

Radio-Electronics®

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THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

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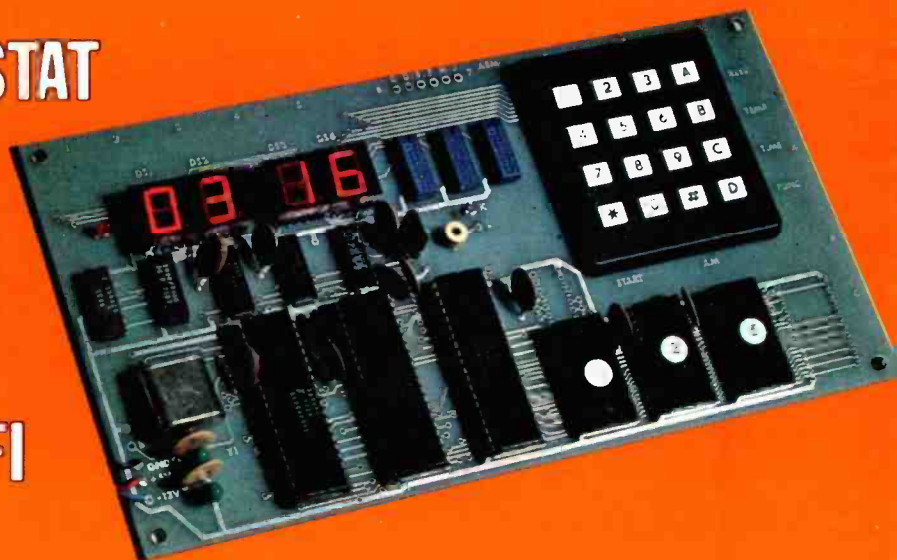
Cuts heating bills

VIDEODISC PLAYER

Look at the circuitry

CAR STEREO GOES HI-FI

Special roundup report



SWITCHING POWER SUPPLIES

How to roll your own

R.E.A.L. SOUND LAB

JVC JR-S501 receiver

Scott 530T tuner



BUILD TELECORDER

For your phone

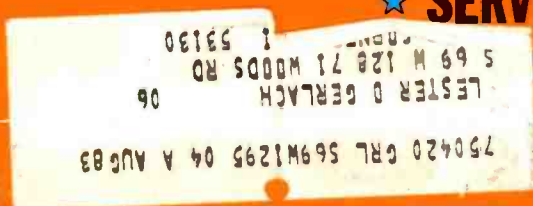
TIM DISTORTION

New audio spec

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Zener diodes

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The Personal Computer Line by OHIO SCIENTIFIC

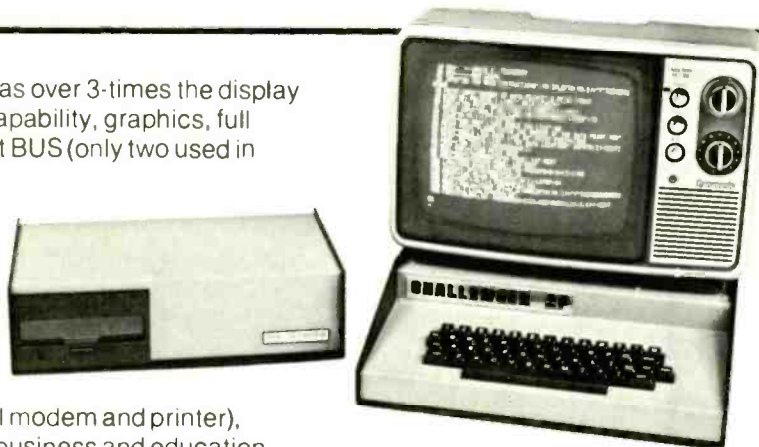


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* Monitors and cassette recorders not included. Ohio Scientific offers a combination TV/Monitor (AC-3P) for \$115.

For cost effective capacitance measurement



One C-meter stands out of the darkness— the \$130 B&K-PRECISION 820

For about one-third the cost of the most popular digital capacitance meter, you can own five times more measurement capability. The new B&K-PRECISION 820 reads all the way to 1 Farad, in ten ranges. With 0.5% accuracy, the 820 resolves to 0.1pF for a maximum count of 9999.

The 820 keeps on going in freezing cold to blistering 100 degree heat, making it ideal for field use. The bright LED display is easily readable under all lighting conditions. It has the versatility needed for any application and the durability to stay on the job. The 820 can be powered by disposable batteries or optional rechargeable batteries.

Unlike many specialized instruments, the 820 has almost unlimited applications in engineering, production line work, QC, education and field service. First time users are quickly discovering that the number of time-saving applications exceed their original expectations. For example, you can measure unmarked capacitors... Verify capacitor tolerance... Measure cable capacitance... Select and match capacitors for critical circuit applications... Sample production components for quality assurance... Measure capacitance of complex series-parallel capacitor networks... Set trimmer capacitors to specific amounts of capacity... Check capacitance in switches and other components.

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Electronics publishers since 1908

JUNE 1979 Vol. 50 No. 6

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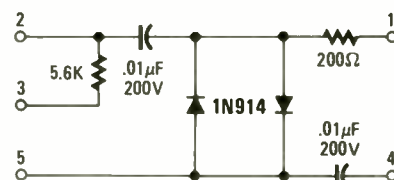
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ON THE COVER

Intelligent Thermostat can save you big fuel dollars. It not only adjusts the temperature several times a day, but it also sets it at different levels on different days of the week. Interested? Read all about it starting on page 35.



INTERFACE DEVICE provides matching and isolation between telephone and Telecorder. Want to build Telecorder? Story starts on page 62.



VIDEODISC PLAYER uses LASER to scan the disc. We tell how the laser circuits work. Turn to page 50.

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looking ahead

Satellite delivery: Satellite communication continues to expand with breathtaking speed, particularly in broadcasting where cable TV systems and Public Television already have their own satellite interconnection systems. Now RCA American Communications, which owns two Satcom satellites has made the nation's television broadcasters an offer that will be difficult to refuse: It has offered to build, maintain and operate—at its own expense—a receive-only earth station for each one of the nation's 725 television stations. Then it would use its own satellite facilities to distribute syndicated programs that currently are "bicycled" from station to station on film or tape.

RCA has developed a system of encoding, or scrambling, the video signal so that it can be directed to specific earth stations and rejected by all stations for which it's not intended. Each station would have a five-meter dish. Interestingly, RCA owns the NBC television network, which uses AT&T intercity lines for connection, and it is now providing a satellite means to connect the nation's television stations.

Meanwhile, radio is also discovering satellite transmission. National Public Radio, Mutual Broadcasting System, Associated Press and United Press International are cooperating with radio stations in installing small receiving dishes for both teletype transmissions and audio news broadcasts.

Portable VCR's: Although the home videocassette recorder race seems to have settled down to two basic formats—Beta and VHS—a new battle could be shaping up for portable VCR standards, and this one could have many more entries. While there are portable versions of both formats already on the market, many companies are betting that both of these are too large for true portability. It's not known how many firms are developing lightweight VCR's or even VCR's combined with solid-state color cameras for the "personal photography" market.

Four portable formats already are at the starting gate. BASF's LVR (for longitudinal video recording) is scheduled for unveiling in prototype form this summer. In its latest form, it's believed to have 72 video tracks on a single-reel cartridge of tape eight millimeters wide and reportedly has three hours of recording time per cassette. Toshiba has demonstrated a portable VCR using an endless-loop tape and a fixed head, with 220 tracks on a ½-inch cassette. This format makes possible a relatively compact recorder.

Funai Electric of Japan hopes to sell a portable VCR weighing about six pounds that uses a ¼-inch cassette resembling an audio cassette, for 20 minutes of color recording. Unlike the others, Funai's VCR uses helical-scan principles. Eastman Kodak is assumed to be developing a portable VCR, too, and this one could be very significant indeed because of Kodak's size and importance in the photography market. While today's fairly large VCR's are basically time-shift devices for recording TV programs, the next generation will be designed for electronic photography. With a furious race developing for this new type of VCR, it seems highly unlikely there'll be anything resembling a standard. Thus, we could have four or six—or 12—different noncompatible units introduced.

'Piracy' problems: Illegal copying of prerecorded video-cassettes is the major new problem of the video age. There's one simple way to foil amateur "pirates," and that is an encoding formula that alters the frequency and amplitude of the vertical sync pulse on legally recorded cassettes. When an amateur attempts to make a duplicate of the cassette, the image goes out of sync on the recorder used for copying. So far, so good. But—along comes the TV set manufacturing industry with new sophisticated color receivers using digital vertical sync and no back-of-set vertical adjustments. Well, a legally recorded cassette, using antipiracy encoding, can throw one of these modern receivers out of sync, just as it does a bootlegging recorder. Upshot: Some prerecorded cassette manufacturers have eliminated the encoding on cassettes sold to people who own certain recent models of TV sets, and the Electronic Industries Association has formed a committee to look into the entire situation.

Videodisc network: In the first major use of videodiscs for industrial communications, MCA DiscoVision and General Motors have tentatively agreed—subject to later equipment tests—to establish a network of videodisc players covering at least 7,000 GM dealers. The videodisc players will be of the optical type—compatible with the ones now being sold by Magnavox in Atlanta and Seattle—but of an industrial version using a microprocessor for automatic indexing. Discs will demonstrate new cars to consumers and will be used in sales training for dealer salesmen. The players will be built in Japan by Universal Pioneer Co., the joint venture of MCA and Pioneer. Similar dealer networks, using Betamax VCRs, have been established by Chrysler and Fiat.

TI's computer: At press time, everybody seemed to be waiting for Texas Instruments' entry in the personal computer field. And TI seemed to be waiting for the FCC to change its rules. TI has postponed introduction several times, and judging by its correspondence with the FCC, this is because as the Commission's rules now stand it couldn't get official approval. The TI computer presumably uses an external RF adapter or modulator to interface with existing TV sets. The Commission, under its present rules, won't approve such modulators, but instead requires that systems to be used with television sets be tested with all equipment in place. TI contends that this rule makes it difficult or impossible to offer expandable, multifunction consumer computers designed to be attached to existing TV sets.

The Commission had already rejected TI's modulator as not meeting its rules. At press time, TI had petitioned the FCC to establish a new category of approved device so such modulators could be permitted. And in an attempt for early approval, it asked the Commission to waive the existing rule and approve its RF attachment while it's considering the rules change.

DAVID LACHENBRUCH
CONTRIBUTING EDITOR



Micro TV Breakthrough

Remember the \$400 Sinclair Micro TV? Here's the story on the greatest TV value ever.

That Sinclair TV shown above is small—the smallest TV in the world.

And when it was first introduced last year, it made history. So did its high price—\$395.

Our company never sold the unit for two reasons: 1) It was being promoted as a pocket TV and we felt it would not fit in most pockets and 2) We felt \$395 was too high a price for the unit regardless of its quality, size and features.

But we were wrong. Thousands of them were sold and it was selected as one of the most exciting new products of the year.

WE BOUGHT ONE

A few months ago we purchased a Sinclair TV and discovered another feature we didn't like. The unit included a 220-volt converter for European operation. This meant that every American who bought the set had to pay extra for the converter even though very few Americans would be taking their TV to Europe.

So we came up with an idea. We went to England and purchased thousands of sets directly from the factory without the converter. We were also able to save money by eliminating the normal mark ups by importers, wholesalers and distributors.

We can now offer you the unit for only \$249.95 and if you want the 220-volt converter, your cost is only \$19.95 extra.

LESS THAN WHOLESALE

JS&A would be offering the exact same Sinclair TV at a price less than Sinclair's actual wholesale price in the United States and we would still make enough profit to pay for the cost of this advertisement.

There is one feature we liked very much about the set. Its rechargeable batteries are built into the unit. Larger portable TV's offer \$60 optional rechargeable battery packs that must be purchased separately. Ours is built in and included in the price.

The Sinclair TV comes complete with an American AC adapter and charger, ear phones, carrying case, rechargeable batteries and a built-in antenna for both VHF and UHF. It

also comes with a cigarette lighter power converter, so you can watch all your favorite TV channels from your boat, plane, motor home or car without even using your batteries.

PHOTOGRAPHIC QUALITY

We were well aware of Sinclair's advanced electronics and quality features. But what we found particularly exciting was its picture tube. Even though the 2" (measured diagonally) tube is small, the TV's resolution resembles that of a clear sharp photograph. You can even read small telephone numbers when they're flashed on the screen.



The Sinclair unit is offered in this advertisement with the same accessories available in the \$395 system with the exception of the 220-volt power converter.

The Sinclair is also convenient. You can take it on trips and entertain your children while you fly or drive. You can keep it on your desk at work and monitor the latest news or stock market reports. And you can view the soap operas as you work around the house. We even took ours to the ball game to watch those instant replays.

BIG POCKETS

But don't expect to carry it in your pocket—it won't fit unless you have big pockets. The unit measures 1½" x 4" x 6¼" and weighs just 28 ounces which includes the built-in batteries.

The TV is serviced in the United States by Sinclair's service-by-mail facility. If service is ever required during its one-year limited warranty, just slip it in its handy mailer and send it to them for repair. Your solid-state unit should operate for years without a problem, but if it ever needs repair, it's good to know that service is an important part of our program.

For \$249.95, the Sinclair Micro TV is worth your test. Order one from JS&A. Take it with you on a trip, bring it to your office, or carry it with you around the house. See how clear and sharp the picture is and how closely it resembles a black and white photograph. Then decide if you want to keep it. If not, no problem. Simply return your TV within 30 days for a prompt and courteous refund. We just want you to prove to yourself, the miracle of space-age electronics before you decide.

AMERICA'S LARGEST

Sinclair Radionics is one of England's largest electronics manufacturers and JS&A is America's largest single source of space-age products—further assurance that your modest investment is well protected even though the unit is offered at such a bargain price.

To order your Sinclair Micro TV, simply send your check for \$249.95 plus \$3.00 postage and handling (Illinois residents, please add 5% sales tax) to the address shown below or credit card buyers may call our toll-free number below. But please act quickly.

The Sinclair TV is an outstanding product that was priced too high. If you felt like we did and you waited, your timing is perfect. Order a Sinclair Micro TV at no obligation, today.

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letters

Ooooooops!

TROUBLESHOOTING COMMUNICATION RECEIVERS

On page 67 of the article "FM Detector and Filter Tests" (February 1979 issue) and page 68 of the article "Troubleshooting Communications Receivers" (April 1979 issue), a piece of test equipment was mistakenly shown as a Cushman *model 107C*—it is a Lampkin *model 107C*.

Also, the photograph on page 66 of the April article should be captioned: Hallcrafters *model FPM-300* SSB/CW transceiver.

BURGLAR ALARM

Mr. Dan Talbot has called our attention to several errors in his article "Build This Burglar Alarm" in the April issue. In Fig. 2 the value of R32 should be 10 *ohms*, not 10K.

The statement in parentheses on the 12th line on page 41 should read "(lasting

about 60 to 90 seconds, depending on the value of C3)."

In Fig. 8 the markings for the base and emitter of transistor Q10 are transposed.

In the third sentence of the second paragraph on page 43, substitute the word "to" for the typographical error that reads "19."

600 MHz FREQUENCY COUNTER

In the article "600-MHz Portable Frequency Counter" (January 1979 issue) R23 was mistakenly shown on the schematic as 1 megohm. The correct value is 1000 ohms as indicated in the parts list. Transistors Q3 and Q4 were shown as NPN types. They should be shown as PNP's. This is the only type that will work in the circuit. The correct value of C11 is 39 μ F. This capacitor does not appear on the parts placement diagram in Fig. 6. It is on the reverse side of the board along with S1-S3, IC6 and a few other parts. It connects, on the board as seen in Fig. 6, to two pads in the upper left corner. The "hot" side goes to the pad

connecting C10 and R12. The other lead goes to ground at the pad between the leads of D8 and R8.

We thank reader W. A. Sullivan of Dearborn, MI, for calling the errors to our attention.

STRING SYNTHESIZER SCHEMATIC ERROR

The schematic on page 72 of the March 1979 issue (Volume 50, No. 3) of the String Synthesizer has a line omitted. There should be a connection from the wiper of R116 to the $+V_L$ line. The circuit board reflects this connection, but the circuit will not work if wired from the schematic.

ERIC BEAN
South Bend, IN

COUNTDOWN ADD-ON FOR MODEL ROCKET

For the "reader in New York" (Hobby Corner, June, 1978) who wanted a digital—*continued on page 12*

Exclusive Sheldahl FLEXSWITCH® kits

With scissors, modify the .030 thick, non-tactile panel into water/dust resistant switching module. Kit includes design guidelines, instructions, Sheldahl membrane switching panel, flexcircuit connector, press-on nomenclature and RFQ checklist. Production quantities cost less. Pressure sensitive back.

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easy to program and operate. Powerful CHIP-8 interpretive language gets you into programming the first evening. Complete documentation provided.

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*Suggested retail price. CDP18S711 does not include video monitor or cassette recorder.
**Available 1st Quarter, 1979.

The fun way
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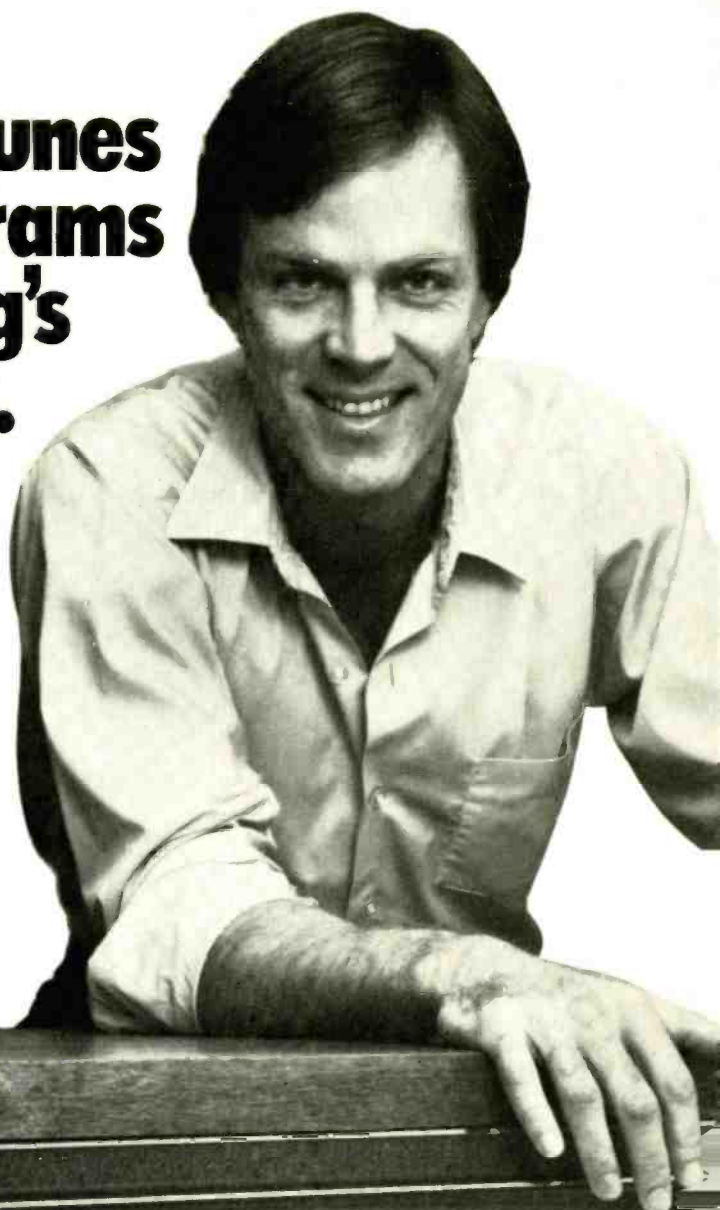
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As you assemble it, you learn how digital tuning systems work, how to adjust and service them. You work with the same advanced features used in the new programmable TV's and video tape recorders. It's exclusive NRI training that keeps you up with the leading edge of technology.

Exclusive Designed-for- learning Concept

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the only such unit in the world. Rather than retrofit lessons to a hobby kit or an already-built commercial set, NRI instructor/engineers have designed this television so each step of construction is a learning experience.

As you build it, you perform meaningful experiments. You see what makes each circuit work, what it does, how it interacts with other circuits. You even introduce defects, troubleshoot and correct them as you would in actual practice. And you end up with a magnificent, big-picture TV with advanced features. One you can sell or use in your home.

Also Build Stereo, Test Instruments

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LETTERS

continued from page 6

readout, automatic countdown add-on for his model rocket launcher, this should do the job (see diagram).

After the on switch is closed, the display is set to 10 by the pushbutton SET switch. Then, by closing the COUNT switch, the display counts down to 0, closes the relay contacts to launch the rocket (make sure the safety switch is closed) and then proceeds to count up. If the 100K potentiometer is set so that the timer generates 1-Hz pulses, the timer can be used to determine

how long the rocket is in flight. When the SET button is pressed again, it changes the counting direction. The LED lights when the counter is set to count down. The circuit assumes the launcher operates off a 12-volt battery and that the relay needs to be closed for only a second.

To make the counter set to some number other than 10, ground the appropriate inputs of the 74192. Pins 15, 1, 10 and 9 are, respectively, the numbers 1, 2, 4 and 8. Ground the inputs that are not necessary for the desired number. For example, to have the counter preset to 5, ground the numbers 2 and 8 (pins 1 and 9). When pin 11 is grounded, the counter resets.

When both counters have counted down to 0, the second 7400 activates the relay and sends a clock pulse to the flip-flop. When the flip-flop changes state, it acts through the first 7400 to change the counting direction. The first 7400 also acts as a one-shot multivibrator when the SET button is pressed to again change direction.

The relay is activated only when counting down to 0. If the counter goes up to 99, it will not close the relay contacts on the next count. Be sure the relay contacts can handle the necessary current. In order that the display will show 10, 9, 8, etc., rather than 10, 09, 08, etc., it is necessary to ground pin 5 of the tens 7447. Any suitable common-anode display can be used (some require that pins 9 and 14 as well as pin 3 be connected to positive).

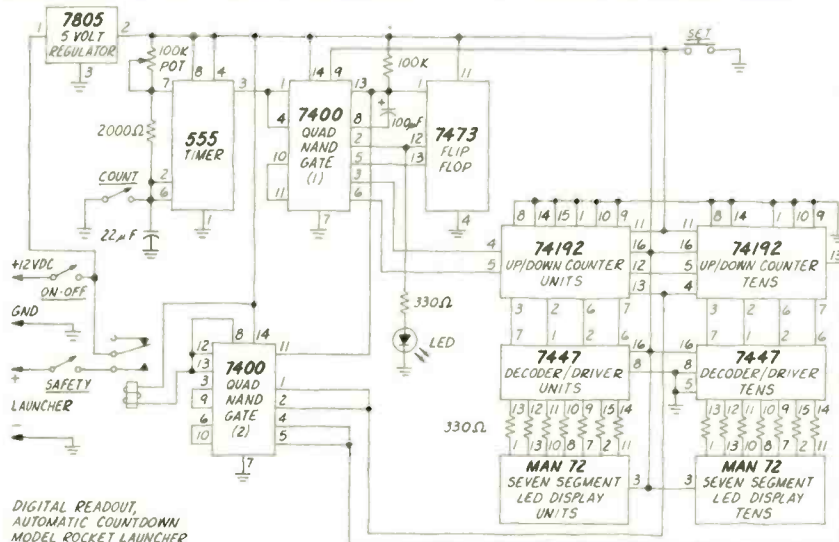
JAMES JOHN HUGHES III
Highlands, TX

RADAR DETECTOR

Scientists were first introduced to the $d = \text{Doppler effect over 15 decades ago}$. About a century ago, Maxwell introduced $c = \lambda\gamma^*$ and showed sunlight was made up of electric and magnetic waves which, only by differing in frequency, were the same as radio waves, X-rays, etc. About 8 decades ago, Marconi invented radio from $c = \lambda\gamma$.

Today, many readers of **Radio-Electronics** can for the very first time measure $\lambda = \text{wavelength at the source (s)}$ and $\gamma = \text{frequency at the observer (o)}$. ALWAYS in the past we have measured $\lambda\gamma$ ONLY at s or ONLY at o, but never at both simultaneously. We thus have the erroneous idea

continued on page 16



DIGITAL READOUT,
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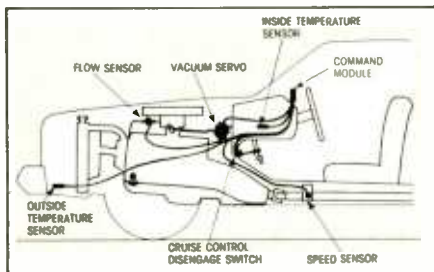
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tion relating to time, distance, fuel and performance of his vehicle.

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COMPUCRUISE

CIRCLE 21 ON FREE INFORMATION CARD

Who was April Fooled?

During the initial planning of our April 1979 issue, one of our editors suggested that we publish an April Fools' article. It has been several years since our last April Fools' article and all agreed that it was time for another one. So we contacted two of our most imaginative authors and told them that we wanted a construction article on an absolutely absurd project. The only requirements were that it must work and could be built inexpensively. When the manuscript arrived, we discovered not one but three absurd projects that worked. We liked them and published the article "3 Unique Projects."

Our story was well received. We are still getting numerous letters congratulating us and the authors for a job well done. Several readers even made some clever and interesting suggestions. One suggested that we should have included an on/off switch in the *Solar Powered Night Light* circuit. After all, why waste energy when you are not using the light. Another admonished us for not mentioning the *One Station Intercom's* greatest advantage—its portability. And another pointed out that the intercom was perfect for a hermit.

However, something happened that we didn't plan on. During the final stages of assembling the April issue, we were alerted to the existence of a revolutionary audio amplifying technique. We were assured that the new Magnetic Amplifier indeed existed, that it worked, and was being marketed by the Carver Corporation. After checking, we immediately allotted room for it and subsequently published "New Breakthrough in Audio Amplifiers." You would not believe the number of letters and phone calls we have been receiving stating just how great a job we did on that April Fools' article on the Magnetic Amplifier. "You had me believing the thing really worked, right up until the end. What a great April Fools' gag."

What disturbed me more than anything else was just how readily so many of our readers dismissed the possibility that the amplifier actually worked. Could it be that we're walking the road of technological progress wearing blinders? The Carver Magnetic Amplifier does exist, but what would have happened if it were still in the theory stage, merely a concept? How many of you would have believed that the amplifier could work?

Progress is the act of advancing from one technological level to the next. We consider today's problems, apply today's technology and advance to the next technological level by following the most logical path. But what would happen if we applied today's technology to yesterday's problems? Would the path be different? Would it lead us to an entirely different conclusion? Perhaps we should take a giant step backwards and rethink the solutions using today's technology. Most important and above all, we should never dismiss a radical new solution as an April Fools' gag just because it happened to have been published in an April issue.

And in looking back at older April Fools' articles we discovered it takes as much as seven years to turn an "absurd idea" into a working product.



ART KLEIMAN
Managing Editor

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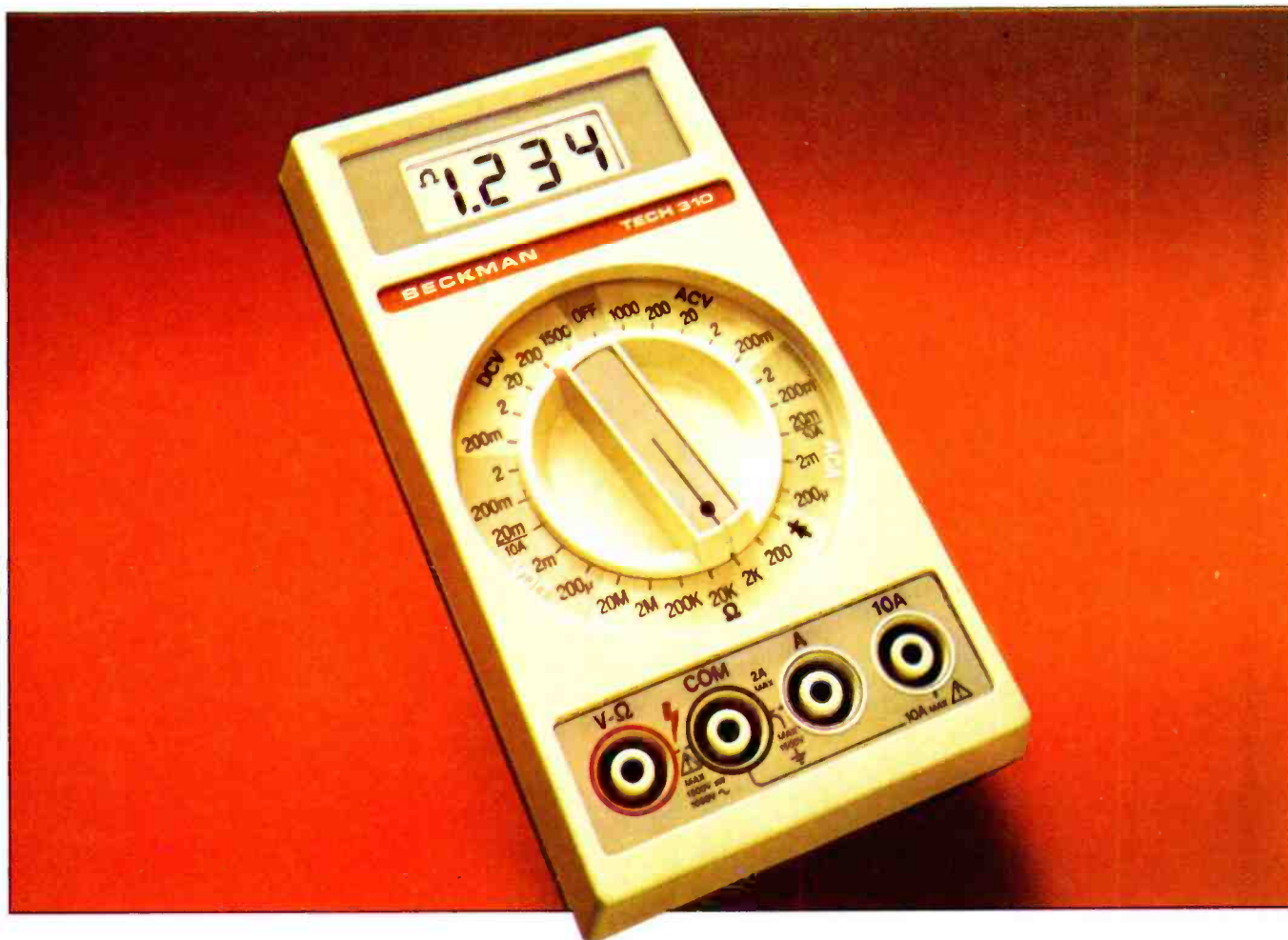
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BECKMAN

CIRCLE 25 ON FREE INFORMATION CARD

LETTERS

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that not even light can travel at a speed greater than 186,000 mps, or c .

We know if $c = \lambda\gamma$, then $\lambda\gamma - c = 0$. Also, $d = \lambda\gamma - c$, so when s and o close $\lambda\gamma > c$, or a superluminal speed, we get up Doppler.

Modify the antenna of a 24-GHz mobile radar (used in a cruising police car) so the antenna radiates fore and aft. Have a police car close at 50 mph on two detectors dead ahead and a mile apart alongside a straight flat road. Both detectors receive 24 GHz plus 1800 Hz or 36 Hz per mph. As soon as the car passes the first detector, it receives 24 GHz - 1800 Hz.

We now have three entirely different frequencies from one. How, unless electromagnetic radiation comes to the detector ahead at 186,000 mps + 50 mph, and the one behind at 186,000 mps - 50 mph? Is value c a universal constant or does it also pick up the radial speed of the source or the antenna on the police car?

(* $\lambda = w$; $\gamma = f$; $d = wf - c$; $>$ is greater than)

JOHN W. ECKLIN
Alexandria, VA

PINK-NOISE TESTING

I have a few questions regarding the article, "Audio Testing With Pink Noise," in the September issue of *Radio-Electronics*. To begin with, the noise heard between sta-

tions on the FM band is white noise, if I remember correctly. Rather than use the white-noise source described in the article, would it be possible to substitute FM interstation noise?

The way I was going to go about setting up my equalizer was to insert the pink-noise filter in the tape monitor 1 position of my receiver and set the receiver up to put out white noise. I don't know the characteristics of FM noise, so would like to know if I will get valid results when I use this method. I am curious to know whether or not the results would be the same.

BRIAN J. DONOVAN
FPO San Francisco, CA

Since you probably have already tried it, I assume you found that FM noise is not a very good white-noise source. Although its exact characteristics will depend on the quality of the tuner (will your tuner pass 20 Hz and/or 20 kHz?) and the frequency tuned to (in relation to all RF sources nearby), you probably also found the noise to be somewhat inconsistent, i.e., varying with time. In any case, spectrum analysis shows most FM noise to be quite unsuitable as a flat signal. However, since it is a broadband noise signal composed of many frequencies, it can be (and has) been used by audio buffs for comparing equipment BY EAR. For the kind of measurements the PNG was designed (i.e., using a level meter), a much more accurate source is needed. The MM5837 digital noise source is ideal for this application.

JEFF MAZUR

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COMPUTER MUSIC PUBLICATION

Readers of *Radio-Electronics* may be interested to learn of a quarterly magazine, *Computer Music Journal*, published by People's Computer Co., Menlo Park, CA. The *Journal* features current news, products, interviews, and conference reports, and offers beginning and advanced articles on such diverse topics as composition algorithms and languages; computer-aided analysis of musical sound; digital signal processing; as well as many more.

A 1-year subscription costs \$20 in the U.S.; \$25 to Canada and Mexico; and \$28 to other countries. For more information, write *Computer Music Journal*, Box E, Menlo Park, CA 94025.

G. ROADS
Editor
Menlo Park, CA

GRAPHIC EQUALIZER KITS

We are currently working on the packing of our fifth run of Graphic Equalizer kits and expect to ship them by January 31. Persons who ordered prior to Christmas have been informed of the delay; those who ordered after have not.

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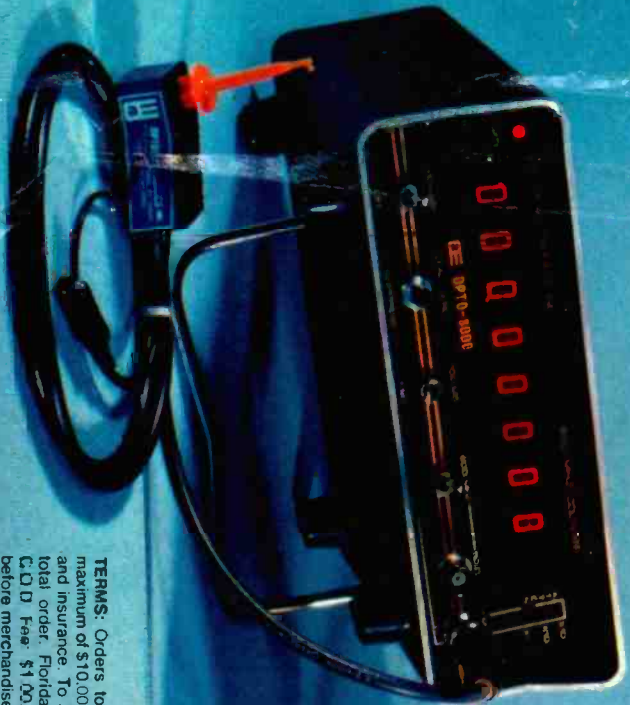
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Ask about the new 8022A. And while you're at it, check into the 8020A Analyst, the improved version of our \$169* DMM. It boasts Fluke's exclusive conductance capability for high resistance measurements and 0.1% measurement accuracy.

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equipment reports

Sabtronics Model 2010A Digital Multimeter



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THIS LOW-COST INSTRUMENT (SABTRONICS, 13426 Floyd Circle, Dallas, TX 75343) turns out to have some interesting surprises packed into its pretty blue plastic case; a 3 1/2-digit LED display, a single-chip LSI, a laser-trimmed resistor network, and an extremely stable bandgap reference element for better long-term accuracy.

The pushbutton control of functions and ranges provides a total of 31 measurement ranges and 6 functions. The functions include

AC/DC voltage, AC/DC current, resistance, plus a high-current measurement range that goes up to 10 amperes.

An added feature of this instrument is an optional touch-and-hold capability. It permits the instrument user to hold a reading on the display. It is provided only when the optional THP-20 probe is used. What this means to the user is that you can make a measurement, take the probe away, and look at the reading on the meter. Like all fully equipped digital multimeters, there is a low-power ohms range for testing semiconductor junctions without damaging the device being tested.

The DC voltage function provides five ranges; 200 mV, 2 V, 20 V, 200 V and 1,000 V. Accuracy, depending on the range in use, varies from 0.1% to 0.2%. The input impedance is 10 megohms. The AC voltage function also provides five ranges; 200 mV, 2 V, 20 V, 200 V and 1,000 V. The accuracy varies from 0.5% on the 200-mV, 2-V and 20-V ranges, to 0.7% on the 200-V range and 1% on the 1,000-V range. The input impedance is 10 megohms

and parallel with 100 picofarads.

There are six DC current ranges; 200 μ A, 2 mA, 20 mA, 200 mA, 2 A and 10 A. The 200- μ A and 2-mA ranges are accurate to 0.1%. The 20-mA and 200-mA ranges are accurate to 0.3%, and both the 2-amp and 10-amp ranges are accurate to 1%. As for AC current, there are six AC current ranges. The first five, 200 μ A, 2 mA, 20 mA, and 200 mA, are accurate to 0.5%. The two higher ranges, 2 amps and 10 amps, are accurate to 1.5%.

There are six resistance ranges; 200 ohms low, 2-K high, 20-K low, 200-K high, 2 megohms low, and 20 megohms high. The first four ranges are accurate to 0.1%. The two high ranges are accurate to 0.2%.

The unit operates on either alkaline "C" cells, rechargeable batteries or a direct AC connection. When nickel-cadmium cells are used, a recharger AC supply is used with them. Batteries are not shipped with the unit unless you order the optional nickel-cadmium cells. A set of alkaline cells will provide about 25 hours of continuous ON time. Fully charged



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nickel cadmium cells will provide about 10 hours of continuous operation. With the optional battery eliminator, you now have an AC-powered bench instrument. Sabtronics recommends that if you use the AC supply, alkaline cells should be removed from the meter.

We used the 2010A on our bench for a period of two weeks and found that it is really a first-rate instrument. All measurements were easily handled and were accurate as verified by other instruments in our lab.

As a general-purpose, 3½-digit digital multimeter, the model 2010A qualifies as a first-rate unit. The only recommendation we would make after using it is that the THP-20 probe is really a must. It adds to the price, of course, but once you have used it, you won't want to do without it. The 2010A costs \$99.50.

Accessories for the model 2010A include the touch and hold probe, THP-20-\$18.00; a high, voltage probe, HVP-30-\$29.95; battery eliminator charger for a 110-120 volt operation, AC-115-\$7.50; battery eliminator charger for a 220-volt operation, AC-230-\$9.50; and a set of nickel-cadmium rechargeable batteries rated at 1200 milliampere hours-\$17.00. If you are looking to buy a new digital multimeter, the model 2010A should certainly be one of those considered before making that purchase.

R-E

Ohio Scientific Superboard II

THE MANUFACTURER DESCRIBES THIS UNIT as "a major breakthrough in small computer technology that dramatically reduces the cost of personal computers." That quote is accurate. How else, for \$279, could anyone own a



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computer with all the features found in Superboard II?

Superboard II is a single-board computer without a case. It is built around a 6502 microprocessor and comes with 8K Microsoft BASIC in ROM. It also includes 4K of static RAM that can be easily expanded to 8K. There is a 53-key keyboard with upper- and lower-case letters and user programmability.

There is a Kansas City standard audio tape cassette interface, a full machine code monitor and I/O utilities in ROM. The direct access video display has 1K of dedicated memory, upper case, lower case, graphics and gaming characters. Screen resolution is up to 256 X 256 points. A TV with overscan, used as a

monitor, can display about 24 rows of 24 characters. A TV that does not have overscan when used as a monitor will display 30 X 30 characters.

The video output of the Superboard II can be directly connected to the video circuitry of a TV monitor, or through an "illegal" RF modulator, to the antenna input of any TV set.

Extras available optionally for Superboard II include an expansion board with 24K static RAM, a dual minifloppy interface, a port adapter for printer and modem and an OSI (Ohio Scientific, Incorporated) 48-line expansion interface. There is also an assembler/editor and extended machine code monitor.

For those not-so-hardy experimenters who would like to get a Superboard II in a case with a power supply, Ohio Scientific also has available the Challenger I-P. It consists of the Superboard II plus a power supply and a case. It costs \$349.00.

To get our Superboard II into operation all we had to do was hook up a +5-volt-DC, 3-amp power supply and connect the video output to our handy video monitor. With the power on "READY" immediately appeared on the monitor screen. We put Superboard II through its paces using preprogrammed material provided by OSI, and entertained everyone with some fascinating video games, balanced our checkbook and set up a household budget.

The cassette interface worked well and loading a program was no problem at all. The advanced BASIC provided all the scientific math functions we needed, and we discovered that you can even use Superboard II for complex problem-solving without doing any programming; simply operating it like a complex calculator.

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RCA SK Replacement Solid State

The built-in BASIC is just as good as you would expect from Microsoft. For the user who does not want to do any programming, there is a lot of software already available that takes care of the applications for you.

When you compare *Superboard II* to other systems, you soon find that a less expensive way of getting started in the personal computer area with equivalent features is hard to come by. The graphics available permit some really dramatic effects.

The fact that the system can be easily expanded to include a floppy means that while you are starting out with a low-cost minimal system, you don't have to throw it away when you are ready to go on to more complex computer functions. Everything is there that you need; you simply build onto what you already have. You don't have to worry about trading off existing equipment to get the system that will really do what you want it to do. At \$279, *Superboard II* (Ohio Scientific, 1333 S. Chillicothe Dr., Aurora, OH 44202) is a tough act to follow. **R-E**

Continental Specialties Corp. Model Max 50 Frequency Counter

CONTINENTAL SPECIALTIES CORPORATION (70 Fulton Terrace, P.O. Box 1942, New Haven, CT 06509) is well-known for its bread-boards and other goodies.

The company also manufactures a line of test equipment. One of the latest is the *model Max 50* 50-MHz frequency counter. This instrument has a 50-Hz to 50-MHz frequency range. It's amazingly compact—no larger than



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a hand calculator.

There is only one switch, and it handles power on-off. Everything else is automatic. Powered by a 9-volt battery for portable use, the counter can also be used with a plug-in AC adapter on the bench. There are three jacks on top of the case. A short whip antenna screws into the middle one. This makes it very handy for checking CB transmitters and other kinds of two-way radios. The manual states it will show stable readings within four feet of a CB antenna. In actual tests, we found that it locked in at distances up to eight feet on a standard CB radio.

The right-hand jack is for use with a

shielded test cable that comes with the unit. This can be used for audio testing, since it has a 1.0-megohm input impedance. This input is protected by diodes. It can also be used for frequency checking at test points in PLL's, etc. The manufacturer claims a 30-mV sensitivity, and again it seems to exceed specifications. Because of its wide frequency range, the *model Max 50* can also be used for checking such ultrasonic units as depth sounders, fish finders and different kinds of digital circuitry. The input can handle 100 volts peak from 100 Hz to 1 kHz, and 50 volts peak to 50 MHz.

The readout is a full six digits and uses magnified LED's. These LED's are pulsed to allow a great apparent brightness. The display is multiplexed to keep battery drain at a minimum. When the unit is turned on, the two decimal points light up—the right one is for kHz and the left one is for MHz. Lead-zero blanking is provided, which means that all zeros to the left of the first non-zero digit are blanked. This feature makes the display much easier to read.

The manual contains a full description of the circuitry. Most of this circuitry is contained on a 40-pin LSI IC. The timebase is a crystal-controlled oscillator with a 3.58-MHz crystal. An accuracy of ± 3 PPM is claimed. We measured it against a much larger and more expensive frequency counter and it checked out fine. A trimmer adjustment is provided if the unit ever needs calibration. The stability is excellent, and is given as better than 0.2 PPM $^{\circ}\text{C}$.

The *model Max 50* comes in a leatherette carrying case, with a space provided for the test cable and whip antenna, plus a belt loop.

continued on page 32

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All in all, we cut over \$100-worth of corners! But not a single one that affected the quality and performance of our new DMM.

Don't let our low price fool you!

Because Sabtronics sells factory-direct — without all the hidden charges a dealer would track on — we can offer the superior 2010A DMM kit for a surprisingly low \$69.95. Surprising because you get the accuracy, features and performance you'd expect from the high priced units.

The 2010A offers you the long-term accuracy of a laser-trimmed resistor network, an ultra-stable band-gap reference element and single chip LSI circuitry — all in a compact, rugged, human-engineered housing. With 31 ranges and 6 functions, you can measure AC and DC volts from 100 μ V to 1000V; AC and DC current from 0.1 μ A to a surprisingly high 10A; resistance from 0.1 Ω to 20 M Ω . Typical DCV and Ohms accuracy is 0.1% $\pm$ 1 digit. And you see these precise readings on a bright, 3 1/2-digit



LED display with automatic decimal placement and large, 9mm numerals.

Of course, that's what you'd expect from a quality DMM. But we've even added more features for extra convenience, flexibility and reduction of human error.

- Unique X10 Multiplier Switch — gives you convenient push-button selection to the next higher decade range. Hi-Lo Power Ohms capability gives you three high-ohms ranges that supply enough voltage to turn on a silicon junction for diode and transistor testing. For in-circuit resistance measurement without turning on a semiconductor junction, you use the three low-ohms ranges.
- Wide Frequency Response — 40Hz to 40kHz bandwidth lets you measure audio through ultra-sonic AC signals.
- Touch and Hold Capability — with optional probe, retains readings for as long as you wish. You can make measurements in hard-

to-reach places without taking your eyes off the probe tip or stopping to record data.

- Plus More — Auto Polarity, Auto Zero, Overrange indication and fully overload protected on all ranges.

