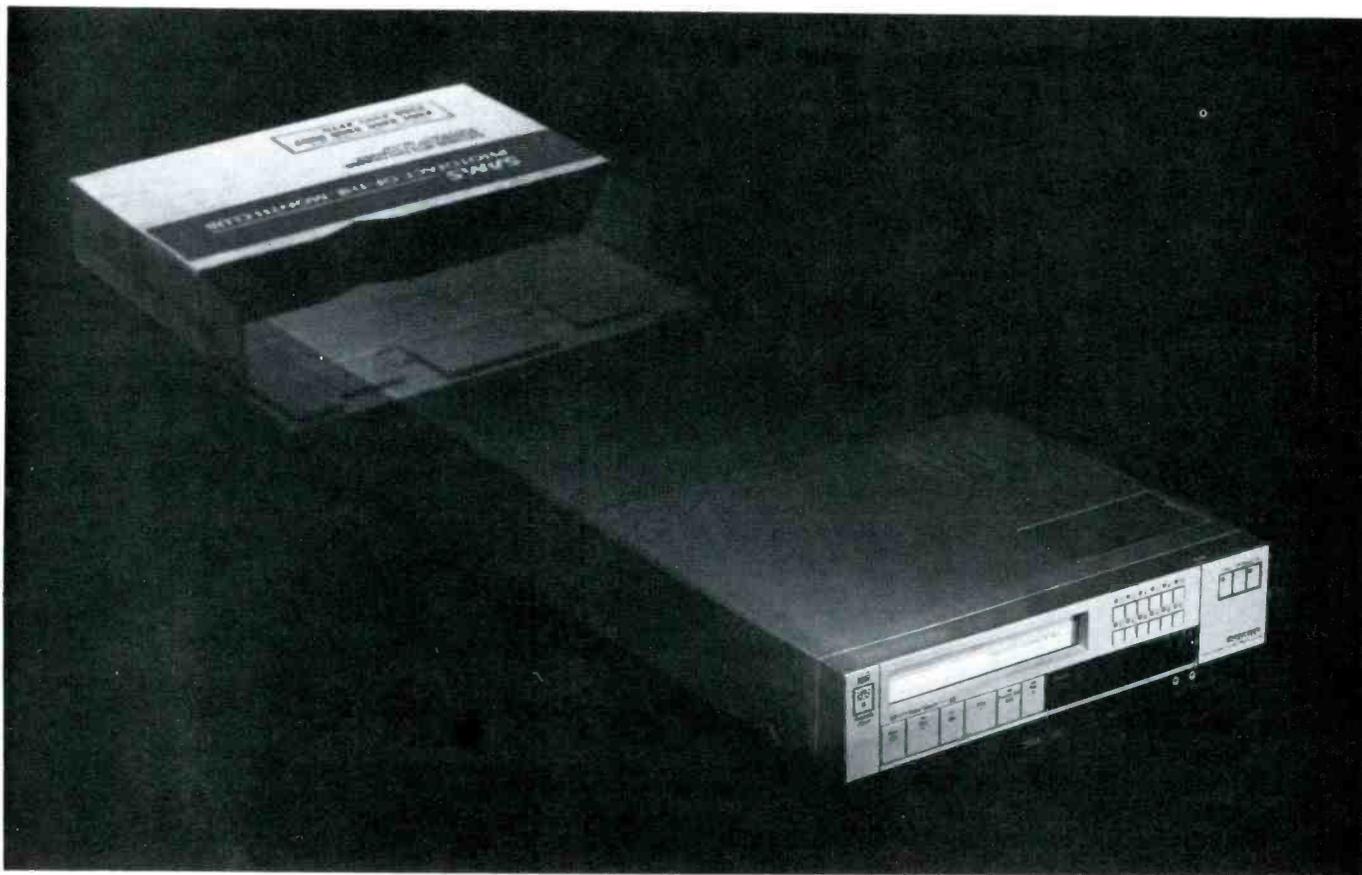
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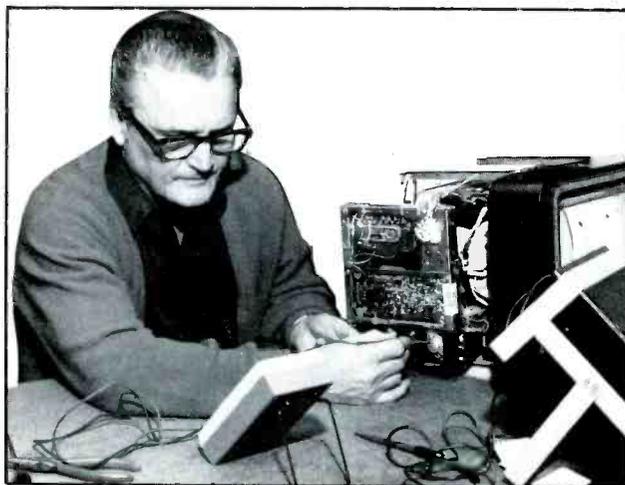
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Circle (15) on Reply Card

Typical problems with RCA CTC97

Effective TV troubleshooting requires a knowledge of any unusual circuits plus a list of the common component failures. These items for the RCA CTC97 chassis are discussed and illustrated.



By Homer Davidson

Various dc-supply voltages in many recent-model color TV receivers are produced by rectifying samples of horizontal-deflection power, rather than by rectifying 60Hz line power, as was done in older models. Several advantages are gained when low-voltage power is generated this way. It's easy to obtain either a positive or negative voltage by reversing the diode's polarity. And any desired voltage can be produced (without requiring a voltage divider) by specifying an appropriate number of turns in the flyback winding. Filtering is less critical because of the much higher ripple frequency. Fewer dropping resistors are needed, so less heat is produced.

In the RCA CTC97 color receiver, 60Hz line voltage is rectified by a conventional diode bridge. The resulting +158V is regulated to +114V and supplied *only* to the Q101 horizontal-output transistor. All other low-voltage supplies are produced by rectification of horizontal power coming from flyback pins eight and 12. After filtering (and sometimes regulation), the low-voltage dc supplies are distributed to all other solid-state-powered stages (see Figure 1).

But there is one problem to overcome. The horizontal-deflection system cannot operate until its oscillator and driver transistors are supplied with dc voltage. However, there is no voltage for them until the horizontal-deflection system operates. This dilemma is solved by a start-up circuit that *temporarily* supplies some dc voltage to the horizontal oscillator and driver transistors. These dc voltages are supplied just long enough for the receiver operation to begin, and when voltages in the +21.1V and +26.4V supplies exceed the start-up voltages, the start-up voltages are disconnected from the supplies by switching diodes.

Most circuit details of CTC97 chassis models used in 19-inch receivers are identical to those in RCA CTC96 which are used in some 13-inch models. Therefore, all information here applies equally to the CTC96.

Two grounds

Two types of grounds are used in the CTC97. The negative lug of

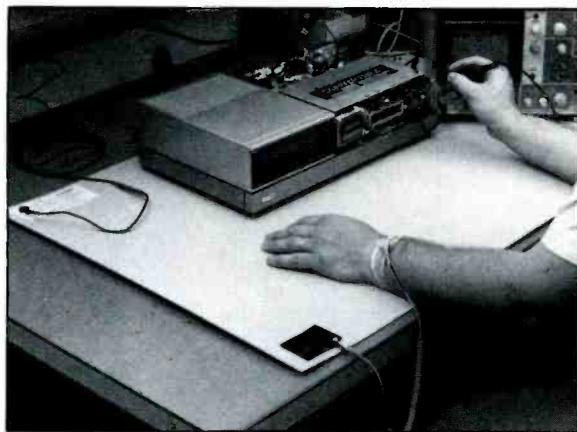
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C114 is a *hot* or *floating* ground that is connected to the bridge rectifier. And the bridge rectifier is connected direct to 120Vac. Therefore, relative to an earth ground, this hot ground measures about 70V. Major components associated with the hot ground are: the diode bridge, C114, SCR101 and the base and emitter circuits of Q101, the horizontal-output transistor. A metal screw near SCR101 (Figure 2) should be used for most tests involving the hot ground.

Another cold-ground system is completely insulated from the hot ground and its wiring. All the transistors (except Q101), ICs and the dc-voltage supplies of Figure 1 (except the +158V supply) are referenced to this cold-ground system.

Although it should be relatively safe to work with cold-ground voltages without using an isolation transformer, it is definitely dangerous to connect to any part of the hot supply or its hot ground without the protection of an isolation transformer. *Use an isolation transformer for all tests, and be safe!*

Failure of start-up

It is important to know the voltages and symptoms that result when start-up does not occur, which happens when the horizontal-sweep system is inoperative.

Imagine that the horizontal-output transistor has been removed (equal to an open transistors) and a CTC97 is switched on. Several pulses of dc current pass through T104 and begin to charge C114 (see Figure 1). As C114 charges rapidly, the current decreases rapidly and, after a fraction of a second, drops to almost zero, as its voltage levels off at about +166V. This is normal because there is virtually no load on the supply.

While the capacitor has been charging, the decreasing-amplitude pulses of current through T104 have produced a decreasing amplitude at the secondary winding. Start-up diodes CR115 and CR113/CR119 rectified these pulses and fed the dc voltage to the +21.1V and +26.4V supplies, temporarily providing the horizontal oscillator and driver with enough voltage to operate. Unfortunately, these

start-up voltages quickly decrease to almost zero, and the oscillator and driver stages either stop operating or operate very weakly.

Consequently, the outward symptoms of a dead horizontal-deflection system are no sound, no raster and no picture. A digital meter and a scope will show more. At the Q101 horizontal-output transistor collector (metal case), a meter should measure about +150V, while the scope should show decreased ripple at C114. Of course, remember that these measurements are made relative to the floating or *hot* ground (see Figure 2). Also, all supplies that obtain dc voltage by rectifying fly-back signals will show zero-voltage readings.

