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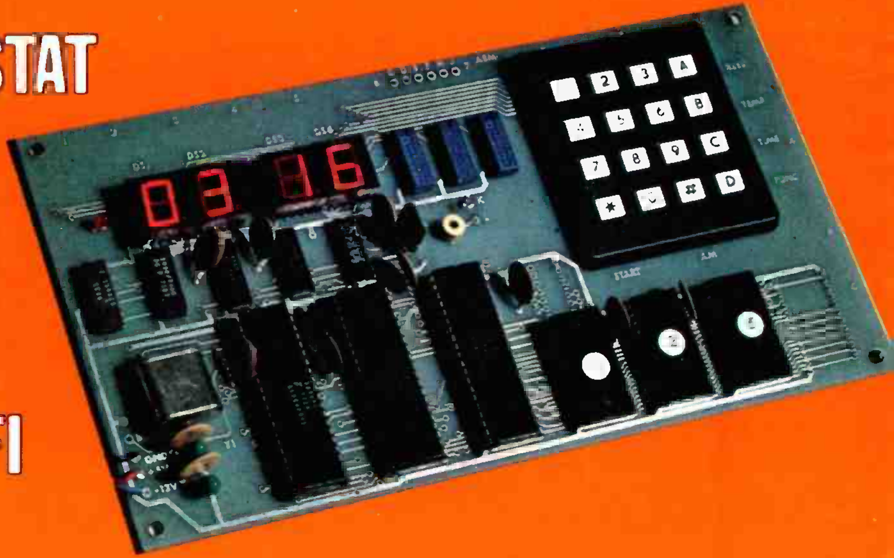
Radio-Electronics®

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS



INTELLIGENT THERMOSTAT
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

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New audio spec

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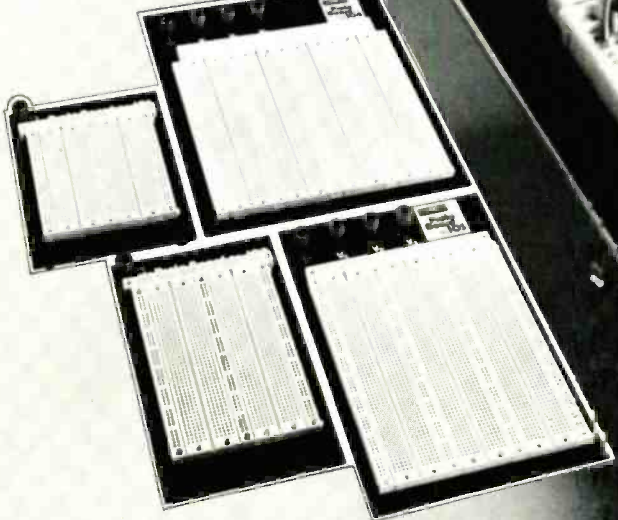
There are 9 Proto-Boards® in all, manufacturer's suggested U.S. resale prices from $15.95 to $124.95.



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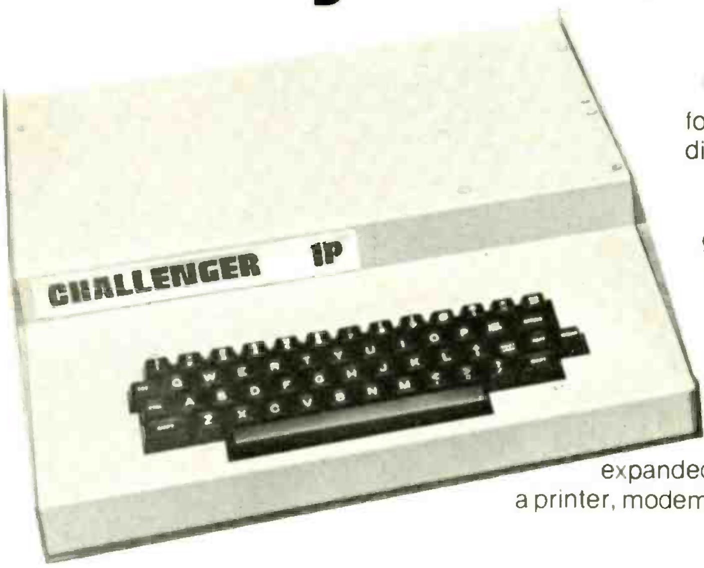
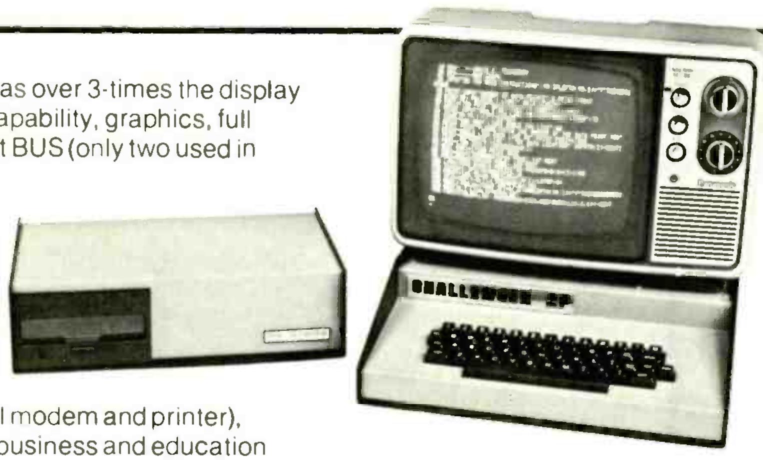
The Personal Computer Line by OHIO SCIENTIFIC



C1P: $349! A dramatic breakthrough in price and performance. Features OSI's ultra-fast BASIC-in-ROM, full graphics display capability, and large library of software on cassette and disk, including entertainment programs, personal finance, small business, and home applications. It's a complete programmable computer system ready to go. Just plug-in a video monitor or TV through an RF converter, and be up and running. 15K total memory including 8K BASIC and 4K RAM — expandable to 8K.

C1P MF: $995! First floppy disk based computer for under $1000! Same great features as the C1P plus more memory and instant program and data retrieval. Can be expanded to 32K static RAM and a second mini-floppy. It also supports a printer, modem, real time clock, and AC remote interface, as well as OS-65D V3.0 development disk operating system.

C2-4P: $598! The professional portable that has over 3-times the display capability of 1P's. Features 32 x 64 character display capability, graphics, full computer type keyboard, audio cassette port, and 4 slot BUS (only two used in base machine). It has 8K BASIC, 4K RAM, and can be expanded to 32K RAM, dual mini-floppies and a printer.



C2-4P MF: $1599! It's a big personal computing mini-floppy system at a special package price. Contains the famous C2-4P microcomputer with 20K static RAM, 5" mini-floppy unit for instant program and data loading, RS-232 circuitry (for optional modem and printer), and four diskettes featuring exciting games, personal, business and education applications.

C2-8P: $799! The personal class computer that can be expanded to a full business system. Has all the features of the C2-4P plus an 8 slot BUS (3-times greater expansion ability than the C2-4P). Can be expanded to 48K RAM, dual floppies, hard disk, printer and business software.

C2-8P DF: $2599! A full business system available at a personal computer price! The system includes the powerful C2-8P microcomputer (32K RAM expandable to 48K), dual 8" floppy unit (stores 8-times as much information as a mini-floppy), and 3 disks of personal, educational and small business applications software. Has all the capabilities of a personal system including graphics plus the ability to perform Accounting, Information Management, and Word Processing tasks for small business. Contact your local Ohio Scientific dealer

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

CIRCLE 6 ON FREE INFORMATION CARD

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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Radio-Electronics®

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

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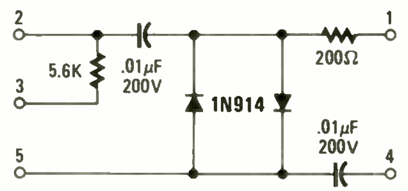
JUNE 1979 Vol. 50 No. 6

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 videocassettes 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

JS&A's new program will save consumers millions.

MISSING ADAPTER

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 1⅝" 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: Hallicrafters *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 μF. 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

Color. VP-590 add-on Color Board allows program control of 8 brilliant colors for graphics, color games. Plus 4 selectable background colors. Includes sockets for 2 auxiliary keypads (VP-580). $69.*

Sound. VP-595 Simple Sound Board provides 256 tone frequencies. Great for supplementing graphics with sound effects or music. Set tone and duration with easy instructions. $24.*

Music. VP-550 Super Sound Board turns your VIP into a music synthesizer. 2 sound channels. Program control of frequency, time and amplitude envelope (voice) independently in each channel. Program directly from sheet music! Sync provision for controlling multiple VIPs, multitrack recording or other synthesizers. $49.*

Memory. VP-570 RAM Expansion Board adds 4K bytes of memory. Jumper locates RAM in any 4K block of up to 32K of memory. On-board memory protect switch. $95.*

EPROM Programmer. VP-565 EPROM Programmer Board comes complete with software to program, copy and verify 5-volt 2716 EPROMs—comparable to units costing much more than the VP-565 and VIP put together! Programming voltages generated on board. ZIF PROM socket included. $99.*

EPROM Interface. VP-560 EPROM Interface Board locates two 5-volt 2716 EPROMs (4K bytes total) anywhere in 32K of memory. VIP RAM can be re-allocated. $34.*

ASCII Keyboard.** Fully encoded, 128-character ASCII encoded alpha-numeric keyboard. 58 light touch keys including 2 user defined keys! Selectable upper and lower case. Handsomely styled. Under $50.*

Tiny BASIC.** VP-700 Expanded Tiny BASIC Board puts this high-level language on your VIP. BASIC stored in 4K of ROM. Ready for immediate use—no loading necessary. This expanded BASIC includes the standard Tiny BASIC commands plus 12 additional—including color and sound control! Requires external ASCII encoded alpha-numeric keyboard. $39.*

Auxiliary Keypads. Program your VIP for 2-player interaction games! 16-key keypad VP-580 with cable ($15*) connects to sockets provided on VP-590 Color Board or VP 585 Keyboard Interface Card ($10*).

COSMAC VIP lets you add computer power a board at a time.

With these new easy-to-buy options, the versatile RCA COSMAC VIP (CDP18S711) means even more excitement. More challenges in graphics, games and control functions. For everyone, from youngster to serious hobbyist. And the basic VIP computer system starts at just $249* assembled and ready to operate.

Simple but powerful—not just a toy.

Built around an RCA COSMAC microprocessor, the VIP includes 2K of RAM. ROM monitor. Audio tone with a built-in speaker. Plus 8-bit input and 8-bit output port to interface relays, sensors or other peripherals. It's easy to program and operate. Powerful CHIP-8 interpretive language gets you into programming the first evening. Complete documentation provided.

Take the first step now.

Check your local computer store or electronics parts house. Or contact RCA VIP Marketing, New Holland Avenue, Lancaster, PA 17604. Phone (717) 291-5848.

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

The fun way into computers.

RCA

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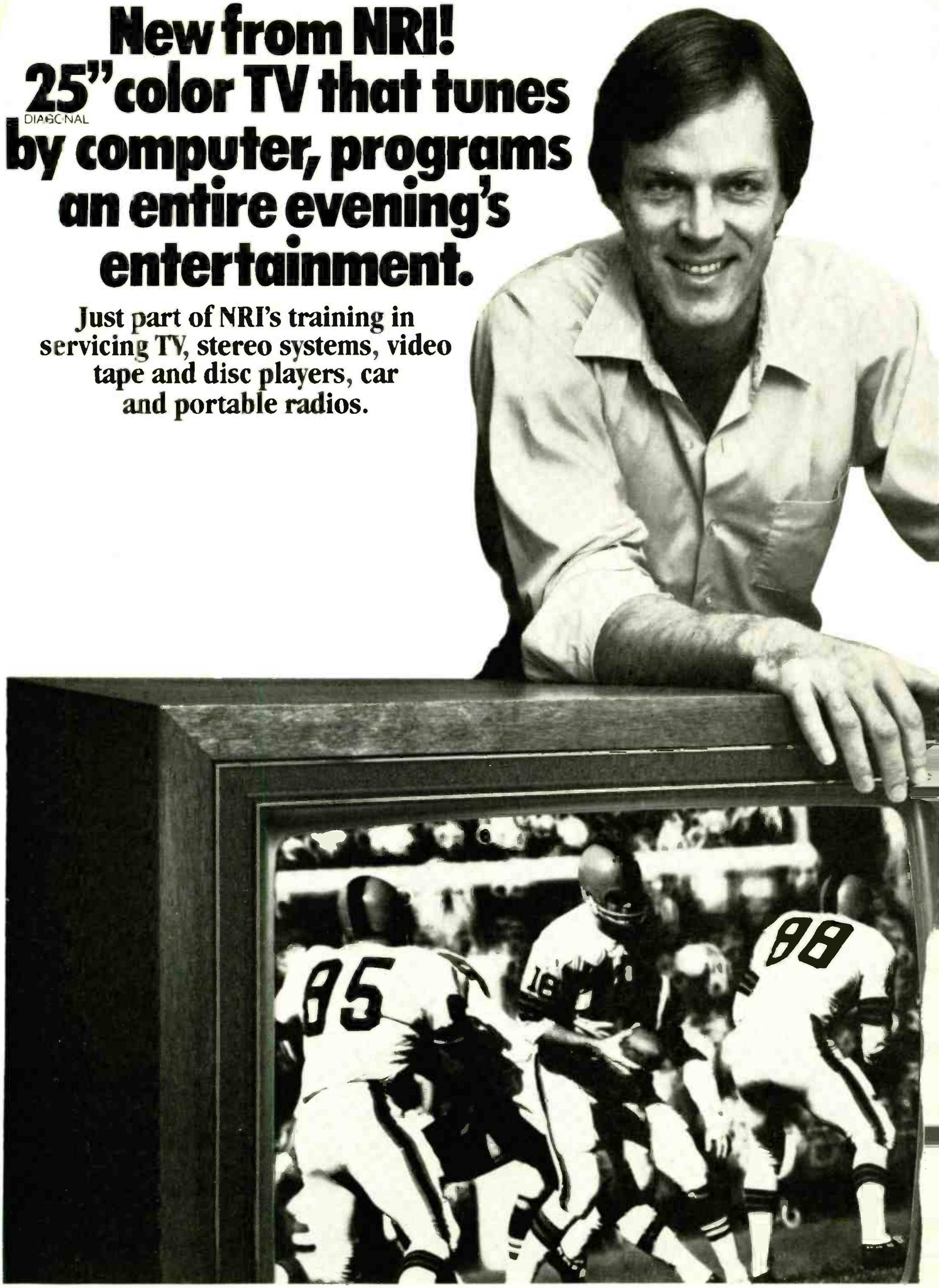

85
18
88

Only NRI home training prepares you so thoroughly for the next great leap forward in TV and audio…digital systems. Already, top-of-the-line TV's feature digital tuning, computer programming is appearing, and new digital audio recording equipment is about to go on the market.

NRI is the only home study school to give you the actual "hands-on" training you need to handle servicing problems on tomorrow's electronic equipment. Because only NRI includes this designed-for-learning, 25" diagonal color TV with electronic tuning, built-in digital clock, and computer programmer as part of your training. With this advanced feature, you can pre-program an entire evening's entertainment… even key lock it in to control children's viewing.

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

The color TV you build as part of NRI's Master Course looks, operates, and performs like the very finest commercial sets. But behind that pretty picture is a unique designed-for-learning chassis…

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

That's just a start. You demonstrate basic principles and circuits on the unique NRI Discovery Lab,® then apply them as you assemble a fine AM/FM stereo receiver, complete with speakers. You also get practical experience as you build your own test instruments, including a 5" triggered sweep oscilloscope, CMOS digital frequency counter, color bar generator, and transistorized volt-ohm meter. Use them for learning, use them for earning as a full- or part-time TV, audio, and video systems technician.

Complete, Effective Training Includes Video Systems

Using NRI's exclusive methods, you learn far more than TV servicing. You'll be prepared to work with stereo systems, car radios, record and tape players, transistor radios, short-wave receivers, PA systems, musical instrument amplifiers, electronic TV games, even video tape recorders and tape or disc video players. Your training covers just about every kind of electronic entertainment equipment available now or in the near future.

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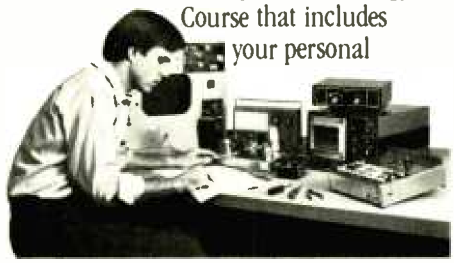
Get all the facts on this exciting course and its potential for you by mailing the postage-paid card today. Our free 100-page catalog includes color photos of all kits and equipment, complete lesson plans, convenient time payment plans, and information on other electronics courses. You'll also find out about NRI's new Computer Technology Course that includes your personal



microcomputer. Or Complete Communications with 2-meter transceiver that gets you ready for opportunities in broadcasting, 2-way radio, microwave, and other growing fields. If card has been removed, write to:

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3939 Wisconsin Ave.
Washington, D.C. 20016

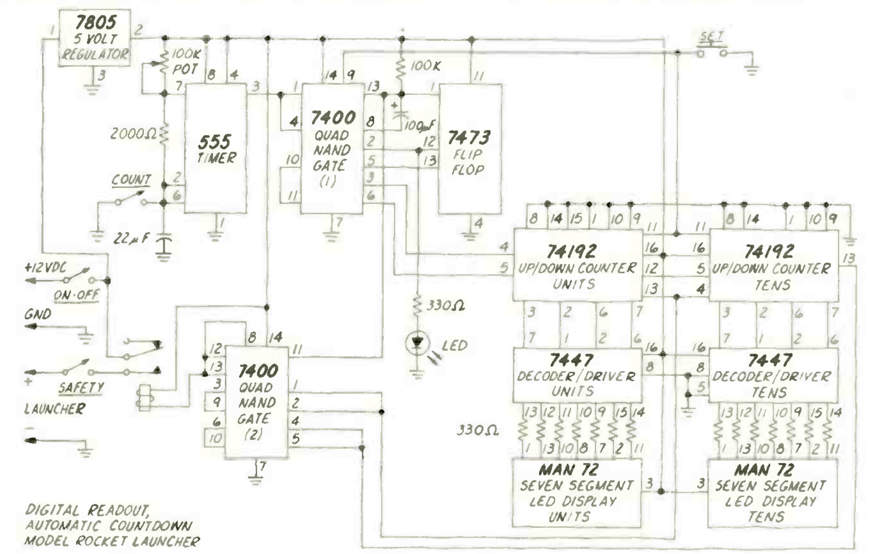
LETTERS

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.



DIGITAL READOUT, AUTOMATIC COUNTDOWN MODEL ROCKET LAUNCHER

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 = 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 λ = wavelength at the source (s) and γ = 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

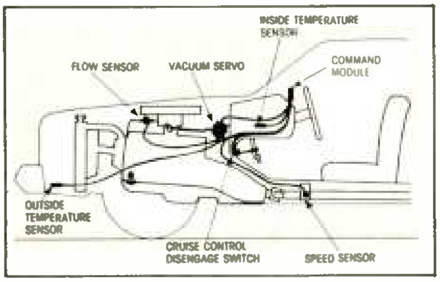
Automotive "brain" astounds the experts, puts both computer and cruise control at your fingertips!

For the first time ever, you can put a true computer in your car, truck or RV which gives you the most effective and functional cruise control ever designed, plus complete trip computing, fuel management system, and a remarkably accurate quartz crystal time system. It is called CompuCruise$_{TM}$.

So simple a child can operate, the new CompuCruise combines latest computer technology with state-of-the-art reliability in a package which will not likely be available on new cars for years to come.

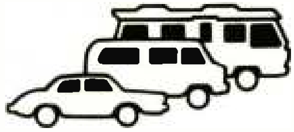
CRUISE CONTROL WITH A MEMORY, UNIQUE SEEK-AND-HOLD CAPABILITY.