And, although designed for benchtop use, the sleek, compact 2010A is powered by 4 "C" cells (not included), bringing wide-range lab performance to the field when you need it.

You save either way.

Your 2010A DMM kit comes complete with easy-to-follow assembly instructions, all parts (including high-impact case), and test leads. You can complete assembly in a single evening. However, for a slight additional fee, Sabtronics will ship your 2010A factory-assembled and calibrated: at \$99.50 it's still an incomparable value!

Whether you're a professional or hobbyist, if quality and accuracy are important — and padded prices aren't — you should inspect the 2010A DMM for yourself. If you're not completely satisfied, return it in its original condition within 10 days for a prompt and courteous refund of purchase price. Call us with your MasterCard or Visa order today, or simply fill out the convenient order form.

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INTERNATIONAL INC.

13426 Floyd Circle M/S 35 • Dallas, Texas 75243
Telephone 214/783-0994

Brief Specifications

DC Volts: 100 μ V to 1000V in 5 ranges

AC Volts: 100 μ V to 1000V in 5 ranges

DC Current: 0.1 μ A to 10 A in 6 ranges

AC Current: 0.1 μ A to 10 A in 6 ranges

Resistance: 0.1 Ω to 20 M Ω in 6 ranges

Diode Test Current: 0.1 μ A, 10 μ A, 1mA

ACV Frequency Response: 40Hz to 40kHz

Input Impedance: 10 M Ω on ACV and DCV

Overload Protection: 1200 VDC or RMS on all voltage ranges except 250 VDC or RMS on 200mV and 2V AC ranges. Fuse protected on ohms and mA ranges.

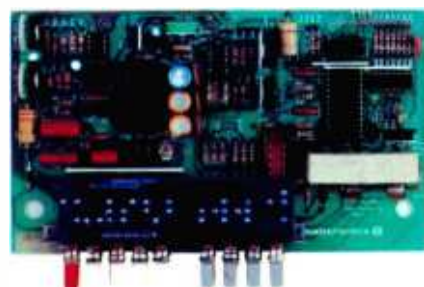
Power Requirement: 4.5 to 6.5 VDC (4 "C" cells)

optional NiCd batteries or AC adapter/charger

Display: 0.36" (9.2mm) Digits reading to $\pm$ 1999

Size: 8"W x 6.5"D x 3"H (203 x 165 x 76 mm)

Weight: 1.5 lbs. (0.68kg.) excl. battery



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My father always told me that there were certain advantages to putting all your eggs in one basket. "John," he said, "learn to do one important thing better than anyone else, and you'll always be in demand."

I believe he was right. Today is the age of specialization. And I think that's a very good thing.

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I'll tell it to you straight. If you think electronics would make a nice hobby, check with other schools.

But if you think you have the cool—and want the training it takes—to make sure that a sound blackout during a prime time TV show will be corrected in seconds—then answer this ad. You'll probably find CIE has a course that's just right for you!

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EQUIPMENT REPORTS

continued from page 25

The instrument itself will fit easily into a shirt pocket, which makes it very handy for working in all kinds of vehicles. With its fully automatic operation, you can check all the CB channels in a very short time. The price is very reasonable (\$89.95) for an instrument of this kind and quality.

R-E

Magnesonics Cassette Eraser and Rapid Rewinder



CIRCLE 104 ON FREE INFORMATION CARD

IF YOU OWN A CASSETTE RECORDER, YOU SPEND a lot of time either erasing or rewinding tapes. Every time you record, your machine first erases the tape before it records. However, unless you have an expensive recorder, this can result in a higher level of tape noise on the tape than when using new tape. Also, every time you rewind or "fast-forward" the tape, this uses up more time than is necessary; and if you

use batteries, this consumes precious battery power! There's a better way to go: Use Magnesonics Erase-Sure cassette bulk eraser and the Rapid-Rewinder. Both these devices are simple, straightforward and efficient, and each is designed for a specific purpose.

The Erase-Sure uses a patented principle that consists of erasing a prerecorded magnetic tape by passing it through a rotating magnetic field. And the tape erased on this unit has a residual noise level that is equal to or better than new tape.

The Erase-Sure is housed in a plastic box, measuring about 4 inches wide, 3½ inches deep and 2¼ inches high. It weighs just under 1 pounds, including four AA penlight batteries that power a small motor when you press the switch on top. The motor shaft is held against a turntable by a flexed steel wire that presses against the motor shoulder gently but firmly. This design eliminates fancy clutches or gearboxes. Anchored to the platform are two very powerful magnets mounted so that they have opposite polarities. Each magnet is 1¼ inches long, ¼ inch wide and ¼ inch thick. As the platform is spun by the motor, a strong rotating magnetic field is created. The case acts as a guide track for the tape.

You simply turn on the Erase-Sure by pressing the red button on top and holding it down. You'll feel some vibration as the rotating magnets come up to speed. Slide the cassette you want erased slowly along the guide track on the top of the case and off the end; remove the cassette from the immediate vicinity of the Erase-Sure before releasing the red button. That's all there is to it! One pass will do it, but flipping the cassette over and doing it again won't hurt. To keep the tape

inside the cassette from loosening up (due to vibration) a molded plastic handle (neatly stored in the top of the case) is inserted into the cassette hubs to lock them into position as you slide the cassette along the guide track.

The erase action is swift and sure, and the penlight batteries should be able to completely erase several thousand tapes before they have to be replaced. Top-quality components and molding make this device a long-life item.

The Rapid-Winder is also a simple but very well-made device. Much thought has gone into making it uncomplicated and efficient. Two self-aligning white spindles allow you to easily place a cassette tape on top of the unit with no hub interference. Press the red button and the left-hand spindle turns clockwise at high speed. A small but powerful motor (powered by four AA penlight batteries) drives the inside of this spindle rim with firm torque, but automatically slips when the tape reaches the end without tearing or stretching the tape. A flexed, straight steel wire that presses against the motor-case shoulder provides just the right amount of side pressure. The right-hand spindle does not freewheel, since this would allow tape spillage. To prevent such spillage, a slight drag is applied to the right-hand spindle by another flexed steel wire that presses against its side.

Every cassette should be run through a fast-winding procedure before it is first used or after long storage, in order to insure that the winding is uniform within the tape roll. This helps eliminate tape wow-and-flutter, and jamming.

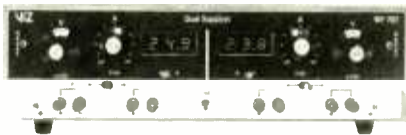
The Erase-Sure and Rapid-Rewinder are available in many audio and electronic retail outlets for \$19.95 each; or you can order them

REDI-CHECK Awards '79



by mail directly from Magnesonics Sales, P.O. Box 758, Ventura, CA 93001 for \$19.95, plus \$1.55 for handling and postage each in the U.S. (California residents add state and local taxes where applicable.) **R-E**

VIZ DC Power Supplies



CIRCLE 105 ON FREE INFORMATION CARD

THE VIZ MFG. CO. (335 E. PRICE STREET, PHILADELPHIA, PA 19144) manufacturer of test instruments, has recently developed a group of three DC power supplies. These power supplies can be used for any kind of electrical or electronics testing, as well as for research and design. They're called *DC Power Supplyists*. The *model WP-705* goes up to 50 volts at a 2A rating; the *model WP-706* is 0-25-volt supply at a 4.0A rating; and the *model WP-707* (shown) is a dual 0-25-volt supply at a 2.0A rating each. Maximum current rating can be used at any voltage setting.

These power supplies are regulated to within an inch of their life. The load regulation is 0.075% maximum at full output voltage and current, and over an input-voltage range from 108-130 VAC. The ripple is only 10-mV maximum. The overload protection used is a foldback current-limiting circuit, plus an automatic shutdown in case of severe overload. If

overload happens, there is a RESET pushbutton on the front panel.

Each unit has two digital panel meters with 3-digit readouts. These meters can be fully isolated from the internal circuitry and used to read external DC voltages; or they can be switched to read either voltage or current, as in the dual-supply *model WP-707*. In the two single-voltage power supplies, one digital meter reads the current and the other reads the voltage. Grounds are fully floating on all supplies.

In the *model WP-707*, the two 25-volt supplies are completely isolated. If necessary, they can be connected in series for output voltages up to 50 at the 2A rating. In such cases, one meter is available for possible use to read current while the other reads voltage across the output terminals.

The maximum-current setup is very simple: Just switch the panel meter to current; short the output leads; then hold down the RESET pushbutton and turn up the current control until you see the maximum current you want. The manufacturer recommends not holding the RESET pushbutton down for more than 10 minutes, but since the maximum-current adjustment takes only about 10 or 15 seconds, this shouldn't worry you.

These units would be handy for powering TV modules, circuits in TV sets and so on. Set up for the correct voltage, and then you can use the meter to read DC voltages at any point in the module circuitry. The maximum voltage is 99.9. With the dual-supply *model WP-707*, you could monitor the load current with one meter, while taking voltage readings in-circuit with the other meter.

The output-voltage adjustment is a dual-

concentric control. The outer knob sets the output voltage over any range from 0-5 up in 5-volt steps. The inner knob is a fine control for the precise setting of output voltage. The current control is calibrated from LOW to HI, and you read the current meter to determine the current that is needed or being used by the load.

This is quite a versatile group of instruments, and should be handy for any kind of electronics work. And they're not "little bitty" instruments either. I had quite a time picking my test unit up off the bench! They weigh a hefty 15 lbs! All the necessary test leads and cables come with each instrument. One end of the cable has a dual banana plug and the other end has an insulated alligator clip. The cables look large enough and tough enough to stand hard use. The power supplies cost from \$240—\$299. **R-E**



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PETER GISE

THE RISING COSTS OF ENERGY TODAY necessitate the continual search for new applications of electronics as just one means to reduce the costs of heating and cooling for the average homeowner. Studies, for example, have shown that it is possible to save up to 16% on heating and up to 20% on cooling costs through the use of set-back thermostats.

The microprocessor-based Intelligent Thermostat described in this article does everything a conventional thermostat can do and more. The Intelligent Thermostat remembers four different temperature settings for each day of the week. In the winter, for example, homeowners can set the thermostat to automatically lower the temperature after going to bed, raise the house temperature before waking, automatically lower it again after the members of the family have gone to work or school, and once again, bring it back to a comfortable level before the family returns home. And each day can be set to a different schedule. This is especially important on weekends, when home and office schedules typically vary. In the summer, the same principle reduces air conditioning costs as well. When schedules change, the manual temperature override feature allows a specific temperature level to be set for a specific period or indefinitely. Normal operation will resume automatically or under user control.

The Intelligent Thermostat is based upon the F8 microprocessor IC manufactured by Fairchild Semiconductor, 465 Ellis St., Mountain View, CA 94042. The configuration chosen for the project includes the 3850 central processing unit (CPU) which is an 8-bit processor featuring 64 bytes of on-board random-access memory (RAM), more than 70 instructions in its instruction set and two latched, bi-directional 8-bit I/O ports. For programs smaller in size than 1024 bytes, it is possible to construct a two-IC system using the 3850 CPU and the 3851 program storage unit (PSU). This project requires nearly 1500 bytes of code, so the system was expanded using the 3853 static memory interface (SMI) and three 512-byte 93448 bipolar PROM's. A socket and the appropriate address decoding for a fourth PROM are provided on the board to allow programs up to 2048 bytes to be accessed by the CPU if needed for future expansion. A 3861 (PSU less ROM) also provides the two additional latched, bi-directional 8-bit I/O ports required for the keyboard and A/D converter.

The circuit requires 5-volt at 600-mA and 12-volt at 30-mA be connected along with a ground to the appropriate points of the printed circuit board. There is also provision for a momentary closed reset pushbutton to be connected, but since the 3850 CPU features power-on-reset, the

switch is normally not required. There are three output DIP relays with two connections each for a fan, cooling and heating. The 16-button keyboard allows selection of the various functions (both programming and command) while also allowing data entry. A number of the command functions are listed in Table 1.

TABLE 1

Function	Command Number
Display Temperature	1
Display Time	2
Display Time & Temperature	3
Force Heat On	5
Force Cool On	6
Force Fan On	7
Turn Heat on Auto	8
Turn Cool on Auto	9
Turn Heat Off	10
Turn Cool Off	11
Turn Fan Off	12
Turn All on Auto	13
Enter Today's Time	81
Enter Today's Day	83
Temperature Override	95
Back to Normal	4
Enter Temperatures 1-4	91-94

Theory of operation

The schematic for the F8-based Intelligent Thermostat is shown in Figs. 1, 2 and 3. The basic three-IC system includes

a 3850 central processing unit, a 3861 program storage unit (less ROM) and a 3853 static memory interface. Port 0 of the 3850 CPU (IC6, Fig. 3) is connected to the two 9368 seven-segment decoder driver latches. In order to minimize the parts count, one 9368 actually drives the segments of the digit pairs; IC4 drives the segments of digits DIS1 and DIS3 while

IC3 drives the segments of digits DIS2 and DIS4. The inputs to the 9368's are BCD, thus requiring decoding within the stored program. Current is limited internally in each 9368, eliminating the need for current limiting resistors. Normally, the brightness would suffer by attempting to drive the segments of two digits simultaneously. However, by

enabling adjacent digits under program control (i.e., 1 and 2 or 3 and 4) only one digit is really on at any one time. Bits 0-3 of Port 0 are bits 0-3 of the BCD word used to encode the segments of digits 2 and 4 while bits 4-7 represent bits 0-3 of the BCD word used to encode the segments of digits 1 and 3. The segments are enabled by writing high levels or ones at

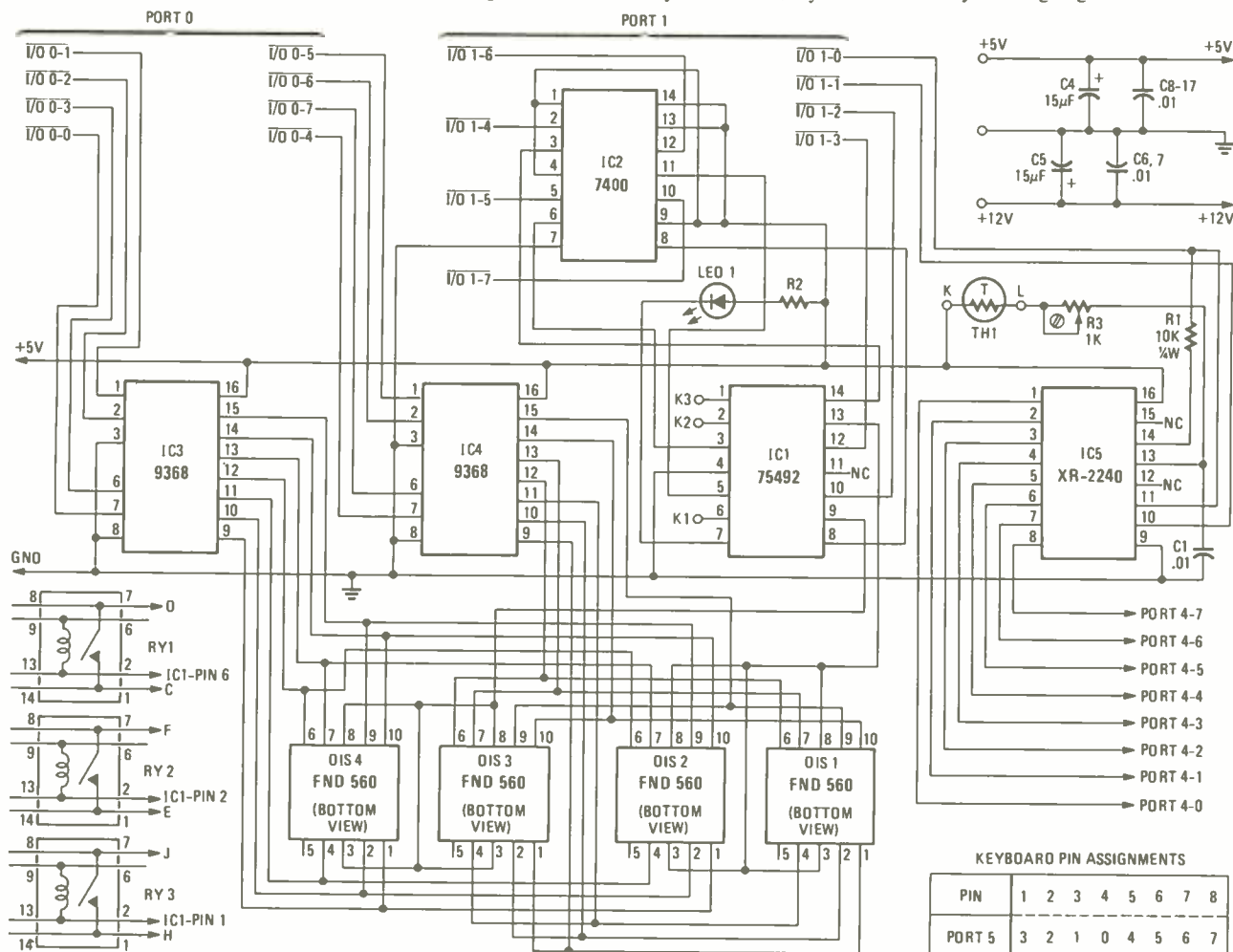


FIG. 1—INTERFACE CIRCUITRY contains the displays and thermostat.

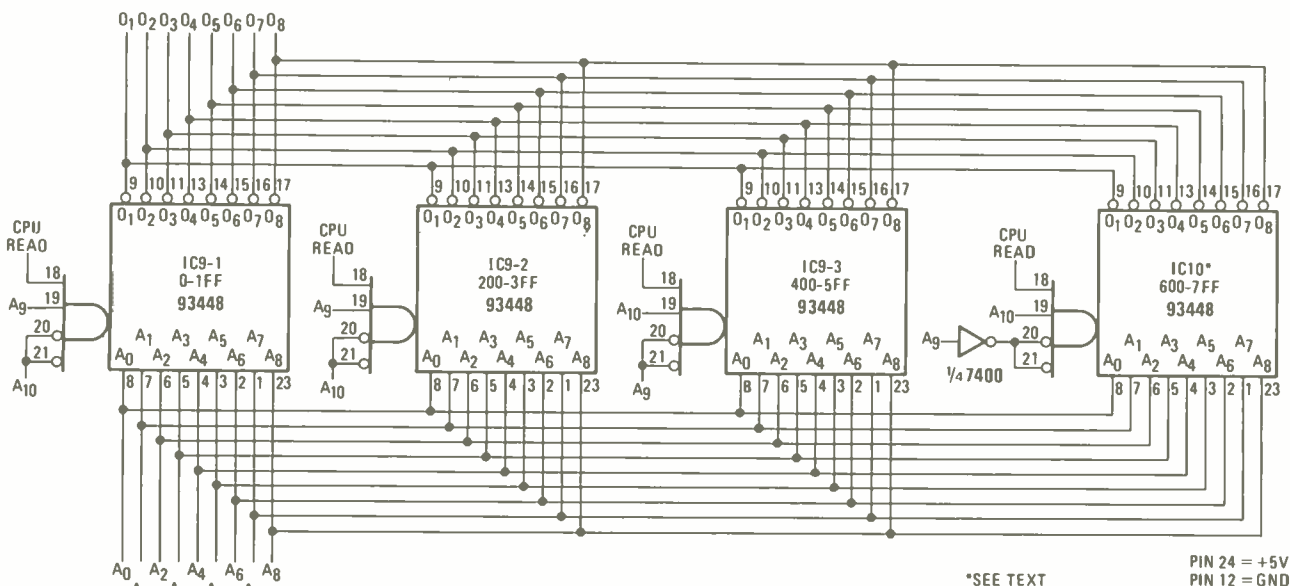


FIG. 2—THREE ROM's contain program. Fourth ROM is for expansion.

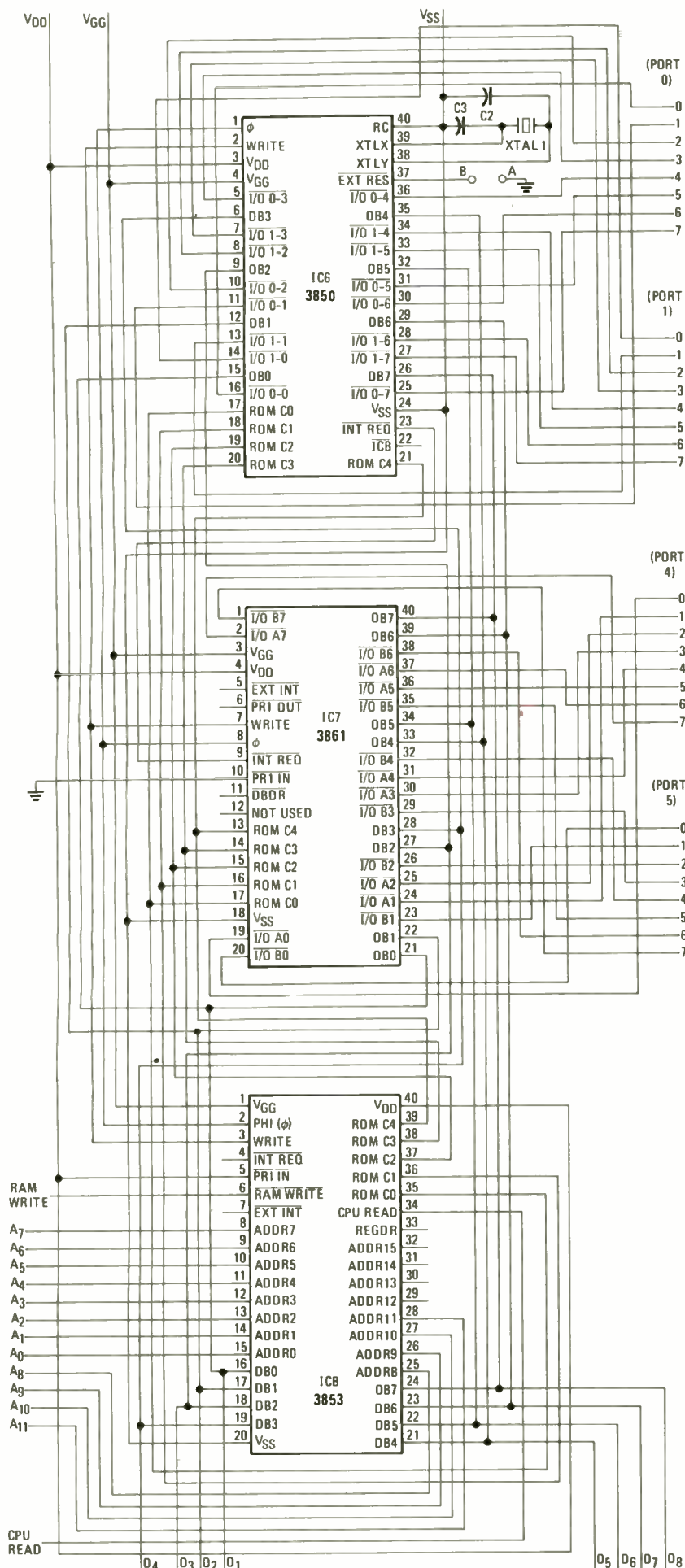


FIG. 3—CPU and memory interface circuitry.

Port 0. Each digit pair is enabled by applying a high level or a logic one level to pin 12 of the 75492 digit driver IC1 for digits 1 and 2 and to pin 10 for digits 3 and 4. These pins are connected to bits 3 and 2, respectively, of Port 1, which serves as the control port. This port also provides two control signals to the 2240 (IC5) which is discussed below, and four outputs, i.e., bits 4–7, which are used to control external devices (although the AM/PM indicator LED 1 is driven by one of these lines).

The heart of the temperature detection circuitry is the unique connection of IC5, the 2240 programmable timer/counter. This integrated circuit is normally used to generate programmable time delays of from a few microseconds up to five days. Electrically, the circuit consists of an eight-stage, open-collector binary counter preceded by a timebase oscillator whose frequency is controlled by an external R–C network. The counter can be reset to zero by applying a positive-going pulse to pin 10. This pin is controlled by bit 1 of Port 1 from the 3850 CPU. Once reset, the 8 output bits of the 2240 that are connected to the 8 bits of Port 4 drop to the low state until a trigger signal is sent to pin 11 via bit 0 of Port 1. This signal starts the internal oscillator running. If the timebase output (pin 14) is connected to the trigger signal through a 10K resistor, the count is stopped and held in the counter simply by bringing the trigger line low. A 5K thermistor and a .01- μ F capacitor form the R–C network that controls the frequency of the 2240's timebase.

By starting, stopping and resetting the counter under program control during each interrupt and then reading the 8-bit word from the counter at Port 4 of the 3861 PSU, a count is obtained that is proportional to the ambient temperature. This count is then compared with a table stored in PROM to determine the corresponding temperature. The 2240, when used in this manner, becomes a very inexpensive A/D converter!

The remaining circuitry is quite straightforward, with the four rows and four columns of the keyboard connected in matrix fashion to Port 5 of the 3861 PSU. The four 93448 bipolar PROM's are decoded as program locations 0–1FF₁₆, 200₁₆–3FF₁₆, 400₁₆–5FF₁₆, and 600₁₆–7FF₁₆, although only the first three PROM locations are used for this project. You can purchase preprogrammed PROM's or you can program them yourself, following the program in Table 2.

The software stored in PROM consists of an interrupt-service routine, a display routine, a keyboard-read routine, and a series of temperature and control routines. The interrupt-service routine uses the programmable local timer within the 3850 CPU to generate an interrupt every 3.953 ms for a 2-mHz clock. A loop counter within the software counts 253

TABLE 2—PROGRAM for the first 93448 PROM

IC9-1																									
T0000	1A	73	B7	B6	7F	B1	70	BE	54	53	71	0B	71	5C	0A	1F									
T0010	25	40	94	F8	1B	29	00	9F	00	00	00	00	00	00	00	00									
T0020	1E	58	0A	57	62	6A	3C	6D	4C	25	FC	84	24	25	FB	94									
T0030	26	A1	22	0F	B1	70	B4	2A	05	42	6B	20	45	5C	A4	8D									
T0040	92	07	20	67	DC	5C	90	F7	A1	21	F0	22	0D	B1	90	07									
T0050	A1	21	F0	22	0E	B1	6D	3C	94	3F	20	FD	5D	46	21	20									
T0060	84	02	3A	20	67	DC	25	59	5C	82	2E	70	5D	8F	03	90									
T0070	F3	20	67	DC	5C	25	12	94	1A	43	21	02	43	84	06	21									
T0080	FD	53	90	15	22	02	53	69	4C	1F	25	08	94	02	71	5C									
T0090	90	07	25	12	82	03	71	5C	2B	1D	47	0B	48	1B	1C	62									
T00A0	6C	4D	21	07	50	6E	84	1E	25	06	84	43	30	84	29	43									
T00B0	22	01	53	30	84	1B	30	84	36	4C	21	01	84	31	1A	A1									
T00C0	22	0C	B1	90	6C	4D	21	0F	25	03	92	0D	43	22	01	53									
T00D0	6B	4D	52	70	50	90	2E	4D	43	21	02	1A	84	06	A1	22									
T00E0	80	90	04	A1	21	7F	B1	1B	51	4D	52	4D	90	E7	61	43									
T00F0	21	10	1A	84	06	A1	22	80	90	04	A1	21	7F	B1	1B	4D									
T0100	52	4D	90	D1	1A	A1	6D	62	22	0C	B1	43	21	01	84	10									
T0110	33	4E	25	FB	84	1B	42	18	B0	A1	21	FB	B1	90	12	43									
T0120	1F	53	4E	25	FB	84	0A	1A	40	18	B0	A1	21	F7	90	ED									
T0130	2B	1B	20	F0	B5	A5	21	0F	84	2D	44	21	80	44	62	6A									
T0140	94	08	22	80	54	7F	5C	90	6C	4C	21	FF	94	67	44	21									
T0150	7F	54	1A	2A	03	D1	20	10	50	B5	A5	21	0F	94	0D	72									
T0160	8E	40	13	94	F4	1B	20	10	55	90	4A	1B	12	84	0F	12									
T0170	84	0D	12	84	03	12	16	16	15	14	50	90	05	16	16	90									
T0180	F9	45	18	1F	C0	84	2E	40	55	61	6E	46	12	84	15	12									
T0190	84	75	12	84	31	12	84	34	12	84	28	12	84	31	12	84									
T01A0	28	90	1A	40	25	0F	94	18	72	56	62	6C	4C	15	22	03									
T01B0	5C	29	02	DE	46	21	20	94	04	29	04	21	29	03	25	29									
T01C0	03	2E	29	03	2E	29	03	31	29	03	E0	29	02	F2	40	25									
T01D0	0E	84	4A	90	E0	21	F0	22	04	90	29	21	F0	22	08	90									
T01E0	23	22	10	90	1F	22	02	21	F3	90	19	22	01	90	F9	21									
T01F0	F9	90	11	21	F6	90	0D	21	EF	90	09	21	F0	22	03	90									

IC location is indicated by the square pad of each pattern. Next, mount all of the capacitors, crystal, resistors and the LED. Be careful to note the polarity of the two dipped tantalum electrolytics (C4 and C5) in the lower left corner of the board. The square pad indicates the positive connection to the capacitor. Next, mount the 14- and 16-pin IC's and the four LED displays. If you wish to socket the displays, take a 24-pin socket and remove two end pins and two center pins to accommodate the 10-pin displays. Solder the thermistor in place between points K and L and add relays RY1-RY3 if you wish to have relay control.

The keyboard may be soldered directly to the board at this point and the plastic mounting posts melted slightly to hold it in place, or a short length of ribbon cable can be soldered to the board with a socket to allow mounting the board in an enclosure. If this is to be done, the thermistor should also be mounted on a cable to prevent erroneous measurements within the enclosure. Very carefully insert each of the three 40-pin MOS devices in their sockets, taking the necessary precautions in protecting them against static discharges. Install the three bipolar PROM's, IC9-1, IC9-2 and IC9-3. The PROM's are numbered 1, 2 and 3, and are installed from left to right, respectively. Location IC10 on the far right is not used.

Installation and operation

Connect the circuit board to +5 volts

interrupts, which yields a nominal time-base of 1 second. The routine then starts the 2240 using the trigger control line and updates both the time and the day if required. During the next interrupt, the 2240 is stopped, the temperature is updated, and the 2240's counter is reset, using the reset control line.

The keyboard routine first reads the keys by writing logic one levels to the four rows of the matrix keyboard and then scanning the four columns to detect a key pressed. Once a key closure is detected, the routine debounces the key and decodes the key for the appropriate action. The functions available to the programmer are indicated in Table 1.

The temperature routines determine whether or not heating or cooling is required by a simple subtract and compare to zero algorithm while the control routines simply turn on and off the appropriate relays.

Construction

All components mount directly on the PC board so assembly is quite straightforward. Figures 4 and 5 are foil patterns for the double-sided PC board, and Fig. 6 shows the parts placement. If you wish to mount the board within an enclosure, the 16-pad keyboard can be mounted on the outside of the enclosure with a short length of 8-conductor ribbon cable, and an opening may be cut over the display for viewing the time, temperature and programming functions.

First, mount the three 40-pin DIP

sockets and the three 24-pin DIP sockets, being careful to avoid any solder bridges due to the density of the traces for these IC's. Note that pin number one of each

TABLE 2 (continued)—PROGRAM for the second PROM

IC9-2																									
T0200	03	21	E0	5C	90	66	40	25	09	92	10	61	6F	4E	15	51									
T0210	4D	14	C1	5E	4C	15	C0	5C	90	A6	25	0E	84	5B	61	6E									
T0220	25	0D	84	58	25	0C	84	3E	25	0B	94	94	4C	52	32	70									
T0230	84	3C	32	84	3A	32	84	38	32	63	68	4C	84	2B	32	84									
T0240	95	32	84	98	32	84	9B	32	84	9C	32	84	9F	20	FA	32									
T0250	1F	94	FD	32	4C	84	99	32	84	9A	32	84	9B	32	84	9C									
T0260	32	84	9F	90	11	29	02	CB	21	3F	5C	90	79	1F	1F	15									
T0270	62	6C	5C	90	71	29	03	16	29	02	E5	4C	50	21	FF	84									
T0280	F5	25	84	92	F1	62	6C	4C	21	F0	22	06	5C	61	6E	74									
T0290	56	4C	25	83	84	2F	25	81	84	24	25	82	94	09	43	21									
T02A0	1F	22	60	53	90	39	14	84	CD	25	07	92	C9	4C	15	14									
T02B0	84	C4	25	04	92	C0	4C	5A	43	21	1F	90	E7	43	21	1F									
T02C0	22	50	90	E0	43	21	1F	22	60	90	D9	4C	50	20	90	51									
T02D0	28	04	D5	1B	42	25	06	92	3E	5A	78	56	90	01	61	6E									
T02E0	70	5D	5C	90	4A	62	6C	4C	14	5C	71	56	29	00	9F	29									
T02F0	02	0B	28	05	20	1B	25	0B	94	35	4C	51	4A	25	05	84									
T0300	0A	3A	4A	24	20	0B	41	5C	90	DC	63	68	4C	21	3F	22									
T0310	40	5C	41	5B	90	D0	7A	5A	20	20	56	62	6C	4C	21	F0									
T0320	22	05	5C	90	0A	7F	FA	94	03	90	BB	29	00	9F	29	00									
T0330	9F	61	6E	28	05	20	1B	43	21	E0	84	1C	25	20	84	EF									
T0340	25	40	84	49	40	25	0B	94	E6	4C	25	07	92	C9	25	00									
T0350	84	C5	62	69	5C	90	8F	28	05	20	1B	25	0C	94	D0	4D									
T0360	50	4C	51	43	21	10	52	28	04	ED	1B	4A	52	14	1A	2A									
T0370	03	D8	8E	16	50	1B	32	42	21	0F	C0	0B	41	5C	20	40									
T0380	56	62	6C	4C	21	F0	22	03	5C	29	02	DE	40	25	0A	94									
T0390	10	43	21	10	43	84	06	21	EF	53	90	93	22	10	90	FA									
T03A0	25	0B	94	8B	43	21	10	43	84	05	22	02	90	03	21	FD									
T03B0	53	61	6E	4D	50	25	59	92	13	4D	25	00	84	0E	25	12									
T03C0	92	0A	62	5E	40	5E	70	5C	29	02	E5	29	03	16	29	03									
T03D0	2E	14	B7	25	A8	36	09	DC	FE	24	28	2C	30	34	38	3C									
T03E0	61	28	05	20	1B	25	0B	94	E6	4C	50	30	25	04	92	DC									
T03F0	4A	21	0F	51	4A	14	24	18	0B	4C	31	84	12	31	84	15									

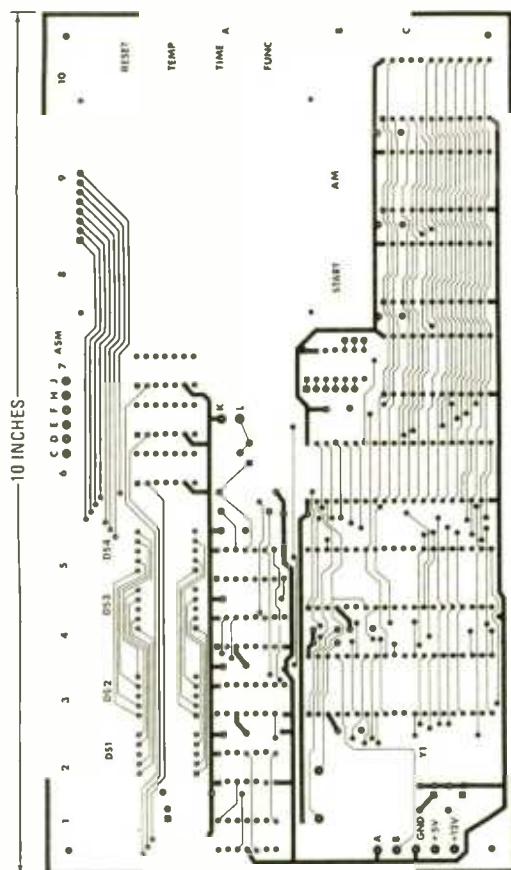


FIG. 4—FOIL PATTERN for the board's front surface. Keyboard plugs into 8 pads in top-right corner.

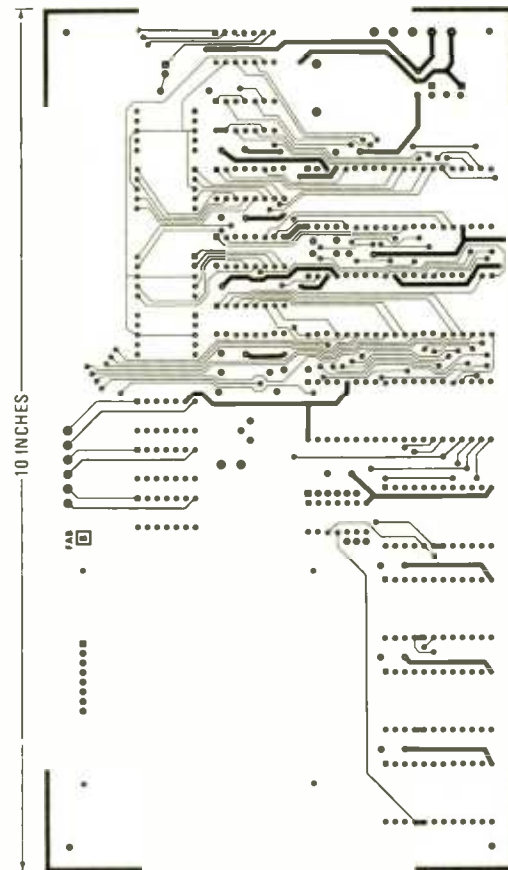


FIG. 5—THE REAR SURFACE of the board has this foil pattern. These patterns are shown slightly smaller than half-size.

TABLE 2 (concluded)—PROGRAM for the third 93448.

IC9-3																	
T0400	31	84	18	21	3F	51	40	15	13	13	C1	5C	90	BB	21	FC	
T0410	51	40	90	F7	21	F3	51	40	90	EF	21	CF	51	40	15	90	
T0420	EA	63	68	4E	21	C0	84	05	4B	50	90	5C	62	6F	4D	50	
T0430	4D	51	43	21	02	52	28	04	ED	1B	74	52	4C	50	1A	2A	
T0440	03	D8	8E	16	0B	1B	4D	18	1F	1C	92	12	32	94	F8	28	
T0450	05	39	1B	12	12	14	22	20	0B	4C	50	90	2B	32	84	20	
T0460	32	84	0B	32	84	12	30	94	E7	77	50	90	E3	28	05	39	
T0470	1B	21	0C	12	12	90	E0	28	05	39	1B	21	03	90	D8	28	
T0480	05	39	1B	21	30	90	CF	2B	63	68	4C	21	1F	84	3B	4C	
T0490	21	04	84	06	20	10	50	90	30	4C	21	08	84	05	20	60	
T04A0	90	F5	62	6B	4C	51	28	04	D5	1F	63	68	84	0F	4C	21	
T04B0	02	94	E2	4C	21	10	84	12	20	40	90	DB	4C	21	01	84	
T04C0	F3	42	25	10	82	EE	90	D7	1B	70	50	1A	A1	21	0F	C0	
T04D0	B1	1B	29	00	9F	08	40	1F	52	41	18	D2	52	92	04	70	
T04E0	90	5E	41	1F	52	40	18	D2	52	20	FF	90	53	08	42	21	
T04F0	FF	94	05	20	78	D1	51	41	25	00	84	22	25	24	92	1E	
T0500	70	84	0F	24	06	52	20	FE	D1	51	20	67	D1	51	42	94	
T0510	F3	51	40	14	C1	51	40	25	59	92	03	90	23	29	03	16	
T0520	08	40	25	09	82	0B	25	0A	84	0D	25	0E	84	06	90	10	
T0530	29	02	0B	29	02	E5	29	03	91	08	40	24	18	0B	4C	1A	
T0540	09	1C	FF	FA	F8	F4	F0	EF	E9	E6	E4	E3	E0	E0	E0	E0	
T0550	E0	E0	DF	DA	D9	D7	D5	D1	D0	CF	CD	C9	C8	C7	C5	C4	
T0560	C3	C1	C0	BE	BA	B9	B6	B5	B3	B1	B0	AD	AA	A8	00	00	
T0570	00	00	0A	07	1C	02	8C	0D	06	1E	06	09	0A	08	0E	0F	
T0580	E8	D0	C0	D2	B0	E3	D2	F0	E0	F3	D1	E5	F1	C0	CA	E6	
T0590	E0	C8	E2	C4	F1	D0	D1	D0	E8	E0	C3	F3	D2	D7	E4	FD	
T05A0	EA	7A	F0	7A	7A	7A	5A	EA	8A	CE	69	EB	2A	7A	72	6A	
T05B0	76	5A	FA	EF	4E	6E	7A	FA	FA	EB	6A	3A	BA	5A	78	78	
T05C0	84	AC	8D	84	00	85	85	85	84	85	8C	8C	84	C5	80	85	
T05D0	9D	81	15	85	B1	81	89	8D	85	85	85	83	89	86	85	D3	
T05E0	0A	03	15	0E	0A	0E	0E	08	06	0E	0B	0E	2E	2A	0B	2A	
T05F0	07	06	8F	0C	0A	06	89	0C	8B	0B	0E	1E	0F	8E	08	3B	

at 600 mA and +12 volts at 30 mA along with ground to the labeled points in the lower left-hand corner of the printed circuit board. Figure 7 shows a simple power-supply circuit that may be used. Several manufacturers offer plug-in power supplies that will also power the board. A momentary closed RESET pushbutton may be connected at points A and B although, typically, the system will reset upon power-up.

Programming the thermostat

Upon power-up the display will show 01 01 and will begin to increment-starting in the rightmost digit at the rate of one count per minute. The command keys are A(reset), B(temperature), C(time/day), D(function), #(AM), and *(start) as labeled on the printed circuit board.

To begin programming, press and hold the D(function) key until the first two digits are blanked and 00 is displayed in the second two digits. At this point, any *numbered* function can be entered from Table 1 by pressing the corresponding number key or keys. If you press a key out of sequence, the display will flash on and off several times and either reset automatically after a few seconds or you may press A(reset) and start over. All functions are initiated after the appropriate data has been entered by pressing the

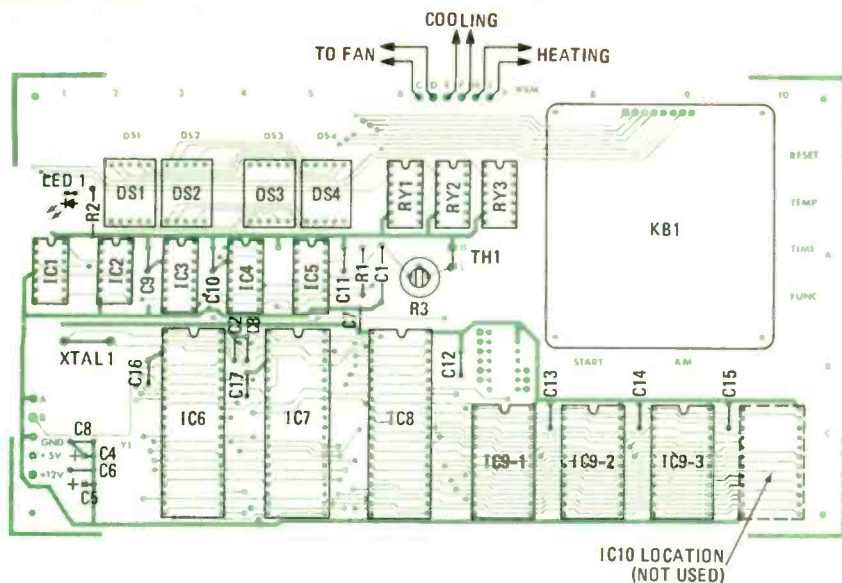


FIG. 6—HOW PARTS ARE PLACED on the thermostat board.

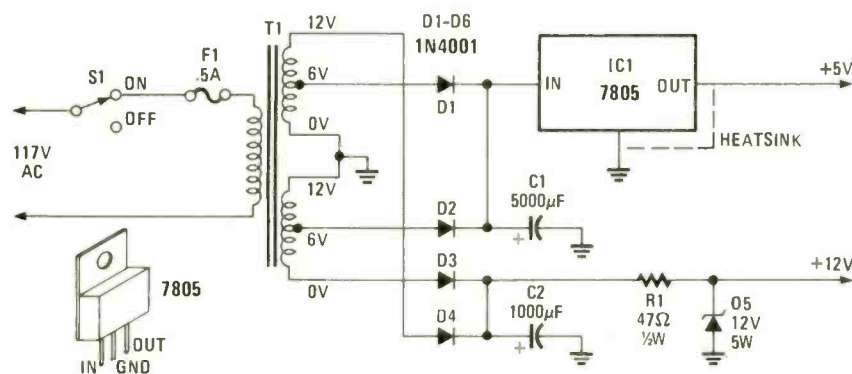


FIG. 7—THE POWER SUPPLY SCHEMATIC. The power transformer has two 12-volt secondaries.

*(start) key.

Let's take a few examples to see how it works. In the following examples, b = blank and X = don't care.

	Keystrokes	Display
1. Display Temperature (72° F is assumed)	D(function) 1 *(start)	bb 00 bb 01 bb 72
2. Set Time (12:01 AM is assumed)	D(function) 8 1 C(time/day) 00 00 1 00 01 2 00 12 0 01 20 1 12 01 #(am) LED *(start)	bb 00 bb 08 bb 81 00 00 00 01 00 12 01 20 12 01 LED bb 72
(Note that the display returns to temperature display function)		
3. Display Time/Temperature	D(function) 3 *(start)	bb 00 bb 03 bb 72 (3 sec.) 12 OX (7 sec.)