In summary, when there is no short circuit or excessive leakage on the +158V supply, a failure to achieve start-up produces these symptoms: no sound and no raster, a higher voltage (perhaps +166V) and reduced 120Hz ripple at C114; about +150V at the Q101 collector and zero dc voltage from the other supplies.

RCA CTC97 does not have a

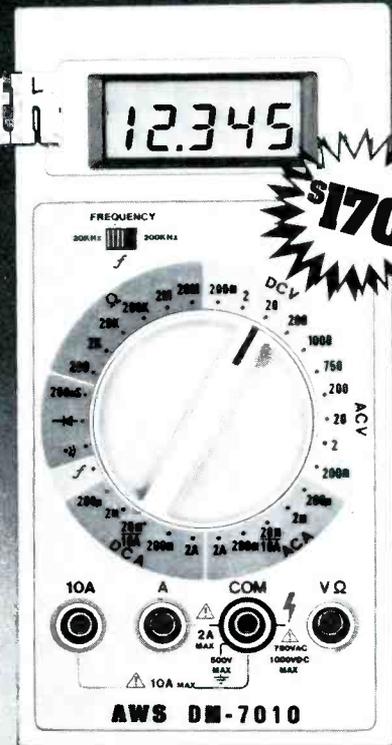
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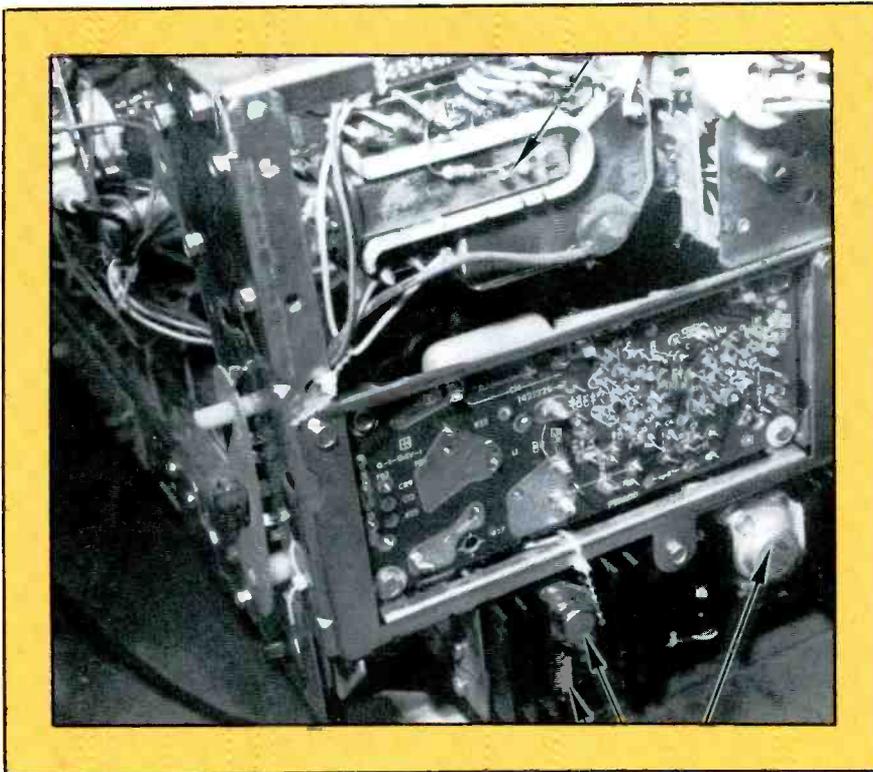


Figure 2. Arrows show locations of important components on the CTC97 chassis' side. At the bottom, the arrow on the far left points to a metal screw that is connected to hot ground. This screw is important for voltage and waveform measurements. Next is SCR101, the SCR switch of the +114V supply. Q101, the horizontal-output transistor, is at the right. The arrow at the top indicates flyback T101. The PW600 regulator circuit board is below the flyback.

shut-down safety circuit that eliminates the horizontal sweep when excessive high voltage or excessive picture-tube current occurs. Instead, the safety circuit (described later) changes the horizontal-oscillator frequency so drastically that it cannot be locked. Additionally, the frequency change is in the direction that reduces the high voltage somewhat. But the screen will show out-of-lock stripes and sound can be heard.

However, complete shut-down can occur even after start-up was successful and the receiver has operated for a time, if the horizontal-sweep power is interrupted. When ac power in the home blinks off for a second or two, the receiver is forced into shut-down because there was a loss of dc voltage power to the horizontal system, but it was not missing long enough for C114 to discharge. Unless operation is attempted while C114 is discharged, start-up cannot function. However, in the absence of a receiver defect, the receiver will resume normal operations, if the power switch is turned off for a moment or two,

and then switched back on. Successful start-up will produce normal performance.

Failure to start-up can occur, also, during troubleshooting tests. For example, suppose you placed a jumper from the horizontal oscillator base to ground and forgot to remove it when you switched on the receiver next time. Start-up would fail because the oscillator was not working, but removing the ground jumper *while the power was still on* would not produce start-up. The receiver would appear to be completely dead. Instead, the power must be turned off long enough for the C114 voltage to reach almost zero. After that time, application of power should provide proper start-up if the horizontal-sweep system is normal.

Remember, when start-up fails, the receiver has no sound or raster, the 158V supply and the Q101 collector voltage probably will be high, and the C114 ripple will be lower than usual. The same symptoms are produced by correct start-up followed by shut-down.

Servicing by tic-tic

A regularly recurring tic-tic sound from the flyback transformer in the CTC97 and several other RCA chassis can often help during troubleshooting. When there is no sound and no picture, a faint tic-tic sound from the flyback (Figure 3) usually proves the +158V supply and the SCR-regulator circuit are functioning normally, or at least as normally as they can without any horizontal-deflection power.

The tic-tic sound is generated by a low-frequency self-oscillation in the SCR-regulation circuit. The tic-tic sound is weak, but don't get too near the flyback in case it does have power. Use a short length of garden hose as a stethoscope, bringing flyback sounds to your ear, but preventing the possibility of shocks.

Use the following sequence to locate the problem area:

- Apply power to the chassis, listening for a short burst of sound. If the raster does not light after one minute, listen for the tic-tic sound around the flyback.
- If there was no raster or picture and no sound was heard at any time, but a tic-tic of about two

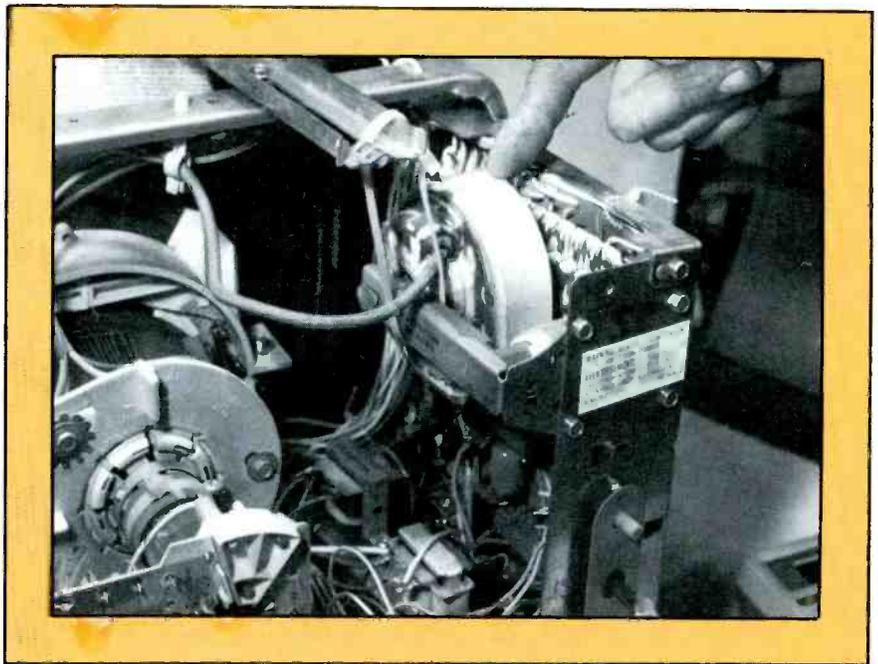


Figure 3. When there is no sound and no picture but the +158V supply has excessive voltage, listen for a continuous tic-tic sound from the flyback (horizontal output transformer). Roll up a paper, or use a short length of garden hose like a stethoscope. A steady tic-tic sound usually indicates the +158V supply and the +114V-regulator circuit are normal. If so, test the horizontal-deflection circuit.