CompuCruise remarkable cruise control performs in a totally different manner than any other unit because it is more than a simple speed maintaining device. With CompuCruise, you establish your desired cruising speed even before you reach the highway and activate the system any time by simply pressing a button. CompuCruise then seeks and maintains the desired speed until you override or shut off the system. You resume cruise control again at any time by pressing the same button. CompuCruise, unlike most vacuum-mechanical systems, is fully electronic, more accurate and more reliable than any other unit you can buy.



AIRLINE PILOTS COMPARE COMPUCRUISE$_{TM}$ TO SOPHISTICATED AVIONICS EQUIPMENT.

Similar to types of computers used on modern airliners, the CompuCruise slim panel-mounted control module contains a digital readout and back-lighted control buttons, both readily visible in the dark. By quickly learned systems of inquiry, the driver can elicit virtually any informa-



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

There are a number of digital-type instruments on the market which can be purchased for your car, purporting to provide functional data on performance, but all are basically calculators, operating on fixed information provided by the driver.

CompuCruise is a true computer, operating from automatic data sensors which constantly react to changing conditions, automatically recomputing vital data every second. Each function operates independently, with data displayed and updated constantly until you change your request of the computer.

Fuel management takes on new significance because CompuCruise tells you the most effective driving speeds, the type and brand of gasoline most suitable for your vehicle. It will tell you the effects of different types of tires and different tire pressures, road conditions, and engine tune-up condition. You can get instantaneous computations on current gas mileage, fuel required to arrival, and actual fuel remaining.

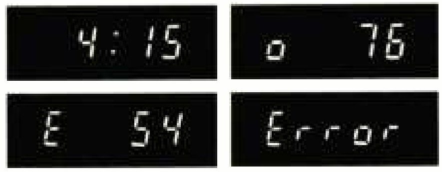
Battery condition can be checked regularly, saving you from the potential embarassment of being stranded without warning.

TYPICAL DATA:

- Cruise Control
- Time, E.T., Lap Timer, Alarm
- Time, Distance, Fuel to Arrival
- Time, Distance, Fuel to Empty
- Time, Distance and Fuel on Trip
- Current or Average MPG, GPH
- Fuel Used, Distance since Fillup
- Current and Average Vehicle Speed
- Inside, Outside or Coolant Temperature
- Battery Voltage
- English or Metric Display

COMPUCRUISE$_{TM}$ DIGITAL QUARTZ CRYSTAL TIME SYSTEM IS INCREDIBLE.

CompuCruise digital time system performs four independent time functions encompassing (a) stop watch and lap timer functions, (b) hours, minutes and seconds, (c) alarm or warning function, and (d) trip time indicator. The time system operates full time, whether your vehicle is operating or not. It will even wake you up after a short roadside nap.



YOUR COMPUCRUISE IS SMART! IF YOU PUSH THE WRONG BUTTON IT WILL LET YOU KNOW BY DISPLAYING "ERROR".

COMPUCRUISE$_{TM}$ WORKS ON FOREIGN OR AMERICAN CARS; IS PRICED FOR THE AVERAGE MAN'S BUDGET

You do-it-yourselfers can readily install the unit, but complete and detailed instructions are also included for the automotive service facility. CompuCruise units are fully operable on most foreign or American cars, trucks or RV's. At $199.95 the unit is only a few dollars more than the cost of cruise control alone on most vehicles, yet offers a whole new world of computerized management functions.

This is an exclusive system, fully warranted for 90 days from installation, delivered to you complete with all required hardware. You need only basic tools for the total job.

When you receive your unit, inspect it completely. If you are not 100% satisfied, return the complete unit before installation and your money will be refunded without question.

TO ORDER YOUR UNIT, complete the coupon below, enclosing $199.95 (ADD $5.50 if front-wheel drive). This covers all shipping, insurance and handling costs. Your unit will be shipped within three weeks.

NOTE: Mountable on foreign or domestic vehicles including standard trans. **EXCEPT FOR DIESEL OR FUEL INJECTED ENGINES.**

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editorial

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 alloted 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

ART KLEIMAN
Managing Editor

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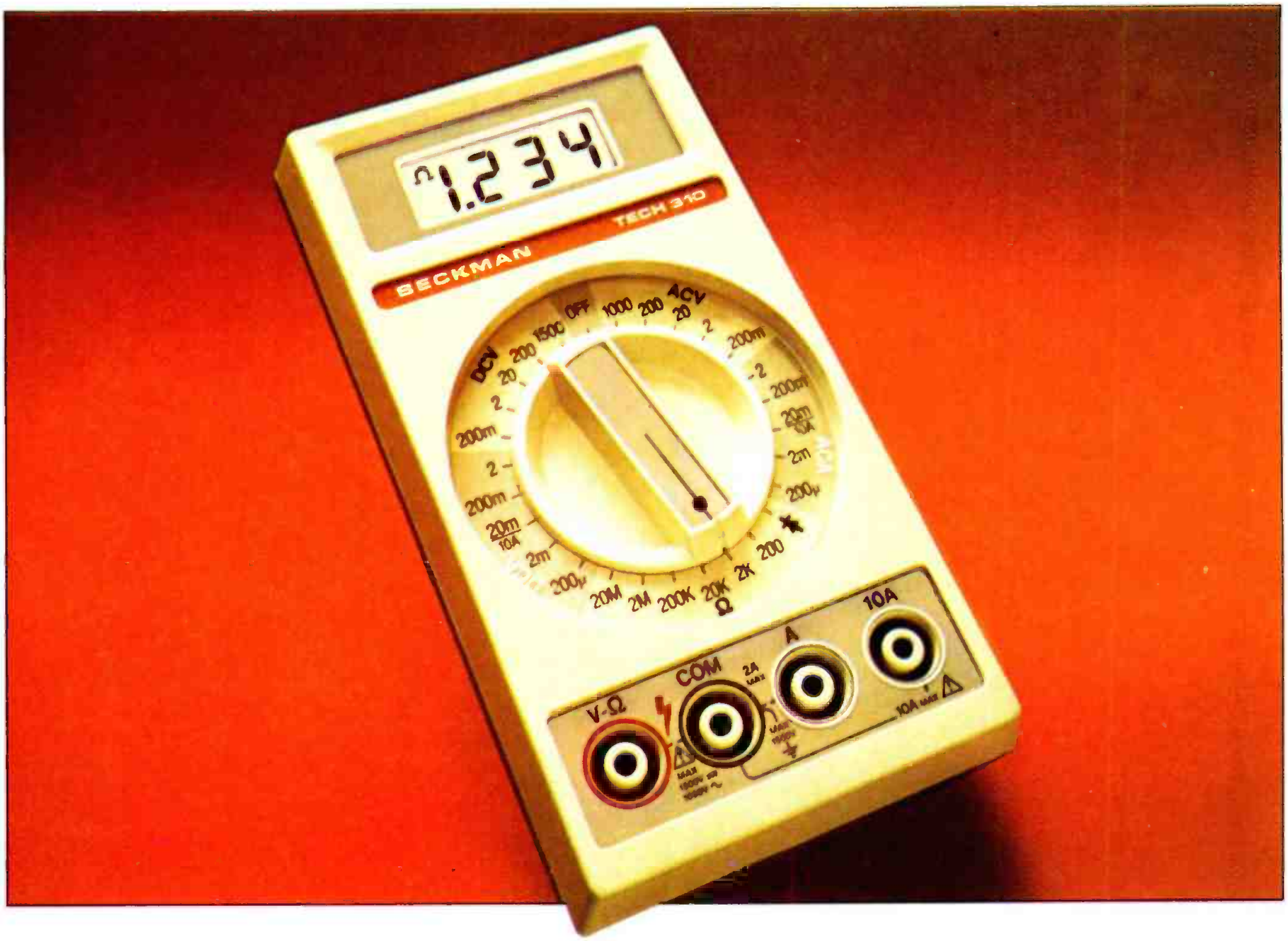

Featuring new continuity function.

If you've ever been troubled by a faulty multimeter—or had to use one that wasn't quite up to the tougher jobs—your troubles are over. Now there's the Beckman line of digital multimeters. A new generation of 3½-digit models that combine superior reliability with highly versatile features.

Features like a unique continuity test function. With Beckman's new Insta-Ohms™ quick continuity indicator, you no longer need an analog VOM for fast, convenient continuity checks.

There's also 10-amp current ranges, in-circuit resistance measurement capability in all six-ohm ranges, a dedicated diode test function, and up to two years normal operation from a common 9V battery.

The Model TECH 310 with all these features, 7 functions, 29 ranges, and 0.25% Vdc accuracy is only $130.

The Model TECH 300 with 0.5% Vdc accuracy, but without the continuity function or the 10-amp current ranges, is just $100.

Whichever model you choose, you get a multimeter that won't let you down. There's exceptional overload and 6kV transient protection, plus ruggedness to take a 6-foot fall and to come up working.

So get the Beckman digital multimeter that performs and keeps on performing. No matter how tough the going gets. For information on the complete line and accessories, write or call your local distributor or the Advanced-Electro Products Division, Beckman Instruments, Inc., 2500 Harbor Boulevard, Fullerton, CA 92634, (714) 871-4848, ext. 3651.

BECKMAN

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LETTERS

continued from page 12

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?

*(λ = w; γ = 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 stations 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

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.

We will (finally!) have complete kits in stock and expect to maintain stock for the indefinite future.

We no longer sell individual printed-circuit boards.

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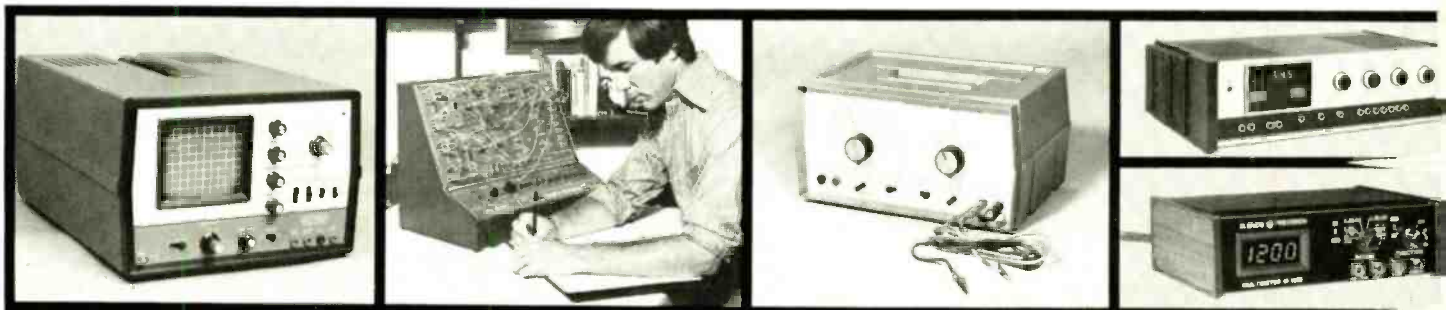

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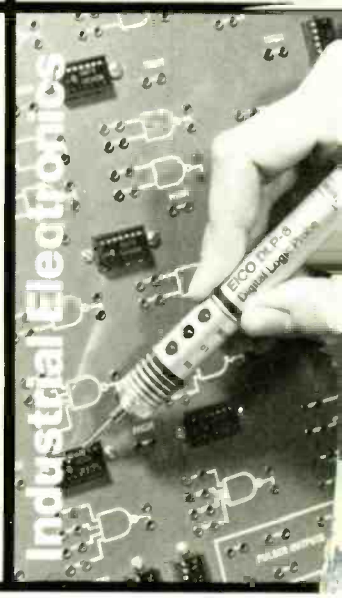

The world of electronics is daily becoming more challenging. Technology is growing more specialized, and the importance of digital systems increases every day. Test instruments, home entertainment units and industrial control systems are all going digital. And now, NTS training programs include a wider choice of solid-state and digital equipment than ever before offered in any home study course: Advanced NTS/Heath digital color TV (25" diagonal with optional programming capability), NTS/Heath microcomputer, digital test equipment, digital stereo receiver (70 watts per channel), NTS compu-trainer, plus much more state-of-the-art equipment to make your training exciting and relevant.

The equipment you receive with NTS training programs is selected to provide you with a solid background in electronic systems. Kits and lessons are designed to work together to demonstrate electronic principles and applications. The kit-building not only shows you how electronic hardware functions, but how various circuit designs accomplish different purposes. Your lessons guide you through any number of experiments associated with many projects. This is the Project-Method, and it works. Step-by-step, you learn how and why digital electronics has become a part of our world, and the even bigger role it is sure to play in the future.

Whether you are looking for training in Consumer, Commercial, or Industrial electronics, NTS offers fourteen courses, some basic, many advanced, in several areas of electronics. An all-new full-color NTS catalog shows you what each course covers,

Introducing the Troubleshooter.

Six functions and 24 ranges for $129* make the jump from Analog to Digital more affordable than ever.

We call our new hand-held 8022A DMM the Troubleshooter. It combines the basic performance features you want with all the advantages that give digital DMM's the edge over analog— 0.25% basic dc accuracy, a rugged, reliable design, a razor sharp 3½-digit LCD readout, small size and light weight.

Measure for measure you won't find a better value. Six functions—high and low ohms, ac and dc voltage and current (24 ranges in all) make the Troubleshooter a 13 ounce (0.37 kg) package of excellent measurement value. This kind of value wasn't possible until our custom CMOS LSI single chip design made hand-held DMM's an affordable reality and Fluke the industry leader.

Here's something new that won't shock you. Fluke's exclusive probe design features finger guards on the probe and shrouded connections to discourage accidental contact with circuit voltages.

You won't find a more rugged or reliable hand-held DMM. There's a lot more to building a high-quality hand-held DMM than you might suspect. The case has to survive bumps, scrapes, and scuffs. The LCD readout must withstand the extremes of humidity, temperature, and vibration. Function switches need to perform reliably through thousands of cycles. And electrical circuitry must survive both physical shock and electrical overloads.

We built the 8022A to withstand all these tortures—with a rugged impact resistant plastic case, a custom LCD display, reliable push-buttons instead of rotary switches and over 20% of the components devoted to overload protection.

Take the next step. Contact the Fluke office, representative or authorized distributor in your area. In the U.S., CALL TOLL FREE (800) 426-0361. (For residents in Alaska, Hawaii, and Washington, the number is (206) 774-2481.)

In Europe, contact: Fluke (Nederland) B.V., P.O. Box 5053, Tilburg, The Netherlands. Telephone (013) 673973. Telex 52237.

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. Both instruments are available at your distributor from stock. For immediate response, fill out the attached coupon.

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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 3½-digit LED display, a single-chip LSI, a lasar-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 μA, 2 mA, 20 mA, 200 mA, 2 A and 10 A. The 200-μA 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 μA, 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 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 computer with all the features found in *Superboard II*?

CIRCLE 102 ON FREE INFORMATION CARD

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 × 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 × 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 1-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.

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. Chillicote 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 manufacturers 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 a hand calculator.

CIRCLE 103 ON FREE INFORMATION CARD

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 °C.

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

continued on page 32

How can Sabtronics possibly sell a $179* lab standard digital multimeter for under $70?

(*Value based on comparable performance and features of other DMM's.)

We confess.

To sell an advanced DMM for under $70 we had to cut corners.

And we sure did! First, we cut off the dealer's mark-up. Then we shaved off the overhead costs of national sales offices and warehouses. Finally, as if that wasn't enough, we even cut out the high labor costs of factory assembly lines.

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.

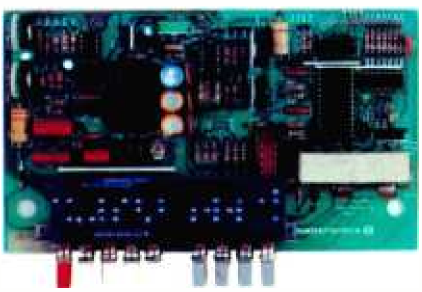
Don't let our low price fool you!

Because Sabtronics sells factory-direct – without all the hidden charges a dealer would tack 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 μV to 1000V; AC and DC current from 0.1 μA to a surprisingly high 10A; resistance from 0.1Ω to 20 MΩ. Typical DCV and Ohms accuracy is 0.1% ± 1 digit. And you see these precise readings on a bright, 3½-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 Frenquency 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 MasterCharge or Visa order today, or simply fill out the convenient order form.

Making Performance Affordable

sabtronics
INTERNATIONAL INC.
13426 Floyd Circle M/S 35 · Dallas, Texas 75243
Telephone 214/783-0994

Brief Specifications

DC Volts: 100μV to 1000V in 5 ranges
AC Volts: 100μV to 1000V in 5 ranges
DC Current: 0.1μA to 10 A in 6 ranges
AC Current: 0.1μA to 10 A in 6 ranges
Resistance: 0.1Ω to 20 MΩ in 6 ranges
Diode Test Current: 0.1μA, 10μA, 1mA
ACV Frequency Response: 40Hz to 40kHz
Input Impedance: 10 MΩ 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 ± 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

To: Sabtronics International, Inc. 13426 Floyd Circle M/S 35, Dallas, TX 75243

Please send me . . .

_____ Model 2010A Digital Multimeter kit(s) @$69.95 plus $4.00† shipping and handling each $ _____
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_____ # AC-115 AC adapter/charger(s) @$7.50 each $ _____
_____ # NB-120 NiCd Battery set(s) @$17.00/set $ _____
_____ # THP-20 Touch and Hold Probe(s) @$18.00 each $ _____
_____ For delivery in Texas, add 5% Sales Tax $ _____
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or, please charge to my ☐ Visa ☐ MasterCharge: Code #
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†Continental U.S. only. AK, HI & PR $5.00. Canada $6.50. Foreign $19.00 Airmail

At CIE, you get electronics career training from specialists.

If you're interested in learning how to fix air conditioners, service cars or install heating systems—talk to some other school. But if you're serious about electronics, come to CIE—The Electronics Specialists.

John E. Cunningham

Special Projects Director
Cleveland Institute of Electronics

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.

Consider doctors. You wouldn't expect your family doctor to perform open heart surgery or your dentist to set a broken bone, either. Would you?

For these things, you'd want a specialist. And you'd trust him. Because you'd know if he weren't any good, he'd be out of business.

Why trust your education and career future to anything less than a specialist?

You shouldn't. And you certainly don't have to.

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Specialists aren't for everyone.

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

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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 1⅞ inches long, ⅞ inch wide and ⅛ 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.

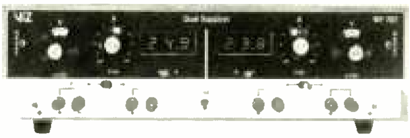
The *Rapid-Winder* is also a simple but very well-made device. Much thought has gone into making it uncomplicated and efficient. Two self-aligning white spindles allow you to easily place a cassette tape on top of the unit with no hub interference. Press the red button and the left-hand spindle turns 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* abd *Rapid-Rewinder* are available in many audio and electronic retail outlets for $19.95 each; or you can order them

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 Supplysts*. 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 poweing 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**

"You said this computer would pay for itself—so collect from it!"

Yesterday you could admire all-band digital tuning in a short wave receiver.* Today you can afford it.

RF—4900

Tune in the Panasonic Command Series™ top-of-the-line RF-4900. Everything you want in short wave at a surprisingly affordable price. Like fluorescent all-band readout with a five-digit frequency display. It's so accurate (within 1 kHz, to be exact), you can tune in a station even before it's broadcasting. And with the RF-4900's eight short wave bands, you can choose any broadcast between 1.6 and 31 MHz. That's all short wave bands. That's Panasonic.


RF-2900

And what you see on the outside is just a small part of what Panasonic gives you inside. There's a double superheterodyne system for sharp reception stability and selectivity as well as image rejection. An input-tuned RF amplifier with a 3-ganged variable tuning capacitor for excellent sensitivity and frequency linearity. Ladder-type ceramic filters to reduce frequency interference. And even an antenna trimmer that changes the front-end capacitance for reception of weak broadcast signals.