(Note that time may be 12:02 or later depending on how long it took you to get from step 2 to 3)

Now, let's see how to program a typical day with four set-points. First, let's pick four temperatures we may wish to recall

and use later. We will call these temperature functions 91, 92, 93 and 94. Next, associate (make a list) a temperature with each function number. For example, we may want to have the following temperature set-points available to us later:

Function	Temperature	#	Temperature
91	1		55° F
92	2		65° F
93	3		75° F
94	4		85° F

Now, using the keyboard we can store the four temperatures away in memory for later use as follows:

	Keystrokes	Display
1. Store Temperature #1	D(function) 9 1 B(temperature) 5 5 *(start)	bb 00 bb 09 bb 91 bb 00 bb 05 bb 55 XX XX

(Note that the display returns to the previously selected display mode)

Next, input the remaining three temperatures and store into functions 92, 93 and 94, respectively, as 65, 75 and 85° F. The next step is to decide which day of the week we want to call day number 1.

PARTS LIST

- R1—10,000 ohms, ¼ watt, 5%
- R2—180 ohms, ¼ watt, 5%
- R3—1000 ohms, trimmer ½ potentiometer
- C1—0.01 µF, Mylar
- C2, C3—20 pF, silvered mica
- C4, C5—15 µF, 25 volts, dipped tantalum
- C6—C17—0.01 µF, ceramic disc
- IC1—75492 (Fairchild, TI, Motorola)
- IC2—7400
- IC3, IC4—9368 BCD to 7-segment LED decoder/driver, constant-current with latch (Fairchild)
- IC5—XR-2240 (Exar)
- IC6—3850 CPU (Fairchild)
- IC7—3861 PIO (Fairchild)
- IC8—3853 SMI (Fairchild)
- IC9-1, IC9-2, IC9-3—93558 preprogrammed PROM (Fairchild)
- IC10—Not used, see text
- LED1—20-mA red LED
- DIS1-DIS4—FND560 common-cathode 7-segment LED display (Fairchild)
- XTAL1—2 MHz, series-resonant crystal, F-700 holder
- RY1-RY3—reed relay, Clare 1A005 or equal
- TH1—5000 ohms, thermistor, Fenwal UUA35J1
- KB1—16-pad keyboard, Digitran KL0075 or equal
- Miscellaneous:**
 - 3—40-pin DIP sockets
 - 3—24-pin DIP sockets
 - 1—printed circuit board
- Note:** The following parts may be ordered from Intelligent Controls, PO Box 772, Santa Clara, CA 95052:
 - IC9-1, IC9-2, IC9-3 preprogrammed PROM's. \$17.00 each.
 - Thermistor TH1 \$4.50; PC board, drilled and etched \$30.00
 - California residents add state and local taxes as applicable.

PARTS LIST FOR POWER SUPPLY

- T1—Transformer, 115 VAC primary, two secondary windings, each 12 VAC center-tapped (Signal Transformer type 24-1 or 24-1A or equal)
- D1-D4—1N4001
- D5—Zener diode, 12 volts, 5 watts
- R1—47 ohms, ½ watt
- C1—5000 µF, 16 volts, electrolytic
- C2—1000 µF, 16 volts, electrolytic
- IC1—7805 voltage regulator

To simplify matters, let's call today's day, number 1. This is programmed using function 83; that is,

	Keystrokes	Display
1. Today's Day	D(function) 8 3 C(time/day) 00 00 1 00 01 *(start)	bb 00 bb 08 bb 83 00 00 00 01 XX XX

The next step is to program the sequence of time-temperature combinations for day number 1. This is done by using the functions 11, 12, 13 and 14, representing day 1 set-point 1, day 1 set-point 2, day 1 set-point 3 and day 1 set-point 4.

continued on page 94

What's New In CAR STEREO

Within a relatively short period, audio accessories for the car have increased from a few tape players and FM radios to a myriad of devices rivalling those available on the home hi-fi market. Here's what's new.

FRED PETRAS

ANYONE SURVEYING THE WORLD OF CAR stereo in depth must ultimately arrive at the conclusion that it is becoming more and more like the world of home stereo. On several levels: power output, sound quality, technological sophistication, operating features, convenience and flexibility, car stereo is running head-to-head with home stereo.

However, a lot of "traditional" low-priced car stereo equipment is still around. And it will be available for at least the next few years, although to a somewhat lesser degree.

While much state-of-the-art car stereo equipment still looks a lot like earlier units, close examination shows that there are substantial differences. Many combination tape player/car radios boast power outputs of more than 10 watts-per-channel, and some range beyond 22 watts-per-channel. (Traditional models generally put out 3 to 6 watts-per-channel.) Many new models offer digital readouts of station frequencies (along with the time of day), and some of these units also allow the electronic presetting of 10 to 14 stations (half AM, half FM) for handy tuning when you must keep your eyes on the road ahead. More and more models include electronic scanning for an extra measure of convenience. A few units come with built-in equalizers for shaping the sound to a particular car or to individual tastes in sound. And the first car stereo cassette/radio combination offering TV audio just made its debut.

A close examination of the car stereo world will show you that 8-track cartridges are steadily losing ground to cassettes, with the latter expected to be the dominant format by the end of this year. There are a number of reasons for this

change. First of all, the industry has faced up to the fact that the cartridge has some basic inherent faults, is not a true hi-fi medium and really can't be improved very much. Second, the cassette's potential is substantial, and improvements in it and equipment on which to play it are continually being made. The cassette is now acknowledged to be a true hi-fi medium, and is expected to become even better as technology continues to advance.

(Figuring prominently in the cassette's future is metal-particle tape, generally called metal tape. This new tape (see "New Breakthrough In Audio Tape," *Radio-Electronics*, November 1978) offers several advantages over regular ferric-oxide or chromium-dioxide tape, including far better dynamic range, less background hiss and flatter frequency response, for balanced, superbly realistic sound. Metal tape's attributes will eventually filter from the home to the car. In fact, one manufacturer already has car stereo equipment that can handle playback of metal-tape recordings.)

Car cassette equipment is also becoming as convenient as cartridges in terms of complete tape playthrough. This is done via automatic reversing, a feature offered in many cassette models. Another angle is that many buffs find cartridge recordings hard to make. Cassettes, by comparison, are easy to record.

Dolby noise-reduction circuitry is being introduced into more and more tape players in the car sound field. This is a natural consequence of what has happened in home audio, where Dolby circuitry is used in perhaps 95% of all those cassette decks regarded as "hi-fi" equipment.

Studying the spec sheets of the higher-priced car stereo equipment, you'll note the frequent use of the design and circuit

concepts common to home hi-fi—reflecting the spillover from home to car sound and manifest as "home-type" car sound equipment.

Truly "up-to-the-minute" car audio dealers are also displaying a whole new line of car stereo equipment, displayed alongside traditional car stereo merchandise. This new equipment bears such proprietary and generic names as *Car-Fi*, *Carponents*, *Mo-Fi*, *Auto-Fi*, *Ultra-Fi*, *Super Separates*, *Hi-Way Fidelity*, *Auto Audio*, *Audio Spec*, and *Audio Compo*, among others.

Essentially, these are separate audio components designed for car use—in effect, miniaturized components. They include tuners; amplifiers; equalizers; equalizer/amplifiers; and "head" units such as tape player/tuner/preamplifier or tape player/tuner combinations, or even player/radio combinations with built-in low-power amplifiers that come with a separate power amplifier that is brought into play for higher sound levels when the occasion demands.

The spec sheets and brochures on car stereo "separates" show operating specifications on some that approach those for home audio components. For example, Fosgate claims less than 0.05% distortion for its 100-watt-per-channel (RMS) amplifier (model *PR-2100*), and a frequency response of ± 0.25 dB, from 20 Hz to 20 kHz into 4 ohms.

Component-type equipment

Let's take a look at some examples of what you'll find in the way of 1979 component-style car stereo at your local store(s):

Equalizers: These run the gamut from tiny models with two rotary or slide-pot tone controls, on up to 10-band graphic equalizers that offer music buffs the same tone-adjustment capability as home

equalizers, in their cars.

Typical of this group is the Sanyo *model EQZ6200*, that provides ± 12 -dB attenuation of seven frequency bands—50 Hz, 150 Hz, 400 Hz, 1 kHz, 2.5 kHz, 6 kHz, and 15 kHz. It also incorporates a tone-defeat switch, -20 -dB audio muting, and left and right LED bar-graph signal-level indicators.

Booster-equalizers: These also range from models with two rotary or slide-tone controls to multiposition graphic units. They also incorporate medium-output amplifiers.

Metro Sound's *model MS-67* has 25 watts-per-channel RMS continuous output and features separate rotary bass and treble controls, plus front-to-rear fader

control. The Boman *model EQR60* and the Audiovox *model AMP-60* are both slide-pot types and feature five equalization bands, plus an output meter and 30-watts-per-channel RMS amplification. Perhaps the most unusual unit in this group is Sparkomatic's *AcoustaTrac model GE-500*, that features an illuminated flexible "rod" that changes its shape in conformance with the control movement over five frequency bands. Looking somewhat like an oscilloscope, it delivers 20 watts-per-channel.

Another unusual model is Clarion's third-generation 300 EQB. It provides five equalization bands, a fader control, 30-watts-per-channel RMS output, and left and right vertical power readout scales, each using six LED's. The 20 watts-per-channel *model PB-66SE* by Inland Dynatronics, Inc. (IDI) uses chromatic light-scale meters that intensify with bright rainbow colors as power is increased; it is priced at \$90.

Amplifiers: Virtually every car stereo manufacturer markets amplifiers of one type or another. A common amplifier is the so-called booster, often sold in conjunction with heavy-duty speakers. Early models of less than top-notch quality have given this group a somewhat negative reputation. Now, many manufacturers are building models with better specifications and terming them amplifiers rather than boosters. Many of them look essentially like large home amplifier heat sinks, painted black. Others—usually the integrated type—look like compact home-component amplifiers. The units range in power from 10 watts-per-channel into 4 ohms to 135 watts per channel into 4 ohms. An example of the lower-powered integrated units is the Marantz *model SA-230* that provides 10 watts per channel into 4 ohms; it has rotary bass and treble controls and a high filter. An example of the higher-powered basic amplifier is Audiomobile's new *model SA2000*, with a power output of 100 watts per channel continuous into 4 ohms (both channels driven) 20 Hz to 20 kHz, with no more than 0.2% THD—placing it squarely into the high-fidelity category. This unit sells for \$400. (Audiomobile was one of the first to enter the component-type car stereo field back in 1976, along with ADS/Nakamichi.)

Sanyo, a proponent of bi-amplification in car stereo player/radios, extends this home audio concept in a new power-amplifier design (*model PA6120*, \$250) with two 50-watts-per-channel RMS woofer amplifiers, and two 10-watts-per-channel RMS tweeters in one chassis. When it is operated in the nonbi-amplified mode, it delivers 50 watts per second RMS. A similar unit (the *model PA6060*, \$200) offers two 25-watts-per-second RMS woofers and two 5-watts-per-second RMS tweeters. When it is operated in the non-bi-amplified mode, it delivers 25 watts per second RMS.

TABLE 1—CAR STEREO EQUIPMENT and manufacturers

Manufacturer	Model	Price	Equipment/Features
Adcom 11 A Jules Lane New Brunswick, NJ 08901			Minispeakers
ADS 1 Progress Way Wilmington, MA 01887			Minispeakers
Advent Corp. 195 Albany St. Cambridge, MA 02139	EQ-1	\$180/pair	Heavy-duty speaker
Afco Electronics, Inc. 471 Roland Way Oakland, CA 94621	AF-1500 AF-2000		Minispeaker Minispeaker Auto-reverse mode, digital readout
Altus Corp. 6 Main St. Melrose, MA 02176	A8CS-112 A8CS A8CS-032 A8CS-052 A8CS-101		Stereo tuner Graphic equalizer/preamp Cartridge player/tuner Cassette player/AM-FM tuner Equalizer/amp/preamp All-in-one system, digital readout, auto-reverse mode
Audiomobile 3221 W. MacArthur Blvd. Santa Ana, CA 92704	SA2000 SP300 ST-770A	\$400 \$150 \$400	Amplifier Preamp Cassette player/AM-FM tuner/Dolby
Audiovox Corp. 150 Marcus Blvd. Hauppauge, NY 11787	AMP-60		Booster equalizer Digital readout, Dolby, all-in-one system, auto-reverse mode
Blaupunkt Corp. 2800 S. 25th Ave. Broadview, IL 60153	Berlin CR-4095		Tape/radio/electronic scan AM-FM stereo/radio/cassette recorder Auto-reverse mode
Boman Industries 9300 Hall Rd. Downey, CA 90241	EQR60 Mach 90 Mach 80	\$600 \$550	Booster equalizer Cassette player/radio Cartridge player/radio All-in-one system
Car Tapes, Inc. 1000 E. Del Amo Blvd. Carson, CA 90746			Auto-reverse mode
Clarion Corp. of America 5500 Rosecrans Ave. Lawndale, CA 90260	300 EQB GT-501E Clean-Z	\$250 \$35.50	Booster equalizer Tuner/w. electronic scan Noise eliminator circuit Dolby, all-in-one system, auto-reverse mode
Cobra Dynascan Corp. 6460 W. Cortland Chicago, IL 60635			All-in-one system
Comm Industries 1505 Commonwealth Ave. Boston, MA 02135			Minispeakers
Concord Electronics 20121 Ventura Blvd. 320 Woodland Hills, CA 91364			All-in-one system, Dolby
Craig Corp. 921 W. Artesia Blvd. Compton, CA 90220			All-in-one system, auto-reverse mode
Draco Labs, Inc. 1005 Washington St. Grafton, WI 53024	D-45E	\$200	Dynamic range expander

chart continues on page 44

Preamplifiers: Only a few manufacturers provide straight preamps, preferring instead to combine them with other links of the hi-fi chain. One of those available is Audiomobile's *model SP300*, priced at \$150. Besides offering preamplification, the unit has double-acting (boost/cut) bass, mid-range and treble controls, plus balance and master volume controls.

Tuners: So far, less than a dozen manufacturers have developed component-type tuners for car use. Among these is Mitsubishi's *model CJ-20EM*, an FM stereo tuner featuring a large signal meter, dimmer connection for night driving and other amenities. It sells for \$115 and is part of a series that comprises a 20-watts-per-channel power amplifier and two cassette decks, one an automatic-reversing type. Panasonic sells the *model CA-9500* for about \$85. It is an AM/FM stereo unit with such basic features as a distance/local switch, AFC on FM, etc., and is part of a series that includes a 10-watts-per-channel power amplifier, two cassette players and one cartridge player. Roadstar's *MOFI* series includes an FM stereo tuner with a signal-strength meter incorporated in the tuning dial; loudness, bass, treble and balance controls; and switchable FM muting. Other *MOFI* models are two power amplifiers, a switching unit, and two cassette decks, one featuring Dolby circuitry and auto-reverse capability.



PANASONIC model CQB-5919

Fujitsu Ten provides two tuners as part of its *Audio Comp* series that also includes a basic stereo power amplifier, a 4-channel power amplifier, a control amplifier, a stereo graphic time-delay unit, and two auto-reversing cassette decks, plus a choice of three hermetically sealed two-way and three-way speaker systems. One of the tuners (the *model AT-7831*) is an AM/FM stereo unit, the other (the *model AT-732*) is an FM-only model; both tuners feature a motor-driven search system and a built-in noise blanker. They sell for \$280 and \$230, respectively.

Tenna is another company that manufactures component-type tuners. Tenna's *Pro* series also includes a graphic equalizer; two cassette players; a cartridge player, plus an enclosed two-way speaker system; and a rear-deck, semienclosed three-way speaker system. The tuner, the *model R-3025MPX*, is an FM stereo-only unit that incorporates electronically preset pushbutton tuning and digital station readouts.

Also marketing a component-type tuner

is Altus Corporation (formerly Automatic Radio). The *model A8CS-112* is an under-dash AM/FM stereo model meant for use with the *model A8CS* 5-band graphic equalizer/preamplifier/40-watt amplifier. Among the latest tuner offerings is the Clarion *model GT-501E* (priced at \$250) which features electronic scanning to automatically select the strongest FM signals. A built-in *Clean Z* circuit helps eliminate noise produced by ignitions, high-voltage lines and neon signs. (The *Clean Z* circuit is also sold as an accessory for other car stereo models, and is priced at \$35.50.)

Semiconductors: This category covers head units designed to operate with matched separate amplifiers. The head units can be an in-dash cassette player/tuner/preamplifier such as Pioneer Electronics' *model KPX-9000* (\$350) or the *model KPX-600*, a component-styled FM stereo *Supertuner*/cassette player/preamplifier tape deck (\$170), for use with either a 6- or a 20-watts-per-channel separate amplifier. The head unit can also be a straight cassette deck for under-



PYRAMID INDUSTRIES model X-Spec-5

dash mounting, such as Pioneer's *model KP-88G* or *KP-66G*, for use with the amplifiers just described.

Other firms offering similar equipment include Marantz with its *model CAR-420* and Royal Sound with the *model RS-2550*; both units are cassette/tuner/preamplifier combinations with matching amplifiers (30 wpc in both cases). Boman also has two models: a cassette player/radio, the *model Mach 90*, at \$600; and a cartridge player/radio, the *Mach 80* at \$550, both packaged with a 25-watts-per-channel equalizer/amplifier.

Altus Corporation manufactures two head units, the *model A8CS-032*, an in-dash cartridge player/AM/FM stereo tuner; and the *model A8CS-052*, an in-dash automatic reversing cassette/player/AM/FM stereo tuner; both meant for use with the *model A8CS-101* 5-band graphic equalizer/preamp/40-watt amplifier. Audiomobile (a division of Advent), one of the major pioneering "mo-fi" manufacturers, still offers its *model ST770A* cassette player/AM/FM tuner, featuring Dolby noise reduction and a *SenAlloy* head for \$400; the amplifier choices for this model should be 20- or 100-watts-per-channel units.

Included in this group are player/radio combinations with built-in low-power amplifiers with provision for hookup to a matching high-powered amplifier, for two levels of playback loudness. One such unit is Jensen's *model R430*, a cassette unit selling for \$529.95; and another is the *model R330* (\$529.95), the cartridge

equivalent; both units have 30-watts-per-channel amplifier power, and both models have bi-amping capability, with 25 watts-per-channel for bass speakers, and 5 watts-per-channel for treble speakers. The power amplifier (included in the price) for the Jensen units is designed to be mounted in a car trunk.

Panasonic manufactures three semi-component combinations for use with a choice of 15-, 20-, or 50-watts-per-channel amplifiers. The *model CQ-8700* features an auto-reverse control, elec-



SOUND CONCEPTS model 1060

tronic digital tuning, automatic seek control and manual frequency scan, 10-station preset capability, Dolby, and quartz-lock tuning. This model retails for about \$700. The *model CQ-7600* features a cassette repeat function, a built-in 5-band equalizer, biamp switch, Dolby, and quartz-lock tuning; its price is about \$400. The *model CQ-7400*, priced at about \$300, is essentially the same unit as the *CQ-7600*, minus Dolby. Amplifier prices were not available at this writing.

Add-on enhancers

Just as the home hi-fi world has accessory equipment, so does the car stereo world. An example of a unit designed to enhance a system's sound quality is Draco Labs, Inc.'s dynamic range expander, the *model D-45E*, which sells for \$200. This expander provides over 30 dB of added dynamic range and simultaneously eliminates FM and tape hiss. It features twin power meters and six LED's for expansion rate display.



SPARKOMATIC model GE-500

Another example of a unit that borrows from home stereo technology is Sound Concepts' *model 1060 Concert Machine*. It is described as an ambience restoration system that augments auto stereo to provide spatial realism and the illusion of a live performance. In use, the machine extracts ambience information from the music played through the car's front speakers, processes it through a complex delay system, and distributes it around the car's interior to duplicate the sound heard at a live performance. The delayed sound is played back over the *Concert*

Machine's two integral 10-watt amplifiers, through the car's rear speakers. It sells for \$300.

Fujitsu Ten also has a time-delay system, the *model RV-130*, that features a graphic window to display the amount of delay; price, \$180.

An off-beat accessory from Pioneer Electronics is aimed at those who want car sound with a different "feel." This is the *Bodysonic System*, advertised as "the

first car stereo product that allows the listener to feel the music as well as hear it. You can experience the intense physical presence that comes from a live performance—not only what you hear, but what you feel." The *Bodysonic System* consists of two parts. One is a cushion containing special transducers that transmit vibrations directly to the person sitting against it. The second part is an amplifier, designed to operate the *Body-*

sonic cushion, featuring an intensity control and on/off switch. It hooks up to a car stereo system just like an ordinary amplifier and can be installed under-dash or in the glove compartment. One *Bodysonic* amplifier can regulate two cushions. The *Bodysonic* cushion sells for \$70; the amplifier for \$80.

All-in-one equipment

While many of the advances taking place are in component-type equipment, there is also a lot of activity on the "all-in-one" player/radio combination front. The key buzzwords in this realm are "more power," "more cassette," and "more in-dash."

So far, at least 15 manufacturers have in-dash cassette player/radios with 10 or more watts-per-output channel. These all-in-one units have been created in response to sophisticated consumers wanting to "trade up" to better equipment with better sound and higher power, but not wanting to go the components route. A factor in this choice is that all-in-ones require a simpler installation and less equipment, thereby taking up less precious car space. Manufacturers of such equipment include Audiovox, Altus, Boman, Clarion, Cobra, Concord, Craig, Fultron, J.I.L., Jensen, Kraco, Metro, Panasonic, Pioneer, Sanyo and Sparkomatic.

The all-in-one equipment—be it regular power (3 to 6 watts-per-channel) or high power—ranges from basic to elaborate, depending on how much you want to spend, and offers some of the amenities and technology of home stereo equipment. For instance, Sharp's *model RG-3550* in-dash cassette/radio (\$220) features its proprietary Automatic Program Search System (APSS) that permits the user, in one move, to skip to the next selection on a cassette or back to the start of the current song selection. The APSS feature is also included in Sharp's *model RG-5252*, a cassette/radio designed for use in foreign-made cars. This model sells for \$170. (This feature first appeared in the Sharp home cassette deck line, then in its subsidiary Optonica home audio line.)

Electronic scanning, an esoteric feature in home hi-fi equipment, is beginning to show up in deluxe high-powered car tape/radios. It is featured in J.I.L.'s *model 634E*, Kraco's *models LED-508* and *LED-509*, Panasonic's *model CQ-8520*, Blaupunkt's *Berlin*, Fujitsu Ten's *EP-750*, Marantz' *model CAR-420*, Midland's *model 67-440*, Royal Sound's *model RS-3110* and Sanyo's *model FT-1670*, among others.

Popular in home hi-fi, digital station readouts (often combined with time readouts) are also becoming popular in the car stereo world. At least 10 manufacturers now provide this feature, which is no longer considered a gimmick. Check Altus, Afco, Audiovox, J.I.L., Kraco, Ma-

TABLE 1—CAR STEREO EQUIPMENT—continued

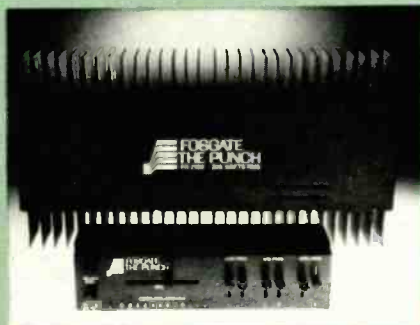
EPI 1 Charles St. Newburyport, MA 01950	LS70	\$150/pair	Semi-enclosed speaker
Fosgate Electronics, Inc. 2923 N. 33rd Ave. Phoenix, AZ 85107	PR-2100		Amplifier
Fujitsu Ten Corp. 1135 E. Janis St. Carson, CA 90746	AT-7831 AT-732 RV-130 EP-750	\$280 \$230 \$180	AM/FM tuner FM tuner Time-delay system Tape/radio/electronic scan Minispeakers, auto-reverse
Fulton 260 Monroe Memphis, TN 38103	16-6800 16-8600	\$500	Cassette player/radio CB/cassette/radio All-in-one system, auto-reverse mode
GR-Grundig Electronic Corp. 635 Madison Ave. New York, NY 10022			Minispeakers
Hitachi Sales Corp. 401 W. Artesia Blvd. Compton, CA 90220			Minispeakers
Inland Dynatronics, Inc. 10 Horizon Blvd. S. Hackensack, NJ 07606	PB-66SE		Booster equalizer
Jensen Sound Labs 4136 N. United Pkwy Schiller Park, IL 60176	R430 R330	\$529.95 \$529.95	Cassette/radio Cartridge player/radio Dolby, all-in-one system
J.I.L. Corp. 737 W. Artesia Blvd. Compton, CA 90220	634E 860CB 615CB		Tape/radio/electronic scan CB/tape/radio CB/tape radio Digital readout, auto-reverse mode, all-in-one system
JVC 58-75 Queens Midtown Pkwy Maspeth, NY 11378			Minispeakers
Kraco Enterprises 505 E. Euclid Ave. Compton, CA 90224	LED-508, LED-509 KCB-4090 KCB-4095		Tape/radio/electronic scan CB/tape/radio CB/tape/radio Digital readout, minispeakers, all-in-one system
Marantz (Superscope Inc.) 20525 Nordhoff St. Chatsworth, CA 91311	SA-230 SP-300 CAR-20		Amplifier Preamp Cassette/tuner/preamp Digital readout, auto-reverse mode
Metro Sound P.O. Box 9849 No. Hollywood, CA 91609	MS-67		Booster equalizer All-in-one system, minispeakers auto-reverse mode
Mitsubishi 3030 E. Victoria St. Compton, CA 90221	CJ-20EM	\$115	FM stereo tuner Minispeakers, auto-reverse mode
Motorola Automotive Products Div. 1299 E. Algonquin Rd. Schaumburg, IL 60196	TC894AX TC890AX CT950AX CC975AX	\$350 \$300	Cassette/radio/metal-tape playback Cassette/radio/metal-tape playback CB/tape/radio CB/tape/radio

chart continues on page 46

rantz, Midland, Panasonic, Roadstar, Sanyo and Sparkomatic.

Dolby noise-reduction circuitry, now incorporated in virtually all home cassette decks, is also being used in many high-powered combination players as well as some lower-powered sets. Companies featuring Dolby are Audiovox, Clarion, Concord, Jensen, Panasonic, Motorola, Roadstar and Sanyo.

Another home audio feature that is appearing in car stereo units is automatic-reversing capability. Some high-powered sets offer this feature, and it is also available in lower-powered units. Auto-reverse (as it is also called) is among the attributes of the cassette that is leading up to the eventual demise of the cartridge



FOSGATE model PR2100

tape format in cars. At least 20 manufacturers use it; namely, Afco, Altus, Audiovox, Blaupunkt, Car Tapes, Clarion, Craig, Fultron, Fujitsu Ten, J.I.L., Marantz, Metro, Midland, Motorola, Mitsubishi, Muntz, Roadstar, Panasonic, Royal Sound, Sankyo, Sanyo, Sparkomatic and Tenna.

One cassette player/radio combination that sort of summarizes the current state-of-the-art and also hints at its future, is the Fultron in-dash model 16-6800. This unit has touch-sensitive electronic controls for volume, tone, balance and tuning; digital station readouts; LED power readout; 14-station/preselct capability; and automatic reverse. Its power output is 12 watts-per-channel RMS, and its price is \$500.

Another model hinting of the future and what may one day be a major feature in car stereo systems is the Roadstar model 2141. This is an in-dash cassette player/radio featuring dual-band VHF TV audio reception. It sells for \$270. (Last year U.S. Pioneer introduced a home audio component tuner featuring TV sound.)

Roadstar also has five other in-dash models that may also be trendsetters in one or more ways. They are the model 3800 and model 3810U cassette deck/tuners designed for use with separate power amplifiers, and the models 3200, 3210U, and 2300U, that are self-contained cassette player/radio combinations, priced in a range from \$300 to \$540. All five units feature LED tuning displays instead of moving pointers.

When you examine spec sheets and

brochures, you'll note other features common to home stereo cropping up in regular and deluxe all-in-one tape player/radio combos, as well as straight players. For instance: loudness controls, FET and MOSFET front ends, phase-locked-loop tuning, quartz-lock tuning, electronic switching, automatic tape-end alarm, dual capstan drive, biamplified power stages, and solid-state varactor tuning and preset tuning.

As noted earlier, the latest advance in the cassette field is fine metal-particle tape that was introduced in the home audio market last summer. At press time, Sanyo announced four cassette/radio combinations with metal-tape playback capability: the models FT646, FT2400, FT1498, and FT1490-2, priced from \$220 to \$390. These new sets also have equalization switches to accommodate normal, chrome and ferrichrome tapes.

Motorola also offers equalization switches for ferrite and chrome tapes in its auto-reversing models TC894AX at \$350 and the model TC890AX at \$300.

Seldom mentioned is the recording capability of car stereo units. The simple reason is that few manufacturers offer it. But that situation will begin to change as technology advances and suppliers are forced to seek new ways to attract customers. Recording "on the go" is not a new idea; a few manufacturers tried



MITSUBISHI CAR AUDIO model CJ-20

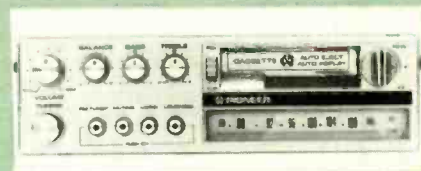
incorporating this capability a decade ago, but got nowhere. One reason was that the technology was still somewhat primitive. Another was that recording capability was monophonic only. Now, Blaupunkt has come on the scene with its model CR-4095, an AM/FM stereo radio/cassette recorder for both regular as well as small car installation. It offers the user a chance to record his own cassette tapes in stereo from the tuner section while the car is on the go. Furthermore, it offers monophonic voice recording via microphone (supplied).

Suppose you want CB capabilities in your car in addition to tape/radio facilities, do you settle for separate installations for a crowded dashboard? Not necessarily. Several manufacturers are now providing CB along with tape/radio facilities in one-unit combinations for in-dash or under-dash mounting. Among brands in which you'll find these are: Fultron (16-8600, cartridge); J.I.L. (860CB, cartridge, 615CB, cassette); Kraco (KCB-4090, cartridge, KCB-4095, cassette); Motorola (CT950AX, cartridge,

CC975AX, cassette); Panasonic (CQB-5919, cassette, CQB-5959, cartridge); Roberts (RCB-4150, cartridge); Sankyo (SCS-555, cassette).

Speakers

When booster amplifiers first appeared in car stereo systems several years ago, they were accompanied by a surge of new speakers—heavy-duty models, with greater power-handling capability. Since then, manufacturers have steadily been



PIONEER model KPX-600

putting out speakers with better reproduction capabilities, plus higher power-handling capacity, to accommodate the higher fidelity, higher power electronics coming on the car stereo scene. Today there are four basic categories of speakers:

1. The traditional type of driver meant for traditional low-powered tape players and player/radios.

2. The heavy-duty, high-quality driver designed for cutout installation with component-type electronics/players, or high-powered tape players and radio/players.

3. Semi-enclosed two- or three-way speaker systems for loud-level reproduction in cutout installations.

4. The self-contained two-way (even three-way) minispeaker system, meant for high-powered, high-fidelity car stereo outfits.

The latest example in the second category is Advent's model EQ-1, priced at \$180 the pair. This speaker consists of a dual-cone, 6- by 9-inch driver with an equalized power amplifier built onto the back of the speaker frame. The model EQ-1 has been designed and frequency-

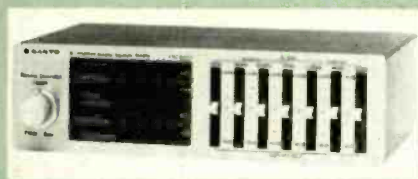


SANYO model EQZ-6200

equalized specifically for rear-deck mounting, and comes with a remote power on/off switch.

A recent example of the semi-enclosed speaker described in the third category is the EPI model LS70, priced at \$150 the pair. This unit consists of a 6-inch woofer mounted adjacent to a 1-inch tweeter in an open-backed housing meant for rear-deck installation in a standard 6- by 9-inch cutout. The model LS-70 can also be mounted on some door panels.

Typical of the two-way minispeaker



SANYO model EQZ-6400

system is Afco Electronics' models AF-1500 and AF-2000. The former uses a 3 1/4-inch woofer and a 2-inch tweeter. The latter uses a 4-inch long-throw woofer and a 2-inch super tweeter. Both use aluminum housings and perforated metal grilles, and can handle 40 watts and 50 watts maximum, respectively.

Other two-way minispeakers are manufactured by ADS, Adcom (Braun, Canton), Comm, Fultron, Fujitsu Ten, Hitachi, Grundig, JVC, Kraco, Metro, Mitsubishi, Royal Sound, Sanyo, Tenna and Ultralinear.

A few manufacturers are marketing three-way minispeaker systems for cars or vans; for example, Afco, Comm, Fujitsu Ten, Royal Sound, Setton and Sparkomatic.

TABLE 1—CAR STEREO EQUIPMENT—continued

Muntz Hi Z, Inc. 871 Folsom St. San Francisco, CA 94107			Auto-reverse mode
Panasonic Co. Car Audio Div. 1 Panasonic Way Secaucus, NJ 07094	CA-9500 CQ-8700 CQ-7600 CQ-7400 CQ-8520 CQB-5919 CQB-5959	\$85 \$700 \$400 \$300	FM stereo tuner Semicomponent unit (deluxe) Semicomponent unit Semicomponent unit (less Dolby) Stereo tape/radio/electronic scan Cassette/CB Cartridge/CB Digital readout, all-in-one system, Dolby, auto-reverse mode
Pioneer Electronics 1925 E. Dominguez St. Long Beach, CA 90810	KPX-9000 KPX-600 KP-88G, KP-66G <i>Bodysonic System</i>	\$350 \$170 \$70-80	Cassette player/tuner/preamp Tuner/cassette player/preamp Cassette decks Sound enhancer All-in-one system
Roadstar Corp. of America 5312 Production Dr. Huntington Beach, CA 92649	2141 3800, 3810U, 3200, 3210U, 2300U <i>MOFI series</i>	\$270 \$300-540	Cassette player/radio Cassette deck/tuner Cassette player/radios Tuners Digital readout, Dolby, auto-reverse mode
Roberts Electronics 3095 NW 77th Ave. Miami, FL 33122	RCB-4150		CB/cartridge tape/radio
Royal Sound Co., Inc. 248 Buffalo Ave. Freeport, NY 11520	RS-2550 RS-3110		Cassette/tuner/preamp Tape/radio/electronic scan Auto-reverse mode, minispeakers
Sankyo Seiki, Inc. 149 Fifth Ave. New York, NY 10010	SCS-555		CB/cassette/radio Auto-reverse mode
Sanyo Electronic 1200 W. Artesia Blvd. Compton, CA 90220	EQZ-6200 PA6120 PA6060 FT-1670 FT646, FT2400, FT1498, FT1490-2	\$250 \$200	Graphic equalizer Amplifier Amplifier Tape/radio/electronic scan
Setton International 60 Remington Blvd. Ronkonkoma, NY 11779			Cassette/radio/metal-tape playback Auto-reverse, digital readout, Dolby, minispeakers, all-in-one system
Sharp Electronics Corp. 10 Keystone Pl. Paramus, NJ 07652	RG-3550 RG-5252	\$220 \$170	Minispeakers
Sound Concepts P.O. Box 135 27 Newell Rd. Brookline, MA 02146	1060 (<i>Concert Machine</i>)	\$300	All-in-one/in-dash cassette/radio Cassette/radio/foreign cars
Sparkomatic Corp. Milford, PA 18337	GE-500 (<i>Acoustatrac</i>)		Ambience restoration system
Tenna Corp. 19201 Cranwood Pkwy Cleveland, OH 44128	R-3025MPX		Booster equalizer Digital Readout, all-in-one system, auto-reverse mode, minispeakers
Ultralinear Loudspeakers 3228 E. 50th St. Los Angeles, CA 90058			Tuner Minispeakers, auto-reverse mode
			Minispeakers

Confused specs

One of the biggest problems facing the industry as it moves into the hi-fi field is in specifications. At the moment, all is confusion. One manufacturer's product brochure describes the output of a given model as, for example, "30 watts." That's a high figure to the prospective purchaser whose current car player/radio is a 5-watt-per-channel model. Thirty watts-per-channel is a lot of output, he thinks, but is that 30 watts a per-channel figure? No, it is actually 15 watts-per-channel, says the fine print at the bottom of the page. But is the output into eight ohms or into four ohms? This information is not given, nor is a distortion reference listed.

Another brochure shows an amplifier emblazoned with "90 watts power." Reading the descriptive copy, you learn that the instrument offers "30 watts continuous sine-wave power per channel (90 watts, peak total music power)." This same brochure also describes a player with "3 watts-per-channel (I.P.P.) max." And another player is rated at "6 watts-per-channel (RMS)." A fourth unit shown in the brochure offers "6 watts of power." Finally, a booster is shown as having "40 watts (25 watts peak power per channel)."

Another specification sheet shows a tape player/radio with "6 watts RMS per channel—36 watts music power" for "72 watts per total power."

What is happening, insiders admit, is that many car stereo manufacturers are playing "specmanship," a game whose goal is to come up with the largest (or smallest) figures for various specs, using whatever measurement standard will give the most advantageous reading.

Fortunately for all concerned—especially the consumer—something is being done to correct the situation. A few conscientious industry voices are calling for an end to such practices—which have already given the industry a black eye. The essential message is that the industry should have strict guidelines on the order of those promulgated by the Federal Trade Commission in 1974 for the home audio component industry. Until such regulations come along, the consumer must evaluate car stereo equipment largely on a "trust-your-own-ears" basis, plus the hope that what he hears in the store will translate into the equivalent in his car.

continued on page 93

ALL ABOUT TIM DISTORTION

Audible differences apparent in the performance of two otherwise identical amplifiers has been traced to a previously undetected type of IM distortion. Here are details of two suggested methods of measurement.

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

MANY AUDIO EXPERTS ARE NOW CONVINCED that audible differences between similarly rated amplifiers having identical power outputs and even identical static distortion ratings (harmonic, intermodulation, etc.) are due in part to a form of distortion known as Transient Intermodulation Distortion (TIM). This type of distortion occurs in an amplifier having a large amount of negative feedback in its main feedback loop and a certain amount of time or phase delay between the input and output signals. In effect, if a very fast transient musical signal or pulse is fed to such amplifiers, the feedback needed to reduce the amplitude of that signal at the input (and later) stages arrives too late, and overload or momentary clipping occurs. At the instant of such clipping, other program-signal elements are also distorted or even obliterated.

Transient intermodulation distortion cannot be measured using the steady-state sinewave input signals normally used for making THD and IM measurements because with such signals, the composite output signal will simply contain some moderate amount of phase shift rather than a momentary overload or overshoot. Many methods have been suggested for measuring and quantifying TIM, but, to date, none has been universally accepted by all segments of the audio high-fidelity industry.

This article takes a look at two such methods—one having been officially proposed to the IEC (International Electrotechnical Commission) as of September, 1978; the other having been more recent-

ly proposed by Sansui Corporation.

IEC measurement proposal

In attempting to measure the distortion caused by rapidly changing signals, any proposed test signal must simulate the time properties of a transient signal. A squarewave is ideal for this purpose, since it exhibits fast transient signals at twice

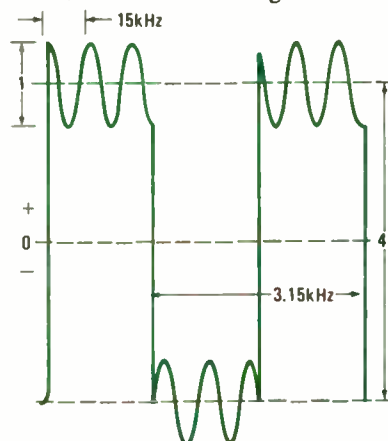


FIG. 1—IEC TEST SIGNAL consists of a 15 kHz squarewave with a superimposed 3.15 kHz sinewave.

the fundamental frequency of the squarewave. In order to limit the risetime of the squarewave to a reasonable value, the signal must be passed through a low-pass filter corresponding to the signal-source bandwidth. The IEC proposal suggests that the low-pass filter have a 50-kHz cut-off frequency for average hi-fi equipment and, perhaps, a 100-kHz cut-off frequency for high-quality amplifiers.

If the squarewave test signal drives the amplifier under test into nonlinearity during its steep rise or fall, distortion of other simultaneously amplified signals will result. Therefore, a sinewave of smaller amplitude than the squarewave is added to the squarewave signal. The current IEC proposal suggests that the fundamental frequency of the squarewave should be 3.15 kHz and that the superimposed sinewave should be 15-kHz. The peak-to-peak amplitude ratio of the two signal components should be 4:1, respectively. Thus, the test signal would appear as is shown in Fig. 1.

A block diagram of the proposed test setup is shown in Fig. 2. To measure the

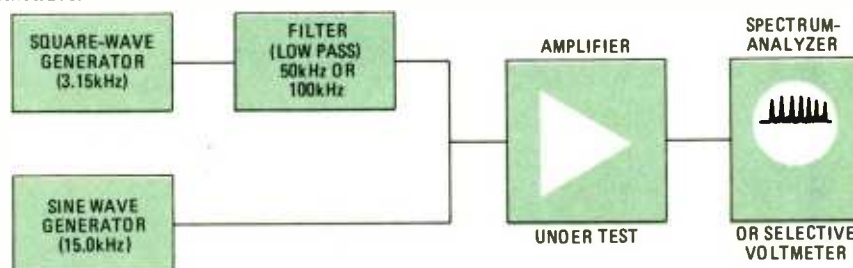


FIG. 2—TIM DISTORTION measurement setup using a narrowband spectrum analyzer.

intermodulation products, a selective voltmeter or a narrowband spectrum analyzer must be used. Studies have shown that TIM can be detected even when its percentages are as low as 0.2%. Therefore, the spectrum analyzer used to display intermodulation must have a dynamic range of at least 80 dB; and, in order to be able to separate the various intermodulation components that arise, the analyzer should have a selectivity of 750 Hz or better. Frequency-selective voltmeters could also be used.

If the fundamental squarewave frequency is designated as f_q (in this case, 3.15 kHz), and the sinewave signal is designated as f_s (15 kHz in the IEC proposal), then various additional frequencies will be present in the test signal as indicated in the left-hand column of Table 1. The intermodulation components that occur in an amplifier having TIM (and which must be taken into account in calculating the percentage of TIM present) are shown as various differences between f_s and multiples of f_q in the second column of Table 1; and the associated voltage amplitudes of these intermodulation components are designated as μ_1 , μ_2 , etc., through μ_9 . The actual frequencies of both the test signal and the intermodulation resulting from TIM are shown in the right-hand column.

To calculate the dynamic or transient intermodulation distortion in an amplifier, it is necessary to measure the amplitude of each of the voltage components, μ_1 through μ_9 , and apply the following formula:

$$d_{TIM} = 100 \times \frac{\sqrt{\mu_1^2 + \mu_2^2 + \dots + \mu_9^2}}{\mu_s}$$

where μ_s is the amplitude of the sinewave component at a frequency of 15 kHz, and μ_n is the amplitude of the intermodulation components at frequencies $f_s - nf_q$, in which n is a positive integer from 1 through 9. Figure 3 shows the components that are observed if the test signal itself is analyzed by a spectrum analyzer. While an ideal squarewave normally does not contain even-order harmonics, actual squarewave generators generally do produce a small amount of such even-order components; hence the small amounts of $2f_q$ and $4f_q$ shown in Fig. 3.

The text of the IEC proposal shows the

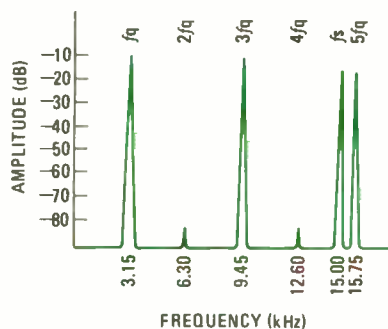


FIG. 3—SPECTRUM ANALYSIS of the IEC test signal.

TABLE 1

Input Signal	Intermodulation Frequency	Component Voltage	Frequency, kHz
f_s	$f_s - 5f_q$	μ_5	0.75
	$f_s - 4f_q$	μ_4	2.40
f_q	$f_s - 6f_q$	μ_6	3.15
	$f_s - 3f_q$	μ_3	3.90
$2f_q$	$f_s - 7f_q$	μ_7	5.55
	$f_s - 2f_q$	μ_2	6.30
$3f_q$	$f_s - 8f_q$	μ_8	7.05
	$f_s - f_q$	μ_1	8.70
$4f_q$	$f_s - 9f_q$	μ_9	9.45
f_s			10.20
			11.85
			12.60
			13.35
			15.00
			15.75

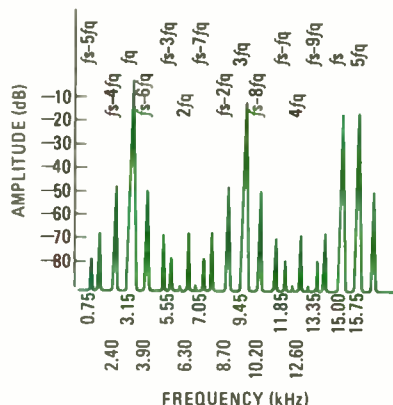


FIG. 4—AMPLIFIER adds distortion to test signal which shows up as additional components in the frequency spectrum.

frequency spectrum of the output signal of a type $\mu A741$ operational amplifier under the following conditions: noninverting circuit, 20-dB gain, 5K-ohm load resistance and an output of 5 volts peak-to-peak, with a supply voltage of ± 15 . Figure 4 is a diagram of the spectrum display. The nine new intermodulation amplitudes would have to be entered into the distortion formula shown above to arrive at a percentage value for TIM—or DIM (Dynamic InterModulation) distortion as it is called in the proposal.

The DIM distortion can be presented as a function of amplifier power or volt-

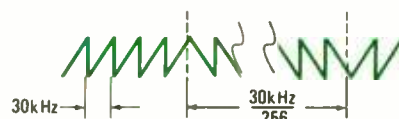


FIG. 5—TEST SIGNAL proposed by Sansui consists of a 30 kHz sawtooth waveform with a phase reversal every 30 kHz / 256.