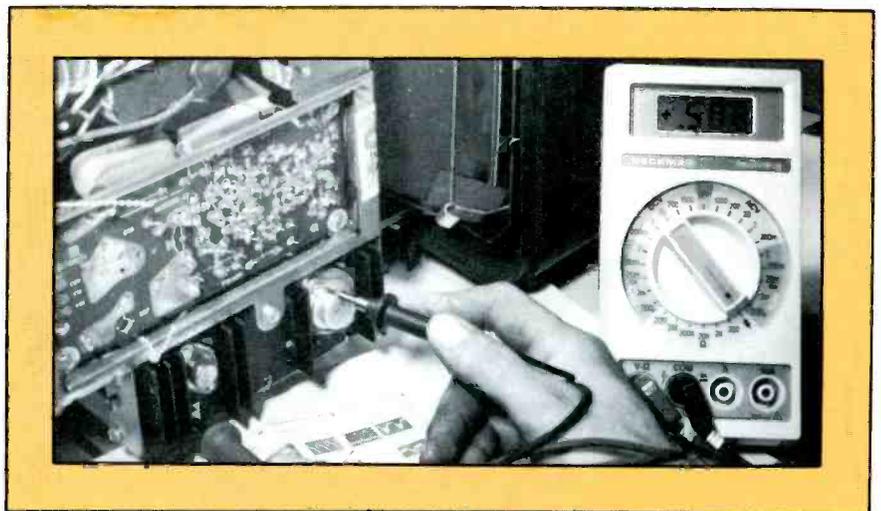


Figure 4. Testing for a Q101 collector short or a shorted CR101 damper using a voltage-drop junction or diode test. The reading here shows a normal damper forward-bias reading. Notice the *positive* test lead is placed against the hot-ground screw.

per second was heard around the flyback, the +158V hot supply and the SCR-regulator circuit probably are working, but the horizontal-sweep system is dead. Check the sweep circuit and make repairs. (Start-up was not complete.)

- If there was a short burst of sound immediately after power-on but it stopped quickly, there was no raster or picture, and the tic-tic sound could be heard from the flyback, the problem is likely to be excessive current in a volt-

age supply, such as the one for vertical sweep. Check for shorts and other overloads. (Note: Start-up was successful but was followed immediately by shut-down.)

- If power-on produces no sound, picture, raster or tic-tic, look for a defect in the +158V supply or the SCR regulator. (Start-up did not begin.)

Tests with meter

A convenient hot ground for testing the +158V floating-ground

supply can be found on the heat sink just below SCR101 (Figure 4), while the Q101 horizontal-output transistor is at the right on the same heat sink. When the set is in shut-down mode, both metal cases should measure higher than usual. If the SCR101 anode (metal case) measures much lower than the shut-down +166V, it is likely the +158V hot supply has a defect. In that event, check the bridge diodes and C114. Start-up is unlikely when the +158V supply is defective. Therefore, make all necessary repairs to the +158V supply first.

If the SCR101 anode voltage reading is correct for the shut-down mode, measure the dc voltage at Q101 collector (metal case). Without horizontal pulses to sync the regulator, the +114V supply should measure about +150V at the Q101 collector.

A CTC97 that is in shut-down condition should be tested by kick-starting the oscillator and driver from an external supply. Those details will be given later.

The Figure 5 partial schematic shows several components that should be tested before kick-starting is employed. After a time of operation, switch off the power and feel the Q101 output transistor's case. If it is warmer than normal, suspect leakage. The digital meter of Figure 4 shows the correct voltage-drop diode test of the damper diode CR101. Next, remove the Q101 transistor for accurate external tests.

C103 in Figure 5 will increase the high voltage to a dangerous value, if it opens. Check it carefully before installing a new Q101. C8 is the storage capacitor for the regulation. Check it for capacitance and leakage.

Quickly test all low-voltage power supplies for any sign of shorts or leakages. Do not operate the receiver at full-time voltage until C103 and the voltage supplies have been checked and cleared of suspicion.

Kick-starting and scope tests

When previous tests have not

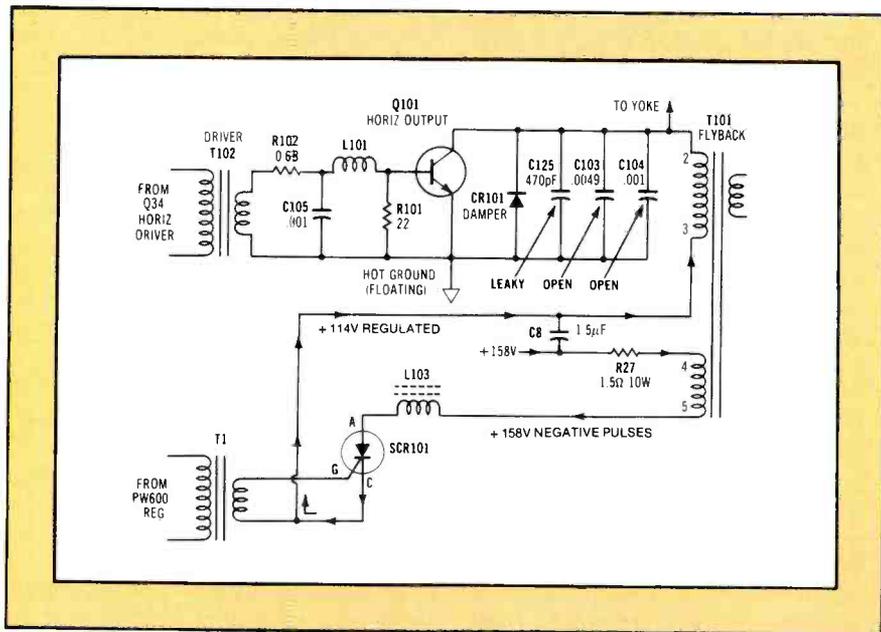


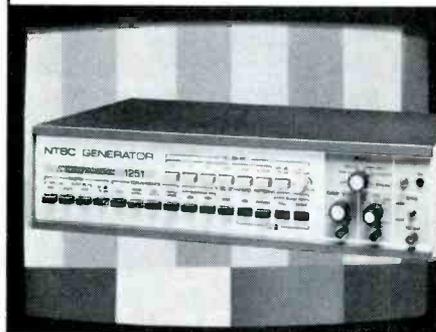
Figure 5. Regulation of the +114V supply (and with it, regulation of the signals and dc voltages rectified from the flyback) is accomplished by varying the conduction time of the SCR. A longer time of conduction increases the regulated +114V after it is integrated by C8. Notice that C8 is not electrolytic, but one designed to handle pulse current. It is a NPO type for stability. A second factor of regulation is the flyback pulses that are applied through current-limiting coil L103 to the SCR101 anode. These negative-going pulses turn-off SCR101; but in addition, some rectification of these pulses by SCR101 adds current to the regulated-voltage supply, thus increasing the effectiveness of the regulation. Several small transistors make up the circuit that drives SCR101 (at the proper time during each horizontal cycle) into full conduction that is stopped later by the negative-going pulses. The Q101 horizontal-output stage is more conventional. An open in C125, C103 or C104 (and especially C103) will increase the high voltage and add ringing wrinkles to the Q101 collector waveform pulses. A short or serious leakage in any of the three will eliminate the sweep and high voltage.

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located any erratic operation or serious overloads in the horizontal-deflection system, it is time to test with reduced power, thus minimizing damage to components. When reduced power is used, the horizontal must be kick-started from an external power supply.

Because the picture-tube heater is powered by horizontal from the flyback, these tests at low voltage do not produce a raster or picture. However, some high voltage can be measured. Ideally, the external power supply should provide about +20V of regulated output and be capable of supplying 200mA continuously.

Follow these steps:

- From the positive terminal of the external power supply, connect the anodes of two silicon diodes. The cathode of one should be wired to the cathode of CR115 (see Figure 1), and the cathode of the other diode should be connected to the CR119 cathode. These diodes pass power to oscillator and driver while providing isolation if the receiver supplies exceed the external voltage. Negative terminal of the power supply should be connected to a chassis cold ground.
- Apply about 35Vac from an isolated variable-voltage transformer to the receiver. This should provide about +40V at the Q101 output transistor collector. It is not necessary to disable the SCR regulator, although a jumper can be placed on SCR101 between anode and cathode, if desired, to eliminate all questions about the regulator.
- With a scope, check for the proper waveform and frequency at the base of Q34 horizontal driver. If either waveform or frequency is incorrect, the oscillator stage might be defective. When they are normal, scope the Q34 collector and the Q101 base. Some distortion and slightly lower PP level must be expected, particularly with the base waveform which should have fewer small pulses on it. Stop and make repairs anytime the waveforms and amplitudes deviate too much from the amounts described.
- Scope the Q101 collector and analyze the waveform. Although

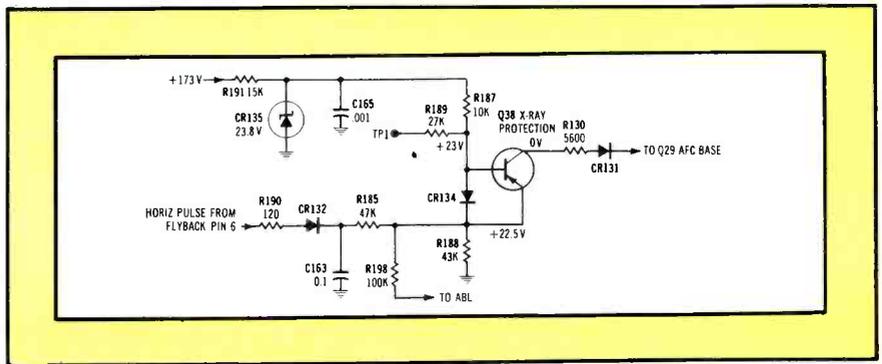


Figure 6. In the RCA CTC97 chassis, the X-ray protection circuit does not produce total shut-down of the receiver (as many later models do). Instead, excessive amplitude of pulses from the flyback causes Q38 conduction which increases the positive voltage in the AFC circuit to change the horizontal-oscillator frequency so much that the picture cannot be locked by rotation of the horizontal-hold control.

the amplitude seldom will exceed 50 percent of the PPV for normal supply voltage, the waveshape should be virtually identical to the usual waveform. Two or three small ringing pulses on each large positive pulse might indicate an open C103 or C104. (During full-power operation, an open in either will raise the high voltage to a dangerous level that usually triggers the X-ray protection circuit, forcing the horizontal out-of-lock.) **Warning:** Examine the collector waveform for positive peaks about halfway between the normal positive peaks. If one or two such peaks having 30 percent to 60 percent of the larger retrace peaks' amplitude are seen, a serious overload is present on the flyback/yoke system or one of the power supplies that are produced from rectified horizontal power. Do not operate this unit at 120Vac, or the horizontal-output transistor undoubtedly will be ruined! Locate and repair the defect before leaving the safety of this low-voltage test.