To help you control all that sophisticated circuitry, Panasonic's RF-4900 gives you all these sophisticated controls. Like an all-gear-drive tuning control to prevent "backlash." Separate wide/narrow bandwidth selectors for crisp reception even in crowded conditions. Adjustable calibration for easy tuning to exact frequencies. A BFO pitch control. RF-gain control for improved reception in strong signal areas. An ANL switch. Even separate bass and treble controls.

And if all that short wave isn't enough. There's more. Like SSB (single sideband) amateur radio. All 40 CB channels. Ship to shore. Even Morse communications. AC/DC operation. And with Panasonic's 4" full-range speaker, the big sound of AM and FM will really sound big. There's also the Panasonic RF-2900. It has most of the features of the RF-4900, but it costs a lot less.

The Command Series from Panasonic. If you had short wave receivers as good. You wouldn't still be reading. You'd be listening.

*Short wave reception will vary with antenna, weather conditions, operator's geographic location and other factors. An outside antenna may be required for maximum short wave reception.

Panasonic.
just slightly ahead of our time.

CIRCLE 86 ON FREE INFORMATION CARD

PROGRAMMABLE HOME THERMOSTAT

The Intelligent Thermostat controls up to four temperature levels each day—turning on furnace or air conditioner as needed. Thus, with it, you can have optimum comfort along with a maximum saving in energy.

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.

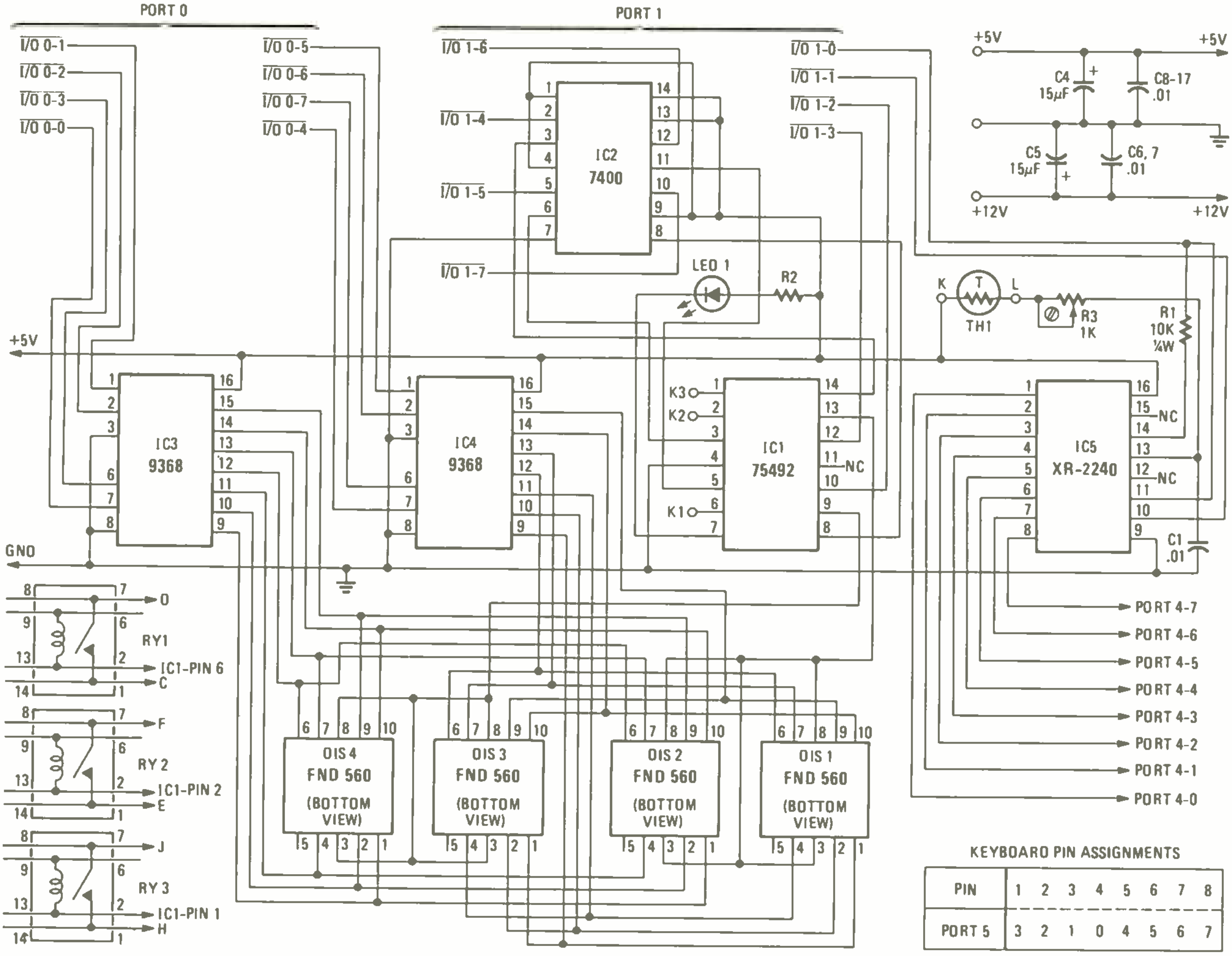
TABLE I

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



KEYBOARD PIN ASSIGNMENTS

PIN	1	2	3	4	5	6	7	8
PORT 5	3	2	1	0	4	5	6	7

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

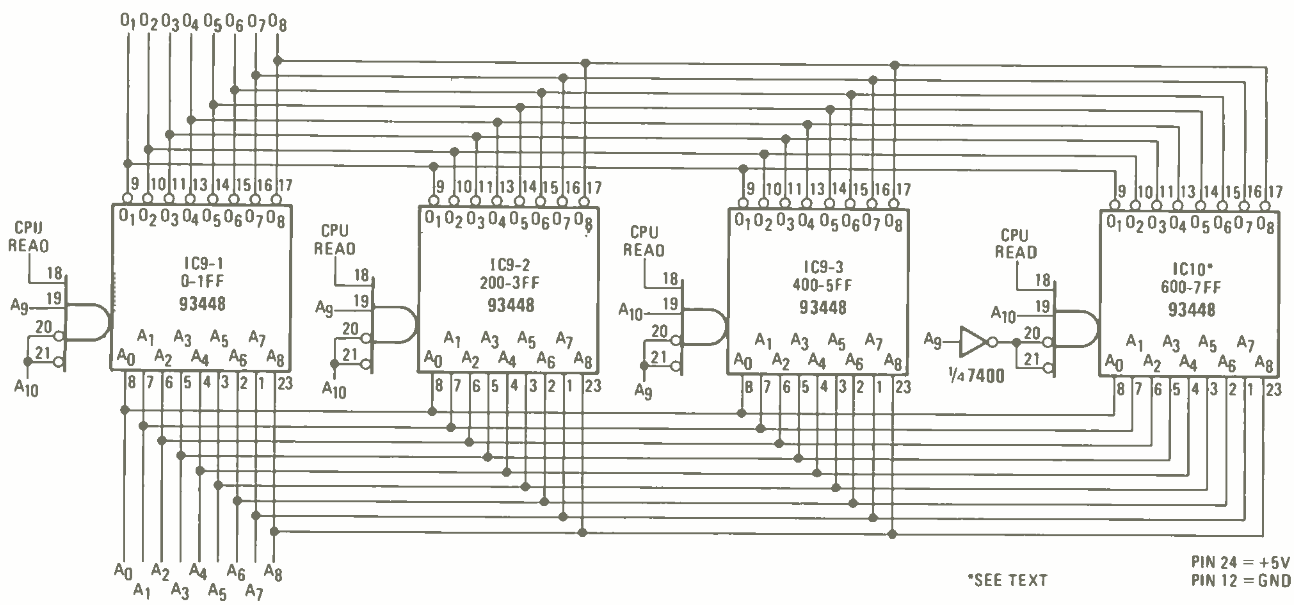


FIG. 2—THREE ROM's contain program. Fourth ROM is for expansion.

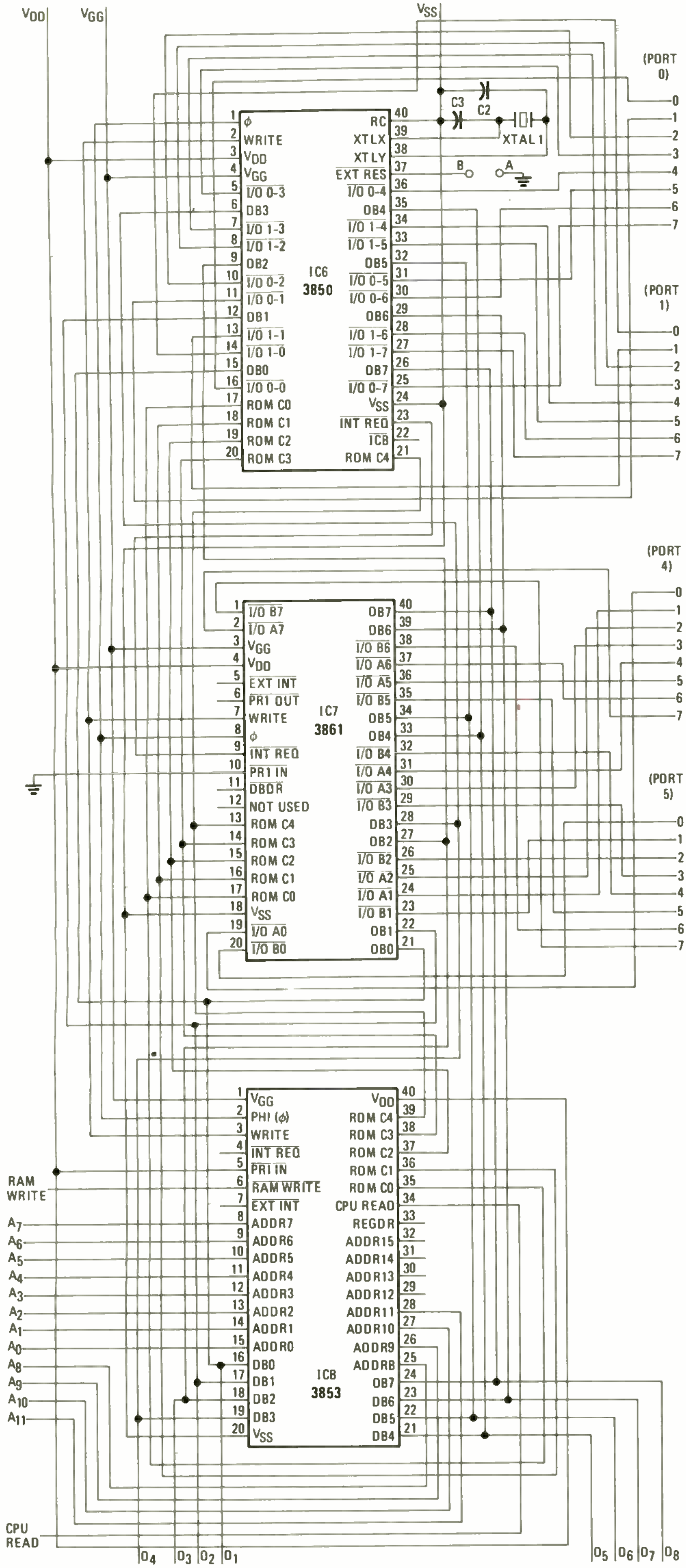


FIG. 3—CPU and memory interface circuitry.

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-μF 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–$1FF_{16}$, 200_{16}–$3FF_{16}$, 400_{16}–$5FF_{16}$ and 600_{16}–$7FF_{16}$, 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

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 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

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

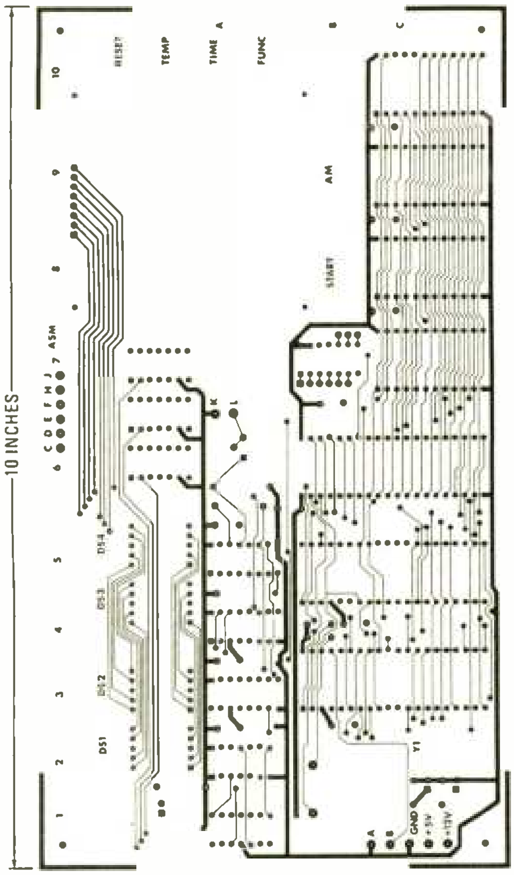


FIG. 4—FOIL PATTERN for the board's front surface. Keyboard plugs into 8 pads in top-right corner.

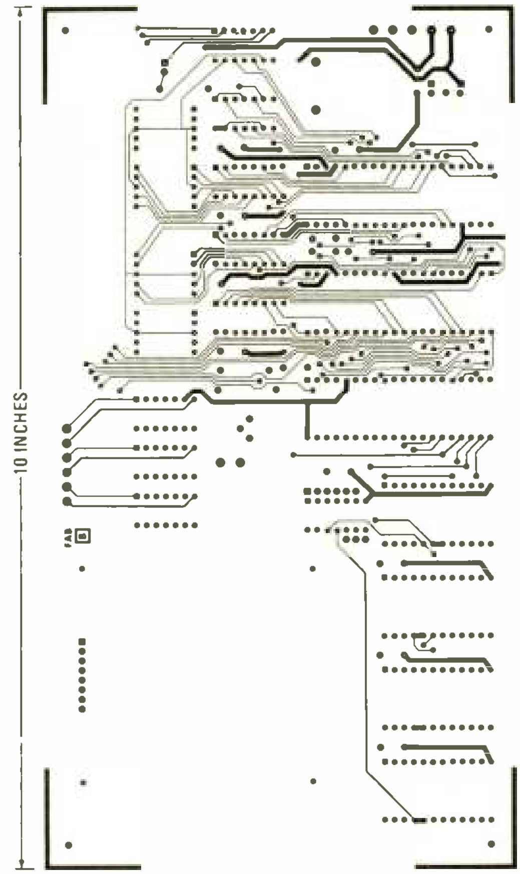


FIG. 5—THE REAR SURFACE of the board has this foil pattern. These patterns are shown slightly smaller than half-size.

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

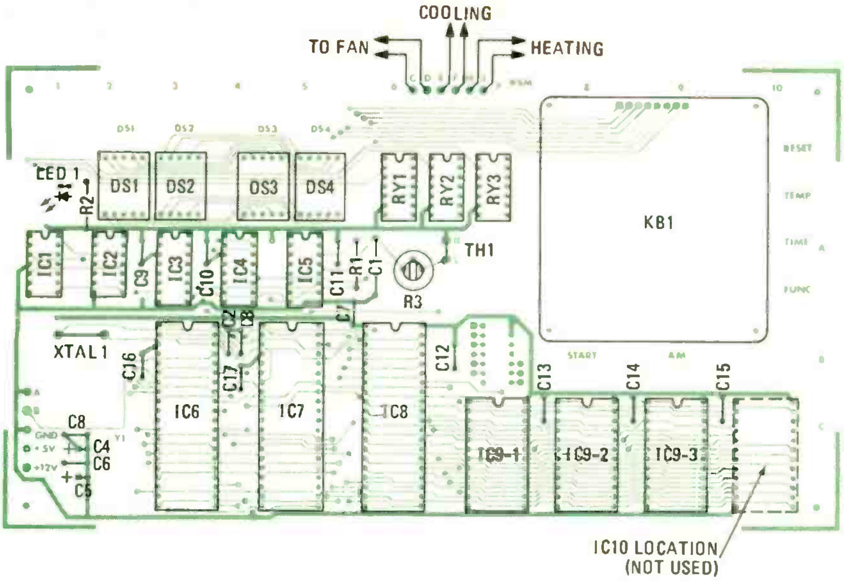


FIG. 6—**HOW PARTS ARE PLACED** on the thermostat board.

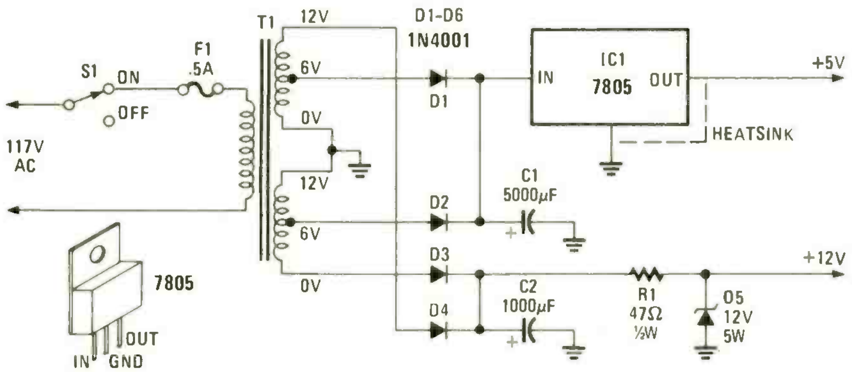


FIG. 7—THE POWER SUPPLY SCHEMATIC. The power transformer has two 12-volt secondaries.

*(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	D(function)	bb 00
	1	bb 01
(72° F is assumed)	*(start)	bb 72
2. Set Time	D(function)	bb 00
(12:01 AM is	8	bb 08
assumed)	1	bb 81
	C(time/day)	00 00
	1	00 01
	2	00 12
	0	01 20
	1	12 01
	#(am)	LED
	*(start)	bb 72

(Note that the display returns to temperature display function)

	Keystrokes	Display
3. Display	D(function)	bb 00
Time/Temperature	3	bb 03
	*(start)	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	D(function)	bb 00
Temperature	9	bb 09
#1	1	bb 91
	B(temperature)	bb 00
		bb 05
	5	bb 55
	5	XX XX
	*(start)	

(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)	bb 00
	8	bb 08
	3	bb 83
	C(time/day)	00 00
	1	00 01
	*(start)	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-

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 biamplification 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 nonbiamplified 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-biamplified 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.)

Semicomponents: 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 *Bodysonic* 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.

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

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.

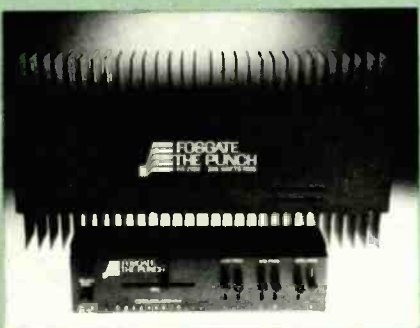
The all-in-one equipment—be it regular power (3 to 6 watts-per-channel) or high power—ranges from basic to elaborate, depending on how much you want to spend, and offers some of the amenities and technology of home stereo equipment. For instance, Sharp's *model RG-3550* in-dash cassette/radio ($220) 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, Marantz, 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/preselect 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

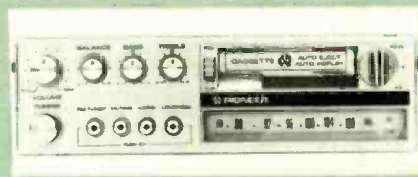

MITSUBISHI CAR AUDIO model CJ-20

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.

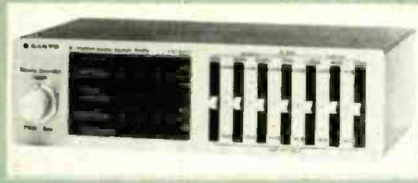
The latest example in the second category is Advent's *model EQ-1*, priced at $180 the pair. This speaker consists of a dual-cone, 6- by 9-inch driver with an equalized power amplifier built onto the back of the speaker frame. The *model EQ-1* has been designed and frequency-

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 3¼-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.