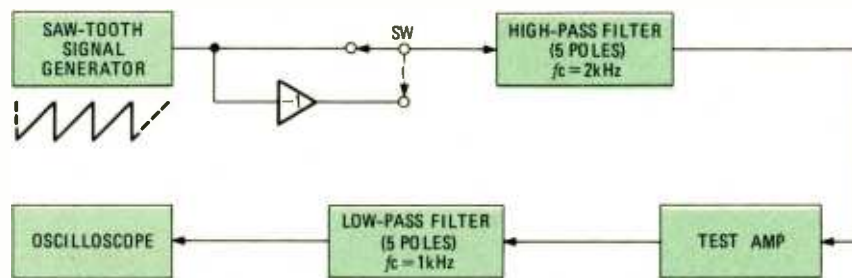


FIG. 6—TIM MEASUREMENT setup proposed by Sansui using the test signal shown in Fig. 5.

age output. To permit comparison on the basis of equal peak-to-peak results of measurements made with different test signals upon different amplifier products, the output voltage is expressed in terms of a reference output voltage. This could be the RMS value of a sinusoidal signal having the same peak-to-peak value as the test signal appearing at the output terminals of the amplifier under test.

In addition to requiring a fairly expensive spectrum analyzer, this measurement method requires a good deal of calculation by the tester, and it cannot be done quickly, although the results, according to proponents of the scheme, seem to give very good correlation between listener-perceived TIM and measured results.

Sansui proposal

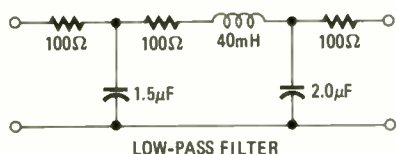
Sansui Corporation has developed a proposal that seems much simpler: The proposed signal for TIM measurements is derived from inverting the phase of a 30-kHz sawtooth waveform with a 30 kHz / 256 period, as shown in Fig. 5. The signal therefore consists of two alternating series of signals, one series of instantaneously *rising* waveforms, the other of instantaneously *falling* signals. The measurement setup is shown in the block diagram of Fig. 6.

The switch shown in Fig. 6 reverses the polarity of the sawtooth signal at a frequency rate that is within the audible range. Since the sawtooth signal is modulated by polarity-reversing, it contains frequencies that are lower than the fundamental frequency as well as its own fundamental frequency. The high-pass filter eliminates these lower frequencies. The filtered signal is then fed to the

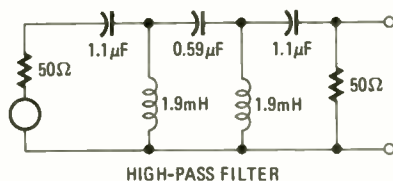
amplifier, and the amplifier's output signal is fed through a low-pass filter to eliminate the frequency components of the sawtooth signal itself. The output of the low-pass filter is then displayed on an oscilloscope for measurement.

The test signal consists of a series of sawtooth waveforms that are reversed in polarity at intervals falling within the audio range. If the amplifier under test is prone to TIM, then at the output of the low-pass filter a signal appears whose shape is rectangular. Each time the input signal reverses polarity, a rectangular output waveform appears that is due to the shift in average voltage or DC level. This output signal represents the amount of TIM generated in the amplifier under test.

Sansui Corporation has devised some experimental test equipment, which we were fortunate enough to be able to borrow to prepare this article. The equipment contains a sawtooth signal generator with a 30-kHz fundamental frequency, whose polarity reversal is 30 kHz ÷ 256. Rise- and falltimes of the sawtooth waveform are both 30 ns. The test apparatus



LOW-PASS FILTER



HIGH-PASS FILTER

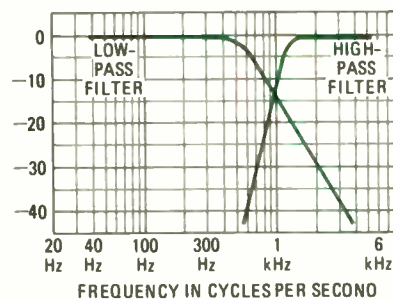


FIG. 7—TIM DISTORTION ANALYZER from Sansui includes low-pass and high-pass filters with the above response characteristics.

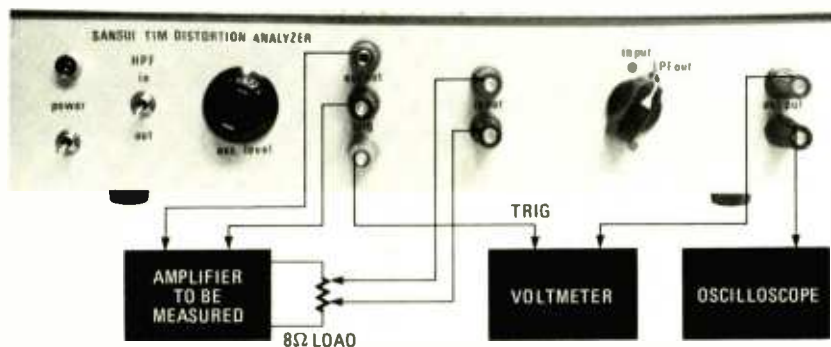


FIG. 8—MEASUREMENT SETUP using Sansui's TIM Distortion Analyzer.

also includes low- and high-pass filters, whose component values and response characteristics are shown in Fig. 7.

To make the TIM measurement using this equipment, only an oscilloscope is required in addition to the amplifier being tested. Figure 8 shows how each unit is connected. The output level of the amplifier is adjusted by varying the oscillator level control. The output power is determined by using a voltage-calibrated scope and adjusting the peak-to-peak amplitude of the sawtooth waveform so that it equals the peak-to-peak amplitude of a sine wave whose RMS value can be calculated from the output power at which the measurement is to be made. During this phase of the test, the low-pass filter is switched out of the circuit, and the output waveform that appears is shown in the scope photo of Fig. 9. The peak-to-peak value (in volts) is recorded. Next, the low-pass filter is switched in, and the scope's vertical gain is increased until the waveform shown in Fig. 10 appears (this indicates evidence of TIM); TIM is calculated as

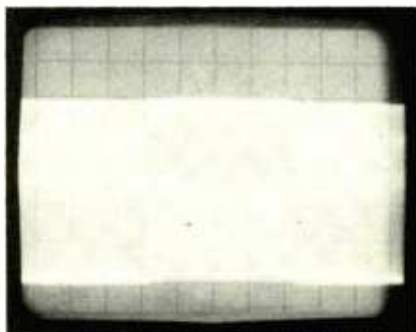


FIG. 9—OUTPUT WAVEFORM from amplifier being tested with the low-pass filter bypassed.

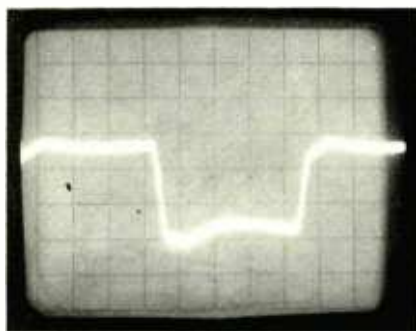


FIG. 10—OUTPUT WAVEFORM from amplifier with low-pass filter connected. TIM distortion is proportional to squarewave amplitude.

$$\text{TIM} = \frac{\text{amplitude (P-P) of sawtooth}}{\text{amplitude (P-P) of squarewave}} \times 100 (\%)$$

If the TIM value is too small to be measured accurately by a calibrated oscilloscope, you can use a voltmeter. In this case, however, you must convert the voltmeter reading to peak-to-peak values relative to the output sawtooth waveform. For "unity" indications on the voltmeter, the sine wave peak-to-peak value would be 2.8, the sawtooth waveform's peak-to-peak value would be between 3.2 and 3.8, while the peak-to-peak value of the TIM squarewave would be 1.8.

Unfortunately, the actual percentages that will be calculated for TIM using the proposed Sansui method will not agree with those determined using the proposed IEC method. The measured TIM percentages using either method will vary with the high-frequency component of the signal (a 30-kHz sawtooth waveform for the Sansui method, and a 15-kHz sine wave for the IEC method), as well as with any variation in the low-frequency portion of the test signal (3.15 kHz for the IEC method, 30 kHz ÷ 256 for the Sansui method). Nevertheless, each method, will provide correct *relative* TIM indications.

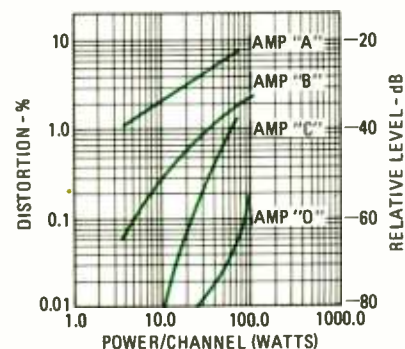


FIG. 11—TIM DISTORTION rating obtained using the Sansui test method for four different amplifiers.

For example, using the Sansui method, four typical amplifiers were measured. All the amplifiers had approximately the same rated *continuous* power output (between 50 and 100 watts-per-channel) and approximately the same rated total harmonic distortion. Amplifier A was a relatively old unit that had a great deal of overall negative feedback and no provision made for a high slew rate. Amplifier B used faster transistors and somewhat less total negative feedback. Amplifiers C and D both had so-called DC configuration, in which amplifier D had the highest observed slew rate, and all the time constants (capacitors) were eliminated from the signal path as well as from the feedback network. The vastly differing results (see Fig. 11) correspond closely with theory and with the audible performance of each amplifier.

R-E

Videodisc — Look at

LARRY STECKLER EDITOR

IN OUR APRIL ISSUE WE PRESENTED AN INTRODUCTORY ARTICLE about the two basic kinds of videodiscs. This month we're going to take a closer look at the Philips system as sold by Magnavox under the name *Magnavision*. Let's start by taking a look at playing time. Then we'll go on to take a close look at the laser. As a bonus, we are including the complete schematic of the unit.

The illustrations on this page and the facing right-hand page show the two types of Philips videodiscs that will be available—*Standard Play* and *Extended Play*. Standard play provides 30 minutes of video and stereo sound on a single side of the disc. Extended play makes that playing time twice as long—one hour per side.

If you placed a standard-play and an extended-play disc side-by-side, there would be no visible differences as the outward appearance of the two discs is similar. The real difference can be seen by comparing the illustrations on these two pages. The difference lies in the physical arrangement of each successive video field on the disc.

Each time a standard-play disc makes one complete revolution, one complete TV frame is played. This frame consists of the customary two interlacing fields. So each time the disc completes one revolution, the TV screen has been scanned twice. The two fields are separated by the vertical sync and blanking sections. Note that the vertical field track length varies in physical length, depending on whether you are close to the center of the disc or the outer edge. This arrangement holds true during the entire time the disc plays. Remember, the disc rotates at a consistent 1800 rpm—this is 30 Hz, the TV frame rate—and tracks from the center of the disc to the outside (a reverse spiral as compared with a conventional audio record). It is this feature of the standard-play disc that makes Still Motion, Slow Motion and Random Access modes of operation possible.

Extended-play video discs do not have the constant arrangement of the vertical fields (see the illustration on the right-hand page). Instead the track length of the vertical field is held

constant throughout the diameter of the disc. This allows the information on the disc to be crammed in more tightly, providing the double-length playing time. To do this, we do lose the special operating modes because of the varying position of the vertical fields on the disc. Also, to keep a constant velocity as the video information on the disc is scanned, motor speed must be varied as the disc is played.

In addition to the picture-information tracks, there are special tracks labeled *Lead-In* and *Lead-Out*. These are located at the inner and outer diameters of the disc. They are specially coded so that the focused laser beam will not move beyond them. When the lead-out tracks are reached, the light beam automatically moves back to the lead-in tracks and repeats the program.

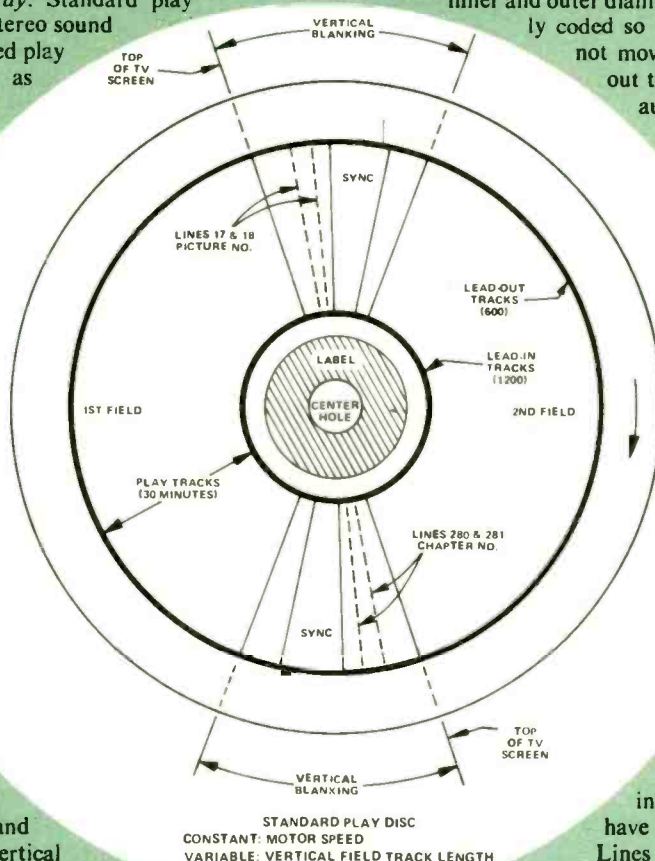
The vertical blanking time of the TV raster is longer than the vertical sync time. In fact, several horizontal lines at the top of each field occur before the downward scan reaches the top of the screen. Some of these unseen horizontal lines at the top of each field are reserved for special purposes.

In the first field, for example, line 17 contains a code that represents the picture number or elapsed time, depending upon the type of disc. Line 18 duplicates line 17 so if line 17 is damaged or distorted, line 18 provides the information that might otherwise have been lost.

Lines 280 and 281 are above the top of the screen during the second field. When they are used, line 280 contains a digital code that represents the chapter number. Line 281 simply duplicates line 280.

Special variations in these codes (lines 17, 18, 280, 281) provide the automatic stop and return to normal play features, when they are used.

Other unseen horizontal lines during vertical blanking contain a *Vertical Interval Test Signal* (VITS) on line 20; an *International Test Signal* (ITS) on line 283; and a *Vertical Interval Reference Signal* (VIRS) on lines 19 and 282. VITS, ITS and VIRS are not used by the disc player. The VITS and ITS signals



STANDARD PLAY DISC
CONSTANT: MOTOR SPEED
VARIABLE: VERTICAL FIELD TRACK LENGTH

FIG. 1

the circuitry



are used by the videodisc manufacturers to test for noise and intermodulation distortion.

One side of a videodisc can store up to 54,000 separate frames or pictures [30-Hz frame rate times 1800 seconds (30 minutes)]. When the program material is less than 30 minutes in length, fewer frames are used since fewer are needed.

The most common reason for using fewer frames is the use of movie film as the program source instead of video tape. Movie cameras run at a frame rate of only 24 Hz. To overcome this problem, the movie film is converted to TV fields. The film frames are alternately scanned for three video fields and two video fields. So five video frames are used while scanning four film frames. Picture numbers are added only to the first video field per film frame. Since only four picture numbers are used for each five video frames, the picture numbers will only reach about 43,200.

Next, the laser

The laser used in the Magnavision videodisc player is a gas-filled vacuum tube that has both an anode and a cathode. It is a long glass tube that has a mirror on the inside at each end. The laser operates in a manner similar to that of a thyratron. A specific firing voltage must be applied between the anode and cathode to make the gas ionize and cause current flow. Once the tube has fired (in laser language "ignited") less voltage is required to maintain the current flow (sounds just like a neon lamp, doesn't it).

A mixture of helium-neon gases is used in this laser. When it ionizes, it emits a red light. The light reflects back and forth between the mirrored ends inside the glass tube, continually gaining power. One of the mirrored ends is only partially reflective. When the light beam gets strong enough, it penetrates that mirror and exits the tube as a laser beam.

The optical power of the laser is 1.2 mW. This strength is not dangerous if the beam should happen to touch your skin. It would not even damage a piece of tissue paper. However; **THE BEAM MUST NOT BE ALLOWED TO TRAVEL DIRECTLY INTO THE EYE.** To prevent this, the player is designed so

that the laser is turned off whenever the lid is raised. Double protection is provided by mechanically blocking the light path as the lid is opened.

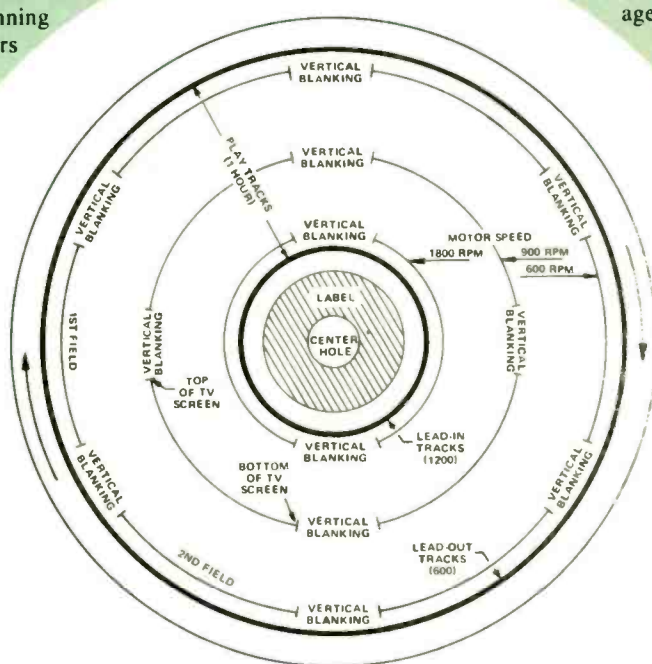
The DC power supply for the laser is shown in Fig. 4. It is driven by a secondary winding of transformer T1. Diodes D7 and D8 act as a voltage doubler. During positive half-cycles, D8 conducts and charges C9, C10 and C11 to about 900 VDC. During negative half-cycles, D7 conducts charging C6, C7, and C8. The polarities are additive so that the voltage across the six capacitors is 1800 VDC.

The resistors in parallel with the capacitors are all 1 megohm. They equalize the voltage across each capacitor and discharge the capacitors when the power is turned off. Capacitor C21 acts as a surge suppressor. Capacitor C3 and R17 form a high-pass filter to eliminate high-frequency noise that might otherwise get into the supply.

The laser and laser igniter are shown in Fig. 5. The igniter is completely encapsulated and looks very much like the high-voltage tripler in a color TV. The series circuit has the 1800-VDC source supplying current through the regulator, laser and laser igniter to ground. You'll note that neither side of the 1800-VDC supply is connected to ground. The cathode lead from the laser passes through the laser igniter, yet no connections are made to it. This is done to keep both laser leads safely encapsulated in the laser igniter.

The 1800-VDC will not turn the laser on. A multivibrator circuit is used to drive step-up transformer T1 inside the igniter. Transformer T1's output is about 10 kV. When this high voltage is fed across the laser, the laser ignites and C1 dumps its energy through the laser and R1 to provide the initial turn-on current.

As soon as 5-mA is flowing through the laser, the regulator turns the multivibrator off and the 10 kV disappears. Now the laser requires only about 1200-VDC to maintain 5-mA conduction, and the 1800-VDC source can now keep the laser operating. The extra 600 volts is dropped across the regulator. In



EXTENDED PLAY DISC
CONSTANT: VERTICAL FIELD TRACK LENGTH
VARIABLE: MOTOR SPEED

FIG. 2

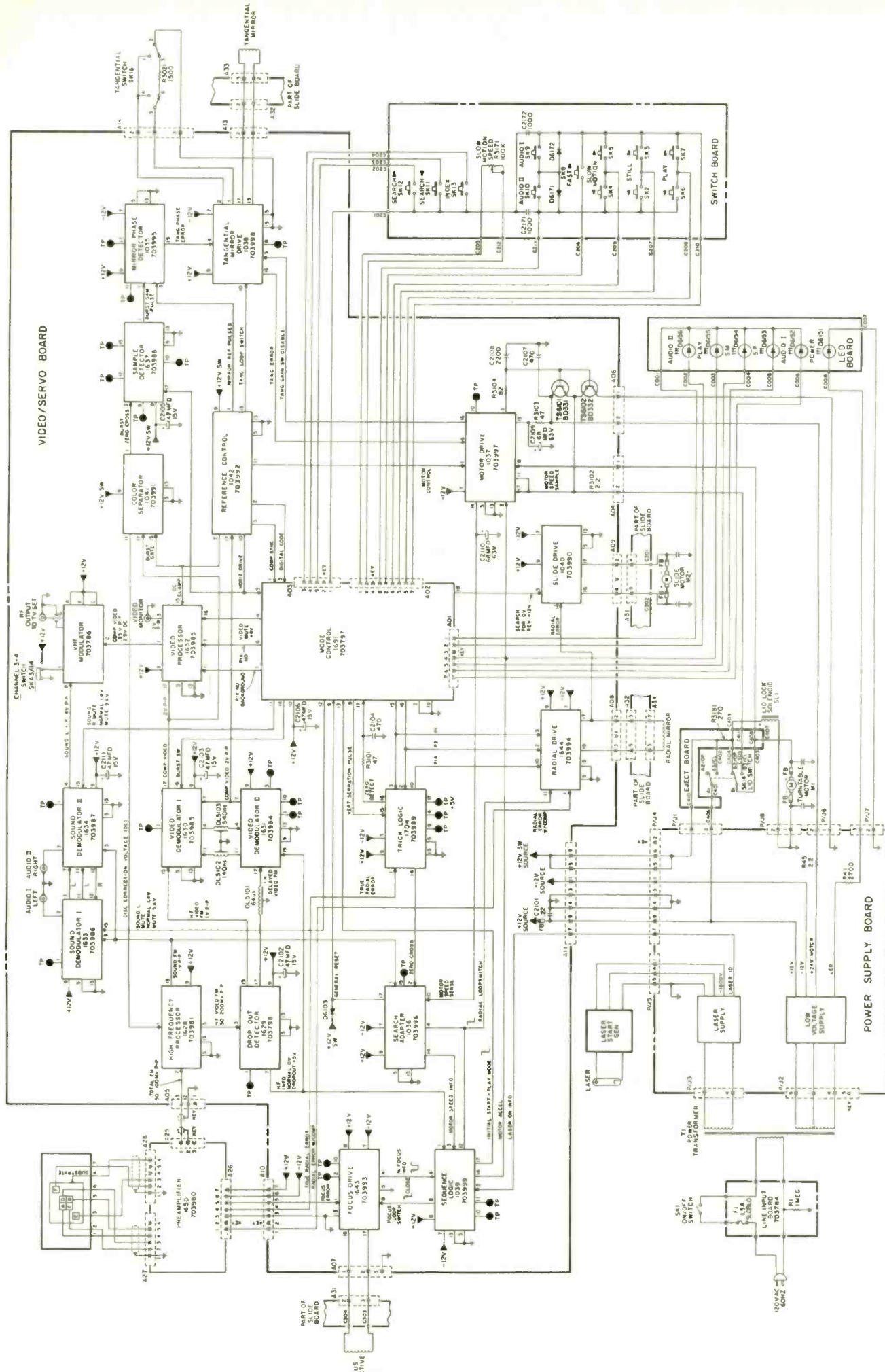


FIG. 3—THE COMPLETE SCHEMATIC OF THE MAGNAVOX model VH8000 videodisc player. The details of the power supply are not included in this schematic.

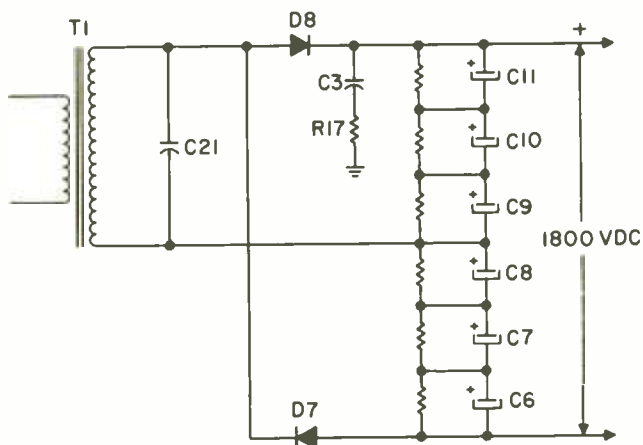


FIG. 4—LASER POWER SUPPLY CIRCUIT delivers 1800VDC to the laser for igniting the helium-neon device.

actual operation the 600 volts varies from below 100V to more than 800V depending upon line voltage, laser current, etc. Once the laser is conducting, T1's secondary, inside the igniter, has too much resistance to permit enough DC current flow. Diode D2 now shunts this winding and the 5-mA current flows through D2 instead of D1 and T1.

The actual laser-regulator supply circuit is shown in Fig. 6. It consists of a constant-current source, Q1, plus Darlington pairs Q8 and Q9, Q6 and Q7, and Q13 and Q14. These Darlington pairs are used because of their high gain and the resulting sensitive regulation they provide. Four transistors (Q9, Q7, Q14 and Q1) are arranged in series to distribute the voltage. A single transistor could not withstand the 600 volts or more that is dropped across the regulator.

The +12V switched source generates a regulated fixed voltage at the junction of R1 and R25. Zener diode Z1 drops 6.8V and D5 and D6 add about 1.2V so that the fixed voltage reference is about 8V at the base of Q1. With fixed bias, Q1 acts as a constant-current source. Resistor R2 is adjusted to deliver a

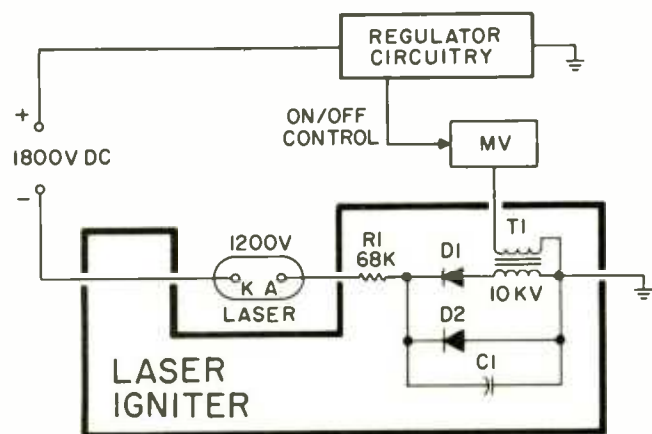


FIG. 5—SIMPLIFIED DIAGRAM OF THE laser and igniter. The igniter is a completely sealed unit.

fixed current of 5 mA. Since the laser is in series, laser current is also set to 5 mA. Resistor R3 is a 1K sensing resistor so when the current is 5 mA, the voltage at TP5 is 5V.

When the laser is on, the 5V appears at TP5. This voltage is coupled through D4 to the Video/Servo board and tells the circuit that the laser is on. Now when the laser ignites, this 5V also goes to the multivibrator and turns it off. The multivibrator is powered from the 12-V switched source so the circuit can never operate if the player lid is open. Capacitor C2 charges to the emitter voltage of Q1. When the 12V switched is not there (if the lid is open) the voltage on C2 reverse-biases Q1 and

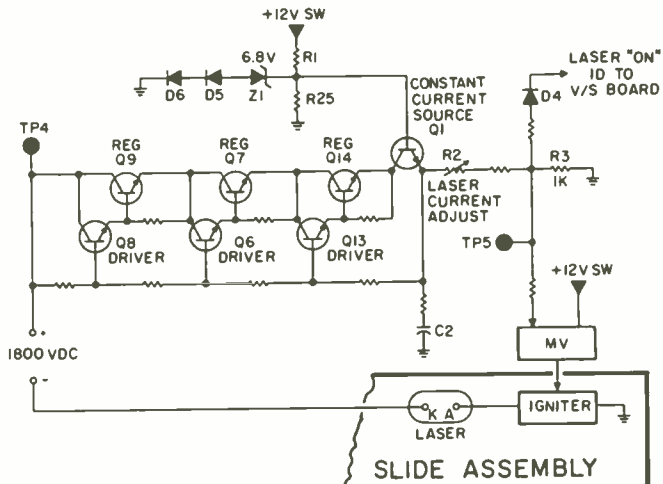


FIG. 6—LASER SUPPLY REGULATOR CIRCUIT using Darlington pairs of transistors to handle the high operating voltage.

instantly shuts down the laser.

NOTE: THE LASER MUST NEVER BE SHORTED OR BRIDGED IN ANY MANNER, NOT EVEN WITH A HIGH-IMPEDANCE VOLTMETER. This protects the series transistors against cascade failure.

The last element in the laser circuit is the laser multivibrator shown in Fig. 7. It drives the laser igniter. It is a free-running type and consists of Q3 and Q4. When the player lid is closed the switched 12-V source appears and turns Q4 on through R13, and the multivibrator starts operating. The result is a 250-Hz squarewave that drives the base of Q5, a high-current amplifier used to drive the laser igniter. The driving waveform can be monitored at TP6, **BUT IS ONLY PRESENT FOR A BRIEF INSTANT DURING TURN-ON OF THE PLAYER.** As soon as the laser fires, 5V appears at TP5 and turns on Q2. This shorts Q4's base to ground through D1, disables Q4 and turns off the multivibrator.

A Darlington is used for Q4 because we need high gain to drive Q5. Diode D2 in series with the base of Q3 increases the turn-on requirement for Q3, to balance it with the similar turn-on requirements of Q4. Diodes D3 and D20 protect against positive voltage spikes that might otherwise appear at TP6 and

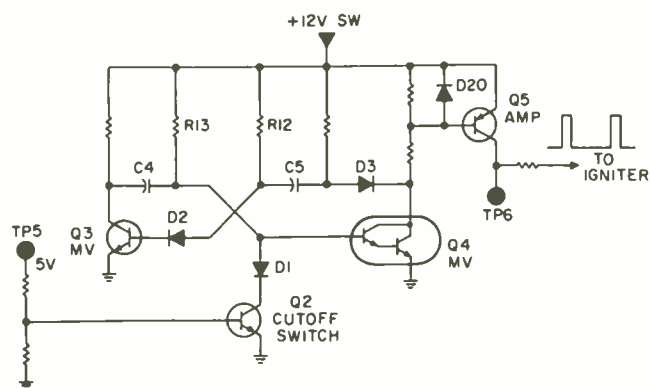


FIG. 7—LASER MULTIVIBRATOR that drives the laser igniter is a free-running type.

damage components or upset circuit operation.

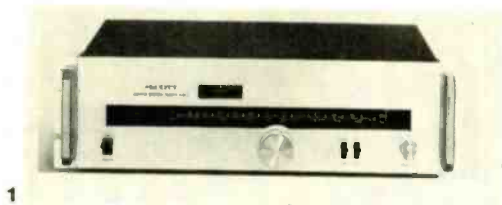
That handles the operation of the laser and its associated components. Next time we will take a close look at the other circuits that are needed to make a videodisc player work. These include the video dropout detector, video FM signal processor, composite video signal processor, RF signal modulator, turntable motor control, color separator, sample detector circuits and several others that are probably new to most of us. In addition several photographs will illustrate the interior layout showing where the various circuits are physically located and how you can get at them.

R-E

Radio-Electronics Audio Lab Tests

Scott Model 530-T AM/FM Stereo Tuner

LEONARD FELDMAN
CONTRIBUTING HI-FI EDITOR



DON'T BE DECEIVED BY THE PLAIN-LOOKING front panel of this low-cost tuner from H.H. Scott, Inc. (20 Commerce Way, Woburn, MA 01801). Nor should the light weight discourage you from putting it through its paces if you are in the market for a budget-priced AM/FM stereo tuner. This tuner proves to be a superb performer for its price or even if it were priced much higher.

The front panel, shown in Fig. 1, is dominated by a relatively narrow, long dial area containing a precisely calibrated linear FM frequency scale (with markings at every 200 kHz), plus a less precisely calibrated AM frequency scale. To the left of these scales is the usual stereo indicator light. A window situated above the frequency scales and to the left of center discloses the single meter provided with the tuner. The meter acts as a zero-center indicator when tuning to FM stations and as a signal-strength indicator when the *model 530-T* is used in the AM mode. At the lower left of the panel is a power on/off lever, while farther to the right is located a massive tuning knob that is coupled to a reasonably effective fly-wheel. Next to this control are two more lever switches; one selects the stereo or mono mode, the other turns the interstation muting circuitry on or off. (It is really amazing that Scott has separated these two functions while manufacturers of much more expensive tuners and receivers have seen fit to combine them so that defeating the mute circuitry becomes impossible in the stereo mode!) Finally, a small two-position rotary switch on the bottom right of the panel selects AM or FM reception. Although there are not many controls here to entertain the knob-twirler, just read on.

The rear panel contains one feature not usually found on tuners sold in the U.S. In addition to the terminals for connecting 300-ohm, 75-ohm FM and external AM antennas, a ball-joint pivotable built-in ferrite-bar AM antenna, a pair of audio output jacks, a single convenience AC receptacle and a line fuse-holder, there is also a three-position slide switch. The switch alters the de-emphasis of the tuner from 75 μ s to either 50 μ s (which is standard for European FM broadcasting), or 25 μ s (required when listening to Dolby FM broadcasts with the aid of a separate Dolby decoder). Interestingly enough, the tuner's power cord is supplied separately. A needless expense, you might think? Not really, since this innovation permits Scott to supply different cords for the set if it is sold in different countries. The power-cord receptacle contains three pins for accommodating three-wire (grounded) power cords in those countries now requiring such line cords. A view of the rear panel is shown in Fig. 2.



When you first view the inside of the chassis you could get the impression that several line workers were absent the day the tuner was put together since there are several "unfilled"

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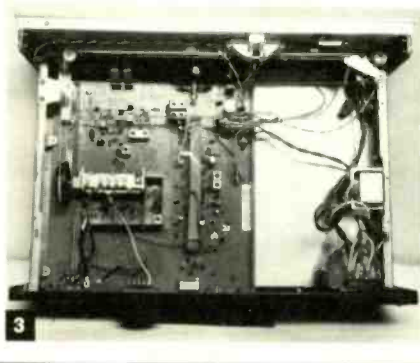
RATES

SCOTT 530-T STEREO TUNER

EXCELLENT

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holes in the single master PC board (see Fig. 3). Actually, we suspect that this master board was cleverly designed to accommodate a variety of tuner circuits, of which the *model 530-T* is the least expensive and the least complex. We also suspect that Scott's *model 570-T* and *model 590-T* tuners (selling for \$50 and \$100 more, respectively) use the same basic PC board with many of those holes occupied by



circuit components. We consider this good economical engineering; it helps to keep the price down on all three models.

Circuit highlights

The FM front end of the *model 530-T* uses a full 4-section tuning capacitor for FM as well as a dual-gate MOSFET for the RF amplifier stage. Three dual-element ceramic filters are used in the IF section, and a phase-locked-loop IC circuit is used for stereo multiplex decod-

MANUFACTURER'S PUBLISHED SPECIFICATIONS:

FM TUNER SECTION:

Usable Sensitivity: 10.8 dBf (1.9 μ V). **50-dB Quieting:** mono, 16.8 dBf (3.8 μ V); stereo, 36 dBf (35 μ V). **Selectivity:** 60 dB. **Capture Ratio:** 1.5 dB. **Distortion, 1 kHz:** mono, 0.15%; stereo, 0.3%. **Separation at 1 kHz:** 45 dB. **Frequency Response:** 25 Hz to 15 kHz, $\pm$ 2.0 dB. **S/N Ratio:** mono, 72 dB; stereo, 67 dB. **Spurious Rejection:** 80 dB. **IF Rejection:** 85 dB. **Image Rejection:** 65 dB. **Subcarrier Rejection:** 58 dB. **Output Voltage:** 0.75 volt.

AM TUNER SECTION:

Sensitivity (Bar Antenna): 250 μ V-per-M. **Selectivity:** 40 dB. **Image Rejection:** 40 dB. **S/N Ratio:** 45 dB. **Output Voltage:** 0.3 volt.

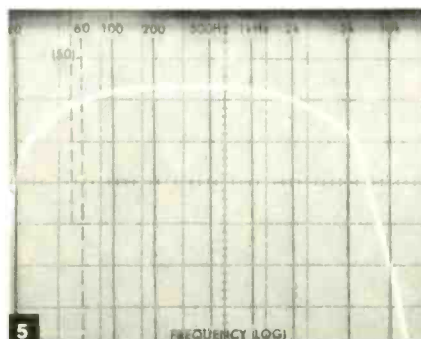
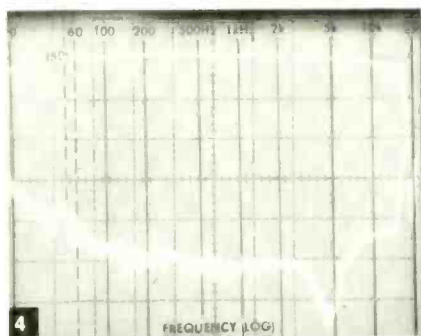
GENERAL SPECIFICATIONS:

Power Requirements: 117 volts, 60 Hz, 20 watts. **Dimensions:** 17 W x 5 1/4 H x 11 1/4 Inches D. **Net Weight:** 11.5 lbs. **Suggested Retail Price:** \$199.95.

ing. Figure 3 shows an internal view of the chassis. The power-supply components (including the small power transformer) are well separated from the tuner circuitry itself to minimize hum and noise.

FM measurements

Table 1 summarizes our lab measurements on the *model 530-T's* FM performance. Note that, except for mono usable sensitivity (which proved to be exactly 1.9 μ V, or 10.8 dBf, as claimed), virtually every other performance specification exceeded the manufacturer's claims. Although Scott does not provide all the required specifications (for example, separation is given for only one frequency, as is harmonic distortion), the company could have supplied the additional data for low and high frequencies, since in all instances these values were superb. Even harmonic distortion, in the stereo mode, at 6 kHz was a very low 0.15%, and all other THD measurements (in both mono and stereo modes) were well under that maximum figure.



Stereo separation was a high 54 dB at mid-frequencies (as against the 45 dB claimed), and remained a high 50 dB at 100 Hz and an even more amazing 40 dB at the 10 kHz test frequency. Muting and stereo switching thresholds were set at ideal values of 7.0 μ V (22.1 dBf) and 5.0 μ V (19.2 dBf), respectively, and muting is overcome without any transitional noise or fluctuation in amplitude of recovered signals. Dial calibration was so precise as to preclude our indicating in Table 1 any deviation from "absolute accuracy."

Frequency response in the stereo mode, as well as stereo FM separation, are shown in the scope photo of Fig. 4. The 1.8-dB tolerance cited in Table 1 (with respect to frequency response) is in the negative-only direction and represents the reading obtained at the 15-kHz extreme. At 10 kHz, response was down less than 1.0 dB. The lower trace of Fig. 4 represents crosstalk and corresponds nicely with the separation figures at specific frequencies listed in Table 1.

TABLE 1
RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: Scott

Model: 530-T

FM PERFORMANCE MEASUREMENTS

SENSITIVITY, NOISE AND FREEDOM FROM INTERFERENCE	R-E Measurement	R-E Evaluation
IHF sensitivity, mono: (μ V) (dBf)	1.9 (10.8)	Excellent
Sensitivity, stereo (μ V) (dBf)	5.0 (19.2)	Very good
50-dB quieting signal, mono (μ V) (dBf)	2.4 (12.8)	Excellent
50-dB quieting signal, stereo (μ V) (dBf)	32.0 (35.3)	Excellent
Maximum S/N ratio, mono (dB)	74	Excellent
Maximum S/N ratio, stereo (dB)	69	Very good
Capture ratio (dB)	1.4	Very good
AM suppression (dB)	55	Good
Image rejection (dB)	68	Good
IF rejection (dB)	85	Very good
Spurious rejection (dB)	88	Very good
Alternate channel selectivity (dB)	62	Good

FIDELITY AND DISTORTION MEASUREMENTS

Frequency response, 50 Hz to 15 kHz ($\pm$ dB)	1.8	Good
Harmonic distortion, 1 kHz, mono (%)	0.06	Superb
Harmonic distortion, 1 kHz, stereo (%)	0.07	Superb
Harmonic distortion, 100 Hz, mono (%)	0.09	Superb
Harmonic distortion, 100 Hz, stereo (%)	0.07	Superb
Harmonic distortion, 6 kHz, mono (%)	0.09	Superb
Harmonic distortion, 6 kHz, stereo (%)	0.15	Excellent
Distortion at 50-dB quieting, mono (%)	0.8	Good
Distortion at 50-dB quieting, stereo (%)	0.45	Very good

STEREO PERFORMANCE MEASUREMENTS

Stereo threshold (μ V) (dBf)	5.0 (19.2)	Excellent
Separation, 1 kHz (dB)	54	Superb
Separation, 100 Hz (dB)	50	Superb
Separation, 10 kHz (dB)	40	Superb

MISCELLANEOUS MEASUREMENTS

Muting threshold (μ V)	7.0 (22.1)	Good
Dial calibration accuracy ($\pm$ kHz at MHz)	Absolute	Superb

EVALUATION OF CONTROLS, DESIGN, CONSTRUCTION

Control layout	Good
Ease of tuning	Excellent
Accuracy of meters or other tuning aids	Superb
Usefulness of other controls	Good
Construction and internal layout	Very good
Ease of servicing	Excellent
Evaluation of extra features, if any	Good

OVERALL FM PERFORMANCE RATING

Excellent

TABLE 2
RADIO-ELECTRONICS PRODUCTS TEST REPORT

Manufacturer: Scott

Model: 530-T

OVERALL PRODUCT ANALYSIS

Retail price	\$199.95
Price category	Low
Price/performance ratio	Excellent/Superb
Styling and appearance	Good
Sound quality	Excellent
Mechanical performance	Very good

Comments: We were amazed at the quality and true high-fidelity performance that Scott packs into this under \$200 little tuner. The major specifications measured fully as well as those of tuners selling for more than twice the price. Devoid of frills, this simple-looking tuner provides FM reception that is probably limited only by the quality of the broadcast programming itself. Without resorting to alternate-selectivity, Scott's engineers achieved just the right balance between bandwidth of the IF system and selectivity to deliver ultra-low distortion FM reception even at full (and over) modulation levels. This should not surprise old Scott fans who remember that this company first gained fame with its sophisticated tuners and receivers back in the days of vacuum tubes.

The tuner will appeal to those who travel abroad and take their hi-fi gear with them, since it offers European 50- μ s de-emphasis, in addition to the U.S. standard 75- μ s and Dolby 25- μ s de-emphasis. The owner's manual was prepared with care and uses the clever partial-page format that permits you to keep both front- and back-panel illustrations in view as you thumb through the operating instructions.

Most important, the tuner delivers excellent reception, especially when equipped with even an inexpensive directional outdoor FM antenna. Calibration is perfect from one end of the dial to the other, and center-of-channel tuning corresponds exactly with lowest-distortion tuning points at any frequency, indicating careful alignment. Admittedly, frills such as "frequency synthesis" and "quartz-lock" tuning are wonderful technological advances; but if all you want is clean FM reception and you don't have a fistful of dollars, consider the *model 530-T* FM-AM tuner.

Summary

An overall product analysis is given in Table 2, together with our summary comments. A tuner such as the *model 530-T* makes us wonder whether it is really worth investing in one of the more sophisticated FM tuners available today, particularly in view of the generally poor quality of program material presently being transmitted by a majority of FM broadcasters these days. Of course, there are a few

instances where additional selectivity, higher image and IF-rejection capability, and better spurious-response rejection may prove useful, but these requirements are rather rare. Such refinements as "frequency synthesis" do insure perfect tuning for least distortion. However, since the Scott *model 530-T* also achieves such perfect tuning when the meter is carefully set for a correct center-indication, if the user just has a little patience, he can save himself a

considerable amount of money while providing close-to-optimum FM reception.

Figure 5 shows the AM frequency response, and you will note that the response is down only about 6 dB at 5 KHz. This value may not impress hi-fi buffs, but if you compare it with results obtained from the AM sections of some more expensive tuners and receivers, you may agree that this is a most unusual AM/FM tuner at a most attractive price. **R-E**

Radio-Electronics Audio Lab Tests

JVC JR-S501 AM/FM Receiver



1
RS #107

JVC AMERICA, INC.'S 1979 RECEIVERS INCORPORATE some of the innovative and different-looking designs that were first introduced in the company's 1977-1978 receivers. Perhaps the most outstanding feature of JVC's *model JR-S501* is the full five-band graphic equalizer that replaces the usual bass and treble tone controls and offers greater flexibility than any three-control tone system in the most costly receivers.

Another unique feature of the *model JR-S501* is that, aside from the thumbwheel/flywheel-tuning arrangement, there is not a single rotary control knob on its sleek, three-

dimensional front panel (see Fig. 1). The internal circuitry has also been significantly improved, with the power-amplifier section now fully DC-coupled, and overall rated distortion levels reduced even more from previous low ratings.

There is a shelf-like protrusion at the bottom of the panel that has a series of pushbuttons on the left-hand side, an effective tuning flywheel and a slider-type VOLUME control on the right-hand side. Other pushbutton controls include a POWER on/-off switch, an SEA record switch (that permits the pre-equalization of programs fed to connected tape decks), a tape DUBBING

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

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R.E.A.L. SOUND

RATES

JVC JR-S501 RECEIVER

VERY GOOD

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2

MANUFACTURER'S PUBLISHED SPECIFICATIONS:

FM TUNER:

Usable Sensitivity: mono, 10.3 dBf (1.8 μ V). **50-dB Quieting:** mono, 14.8 dBf (3.0 μ V); stereo, 37.2 dBf (39.7 μ V). **S/N Ratio:** mono, 78 dB; stereo, 70 dB. **Selectivity:** 80 dB. **Capture Ratio:** 1.0 dB. **Image Rejection:** 80 dB. **IF Rejection:** 110 dB. **AM Suppression:** 65 dB. **Frequency Response:** 20 Hz to 15 kHz, +0.3, -0.8 dB. **THD:** mono, 0.08% at 1 kHz and 100 Hz, 0.15% at 6 kHz; stereo, 0.1% at 100 Hz and 1 kHz, 0.2% at 6 kHz. **Stereo Separation:** 52 dB at 1 kHz, 45 dB at 100 Hz and 10 kHz.