- After the Q101 waveform is normal, test the high voltage at the picture tube. Perhaps 10kV to 11kV is satisfactory for low-voltage operation, the exact figure changes with the precise line voltage applied. After the waveforms and the high voltage appear reasonable, considering the low line voltage, the external power supply should be disconnected and the receiver switched on with 120Vac applied. A normal picture and sound should be produced. If not, there might be

a defect in the start-up circuit.

Remember C114 is the only filter capacitor that has any importance for the +158V supply and the start-up operation. If it is low in capacitance, start-up might be erratic. If C114 is open, the chassis can be kick-started and it will operate. However, the picture will have two areas where the width is almost zero, and the narrowed areas move upward slowly just as hum does. It is possible for start-up transformer T104 to develop shorted turns, and this would stop that start-up completely. However, such defects are rare. Just make certain that someone who might have worked on the set previously has not added a filter before T104 or changed the point where C114 connects to the output side of the T104 winding. Start-up is impossible if a large filter is connected at the bridge output before T104.

These tests, ranging from simple tic-tic to scope analysis, should have found the problem in the horizontal-sweep system or the power supplies by now.

X-ray protection

Many of the newer model color receivers include a protective circuit that forces the horizontal and its power supplies into shut-down mode if the picture-tube current or high voltage is excessive. That is not true of the RCA CTC97. Instead, excessive pulse voltage from the flyback forces the oscillator's horizontal frequency so far out of tolerance that the picture cannot be locked by any adjustment of the horizontal-hold control.

Figure 6 shows the X-ray protec-

tion circuit. The Q38 base voltage is clamped to about +23V by zener CR135 and R191. Horizontal pulses from the flyback are rectified by diode CR132, filtered by C163, and the resulting dc voltage is reduced by voltage divider R185/R198, so the Q38 emitter voltage is slightly less positive than its base. Therefore, in normal operation, Q38 has reverse bias and is non-conductive. When the flyback pulses rise to a dangerous level, the Q38 emitter voltage rises until it is more positive than the base. Q38 now has forward bias, because it is a PNP type, and some of the emitter's positive voltage passes through the transistor, exiting at the collector, and then is sent to the base of Q29, the AFC transistor of the horizontal oscillator circuit. The Q29 base normally is positive (partially because the horizontal-hold control varies this base voltage in order to change the oscillator frequency), and the Q38 voltage forces it more positive so the hold control cannot lock the picture.

Although the circuit does not stop all horizontal operation, it reduces the high voltage slightly, and the out-of-lock picture should prompt the viewer to have the receiver repaired (including the cause of the high voltage). Extreme cases of excessive HV *might* kill the horizontal oscillator and thus cause shut-down, but I have not seen one of that severity so far.

A quick way to determine whether or not an out-of-lock picture is caused by the X-ray circuit is to ground the collector or emitter of Q38, or to connect together base and emitter. If this allows correct horizontal locking, either the high voltage is excessive or the Q38 circuit is defective. In either event, the horizontal oscillator has been cleared of suspicion.

Notice the TP1 testpoint. When it is grounded, the receiver should fall out of horizontal locking; and adjustments of the horizontal-hold control should not be able to lock it. This is the desired operation. If grounding TP1 does not force the oscillator out-of-lock, the X-ray protection circuit should be tested to find the defect.

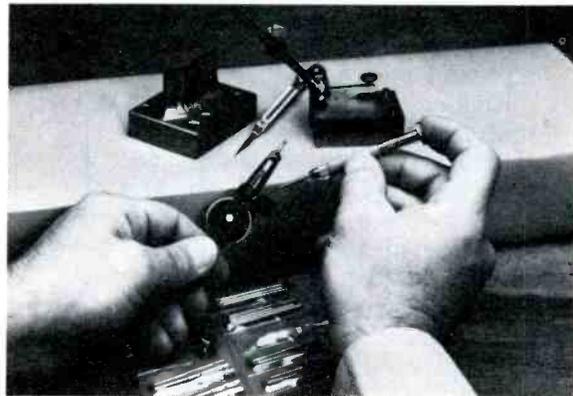
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successful start-up is a shorted yoke. The heavy load on the horizontal-sweep system prevents sufficient buildup of dc voltage in the power supplies, so the start-up surge arrives and passes, but it is not replaced by rectified voltage. *Start-up begins, but fails.* There is no sound and no raster.

Ringing the yoke is an excellent test method, but the two coils should be tested separately for best accuracy. A quick method that often works is to disconnect one wire of the horizontal yoke (Figure 7), turn down the bright-

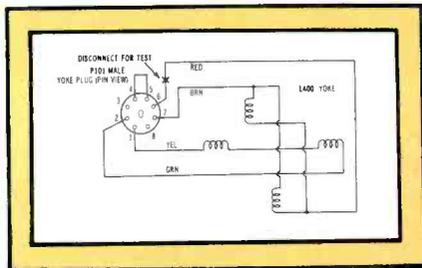


Figure 7. If disconnecting one end of the horizontal yoke restores the sound, it is likely that the yoke is defective.

ness control and switch on the ac power. Try the volume control. Loud audio sound obtained when the yoke is disconnected, and no sound with it connected, normally is proof that the yoke is defective and should be replaced. Operation with an *open* yoke widens the retrace pulses in the Q101 collector waveform, but the test permits some high voltage to be produced.

Overload test

An alternate method of minimizing damage to transistors and other sweep components during preliminary tests is to limit the ac line current by temporarily connecting a 100W incandescent light bulb across an open ac fuse (Figure 8). If the fuse is not open, remove it from the holder. The bulb limits the maximum current to less than 1A, while showing by its brightness the relative amount of current and voltage at the bulb.

Oscillator problems

Figure 9 shows several oscillator components that have been known to cause problems. C146 is the principal frequency determining component, so the slightest deviation from specification causes erratic operation. Q30 and Q31 form an emitter-coupled oscillator,

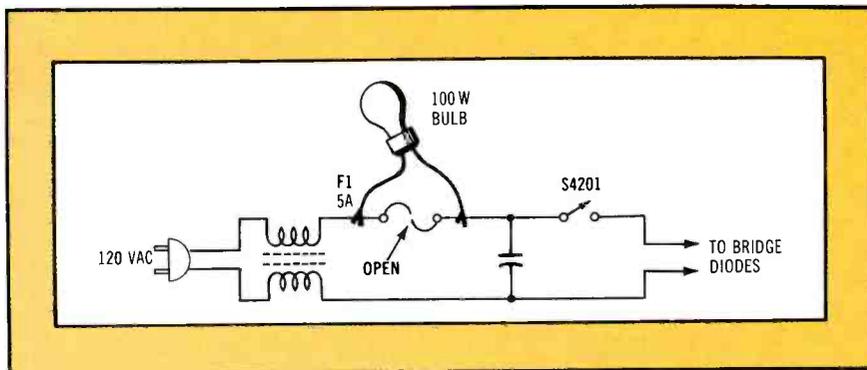


Figure 8. When the ac-line fuse is open (or removed), a 100W light bulb connected across the fuse contacts limits the current, and will show by the brightness how much current is flowing.

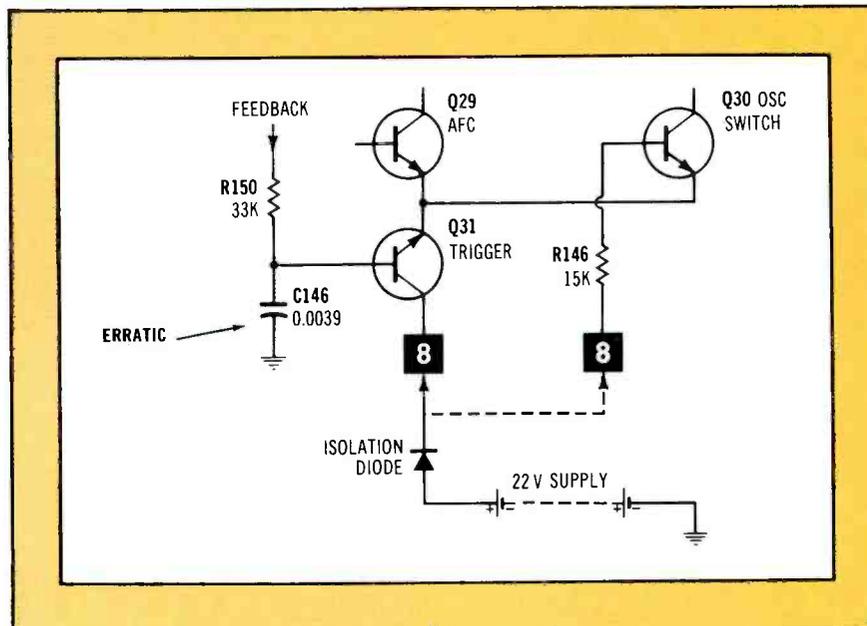


Figure 9. These three horizontal-oscillator transistors and frequency-determining capacitor C146 have caused some problems in the past. Check them first.