TABLE 1—CAR STEREO EQUIPMENT—continued

Muntz Hi Z, Inc.			Auto-reverse mode
871 Folsom St.			
San Francisco, CA 94107			
Panasonic Co. Car	CA-9500	$85	FM stereo tuner
Audio Div.	CQ-8700	$700	Semicomponent unit (deluxe)
1 Panasonic Way	CQ-7600	$400	Semicomponent unit
Secaucus, NJ 07094	CQ-7400	$300	Semicomponent unit (less Dolby)
	CQ-8520		Stereo tape/radio/electronic scan
	CQB-5919		Cassette/CB
	CQB-5959		Cartridge/CB
			Digital readout, all-in-one system, Dolby, auto-reverse mode
Pioneer Electronics	KPX-9000	$350	Cassette player/tuner/preamp
1925 E. Dominguez St.	KPX-600	$170	Tuner/cassette player/preamp
Long Beach, CA 90810	KP-88G, KP-66G		Cassette decks
	Bodysonic System	$70-80	Sound enhancer
			All-in-one system
Roadstar Corp. of America	2141	$270	Cassette player/radio
5312 Production Dr.	3800, 3810U, 3200,		Cassette deck/tuner
Huntington Beach, CA 92649	3210U, 2300U	$300-540	Cassette player/radios
	MOFI series		Tuners
			Digital readout, Dolby, auto-reverse mode
Roberts Electronics	RCB-4150		CB/cartridge tape/radio
3095 NW 77th Ave.			
Miami, FL 33122			
Royal Sound Co., Inc.	RS-2550		Cassette/tuner/preamp
248 Buffalo Ave.	RS-3110		Tape/radio/electronic scan
Freeport, NY 11520			Auto-reverse mode, minispeakers
Sankyo Seiki, Inc.	SCS-555		CB/cassette/radio
149 Fifth Ave.			Auto-reverse mode
New York, NY 10010			
Sanyo Electronic	EQZ-6200		Graphic equalizer
1200 W. Artesia Blvd.	PA6120	$250	Amplifier
Compton, CA 90220	PA6060	$200	Amplifier
	FT-1670		Tape/radio/electronic scan
	FT646, FT2400, FT1498, FT1490-2	$200-390	Cassette/radio/metal-tape playback
			Auto-reverse, digital readout, Dolby, minispeakers, all-in-one system
Setton International			Minispeakers
60 Remington Blvd.			
Ronkonkoma, NY 11779			
Sharp Electronics Corp.	RG-3550	$220	All-in-one/in-dash cassette/radio
10 Keystone Pl.	RG-5252	$170	Cassette/radio/foreign cars
Paramus, NJ 07652			
Sound Concepts	1060 (*Concert*		
P.O. Box 135	*Machine*)	$300	Ambience restoration system
27 Newell Rd.			
Brookline, MA 02146			
Sparkomatic Corp.	GE-500		Booster equalizer
Milford, PA 18337	(*Acoustatrac*)		Digital Readout, all-in-one system, auto-reverse mode, minispeakers
Tenna Corp.	R-3025MPX		Tuner
19201 Cranwood Pkwy			Minispeakers, auto-reverse mode
Cleveland, OH 44128			
Ultralinear Loudspeakers			Minispeakers
3228 E. 50th St.			
Los Angeles, CA 90058			

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.

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 (*I*nternational *E*lectrotechnical *C*ommission) as of September, 1978; the other having been more recently 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 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.

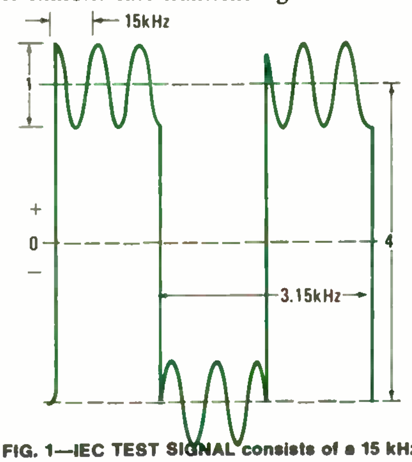


FIG. 1—IEC TEST SIGNAL consists of a 15 kHz squarewave with a superimposed 3.15 kHz sinewave.

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

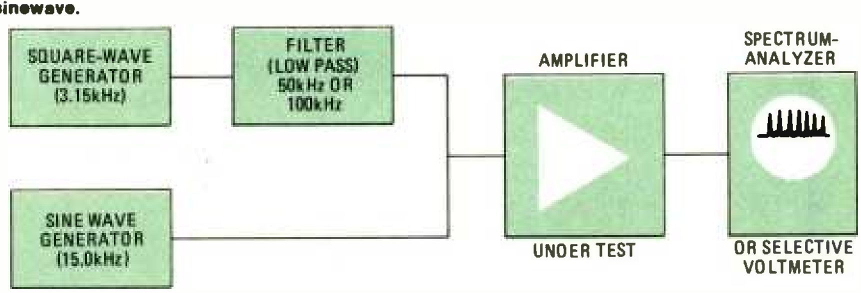


FIG. 2—TIM DISTORTION measurement setup using a narrowband spectrum analyzer.

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:

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

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

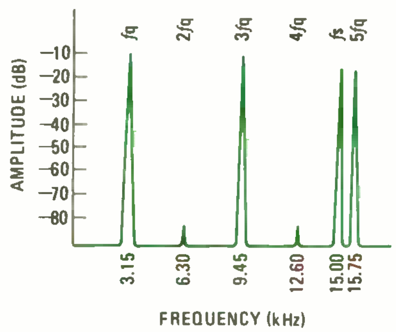


FIG. 3—SPECTRUM ANALYSIS of the IEC test signal.

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			3.15
	f_s–$6f_q$	μ_6	3.90
	f_s–$3f_q$	μ_3	5.55
$2f_q$			6.30
	f_s–$7f_q$	μ_7	7.05
	f_s–$2f_q$	μ_2	8.70
$3f_q$			9.45
	f_s–$8f_q$	μ_8	10.20
	f_s–f_q	μ_1	11.85
$4f_q$			12.60
	f_s–$9f_q$	μ_9	13.35
f_s			15.00

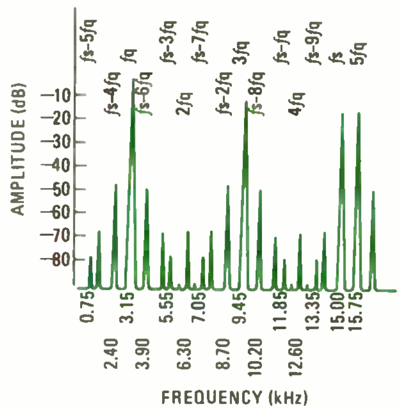


FIG. 4—AMPLIFIER adds distortion to test signal which shows up as additional components in the frequency spectrum.

frequency spectrum of the output signal of a type μA741 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 (*D*ynamic *I*nter*M*odulation) distortion as it is called in the proposal.

The DIM distortion can be presented as a function of amplifier power or voltage 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.

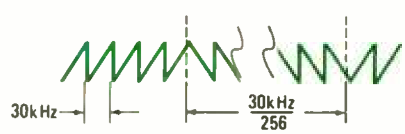


FIG. 5—TEST SIGNAL proposed by Sansui consists of a 30 kHz sawtooth waveform with a phase reversal every 30 kHz ÷ 256.

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

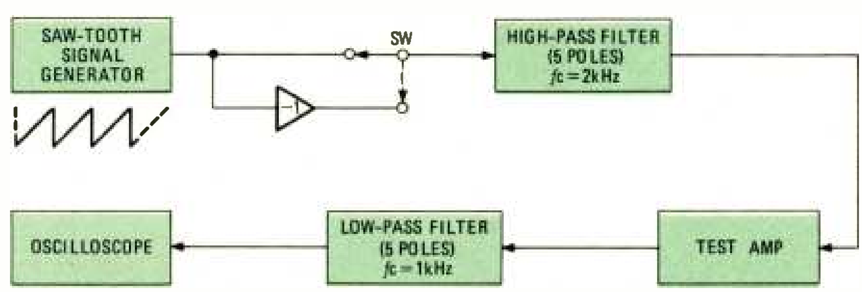


FIG. 6—TIM MEASUREMENT setup proposed by Sansui using the test signal shown in Fig. 5.

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 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 sinewave 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

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

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 sinewave 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 sinewave 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.

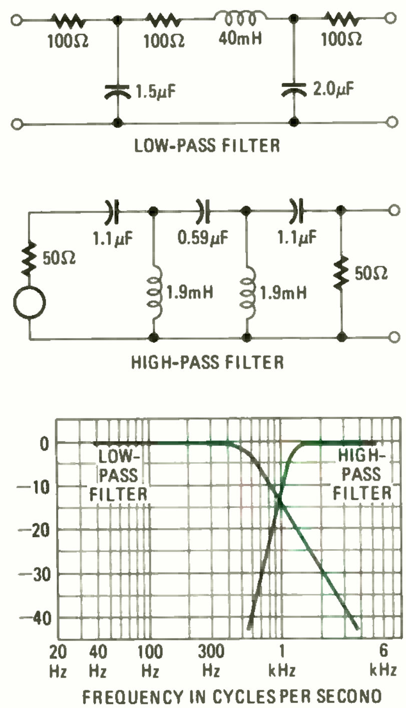


FIG. 7—TIM DISTORTION ANALYZER from Sansui includes low-pass and high-pass filters with the above response characteristics.

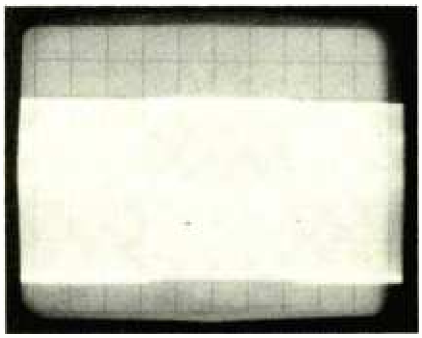


FIG. 9—OUTPUT WAVEFORM from amplifier being tested with the low-pass filter bypassed.

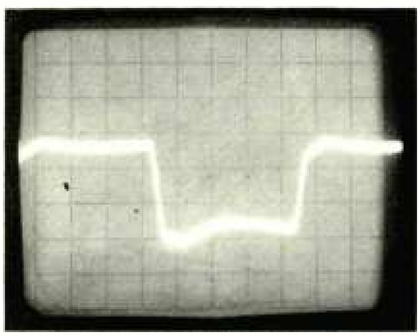


FIG. 10—OUTPUT WAVEFORM from amplifier with low-pass filter connected. TIM distortion is proportional to squarewave amplitude.

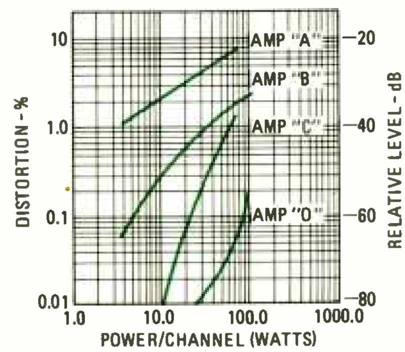


FIG. 11—TIM DISTORTION rating obtained using the Sansui test method for four different amplifiers.

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**

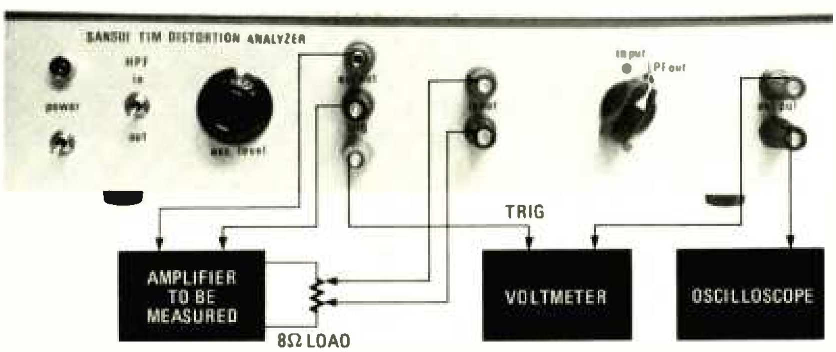


FIG. 8—MEASUREMENT SETUP using Sansui's TIM Distortion Analyzer.

TECHNOLOGY TODAY

Videodisc — Look at

LARRY STECKLER EDITOR

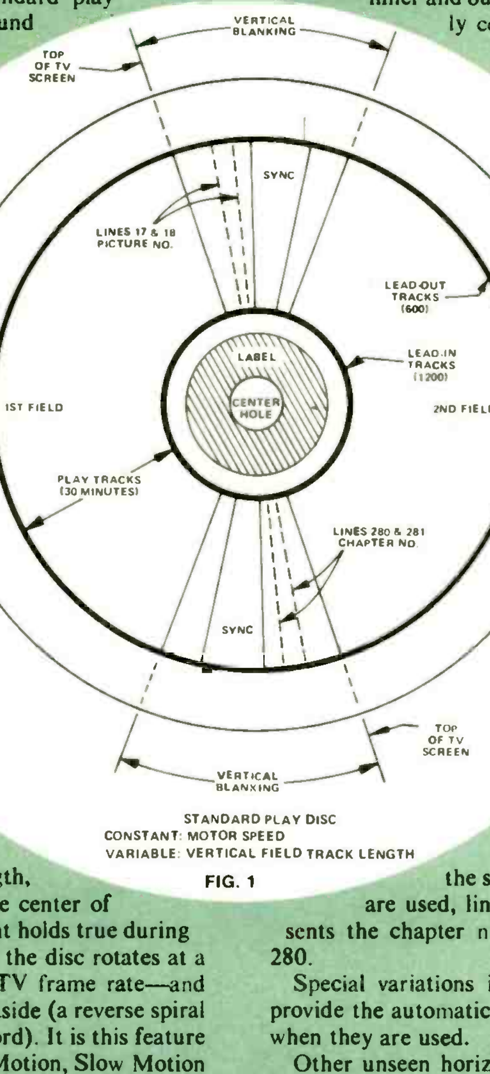
IN OUR APRIL ISSUE WE PRESENTED AN INTRODUCTORY ARTICLE about the two basic kinds of videodiscs. This month we're going to take a closer look at the Philips system as sold by Magnavox under the name *Magnavision*. Let's start by taking a look at playing time. Then we'll go on to take a close look at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



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

FIG. 1

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

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.

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

FIG. 2

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

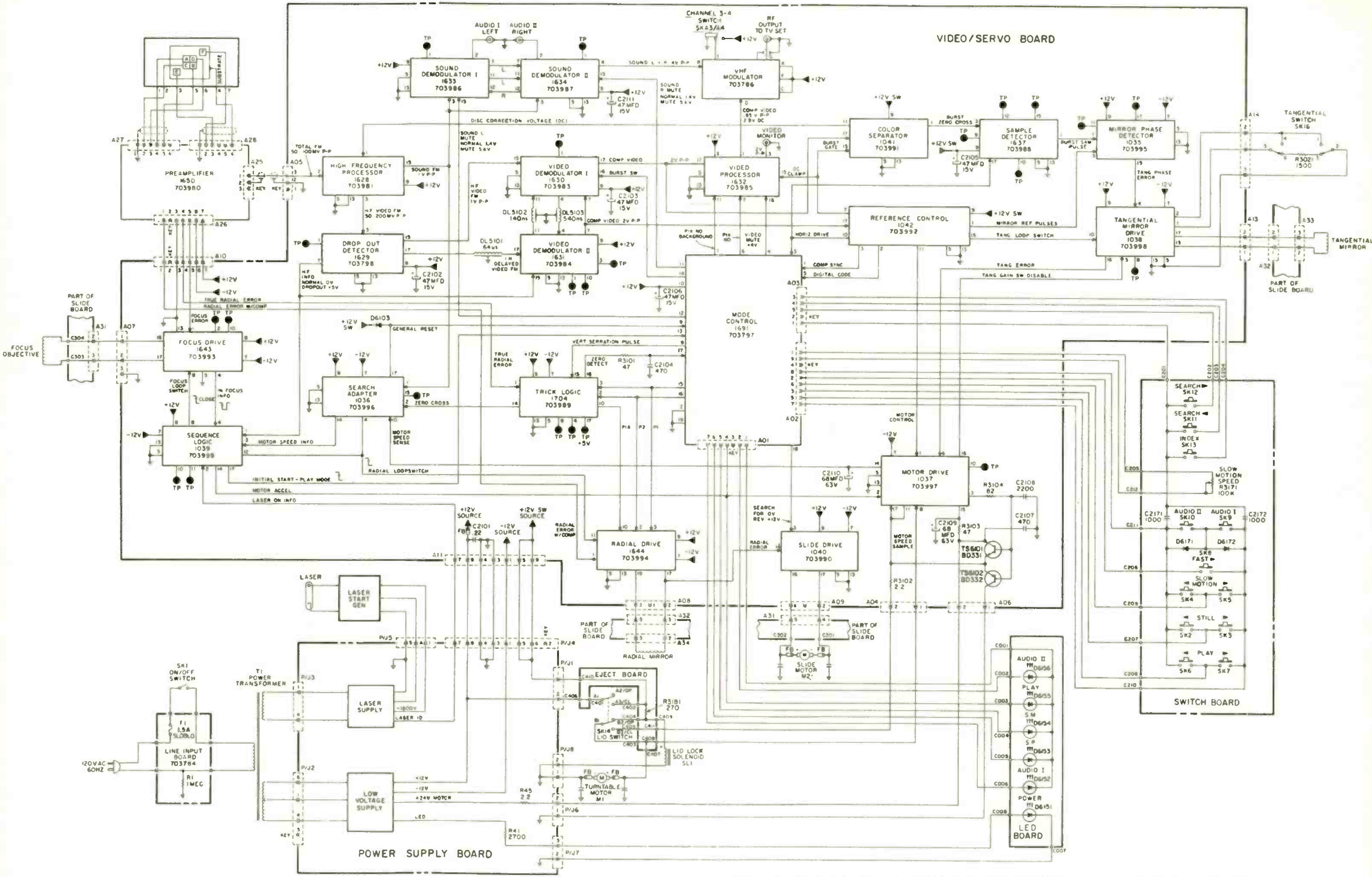


FIG. 3—THE COMPLETE SCHEMATIC OF THE MAGNAVOX *model VH8000* videodisc player. The details of the power supply are not included in this schematic.

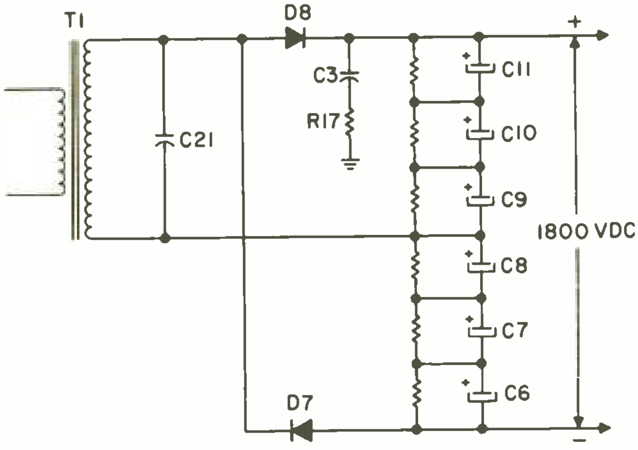


FIG. 4—LASER POWER SUPPLY CIRCUIT delivers 1800VDC to the laser for igniting the helium-neon device.