AM TUNER:

Sensitivity: 30 μ V (external antenna). **Selectivity:** 50 dB. **S/N Ratio:** 55 dB.

AMPLIFIER/PREAMPLIFIER:

Power Output: 120 watts-per-channel into 8 ohms, 20 Hz to 20 kHz. **Harmonic Distortion:** 0.03%. **IM Distortion:** 0.01%. **Damping Factor:** 70. **Input Sensitivity:** phono, 2.5 mV; high level, 250 mV. **Phono Overload:** 250 mV. **Frequency Response:** phono, RIAA ± 0.2 dB; high level, 5 Hz to 40 kHz, +0, -1.0 dB. **S/N Ratio (IHF A-Weighted):** phono, 75 dB; high level, 95 dB. **Graphic Equalizer Center Frequencies:** 40 Hz, 250 Hz, 1 kHz, 5 kHz, 15 kHz. **Control Range:** ± 12 dB.

GENERAL SPECIFICATIONS:

Dimensions: 22 $\frac{1}{16}$ W $\times$ 6 $\frac{1}{16}$ H $\times$ 16 $\frac{1}{16}$ inches D. **Weight:** 46.2 lb. **Suggested Retail Price:** \$700.

switch, TAPE-1 and TAPE-2 monitor switches, MONO/stereo and LOUDNESS switches, and a PHONO 1/phono 2 selector switch.

Directly above the volume control is a center-detented slider balance control. Just above this switch (on the vertical section of the panel) are located five slide controls that comprise the graphic-equalizer. Above the flywheel tuning control are five light-touch rectangular pushbuttons—four select program sources and the fifth pushbutton handles FM muting. Red indicator lights adjacent to the program-selector pushbuttons illuminate to show the program source being listened to.

The upper left-hand section of the panel contains the AM and the linearly calibrated FM frequency dial plus an illuminated dial pointer. Above the frequency scales, to the left, are center-of-channel and signal-strength tuning meters. To the right is a pair of symmetrically positioned power-output meters calibrated from 0.25 watts to 120 watts (referred to an 8-ohm load), with a stereo indicator light placed between them.

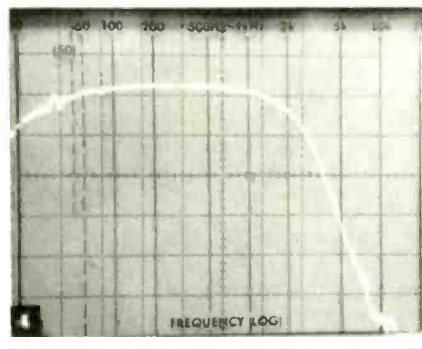
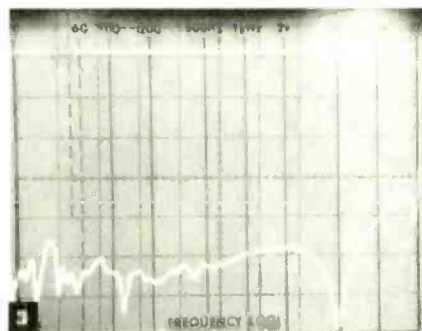
Figure 2 shows the conventional layout of the rear panel. The AM, 75-ohm and 300-ohm antenna terminals are on the left, with a short pivotable AM ferrite-bar antenna located directly above. Pairs of phono inputs (for connecting two turntable systems), auxiliary input, tape inputs and tape outputs and a record/play DIN multiple-pin connector are

located near the center of the panel to the right of which are spring-loaded speaker terminals (enough for two pairs of speakers) along with a pair of convenience AC receptacles (one unswitched, the other switched).

The owner's manual supplied with the *Model JR-S501* does not tell you much about the circuit design other than to highlight the fact that the power amplifier is a full DC-coupled configuration and contains no coupling capacitors either in the signals path or in the overall negative-feedback network. The manual also states (although in rather vague terms) that the receiver's amplifier circuitry is protected by a triple-protection circuit that presumably senses overdrive (current, conditions, output short circuits or excessive thermal buildup. Since no schematic diagram is provided, we treated the receiver as if it were a "black box," and simply measured its performance on the bench and in subsequent listening tests.

FM measurements

Table 1 summarizes the results of our FM measurements of the *model JR-S501* receiver. While mono and stereo usable sensitivity were not particularly outstanding, 50-dB quieting was a bit better than claimed in mono and just about as claimed in stereo. Stereo threshold (or switching point) occurs at 10 μ V (25.2 dBf), which makes that value apply also to the usable stereo sensitivity and is a bit higher than it had to be. Distortion in mono was generally a bit higher than claimed although still quite good, but, surprisingly, the stereo harmonic distortion readings were actually better than claimed and better than those obtained in mono.



The curves shown in the scope photo of Fig. 3 (one vertical division equals 10 dB of amplitude change) display an almost perfect frequency-response characteristic out to beyond 15 kHz, while the lower trace shows channel separation at all stereo frequencies of interest. The sharp dip (or increased separation) at 5 kHz seems unusual and we cannot explain it, except to say that we repeated the sweeps several times and always obtained this unusual result.

TABLE 1 RADIO-ELECTRONICS PRODUCT TEST REPORT		
Manufacturer: JVC America, Inc.		Model: JR-S501
FM PERFORMANCE MEASUREMENTS		
SENSITIVITY, NOISE AND FREEDOM FROM INTERFERENCE	R-E Measurement	R-E Evaluation
IHF sensitivity, mono (μ V) (dBf)	2.0 (11.2)	Good
Sensitivity, stereo (μ V) (dBf)	10 (25.2)	Fair
50-dB quieting signal, mono (μ V) (dBf)	2.9 (14.4)	Very good
50-dB quieting signal, stereo (μ V) (dBf)	40.0 (37.2)	Good
Maximum S/N ratio, mono (dB)	78	Excellent
Maximum S/N ratio, stereo (dB)	69	Good
Capture ratio (dB)	1.0	Excellent
AM suppression (dB)	65	Excellent
Image rejection (dB)	82	Good
IF rejection (dB)	100+	Excellent
Spurious rejection (dB)	98	Very good
Alternate channel selectivity (dB)	80	Excellent
FIDELITY AND DISTORTION MEASUREMENTS		
Frequency response, 50 Hz to 15 kHz ($\pm$ dB)	0.3	Very good
Harmonic distortion, 1 kHz, mono (%)	0.12	Excellent
Harmonic distortion, 1 kHz, stereo (%)	0.07	Superb
Harmonic distortion, 100 Hz, mono (%)	0.14	Excellent
Harmonic distortion, 100 Hz, stereo (%)	0.09	Superb
Harmonic distortion, 6 kHz, mono (%)	0.30	Good
Harmonic distortion, 6 kHz, stereo (%)	0.13	Excellent
Distortion at 50-dB quieting, mono (%)	0.9	Fair
Distortion at 50-dB quieting, stereo (%)	0.25	Very good
STEREO PERFORMANCE MEASUREMENTS		
Stereo threshold (μ V) (dBf)	10 (25.2)	Fair
Separation, 1 kHz (dB)	52	Excellent
Separation, 100 Hz (dB)	52	Superb
Separation, 10 kHz (dB)	38	Very good
MISCELLANEOUS MEASUREMENTS		
Muting threshold (μ V) (dBf)	12 (26.8)	Fair
Dial calibration accuracy ($\pm$ kHz at MHz)	100	Very good
EVALUATION OF CONTROLS, CONSTRUCTION AND DESIGN		
Control layout		Excellent
Ease of tuning		Excellent
Accuracy of meters or other tuning aids		Excellent
Usefulness of other controls		Excellent
Construction and internal layout		Very good
Ease of servicing		Good
Evaluation of extra features, if any		Very good
OVERALL FM PERFORMANCE RATING		Very good

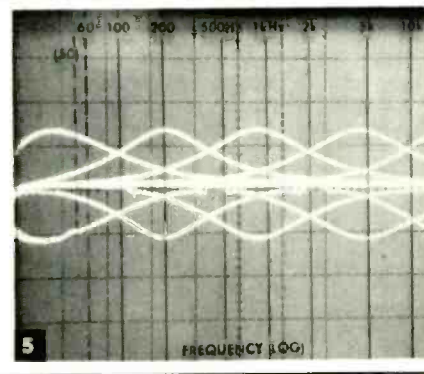
The frequency response in AM (see Fig. 4) was no better than that typically observed on most stereo high-fidelity integrated receivers, with sharp rolloff beginning at around 2 kHz. This is no doubt why most audiophiles look down on AM radio. Yet, many AM broadcasters are proud of the fact that they transmit a wide-response signal. It's actually the existing receivers that prevent us from enjoying high-quality AM reception.

Amplifier measurements

Table 2 summarizes our measurements on the amplifier section of the *model JR-S501*. The amplifier had no difficulty exceeding its high power-output rating at mid-frequencies with even some power margin to spare at the low-frequency extremes. It must be remembered there is a published distortion rating of only 0.03%, so that our power-output values are based upon the power levels obtainable before that 0.03% distortion level is reached. Actually, clipping levels are at considerably higher power-output values. Even when measured through the entire signal path (from auxiliary input to speaker outputs) high-level frequency response went all the way down to 4 Hz (and up to 40 kHz) before achieving 1 dB of attenuation.

The curves shown in Fig. 5 demonstrate the usefulness of the five graphic-equalizer slide controls. The maximum range of each slider

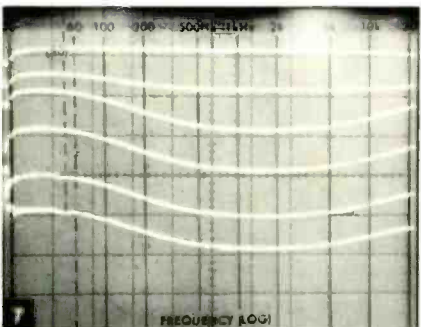
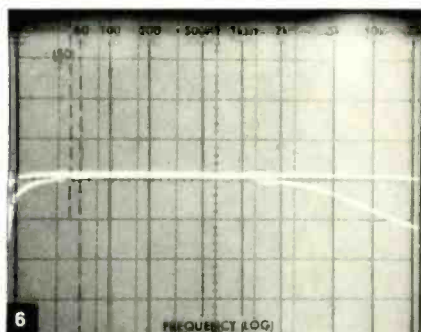
control is shown and, of course, it is possible to create a complex overall response curve that falls just about anywhere in the area included



in these individual curves. Center frequencies of each control were almost precisely as designated.

Figure 6 shows the low-cut filter provides steep attenuation below 20 Hz, and effectively reduces the effects of turntable rumble or other subsonic noise. The high-cut filter, with its very gradual slope and mid-frequency turnover or cut-off point, is really no more effective in reducing high-frequency noise than the upper-frequency graphic-equalizer control.

Action of the loudness control is shown in the scope photo of Fig. 7 and is typical of the loudness compensation found in most stereo receivers.



ers. Both bass and treble frequencies are emphasized as volume-control settings are lowered.

Summary

Our overall product analysis and brief summary of the receiver are given in Table 3. We have always been favorably impressed with the design of JVC's receivers, and ever since a five-band equalizer was included in all-in-one receivers, we are even more enthusiastic. The tuner admittedly falls a bit short of state-of-the-art FM technology, but in view of the general type of FM program material and broadcast practices prevalent in the U.S., the FM circuitry in the JVC receiver will probably not be a quality-limiting factor. The phono preamplifier, voltage amplifier and power amplifier sections of the *model JR-S501* are all beyond reproach, and the amplifier is powerful enough to drive even the least-efficient loudspeakers to full, resounding listening levels. Extended listening tests conducted at rather loud sound-pressure levels proved the receiver is extremely reliable and stable, and exhibited no undue heat buildup during either our bench or listening tests. **R-E**

TABLE 2
RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: JVC America, Inc.

Model: JR-S501

AMPLIFIER PERFORMANCE MEASUREMENTS

	R-E Measurement	R-E Evaluation
POWER OUTPUT CAPABILITY		
RMS power/channel, 8-ohms, 1 kHz (watts)	144	Excellent
RMS power/channel, 8-ohms, 20 Hz (watts)	121.6	Very good
RMS power/channel, 8-ohms, 20 kHz (watts)	120.0	Very good
RMS power/channel, 4-ohms, 1 kHz (watts)	170.0	Excellent
RMS power/channel, 4-ohms, 20 Hz (watts)	160.0	Excellent
RMS power/channel, 4-ohms, 20 kHz (watts)	160.0	Excellent
Frequency limits for rated output (Hz-kHz)	20-20	Good
DISTORTION MEASUREMENTS		
Harmonic distortion at rated output, 1 kHz (%)	0.025	Excellent
Intermodulation distortion, rated output (%)	0.003	Superb
Harmonic distortion at 1-watt output, 1 kHz (%)	Less than 0.03	Excellent
Intermodulation distortion at 1-watt output (%)	0.025	Very good
DAMPING FACTOR, AT 8 OHMS	78.5	Excellent
PHONO PREAMPLIFIER MEASUREMENTS		
Frequency response (RIAA $\pm$ dB)	+0, -0.1	Superb
Maximum input before overload (mV)	270	Superb
Hum/noise referred to full output (dB) (at rated input sensitivity) (A-weighted)	77	Excellent
HIGH LEVEL INPUT MEASUREMENTS		
Frequency response (Hz-kHz, $\pm$ dB)	4-40, 1.0	Excellent
Hum/noise referred to full output (dB) (A-weighted)	105	Superb
Residual hum/noise (minimum volume) (dB) (A-weighted)	108	Excellent
TONAL COMPENSATION MEASUREMENTS		
Action of bass and treble controls		Superb (see text)
Action of secondary tone controls		Superb (see text)
Action of low-frequency filter(s)		Excellent
Action of high-frequency filter(s)		Fair
COMPONENT MATCHING MEASUREMENTS		
Input sensitivity, phono 1/phono 2 (mV)	2.5/2.5	
Input sensitivity, auxiliary input(s) (mV)	225	
Input sensitivity, tape input(s) (mV)	225	
Output level, tape output(s) (mV)	225	
Output level, headphone jack(s) (V or mW)	750 mV/8 ohms	
EVALUATION OF CONTROLS, CONSTRUCTION AND DESIGN		
Adequacy of program source and monitor switching		Excellent
Adequacy of input facilities		Excellent
Arrangement of controls (panel layout)		Superb
Action of controls and switches		Excellent
Design and construction		Very good
Ease of servicing		Good
OVERALL AMPLIFIER PERFORMANCE RATING		Excellent

TABLE 3
RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: JVC America, Inc.

Model: JR-S501

OVERALL PRODUCT ANALYSIS

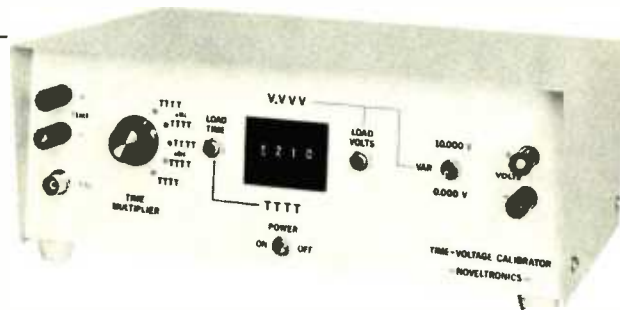
Retail price	\$700
Price category	Medium/high
Price/performance ratio	Excellent
Styling and appearance	Superb
Sound quality	Very good
Mechanical performance	Excellent

Comments: Visually, the *model JR-S501* is as different from the conventional stereo receiver as can be. Since stereo styling is largely a matter of taste, there are those who are instantly attracted to this clean, uncluttered look and those who prefer a more conventional panel layout. The built-in graphic equalizer offers a degree of tone control flexibility that far surpasses anything possible with ordinary bass and treble controls or even variable-turnover controls plus a mid-range control. FM reception was extremely stable and clear; and, with the muting switch defeated, we had no trouble picking up distant signals as well as local ones.

It has been argued that incorporating a DC amplifier circuit only in the power-amp section does not audibly improve the overall sound quality of the system, since the signal is capacitively coupled at other points in its path. Based upon our listening tests we disagree. We listened to several direct-to-disc recordings played through the *model JR-S501* and were particularly impressed with the way it handles loud musical transients and peaks. These were reproduced effortlessly and without the slightest trace of clipping distortion or listening fatigue. Considering its high power-output capability, the inclusion of that magnificent graphic equalizer feature and the overall versatility of its controls and other features, we believe that the *model JR-S501* is well priced and represents a significant improvement over JVC's previous receivers.

BUILD THIS

Time/Voltage Calibrator



Part 2—Precision digital test equipment requires special test instruments to insure that calibrations are within specified tolerances. This calibrator supplies time and voltage references you'll need.

DOUG FARRAR

IN THE MAY ISSUE WE DISCUSSED THE time-voltage calibrator and analyzed its various sections. Now, we are going to cover construction and calibration; along with debugging, if it should be needed.

Construction

Unless you are familiar with low-noise wiring techniques, it is advisable to use the PC board layout shown in Fig. 8. This layout minimizes ground loops and voltage spikes, resulting in very clean DC and AC signal waveforms.

You should prepare the chassis first before stuffing the PC board with parts. The cabinet specified in the Parts List has what is described as a "built-in chassis" (see Fig. 9-a), which consists of another sheet of aluminum mounted to two U-brackets. Because chassis space is limited, you must discard this extra chassis base and the U-brackets as well, which however are required to hold the top of the cabinet in place. The leg of the U-bracket that is exposed is also in the way of the PC board. Use a hacksaw and remove it, as shown in Fig. 9-b, and make an L-bracket. File the edges smooth to avoid cutting yourself later on (NOTE—the chassis supplied with the kit described in the Parts List comes with this procedure already performed).

Remove the L-brackets and set them aside. Place the PC board foil-side down on the bottom of the chassis, so that it rests centered left to right, and about 1/4 inch from the chassis' backwall. Mark the PC board's four mounting hole locations on the chassis, then carefully drill the spots with a 1/4-inch drill bit. Refer to Fig. 10 and machine the unit's front side as

shown. Remove all burrs. I found it was easier to cover the entire chassis front with neatly placed strips of masking tape

and to draw on the tape. Then, when you cut the hole for the thumbwheel switches with a jigsaw, this protects the paint from

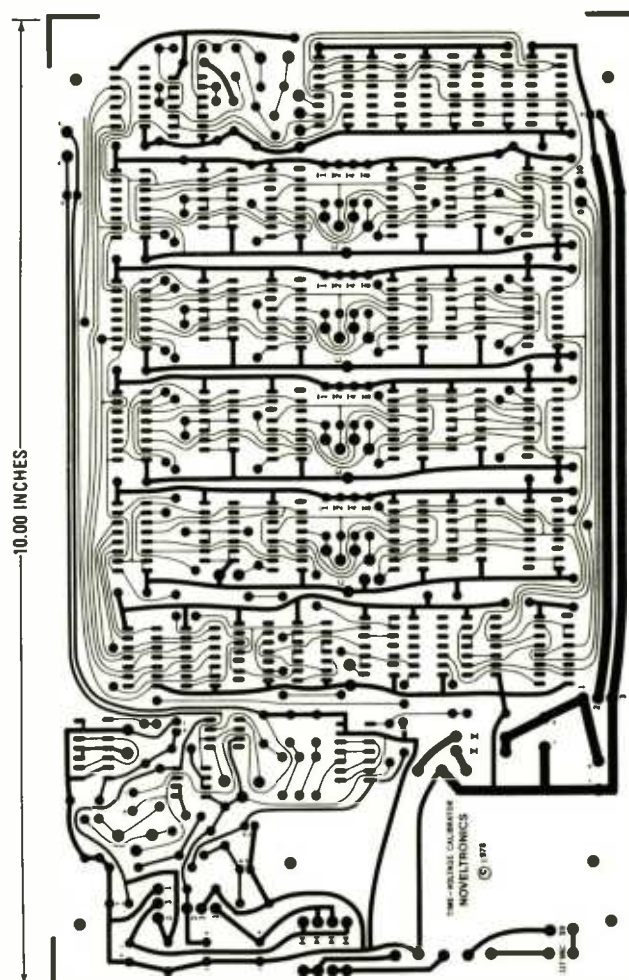


FIG. 8—FOIL PATTERN of the PC board reproduced half-size. This layout was developed to provide low-noise characteristics along with freedom from unwanted ground loops and voltage spikes.

the saw's vibrations. Try hard to keep the thumbwheel-switch hole close to the dimensions shown. An oversize hole defeats the switches' self-locking mechanism.

The thumbwheel switches specified are designed to mount through a $\frac{1}{8}$ -inch-

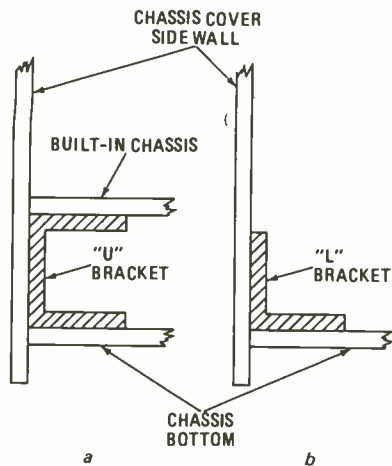


FIG. 9—THE CABINET has a built-in chassis that must be removed and modified before the PC board can be mounted. See text.

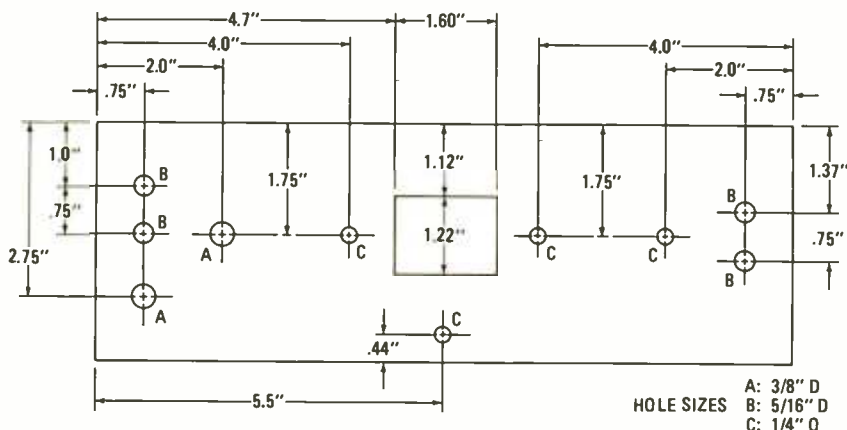
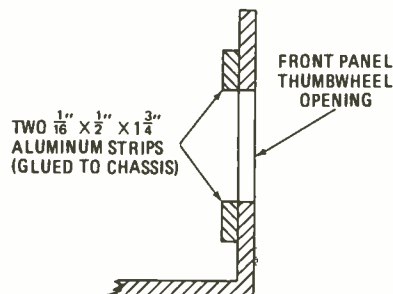


FIG. 10—DRILLING GUIDE for the front panel. We advise protecting the panel's face with masking tape until all holes have been drilled.



THUMBWHEEL SWITCH MOUNTING STOPS
FIG. 11—CROSS-SECTION of the slot for the thumb switches. Add shims as shown so switches fit and are self-locking.

thick panel. Since this chassis is $\frac{1}{16}$ -inch thick, you must add a $\frac{1}{16}$ -inch-thick shim to the back of the chassis hole where the thumbwheel switches lock into place (see Fig. 11). Epoxy two strips of $\frac{1}{4} \times \frac{1}{2} \times \frac{1}{16}$ -inch aluminum (or PC-board scrap) as shown. Make sure that the strips' edges and front-panel hole edges are aligned.

Lastly, drill two holes through the

chassis' backwall, one for the power cord's strain relief, the other for mounting regulator IC45 to the chassis. Both holes should be centered top to bottom. Drill the strain-relief hole 1 inch from the chassis' left edge, and the regulator hole $3\frac{1}{2}$ inch from the same edge.

Past experience has shown that the baked enamel finish on the chassis does not take dry transfer letters very well. I recommend painting the (now-machined) chassis cover with three coats of flat white lacquer, followed by two coats of flat clear lacquer. After a day of drying, you can letter this surface and then coat the letters with two or three more coats of the clear flat finish. The letters sink into the finish and are beautifully protected. This procedure was used on the unit shown in the photograph.

While the paint is drying, you can start stuffing the PC board. Solder the forty-seven jumpers and all the resistors, IC's and capacitors (in that order) on the board (see Fig. 12 and the italicized paragraph below). Only two of these components do not mount on the board: bypass capacitor C18 and +5-voltage regulator

board, but its wire leads must be trimmed down to size first. Hold the transformer near the edge of a table, so that one of its sets of wires hangs over the table edge, then cut each wire to a $\frac{1}{4}$ -inch length below the table top. Repeat this procedure for the other set of wires on the other side, and then strip back the insulation $\frac{1}{4}$ inch. The transformer wires will now drop directly into the holes in the PC board, and no wire-crossing is necessary. Secure the transformer to the PC board with 4-40 $\times \frac{1}{2}$ -inch hardware, and then solder the wires in place.

Using an electric drill, twist two 30-inch wires (one black and one red) together and then cut them into 6-, 6-, and 14-inch lengths. Solder these wire pairs into the PC board locations for switches S6, S7 and S9, respectively. Next, twist three color-coded 9-inch wires together and solder them into the PC board location for toggle switch S8. Twist four 11-inch color-coded wires together and solder them into the board locations for rotary switch S5. Lastly, twist five color-coded 20-inch wires together and cut them into four 5-inch pieces. These wires go to the thumbwheel-switch terminals on the PC board.

I strongly recommend using coaxial cable to bring the VOLTS outputs and two TIME outputs from the PC board out to the front panel. Although the characteristic impedance of the coax is not overly important, 50-ohm-impedance cable, such as RG-174/U, is recommended. Using coax cable will reduce the amount of noise pickup from all the TTL circuitry feeding into the VOLTS output. Twisted-pair cable can be used instead, but don't expect the good results from the calibrator that you get using coax cable. Whatever type of cable you choose, cut three 6-inch lengths each of the cabling. Strip $\frac{1}{2}$ inch of braid from each end (in the case of coax) of each 6-inch length, then solder the cable into the board. Make sure that the braided shield is inserted into grounded solder pads K, R or T (not the signal end).

At this point, attach the loose ends of the wires to their respective switches (except for the thumbwheel switches), but don't actually mount the switches to the front panel yet. Bolt four $\frac{3}{4}$ -inch spacers, tapped with 4-40 threads on both ends, to the chassis. Bring the power cord in through the strain-relief hole and solder it to its PC board locations, 21 and 22. Now mount the PC board on the spacers and secure in place with four more bolts.

Mount regulator IC45 against the chassis backwall (it has already been wired to the PC board). Snap the thumbwheel switches in place in the chassis panel, and then solder the four 5-wire bundles to the appropriate switches. Be careful here because the most significant thumbwheel switch is on the left-hand side of the chassis, but it is wired to the right-hand side of the PC board. Simi-

IC45. The capacitor should be mounted right on the front-panel VOLTS binding posts. Regulator IC45 needs heat-sinking, so mount it against the chassis' backwall in the hole provided. Solder three wires to the three leads of IC45, and run them to the circled PC board connections—A, B and C. Don't bolt the IC to the chassis until you're ready to mount the board in place on its spacers.

If you have access to an accurate $4\frac{1}{2}$ -digit (or greater) DVM, solder capacitors C17 and C31, resistors R29–R32 and trimmer R35 in place. If not, remove all these components, as well as the wire jumper marked "J*" (between IC43 and IC44, and next to R29) and insert a jumper wire in the location marked for capacitor C17. Also, if you have access to an accurate frequency meter, mount capacitor C35 and trimmer C36 as shown. If not, then substitute a 91-pF capacitor for C35 and omit the trimmer.

Transformer T1 mounts directly on the

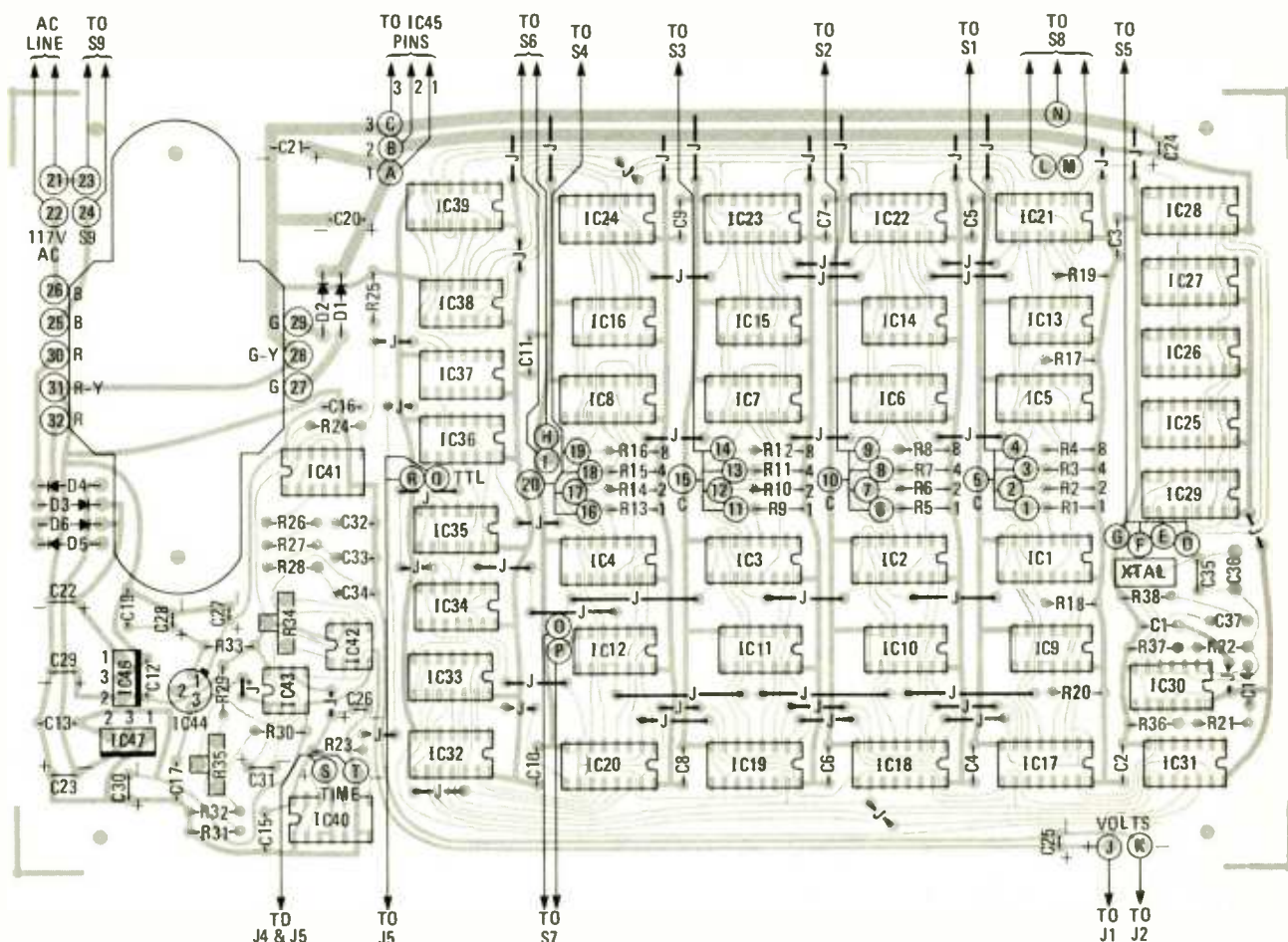


FIG. 12—PARTS PLACEMENT DIAGRAM is superimposed on reverse of PC pattern to show location of parts and to serve as a circuit-tracing aid.

larly, the least-significant counter is located at the left side of the board. So the wires cross, and if you fail to observe this, you will get reversed front-panel digit inputs.

Insert and tighten the four binding posts (J1–J4) and BNC connector J5 to the chassis; then solder the appropriate coax (or twisted-pair) cable to each. Attach the toggle switches and rotary switch to the chassis. Solder capacitor C18 directly to the VOLTS binding-post connectors. This now completes construction of the Time-Voltage Calibrator.

Debugging and calibration

This operation is optional. Before applying power, use an ohmmeter to check each voltage-regulator IC output to make sure that there are no obvious dead shorts to ground. I once encountered an interesting problem with a shorted +5-volt supply line (IC45 pin 2). By progressively removing power wires on the PC board, I traced down the short to one row of IC's. A visual inspection of that row showed nothing wrong, but by desoldering one V_{CC} pin at a time, I found an IC with a dead short between its supply lines.

Also inspect each IC visually to make sure that it is soldered onto the board correctly because if you apply power to a unit that is plugged in backwards, you will ruin the IC.

Apply power and measure all three regulator outputs with a voltmeter to check that you are getting +5, +15 and –5 volts. If not, shut down immediately and correct the problem. Look for open holes in the board where a component or jumper might be missing.

Set TIME MULTIPLIER switch S5 in the TTTT msec position, dial 2000 into the thumbwheel switches, and press the LOAD TIME pushbutton. Using a voltmeter on the TTL TIME output, you should observe the meter stay high for 1 second and then low for another. Otherwise, you'll have to debug the time-calibrator section.

Place toggle switch S8 in the 10.000 v position and measure the VOLTS output. After about 10 seconds, the voltmeter should measure very close to 10 volts. If not, something is faulty from IC39-b forward, and you must check it. Place switch S8 in the VAR position, dial in 5000 and press the LOAD VOLTS pushbutton. After 10 seconds, the VOLTS output will read approximately 5 volts. If not, the TTL portion of the volts calibrator section is malfunctioning.

Once the volts and time sections are working, dial and load 5 volts and 4 seconds, then monitor the TIME output (not the TTL output). If you don't get a voltage swing between 0 and 5 every 2 seconds, the trouble lies somewhere around IC43-a, IC40 and/or IC37-a.

Of course, an oscilloscope is an invaluable debugging aid, but by dialing in a very long time period (in seconds) you can slow down the time section enough for a voltmeter to be helpful. However, even if the above tests check out OK, there could still be high-frequency problems in the time section. The most difficult timing sequence is with a dialed-in value of 0010 with the time multiplier set in the TTT.T μ SEC position (i.e., a 1.0- μ s time period). If you can satisfy yourself that this operation works, you're home free. If not, then you may need a scope. As stated earlier, the four time counters, IC21–IC24, must only be those made by the recommended manufacturers. If the time section works from 0.1 μ s to 0.9 μ s but not 1.0 μ s, then your problem lies in the time counter.

Once the two sections are debugged you may (or may not) want to fine-tune the calibrator, depending on the equipment you have available. Apply power to the calibrator for at least 15 minutes before trimming. By this time you have selected the PC board design that matches your trimming capabilities. If you want to adjust the time section, hook up a frequency meter to the calibrator's TTL output and load in a period of 0.1 μ s. Adjust trimmer capacitor C36 until the meter measures exactly 10.0 MHz.

continued on page 92

Record/Play TELEPHONE ACCESSORY

Looking for a simple and inexpensive way to connect a tape recorder to your telephone line? If so, give this a try. Recorder isn't energized until receiver is lifted.

JULES GILDER

AT ONE TIME OR ANOTHER, MOST OF YOU have had the need to record a telephone conversation. To do so, you've probably had to hunt around for a telephone pickup coil, attach it to the phone and your recorder, hope that the batteries in your tape recorder would last and then try not to get tangled up in the wires and accidentally pull the coil away from the telephone.

With the Telecorder, you can eliminate recording problems. For less than the cost of a commercial unit that does not contain its own power supply, you can build this device which will automatically record all incoming and outgoing calls from your phone. It works with your cassette recorder and any telephone.

The Telecorder (see Fig. 1) contains a built-in regulated power supply that can be used to power the recorder and save batteries. This is particularly important in continuous monitoring applications.

About the circuit

The heart of the Telecorder is the interface module (Fig. 2). This module is the element that interfaces the phone line with the recorder. When it is connected to the red and green wires of the telephone, it senses the voltage across these two wires and produces a switching signal that energizes a relay connected across terminals 3 and 5. A relay switching signal is produced every time the telephone receiver is lifted off the hook.

The interface module also isolates the recorder from the phone line and protects the input of the tape recorder from damage that might be caused by the 90-volt ringing signal. A 10- μ F nonpolarized capacitor is placed across the relay to keep the ring signal from affecting it.

The audio signal from the phone line is fed through the module into the auxiliary audio input jack of the cassette recorder. The operation of the tape recorder is controlled by the relay, whose normally closed contacts are connected to the remote switch jack on the recorder.

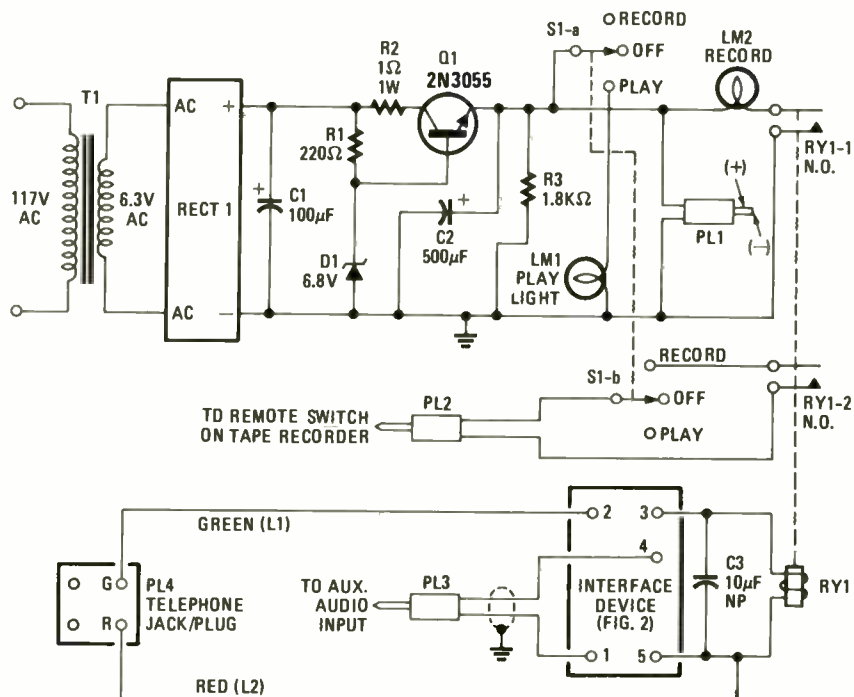


FIG. 1—SCHEMATIC of the Telecorder. The regulated supply can be used to power the recorder, thus eliminating the drain on its batteries. The interface device connects Telecorder to phone line.



The design of the power-supply portion of the Telecorder is relatively straightforward. The AC line voltage is stepped-down and rectified, and then applied to a regulating circuit. The supply's output voltage is determined by the voltage across Zener diode D1 minus the 0.7-volt drop across transistor Q1. If your recorder requires a 7.5-volt supply, substitute an

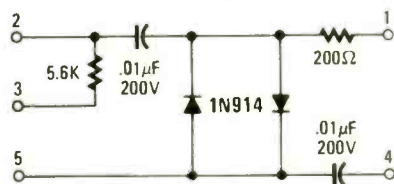


FIG. 2—INTERFACE DEVICE provides matching and isolation between phone and recorder.

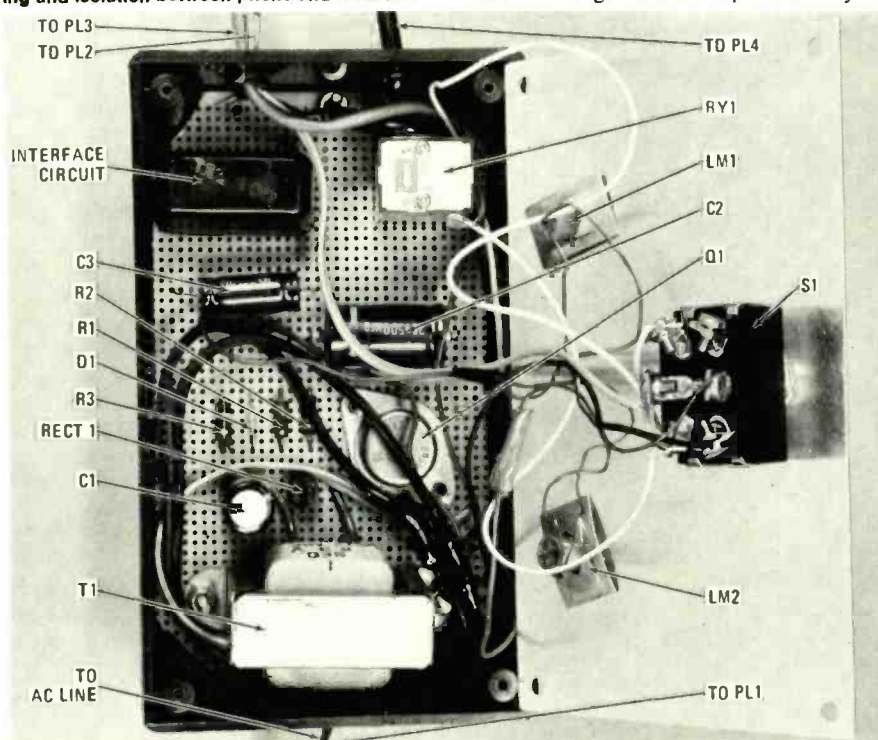


FIG. 3—INTERIOR VIEW OF THE TELECORDER shows the location of all of the components. The simplicity of the circuit makes point-to-point wiring on perforated board easy to use.

8.2-volt Zener diode for the 6.8-volt diode specified.

Construction

The circuit can be easily assembled on a perforated board (see Fig. 3). Except for the two panel lights and the control switch, all components are mounted directly on the circuit board. When installing the semiconductors, make sure to observe the proper polarities and heat-sink their leads while soldering.

In the prototype, the circuit board was mounted in a 6¼ × 3¼ × 2-inch plastic utility box. Drill three holes in the box to accommodate wires going to and from the Telecorder. Make sure to line these holes with rubber grommets to prevent frayed

PARTS LIST

Resistors ¼ watt, 10% unless otherwise noted

- R1—220 ohms
 - R2—1 ohm, 1 watt
 - R3—1800 ohms
 - C1—100 µF, 16 volts, electrolytic
 - C2—500 µF, 16 volts, electrolytic
 - C3—10 µF, 50 volts, nonpolarized
 - D1—6.8-volt Zener diode
 - RECT1—diode bridge, 50 volts PIV
 - Q1—2N3055
 - LM1, LM2—6-volt lamp
 - S1—DPDT center OFF switch
 - PL1—coaxial power plug
 - PL2—subminiature phone plug
 - PL3—miniature phone plug
 - PL4—telephone jack-in-a-plug
 - RY1—24-volt DPDT relay, coil resistance, 2000 ohms
 - T1—power transformer, 115-volt primary, 6.3-volt secondary
- Interface module (see Fig. 2)

wires.

While the layout of the circuit is not critical, it is important that the audio input lead to the tape recorder be shielded to prevent 60-Hz hum from being picked up. A two-conductor shielded cable is recommended, with the shield connected to ground at the PC board. Connections to plugs PL2 and PL3 are not critical in that any wire can be connected to the tip or the body of the plug. The interface module can be built by following the schematic diagram in Fig. 2 and using discrete components.

Installation and operation

The Telecorder can be connected to any telephone or directly to the telephone junction box. But the easiest way to hook it up is to use a telephone jack/plug, available from most electronic parts suppliers. This device fits in between a standard telephone plug and a standard jack.

continued on page 98

ALL ABOUT Switching Pow

The switching-type voltage regulator is a fairly recent development aimed at greater efficiency and a reduction of power lost in series-pass transistors in more conventional power supplies.

L. STEVEN CHEAIRS

FOR YEARS WE HAVE BECOME INCREASINGLY aware of the duality that exists in signal-processing electronics. That is, for each problem there seems to be both a digital and analog solution. When the hobbyist encounters the problem of voltage-regulator design, the common solution has been to use a linear unit; the three-terminal series-pass voltage regulators are an example. These monolithic integrated circuits have simplified power-supply design. Series-pass, or shunt or linear regulators are easy to use and possess a very low noise and ripple component in their output. For these reasons, they have dominated the market for a long time.

In the linear units, the power-regulating transistor operates in a continuous-conduction mode; thus, it dissipates a great deal of power at high current levels. The efficiency of these regulators is determined by the ratio of V_{OUT}/V_{IN} —for a fixed output voltage, the efficiency decreases as the input voltage increases. When the output voltage (V_{OUT}) is significantly different from the input voltage (V_{IN}), the series-pass transistor must dissipate the additional power; thus, large transistors and heat sinks are needed. Furthermore, the linear regulator requires that the voltage at the output be between ground potential and the input level. The series-pass transistors require that large transformers and filter capacitors be used.

The other solution?

The digital face of a voltage regulator is the switcher. The switching regulator, a more recent development, is replacing the linear regulator in many applications where high efficiency and size are important. In some cases, the switching regula-

tor is combined with a linear regulator—thus creating an enhanced hybrid unit. The switching regulator has high efficiency for all input and output conditions (up to 90%).

Whereas the linear regulators are simple devices, the switching regulators are more complex and require a few external components (along with some knowledge as to their use). A second problem is that they contribute to the output ripple. The switching regulator's response time to rapid changes in load current is poor compared with the series-pass units; this is because switching regulators can only reach a new equilibrium after the average inductor current has reached a new steady-state condition (this problem can be solved by keeping the difference between the input and output voltages large, or by using only low inductor values, which implies high capacitor values).

Another problem is that the switching regulator generates noise, which is due to its basic design. The power, from the primary source, is applied as pulses—efficiency considerations dictate that these pulses have short rise- and falltimes. In those designs where there is a significant series impedance between the regulator and the supply voltage, any rapid change in current will most likely generate noise. To reduce this problem, filter the input of the regulator, increase the switching time, or reduce the series impedance.