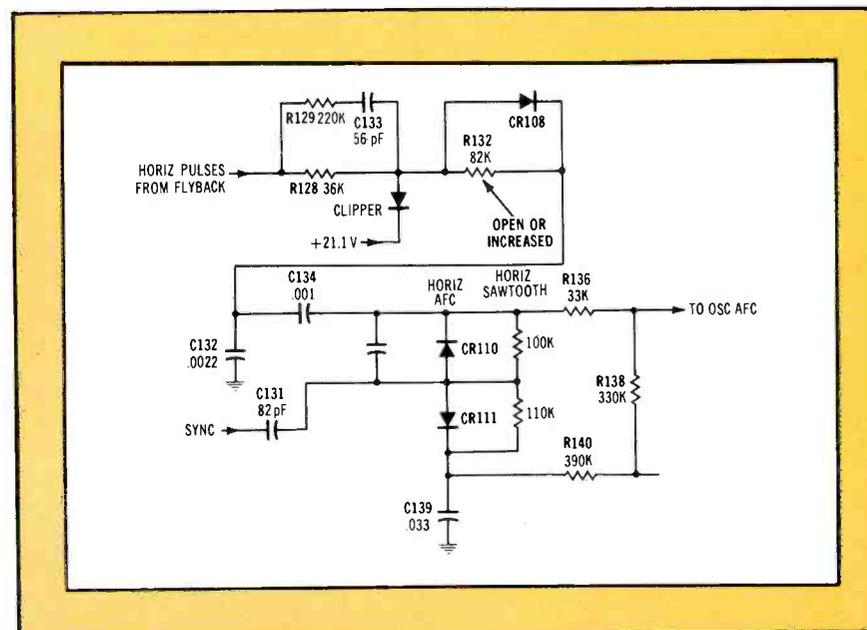


Figure 10. An increased value or an open circuit in R132 can produce an unstable picture or erratic horizontal locking. The defect reduces the amplitude of the horizontal-deflection sawtooth that is compared against the sync pulses.

while Q29 varies the oscillator bias to change the frequency sufficiently for locking with the video.

Unstable horizontal locking or picture-pulling can be caused by a changed value of R132 (Figure 10). Remember that sawteeth formed from the horizontal-sweep signal and pulses from the separated sync must *both* be applied to the horizontal-AFC diodes before solid locking can be obtained.

Unusual problems

One CTC97 showed a picture of excessive brightness. Adjustments of brightness or screen-grid controls had little effect on the brightness. Under normal conditions, the screen-grid control can vary the screen voltage between about +220V and +725V, but in this receiver, the control changed the screen voltage very little and never below about +650V. Evidently, the high screen-grid voltage was producing the excessive picture brightness. In the CTC97, the screen-grid control is part of a voltage divider that includes the picture-tube focus control (Figure 11). Most components

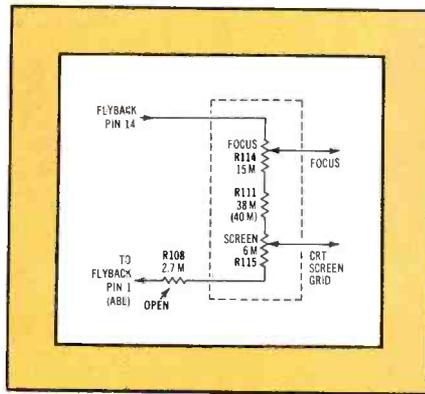


Figure 11. An open R108 in the focus/screen-voltage divider produces excessive brightness.

are inside the assembly, but the R108 2.7M resistor that completes the divider path back to the flyback winding is external. *R108 was open.* Replacement and screen-grid control adjustment for proper CRT-gun cut-off point restored correct brightness and color tracking.

In another case, the picture would bloom and the size would pulsate, regardless of the brightness-control adjustment. When measured at the picture tube, the high voltage varied between 12kV and 14kV, obviously too low. In-

stallation of new flyback restored the correct high voltage and stopped the pulsed blooming.

Comments

RCA CTC97 supplies power to only one transistor (Q101 horizontal output) from the line-rectified hot supply. All other dc-supply voltages come from rectification of horizontal-deflection power from the flyback transformer, followed by filtering and sometimes regulation. Therefore, start-up dc voltages must be supplied to the horizontal oscillator and driver (the output has voltage) before the horizontal system can operate and produce power for the other voltage supplies.

When a CTC97 is operated with low power to prevent component damage during tests, an external voltage supply must be connected to furnish B+ voltages for the horizontal oscillator and driver transistors.

After these facts are understood, troubleshooting can proceed along the same general lines as for other solid-state color TV receivers.

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Clearing up a snowy TVRO picture

By Tom Moore

Solving problems in a satellite receiving system starts with isolating it to a specific component.

In a satellite earth station, the LNA (low-noise amplifier) amplifies the TV signal collected by the dish by 40dB. The amplified signal then passes through the downconverter where the frequency is ultimately converted to 70MHz. Components used in this stage are field effect transistors with low noise characteristics and high amplification.

Because the incoming signal varies between 3.5 and 4.5GHz, a variable oscillator is used to supply the mixing signal which converts the incoming signal to 1100MHz. Next, the signal goes through the first IF stage where it is boosted another 5 to 10dB. This stage is biased for class A operation and can be tuned in the field.

A second mixing signal is applied, reducing the signal frequency to 70MHz. The next IF amplifier is very critical and is usually tuned at the factory. It sets the noise bandwidth of the receiver as well as supplying 60dB gain.

Most TVRO installations are this type of system, referred to as *dual conversion*. These systems reduce interference from signals near the 4GHz band. You should be aware, however, that a few systems use one mixing stage and one IF amplifier: *Single conversion* types.

From the second IF amplifier, the signal goes to the receiver and passes through a phase-locked loop signal processor. A feedback AFC signal is applied to the incoming signal for greater stability. Output from the signal processor is split into video, audio and RF components.

If a viewer is really serious about getting the most from his system, he'll invest in a TV monitor for the video and a good stereo for the audio. The video and audio com-

ponents from the signal processor are fed through output jacks at the back of the satellite receiver so the viewer can inject the signal directly into his monitor and stereo set. For a conventional TV set without a cable input, the RF component passes through the RF *out* jack and goes through an adapter which connects to antenna terminal connections at the back of the set.

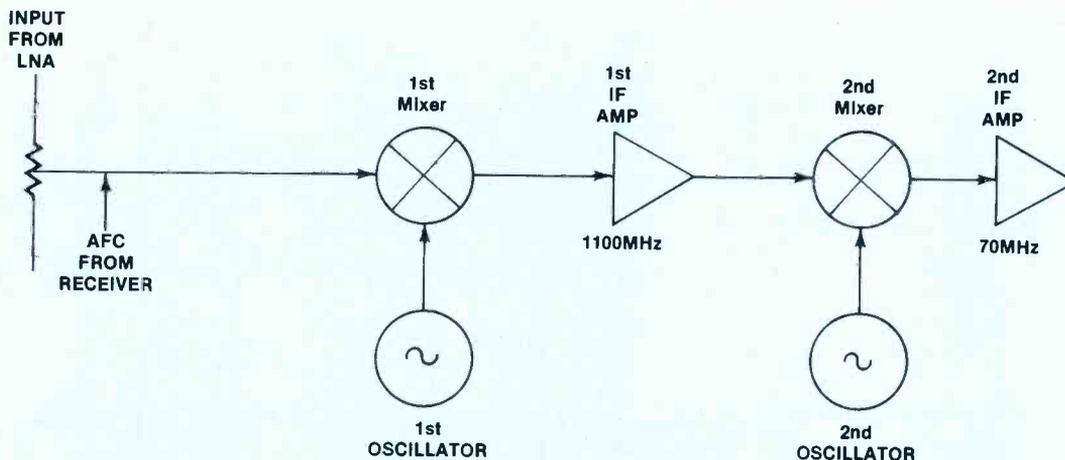
The receiver accepts signals not only from the low-noise amplifier/downconverter, (LNA/DC), but also from a conventional antenna on the roof for local stations. This signal enters the receiver through an RF *in* jack. The final connection is the power cable between the receiver and the LNA. This supplies the power to the LNA/DC.

This basic understanding of the various components in an earth station will help correct a common TVRO troubleshooting problem: *snow* in the picture. The purpose is to show how to isolate the problem to a specific component.

In the past, this kind of problem indicated a faulty antenna installation or a set which needed alignment. This still may be the case. Because the receiver accepts input from either the satellite dish or a rooftop antenna, as a first diagnostic step, set the receiver to accept the local stations from the conventional antenna. If snow continues, then the problem is either in the set or the antenna. If you switch the reception back to accepting inputs from the satellite system and snow continues, the problem is most likely in the set.