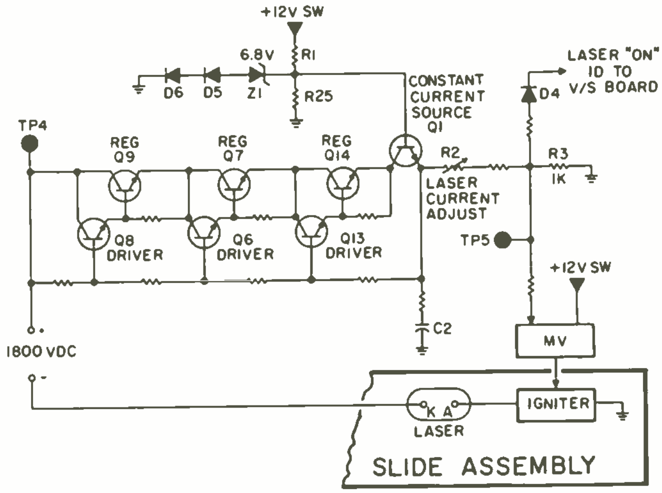


FIG. 6—LASER SUPPLY REGULATOR CIRCUIT using Darlington pairs of transistors to handle the high operating voltage.

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

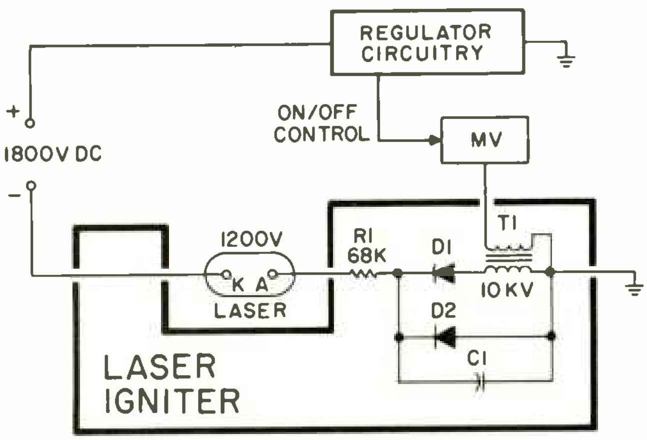


FIG. 5—SIMPLIFIED DIAGRAM OF THE laser and igniter. The igniter is a completely sealed unit.

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 miltivibrator 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 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

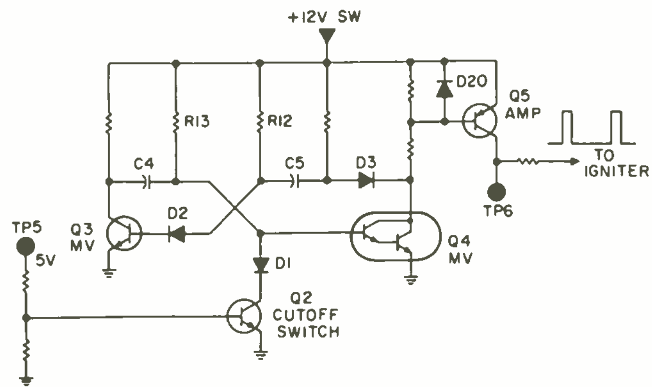


FIG. 7—LASER MULTIVIBRATOR that drives the laser igniter is a free-running type.

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

1

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 flywheel. 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.

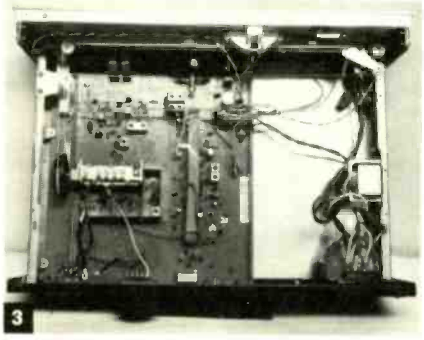
The rear panel contains one feature not usually found on tuners sold in the U.S. In addition to the terminals for connecting 300-ohm, 75-ohm FM and external AM antennas, a ball-joint pivotable built-in ferrite-bar AM antenna, a pair of audio output jacks, a single convenience AC receptacle and a line fuse-holder, there is also a three-position slide switch. The switch alters the de-emphasis of the tuner from 75 µs to either 50 µs (which is standard for European FM broadcasting), or 25 µs (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.

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"

RADIO-ELECTRONICS AUDIO LAB
R.E.A.L. SOUND
RATES
SCOTT 530-T STEREO TUNER
EXCELLENT

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



3

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 µV). **50-dB Quieting:** mono, 16.8 dBf (3.8 µV); stereo, 36 dBf (35 µV). **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, ±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 µV-per-M. **Selectivity:** 40 dB. **Image Rejection:** 40 dB. **S/N Ratio:** 45 dB. **Output Voltage:** 0.3 volt.

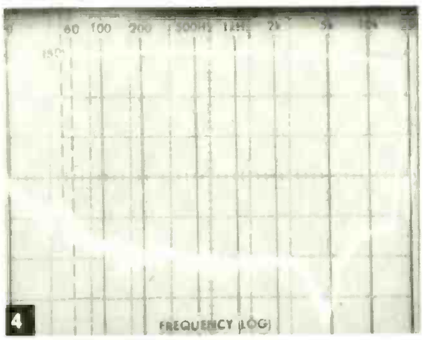
GENERAL SPECIFICATIONS:
Power Requirements: 117 volts, 60 Hz, 20 watts. **Dimensions:** 17 W x 5¼ H x 11¾ inches D. **Net Weight:** 11.5 lbs. **Suggested Retail Price:** $199.95.

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 μV, 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.

4



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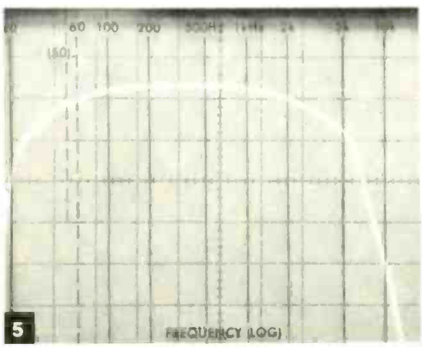

Stereo separation was a high 54 dB at mid-frequencies (as against the 45 dB claimed), and remained a high 50 dB at 100 Hz and an even more amazing 40 dB at the 10 kHz test frequency. Muting and stereo switching thresholds were set at ideal values of 7.0 μV (22.1 dBf) and 5.0 μV (19.2 dBf), respectively, 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: (μV) (dBf)	1.9 (10.8)	Excellent
Sensitivity, stereo (μV) (dBf)	5.0 (19.2)	Very good
50-dB quieting signal, mono (μV) (dBf)	2.4 (12.8)	Excellent
50-dB quieting signal, stereo (μV) (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 (±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 (μV) (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 (μV)	7.0 (22.1)	Good
Dial calibration accuracy (±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-μs de-emphasis, in addition to the U.S. standard 75-μs *and* Dolby 25-μs 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

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

RADIO-ELECTRONICS AUDIO LAB
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JVC JR-S501 RECEIVER
VERY GOOD

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.

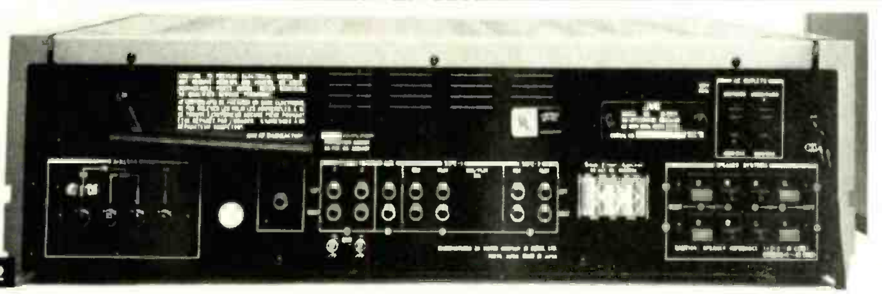
Another unique feature of the *model JR-S501* is that, aside from the thumbwheel/flywheel-tuning arrangement, there is not a single rotary control knob on its sleek, three-dimensional front panel (see Fig. 1). The internal circuitry has also been significantly improved, with the power-amplifier section 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 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 (referenced 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



2

MANUFACTURER'S PUBLISHED SPECIFICATIONS:

FM TUNER:
Usable Sensitivity: mono, 10.3 dBf (1.8 μV). **50-dB Quieting:** mono, 14.8 dBf (3.0 μV); stereo, 37.2 dBf (39.7 μV). **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 μV (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 1/16 W × 6 9/16 H × 16 15/16 inches D. **Weight:** 46.2 lb. **Suggested Retail Price:** $700.

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 μV (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.

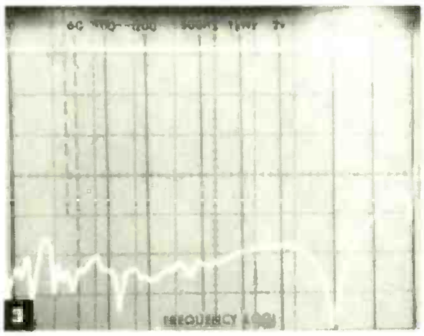
TABLE 1

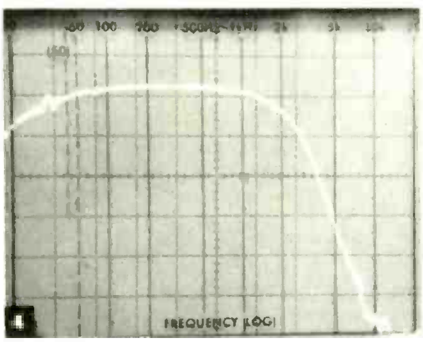
RADIO-ELECTRONICS PRODUCT TEST REPORT

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: (μV) (dBf)	2.0 (11.2)	Good
Sensitivity, stereo (μV) (dBf)	10 (25.2)	Fair
50-dB quieting signal, mono (μV) (dBf)	2.9 (14.4)	Very good
50-dB quieting signal, stereo (μV) (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 rsponse, 50 Hz to 15 kHz (±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 (μV) (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 (μV) (dBf)	12 (26.8)	Fair
Dial calibration accuracy (±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





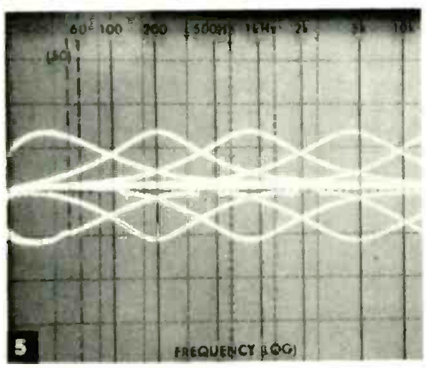
The curves shown in the scope photo of Fig. 3 (one vertical division equals 10 dB of amplitude change) display an almost perfect frequency-response characteristic out to beyond 15 kHz, while the lower trace shows channel separation at all stereo frequencies of interest. The sharp dip (or increased separation) 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.

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.

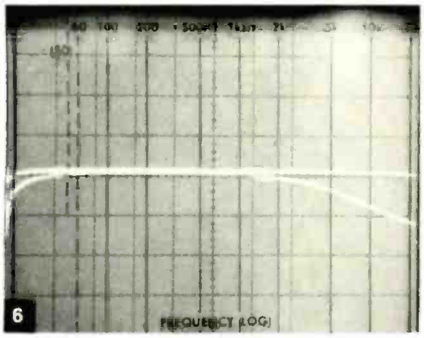
The curves shown in Fig. 5 demonstrate the usefulness of the five graphic-equalizer slide controls. The maximum range of each slider control is shown and, of course, it is possible to create a complex overall response curve that falls just about anywhere in the area included

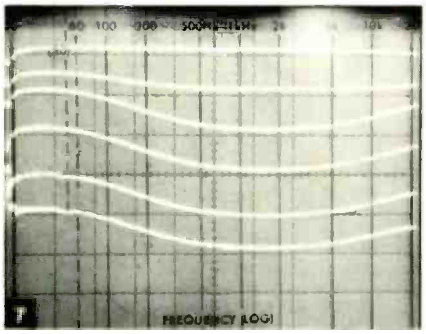


in these individual curves. Center frequencies of each control were almost precisely as designated.

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 receiv-





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 ±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, ±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, auxillary 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**

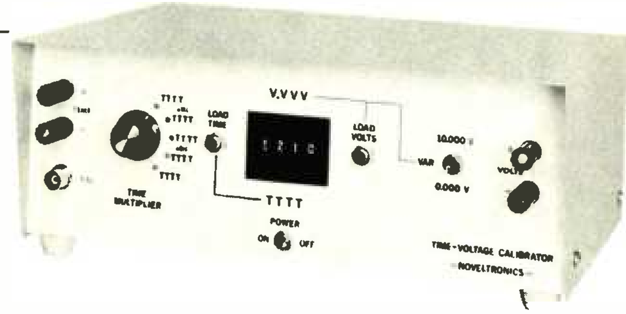
OVERALL PRODUCT ANALYSIS

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 ¼ inch from the chassis' backwall. Mark the PC board's four mounting hole locations on the chassis, then carefully drill the spots with a ⅛-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

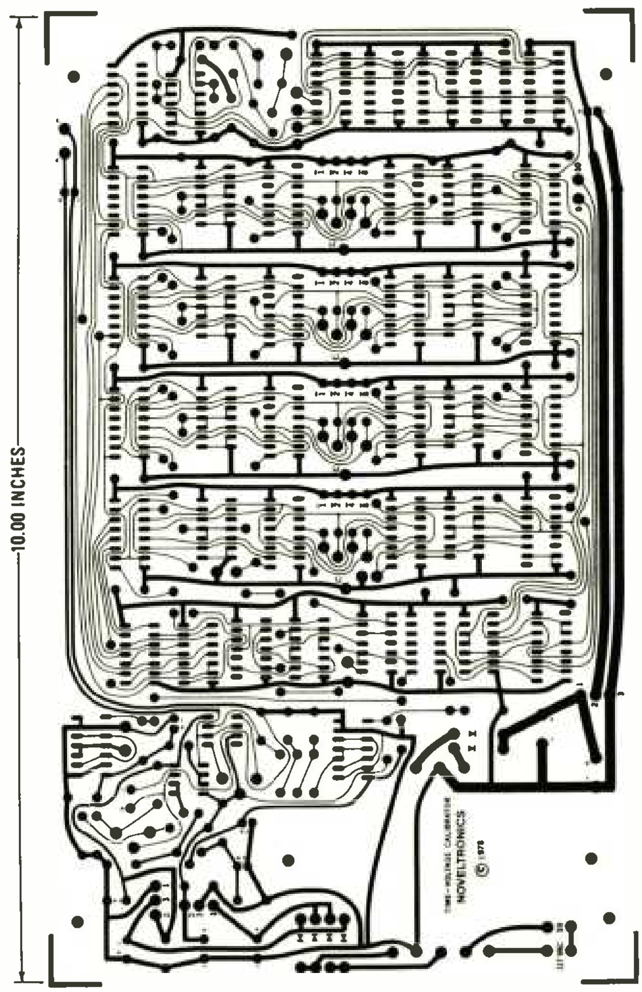
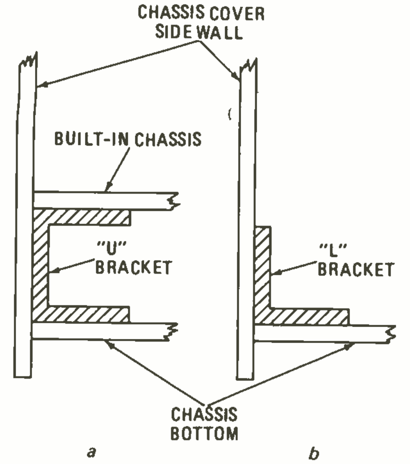


FIG. 8—FOIL PATTERN of the PC board reproduced half-size. This layout was developed to provide low-noise characteristics along with freedom from unwanted ground loops and voltage spikes.

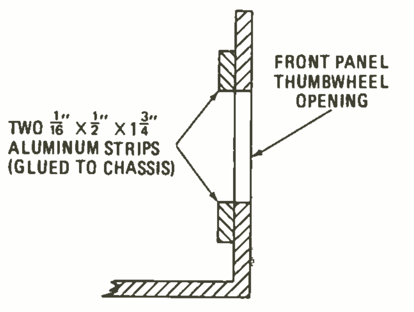
the saw's vibrations. Try hard to keep the thumbwheel-switch hole close to the dimensions shown. An oversize hole defeats the switches' self-locking mechanism.

The thumbwheel switches specified are designed to mount through a 1/8-inch-



CHASSIS MODIFICATIONS

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



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 1/16-inch thick, you must add a 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 1 3/4 × 1/2 × 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 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

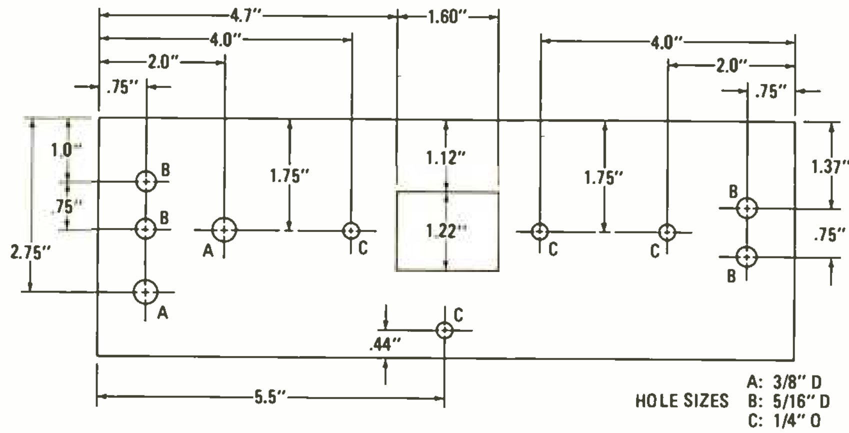


FIG. 10—DRILLING GUIDE for the front panel. We advise protecting the panel's face with masking tape until all holes have been drilled.

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 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 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 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 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 × 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 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 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-*

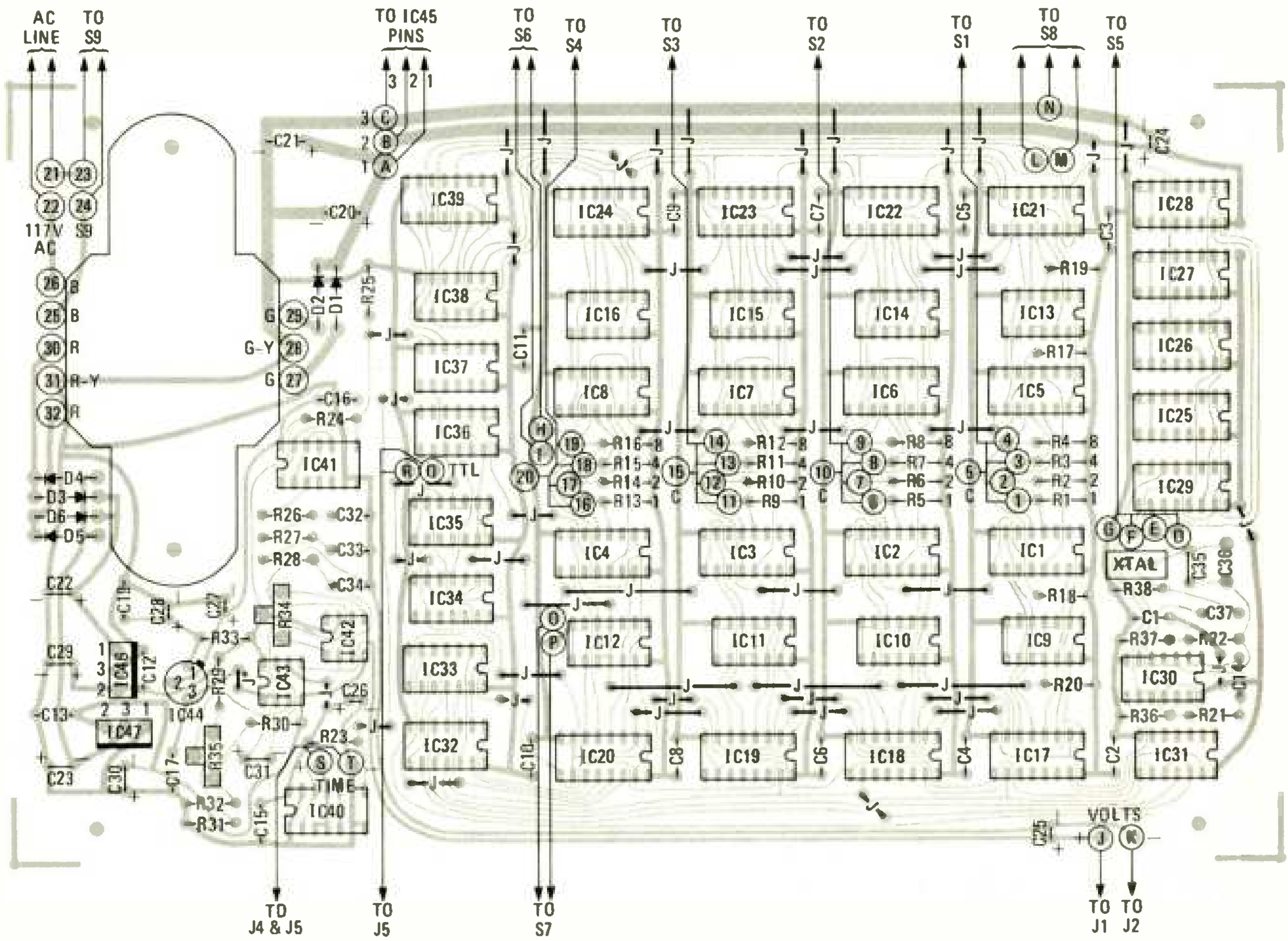


FIG. 12—PARTS PLACEMENT DIAGRAM is superimposed on reverse of PC pattern to show location of parts and to serve as a circuit-tracing aid.