Even with all the disadvantages described above, the switching regulator occupies a front-line position due to the following advantages: a switching regulator can be built small and lightweight and can be made very efficient. These regulators can be driven with very poorly filtered DC (or directly from the three-phase rectifiers (without filtering) in

high-power applications). The switching regulator can be designed with excellent load-transient properties—thus, load-current step increases cause only relatively small instantaneous changes in the output voltage (generally less than a few hundred microseconds). These translate into power supplies with small transformers, minimum cooling, low operating cost, low power consumption and high efficiency.

The linear regulator must have the input voltage greater than the output ($|V_{IN}| > |V_{OUT}|$). The switching regulator can be designed as a step-up regulator ($V_{OUT} > V_{IN}$), or as a step-down regulator ($V_{OUT} < V_{IN}$), or as a voltage inverter (V_{OUT} 's polarity is the opposite of V_{IN} 's polarity). As with the linear regulators, monolithic IC's have made the design of switching regulators relatively easy, and a host of IC's are available to further simplify this design.

The basic configurations

Unlike a linear regulator, switching regulators use transistor switches in a nonlinear fashion to store energy in an inductor and capacitor; this energy is then supplied to the load as needed. Since the power transistor is used as a switch, it is either off or saturated (except during very brief transitions between these two states); the voltage is applied across the inductor rather than across the transistor, as with the linear regulator. The series-pass transistor dissipates power while an inductor does not; this provides the switching regulator with its high efficiency.

The switch is turned on and off at a frequency that is determined by the input voltages, output voltages and load current in order to provide the required power to

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the load. Through a feedback circuit, the output-voltage level is sensed by the control circuitry, which then modifies the switching rate as required to keep a constant output voltage. The output capacitor stores energy during the transistor's off period; this provides an average flow of current to the load. Also, when the transistor is off, the energy stored in the inductor maintains current flow to the load; current-flow return is through the diode. The ESR (*Equivalent Series Resistance*) of the capacitor for frequencies greater than 20 kHz is of prime importance. Even when low ESR capacitors (high-quality components) are used, a larger than normal capacitance value is required to achieve the required ripple level.

Figure 1-a shows the step-up switching regulator; i.e., its output voltage is greater than the input voltage. When the transistor saturates, point X will be near ground potential; thus voltage V_{IN} , minus the saturation voltage, is applied to the inductor. This causes current i_L to increase at a linear rate. The diode is reverse-biased, since the voltage at point X is less than the output voltage and no current flows to the output. When the transistor is switched off, current i_L continues to flow since it cannot change instantaneously. The voltage at point X now becomes equal to the sum of the output voltage and the voltage drop across the diode. In this state, current will flow through the diode (since it is now forward-biased) to the output capacitor and into the load—it will decrease at a linear rate. The cycle switching time of the transistor is varied to cause the average current to the output to equal the required load current.

The off-time is a function of the input voltage (V_{IN}), the output voltage (V_{OUT}), the voltage drop across the diode (V_D) and the inductor. The on-time is dependent upon the transistor saturation voltage, the input voltage and the inductor. Whereas the ratio of the on-time to the off-time is a function of maximum output current (as is the case for circuit voltage). When the saturation voltage and voltage drop across the diode are small compared with the input and output voltages, then the efficiency approaches 100%. Ripple (a function of the output capacitor, off-time, output current and input voltage) is reduced by using a large output capacitor; this does not affect circuit performance. This type of circuit is sometimes also called a flyback converter; it is always identified by the fact that the inductor is parallel to the load, causing its stored energy to flow to the load only when the transistor is off.

Figure 1-b shows the basic step-down voltage regulator circuit, $V_{OUT} < V_{IN}$. In this configuration, sometimes called "a forward converter," the inductor is in series with the output load; thus, the energy is transferred directly to the load and inductor simultaneously when the transistor is both saturated and off. When the power switch is saturated, the voltage at point X increases to the input voltage minus the transistor saturation voltage. The difference between the voltage at point X and the output voltage is across the inductor. As previously stated, the current flows into the load via the transistor, inductor and output capacitor. When the voltage at the output increases beyond a predetermined level, the transistor is switched off via a feedback circuit. After

the switch is shut off, current continues to flow for a while. Next, the voltage at point X decreases to minus the voltage drop of the diode. The diode acts as one leg of the inductor's energy path; the voltage across the inductor is minus the sum of the output voltage and the voltage drop across the diode. The inductor current will fall towards ground until the transistor is turned on again.

The duty-cycle is adjusted so that the average inductor current is equal to the output-load current; the average capacitor current is zero, causing the output voltage to be constant.

Peak current is a function of the input, output and switch voltages plus the amount of inductance and the amount of time the power transistor is saturated. In normal operation, the on-time is the variable. The proper ratio of on-time to off-time is a function of the input voltage, output voltage, the voltage across the diode, and to the voltage drop across the transistor. The off-time is determined by the output voltage, the diode-voltage drop and the inductor's size. Efficiency again approaches 100% when the transistor and diode-voltage drops are small. Output ripple is a function of the duty-cycle and the value of the output capacitor. The larger the value of the capacitor, the lower the ripple.

Figure 1-c is the voltage inverter. This circuit generates a negative output for a positive input. When the power transistor is saturated, the voltage at point X increases to a point that is equal to the input voltage minus the voltage drop across the transistor. This voltage is applied to the inductor, causing its current to increase linearly. Next, the switch opens and the voltage at point X drops to minus the output voltage minus the voltage drop across the diode. This will forward-bias the diode and the inductor current decays as a linear function. As with the step-down circuit, current from the input flows only when the transistor is saturated.

For this configuration, optimum on-time and off-time values are dependent upon the input voltage, output voltage

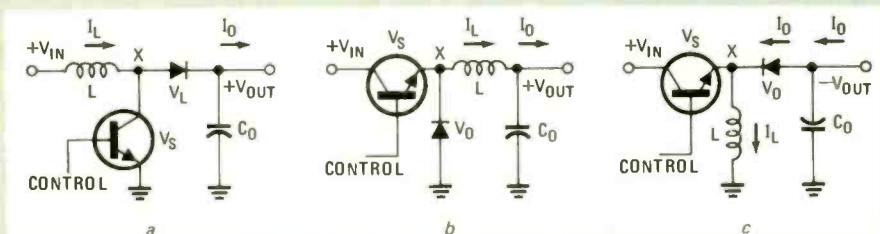


FIG. 1—BASIC SWITCHING REGULATORS. Step-up is shown in a, step-down is shown in b, and inverting-type is shown in c.

and saturation voltage of the transistor plus the amount of inductance. The ratio of the on-time and off-time is dependent upon just the voltages. Efficiency again depends upon the input and output voltages. Ripple is minimized by making the value of the output capacitor large.

Another possible design is the push-pull configuration that can also provide a stepped-up and stepped-down or inverted output (see Fig. 2). With this design, multiple outputs are possible—just by adding taps to the secondary winding or by using multiple secondary windings. Each winding needs its own diodes and filter capacitors. The push-pull converter doubles the ripple-current frequency to the output filter, reducing output-voltage ripple. The transformer can be made small since it excites the core alternately in both directions. One problem is that core saturation can occur since push-pull converter transformers are subject to DC imbalance.

components required to form a flyback-type switching regulator; it consists of a power diode, an operational amplifier, a temperature-compensated 1.3-volt reference, a variable duty-cycle oscillator, a current-limiting circuit, an error amplifier, and a high-current, high-voltage output switch. Using the internal switching-transistor, operation from 2.5 volts to 40 volts with output currents to 1.5 A is possible. If voltages or current levels exceed these values, then an external NPN or PNP transistor can be used.

The $\mu A78S40$ was designed for use as a step-up, step-down, or inverting flyback-type switching regulator. It can also be used to construct a linear series-pass regulator. It features a wide voltage range, a high efficiency, low drift and low standby power dissipation; and is well suited for battery-operated systems. The oscillator frequency, 100 Hz to 100 kHz, is determined by an external capacitor—the duty-cycle is fixed internally at 8:1.

thus, for 5-volt logic systems an efficient regulator circuit is possible. Most switching regulators experience a serious drop in efficiency for low-level applications. But due to its extremely low stand-by current rating, the $\mu A78S40$ regulator retains its high efficiency.

A second type of monolithic switching regulator is Motorola's MC3520/3420. This switch-mode regulator-control circuit is an inverter that provides all the circuitry for a pulse-width-modulation push-pull, bridge, or series-type power supply. This IC is designed so as to provide drive current to the base of two external power transistors that are 180° out of phase.

An internal voltage reference is provided for possible use in setting the dead-time or for reference to an external error amplifier. Triangular waveforms that are symmetrical and ramp between 2.4 volts and 6.0 volts are produced by an internal ramp generator. The frequency of these waveforms is determined by an external resistor and capacitor. A pulse-width-modulation comparator compares the control voltage to the ramp-generator output. Thus, the amplitude of the control-voltage input determines the output pulse width (duty-cycle). The duty-cycle of each output can be varied from 50% to 0%, minus dead-time. For a 0% duty-cycle, the control voltage is about 6.0 and for a 50% duty-cycle, approximately 2.4.

Another comparator allows the independent adjustment of the dead-time (or

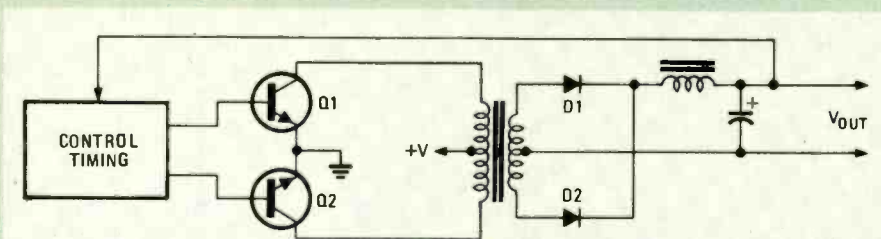


FIG. 2—PUSH-PULL SWITCHING REGULATOR uses diodes to direct current flow. When Q1 is saturated, diode D1 conducts. When Q1 is off, both diodes conduct. When Q2 is saturated, diode D1 conducts.

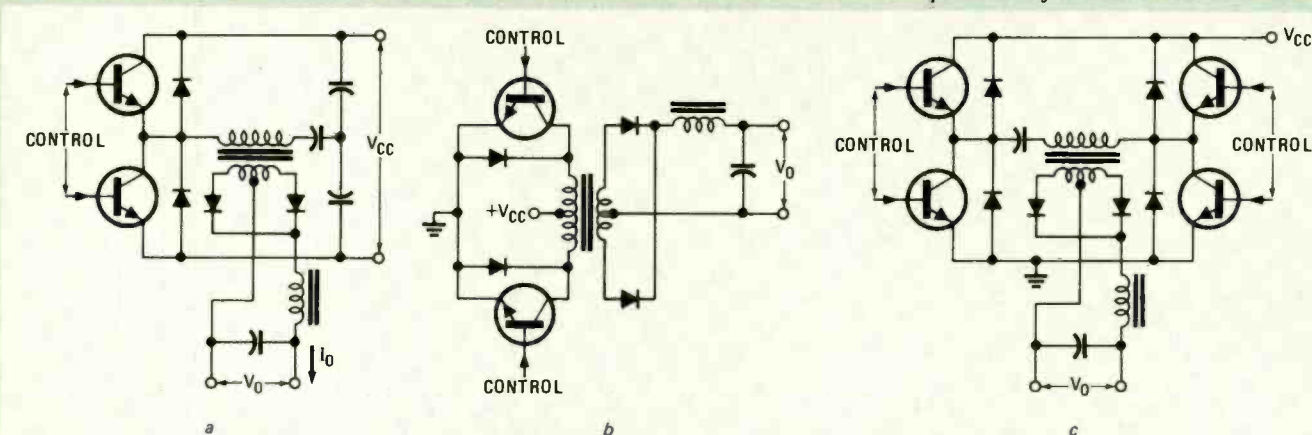


FIG. 3—PUSH-PULL CONFIGURATIONS. Single-ended is shown in a, push-pull is shown in b and full-bridge is shown in c.

The transformer primary can be connected in a number of ways—for example, single-ended, push-pull or full bridge as shown in Fig. 3. This is excellent when used for a high-power, single-output, high-performance voltage regulator with a ripple component less than 1%.

Monolithic building blocks.

Currently, there are a variety of monolithic switching-regulator IC's on the market. In this article, we'll look at two units representing the two basic types.

The first unit is the $\mu A78S40$ universal switching-regulator subsystem from Fairchild. This IC contains all the internal

The current-limiting circuit causes the duty-cycle to vary by varying the on-time. An external resistor, R_{sc} , is used as a current-level sensor. The current-limiting circuit senses the amount of current flow through the switching transistor and then changes the oscillator duty-cycle (on-time only) to limit the peak current, thus protecting the switching transistor. The temperature-compensated voltage reference, 0.1 mV/per °C, can provide 10 mA without using an external transistor. An internal high-gain differential error amplifier disables the switching transistor whenever the output voltage is too high. This unit requires only 2.0 mA at 5 volts;

maximum duty-cycle). By using an external voltage divider, the voltage reference is divided and applied to the negative input of the dead-time comparator. Thus, a stable dead-time is obtained to prevent the two output transistors from saturating simultaneously during 50% duty-cycles.

The internal phase splitter was included to obtain two 180° out-of-phase outputs to use in push-pull applications. It is formed by a toggle-type flip-flop.

Now that we've been introduced to the switching-type power supply, we'll call a halt until next month when we go into circuit design.



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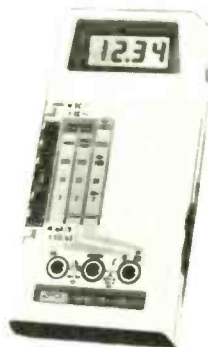
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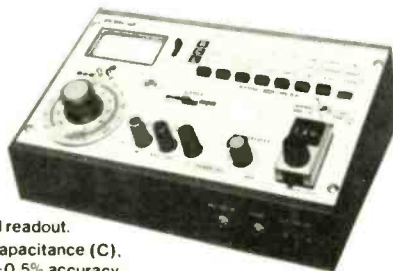
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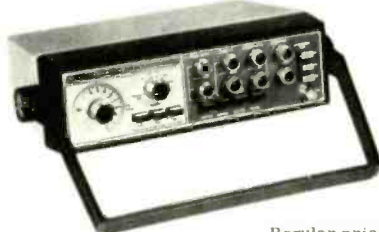
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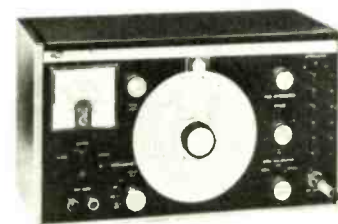
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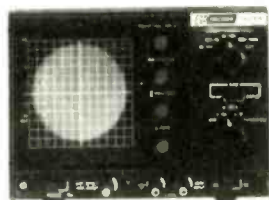
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HOBBY CORNER

A look at Zener diodes—what they are and how they work.

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

IN THE AUGUST 1978 COLUMN, WE USED A Zener diode in the construction of an expanded-scale voltmeter to monitor the AC line and other voltages. This month we'll take a close look at Zener diodes—how they work, how you can "make" your own and how to determine unknown values.

Zener diode action

You know that a diode rectifier that is connected cathode-to-positive, as shown in Fig. 1, will not conduct. Let's see what happens as the applied voltage starts at zero and increases.

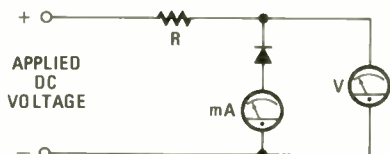


FIG. 1

At first, no current flows through the diode and the milliammeter reads zero. (Actually, there are a few *microamperes* of current, but that is not enough to matter in most cases.) Since no significant current flows then through the resistor, there is no $I \times R$ drop across it, and the voltmeter reads the same as the applied voltage.

This situation continues as you increase the applied voltage *until* you reach a certain value. Just what that value is varies from one diode to the next. It can range from a volt or two up to several hundred volts. At that value, called the "knee," things begin to happen.

Suddenly, the diode begins to conduct and the milliammeter shows rising current. The voltmeter reading, which has been following the applied voltage, stops rising. Even though the applied voltage continues to increase, the voltmeter remains within a few volts of what it was when the diode current started.

Figure 2 shows a graph of the current and the *applied* voltage. If it were not for the resistor limiting the current, the "avalanche" of current would quickly overheat and burn out the diode.

The above description is of *Zener action*: from no current to high current at a specific voltage level. The voltage across

the diode rises to that voltage and then stays there. This voltage value is called the Zener voltage.

You may have noted that nothing was said earlier about using a Zener diode. That's because practically all diodes behave this way, and those with the sharpest knee are known as Zener diodes.

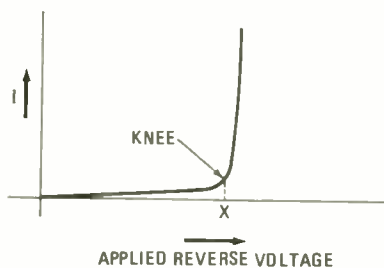


FIG. 2

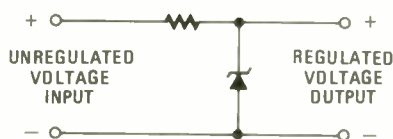


FIG. 3

Since the voltage across a Zener diode remains constant in spite of higher applied voltages (within certain limits), this diode is often used as a voltage regulator. Figure 3 shows a circuit diagram that uses the usual symbol for a Zener diode. Compare this circuit with the circuit in Fig. 1, and you will note that the output will not exceed the Zener diode voltage even as the input goes up. In practice, a higher voltage is applied so that the output stays at the Zener voltage level.

Making Zener diodes

You can make—actually, *find*—Zener diodes in strange places. As already indicated, almost any signal or rectifier diode displays Zener diode action. So, first look in your diode storage box. You have only to determine the diode's knee voltage and its power capability (wattage).

A less obvious source of Zener diodes is your stock of transistors. As you know, a transistor consists of two diodes (junctions). Either of these diodes can be used as a Zener diode. You can even use "burned-out" transistors if only one of the internal diodes has been destroyed.

An NPN transistor's diodes behave like those shown in Fig. 4. Obviously, in a PNP transistor, each diode would be pointing in the opposite direction. In using these NPN-transistor diodes, don't forget to connect them, i.e., cathode-to-positive.



FIG. 4

Transistor diodes may vary in Zener voltage from a few volts to several hundred in the power transistors. One caution: After you use a transistor for a Zener diode, don't use it later as a transistor because its efficiency will have decreased.

Finding the working values

Finding the working values for the unknown Zener diodes requires the answers to three questions:

1. Which end is the cathode?
2. What is its knee voltage?
3. What is the power capability?

Of course, you can check diode polarity with an ohmmeter, but this can cause two difficulties. First, some ranges of many meters can destroy small signal diodes and transistors. Second, you must know and remember which lead is positive when the meter is on a resistance range. It is *not* always the red lead. One of mine is like that—very confusing! I prefer to toss together the little diode-identifier circuit shown in Fig. 5 since it is easy and safe.

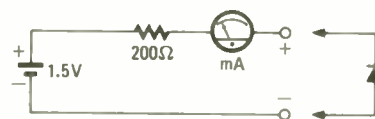


FIG. 5

In this circuit, the 200-ohm resistor limits the maximum current to about 7.5 mA. The meter used can be your VOM on a low current range, or a panel meter. To check a diode, just place it across the terminals as shown and then reverse it.

If there is current in both directions (when it is first connected *and* when it is reversed), the diode is bad. The diode is good if there is current in only one direction. The cathode is the end on the *plus*

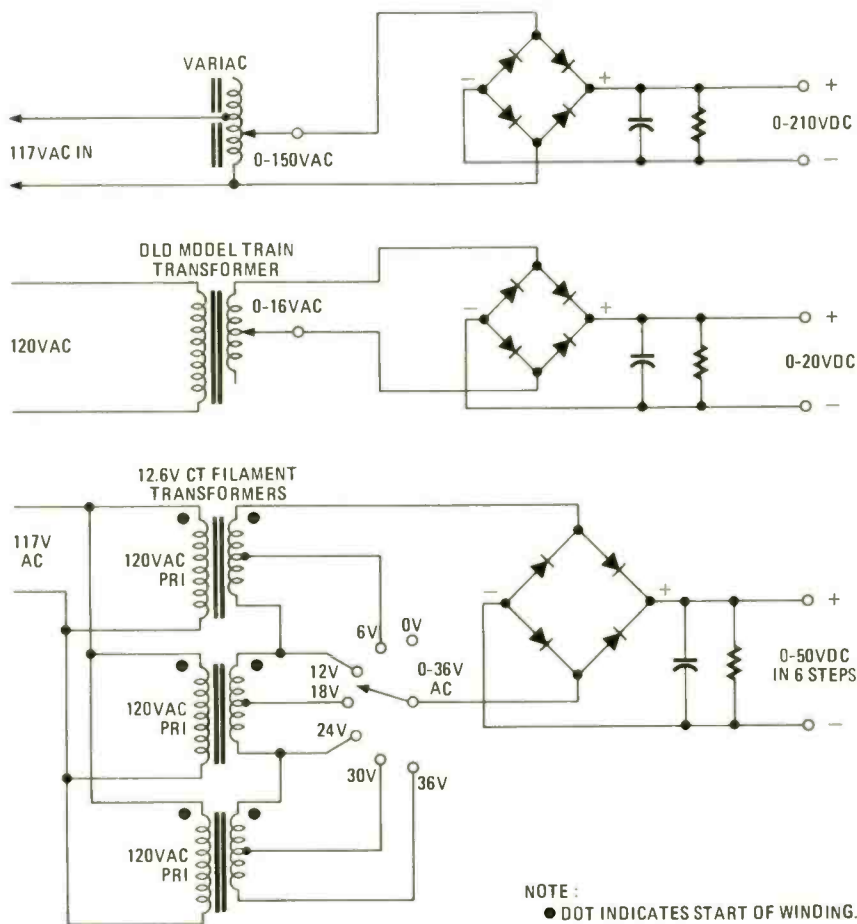


FIG. 6

terminal when *no* current flows.

This diode tester also checks the diode junctions in transistors—base-to-emitter and base-to-collector. Incidentally, as shown in Fig. 4, if the base is the anode, the transistor is an NPN; if the base is the cathode, it is a PNP transistor.

To determine the Zener voltage, you need a source of variable DC. You can use a variable bench-power supply if you have one, or you can assemble one of those shown in Fig. 6. In each case, the ratings of the rectifier and filter components must be chosen to match the maximum AC source available. When you wire the filament transformers, if one does not *add* to the preceding one, just reverse *either* the primary or secondary connections. I'm sure other possible combinations will occur to you.

Actually, any voltage source will do—even batteries. I have an old Heath C-3 capacitor checker that provides current-limited voltages of 50 to 500 in several steps. Although it is intended for checking leakage in electrolytic capacitors, this unit is ideal for checking higher-voltage Zener diodes.

Whatever voltage source you use, the variable DC is applied to the circuit shown in Fig. 7. The 100-ohm resistor limits the current on low voltages. The voltmeter must be able to read the maximum applied DC.

continued on page 82

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SENSITIVITY	5mV/cm 5V/cm 10 STEPS 1.25 SEQUENCE
	UNCALIBRATED AND CONTINUOUSLY
	VARIABLE IN BETWEEN STEPS
INPUT IMPEDANCE	1M Ohm 35pF
INPUT VOLTAGE	600V IDC AND AC PEAK
DISPLAY MODES	CHANNEL 1, CHANNEL 2, ALTERNATE,
	CHOP (230kHz), X-Y (CH 1 - X, CH 2 - Y)
RISE TIME	11.7nS
TRIGGERING	CH 1, CH 2
SIGNAL DELAY	120nS

HORIZONTAL

SWEEP TIME

0.2uS/cm 0.5 Sec/cm
MAX SWEEP 20nS/cm WITH MAG. x 10
UNCALIBRATED AND CONTINUOUSLY
VARIABLE IN BETWEEN STEPS
AUTO. SYNCHRONIZE TO REPEATED
WAVE-FORM OVER 20Hz
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UNDER NO TRIGGER CONDITIONS.
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ADVANCE
ELECTRONICS

JUNE 1979

71

communications corner

What is the "T" band; where did it come from and how is it used.

HERB FRIEDMAN, COMMUNICATIONS EDITOR

IT WASN'T TOO LONG AGO THAT THE TERMS "VHF monitor radio" or "VHF radio" meant a receiver that was capable of receiving low-band frequencies of 30-50 MHz, high-band frequencies of 150-170 MHz (possibly also with the 144- to 148-MHz amateur frequency band) or both low- and high-band frequencies. The virtual explosion in the use of VHF frequencies soon had the Federal Communications Commission opening a UHF band covering the 450-470-MHz range.

As you might well imagine, with all the public and private individuals running around with walkie-talkies in their hands, even the new UHF band became overcrowded. Before we could get used to VHF radios that covered "all" public service bands—low, high and UHF—we found ourselves reading about UHF scanners with *both* UHF bands, though few users had any idea what the word "both" meant. According to certain VHF radio dealers, some potential VHF/UHF hobbyists believed both UHF bands meant the UHF public service band and the 420-MHz amateur band (which some scanners actually did cover).

In actual fact, however, both UHF bands means the 450-470-MHz UHF band and the "T" band, which are the UHF frequencies of 470-512 MHz, representing UHF television Channels 14 through 20. Some of the most modern VHF/UHF scanner promotional material specifically state coverage of the UHF and "T" frequency bands, rather than both UHF bands.

The "T" band was created in this manner: Before anyone could even start to remember the frequencies of the UHF band, they were practically used up in many metropolitan areas, particularly in view of the booming popularity of the UHF walkie-talkie. But right above the UHF band were the lower UHF TV frequencies that were little used throughout the U.S.; these frequencies could be accommodated by the same technology used for the UHF band. There's essentially no difference between a transceiver designed for about 470 MHz and one designed for 472 MHz or even 512 MHz. So the FCC determined that TV Channels 14-20 should be used for UHF

communications whenever they were not assigned to for a local TV station.

The frequency allotment for each TV channel is identical. For example, if 476.5625 MHz is a local government assignment for Channel 15, the Channel 16 assignment is 482.5625 MHz and the Channel 17 assignment is exactly 6 MHz higher. This makes it easy to assign frequencies on either side of the channels actually used by TV transmitters. Table 1 lists the various "T" bands.

TABLE 1—THE "T" BAND Frequency Groups*

470-476 MHz, TV Channel 14
476-482 MHz, TV Channel 15
482-488 MHz, TV Channel 16
488-494 MHz, TV Channel 17
494-500 MHz, TV Channel 18
500-506 MHz, TV Channel 19
506-512 MHz, TV Channel 20

*Those frequency groups not assigned to a local TV station might be assigned for UHF communications.

Naturally, the question is asked, "How can one front end handle a factory alignment for a total spectrum of at least 450-512 MHz?" In the good old days (i.e., 1977) the answer was: "not too well." Generally, the user requested a factory alignment for maximum sensitivity to a specific UHF frequency, or to a frequency band about 6 MHz wide. Today, thanks to microprocessors, front-end UHF tuning is usually tracked automatically to the operating frequency, and the user has no problems regardless of which end of the UHF band he is monitoring.

CB—to beep or not to beep

With CB sales in the doldrums, just about everyone concerned is hoping computerized transceivers will rekindle the imaginations of old and new CB'ers and lead to greater replacement sales and more high-end sales among new licensees.

While the terms "computer" or "microprocessor" conjure up visions of a new era in CB communications, so far the on-board microprocessor has been integrated only with the receiver. The processor generally provides some form of memory-controlled scanning whereby you can program up to 5 or 10 channels to be continuously scanned for busy or clear conditions. Or it allows you to program a primary and alternate channel for operation and monitoring, or for operation and automatic switching to the secondary channel (the exact type of scanning depends on the design developed by the individual manufacturer).

There is a divergence of opinion on a function of importance to the user; it concerns *tactile feedback*. As calculator manufacturers learned too late, people need to be certain they have properly entered a numeral or a function on a keyboard. Calculators with keypads that did not produce a decided "click" or "snap" didn't do well in the marketplace. Several of the touch-to-operate keypads had to incorporate a *beep tone* to generate customer interest.

A similar situation is developing with the computerized CB transceivers. Even though all present models incorporate a tactile entry capability, whereby you sense a click or snap upon depressing a key, sometimes you can get a gut feeling that an entry didn't take, and some microprocessor designs make it a bit of a hassle to check a memory entry.

The first manufacturer to solve the tactile sensation problem is SBE, Inc. They provide both tactile and auditory confirmation of a tactile entry. On the SBE *Sidebender VI*, an AM/SSB computerized transceiver, all the keypad switches have tactile feedback that let you feel the entry as the key is depressed. In addition, depressing the CHANNEL (programming) entry key generates a low tone in the speaker. A higher pitched tone is generated when the actual channel number is entered into memory or directly accessed. It's almost identical to the "tone confirmation" used in some state-of-the-art computer terminals. Although admittedly not the most important feature of CB receivers, it is very reassuring to have and may become a standard feature on most of the higher priced computerized transceivers.

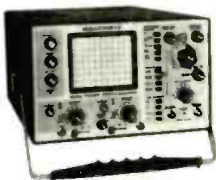
continued on page 74

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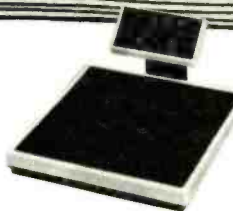


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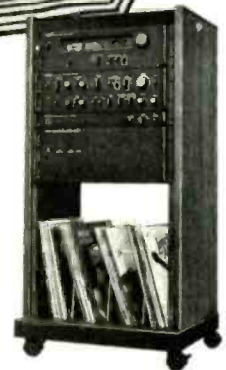
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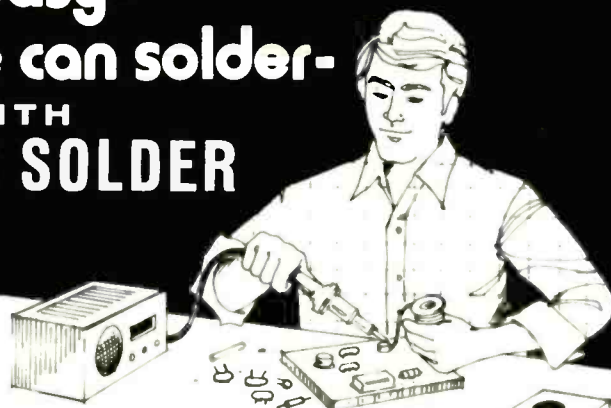
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COMMUNICATIONS CORNER

continued from page 72

CB and the fuzz

A lot of newspaper publicity lately has concerned a few individuals who beat a police radar-supported speeding ticket by establishing that a CB transmission caused certain radar speed detectors to give erroneous readings.

As with almost everything else, only the pioneers are winners—the first few to "beat the radar." Be advised that CB jamming has been confirmed in only one particular type of police radar. If your local police department uses a different radar system, you can tape down the press-to-talk switch on your mike and it won't make any difference. Similarly, be careful of the radar pistols that are the same type used to clock the speed of a pitched baseball when it crosses home plate. By the time your radar detector senses the radar signal, you've been clocked and possibly from the sides, rear, or above.

But is it talk power?

Many CB'ers assumed that the FCC's limitation on 100% modulation from the type-approved transceivers would forever put an end to "splash," which is when the modulation on one channel is heard on several other channels. Unfortunately, as many have learned, you can have 100% modulation limiting and still have "splash." This effect is actually caused by distortion products that are generated by a severely clipped and poorly filtered

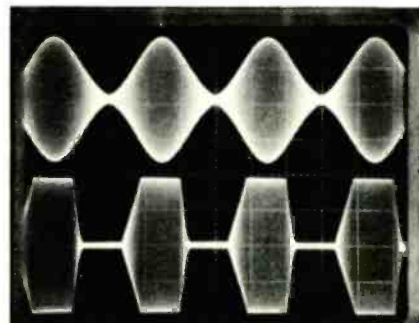


FIG. 1—THE DIRECT 27-MHZ OUTPUT of two CB transceivers modulated by 1000 Hz fed directly into the microphone through a microphone coupler. The signal level represents a "loud voice." The transceiver that produced the top trace maintains waveform purity by adjusting the overall amplifier gain to provide 100% modulation limiting.

modulation waveform. Whether you have a clean signal or not depends on how the modulation-limiting capability is attained in your particular transceiver. If your transceiver uses a μ max-type limiter, this combination of a variable-gain amplifier and a peak-modulation suppressor will produce the waveform shown in the top trace of Fig. 1—about 85% to 95% modulation with very little distortion of 1000-

continued on page 82

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TOTAL CONVENIENCE

With System X-10 at your side, you can operate almost every light and electrical appliance in your home without leaving the comfort of your easy chair. Imagine turning on a TV set or stereo; even dimming a light in the next room without moving from your chair.

It may sound like one of those electronic devices found in a spy thriller, but you can have one today.

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Each module will control any incandescent lamp rated up to 300 watts from control signals received from the Command Console. Functions include on and off, brighter and dim. UL listed.

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Each module receives signals from the Command Console to turn appliances on and off; such as TV, stereo, fan, etc. Maximum appliance ratings: Resistive load—15 amps., Motor load—1/3 HP, Incandescent Lamp—500 wats. UL listed.

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service clinic

How the automatic brightness limiter circuit works and how to troubleshoot it.

JACK DARR, SERVICE EDITOR

THERE'S A CIRCUIT THAT HAS BECOME very common in solid-state color TV—the automatic brightness limiter. This circuit seems to be a mystery to many technicians (it was to me!). The most commonly used circuit looks a little unusual, but once you boil it down to fundamentals, it'll hopefully become clearer.

Basically, this is what these circuits do: Screen brightness is directly related to the amount of beam current drawn by the picture tube. So, the circuits monitor this current. The *bottom* end of the high-voltage supply is returned to ground through a small resistor. The DC voltage drop across this is directly proportional to the beam current, since the beam current flows through it. Check to see if the bottom end of the high-voltage winding of the flyback does *not* return to common or boost. If it doesn't, then the automatic brightness limiter circuit is being used.

The small DC voltage developed across the resistor is negative with respect to ground. Why is this so? (This puzzled me until I checked.) Because electrons leave the picture tube cathodes and flow to the screen, then they return to ground through the high-voltage supply. So, the *electron flow* through this resistor develops a negative voltage. The end of a resistor that electrons flow into will be more negative than the other end—this is ground here. The higher the beam current, the higher this DC voltage. (See Fig. 1)

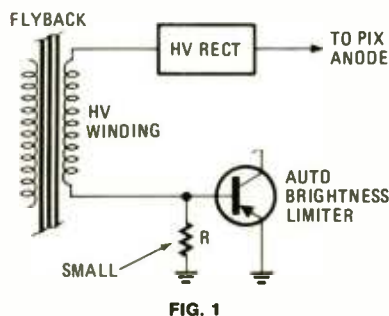


FIG. 1

In color sets, the beam current is directly controlled by the bias on the video amplifier stages, which control the cathode voltages of the picture tube.

Almost all of these are DC-coupled. We can control the beam current by controlling the bias on one of these transistors, even in an early stage.

Many sets use a DC-amplifier stage to sense the beam current, whose output controls the bias on the video stage(s). These sets are designed so that if the beam current exceeds the desired level, the brightness limiter circuit will automatically reduce the beam current. This tends to hold the brightness at the level to which it was set by the brightness control, despite picture content in terms of black to white. (Black is zero beam current or cutoff, and white is maximum beam current. Therefore, an all-white raster draws the most beam current.)

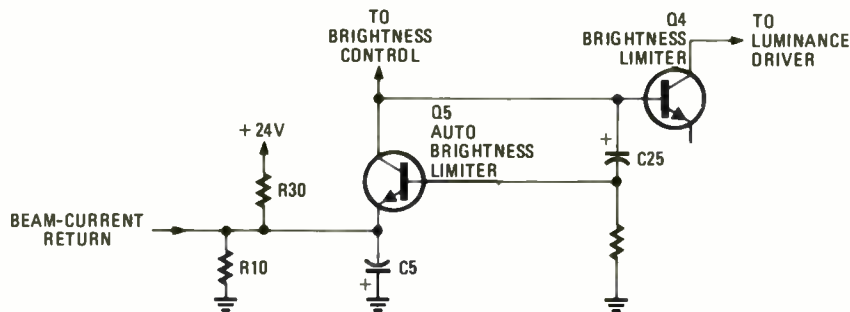


FIG. 2

In many sets, the sense voltage is fed into a resistor that is also part of a voltage divider fed from a low DC supply. Figure 2 is a diagram of a circuit used in a Magnavox T815 chassis. This circuit is designed so that the negative voltage developed by the normal beam current through R10 is balanced out by the positive voltage of the divider, leaving the control voltage at zero. The control voltage varies the bias of transistor Q5, which is directly coupled to brightness transistor Q4. This transistor, in turn, controls a luminance-driver transistor (not shown in Fig. 2) that does the actual work.

In normal operation, transistor Q5 is in the cutoff state and has no effect. If the beam current goes up, the control voltage goes more negative, and Q5 starts conducting. When Q5 conducts, it reduces the conduction of Q4 and holds down the

brightness. The variation is deliberately slowed down to avoid rapid fluctuations. This is accomplished by connecting a large capacitor to the base of Q4 to slow down the change.

You can pin down problems in this circuit by measuring the DC voltages on the brightness limiter transistor (Q5), the brightness control transistor (Q4) and luminance driver transistor. The DC voltage on the emitter of Q5 should go more negative with a white raster or a very light picture. If the emitter voltage is varying but the collector voltage does not vary, then Q5 could be open. If the collector voltage of Q5 varies normally but the collector voltage of Q4 does not, then you can suspect Q4 is open.

Other problems will display typical symptoms. If the brightness is too high, although the brightness and brightness range controls are properly set and reacting OK, check all the parts, including

resistors, capacitors, etc., in the automatic brightness limiter circuitry. **R-E**

service questions

HIGH-VOLTAGE PROBLEMS

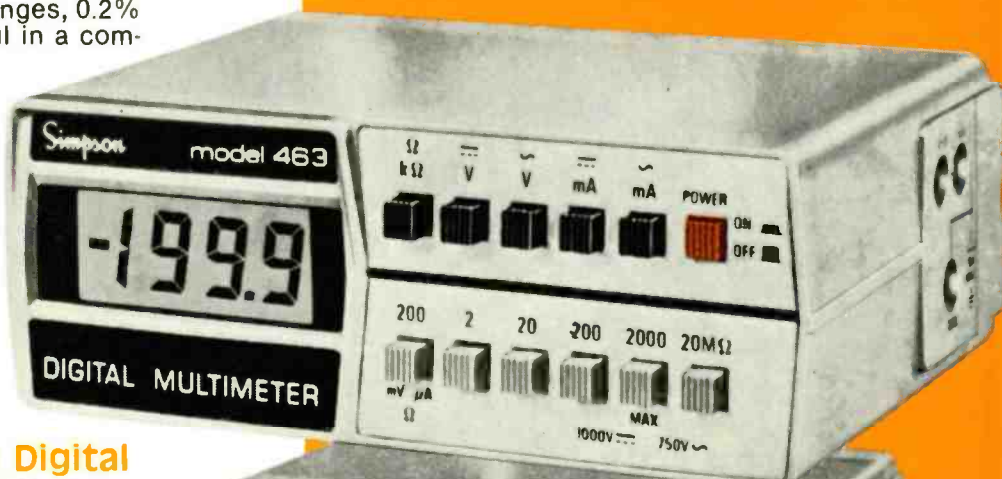
We had written each other about an odd problem in a Zenith chassis 14A9C50. After 10 to 20 minutes, the high voltage dropped to about 13 kV and the grid of the 6HV5 regulator would go more positive. I changed the tube in the customer's home along with other HV tubes, but the problem was still there. You said that grid emission in the 6HV5 could cause this problem. So, I brought it into the shop.

continued on page 78

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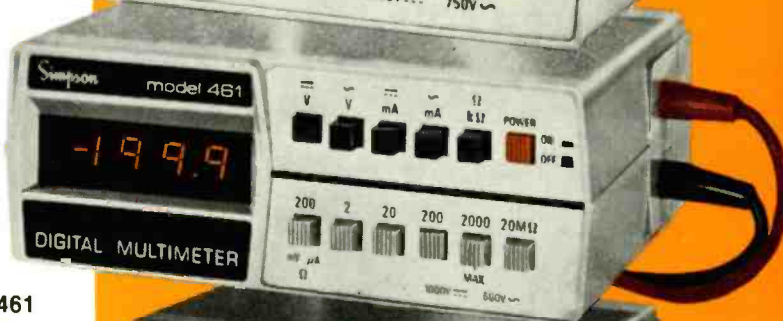


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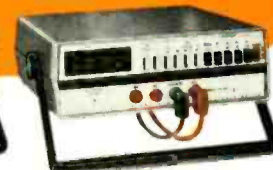
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CIRCLE 56 ON FREE INFORMATION CARD



JUNE 1979

SERVICE QUESTIONS

continued from page 76

I changed out the two VDR's in the circuit, assuming they were bad—same trouble. I figured it couldn't be my new 6HV5 tube, or could it? So I changed the tube *again* and the whole problem cleared up! The only bright spot was that later on I got another set with the same chassis and the same symptoms. I replaced both VDR's *and* the 6HV5, and . . . the set took off like gangbusters!

I just thought you'd like a little feedback. The crystal ball was right again!

(Thanks very much to Jim Hoffmann of Hoffmann Communications, Rochester, NY.)

HORIZONTAL OSCILLATOR COIL

I've been looking for a horizontal oscillator coil for a Dumont-Emerson model 41-P01. The manufacturer says it's no longer available. Is there any substitute?—L. B., Washington, DC.

Thordarson's *Transformer Guide* shows this chassis and a substitute for the coil. The original part number is 716151, and the Thordarson replacement number is HS-27.

NO VERTICAL SWEEP

This Sylvania *model E21-03* came in with no vertical sweep at all. There's a thin horizontal line across the screen. It looks like the service switch is in the service position. I've run into this situation before so I check all the solder joints on the terminal strip at the back of the deflection yoke. And I resolder them if they're bad.

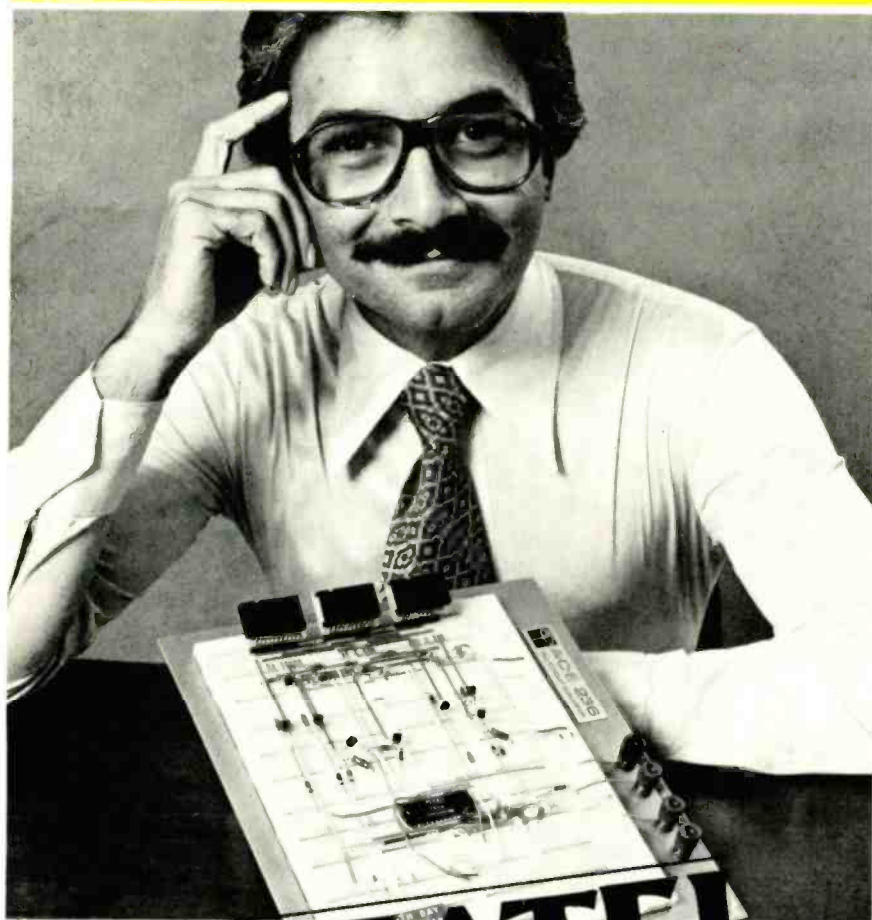
Thanks to Fay Jackson, Fay Jackson TV, Driggs, ID, for this tip.

DAMPER TUBE TROUBLE

Ken Krueger of Milwaukee, WI, sends along some very interesting data about damper tube problems. He says the problems could be caused by the tubes themselves, in an unusual way!

Some damper tubes carry dual markings. Those labeled "6CJ3/6DW4" may have a heater current of only 1.2 amp instead of the normal 6CJ3 1.8-amp heater current. Zenith and other sets used a special circuit: the heaters of the damper and high-voltage regulator are wired in series across a 12.6-volt winding. The reason for this circuit scheme is that if the high-voltage regulator tube burns out, the damper goes dark and the set shuts down. Special pairs of tubes should be used; 6HV5 and 6CJ3, for example. The 6HV5 heater current is 1.8 amp. So, two tubes in series must have the same heater current.

This causes several problems if the 1.2-amp 6CJ3 tubes are used. First, the high-voltage regulator won't heat up fast enough, and the high voltage goes way up. Later on, the regulator pulls the high



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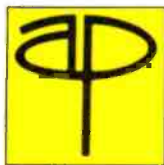
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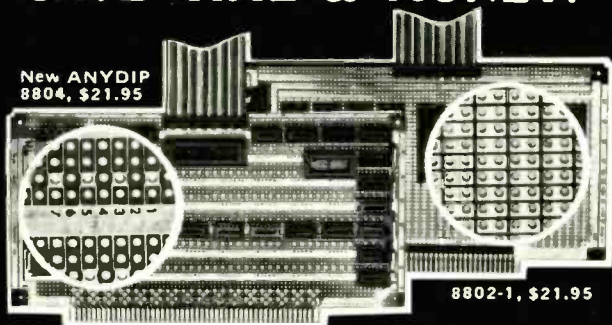
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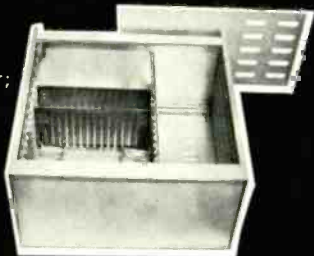
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voltage down, and the sweep decreases, causing a narrow raster.