Suppose the local programs are clear, the next question is, does the problem exist on all of the satellite channels? The reason is that not all satellite transponders are equal in

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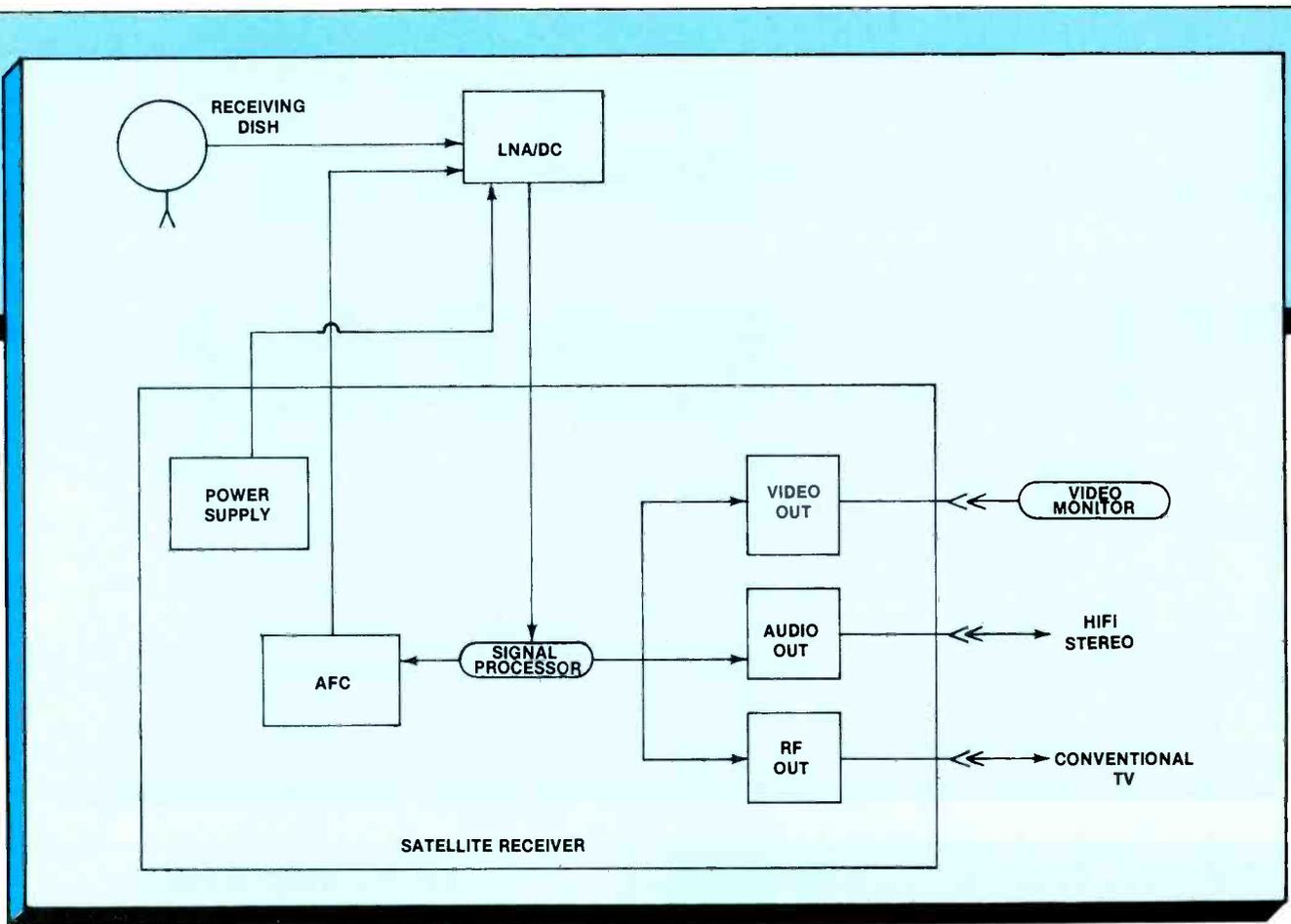
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output power. A transponder can vary between 6 and 9W according to the needs of the individual broadcaster leasing the transponder.

If the problem isn't on all the channels, the problem is likely in the receiving dish. An 8-foot dish will have more signal loss than a 10-foot dish of equal quality, therefore sparkling will be apparent on the weaker channels. If the customer has a 10-foot dish, the next question is: how many sections were used to assemble it? If more than two sections were used, it is expected that there would be higher signal loss. A visual inspection of the dish should detect any blemishes which might cause the problem.

If the problem is on all of the satellite channels, and the dish is adequate for the locality, then the problem is most likely in the downconverter. If it uses single conversion rather than dual conversion, the problem might be caused by mutual interference. If

it uses dual conversion, an IF alignment of the first stage might clear the problem.

So far, the solutions to a troubleshooting problem have only dealt with components which process the incoming signal. The most common problem with earth stations has come from a component outside of the signal path, the remote device. A lot of people use a device which has a computer memory. Whenever you want to position the dish on a different satellite, you merely punch in an alphanumeric code.

Unfortunately, these devices can lose the memory due to power surges or loss, stray microwave signals, or faulty components which necessitates reprogramming. Reprogramming is very simple. These devices have both an east-west switch and a set of alpha and numeric keys. Push the switch to west and let the dish slew over to the azimuth of the westernmost satellite, Satcom III. When the dish is pointing at the satellite, use

the east-west switch to rock the dish back and forth until the strongest signal is received. When the picture is peaked, hit the program key and enter the code for the satellite. Move the dish back to the east until the next satellite is reached and repeat the process. Repeat the procedure until all satellites have been entered.

With this knowledge of remote devices, let's return to the original problem of snow in the picture. As you can see, each satellite should be peaked before the code is entered in the device. If reception from one of the satellites wasn't peaked, then the reception will always be off because the remote device will position the dish according to the setting entered. The final question when troubleshooting this problem asks: Is the trouble from different satellites or one particular satellite? If it is only one satellite, then a few minutes to reprogram the remote device for the satellite in question could clear up the problem.

ES&T

Literature

A 20-page short-form catalog describing more than 50 test instruments, including digital and analog meters, isolated ac power sources, signal generators, dc power supplies and universal counters is now available from **VIZ Test Equipment**, division of **VIZ Manufacturing Company**, Philadelphia.

This color catalog introduces nine new instruments including three new isolated ac power sources and four new digital frequency counters. Technical specifications listed include voltage and current ranges, meter accuracy, measuring range and resolution.

Circle (127) on Reply Card

Vaco Products Company offers an 8-page catalog containing full-color photographs and complete descriptions on a number of new products which Vaco introduced earlier this year. These products include a new family of ratchet magnetic screwdriver sets, Nibbler cutting tool, micro wire stripper, Teflon & fiber-optic stripper, Slide-a-Socket, line of magnetic metric nut drivers, expanded screwdriver line, hex key vinyl displays and electrical testers.

Circle (130) on Reply Card

Simpson Electric Company is offering their 28-page, 4-color catalog 5400-P. The catalog lists the entire Simpson stock line of more than 1500 U.S.-made analog and digital panel meters, meter relays and controllers. Also listed are panel-mount chart recorders. Included are Simpson's popular styles: the Wide-View, Bold-View, Century, Designer and other meter series, which are offered in

many sizes from 1½-inch to 7-inch and in most preferred ranges.

Circle (131) on Reply Card

A full-color, 4-page brochure providing a complete explanation of power problems confronting computers and other sensitive computerized equipment, including price/performance comparisons of the available solutions, is available from **Shape Magnetics**.

This brochure also provides detailed performance specifications for Shape's Z-Phase Line Tamer power conditioners for applications requiring 3-phase power protection, and for Shape's Computer Line Tamers for single-phase systems. Shape Z-Phase Line Tamers are available in standard capacity ratings, ranging from 7.5kVA to 75kVA for 3-phase applications. Single-phase Computer Line Tamers range from 30VA through 75kVA

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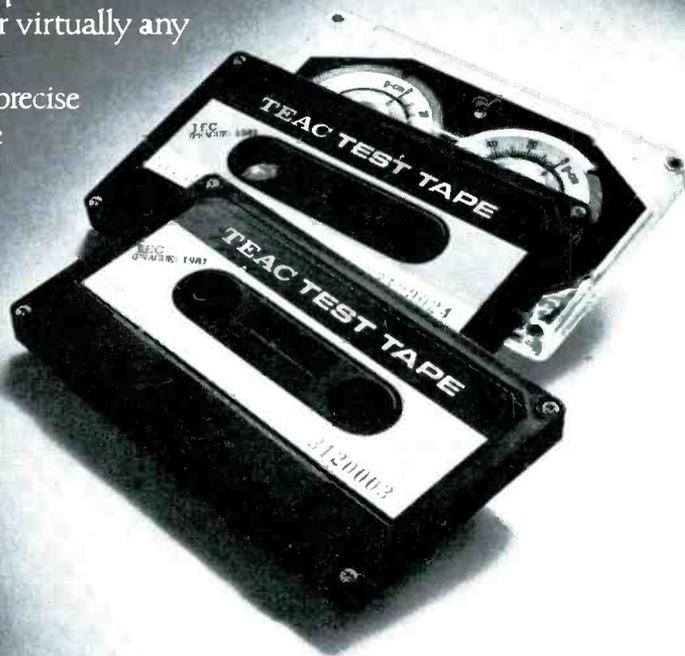
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Test your electronic knowledge

By Sam Wilson

It is a good idea to periodically review the basic ideas related to technology. The questions in this quiz cover many specialties in electronics.

1. For the system of Figure 1, an increase in the strength of the magnetic field causes an increase in the generated voltage (V). This is an application of:

- (A) Lenz's Law.
- (B) Field Effect.
- (C) Hall Effect.
- (D) Thompson Effect.

2. A VOM rated with a sensitivity of $20,000\Omega/V$ is used to measure 6V. The impedance of the meter, when making this measurement is: $6 \times 20,000 = 120,000\Omega$.

- (A) This is a correct interpretation of the ohms-per-volt rating.
- (B) The ohms-per-volt rating cannot be used this way.

3. In the circuit of Figure 2, the meter indicates a current of value I. Assume there is no internal resistance in the battery. If the battery and meter are interchanged, the meter will indicate:

- (A) a higher current.
- (B) a lower current.
- (C) the same amount of current.
- (D) an amount of current that cannot be determined from the information given.

4. The circuit in Figure 3A is a complicated interconnection of resistors and batteries that produces a voltage across terminals w and x. It doesn't make any dif-

ference how complicated the circuit is, it can always be represented by the simple circuit of Figure 3B. Both circuits will produce the same amount of current through a given value of load resistance (R).

- (A) The above statement is not true.
- (B) The above statement is true.

5. Which of the following is a component that acts as an interface between two logic circuits that could not be directly connected?