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 μSEC position (i.e., a 1.0-μs 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 μs to 0.9 μs but not 1.0 μs, 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 μs. Adjust trimmer capacitor C36 until the meter measures exactly 10.0 MHz.

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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-μF 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.

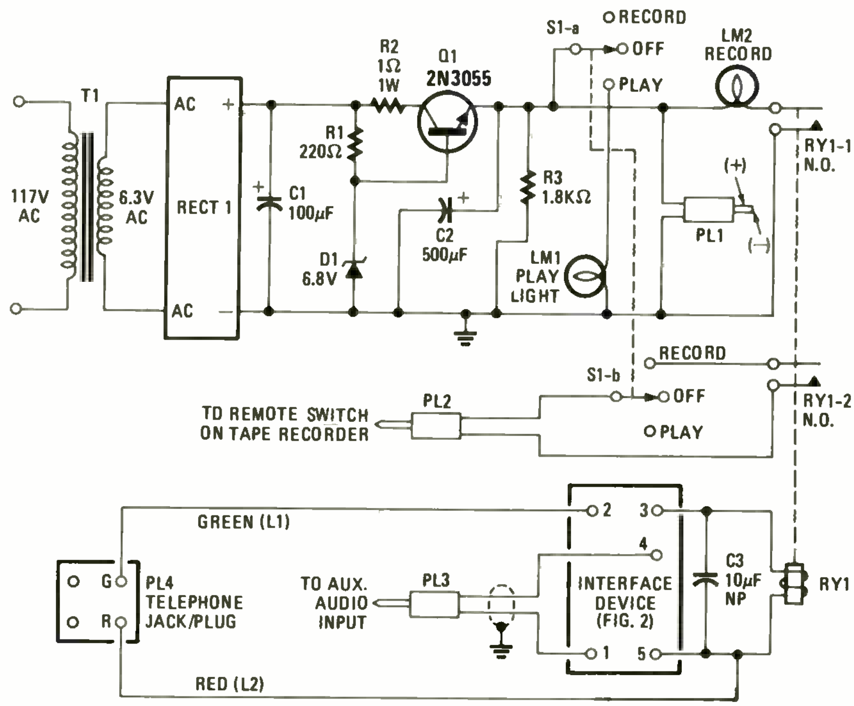

FIG. 1—SCHEMATIC of the Telecorder. The regulated supply can be used to power the recorder, thus eliminating the drain on its batteries. The interface device connects Telecorder to phone line.

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

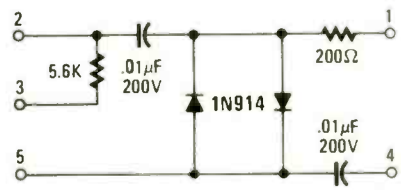

FIG. 2—INTERFACE DEVICE provides matching and isolation between phone and recorder.

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 wires.

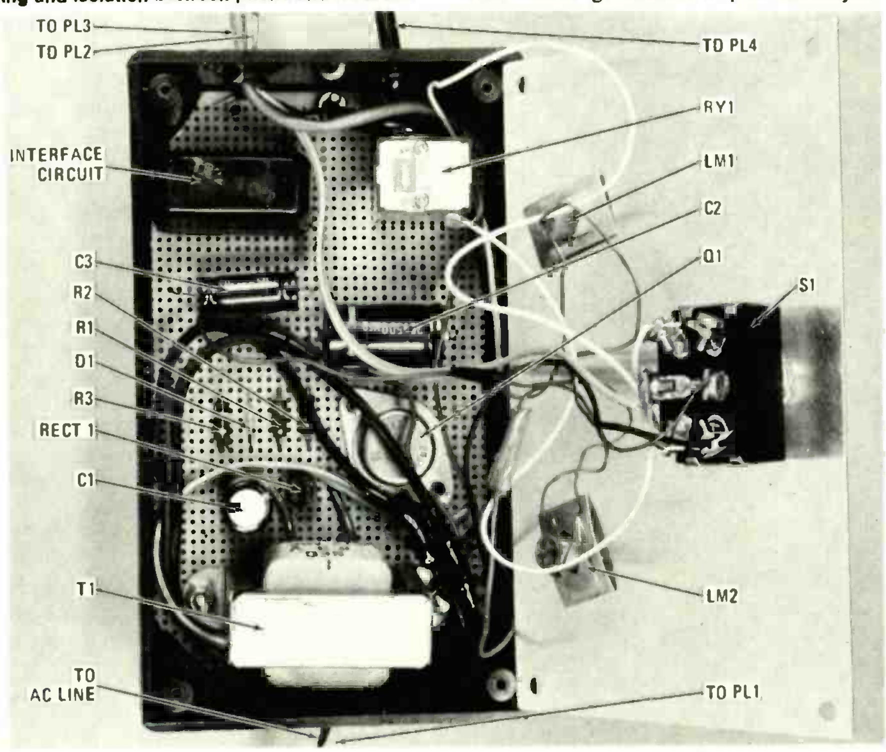

FIG. 3—INTERIOR VIEW OF THE TELECORDER shows the location of all of the components. The simplicity of the circuit makes point-to-point wiring on perforated board easy to use.

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)

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 PL 3 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.

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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 regulator 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

er Supplies

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 (*E*quivalent *S*eries *R*esistance) 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 ouput 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

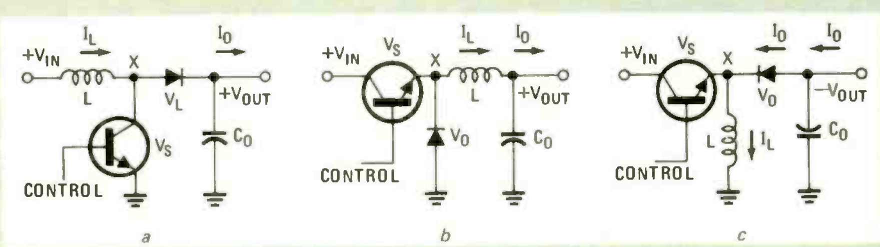

FIG. 1—BASIC SWITCHING REGULATORS. Step-up is shown in *a*, step-down is shown in *b*, and inverting-type is shown in *c*.

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 μA78S40 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.

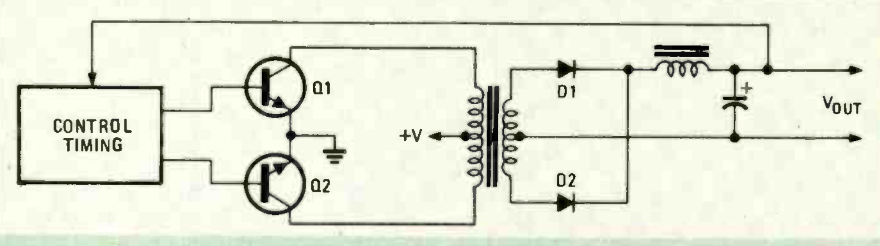

FIG. 2—PUSH-PULL SWITCHING REGULATOR uses diodes to direct current flow. When Q1 is saturated, diode D1 conducts. When Q1 is off, both diodes conduct. When Q2 is saturated, diode D1 conducts.

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 μA78S40 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

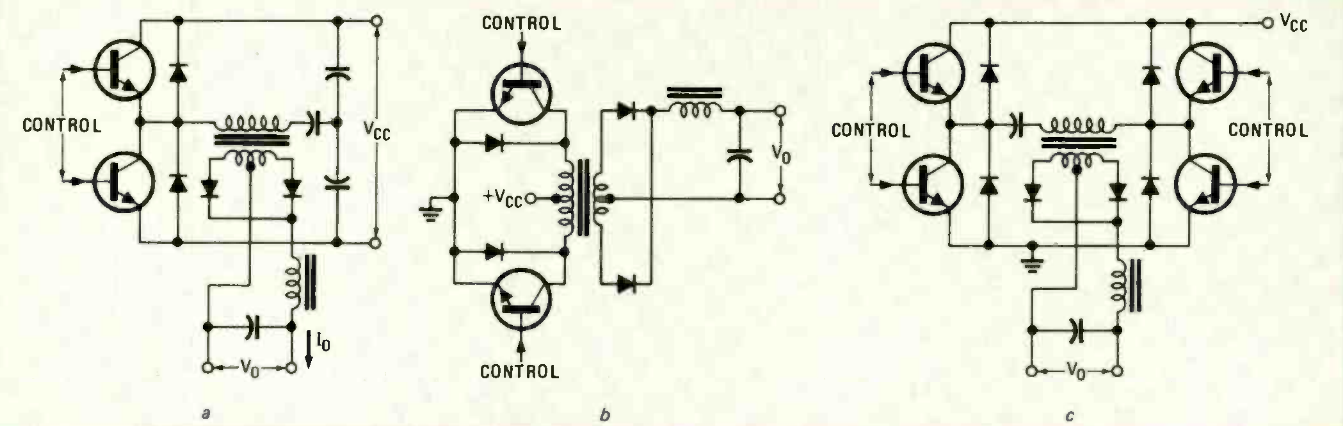

FIG. 3—PUSH-PULL CONFIGURATIONS. Single-ended is shown in *a*, push-pull is shown in *b* and full-bridge is shown in *c*.

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 μA78S40 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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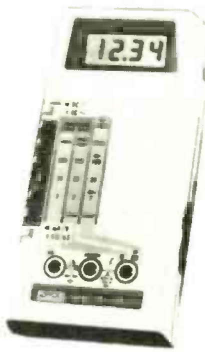

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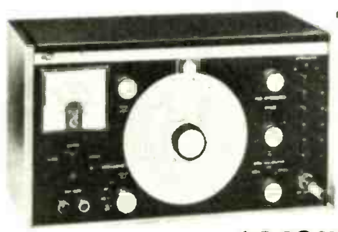

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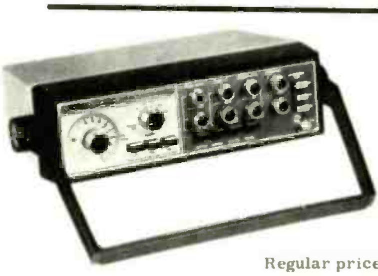

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HOBBY CORNER

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.

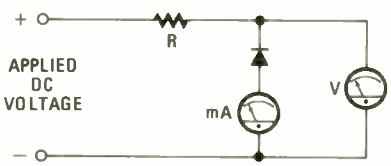

FIG. 1

At first, no current flows through the diode and the milliammeter reads zero. (Actually, there are a few *micro*amperes 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×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 being 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.

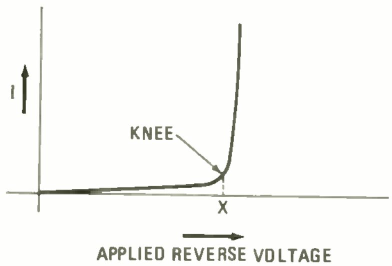

FIG. 2

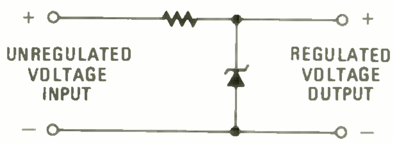

FIG. 3

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.

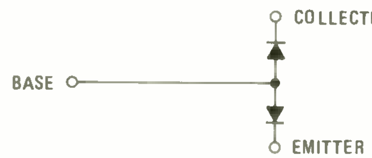

FIG. 4

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.

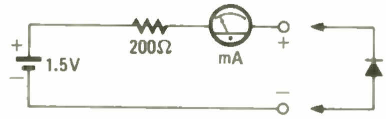

FIG. 5

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*

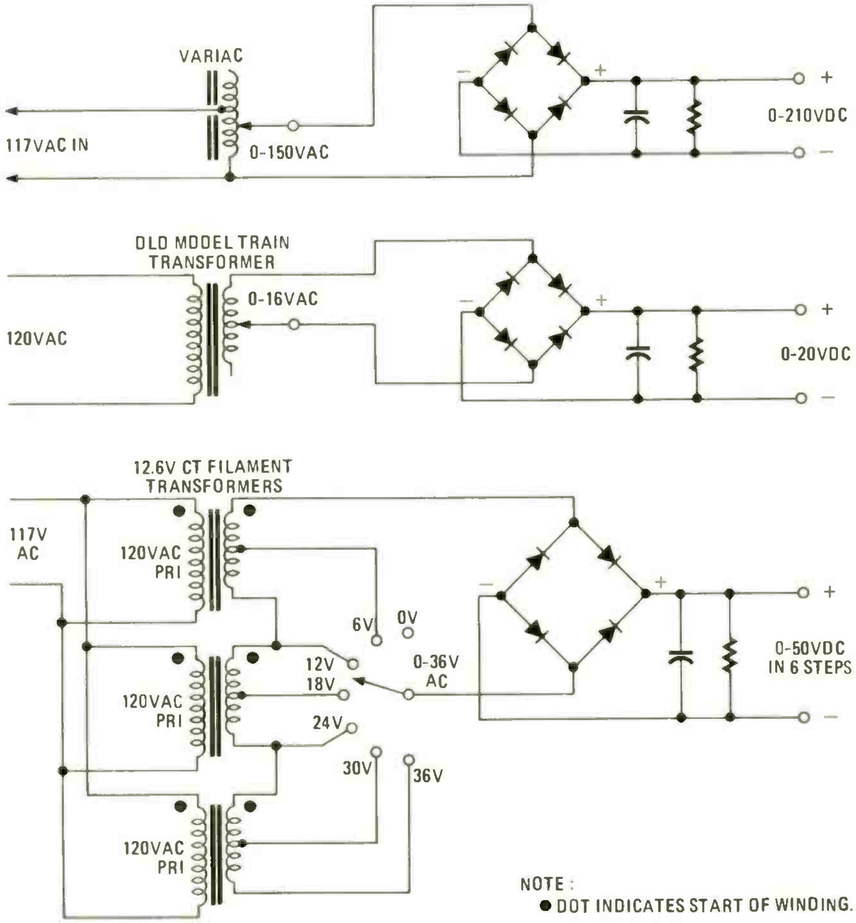

FIG. 6

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.

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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 channel entry. On the SBE *Sidebander 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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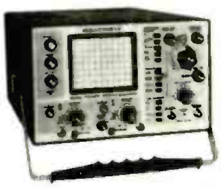

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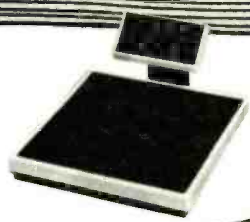

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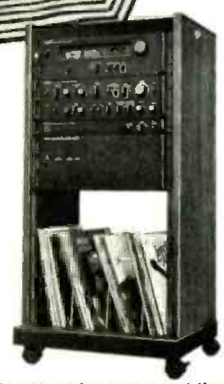

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COMMUNICATIONS CORNER

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 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 *μmax*-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-

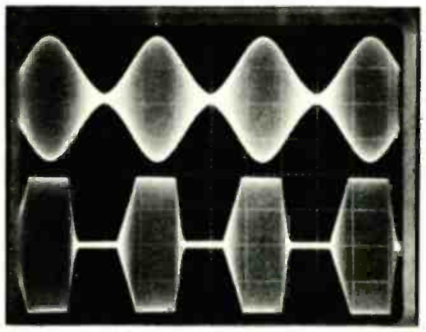
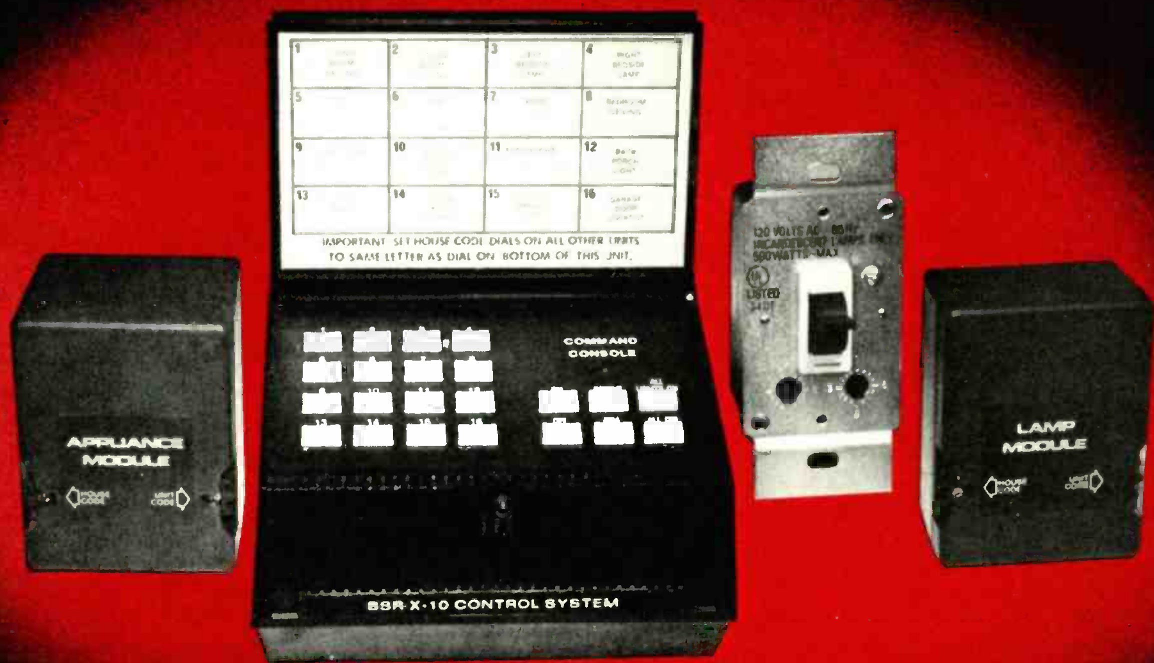


FIG. 1—THE DIRECT 27-MHZ OUTPUT of two CB transceivers modulated by 1000 Hz fed directly into the microphone through a microphone coupler. The signal level represents a "loud voice." The transceiver that produced the top trace maintains waveform purity by adjusting the overall amplifier gain to provide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

continued on page 82

PLUG IT IN AND TAKE COMMAND



X-10 Remote Control For Lights and Appliances

NO WIRES NO HASSLES

System X-10 requires no special wiring or complicated installation. Simply plug the Command Console into your wall outlet in any desired location in your home. Plug each lamp or appliance into the appropriate module and then plug that module into any wall outlet. Any number of command consoles may be used in a single system.

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.