The other pair of tubes, the 6JH5 regulator and the 6DN3 damper, both have a 2.4-amp heater current. Plus the 6JK5 regulator/6CJ3 damper tube combination is rated at 1.8 amp.

Many thanks, Ken, for this information. We appreciate it.

ALWAYS CHECK THE FIGURES

Thanks very much for your letter on the horizontal instability in the Philco model 21L23. I was at the end of my rope and was shotgunning the whole circuit! When I checked back, I found I'd replaced the 390-pF coupling capacitor with the wrong value! Putting in a new one with exactly the right value fixed the problem!—D. McK., Fall River, MA.

Quite a long time ago I kept getting funny results when replacing bypass capacitors. After much head-scratching, I discovered that I had several (new) capacitors in my drawer, marked 0.001 μ F. My capacitor tester showed plainly that they were 0.0001 μ F, quite a difference! Moral: when in doubt, check!

WHAT'S A "BARKLEIGH" TV?

Do you have any information on a TV set called a "Barkleigh"? Neither Sams, Sanyo nor anyone else has any information. The problem lies in the horizontal sync, but we don't want to work on a set without a schematic.—J. C., Slidell, LA.

The reader then wrote again to let us know that the Barkleigh was a set manufactured in Korea, and sold by a New Orleans discount house.

The problem was found and fixed! Someone in the TV plant had apparently used a pair of cutters to clip off the longer leads on the PC board. However, he forgot to resolder the leads with bad joints. After about 25 of these leads were resoldered, the set works!

R-E

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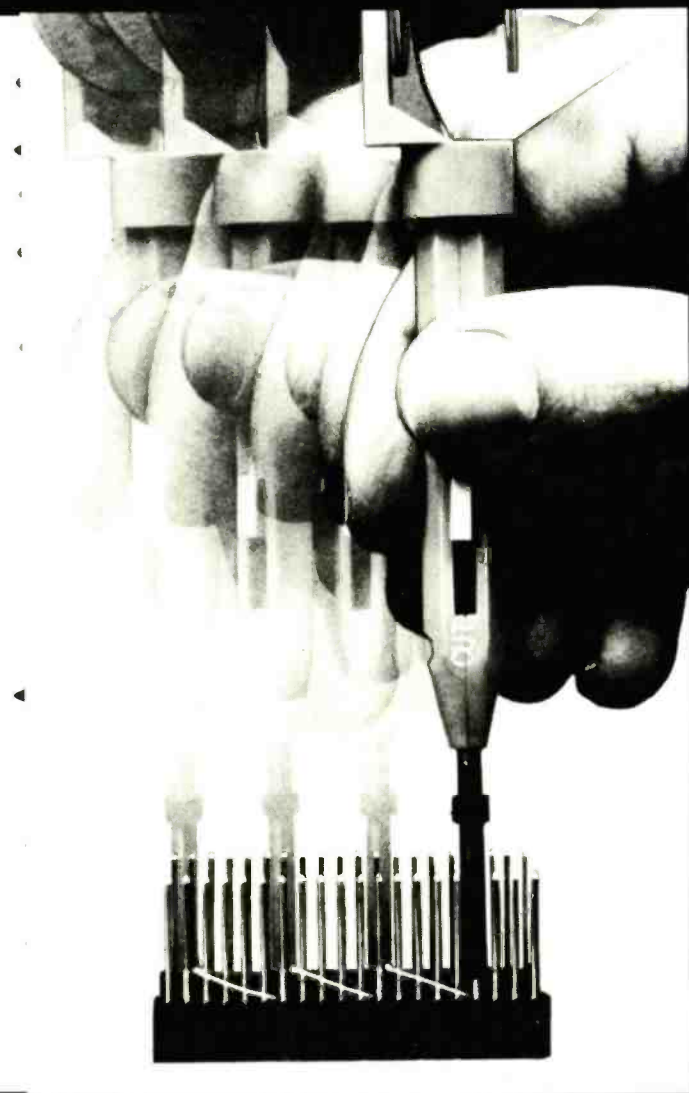
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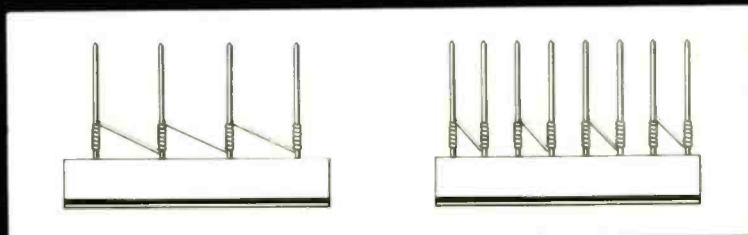
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Hz fed directly into the microphone.

If your rig has a wide-open mike-preamplifier and straight peak clipping, you will see the waveform that is shown in the lower trace of Fig. 1 (with the same signal fed into the mike). Note how the peak clipping produces sharp square-waves whose harmonics spread out over adjacent channels. Both rigs meet the 100%-modulation-limiting requirement, but the signal waveform that created the top trace obviously has a "cleaner" sound and greater "talk power." R-E

The diode is connected as shown, cathode-to-positive. The voltage is increased slowly, and the reading on the voltmeter rises with it while the milliammeter remains at zero. When the Zener knee is reached, the milliammeter begins to show current and the voltmeter stops rising (or nearly so). Do not allow more than a few milliamperes to flow through the Zener diode for more than a short time.

When the voltmeter reading levels off, even with briefly applied higher input voltage, the meter reading is the Zener

voltage of that diode.

The third and final question posed earlier about the unknown Zener diode is its wattage rating. About the best you can do is to apply overvoltage (and high current) until the Zener diode burns out and then compute $P = I \times E$.

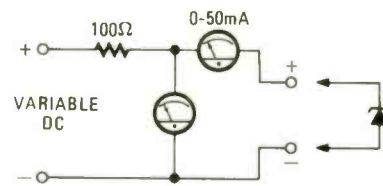


FIG. 7

Fortunately, however, you can guess at the power rating from the size and form of the diode. To obtain a basis for comparison, take a close look at some Zener diodes at your local distributor. Obviously, it is better to underrate the diode than to overrate it. Also, in applying your self-rated Zener diodes, keep in mind that heat is the enemy, so use regular heat sinks on metal Zeners (both the diode and the transistor variety).

There you have the Zener diode story—or most of it. You should be able to devise any kind you need without breaking the bank—even big models to replace voltage-regular tubes in older tube-type equipment. R-E

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second gate times. Three timebases are available: standard timebase offering 5-ppm temperature stability, crystal oscillator with 1-ppm stability, and a crystal-oven oscillator with 0.02-ppm

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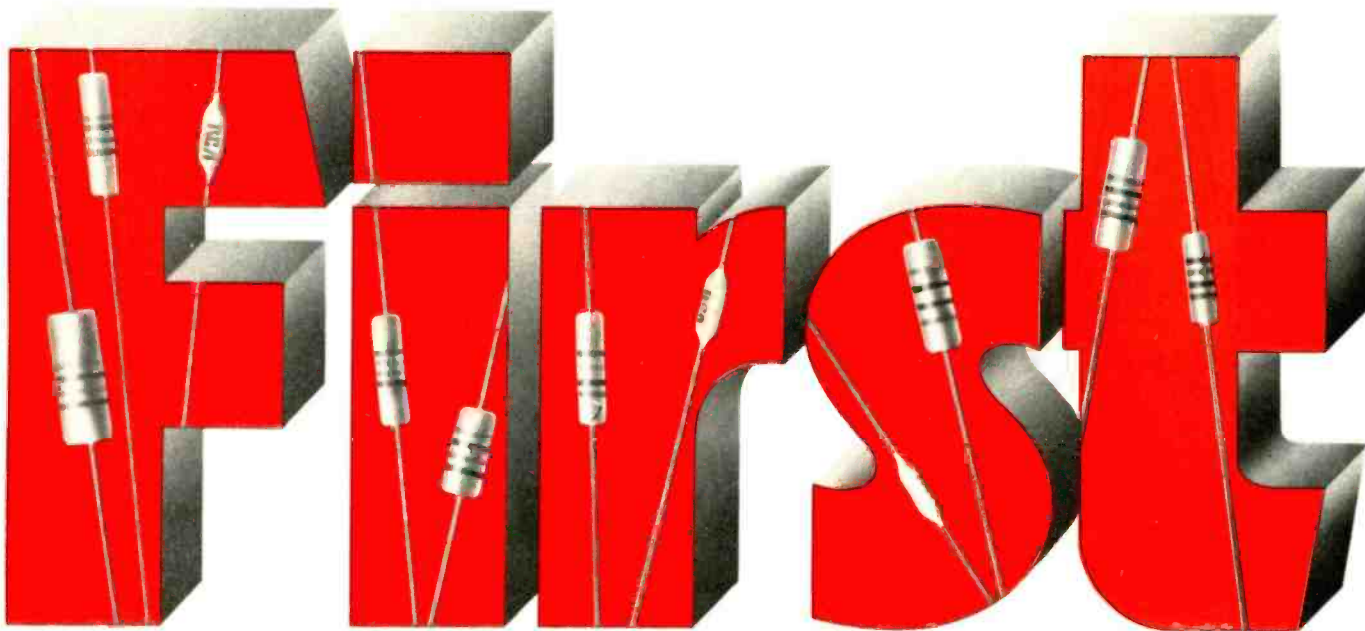
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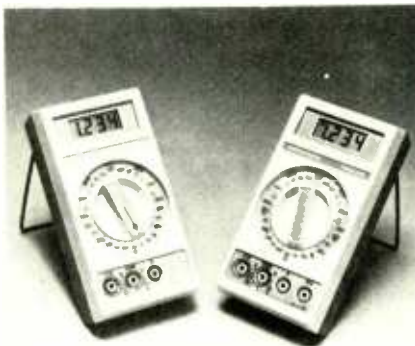
handles are released. The *model 70334C* is available at local distributors.—**Vaco Products Co.**, 1510 Skokie Blvd., Northbrook, IL 60062.

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VDC or RMS. A 9-volt battery, spare fuse, safety test leads and user's manual come with each meter; optional accessories include carrying cases, probes and tips, and a test lead kit. Suggested retail prices: the *model Tech 300*, \$100; the *model Tech 310*, \$130.—**Beckman Instruments, Inc.**, 2500 Harbor Blvd., Fullerton, CA 92634.

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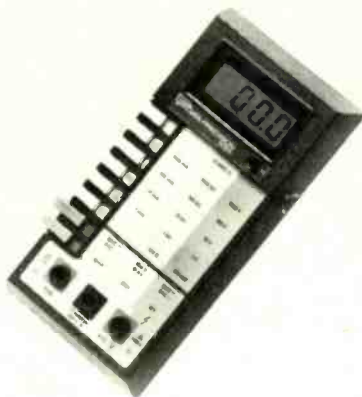
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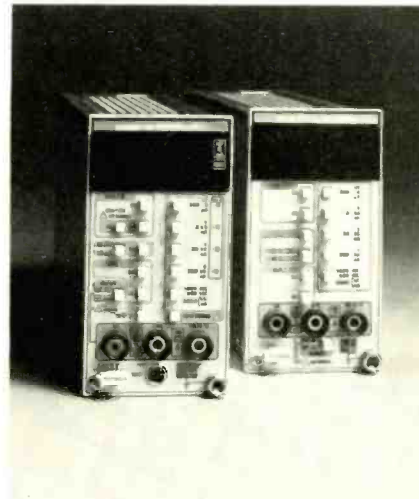


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DC range and provides a 100-μV sensitivity. Full overvoltage, overcurrent and high-transient protection is provided, and current ranges are fuse-protected against inputs greater than 2A. All ranges, functions and excitation level are push-button-selectable, and measurements are shown on a 3½-digit, ½-inch-high liquid crystal display.

Power is provided by a 9-volt alkaline battery; optional AC adapter is available. The instrument is housed in rugged plastic, measures 3½ X 6¼ X 1½ inches, and weighs 9 oz. Test leads, battery, spare fuse, warranty and operator's manual are included. Price: \$149.—Data Precision Corp., Electronics Ave., Danvers, MA 01923.

3½-DIGIT DMM'S, model DM 502A and model DM 505. The model DM 502A measures DC/AC voltage and current, resistance, dBV and dBm, and temperature; it provides autoranging capa-



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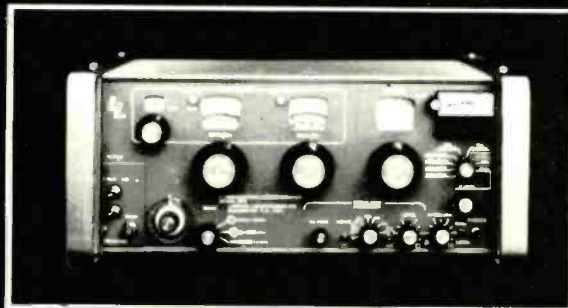
bility for voltage, resistance and dB measurements. It also provides a true RMS reading and plug-in capability for all Tektronix TM-500 instruments. The model DM 505 measures DC/AC voltage and current, and resistance. The model DM 502A also offers pushbutton-selectable functions and ranges, LED display, a choice of front-panel or rear-connection inputs (also pushbutton-selectable); the unit is available with or without probe. Suggested retail prices: the model DM 502A with probe, \$520; without probe, \$395; the model DM 505, \$250.—Tektronix, Inc., P.O. Box 500, Beaverton, OR 97077.

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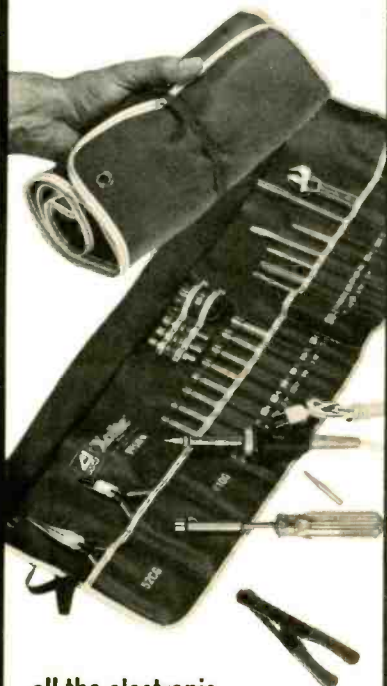
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TIME/VOLTAGE CALIBRATOR

continued from page 61

If you find that you cannot trim the frequency properly, you may have to experiment with different values for C35. Increasing this capacitance decreases the frequency of operation. For instance, on a prototype unit, substituting a value of 150 pF for (C35 + C36) dropped the frequency about 700 Hz below center, while a value of 47 pF increased it 1700 Hz above center. Your own results may vary from these values but will follow a similar trend. A couple of trial and error runs will pin down the correct value.

Adjusting the voltage section is a two-step process. Any DVM can be zeroed by shorting its test leads, and this zero accuracy is needed to zero the calibrator. With the DVM connected to the VOLTS output, set toggle switch S8 to the 0.000-volt position, and after one minute, adjust trimmer R34 for a 0.000-volt output. Now, if your DVM is 4½ digits or better and recently calibrated, flip switch S8 to the 10.000-volt setting and after another minute adjust trimmer R35 for a 10.000-volt output; that's all the fine tuning you can do. Attach the chassis top and you're ready to go.

Using the calibrator

Now that you have become used to operating the unit, let's look at how you use the calibrator. Loading a value is as simple as dialing the desired value into the thumbwheel switches and pressing the appropriate LOAD pushbutton. Once a load is performed, the thumbwheel switches can be set to any other value without upsetting the previously latched value.

The volts output takes about 10 to 15 seconds to stabilize when changing from one value to another. Remember that the overall accuracy is specified as a *percentage of the setting* and not a percent of full scale.

The non-TTL time output has an upper frequency limit that is dependent upon the volts section setting. A frequency of 5 MHz is about the highest frequency you can attain, but requires a 10-volt setting. Operation below about 4.5 volts peak-to-peak is uncertain at any frequency. However, the TTL output can operate at any setting.

When you want only a DC output and the time output is a "don't care," then load 0000 into the time section and set the time multiplier to "TTTT mSEC." This minimizes noise in the calibrator and provides the cleanest possible volts output.

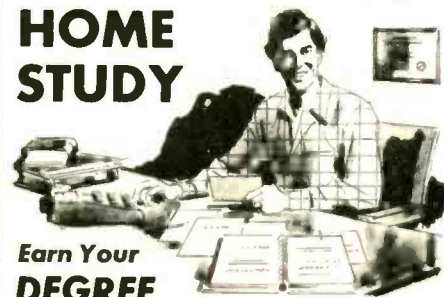
Even though you may use the calibrator only a few times per year, you won't ever have to worry about your test gear's accuracy, and the other uses you'll probably find for it may surprise you. You should check your test equipment on a regular basis.

R-E

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CAR STEREO

(continued from page 46)

(Regarding the above, a rule-of-thumb applies: Usually if a given player or ensemble sounds good in a store (and loud enough), it is likely to sound better, as well as louder, in a car.)

Installations

The use of component-type equipment in cars poses a few problems. One is installation; this requires a certain amount of ingenuity to fit the units into tight in-dash and under-dash space. A bigger problem is the matter of selecting and installing the right speakers in the right place to capitalize on the inherent "component quality" sound and to avoid problems such as moisture. Many a hi-fi buff who bought a component-type car stereo rig with high hopes for home-quality sound has been disappointed by a bad installation—either of the electronics or the speakers, or both.

The growing interest in component-type car stereo equipment has persuaded many audio specialty distributors to carry a car stereo line. These stores also provide an installation business, with generally happier results for the consumer in terms not only of a more expert installation, but a better matching of the elements that

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TK54C

make up a component-type car system.

The astute prospect for mo-fi should shop as carefully for a proper installation as he does for the proper equipment. His best bet is the car stereo sales specialist/installer or audio shop/installer, rather than the local TV/radio/appliance dealer who sells car stereo units but does not install them.

The chances of getting a decent mo-fi installation are substantially better than, say, a year ago. Manufacturers, getting feedback from their dealers relative to installation and matching problems, have been following up on that feedback and developing information bulletins and other forms of communication to help those dealers. One company, Craig, offers installation schools to help its dealers and installers do a better job. The results of all these efforts are steadily becoming more apparent in terms of quality installations.

R-E

INTELLIGENT THERMOSTAT

continued from page 40

point 4. These function numbers are followed by the C(time/day) key for the time and the B(temperature) key for the temperature and initiated by the *(start) key. The following example should clarify the procedure:

	Keystrokes	Display
1. Set 11 to 75°	D(function)	bb 00
F at 8:00 am	1	bb 01
	1	bb 11
	C(time/day)	00 00
	8	00 08
	0	00 80
	0	08 00
	#(am)	LED
	B(tempera- ture)	bb 00
	3	bb 03
	*(start)	XX XX

(Note that LED may or may not be on depending on the last time-set operation)

At this point, the board will turn on the heater relay at 8:00 am and leave it on until the ambient temperature reaches 75° F. (You may test this at 8:00 am by using your fingers to warm the thermistor located in the middle of the board at K and L and observing the operation of the relay.)

In a similar manner, points 2, 3 and 4 may be set to any time and any of the four stored temperatures so that you can raise and lower the temperature to preset points. By repeating the procedure for functions 21, 22, 23 and 24, day number 2 can be set. The procedure is then repeated for the remaining days of the week (days 2-7). Note that once you have programmed all of the set-points for all of the days, it is necessary to initiate auto-

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matic operation by selecting and starting function 13.

It is also possible to override the heating, cooling and fan operations by using functions 5, 6, 7, 10, 11 and 12. The temperature set-points may be overridden by simply setting the desired temperature, using function 95 (similar in programming to functions 91-94). **R-E**

FET RF AMP PROBLEM

There's a problem in my Heathkit model GR169, which has been working very well since 1973. The MOSFET-RF amplifier blows out. The DC supply to this is +30 volts. All the possible substitutes I can find are rated at only 25 volts. I've contacted several sources without receiving much help. Can you help me? E.S., Mt. Dora, FL.

I'll try. This problem has shown up in some other sets.

For one thing, I'd get that DC voltage to the tuner down to less than the FET rating! Let's make it +22 volts or so. To do this, connect a suitable 22-volt Zener diode across the +30-volt supply to it, using a resistor large enough so that the Zener diode holds. This should keep it in the ball park as far as excess power dissipation is concerned. This has worked in some other cases, so it's worth a try. Good luck!

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Regardless of how minimal your computer background is now, you can learn to program an ELF II in almost no time at all. Our *Short Course On Microprocessor & Computer Programming*—written in non-technical language—guides you through each of the RCA COSMAC 1802's capabilities, so you'll understand everything ELF II can do... and how to get ELF II to do it! Don't worry if you've been stumped by computer books before. The *Short Course* represents a major advance in literary clarity in the computer field. You don't have to be a computer engineer in order to understand it. Keyed to ELF II, it's loaded with "hands on" illustrations. When you're finished with the *Short Course*, neither ELF II nor the RCA 1802 will hold any mysteries for you.

In fact, not only will you now be able to use a personal computer creatively, you'll also be able to read magazines such as *BYTE*, *INTERFACE*, *AGE*, *POPULAR ELECTRONICS* and *PERSONAL COMPUTING* and fully understand the articles. And, you'll understand how to expand ELF II to give you the exact capabilities you need!

If you work with large computers, ELF II and the *Short Course* will help you understand what they're doing.

Get Started For Just \$99.95, Complete!

\$99.95 ELF II includes all the hardware and software you need to start writing and running programs at home, displaying video graphics on your TV screen and designing circuits using a microprocessor—the very first night—even if you've never used a computer before.

ELF II connects directly to the video input of your TV set, without any additional hardware. Or, with an \$8.95 RF modulator (see coupon below), you can connect ELF II to your TV's antenna terminals instead.

ELF II has been designed to play all the video games you want, including a fascinating new target/misile gun game that was developed specifically for ELF II. But games are only the icing on the cake. The real value of ELF II is that it gives you a chance to write machine language programs—and machine language is the fundamental language of all computers. Of course, machine language is only a starting point. You can also program ELF II with assembly language and tiny BASIC. But ELF II's machine language capability gives you a chance to develop a working knowledge of computers that you can't get from running only

ELF II Gives You The Power To Make Things Happen!

Expanded, ELF II can give you more power to make things happen in the real world than heavily advertised home computers that sell for a lot more money. Thanks to an ongoing commitment to develop the RCA 1802 for home computer use, the ELF II products—being introduced by Neronics—keep you right on the outer fringe of today's small computer technology. It's a perfect computer for engineering, business, industrial, scientific and personal applications.

Plug in the **GIANT BOARD** to record and play back programs, edit and debug programs, communicate with remote devices and make things happen in the outside world. Add **KLUGE (prototyping) Board** and you can use ELF II to solve special problems such as operating a complex alarm system or controlling a printing press. Add **4K RAM Boards** to write longer programs, store more information and solve more sophisticated problems.

ELF II add-ons already include the ELF II Light Pen and the amazing ELF-BUG Monitor—two extremely recent breakthroughs that have not yet been duplicated by any other manufacturer.

The ELF-BUG Monitor lets you debug programs with lightning speed because the key to debugging is to know what's inside the registers of the microprocessors. And, with the ELF-BUG Monitor, instead of single stepping through your programs, you can now display the entire contents of the registers on your TV screen. You find out immediately what's going on and can make any necessary changes.

The incredible ELF II Light Pen lets you write or draw anything you want on a TV screen with just a wave of the "magic wand." Neronics has also introduced the ELF II Color Graphics & Music System—more breakthroughs that ELF II owners were the first to enjoy!

ELF II Tiny BASIC

Ultimately, ELF II understands only machine language—the fundamental coding required by all computers. But, to simplify your relationship with ELF II, we've introduced an ELF II Tiny BASIC that makes communicating with ELF II a breeze.

Tiny BASIC saves you the time of having to code your individual instructions in machine language for ELF II. Instead, you simply type instructions on a keyboard—PRINT, RUN, LOAD, ETC. Your Tiny BASIC program automatically translates them into machine language for ELF II. Then it translates ELF II's output back into simple words and symbols for you.

Now Available! Text Editor, Assembler, Disassembler And A New Video Display Board!

The Text Editor gives you word processing ability and the ability to edit programs or text while it is displayed on your video monitor. Lines and characters may be quickly inserted, deleted or changed. Add a printer and ELF II can type letters for you—error free—plus print names and addresses from your mailing list!

ELF II's Assembler translates assembly language programs into hexadecimal machine code for ELF II use. The Assembler features mnemonic abbreviations rather than numerics so that the instructions on your programs are easier to read—this is a big help in catching errors.

ELF II's Disassembler takes machine code programs and produces assembly language source listings. This helps you understand the programs you are working with—and improve them when required.

The new ELF II Video Display Board lets you generate a sharp, professional 32 or 64 character by 16 line upper and lower case display on your TV screen or video monitor—dramatically improving your unexpanded \$99.95 ELF II. When you get into longer programs, the Video Display Board is a real blessing!

Ask Not What Your Computer Can Do...

But WHAT CAN IT DO FOR YOU?

Don't be trapped into buying an expensive dinosaur, simply because you can afford it. ELF II is more advanced and more fun to use than big name computers that cost a lot more money. With ELF II you learn to write and run your own programs. You're not just a keypunch operator. No matter what your interests are, ELF II is the fastest way to get into computers. Order from the coupon below!



More information on new lit is available from the manufacturers of items identified by a Free Information number. Use the Free Information Card inside the back cover of this issue.

ELECTRONICS CATALOG, 164-page illustrated catalog for radio/TV service technicians, electronic technicians, hobbyists, CB'ers. Over 3000 items are listed, including test equipment, CB equipment and tools, intercoms, microphones, scanners, telephones and accessories, tool cases, antennas, etc. The catalog also contains a handy order form.—**Fordham Radio Supply Co.**, 855 Conklin St., Farmingdale, NY 11735.

CIRCLE 141 ON FREE INFORMATION CARD

TEST INSTRUMENT CATALOG describes portable, battery-operated digital multimeters, oscilloscopes and frequency meters. Meters measure 1.9 X 2.7 X 4.0 in., and have either LED or LCD readouts; oscilloscopes are single or dual-trace instruments and weigh under 3 lb; frequency meters count to 512 MHz. Catalog also features leather carrying cases.—**Non-Linear Systems, Inc.**, P.O. Box N, Del Mar, CA 92014.

CIRCLE 142 ON FREE INFORMATION CARD

SEMICONDUCTOR CROSS-REFERENCE GUIDE, *Tech-Mate*, is expanded catalog containing 161,016 listings of universal and replacement IC's, IC modules, voltage multipliers, semiconductor and accessories. Designed for electronic components distributors and service technicians, the component numbering system provides easy cross-reference identification.—**Thordarson Meissner, Inc.**, Electronic Center, Mt. Carmel, IL 62863.

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INDOOR TV ANTENNAS. Promotional wall chart contains illustrations and specifications for RCA's full line of indoor TV antennas. Chart can be used as a mailing piece or a wall poster. Available from RCA antenna distributors.—**RCA Distributor and Special Products Division**, Sales Promotion Services, Deptford, NJ 08096.

CIRCLE 144 ON FREE INFORMATION CARD

HEATHKIT CATALOG provides 96 pages of electronic kits plus many Heath-recommended assembled units. New products in this edition include a rack-mounted FM/AM stereo tuner, a DC to 35-MHz dual-trace oscilloscope, an FM deviation meter, a precision RF generator, and many more. The catalog also describes two personal computer systems, digital clocks, color TV systems, continuing education programs etc.—**Heath Company**, Dept. 570-170, Benton Harbor, MI 49022.

CIRCLE 50 ON FREE INFORMATION CARD

COILS AND CHOKES, *General Catalog 79*, contains 96 pages of hundreds of essential components, including interference filters, RF coils, auto radio replacement parts, antenna relays, tuning tools and hardware, TV replacement coils, coil forms, etc. Index lists items by type and frequency, there is an extensive price list, and schematic diagrams for shielded and unshielded units are shown in the back of the catalog.—**Bell Indus-**

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COMPUTER IC BROCHURE contains 24 pages and shows a complete line of IC devices for personal computers. More than 100 components are described, including microprocessors, memories, CRT controllers, floppy-disc Interfaces, analog and printer Interfaces and LED displays.—**National Semiconductor Corp.**, 2900 Semiconductor Dr., Santa Clara, CA 95051.

CIRCLE 148 ON FREE INFORMATION CARD

SEMICONDUCTOR REPLACEMENT GUIDE, No. ECG212H-3, third supplement to 1978 Master Replacement Guide, contains 32 pages that include data on 47 additional new devices. The cross-reference section contains over 3000 additional component numbers, and separate listings give recommended changes in ECG replacements and deletions from the line.—**GTE**, 1 Stamford Forum, Stamford, CT 06904.

CIRCLE 149 ON FREE INFORMATION CARD

VCR PROGRAM SOURCE, Video Programs/ Index, 20 pages, lists over 175 sources of available prerecorded video programs for use by libraries, schools, hospitals, etc. Includes the following: a format index (3/4U, Beta-1 and Beta-2, VHS-2, Quasar, etc.); a movie index; 461-category program index; and more. The catalog costs \$3, prepaid.—**Video Programs/Index**, 923 6th St. SW, Washington, DC 20024.

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TELEPHONE ACCESSORY

continued from page 63

Two of the four terminals on the jack/
plug are marked R and G for (red and
green). Wire L2 from the Telecorder is
connected to terminal R and wire L1 is
connected to terminal G. The jack/plug
is then inserted into the telephone jack,
and the plug on the telephone is inserted
into the Telecorder's jack/plug.

When the jack/plug is inserted into the
telephone jack, you should hear the relay
click. If you do not, check to make sure
the wires are properly connected to the
jack/plug. Now with the switch in the
center (off) position, plug in the AC line
cord. None of the panel lights should go
on. If the RECORD light is on, the relay
isn't working and the unit is probably
incorrectly connected to the phone line. If
the PLAY light is on, the wiring to the
switch is at fault.

Now, set the switch to the PLAY posi-
tion. The PLAY light should illuminate
and the recorder should be operational. If
it is, place the switch in the RECORD posi-
tion. The PLAY light should go out and
the recorder should stop. At this point,
the RECORD light should not be on. Lift
the telephone receiver off the hook. The
RECORD light should now go on and the
recorder should now be taping anything
that is heard in the telephone receiver.
When you replace the receiver in its
cradle, the light should extinguish and
the recorder should stop.

For a continuous monitoring operation,
the Telecorder is connected to both the
recorder and the phone line, and both
units are placed in the RECORD mode.

Note that, although it is not illegal to
connect privately owned equipment to the
telephone line (due to the 1968 Carter-
fone Decision), in some areas of the coun-
try it is against internal phone company
regulations. In those areas, for the device
to be strictly legal, it is necessary to place
a recorder coupler between the phone line
and the equipment to be connected to it.
If you want to make sure if a recorder is
required in your area, it is best to check
with your local phone company.

*(Material for this story was taken
from the author's book, Telephone Ac-
cessories You Can Build. Published by
Hayden Book Co., Rochelle Park, NJ
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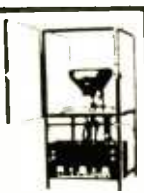
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LINEAR AMPLIFIER, Ham only 2–30 MHz, 100 watt. 300-MHz counter. Modulation booster, omnipolarized antenna. Plans \$3.00 each, \$10.00/ all. Catalog \$1.00, free with order. **PANAXIS**, Box 130-F6, Paradise, CA 95969

ALUMINUM panels 19 X 6 X 1/4. Perfect for rack mounting and custom installations. Easily cut to other sizes. \$6.50 each ppd. **RJP SALES**, 2360 Rockymont, St. Louis, MO 63136

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Assemble electronic devices in your home. Be your own boss. Get started in spare time. Experience. Little Knowledge or Investment Necessary. Expect big profits: \$300 - \$600/Wk. Possible. Write for free literature telling how.

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Positive Acting Photo Resist; Carbide bits; Bubble etchers; Artwork; Epoxy Glass Boards.

Send stamp & address label for flyer

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Two can ride cheaper than one.



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Delta Burglar ALARM

Featured in April Radio Electronics and Popular Mechanics Magazines!

Elementary Electronics, Too!

DELTA MOTION DETECTOR. This device detects any motion or movement for a minimum distance of 8-ft. The secret is in the ultra-complex custom 131 chip, which combines the latest in linear & digital circuitry. The device is completely self-contained, in a case 6 x 3 x 2 1/4", and operates from four "AA" NiCad batteries. Nothing else is needed, for the device to perform its basic function, motion detection. When motion or movement is detected, a "whoop" alarm is sounded. The **MOTION DETECTOR** is designed to provide either an audible or silent alarm. The silent alarm is controlled by a timer, which delays the alarm up to 30 seconds. The silent alarm activates a relay, whose contacts are brought out to plug, and will activate ANY device, such as siren, horn, tape recorder, telephone dialer, etc.

Delta No.	Description	Sale
5611R	Complete motion detector kit (less batteries)	\$24.50
1072R	Motion Detector Chip only, with data	8.95
5611R	P.C. boards, set of 2	6.50
5288R	"AA" NiCad Batteries, set of 4	4.50
5636R	Battery charger for above	5.95
5635R	Completely assembled kit, w/batteries & charger	69.50

Motion & FIRE Detector!

75¢

MOS FET N Channel Transistors!
1st time anywhere in surplus!
Motorola SFE616 or Siliconix 1524K5 originally designed for smoke detector operation.
No. 4606R 6 for \$4.

HIGH VOLTAGE—HIGH CAPACITANCE

Laser & Photo Flash Capacitors

\$20.95 EACH for \$40.

These capacitors are 40 Mfd@300V and are basically for laser & high-speed photography, but may be used wherever high voltage, high capacity is needed. These capacitors are oil-filled & removed from eqpt. Completely tested & guaranteed. They are mfg by several companies, SPRAGUE, CORNELL DUBILIER, etc. Wt. 10 lbs. Size 3 1/2" x 4 1/2" x 9 1/2". No. 2738R

Weston Meters!

Price Slash **\$9.95**

\$3 off our \$12.95 price. Brand new; sold orig. for \$75. Has large ZERO set wheel (removable). TWO scales: 0-100, 20 Mirror scale! Taut hand! Largest 7 1/2" No. 5673R 2 for \$19.

Tested 'AA' NICADS 98¢

SPECIAL-BY-MAIL OFFER

Brand new — slight imperfections on case!

Delta No.	Type	Ampere Hours	Dimen.	SALE
5688R	1/3A	.170	.619dia.x.680	.78
5686R	1/3A	.200	.619dia.x.758	.88
5687R	AA	.500	.545dia.x.1.83	.98
5689R	AA	.550	.687dia.x.1.98	.98
5680R	Sub C	1.2	.865dia.x.1.645	1.58
5687R	C	2.0	1.06 dia.x.1.87	2.08
5687R	C	2.0	1.028dia.x.1.85	1.98
5687R	1/2D	2.3	1.305dia.x.1.375	1.98
5687R	D	4.0	1.308dia.x.2.28	2.78

BUTTON CELLS

			Sale
5685R	1.2	.05 .895dia.x.205	.58
5683R	1.2	.15 .985dia.x.275	.68
5684R	1.2	.22 1.36 dia.x.207	.78
5682R	1.2	.22 1.36 dia.x.308	.88
5681R	1.2	.22 1.61 dia.x.320	.98

100% Guaranteed—Rechargeable

*Have tabs to permit soldering. +=buttons on both ends.

Video Cube TV Interface! \$12.95

The perfect interface between your computer and TV set. Allows you to use your set without any further outlay for a video terminal. Works on both b. & w. and color TVs. Comes with 300 ohm output & selector switch for switching from TV to computer. Draws about 10 mA at 5V to 12V. This meets all FCC requirements for this type of device. Delta includes complete instructions & reprint of the article "The Versatile Videocube" by Glen Dash No. 5499 2 for \$24

Versatile Triple Precision Timer! \$4.95

Unusual electronic timer, has 3 "timing circuits". Timers control a 3PDT relay, with 5 amp contacts. Choice of 2 time delays are selected thru a third timing circuit. The timing circuit in use is indicated by a pilot light. Two timing circuits are 0.1 to 15 seconds each, and the third is 0.1 to 5 seconds. All time delays may be changed to suit your individual needs. An unusual precision timer. Operates from 115 VAC, with circuit diagram & data. Size: 2 1/2" x 2 1/2" x 1 1/2". No. 5714R 2 for \$9.



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176 SECOND AVE.
WALTHAM, MASS.
02154
TEL. (617) 388-4705

Speaker Cabinet Kit!

We have a limited number of speaker assemblies from a famous prestige manufacturer of audio equipment. The photo shows an assembled kit. The speaker case is 10 1/2" x 17 1/4". Assembly holds a 3 1/2" tweeter, an 8" woofer (not included), and has a 2 1/2" port. Provision is made for a paddle adjustment (not shown). This assembly was used in the maker's \$300 speakers. Case material is simulated walnut. Kit is available in the following ways:

Delta No.	(2 for \$26)
5715R	Above, less spkrs.. \$13.95
5716R	Above, less spkrs, with grille cloth assembly, paddle assembly, terminal mtg. plate & terminals \$15.95 (2 for \$30)
5673R	Tweeter \$3.95 (2 for \$7)
5718R	8" Woofer for above, 10" air-suspended speaker \$16.95 (2 for \$33)

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7406	276-1821	49¢
7410	276-1807	39¢
7413	276-1815	79¢
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7432	276-1824	49¢
7441	276-1804	99¢
7447	276-1805	99¢
7448	276-1816	99¢
7451	276-1825	39¢
7473	276-1803	49¢
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7475	276-1806	79¢
7476	276-1813	59¢
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74154	276-1834	1.29
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4012	276-2412	69¢
4013	276-2413	89¢
4017	276-2417	1.49
4020	276-2420	1.49
4021	276-2421	1.49
4023	276-2423	69¢
4027	276-2427	89¢
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4046	276-2446	1.69
4049	276-2449	69¢
4050	276-2450	69¢
4051	276-2451	1.49
4066	276-2466	99¢
4070	276-2470	69¢
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4518	276-2490	1.49
4543	276-2491	1.89

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For Low-Cost Digital Readout

CMOS chip replaces over 8 separate IC's in a digital display circuit. Input pulse shaping. Master reset pin. 16-pin DIP. 276-2498 2.99

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Under 450 nS Access Time

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NEW LEDs

- Tri-Color
- Red Flasher



① Displays red, green, yellow. Uniform light output of 0.6 mcd. Forward voltage: 2.2VDC. Max. current: 25mA. T1-1/4 case style. 276-035 1.39
② Operates directly from 5VDC power source. Pulse rate: 3 Hz. Max. current: 20 mA at 5VDC. 276-036 1.29

SN-76477 Sound/Music Synthesizer IC



299 Featured in Oct. Popular Electronics

Creates almost any type of sound — music to "gunshots!" Built-in audio amp. Includes 2 VCO's, LF osc., noise gen., filter, 2 mixers, envelope modulator, logic circuit. 28-pin DIP. With data/application circuits. 276-1765 2.99

NEW Mercury Tilt Switch

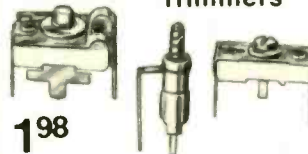
- Hermetically Sealed
- Perfect for Alarm Circuits



89¢ Actual Size!

Subminiature position-detecting switch for use in projects or special applications. Switch is normally closed when upright, opens when tilted more than 45°. Rated 100mA at 24VDC. 275-025 89¢

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198

Assorted low-loss RF trimmer capacitors. May include both compression and piston types rated up to 500VDC with maximum capacity values of 3 to 100 pF.

272-805 Pkg. of 15/1.98

Top-Quality IC and PCB Accessories



① PC Board. Mounts two 14 or 16-pin ICs or sockets for bread boarding. Copper clad. 2 1/2 x 5 x 1 1/16". 276-151 2.99

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⑤ 8-Position DIP Switch. 275-1301 1.99

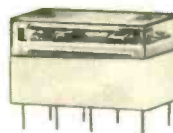
⑥ 4-Position DIP Switch. (Not shown.) 275-1304 1.49

⑦ Vertical 16-pin Socket. For LED displays. 276-1986 1.49

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NEW DPDT Dual Inline Relay

Fits Std. 14-Pin IC Socket



449

Subminiature relay is designed for use with TTL or CMOS circuitry. Contacts rated 1A at 125VAC. Coil requires 5VDC. Coil resistance, 50 ohms. 275-215 4.49

SALE Handheld 6-Digit Frequency Counter

Reg. 99.95 **69.95**

- Lead Zero Blanking
- 100 Hz Up to 45 MHz
- kHz and MHz Decimals

Accuracy is 3 ppm at 25°C or less than 30 Hz at 10 MHz. Overload-protected 1-meg input. Sensitivity, 30 mV up to 30 MHz. 3x4 1/2". With mini-rod antenna, leads, case, instructions. Requires 9V battery. 22-351. Sale 69.95
AC Adapter. U.L. listed. 65-731 4.95



Digital IC Logic Probe 24.95

Multi-Logic Family Compatibility from 5-15VDC

Detects one-shot low repetition rate, narrow pulses scopes miss. Combines level detector, pulse detector and pulse stretcher. Hi-LED indicates logic "1". Lo-LED is logic "0". Pulse LED displays pulse transitions to 300 nanoseconds, blinks at 3 Hz for high-frequency signals (up to 1.5 MHz). With cables. 22-300 24.95



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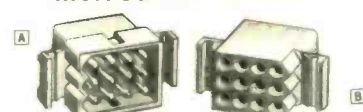


Everything you need for making high-quality custom PC boards.
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- ② Intel Memory Design Handbook. Explains use of Intel's memory components and support circuits in systems. 62-1378 3.95
- ③ Intel Data Catalog. 928 pages of specifications on most of Intel's standard microcomputer-related products. 62-1379 4.95
- ④ Semiconductor Reference and Application Handbook. Complete specs and applications for popular IC transistors, diodes. 276-4002 1.95

Molded Connectors



Rated 6A @ 250V. Standard .093" pin diameter.

Fig	Pins	Type	Cat No	Each	Fig	Pins	Type	Cat No	Each
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A	6	Male	274-226	1.19	B	6	Female	274-236	1.19
A	9	Male	274-229	1.39	B	9	Female	274-239	1.39
A	12	Male	274-232	1.49	B	12	Female	274-242	1.49

2-Pin Male & Female. (Not shown) 274-222

Pair 89¢

Digital Project Accessories

- ① Bezel with Lens. High-contrast filter for LED displays. 3 1/2 x 1 1/2" lens opening. 270-301 3.95
- ② Deluxe Molded Display Case. Red lens. Mount up to four 0.6" or eight 0.3" LED digits. With brackets. 1 1/2 x 3 3/4 x 4 1/4". 270-285 3.95
- ③ MA 1003 Clock Case. For car clock modules. Accepts 3 push-button switches (not inc.). With brackets. Blue lens. 3 1/2 x 2 1/2 x 2". 270-303 5.95

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THE MOST ADVANCED TIMEPIECE OF ITS KIND IN THE WORLD!

LCD Quartz Alarm Chronograph with calendar and dual time zone!! Watch is the same as Seiko but you pay a lot more for the name! Features:



- * 24 hour alarm
- * Chronograph counts up to 12 hrs., 59 mins. 59.9 sec.
- * Precision of chrono up to 1/10 sec indicated by 10 moving arrows!!
- * Lap time (with chrono running uninterrupted)
- * Time displays by LCD for hour, min, sec, day, date of the week and AM/PM.
- * Calendar gives out date-day
- * Dual time zone for any two cities of the world at your own choice.
- * With light switch to allow you to see the time in the dark!

\$65.50

ONE YEAR FULL WARRANTY!

JUMBO 1" LED ALARM CLOCK MODULE

- Assembled - not a kit!
- Features:
- * 1" 4 digits red LED display
 - * 12 hours real time format
 - * 24 hours alarm audio output (just add speaker)
 - * Power failure indicator
 - * Count down timer 59 mins.
 - * 12-16V AC 50/60 Hz input
 - * 10 min. snooze control



\$8.50 EACH

Transformer \$1.75

NEW MARK III 9 Steps 4 Colors LED VU



Stereo level indicator kit with arc-shape display panel!! This Mark III LED level indicator is a new design PC board with an arc-shape 4 colors LED display (change color from red, yellow, green and the peak output indicated by rose red). The power range is very large, from -30dB to +5dB. The Mark III indicator is applicable to 1 watt - 200 watts amplifier operating voltage is 3V - 9V DC at max 400 MA. The circuit uses 10 LEDs per channel. It is very easy to connect to the amplifier. Just hook up with the speaker output!

IN KIT FORM \$18.50

ELECTRONIC DUAL SPEAKER PROTECTOR

Cut off when circuit is shorted or overload to protect your amplifier as well as your speakers. A must for OCL circuits.



KIT FORM \$8.75 EA.

FM WIRELESS MIC KIT

It is not a pack of cigarettes. It is a new FM wireless mic kit! New design PC board fits into a plastic cigarette box (case included). Uses a condenser microphone to allow you to have a better response in sound pick-up. Transmits up to 350 ft.! With an LED indicator to signal the unit is on.



KIT FORM \$7.95

PLASTIC PROJECT BOX

The popular low-cost way to house your electronic experiments. With a copper-clad PC board cover, it allows you to have the circuits made right on top of the box.



Small size
2 7/8" x 2 1/4" x 1 3/8" 0.80 EACH
Large size
4" x 3" x 1 5/8" 1.25 EACH

DIGITAL AUTO SECURITY SYSTEM

4 DIGITS
PERSONAL CODE!!



- proximity triggered
- voltage triggered
- mechanically triggered

3-WAY PROTECTION!