- (A) Encoder
- (B) Decoder
- (C) Register
- (D) Buffer

6. Which of the following is still an advantage of relays?

- (A) Very fast speed
- (B) High fan out
- (C) High fan in
- (D) Low standoff ratio

7. The duty cycle for a square wave is:

- (A) 0 percent
- (B) 50 percent
- (C) 63 percent
- (D) 100 percent

8. Which of the following is more nearly like a perfect filter?

- (A) A filter of the first order
- (B) A filter of the second order

9. Consider this Boolean equation:

$$\overline{A} + \overline{B} + \overline{C} = \overline{ABC}$$

- (A) The equation is correct as given.
- (B) The equation would be correct if the C was eliminated.
- (C) The statement is not correct.

10. Which of the following is needed with open-collector logic?

- (A) A pull-up resistor
- (B) A pull-down resistor
- (C) A filter capacitor
- (D) A voltage divider

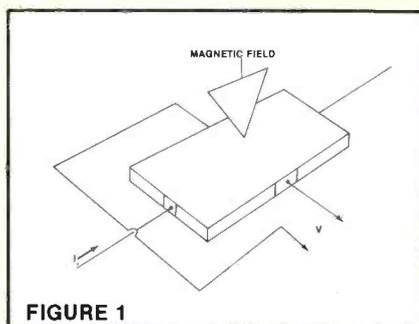


FIGURE 1

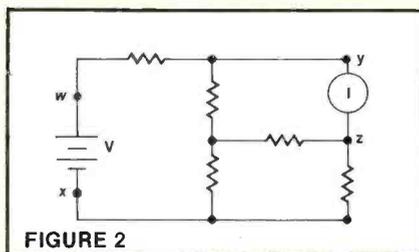


FIGURE 2

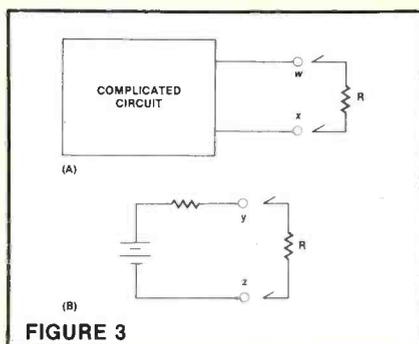


FIGURE 3

Answers to quiz

1. C. The Hall effect device is used in magnetic measuring equipment.

2. B. The ohms-per-volt rating gives the full-scale deflection sensitivity of the meter movement. The full-scale current is the reciprocal of the ohms-per-volt rating. For example, a 20,000Ω/V sensitivity means that the meter will deflect to full scale with a current of 50μA.

3. C. This is an application of the *reciprocity theorem*.

4. B. This is an application of *Thevenin's Theorem*.

5. D. There are several kinds of buffers used in electronic systems. This type does not have a voltage gain, but it often has current gain.

6. B. The high fan out rating means that the relay can simultaneously switch many output circuits.

7. B. Duty cycle is a measure of on time compared to the time for one cycle.

8. B. The higher the order the more closely the filter approaches the ideal filter.

9. A.

10. A. An advantage of open-collector devices is that it makes it a simple matter to connect several outputs together through a single pull-up resistor.

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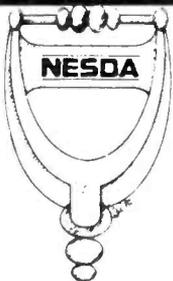
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Circle (69) on Reply Card

Mini/microcomputer regulator

A portable mini/microcomputer regulator, introduced by *Sola Electric*, Elk Grove Village, IL, a unit of General Signal, extends the output range of Sola's plug-in power conditioner line up to 3kVA. This model, UL-listed, protects sensitive electronic equipment such as minicomputers, terminals or test instruments from most ac power problems except total line failure.



The 3kVA unit features high noise attenuation exceeding 60dB for transverse-mode and 120dB for common-mode noise. By contrast, ultra-isolation transformers typically reject only common-mode noise. The new model also maintains sine-wave output containing less than three percent harmonic distortion.

Circle (70) on Reply Card

Satellite receiver

Lowrance Electronics, Tulsa, OK, announces a patent pending phase shift discriminator circuit, the Etched Tunable Phase Shift Detector, as part of its new System 70 satellite receiver. The phase shift portion is etched into the circuit board and can be tuned to exactly 70MHz.

Lowrance has also introduced a new block conversion option for the System 70 series. System 70 receivers can be shipped block ready or existing receivers can be retrofitted for block conversion. The block converter uses a dielectrically stabilized oscillator for exceptional temperature stability. It down converts to 950-1450MHz to avoid the interference problems of the UHF bands and allow use with either four or 12GHz. This option also provides exceptional performance for multiple hookup and commercial applications.

Circle (71) on Reply Card

Heavy duty DMM

Beckman Industrial Corporation, Brea, CA, has added a new heavy duty hand-held DMM to its HD-100 series. The HD-110T is a valuable tool for applications requiring accurate temperature measurement in the expanding service areas because of the meter's ability to measure temperature in either Centigrade or Fahrenheit. The meter is capable of measuring up to 1999°F with one degree resolution.

The HD-110T has a rotary switch, an Insta-Ohms continuity indicator and a 2000-hour battery life. Other features include RF shielding, 22MΩ input impedance, voltage to 1500Vdc and 1000Vac, and 10A ac/dc current capability. Included with all HD-110Ts is a test lead set, battery, spare fuse, operator's manual and a K-type thermocouple wire.

Circle (74) on Reply Card

Circuit board drilling system

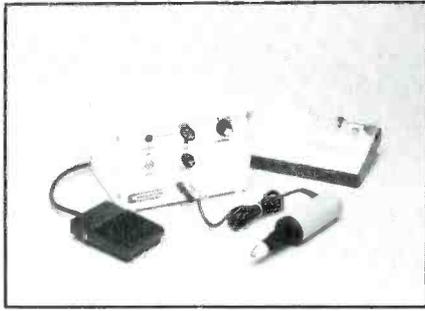
APE Corporation has introduced a new version of model SRS 008 circuit board drilling system. Features include: foot pedal operated power source and widely variable speed control for hand-held motor (0-20,000 rpm's). The system comes complete with heavy duty hand-held motor and



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with versatile chuck, which accommodates tooling up to 9/64-inch. Completing the system is a full assortment of drills, bits, burrs and abrasives to accommodate all circuit board repair requirements.

Circle (73) on Reply Card

Digital frequency counter

VIZ Test Equipment, Philadelphia, PA, introduced a new 5Hz to 100MHz frequency counter which has an overall frequency accuracy of 0.003 percent with stability tolerance of ± 0.002 percent. A switchable attenuator reduces high amplitude input signals by 1/10th to allow accurate measurements and prevent overloads. Built-in low pass filters let the user reject or include low frequency components ($< 10\text{MHz}$) of high frequency signals.

Circle (75) on Reply Card

Metric converter

The Factorpak from Hunter Calculators, Bridgewater, NJ, is a metric conversion unit designed specifically for use with electronic calculators, and it expands the range of even the simplest calculator. The Factorpak is a loose-leaf-bound pocket book that contains, in easy reference form, 71 pages of technical conversion factors. All the factors are multiplying factors logically arranged in tabular form to minimize conversion errors.

Circle (76) on Reply Card

FM atlas

Bruce F. Elving, Ph.D, has published his ninth edition of the *FM Atlas and Station Directory*. The FM Atlas includes 65 pages of maps, showing all cities having FM broadcasting facilities and a large directory that gives programming and technical details on the FM

stations of the United States, Canada and Mexico.

All FM stations, commercial and educational, are shown, as well as translators used to fill in gaps in coverage by conventional stations. The book lists stations having an SCA subcarrier, talks about the new FM station allocation rules, includes a philatelic salute to FM's inventor, Maj. Edwin H. Armstrong, discusses the departure of Dolby from the FM processing scene and has tips for improving reception.

Circle (77) on Reply Card

Three satellite TV receivers

Winegard Company, Burlington, IA, has introduced three models in its latest generation of home satellite TV receivers. Model SC-7037S, the top-of-the-line unit, features infrared remote control and a built-in antenna positioner control and power supply. Model SC-7037, in the mid-priced range, also offers infrared remote. The lowest-priced unit, SC-7037E, is a basic unit without built-in actuator or remote control.

All three Winegard receivers offer these features: rapid scan control, polarity format switch, signal-strength LED bar graph, skew control, audio fine tuning, crystal-controlled channel 3/4 modulator, and video invert switching.

Circle (78) on Reply Card

Hand-held tester

The Lil'Bitty Tester manufactured by Lil'Bitty Tester, Chula Vista, CA, is a hand-held portable go/no go tester. It was designed for the professional electronics technician for field or shop use.

The Lil'Bitty Tester operates with a bipolar LED and audible tone for indication of test results, has a built-in selftest, requires no calibration, yet has the capability of detecting transistor leakage. It indicates the presence and polarity of a dc voltage up to 28V. It can be used to test for continuity. The Lil'Bitty Tester can test discrete components in or out of circuit, such as transistors, FETs, SCRs, triacs, diodes, bipolar and standard LEDs, bridge rectifiers and incandescent lamps.