And how many times have you left a light or an electrical appliance on overnight simply because you were too tired or too lazy to turn it off? Think of the money you can save on electric bills with System X-10. Turn off heaters or appliances from any location in your home without a lot of running around.

MICROPROCESSOR BASED DESIGN

The BSR X-10 System uses the latest digital techniques for trouble-free operation. Digital pulse codes are sent through the power lines to assure reliable control throughout the system. Amazingly compact the command console is only 4¾" X 3½" X 3½".

LAMP MODULE

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, brighten and dim. UL listed.

APPLIANCE MODULE

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.

WALL SWITCH MODULE — NOW AVAILABLE

Receives signals from the Command Console to control incandescent lamps normally operated by a wall switch up to 500 watts. Installs just like any normal wall switch. Functions include on and off by remote or local control and brighten and dim by remote control. UL listed.

GETTING STARTED

Basic starter kit includes: 1–Command Console, 2–Lamp Modules, 1–Appliance Module. Only $87.95 plus $3.00 shipping and handling. Extra Lamp and Appliance Modules $16.00 each. Wall switch modules also $16.00 each. Extra Command Consoles $39.95 each.

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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)

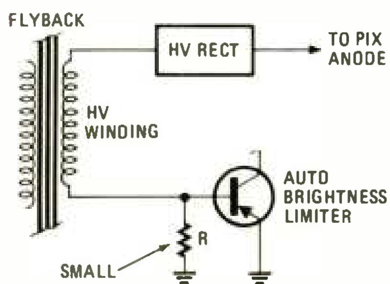

FIG. 1

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.)

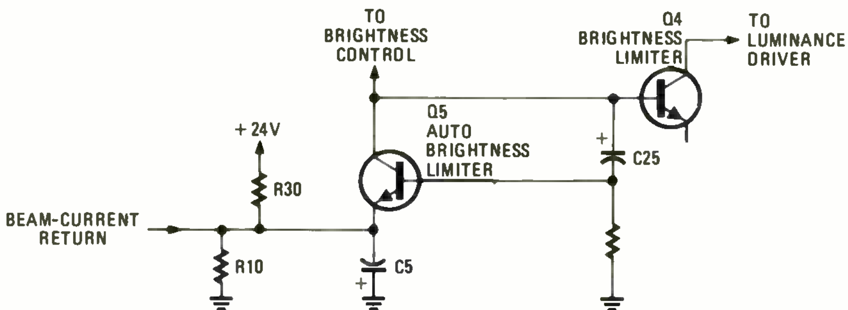

FIG. 2

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 brightnss 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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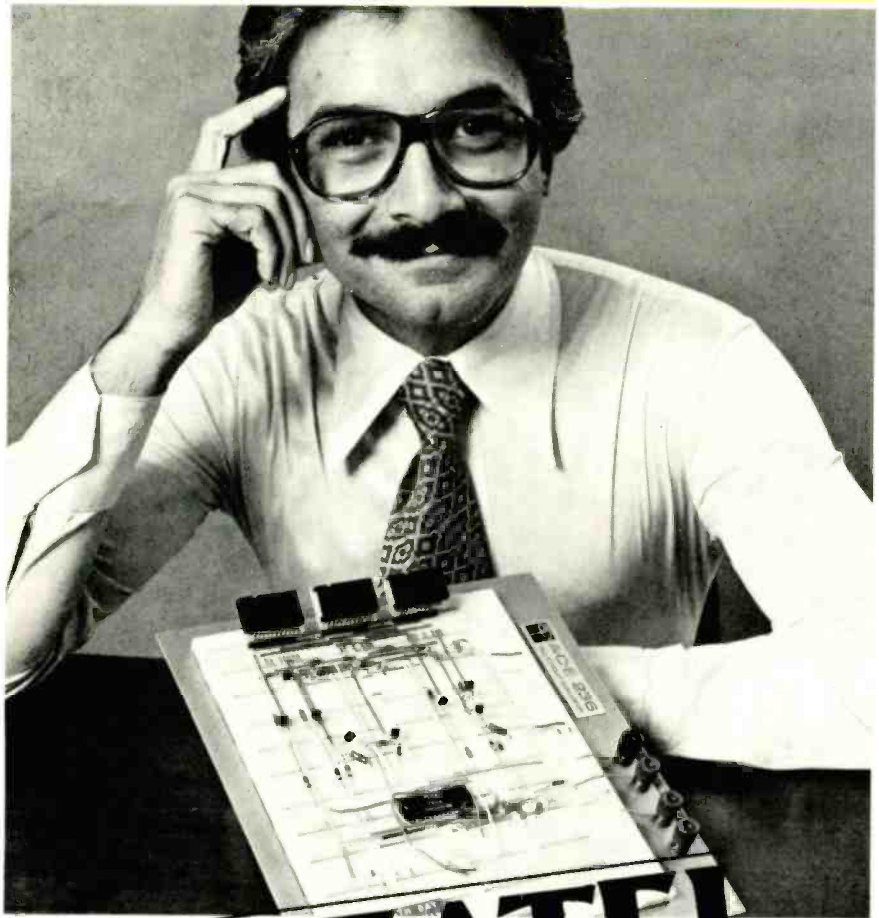


SERVICE QUESTIONS

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

SWITCHES CRYSTALS CONNECTORS HEAT SINKS FUSEHOLDERS TEST CLIPS BOOKS KITS DIP JUMPERS CABLE ASSEMBLIES SWITCHES CRYSTALS CONNECTORS HEAT SINKS

INTEGRATED CIRCUITS MICROPROCESSOR LED'S SOCKETS CAPACITORS DIODES TRANSISTORS RESISTORS POTENTIOMETERS

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 μF. My capacitor tester showed plainly that they were 0.0001 μF, 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**

COMMUNICATIONS CORNER
continued from page 74

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 squarewaves 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**

HOBBY CORNER
continued from page 71

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 × E.

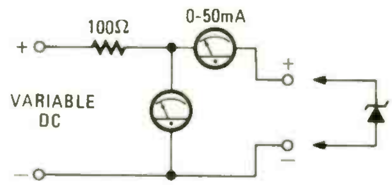
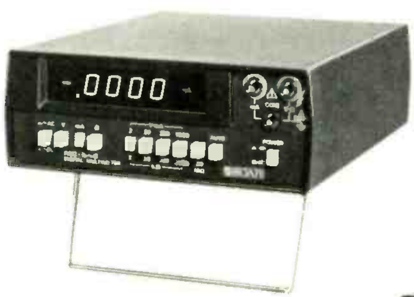
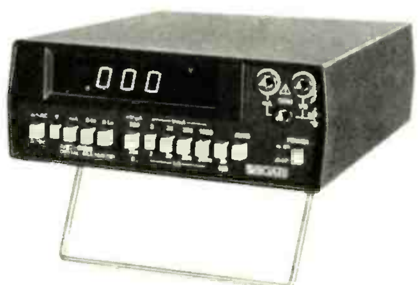


FIG. 7

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**





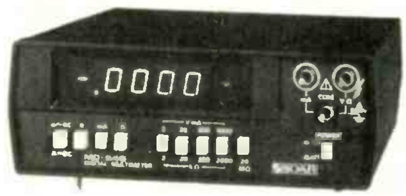
250-MHZ FREQUENCY COUNTER, *model LDC-823*, features an 8-digit fluorescent display, a variable sensitivity to 20 mV, pushbutton attenuation, and a selectable 50-ohm or 1-megohm input impedance. The counter measures frequency from 10 Hz to 250 MHz, with 0.1-, 1-, or 10-second gate times. Three timebases are available: standard timebase offering 5-ppm temperature stability, crystal oscillator with 1-ppm stability, and a crystal-oven oscillator with 0.02-ppm stability. Suggested retail price: $449.95.—**Leader Instruments Corp.**, 151 Dupont St., Plainview, NY 11803.

CIRCLE 151 ON FREE INFORMATION CARD

SIGNAL GENERATOR, *model R-1201A*, covers a frequency range of 100 Hz–1000 MHz in 100-Hz steps in continuous-wave, FM or AM modes. The instrument's 100-Hz resolution and shielded output support any high-frequency system to 100 MHz, as well as CB or 800-MHz bands. Specifications: spurious signal rejection, −40 dB (below 110 MHz), −50 dB (above 110 MHz); harmonics are 25 dB below the fundamental. The signal generator is overload-protected. Suggested retail price: $4325.—**Motorola Inc.**, Communications Div., 1301 Algonquin Rd., Schaumburg, IL 60196.

CIRCLE 152 ON FREE INFORMATION CARD

DIGITAL MULTIMETER, *model MC-545*, is a 4½-digit bench instrument that has five functions and provides automatic zeroing and polarity indications. A BCD output (8,4,2,1) can be used to connect the DMM between a CPU and a digital recorder. The unit measures voltages from 2–1000 AC and DC; current from 2–1000 mA; and resistance to 200 megohms. Suggested retail price: $289.95.—**SOAR Corp.**, 200 13th Ave., Ronkonkoma, NY 11779.



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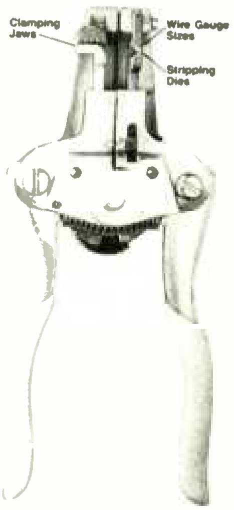
AUTOMATIC WIRE STRIPPER, *model 70334C,* strips 22-gauge to 8-gauge solid or standard wire very fast and can remove insulation up to 7/8-inch thick. The jaws hold wire firmly until cushion-grip



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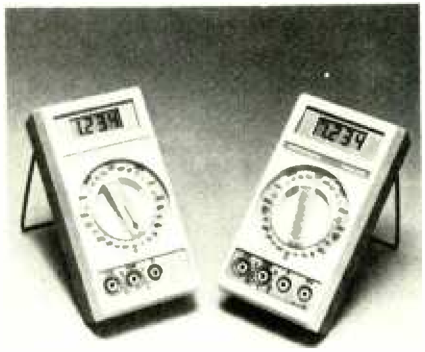
handles are released. The *model 70334C* is available at local distributors.—**Vaco Products Co.,** 1510 Skokie Blvd., Northbrook, IL 60062.

PORTABLE DIGITAL MULTIMETERS, *models Tech 300* and *Tech 310*, are 3½-digit LCD portable DMM's featuring CMOS LSI circuitry. The *Tech 300* offers 0.5% accuracy over 5 DC ranges (200 mV–1500 volts), with a 22-megohm input impedance; measures up to 1000 volts RMS over a 10-kHz bandwidth; and measures current (AC or DC) from 200 μA–2A.

The *Tech 310* has 0.25% accuracy over 5 ranges to 1500 volts with a 22-megohm input impedance; includes *Insta-Ohms* IC test function for making continuity checks; and provides a 10-amp AC/DC measurement range.

Both instruments are fully overload-protected—voltage ranges to above 1500 VDC or 1000 VAC RMS; and resistance ranges to 300



CIRCLE 155 ON FREE INFORMATION CARD

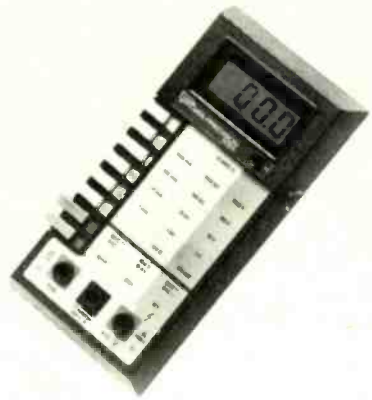
VDC or RMS. A 9-volt battery, spare fuse, safety test leads and user's manual come with each meter; optional accessories include carrying cases, probes and tips, and a test lead kit. Suggested retail prices: the *model Tech 300*, $100; the *model Tech 310*, $130.—**Beckman Instruments, Inc.,** 2500 Harbor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

29-RANGE HAND-HELD DMM, *model 935*, has a basic sensitivity of 100 μV, both in DC and AC measuring functions. The meter provides 5 ranges of DC voltage measurements with 100% overrange capability; it measures from 100V to 1000V in either polarity, with both plus and minus sign displayed. The DC function is protected to

CIRCLE 31 ON FREE INFORMATION CARD

±1000V on all ranges; and the basic instrument accuracy is ±0.1% ±1 digit.

The unit measures resistance in 6 ranges from 100 ohms to 10 megohms with a basic accuracy of ±0.2% on the low range, and ±0.3% on the highest range. The AC range is the same as the

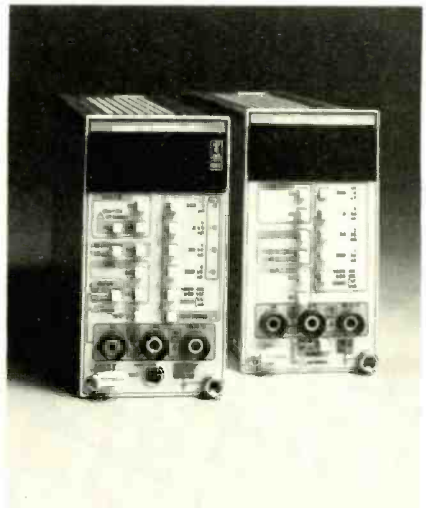


CIRCLE 156 ON FREE INFORMATION CARD

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 pushbutton-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 × 6¾ × 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-



CIRCLE 157 ON FREE INFORMATION CARD

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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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 gears' 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**

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 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° F at 8:00 am	D(function)	bb 00
	1	bb 01
	1	bb 11
	C(time/day)	00 00
	8	00 08
	0	00 80
	0	08 00
	#(am)	LED
	B(temperature)	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 automatic 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!

new lit

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 × 2.7 × 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 replcement IC's, IC modules, voltage multipliers, semiconductors 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.

CIRCLE 143 ON FREE INFORMATION CARD

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-**

tries, J.W. Miller Div., 19070 Reyes Ave., Compton, CA 90224.

CIRCLE 146 ON FREE INFORMATION CARD

MULTIMETER BROCHURE is a 4-page, 4-color brochure listing specifications for a complete line of portable digital and analog multimeters. All meters shown are fully described—they feature LED/LCD readouts, long battery life and 5 function modes.—**Soar Electronics (U.S.A.) Corp.**, 813 2nd St., Ronkonkoma, NY 11779.

CIRCLE 147 ON FREE INFORMATION CARD

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.

CIRCLE 150 ON FREE INFORMATION CARD

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 position. The PLAY light should illuminate and the recorder should be operational. If it is, place the switch in the RECORD position. 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 Carterfone Decision), in some areas of the country 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 Accessories You Can Build. *Published by Hayden Book Co., Rochelle Park, NJ 07662.* —Editor) **R-E**

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WANTED HP-67 calculator. **BARNETT,** 238 Garland Avenue, Decatur, GA 30030

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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 LSI chip, which combines the latest in linear & digital circuitry. The device is completely self-contained, in a case 6 x 3 x 2 ¼", and operates from four "AA" NiCad batteries. Nothink 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.

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Delta No.	Description	Sale
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☐ 5288R	"AA" NiCad Batteries, set of 4	4.50
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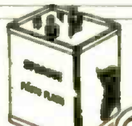

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☐ 5689R*	AA	.550	.687dia.x1.98	.98
☐ 5680R	Sub C	1.2	.865dia.x1.645	1.58
☐ 5677R*	C	2.0	1.06 dia.x1.87	2.08
☐ 5687R	C	2.0	1.028dia.x1.85	1.98
☐ 5679R	1/2D	2.3	1.305dia.x1.375	1.98
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☐ 5684R	1.2	.22	1.36 dia.x.207	.78
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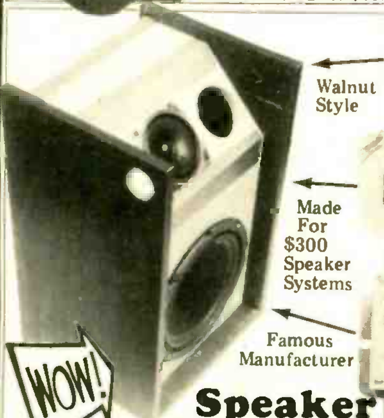

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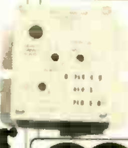

Unusual electronic timer... has 3 "timing circuits". Timers control a 3PDT relay, with 5 amp contacts. Choice of 2 time delays are selected thru a third timing circuit. The timing circuit in use is indicated by a pilot light. Two timing circuits are 0 to 15 seconds each, and the third is 0-to-5 seconds. All time delays may be changed to suit your individual needs. An unusual precision timer. Operates from 115 VAC, with circuit diagram & data. Size: 2¼ x 2¼ x2 ⅜". No. 5714R 2 for $9.

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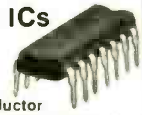

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74194	276-1832	1.19
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4020	276-2420	1.49
4021	276-2421	1.49
4023	276-2423	69¢
4027	276-2427	89¢
4028	276-2428	1.29
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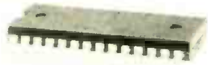
4051	276-2451	1.49
4066	276-2466	99¢
4070	276-2470	69¢
4511	276-2447	1.69
4518	276-2490	1.49
4543	276-2491	1.89

SN-76477 Sound/Music Synthesizer IC

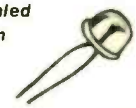


2.99 Featured in Oct. Popular Electronics

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/applications circuits. 276-1765 .... 2.99

NEW Mercury Tilt Switch

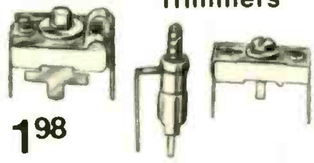
- *Hermetically Sealed*
- *Perfect for Alarm Circuits*



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¢

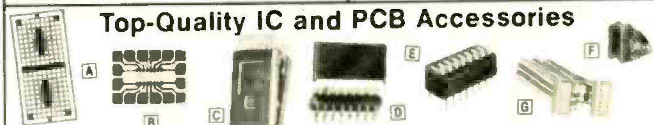
NEW 15 Ceramic Trimmers



1.98

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

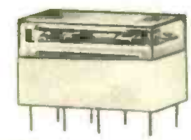
Top-Quality IC and PCB Accessories



- [A] **PC Board.** Mounts two 14 or 16-pin ICs or sockets for bread boarding. Copper clad. 2½x5x1¹/₁₆". 276-151 .... 2.99
- [B] **PC Board.** Mounts single 14 or 16-pin IC or socket. 276-024 .... Pkg. of 2/99¢
- [C] **16-Pin IC Test Clip.** 276-1951 .... 3.99
- [D] **16-Pin DIP Header.** With snap-on cover. 276-1980 .... 1.29
- [E] **8-Position DIP Switch.** 275-1301 .... 1.99
  4-Position DIP Switch. (Not shown.) 275-1304 .... 1.49
- [F] **Vertical 16-pin Socket.** For LED displays. 276-1986 .... 1.49
- [G] **16-Pin DIP Jumper Cable.** 18" long. 276-1976 .... 3.99

NEW DPDT Dual Inline Relay

Fits Std. 14-Pin IC Socket



4.49

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. 3x4½". 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

MC14553 3-Digit BCD Counter IC

For Low-Cost Digital Readout

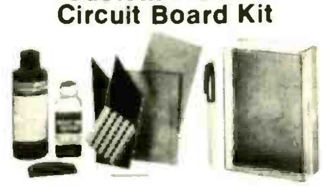
CMOS chip replaces over 8 separate IC's in a digital display circuit. Input pulse shaping. Master reset pin. 16-pin DIP. 276-2498 .... 2.99

RAM Memory ICs

Under 450 nS Access Time

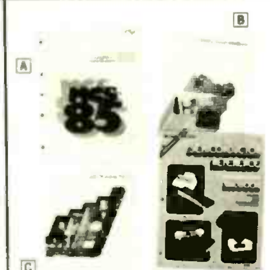
2102 1024 x 1 Array. Low-cost static memory chip. 16-pin DIP. Buy 8 and save!
276-2501 .... 2.49 Ea. or 8/14.95
2114L 1024 x 4 Array. NMOS static RAM. 18-pin DIP. 276-2504 .... 12.95

Custom Printed Circuit Board Kit



Everything you need for making high-quality custom PC boards. 276-1576 .... 7.95
Extra Resist Pen. 276-1530 .... 1.29
Extra Etching Solution. 276-1535 .... 2.19

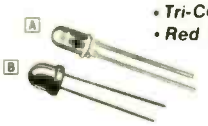
Computer Data Manuals & Semiconductor Handbook



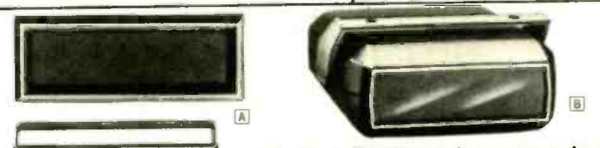
- [A] **Intel 8080/8085 Programming Manual.** Handy reference for programming with Intel's assembly language. 62-1377 .... 3.95
- [B] **Intel Memory Design Handbook.** Explains use of Intel's memory components and support circuits in systems. 62-1378 .... 3.95
- [C] **Intel Data Catalog.** 928 pages of specifications on most of Intel's standard microcomputer-related products. 62-1379 .... 4.95
- [D] **Semiconductor Reference and Application Handbook.** Complete specs and applications for popular IC transistors, diodes. 276-4002 .... 1.95

NEW LEDs

- *Tri-Color*
- *Red Flasher*



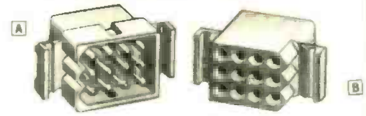
[A] Displays red, green, yellow. Uniform light output of 0.6 mcd. Forward voltage: 2.2VDC. Max. current: 25mA. T1-¾ case style. 276-035 .... 1.39
[B] Operates directly from 5VDC power source. Pulse rate: 3 Hz. Max. current: 20 mA at 5VDC. 276-036 .... 1.29



Digital Project Accessories

- [A] **Bezel with Lens.** High-contrast filter for LED displays. 3⁹/₁₆x1" lens opening. 270-301 .... 3.95
- [B] **Deluxe Molded Display Case.** Red lens. Mount up to four 0.6" or eight 0.3" LED digits. With brackets. 1¹³/₁₆x3⅞x4⁷/₁₆". 270-285 .... 3.95
- [C] **MA 1003 Clock Case.** For car clock modules. Accepts 3 pushbutton switches (not inc.). With brackets, blue lens. 3½x2⅛x2". 270-303 .... 5.95

Molded Connectors



Rated 8A @ 250V. Standard .093" pin diameter.