This alarm protects you and itself! Entering protected area will set it off, sounding your car horn or siren you add. Any change in voltage will also trigger the alarm into action. If cables within passenger compartment are cut, the unit protects itself by sounding the alarm.

SPECIAL \$19.95

ALL UNITS FACTORY ASSEMBLED AND TESTED—NOT A KIT!

TIMATRON RACK MOUNT TYPE CABINETS!



All are of aluminum and machine made to very high-precision quality with sleek, black anodized finish. Front panels come blank and undrilled to allow you to make panels of your own design. For large

quantity orders Formula International will silkscreen print and drill panel holes at a minimal extra charge.

SIZE	PRICE
19" (W) x 2 1/2" (H) x 12" (D)	\$36.85
19" (W) x 4" (H) x 12" (D)	45.25
19" (W) x 8" (H) x 20" (D)	72.00
16" (W) x 2 1/2" (H) x 8" (D)	26.50
16" (W) x 4" (H) x 8" (D)	33.45
9 1/2" (W) x 2 1/2" (H) x 12" (D)	33.45
9 1/2" (W) x 4" (H) x 12" (D)	24.50
9 1/2" (W) x 4" (H) x 8" (D)	30.25

HICKOK LX303 DIGITAL LCD MULTIMETER



- 3 1/2 digits display
- 200 hours 9V battery life
- Auto zero; polarity; overrange indication
- 100MV DC F.S. sensitivity
- 19 ranges and functions
- D.C. volt: 0.1 MV to 1000 V
- A.C. volt: 0.1 V to 600 V
- Resistance: 0.1Ω to 20 MΩ
- D.C. current: 0.01 A to 100 MA

OUR PRICE \$71.45

60W + 60W

STEREO



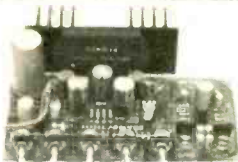
AMPLIFIER

COMPLETED UNIT—NOT A KIT!

OCL pre amp. & power stereo amp. with bass, middle, treble 3-way tone control. Fully assembled and tested, ready to work. Total harmonic distortion less than 0.5% at full power. Output maximum is 60 watts per channel at 8Ω. Power supply is 24 - 36V AC or DC. Complete unit

Assembled \$49.50 ea.
S 8.50 ea.

Power transformer



POWER TRANSFORMER \$6.50 EACH

GREEN COLOR 0.6" LED ALARM CLOCK



- 24 hr. alarm
- 10 min. snooze time
- AM/PM indicator
- Power Interrupt indication
- Green color 0.6" display
- 110V AC 60Hz input
- Factory assembled,

NOT A KIT \$17.50 EACH

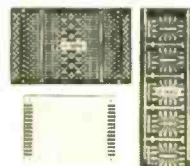
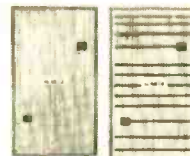
LCD CLOCK MODULE!



- 0.5" LCD 4 digits display
- X'tal controlled circuits
- D.C. powered (1.5V battery)
- 12 hr. or 24 hr. display
- 24 hr alarm set
- 60 min. countdown timer
- On board dual back up lights
- Dual time zone display
- Stop watch function

NIC1200 (12 hr) \$24.50 EA.
NIC2400 (24 hr) \$26.50 EA.

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All Boards are made of High Quality G10 Fiberglass and Phenolic. Pre-drilled in .042" diameter holes on 0.1" centers with tin plated copper eyelet and finger edge connectors (single sided) to allow any kind of standard components to fit board.

Part No.	Size	Holes	Fiberglass	Phenolic
U.S.P. 723	2" x 2.8"	529	\$ 1.27	\$.50
U.S.P. 724	2.8" x 3.7"	750	2.42	.80
U.S.P. 725	3.7" x 5.5"	1500	4.89	1.38
U.S.P. 728	7" x 9.6"	6240	19.50	10.40
H 5612	3" x 6"			1.70
H 5616	3" x 6"			1.70
H 5606	3" x 5"			1.50
H 5602	2" x 6"			1.50

BUTTON CELL



NI-CD RECHARGEABLE BATTERIES
225MA/hr 1.2V per cell
7/8" x 3/8"

Single Cell 1.2V \$1.20
4 cells stack 4.8V \$4.80
5 cells stack 6V \$6.00

special voltage order
accepted at \$1.30 per
cell rate

22W + 22W STEREO HYBRID AMPLIFIER KIT

It Works in 12V D.C. As Well! Kit includes 1 PC SANYO STK-024 stereo power amp. IC LM 1458 as pre amp, all other electronic parts, PC Board, all control pots and special heat sink for hybrid. Power transformer not included. It produces ultra hi-fi output up to 44 watts (22 watts per channel) yet gives out less than 0.1% total harmonic distortion between 100Mz and 10KHz.

\$32.50 PER KIT

SUPER 15 WATT AUDIO AMP KIT



ONLY \$23.50 each

MINI ELECTRONIC ORGAN KIT

PET-102 (25 KEYS)

The kit contains all electronic and mechanical parts, key boards, speaker, switches and PC Board as well as the wooden cabinet. Ideal for school project or gift to children interested in electronics. Uses 6V C size x 4 battery (not included).

\$38.50

MANY SOUND DECISIONS!



\$3.60 EACH

Solid state sound indicator operating voltage 6V DC 30mA. Small size approximately 1" x 1 1/4".

Model EB2116 (Continuous)
Model EB2126 (Slow Pulse)
Model EB2136 (Fast Pulse)



Continuous



Slow Pulse



Fast Pulse

1Watt AUDIO AMP

All parts are pre assembled on a mini PC Board. Supply Voltage 6~9V D.C. SPECIAL PRICE \$1.95 ea.



"FISHER" 30 WATT STEREO AMP

MAIN AMP (15W X 2)

Kit includes 2 pcs. Fisher PA 301 Hybrid IC all electronic parts with PC Board. Power supply: 16V DC (not included). Power band with (KF 1% - 3dB). Voltage gain 33dB. 20Hz - 20KHz.

Super Buy Only \$18.50



5W AUDIO AMP KIT

2 LM 380 with Volume Control. Power Supply 6~18V DC.

ONLY \$6.00 EACH



WE FOUND THE CASE FOR THE FM MIC!

Small nice looking aluminum case size like a pack of cigarettes. It is an intercom. Audio amp inside with a mic jack. A mini toggle switch on top. Can be used for many projects. We give you the circuit data as well.

VERY SPECIAL PRICE 2 for \$4.99

Sub-Mini Size CONDENSER MICROPHONE
FET Transistor Built-In \$2.50 each

ELECTRONIC ALARM SIREN

COMPLETE UNIT
Ideal for use as an Alarm Unit or hook-up to your car back up to make a reverse indicator. Light Output up to 130dB. Voltage Supply 6~12V \$7.50



SOUND ACTIVATED SWITCH

All parts mounted on a PC Board. SCR with built-in relay. 100mA at trigger voltage. Ideal for use as door alarm, sound controlled toys and many other projects. Supply voltage 4.5V ~ 15V D.C. \$1.75 ea./2 for \$3.00



LINEAR SLIDE POT

500KΩ SINGLE
Metal Case 3" Long
2 FOR \$1.20



Rechargeable
NI-CD Batteries Pak
6AA NI-CD in a flat pack gives you a total of 7.2V 450MA output

\$5.25 PER PACK



BATTERY POWERED FLUORESCENT LANTERN

FEATURES

- Circuitry designed for operation by high efficient, high power silicon transistor which enable illumination maintain in a standard level even the battery supply drops to a certain low voltage.
- 9" 6W cool/daylight miniature fluorescent tube.
- 8 x 1.5V UM 1 size D1 dry cell battery.
- Easy sliding door for changing batteries.
- Stainless reflector with wide angle in increasing illumination of the lantern.

\$10.50 EACH
MODEL 888 R



PROFESSIONAL CASE

for our 0-30V Power Supply. It is a nice looking metal cast case with giant 4" volt/amp meter; output blinding post and fuse holder, on/off switch and line cord!

ONLY \$21.50 EA.

CASE 030

POWER SUPPLY KIT



0-30V D.C. REGULATED
Uses UA723 and ZN3055 Power TR output can be adjusted from 0-30V. 2 AMP. Complete with PC board and all electronic parts.

0-30 POWER SUPPLY \$10.50 each

Transformer for Power Supply, 2AMP 24V x 2 \$8.50

12V DC MINI RELAY

6V SPDT 2AMP 1.30
12V SPDT 3AMP 1.60
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ELECTRONIC SWITCH KIT

CONDENSER TYPE

Push On Touch Off
uses 7473 I.C. and 12V relay
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ULTRA SONIC SWITCH KIT



Kit includes the Ultra Sonic Transducers, 2 PC Boards for transmitter and receiver. All electronic parts and instructions. Easy to build and a lot of uses such as remote control for TV, garage door, alarm system or counter. Unit operated by 9-12 DC.

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739-04



739-03

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12V DC POWERED

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Fluorescent Light Tubes

Ideal for camper, outdoor

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T176477

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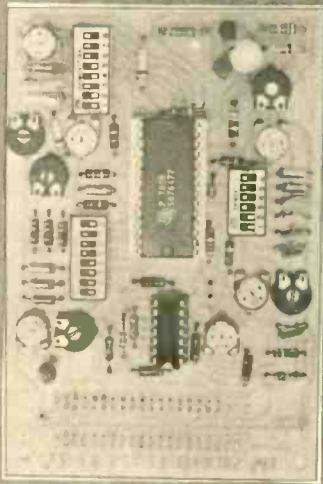
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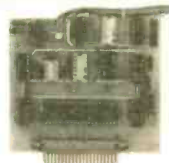
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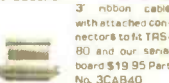
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- Can input into basic
- Can use LPRINT to output, or output continuously
- RS-232 compatible
- Can be used with or without the expansion bus
- On board switch selectable baud rates of 110, 150, 300, 600, 1200, 2400, parity or no parity odd or even, 5 to 8 data bits, and 1 or 2 stop bits. D.T.R. line
- Requires +5, -12 VDC
- Board only \$19.95 Part No. 8010, with parts \$59.95 Part No. 8010A, assembled \$79.95 Part No. 8010 C. No connectors provided, see below.



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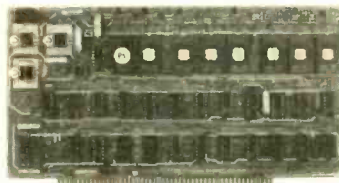


Baud rate is continuously adjustable from 0 to 30,000 • Plugs into any peripheral connector • Low current drain. RS-232 input and output • On board switch selectable 5 to 8 data bits, 1 or 2 stop bits, and parity or no parity either odd or even • Jumper selectable address • SOFTWARE • Input and Output routine from monitor or BASIC to teletype or other serial printer • Program for using an Apple II for a video or an intelligent terminal. Also can output in correspondence code to interface with some selectrics. • Also watches DTR • Board only \$15.00 Part No. 2, with parts \$42.00 Part No. 2A, assembled \$62.00 Part No. 2C

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PIICEON

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- Char. gen. 2513
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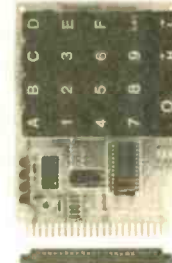
- Converts serial to parallel and parallel to serial
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- All connections go to a 44 pin gold plated edge connector
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E.S.

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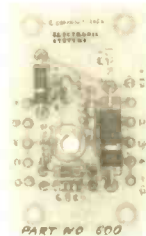
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115-230V 50/60 cy. in 12V DC at 15A out.
5" x 16" x 5" 19 lbs. shipping weight \$49.00
(OV PROTECT)

C/MOS (DIODE CLAMPED)

4001	18	4019	37	4049	35	74C23	65
4002	18	4020	90	4050	35	74C24	45
4006	95	4021	90	4051	45	74C26	40
4007	18	4022	90	4052	110	74C29	75
4009	37	4023	18	4053	125	74C151	140
4010	37	4024	75	4056	70	74C160	105
4011	18	4025	18	4057	18	74C161	105
4012	18	4027	37	4069	45	74C174	105
4013	29	4028	80	4072	21	74C175	105
4014	75	4029	95	4076	97	74C192	120
4015	75	4030	33	4079	70	74C193	120
4016	29	4035	97	74C200	22	74C201	48
4017	105	4042	65	74C202	22	74C202	48
4018	90	4044	65	74C101	27	74C234	170

PRINTED CIRCUIT BOARD

4 1/2" - 6 1/2" SINGLE S-D EPOXY
BOARD 1/16" thick unclipped
\$60 ea. 5/\$260

7 WATT LD-65 LASER DIODE IR \$8.95

2N 3820 P FET \$.45
2N 5457 N FET \$.45
7N2646 UJT \$.45
ER 50A TRIGGER DIODES 4 \$1.00
2N 6128 PROG. UJT \$.65

MINIATURE MULTI-TURN TRIM POTS
100, 1K, 2K, 5K, 10K, 20K, 50K
200K 1Meg, 2Meg. \$.75 each 3/\$2.00

CHARGED COUPLE DEVICES

CCD 201C 100x100 Image Sensor \$95.00
CCD 202C 100x100 Image Sensor \$145.00

VERIPAX PC BOARD \$4.00

This board is a 1/16" single sided paper epoxy board, 4 1/2" x 6 1/2" DRILLED AND ETCHED which will hold up to 21 single 14 pin IC's or 8, 16 or LS1 DIP IC's with bus ties for power supply connector.

FP 100 PHOTO TRANS.
RED, YELLOW, GREEN \$.50

LARGE LED'S 2"
TTL-118 OPTO-ISOLATOR \$.75
MCT-6 OPTO ISOLATOR \$.80
1 WATT ZENERS: 3.3, 4.7, 5.1, 5.6, 9.1, 10, 12, 15, 18, or 22V \$61.00
MCM 6671A 7 x 9 Connector \$1.75

UNIVERSAL 4Kx8 MEMORY BOARD KIT \$69.95

32-2102-1 fully buffered, 16 address lines, on board decoding for env 4 of 64 pages, standard 44 pin buss, may be used with P-8 & KIM

Silicon Power Rectifiers

PRV	1A	1A	12A	50	175A	240A
100	06	14	35	90	370	500
200	07	20	40	130	425	650
400	09	25	65	150	650	950
600	11	30	80	200	850	1250
800	15	35	100	250	1050	1650
1000	20	45	125	300	1250	2000

SAD 1024 x 8 REDICION 1024 static analog \$14.95
16 4148 (1N914) 15/\$1.00
1 of 25V ceramic caps 16/\$1.00 \$5.00/100

RS232 CONNECTORS

DB 25P male \$2.95
DB 25F female \$3.50
HOOKS \$1.50

REGULATORS

323K 5V 3A \$5.75 340K 12, 15 \$1.10
309K \$1.10 or 24V \$1.10
723 \$.50 340T 5, 6, 8, 12 \$1.70
320T 15, 18 or 24V \$1.10
5, 12, or 15 V 78 MG \$1.35
\$1.10 79 MG \$1.35

Full Wave Bridges

PRV	2A	4A	25A
100	1.30	1.30	1.30
200	1.30	1.30	2.00
400	1.30	1.50	3.00
600	1.20	1.75	4.00

DIP SOCKETS

8 PIN	17 PIN	24 PIN	35 PIN
14 PIN	20 PIN	28 PIN	40 PIN
16 PIN	22 PIN	40 PIN	60 PIN
18 PIN	25 PIN		

SANKEN AUDIO POWER AMPS

10 WATTS \$1.70
50 WATTS \$1.70
100 WATTS \$2.50

TANTULUM CAPACITORS

22UF	35V 5/100	68UF	35V 4/100
47UF	35V 5/100 <td>100UF</td> <td>10V \$.25</td>	100UF	10V \$.25
68UF	35V 5/100 <td>22UF</td> <td>25V \$.40</td>	22UF	25V \$.40
1UF	35V 5/100 <td>15UF</td> <td>35V 3/100</td>	15UF	35V 3/100
22UF	20V 5/100 <td>30UF</td> <td>6V 5/100</td>	30UF	6V 5/100
33UF	20V 4/100 <td>33UF</td> <td>20V \$.40</td>	33UF	20V \$.40
47UF	15V 5/100 <td>47UF</td> <td>20V \$.35</td>	47UF	20V \$.35
68UF	15V 5/100 <td>68UF</td> <td>15V \$.50</td>	68UF	15V \$.50

74LS SERIES

74LS00	74LS10	74LS13	74LS14
74LS01	74LS11	74LS12	74LS15
74LS02	74LS16	74LS17	74LS18
74LS03	74LS19	74LS20	74LS21
74LS04	74LS22	74LS23	74LS24
74LS05	74LS25	74LS26	74LS27
74LS06	74LS28	74LS29	74LS30
74LS07	74LS31	74LS32	74LS33
74LS08	74LS34	74LS35	74LS36
74LS09	74LS37	74LS38	74LS39
74LS10	74LS40	74LS41	74LS42
74LS11	74LS43	74LS44	74LS45
74LS12	74LS46	74LS47	74LS48
74LS13	74LS49	74LS50	74LS51
74LS14	74LS52	74LS53	74LS54
74LS15	74LS55	74LS56	74LS57
74LS16	74LS58	74LS59	74LS60
74LS17	74LS61	74LS62	74LS63
74LS18	74LS64	74LS65	74LS66
74LS19	74LS67	74LS68	74LS69
74LS20	74LS70	74LS71	74LS72
74LS21	74LS73	74LS74	74LS75
74LS22	74LS76	74LS77	74LS78
74LS23	74LS79	74LS80	74LS81
74LS24	74LS82	74LS83	74LS84
74LS25	74LS85	74LS86	74LS87
74LS26	74LS88	74LS89	74LS90
74LS27	74LS91	74LS92	74LS93
74LS28	74LS94	74LS95	74LS96
74LS29	74LS97	74LS98	74LS99

LINEAR CIRCUITS

LM101	LM102	LM103	LM104
LM105	LM106	LM107	LM108
LM109	LM110	LM111	LM112
LM113	LM114	LM115	LM116
LM117	LM118	LM119	LM120
LM121	LM122	LM123	LM124
LM125	LM126	LM127	LM128
LM129	LM130	LM131	LM132
LM133	LM134	LM135	LM136
LM137	LM138	LM139	LM140
LM141	LM142	LM143	LM144
LM145	LM146	LM147	LM148
LM149	LM150	LM151	LM152
LM153	LM154	LM155	LM156
LM157	LM158	LM159	LM160
LM161	LM162	LM163	LM164
LM165	LM166	LM167	LM168
LM169	LM170	LM171	LM172
LM173	LM174	LM175	LM176
LM178	LM179	LM180	LM181
LM182	LM183	LM184	LM185
LM187	LM188	LM189	LM190
LM191	LM192	LM193	LM194
LM195	LM196	LM197	LM198
LM199	LM200	LM201	LM202

REGULATED POWER SUPPLIES

POWER SYSTEMS # PS1111
115-230V 50/60 cy. in 5V DC at 35A out.
6" x 16" x 15" 26 lbs. shipping weight \$55.00

POWER SYSTEMS # PS1106
115-230V 50/60 cy. in 12V DC at 15A out.
5" x 16" x 5" 19 lbs. shipping weight \$49.00
(OV PROTECT)

C/MOS (DIODE CLAMPED)

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4010	37	4024	75	4056	70	74C160	105
4011	18	4025	18	4057	18	74C161	105
4012	18	4027	37	4069	45	74C174	105
4013	29	4028	80	4072	21	74C175	105
4014	75	4029	95	4076	97	74C192	120
4015	75	4030	33	4079	70	74C193	120
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1UF	35V 5/100 <td>15UF</td> <td>35V 3/100</td>	15UF	35V 3/100
22UF	20V 5/100 <td>30UF</td> <td>6V 5/100</td>	30UF	6V 5/100
33UF	20V 4/100 <td>33UF</td> <td>20V \$.40</td>	33UF	20V \$.40
47UF	15V 5/100 <td>47UF</td> <td>20V \$.35</td>	47UF	20V \$.35
68UF	15V 5/100 <td>68UF</td> <td>15V \$.50</td>	68UF	15V \$.50

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74LS08	74LS34	74LS35	74LS36
74LS09	74LS37	74LS38	74LS39
74LS10	74LS40	74LS41	74LS42
74LS11	74LS43	74LS44	74LS45
74LS12	74LS46	74LS47	74LS48
74LS13	74LS49	74LS50	74LS51
74LS14	74LS52	74LS53	74LS54
74LS15	74LS55	74LS56	74LS57
74LS16	74LS58	74LS59	74LS60
74LS17	74LS61	74LS62	74LS63
74LS18	74LS64	74LS65	74LS66
74LS19	74LS67	74LS68	74LS69
74LS20	74LS70	74LS71	74LS72
74LS21	74LS73	74LS74	74LS75
74LS22	74LS76	74LS77	74LS78
74LS23	74LS79	74LS80	74LS81
74LS24	74LS82	74LS83	74LS84
74LS25	74LS85	74LS86	74LS87
74LS26	74LS88	74LS89	74LS90
74LS27	74LS91	74LS92	74LS93
74LS28	74LS94	74LS95	74LS96
74LS29	74LS97	74LS98	74LS99

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LM117	LM118	LM119	LM120
LM121	LM122	LM123	LM124
LM125	LM126	LM127	LM128
LM129	LM130	LM131	LM132
LM133	LM134	LM135	LM136
LM137	LM138	LM139	LM140
LM141	LM142	LM143	LM144
LM145	LM146	LM147	LM148
LM149	LM150	LM151	LM152
LM153	LM154	LM155	LM156
LM157	LM158	LM159	LM160
LM161	LM162	LM163	LM164
LM165	LM166	LM167	LM168
LM169	LM170	LM171	LM172
LM173	LM174	LM175	LM176
LM178	LM179	LM180	LM181
LM182	LM183	LM184	LM185
LM187	LM188	LM189	LM190
LM191	LM192	LM193	LM194
LM195	LM196	LM197	LM198
LM199	LM200	LM201	LM202

TRANSISTOR SPECIALS

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2N5086 PNP Si TO 92 \$1.50
2N3137 NPN Si RF \$.55
2N3919 NPN Si TO 3 HI \$1.50
2N1420 NPN Si TO 5 \$1.00
2N3767 NPN Si TO 66 \$.75
2N4222 NPN Si TO 18 \$1.00
2N3055 NPN Si TO 3 \$.50
2N3904 NPN Si TO 18 \$1.00
2N3906 PNP Si TO 18 \$.75
2N5276 NPN Si TO 220 \$.50
2N6109 PNP Si TO 720 \$.50
MPSA 13 NPN Si TO 9 \$1.00

TTL IC SERIES

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7408	7409	7410	7411
7412	7413	7414	7415
7416	7417	7418	7419
7420</			

HICKOK TEST INSTRUMENTS

HICKOK New Digital Mini-Multimeter

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\$74.95
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- Auto zero, Polarity, Overrange Indication
- 100 mV DC F.S. sensitivity
- 19 ranges and functions

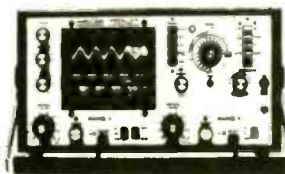
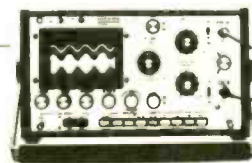


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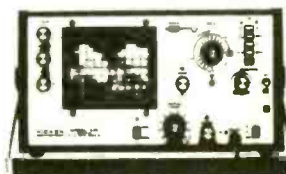


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MODEL 517

Reg. \$695.00
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Reg. \$495.00
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3 1/2 Digit
Mini-Multimeter

- 100 mV DC F.S. Sensitivity
- 19 Ranges and Functions
- 200 Hours 9V Battery Life
- Auto Zero, Polarity, Overrange Indication

Reg. \$74.95 **\$69.50** HICKOK



SENCORE
TV-VTR-MATV
and Video Analyzer



Model VA48
Reg. \$875.00 **\$875.00**

CONTINENTAL SPECIALTIES

100 MHz 8-Digit Counter \$119.00

- 20 Hz 100 MHz Range • 8 1/2 D Display • Fully Automatic
- Includes 100 TPC test probe and other features

Now Available **PS500 500MHZ Prescaler \$52.95**



Model 100

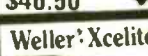
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Portable DMM

- Overhead Protected • Battery or AC operation • 3" high LED Display
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Model 2800
comes complete with test leads, operating manual and spare fuses
Model 2810 **\$110.50**



Ungar
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Reg. \$69.00 **\$46.50**

Weller Xcelite



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BK PRECISION Digital
Capacitance Meter



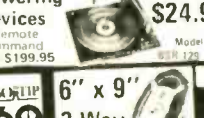
Model 820
Reg. \$130.00 **\$110.50**

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Telephone
Answering
Devices



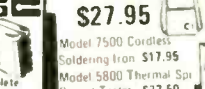
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BSR Changer
Accessories



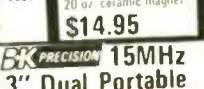
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WAHL
NEW ISO-TIP
"Quick Charge"



Model 7800
12 units
Reg. \$27.95 **\$27.95**

6" x 9"
3-Way
Speaker



Model 7800
20 oz. ceramic magnet
\$14.95

NLS
15 MHz Mini
Oscilloscope



Model MS 15
Reg. \$318.00 **\$269.95**

Attache Style
Tool Cases



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Roll Kit



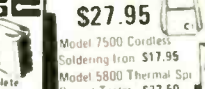
Model 999P
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Logic Monitor



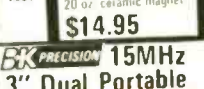
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Reg. \$52.95 **\$52.95**

NEW ISO-TIP
"Quick Charge"



Model 7800
12 units
Reg. \$27.95 **\$27.95**

6" x 9"
3-Way
Speaker



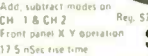
Model 7800
20 oz. ceramic magnet
\$14.95

Logic Probe



Model LP-1
Reg. \$40.00 **\$40.00**

20 MHz.
Dual Trace



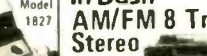
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700 Series



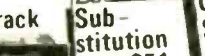
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SUPER
SPECIAL



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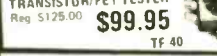
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Trace
Scope



Model 1432P
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Reg. \$49.50 **\$49.50**

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Portable
Frequency
Counter



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Reg. \$120.00 **\$59.95**

AM/FM
Cassette
Stereo



Model 888
Reg. \$57.50 **\$57.50**

Function
Generator



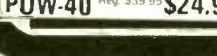
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Reg. \$169.15 **\$169.15**

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Soldering
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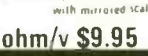
Model WTCP-N
Reg. \$75.00 **\$45.00**

Auto Stereo 40 Watt
Power Booster
POW-40



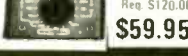
Model POW-40
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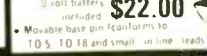
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2SA 496	.50	.64	.70	2SB 415	.30	.35	.40	2SC 727	1.00	1.20	1.30	2SD 330	.60	.70	.80	2SC 1313G	.20	.27	.30
2SA 497	1.00	1.20	1.30	2SB 434	.80	.90	1.00	2SC 730	3.00	3.20	3.40	2SD 350	3.80	4.00	4.40	2SC 1316	4.20	4.40	4.90
2SA 505	.50	.64	.70	2SB 435	.90	1.10	1.20	2SC 731	2.50	2.70	2.90	2SD 380	5.20	5.40	5.95	2SC 1317	.20	.27	.30
2SA 509	.30	.35	.40	2SB 440	.40	.53	.59	2SC 732	.20	.27	.30	2SD 381	.85	1.00	1.10	2SC 1318	.55	.60	.65
2SA 525	.50	.64	.70	2SB 449	1.30	1.45	1.60	2SC 733	.20	.27	.30	2SD 424	3.80	4.00	4.40	2SC 1325A	6.50	6.90	7.60
2SA 530	1.50	1.70	1.90	2SB 461	.90	1.10	1.20	2SC 734	.20	.27	.30	2SD 425	2.90	3.20	3.40	2SC 1327	.20	.27	.30
2SA 537A	1.50	1.70	1.90	2SB 463	.90	1.10	1.20	2SC 735	.20	.27	.30	2SD 426	3.10	3.30	3.60	2SC 1330	.50	.55	.60
2SA 539	.40	.45	.50	2SB 471	1.10	1.25	1.40	2SC 738	.20	.27	.30	2SD 427	1.80	2.00	2.25	2SC 1335	.50	.55	.60
2SA 545	.45	.53	.59	2SB 472	2.10	2.50	2.80	2SC 756	1.50	1.80	2.00	2SD 525	.90	1.10	1.20	2SC 1342	.45	.53	.59
2SA 561	.30	.35	.40	2SB 473	.80	.90	1.00	2SC 756A	1.50	1.80	2.00	2SD 526	.60	.70	.80	2SC 1344	.45	.53	.59
2SA 562	.30	.35	.40	2SB 474	.70	.80	.90	2SC 763	.35	.40	.45	2SK 19BL	.50	.55	.60	2SC 1358	4.20	4.40	4.90
2SA 564A	.20	.27	.30	2SB 481	.90	1.10	1.20	2SC 772	.30	.35	.40	3SK 22Y	1.40	1.60	1.80	2SC 1359	.30	.35	.40
2SA 565	.70	.80	.90	2SB 492	.60	.70	.80	2SC 773	.35	.40	.45	3SK 39	.90	1.10	1.20	2SC 1360	.50	.55	.60
2SA 566	2.50	2.70	3.00	2SB 507	.80	.90	1.00	2SC 774	1.00	1.20	1.30	3SK 40	.90	1.10	1.20	2SC 1362	.35	.40	.45
2SA 606	1.00	1.20	1.30	2SB 509	1.10	1.20	1.30	2SC 775	1.40	1.60	1.80	3SK 41	1.30	1.45	1.60	2SC 1363	.35	.40	.45
2SA 607	1.10	1.25	1.40	2SB 511	.70	.80	.90	2SC 776	2.00	2.20	2.50	3SK 45	1.30	1.45	1.60	2SC 1364	.35	.40	.45
2SA 624	.70	.80	.90	2SB 514	.70	.80	.90	2SC 777	.300	3.25	3.50	AN 203	1.40	1.60	1.80	2SC 1377	3.20	3.40	3.70
2SA 627	3.10	3.30	3.60	2SB 523	.70	.80	.90	2SC 778	2.90	3.20	3.40	AN 214Q	1.50	1.70	1.90	2SC 1383	.30	.35	.40
2SA 628	.30	.35	.40	2SB 526C	.70	.80	.90	2SC 781	1.90	2.10	2.40	AN 239	4.20	4.40	4.90	2SC 1384	.35	.40	.45
2SA 634	.40	.45	.50	2SB 527	.90	1.10	1.20	2SC 783	2.10	2.50	2.80	AN 247	2.50	2.70	3.00	2SC 1396	.45	.53	.59
2SA 640	.30	.35	.40	2SB 528D	.70	.80	.90	2SC 784	.30	.35	.40	AN 274	1.50	1.75	1.95	2SC 1398	.70	.80	.90
2SA 642	.30	.35	.40	2SB 529	.70	.80	.90	2SC 785	.35	.40	.45	AN 313	3.00	3.20	3.40	2SC 1400	.35	.40	.45
2SA 643	.30	.40	.45	2SB 530	3.20	3.40	3.70	2SC 789	.80	.90	1.00	AN 315	1.80	2.00	2.25	2SC 1402	3.00	3.20	3.40
2SA 653	1.90	2.10	2.40	2SB 531	1.80	2.00	2.25	2SC 790	.80	.90	1.00	BA 511A	1.80	2.00	2.25	2SC 1403	3.20	3.40	3.70
2SA 659	.35	.40	.45	2SB 536	1.00	1.20	1.30	2SC 793	2.00	2.20	2.50	BA 521	1.90	2.10	2.40	2SC 1407	.50	.55	.60
2SA 661	.50	.64	.70	2SB 537	1.00	1.20	1.30	2SC 799	2.00	2.20	2.50	HA 1151	1.50	1.75	1.95	2SC 1419	.60	.70	.80
2SA 663	3.65	3.80	4.20	2SB 539	3.20	3.40	3.70	2SC 828	.20	.27	.30	HA 1156W	1.60	1.80	2.00	2SC 1444	1.60	1.80	2.00
2SA 666	.35	.40	.45	2SB 541	3.20	3.40	3.70	2SC 829	.20	.27	.30	HA 1306W	2.00	2.20	2.50	2SC 1445	2.50	2.70	2.90
2SA 671	.30	.35	.40	2SB 554	.600	.660	.660	2SC 830H	2.50	2.70	3.00	HA 1339	2.50	2.70	3.00	2SC 1447	.60	.70	.80
2SA 672	.30	.35	.40	2SB 556	3.20	3.40	3.70	2SC 838	.35	.40	.45	HA 1393A	2.50	2.70	3.00	2SC 1448	.70	.80	.90
2SA 673	.35	.40	.45	2SB 557	2.10	2.50	2.80	2SC 839	.30	.35	.40	HA 1342A	2.50	2.70	3.00	2SC 1449	.60	.70	.80
2SA 678	.35	.40	.45	2SB 561B	.35	.40	.45	2SC 853	.70	.80	.90	HA 1366W	2.50	2.70	3.00	2SC 1451	1.00	1.10	1.20
2SA 679	4.20	4.40	4.90	2SB 564	.40	.53	.59	2SC 867	3.20	3.40	3.70	HA 1366WR	2.50	2.70	3.00	2SC 1454	3.20	3.40	3.70
2SA 680	4.20	4.40	4.90	2SB 595	1.10	1.40	1.50	2SC 867A	3.20	3.40	3.70	LA 403IP	1.80	2.00	2.25	2SC 1475	.80	.90	1.00
2SA 682	.80	.90	1.00	2SB 597	1.10	1.40	1.50	2SC 870	.90	.90	.90	LA 4032P	1.80	2.00	2.25	2SC 1476	.50	.55	.60
2SA 683	.30	.35	.40	2SB 600	5.00	6.00	6.60	2SC 871	.35	.40	.45	LA 4051P	1.80	2.00	2.25	2SC 1477	.50	.55	.60
2SA 684	.35	.40	.45	2SC 183	.40	.53	.59	2SC 895	4.20	4.40	4.90	LA 4400	1.90	2.10	2.40	2SC 1509	.50	.55	.60
2SA 695	.40	.53	.59	2SC 184	.40	.53	.59	2SC 897	2.00	2.20	2.50	LA 4055P	1.80	2.00	2.25	2SC 1557	.60	.70	.80
2SA 697	.40	.53	.59	2SC 281	.30	.35	.40	2SC 898	2.50	2.70	3.00	LA 4400Y	2.00	2.20	2.50	2SC 1567A	.60	.70	.80
2SA 699A	.50	.64	.70	2SC 283	.40	.53	.59	2SC 899	2.00	2.20	2.50	LA 4420	2.00	2.20	2.50	2SC 1584	6.00	6.30	7.00
2SA 705	.40	.53	.59	2SC 284	.80	.90	1.00	2SC 900	.20	.27	.30	LD 3001	2.00	2.20	2.50	2SC 1586	6.50	6.90	7.60
2SA 706	.85	1.00	1.10	2SC 317	.40	.53	.59	2SC 923	.20	.27	.30	MS 1513L	2.00	2.20	2.50	2SC 1624	.60	.70	.80
2SA 715	.60	.70	.80	2SC 352A	2.00	2.20	2.50	2SC 929	.20	.27	.30	STK 011	3.80	4.00	4.40	2SC 1626	.60	.70	.80
2SA 719	.30	.35	.40	2SC 353A	1.40	1.60	1.80	2SC 930	.20	.27	.30	STK 013	7.60	8.00	8.80	2SC 1628	.60	.70	.80
2SA 720	.30	.35	.40	2SC 367	.60	.70	.80	2SC 941	.20	.27	.30	STK 015	4.20	4.40	4.90	2SC 1647	.70	.80	.90
2SA 721	.30	.35	.40	2SC 369	.30	.35	.40	2SC 943	.35	.40	.45	STK 435	4.50	5.00	5.60	2SC 1667	3.00	3.20	3.40
2SA 725	.30	.35	.40	2SC 370	.20	.27	.30	2SC 945	.20	.27	.30	STK 439	7.90	8.00	8.80	2SC 1669	.90	1.00	1.10
2SA 726	.30	.35	.40	2SC 371	.30	.35	.40	2SC 959	1.00	1.20	1.30	TA 7045M	2.00	2.20	2.50	2SC 1674	.30	.35	.40
2SA 733	.20	.27	.30	2SC 372	.20	.27	.30	2SC 971	.70	.80	.90	TA 7055P	2.00	2.20	2.50	2SC 1675	.20	.27	.30
2SA 738	.40	.53	.59	2SC 373	.20	.27	.30	2SC 982	.70	.80	.90	TA 7061P	.90	1.10	1.20	2SC 1678	1.10	1.25	1.40
2SA 740	1.50	1.70	1.90	2SC 374	.30	.35	.40	2SC 983	.50	.64	.70	TA 7062P	1.10	1.25	1.40	2SC 1679	3.00	3.20	3.40
2SA 743A	.85	1.00	1.10	2SC 375	.30	.35	.40	2SC 1000	.35	.40	.45	TA 7203P	2.50	2.70	2.90	2SC 1681	.30	.35	



FREQUENCY COUNTER KIT

Outstanding Performance

CT-50

Incredible Price **\$89⁹⁵**

The CT-50 is a versatile and precision frequency counter which will measure frequencies to 60 mHz and up to 600 mHz with the CT-600 option. Large Scale Integration, CMOS circuitry and solid state display technology have enabled this counter to match performance found in units selling for over three times as much. Low power consumption (typically 300-400 ma) makes the CT-50 ideal for portable battery operation. Features of the CT-50 include: large 8 digit LED display, RF shielded all metal case, easy pushbutton operation, automatic decimal point, fully socketed IC chips and input protection to 50 volts to insure against accidental burnout or overload. And, the best feature of all is the easy assembly. Clear, step by step instructions guide you to a finished unit you can rely on.

Order your today!

CT-50, 60 mHz counter kit
CT-50WT, 60 mHz counter, wired and tested
CT-600, 600 mHz scaler option, add

\$89.95
\$59.95
\$29.95

CB-1, Color TV calibrator-stabilizer
DP-1, DC probe, general purpose probe
HP-1, High impedance probe, non-loader

\$14.95
\$12.95
\$15.95

SPECIFICATIONS:

Frequency range: 6 Hz to 65 MHz, 600 MHz with CT-600
Resolution: 10 Hz to 0.1 sec gate, 1 Hz to 1 sec gate
Readout: 8 digit, 0.4" high LED, direct readout in mHz
Accuracy: adjustable to 0.5 ppm
Stability: 2.0 ppm over 10°C to 40°C temperature compensated
Input: BNC, 1 megohm 20 pF direct, 50 ohm with CT-600
Overload: 50VAC maximum, all modes
Sensitivity: less than 25 mV to 65 mHz, 5-150 mV to 600 mHz
Power: 110 VAC 5 Watts or 12 VDC, 400 ma
Size: 6" x 4" x 2", high quality aluminum case, 2 lbs
ICS: 13 units, all socketed

CAR CLOCK



The UN-KIT, only
5 solder connections

Here's a super looking, rugged and accurate auto clock which is a snap to build and install. Clock movement is completely assembled—you only solder 3 wires and 2 switches, takes about 15 minutes! Display is bright green with automatic brightness control photocell—assures you of a highly readable display, day or night. Comes in a satin finish anodized aluminum case which can be attached 5 different ways using 2 sided tape. Choice of silver, black or gold case (specify)

DC-3 kit, 12 hour format **\$22.95**
DC-3 wired and tested **\$29.95**
110V AC adapter **\$5.95**

Under dash car clock



12/24 hour clock in a beautiful plastic case features 6 jumbo RED LEDs, high accuracy (1 min. mo.), easy 3 wire hookup, display blanks with ignition, and super instructions. Optional dimmer automatically adjusts display to ambient light level
DC-11 clock with mtg bracket **\$27.95**
DM-1 dimmer adapter **2.50**

PRESCALER



Extend the range of your counter to 600 mHz. Works with any counter. Includes 2 transistor pre-amp to give super sens., typically 20 mV at 150 mHz. Specify +10 or +100 ratio.
PS-1B, 600 mHz prescaler **\$59.95**
PS-1BK, 600 mHz prescaler kit **49.95**

OP-AMP SPECIAL

741 mini dip **12/\$2.00**
B1-FET, mini dip, 741 type **10/\$2.00**

VIDEO TERMINAL

A completely self-contained, stand alone video terminal card. Requires only an ASCII keyboard and TV set to become a complete terminal unit. Two units available, common features are: single 5V supply, XTAL controlled sync and baud rates (to 9600), complete computer and keyboard control of cursor, Parity error control and display. Accepts and generates serial ASCII plus parallel keyboard input. The 3216 is 32 char. by 16 lines, 2 pages with memory dump feature. The 6416 is 64 char. by 16 lines, with scrolling, upper and lower case (optional) and has RS-232 and 20ma loop interfaces on board. Kits include sockets and complete documentation.

RE 3216, terminal card **\$149.95**
RE 6416, terminal card **\$89.95**
Lower Case option, 6416 only **\$3.95**
Power Supply Kit **14.95**
Video/RF Modulator, VD-1 **6.95**
Assembled, tested units, add **60.00**

CALENDAR ALARM CLOCK

The clock that's got it all, 6" 5" LEDs, 12/24 hour, snooze, 24 hour alarm, 4 year calendar, battery backup, and lots more. The super 7001 chip is used. Size 5x4x2 inches
Complete kit, less case (not available) **\$34.95**
DC-9

30 Watt 2 mtr PWR AMP

Simple Class C power amp features 8 times power gain, 1 W in for 8 out, 2 in for 15 out, 4 W in for 30 out. Max. output of 35 W. Incredible value, complete with all parts, less case and T-R relay.
PA-1, 30 W, pwr amp kit **\$22.95**
TR-1, RF sensed T-R relay kit **6.95**

FM MINI MIKE KIT



A super high performance FM wireless mike kit! Transmits a stable signal up to 300 yards with exceptional audio quality by means of its built in electret mike. Kit includes case, mike, on-off switch, antenna, battery and super instructions. This is the finest unit available

FM-3 kit **\$12.95**
FM-3 wired and tested **16.95**

CLOCK KITS



our Best Seller
your Best Deal

Try your hand at building the finest looking clock on the market. Its satin finish anodized aluminum case looks great anywhere, while six 4" LED digits provide a highly readable display. This is a complete kit, no extras needed, and it only takes 1-2 hours to assemble. Your choice of case colors: silver, gold, bronze, black, blue (specify).
Clock kit, 12/24 hour, DC-5 **\$22.95**
Clock with 10 min. ID timer, 12/24 hour, DC-10 **27.95**
Alarm clock, 12 hour only, DC-8 **24.95**
12V DC car clock, DC-7 **27.95**
For wired and tested clocks add \$10.00 to kit price.

Hard to find PARTS

LINEAR ICs		REGULATORS	
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567	1.25	7912	1.25
1458	.50	7815	.85
3900	.50	TTL ICs	
CMOS ICs		74500	.35
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4013	.35	7475	.50
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4049	.40	74198T1	1.35
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FET MPF102 type	3/2.00	Jumbo rec	8/1.00
UHF 2N5175 type	3/2.00	Jumbo green	6/1.00
MRF-238 RF	11.95	Jumbo yellow	6/1.00
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24 pin	4/2.00	With info, specs	15/1.00
28 pin	4/2.00	6 hole ballun	5/1.00
40 pin	3/2.00		

Ramsey's famous MINI-KITS

FM WIRELESS MIKE KIT

Transmits up to 300' to any FM broadcast radio, uses any type of mike. Runs on 3 to 9V. Type FM-2 has added sensitive mike preamp stage
FM-1 kit **\$2.95** FM-2 kit **\$4.95**



VIDEO MODULATOR KIT

Converts any TV to video monitor. Super stable, tunable over ch. 4-6. Runs on 5-15V, accepts std. video signal. Best unit on the market!
Complete kit, VD-1 **\$6.95**

TONE DECODER

A complete tone decoder on a single PC board. Features 400-5000 Hz adjustable range via 20 turn pot, voltage regulation, 567 IC. Useful for touch-tone decoding, tone burst detection, FSK, etc. Can also be used as a stable tone encoder. Runs on 5 to 12 volts.
Complete kit, TD-1 **\$5.95**



SUPER SLEUTH

A super sensitive amplifier which will pick up a pin drop at 15 feet! Great for monitoring baby's room or as general purpose amplifier. Full 2 W rms output, runs on 6 to 15 volts, uses 8-45 ohm speaker.
Complete kit, BN-9 **\$5.95**



POWER SUPPLY KIT

Complete triple regulated power supply provides variable 6 to 18 volts at 200 ma and +5V at 1 A. Amp. Excellent load regulation, good filtering and small size. Less transformers, requires 6.3V @ 1 A and 24 VCT.
Complete kit, PS-3LT **\$6.95**



LED BLINKY KIT

A great attention getter which alternately flashes 2 jumbo LEDs. Use for name badges, buttons, warning panel lights, anything! Runs on 3 to 15 volts.
Complete kit, BL-1 **\$2.95**

WHISPER LIGHT KIT

An interesting kit. Small mike picks up sounds and converts them to light! The louder the sound, the brighter the light! Completely self-contained, includes mike, runs on 110VAC, controls up to 300 watts.
Complete kit, WL-1 **\$6.95**

SIREN KIT

Produces upward and downward wail characteristic of a police siren. 5 W peak audio output, runs on 3-15 volts, uses 3-45 ohm speaker.
Complete kit, SM-3 **\$2.95**

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100	25	25	26
100	50	35	36
100	100	39	40
150	15	23	24
220	15	24	25
220	25	32	33
250	16	29	30
250	25	32	33
250	50	45	46
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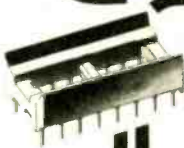
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SYM-1 MICROCOMPUTER BOARD

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