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Readers' Exchange

For Sale: Heathkit microprocessor trainer accessory ETA-3400 with optional 3k memory chips, assembled with manual, \$125. *Calvin Logue Jr., 17 J Washington Lane, Westminster, MD 21157.*

Needed: Schematic for Sanyo color TV, model no. 51C41. *George Saylor, 2319 Parrish St., Philadelphia, PA 19130.*

For Sale: Sencore SG165 stereo analyzer, like new, only used once, \$450. *North Shore Electronics, 681 N. State, Rogers City, MI 49779; 517-734-4300.*

Needed: Toshiba horizontal output transformer, model no. 685-2849, part no. 23226301. Also, JC Penney TV model no. 2849, part no. TFB 200 6A 23226301. *Alma Fulks, Oak Ridge, TN 37830; 615-483-8266.*

For Sale: FC45 frequency counter, \$250. Sencore TF46 Cricket, \$160. EICO 633 CRT tester with adapters, \$80. UPS included. *Bill Bechtold, 7429 Frederick, Omaha, NE 68124; 402-397-2461.*

Needed: Schematic for L 100 Seeburg juke box. *Victor Koestus, Box 37, Martenton, IL 60951.*

For Sale: Sams Photofacts 721-2074 and 2180-2222 with five metal cabinets, \$2000. Sencore SG-165 AM/FM stereo analyzer, \$650. 1200 TV tubes with rack and caddy, \$600. B&K 1076 TV analyzer, \$100. *John Blair, 1315 N. 75th St., Philadelphia, PA 19151; 215-473-4082.*

Needed: Complete correspondence TV repair course with exams and answers from international correspondence schools. *John P. Caputo, 271 Cadman Plaza East, G.P.O., P.O. Box 3175, Brooklyn, NY 11202-3175.*

For Sale: Exidy Sorcerer computer with Micropolis dual drive system, S-100 with 56K of actual user ram, 630KB storage on the drives, includes software package, plus a music interface with more than 100 cassettes and a 1200 baud recorder. Also includes many great graphic arcade games. Hardware, manuals, software and all media included. Price is \$1500 firm, including shipping. *Jack MacGrath, 73 Jordan Road, North Chelmsford, MA 01863; 617-251-4776.*

For Sale: B&K 1077 B analyst, \$400. EICO 944 flyback and yoke tester, \$50. Pattern generator, \$50. Will sell all three for \$450. All in excellent condition with leads and manuals. *Johnny's TV Service, Rt. 1, Box 249, Jonesville, SC 29353.*

For Sale: Hewlett-Packard oscillators, 200CD, 202C, \$25 each. Low-frequency function generator, 202A, \$30. Tektronix 3-inch oscilloscope, RM-17, \$89. Dumont solid-state, dual-channel, delay sweep model 1062 oscilloscope, \$200. *Frederick Jones, 407 Morningbird Court, Niceville, FL 32587; 904-678-1803.*

Needed: Schematic and operating manual for Pierce Simpson ICB 301 mobil radio. *Gerwig's TV Service, Rt. 1, Box 534, Round Hill, VA 22141.*

For Sale: EICO 460 oscilloscope, \$60. EICO 239 FET-TVM, \$60. B&K 470 CRT restorer/analyzer, \$200. All in good working condition, complete with test leads, probes and manuals. Prices are plus freight and shipping. *T. T. Walton, 8209 Lynnhaven Ave., Lubbock, TX 79423.*

For Sale: Back issues of *Electronic Servicing*, *P.F. Reporter*, *Electronic Technician/Dealer*, textbooks on radio and television, Tekfax diagrams—Dec. 1952—Aug. 1979. 1212 diagrams, \$125. *M. Seligsohn, 1455 55th St., Brooklyn, NY 11219.*

For Sale: Sams 300-2020, complete with three filing cabinets, \$950. Also troubleshooting manuals. *Calvin Boddie, 660 E. Yucca St., Ornard, CA 95030; 805-487-3170.*

Needed: One original metal base for an Atwater-Kent E-Speaker, late number Ryder radio manuals, Atwater-Kent both radios. *Charlie Alford, 222 N. San Jacinto, San Jacinto, CA 92383.*

For Sale: Heath IG 5257 TV sweep generator, mint condition, \$100. *Joe Konney, 3155 N. Long, Chicago, IL 60641; 312-777-5588.*

For Sale: Sams Photofacts 131-1116 plus various binders beyond 1116, including filing cabinets, \$800. Quasar 1962 to present, \$350. Zenith 1971 to 1983 including binders, \$300. RCA 1971 to 1983 including binders, \$350. Magnavox volumes 8, 9, 10, 11, including binders, \$100. You pay shipping. *Ireland's Television and Electronics, 1204 E. Main St., Millville, NJ 08332; 609-825-0709.*

Wanted: S meter for a Hallinofter model SX-28 in good condition. *Paul Capito, 637 W. 21st St., Erie, PA 16502.*

For Sale: CRT tester Sencore CR 168 with 16 sockets, \$100. Sencore SM 158 sweep and marker, used once, \$150. *V. Granzella Jr., Box 190, Wheatland, MO 65779; 417-282-6506.*

Wanted: Schematic for RCA Chro Bar generator WR-502A. **For Sale:** EICO 633 CRT tester/rejuvenator VGC with manual, \$30. UPS collect. *Gerwig's TV Service, Rt. 1, Box 534, Round Hill, VA 22141.*

For Sale: Sears modules 35-41300-1, 354430H, 354295H, 3532605-1, 35412021, 3539601-1, 3544200-1. Take all at \$9.50 each plus shipping. *M. Andrews Jr., Box 91, Exeter, RI 02822.*

Needed: Manual for General Radio frequency synthesizer, model 1165; manual for Monsanto automatic counter model 107A; manual for Tennelec memory scan model MCP-1; manual for Fairchild TV camera, model TC177RL. Will pay for copying and shipping. *Lawrence Ferguson, Rt. 1, Brady, NE 69123.*

Wanted and Needed: Sams Photofact for a Hurricane 350 linear. Call collect for price and/or send to *Jim Hannon, P.O. Box 145, Bellville, TX 77418; 409-865-9882.*

Wanted: Motorola portable test set S1059A. *John Gjerdevig, 507 10th Ave. E., West Fargo, ND 58078.*

Wanted: Beltron CTR tester/rejuvenator. State condition and price. *Leonard E. Numola, 583 Davenport Ave., New Rochelle, NY 10805.*

Needed: Power transformer for RCA CTC 40P color TV, RCA part no. 126727. State new or used and price. *Bill Bolton, 1303 N. Calhoun, Liberal, KS 67901.*

For Sale: Sencore VA48 analyzer, \$700. Sencore CB42 analyzer, \$700. Both with leads and factory operation manual. *Al Altigieri, 539 Bernard St., East Meadow, NY 11554; 516-542-0780.*

Needed: Service information on Tape Recorder TR 30. Call or write with price and details. *Ed Tiesman, Ed's TV, 1231 12th Ave., Fulton, IL 61252; 815-589-3576 collect.*

Wanted: One Hickok generator, model 656XC; one Hickok generator model 295X; one Precision Audio generator, tube type. *J. G. Shoemaker, Color TV Sales and Service, 600 First St., Leechburg, PA 15656; 412-842-8321.*

Wanted: EICO 260, 261 audio wattmeter in good condition. Will pay any reasonable price. *Jeff Jeffers, 337 Lambert Ave., Groveport, OH 43125; 614-836-5368.*

For Sale: B&K model 470 picture tube tester/rejuvenator with 10 adapters. Like new, \$150 or best offer. *Allen Josephsen, Al's TV, P.O. Box 115, Anita, IA 50020; 712-762-4210.*

For Sale: Sencore FS-134 field signal strength meter. Like new, \$60. *George H. Blecker, 271 Emporia, Apt. #7, San Antonio, TX 78209.*

Needed: Service manual, schematics and parts list for Advent video beam 750 projection TV with remote control. *A. West, 10550 Hazel St., Largo, FL 33544; 813-398-0412.*

For Sale: Complete TV service shop equipment. More than \$4000 worth of literature (400 Sams and complete Zenith line), test instruments, tools and parts for sale. Best offer over \$2000. *Ezra Hodgson, Ezra's Electronic Service, Box 148D, Berryville, AR 72616; 501-423-2642.*

For Sale: Test equipment—Sencore CR70 CRT analyzer and restorer; Sencore TF46 transistor and FET tester; Sencore PR57 isolation transformer; Sencore LC53 capacitor and coil analyzer; and Sencore CG25 color bar generator. All equipment less than one year old and in excellent condition. Make offer. *Gregory Ward, Video Tronix, 201-5 Villas Drive, New Castle, DE 19720.*

Needed: Horizontal drive transformer for a Midland 15-247 color TV, part no. 15-123341. *Ralph Watson, Watson's TV Service, 1414 N. 10th St., Arkadelphia, AR 71923; 501-246-7535.*

For Sale: B&K 415 TV-FM alignment generator, \$200. B&K 1076 analyst, \$100. Both in good condition, hardly used, with books and cables. *John Russo, 1057 Big Pine, Santa Maria, CA 93454; 805-925-8773 (day), 805-925-2173 (evenings).*

For Sale: Video tune-up program (by Solas Products) which converts Commodore 64/SX-64 computer into full function video analyzer. It generates standard video test patterns (convergence, rainbow, purity, etc.) plus an animated video performance test. Tune video monitors or televisions, \$35 (disk). *Mark Krause, Box 665, Springhouse, PA 19477; 215-362-5028.*

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Checking and replacing the upper cylinder in RCA VCRs—Symptoms produced by a dirty VCR head are often the same as those caused by a defective head. This article, adapted from the "RCA Communicator," describes how to determine if the head is in fact defective and, if so, how to replace it. Also included is a discussion of how to check performance and adjustment once the new cylinder is installed.

Servicing cordless telephones-Part II—The second installment of this 2-part article on servicing cordless telephones deals with the handset. Included in this installment is a description of how the ring is received from the base station and how dialing pulses are generated. Battery operation and charging are also discussed.

Special-purpose diodes—A diode is a diode. Except when it's a breakover diode; or a Shockley diode; or a high-frequency, hot-carrier diode. In this review, Sam Wilson updates the rapidly developing field of special-purpose diodes.

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