Fig	Pins	Type	Cat. No.	Each	Fig	Pins	Type	Cat. No.	Each
A	4	Male	274-224	99¢	B	4	Female	274-234	99c
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¢

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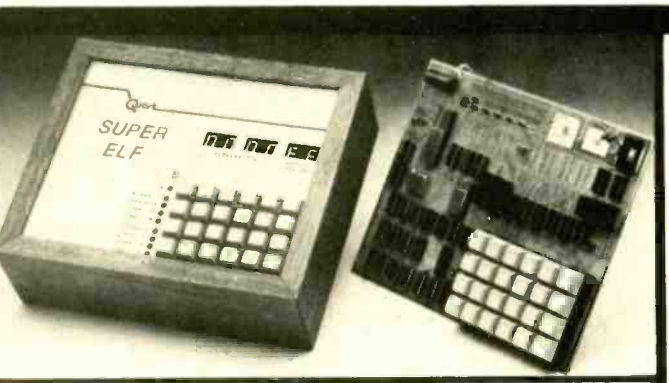

RCA Cosmac Super Elf Computer $106.95

Compare features before you decide to buy any other computer. There is no other computer on the market today that has all the desirable benefits of the **Super Elf** for so little money. The Super Elf is a small single board computer that does many **big** things. It is an excellent computer for training and for learning programming with its machine language and yet it is easily **expanded with additional memory, Tiny Basic, ASCII Keyboards, video character generation, etc.**

The **Super Elf** includes a **ROM** monitor for program loading, editing and execution with **SINGLE STEP for program debugging** which is not included in others at the same price. With **SINGLE STEP** you can see the microprocessor chip operating with the **unique Quest** address and data bus displays **before, during and after** executing instructions. Also, CPU mode and instruction cycle are decoded and displayed on eight LED indicator lamps.

An RCA 1861 **video graphics** chip allows you to connect to your own TV with an inexpensive video modulator to do graphics and games. There is a **speaker system** included for writing your own music or using many music programs already written. The speaker amplifier may also be used to drive relays for control purposes.

A 24 key **HEX keyboard** includes 16 HEX keys plus **load, reset, run, wait, input, memory protect, monitor select** and **single step**. Large, on board displays provide output and optional **high and low address**. There is a 44 pin standard connector for PC cards and a 50 pin connector for the **Quest Super Expansion Board**. Power supply and sockets for **all** IC's are included in the price plus a detailed 127 pg. instruction manual which now includes over 40 pgs. of software info. including a series of lessons to help get you started and a music program and graphics target game.

Many schools and universities are using the Super Elf as a course of study. OEM's use it for training and research and development.

Remember, other computers only offer Super Elf features at additional cost or not at all. **Compare before you buy. Super Elf Kit $106.95, High address option $8.95, Low address option $9.95. Custom Cabinet** with drilled and labelled plexiglass front panel **$24.95. NiCad Battery Memory Saver Kit $6.95.** All kits and options also come completely assembled and tested.

Questdata, a 12 page monthly software publication for 1802 computer users is available by subscription for $12.00 per year.

Tiny Basic for ANY 1802 System

Cassette $10.00. On ROM $38.00. Super Elf owners, 30% off. **Object code listing with manual $5.00. Object list, manual and paper tape $10.00. Original ELF Kit Board $14.95.**

Super Expansion Board with Cassette Interface $89.95

This is truly an astounding value! This board has been designed to allow you to decide how you want it optioned. **The Super Expansion Board comes with 4K of low power RAM** fully addressable anywhere in 64K with built-in memory protect and a **cassette interface**. Provisions have been made for all other options on the same board and it fits neatly into the hardwood cabinet alongside the **Super Elf**. The board includes slots for up to 6K of **EPROM** (2708, 2758, 2716 or TI 2716) and is **fully socketed**. EPROM can be used for the monitor and Tiny Basic or other purposes.

A 1K Super ROM Monitor $19.95 is available as an on board option in 2708 EPROM which has been preprogrammed with a program loader/editor and error checking multi file cassette read/write software, (relocatible cassette file) another exclusive from Quest. It includes register save and readout, block move capability and video graphics driver with blinking cursor. Break points can be used with the register save feature to isolate program bugs quickly, then follow with single step. The Super Monitor is written with subroutines allowing users to take advantage of monitor functions simply by calling them up. Improvements and revisions are easily done with the monitor. If you have the **Super Expansion Board** and **Super Monitor** the monitor is up and running at the push of a button.

Other on board options include **Parallel Input and Output Ports** with **full handshake**. They allow easy connection of an ASCII keyboard to the input port. **RS 232 and 20 ma Current Loop** for teletype or other device are on board and if you need more memory there are two **S-100** slots for static RAM or video boards. A Godbout 8K RAM board is available for $135.00. Also a 1K Super Monitor version 2 with video driver for full capability display with Tiny Basic and a video interface board. **Parallel I/O Ports $9.85, RS 232 $4.50, TTY 20 ma I/F $1.95, S-100 $4.50. A 50 pin connector set** with ribbon cable is available at $12.50 for easy connection between the **Super Elf** and the **Super Expansion Board**.

The Power Supply Kit for the Super Expansion Board is a 5 amp supply with multiple positive and negative voltages $29.95. Add $4.00 for shipping. Prepunched frame $5.00. Case $10.00. Add $1.50 for shipping.

P.O. Box 4430E Santa Clara, CA 95054
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2322 Walsh Ave.

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INTEGRATED CIRCUITS

7400TTL

7400N	17
7402N	17
7404N	19
7409N	23
7410N	17
7414N	63
7420N	17
7422N	1 39
7430N	20
7442N	50
7445N	69
7447N	.60
7448N	.69
7450N	17
7474N	29
7475N	49
7485N	88
7489N	2 00
7490N	43
7492N	43
7493N	43
7495N	69
74100N	90
74107N	29
74121N	34
74123N	59
74125N	39
74145N	69
[illegible]	[illegible]
74151N	69
74154N	1 00
74157N	69
74161N	87
74162N	87
74163N	87
74174N	96
74175N	90
74190N	1 15
74192N	87
74193N	85
74221N	1 55
74298N	1 65
74365N	66
74366N	66
74367N	66

74LS00 TTL

74LS00N	25
74LS02N	25
74LS04N	25
74LS05N	25
74LS08N	25
74LS10N	25
74LS13N	40
74LS14N	90
74LS20N	25
74LS22N	25
74LS28N	41
74LS30N	25
74LS33N	39
74LS38N	30
74LS74N	70
74LS75N	47
74LS90N	51
74LS93N	51
74LS95N	1 89
74LS107N	35
74LS112N	35
74LS113N	35
74LS132N	72
74LS136N	.35
74LS151N	67
74LS155N	.67
74LS157N	67
74LS162N	91
74LS163N	91
74LS174N	95
74LS190N	1 06
74LS221N	1.95
74LS258N	67
74LS367N	1.35

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CA3045	90
CA3046	67
CA3081	1 80
CA3082	1.90
CA3089	2.95
LM301AN AH	35
LM305H	87
LM307N	.35
LM308N	89
LM309H	1 15
LM309K	1.50
LM311H N	.90
LM317T K	2 92
LM318	1.35
LM320K 5	1 20
LM323K 5	6 95
LM320K 12	1 35
LM320K-15	1 35
LM320T-5	1 60
LM320T-8	1.60
LM320T 12	1 50
LM320T 15	1 60
LM324N	1 15
LM339N	1.55
LM340K 5	1.35
LM340K 8	1.35
LM340K 12	1 35
LM340K-15	1 35
LM340K-24	1 35
LM340T-5	1 25
LM340T 8	1 25
LM340T 12	1 25
LM340T 15	1 25
LM340T-18	1 25
LM340T 24	1.25
LM343H	4 50
[illegible]	7.50
LM370	1 15
LM377	3 00
LM379	5 00
LM380N	1 00
LM381	1 60
LM382	1 60
LM703H	40
LM709H	28
LM723H N	50
LM733N	67
LM741CH	.35
LM741N	25
LM747H N	.62
LM748N	35
LM1303N	.82
LM1304	1 10
LM1305	1 27
LM1307	2 00
LM1310	2 75
LM1458	47
LM1800	1 75
LM1812	7 50
LM1889	3.00
LM2111	1.75
LM2902	1 50
LM3900N	60
LM3905	1.75
LM3909N	61
MC1458V	50
NE540L	2 89
[illegible]	85
NE555V	43
NE556A	79
NE565A	1 00
NE566V	1 50
NE567V	1 20
NE570B	5 00
NE571B	5 00
78L05	60
78L08	60
79L05	70
78M05	.85
75108	1.75
75491CN	50
75492CN	55
75494CN	89

A to D CONVERTER

8038B	4 50
8700CJ	13 95
8701CN	22 00
8750CJ	13 95
LD130	9 95
9400CJV/F	7 40
ICL7103	9 50
ICL7107	14 25

CMOS

CD34001 Fair	.50
CD4000	.16
CD4001	21
CD4002	21
CD4006	1 10
CD4007	21
CD4008	21
CD4009	.39
CD4010	39
CD4011	21
CD4012	21
CD4013	36
CD4014	86
CD4015	86
CD4016	36
CD4017	94
CD4018	94
CD4019	21
CD4020	1 02
CD4021	1 02
CD4022	86
CD4023	.21
CD4024	75
CD4025	21
CD4026	1 51
CD4027	36
CD4028	79
CD4029	1 02
CD4030	21
CD4035	1 02
CD4040	1.02
CD4042	71
CD4043	63
CD4044	63
CD4046	1 67
CD4049	.36
CD4050	36
CD4051	1 13
CD4060	1 42
CD4066	71
CD4068	40
CD4069	.40
CD4070	40
CD4071	.21
CD4072	21
CD4073	21
CD4075	21
CD4076	1 75
CD4078	.40
CD4081	.21
CD4082	21
CD4116	47
CD4490	5 50
CD4507	1 00
CD4508	4 25
CD4510	1 02
CD4511	94
CD4515	2.52
CD4516	1 10
CD4518	1 02
CD4520	1.02
CD4527	1 51
CD4528	79
CD4553	3 50
CD4566	2 25
CD4583	4 50
CD4585	1 10
CD40192	3 00
74C00	28
74C04	33
74C10	28
74C14	2 10
74C20	28
74C30	28
74C48	1 95
74C74	75
74C76	1 40
74C90	1 15
74C93	1 40
74C154	3 00
74C160	1 44
74C175	1.35
74C192	1 65
74C221	2 00
74C905	3 00
74C906	75
74C914	1.95
74C922	5.50
74C923	5 50
74C925	6 95
74C926	6 95
74C927	6 95

INTERFACE

8095	65
8096	65
8097	65
8098	65
8T09	1 25
8T10	4 50
8T13	3 00
8T20	5.50
8T23	3 10
8T24	3 50
8T25	3 20
8T26	1 69
8T28	2 75
8T97	1 69
8T98	1 69

MOS/MEMORY RAM

2101-1	3 95
2102-1	95
2102AL 4	1 60
21L02-1	1 18
21F02	1 25
2104A-4	4 95
2107B	4.95
2111-1	3 75
2112-2	3 95
2114L-3	7 30
4116	10 95
2513B	6.30
MM5262	40
MM5280	3 00
MM5320	9 95
MM5330	5 94
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PD411D-4	5.00
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MCM6571A	9 95
9368	3 50
4100	10 00
416	16 00

CLOCKS

MM5309	3 00
MM5311	3 60
MM5312	4 80
MM5313	3 60
MM5314	3 90
MM5315	4.00
MM5316	5 00
MM5318	3 60
MM5369	2 10
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MM5865	7.95
CT7001	5 80
CT7002	8.95
CT7010	8 95
CT7015	7 25
MM5375AA N	3 90
MM5375AB N	4 90
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7207	7 50
7208	15.95
7209	4.95
DS0026CN	3 75
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MICROPROCESSOR

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6802	24 95
8080A with data	8 95
8085	27 00
Z80A	19 75
8212	2 90
8214	8 00
8216	2 90
8224	2 90
8228	5 35
8251	8 50
8253	10 00
8255	9 25
8257	19 50
8259	19 50
1802CP plas	13 95
1802DP plas	17 95
1861P	11 50
CDP1802CD	19 95
CDP1802D	25 00
CDP1861	12 95
6820	9 95
6850	12.95
6502	12 50

IC SOCKETS
Solder Tin Low Profile

PIN	1 UP	PIN	1UP
8	15	22	30
14	18	24	.35
16	20	28	.42
18	27	36	58
20	29	40	.57

3 level wire wrap gold 14 pin .25
2 level 14 pin ww .20

WIRE WRAP LEVEL 3

PIN		PIN	
14	25	24	86
16	.33	28	1.00
18	.57	40	1 23

UART FIFO

AY5-1013	5.50
AY5-1014	7.50
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PROM

1702A	3.95
N82S23	2 95
N82S123	3.50
N82S126	3 75
N82S129	3.75
N82S131	3 75
N82S136	8 75
N82S137	8 75
2708	10.50
DM8577	2 90
8223	2 90
2716T1	29 50
2716 Intel	48 00

CRYSTALS

1 MHz	4 50
2 MHz	4 50
4 MHz	4 25
5 MHz	4.25
10 MHz	4.25
18 MHz	3 90
20 MHz	3 90
32 MHz	3 90
32768 MHz	4.00
1 8432 MHz	4 50
3 5795 MHz	1.20
2 0100 MHz	1.95
2 097152 MHz	4.50
2 4576 MHz	4 50
3.2768 MHz	4 50
5.0688 MHz	4 50
5 185 MHz	4 50
5 7143 MHz	4.50
6 5536 MHz	4 50
14 31818 MHz	4 25
18 432 MHz	4 50
22 1184 MHz	4 50

CONNECTORS

44 pin edge	2.75
100 pin edge	4 50
100 pin edge WW	5 25

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AY5-3600	13.50
74C922	5 50
74C923	5 50
HD0165-5	6 95

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	1	10
Red	55	.47
Black	55	.47

Keyer 8043 14 50
comp w/spec book

TRANSISTORS

2N1893	40
2N2222A	18
2N2369	.30
2N2904A	20
2N2907A	25
2N3053	40
2N3638	25
2N3643	25
2N3904	18
2N3906	18
2N3055	69
2N4400	25
2N4401	75
2N4402	20
TIP31	60
TIP33A	1 00

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25 Pin Subminiatures

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DE9P	1 50
DE9S	1.95
DA15P	2 10
DA15S	3 10

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Special transformer and six switches when purchased w/module	2.95
MA1003 car module .3" green fluor. display	15.95

RESISTORS ¼ watt 5%
10 per type .03 — 1000 per type .012
25 per type .025 — 350 piece pack
100 per type .015 — 5 per type 8 75

KEYBOARDS

56 key ASCII keyboard kit	$67 50
Fully assembled	77 50
53 key ASCII keyboard kit	60 00
Fully assembled 70 00 Enclosure	14 95

LEDS

Red T018	.15
Green, Yellow T018	20
Jumbo Red	20
Green Orange Yellow Jumbo	.25
Cliplite LED Mounting Clips	8/$1.25

(specify red amber green yellow clear)

CONTINENTAL SPECIALTIES in stock
Complete line of breadboard test equip.
MAX-100 8 digit Freq. Ctr. $128.95

OK WIRE WRAP TOOLS in stock
Portable Multimeter $18.00

DIGITAL THERMOMETER $48.50
Batt. oper. General purpose or medical 32 – 230 F. Disposable probe cover ± 2 accuracy. Comp. Assy. in compact case. Switches from F to C

COMPUTER BOARD KITS

8K RAM Board Kit	$135.00
4K EPROM Kit	114 95
I/O Board Kit	44 50
Extender Board w/connector	12 50
16K EPROM board kit w/o PROMS	74 50
North Star Floppy Disk Kit	$665 00
Additional Drive Kit	415.00

SPECIAL PRODUCTS

MM5865 Stopwatch Timer	9 00
PC board	7 50
Switches Mom. Pushbutton	27
3 pos. slide	25
Encoder HD0165-5	6.95
3 Digit Universal Counter Board Kit Operates 5–18 Volt DC to 5 MHz typ. .125" LED display	10 50
Voice actuated switch	50
Paratronics 100A Logic Analyzer Kit	$224.00
Model 10 Trigger Expander Kit	$229 00
Model 150 Bus Grabber Kit	$369.00
Sinclair 3½ Digit Multimeter	$59.95
Clock Calendar Kit	$23.95

TRANSFORMERS

6V 300 ma	3 25
12 Volt 300 ma transformer	1.25
12 6V CT 600 ma	3.75
12V 250 ma wall plug	2 95
12V CT 250 ma wall plug	3 50
24V CT 400 ma	3 95
10V 1.2 amp wall plug	4 85
12V 6 amp	12.95

DISPLAY LEDS

MAN1	CA	.270	2 90
MAN3	CC	125	39
MAN72 74	CA/CA	300	1 00
DL704	CC	300	1 25
DL707/DL707R	CA	300	1 00
DL727/728	CA/CC	500	1.90
DL747/750	CA/CC	.600	1 95
DL750	CC	600	1 95
FND359	CC	357	70
FND500/507	CC/CA	500	1.35
FND503/510	CC/CA	500	.90
FND800/807	CC/CA	.800	2 20
3 digit Bubble			.60
4 digit bubble			80
DG8 Fluorescent			1 75
DG10 Fluorescent			1.75
5 digit 14 pin display			1.00
NSN69 9 digit display			60
7520 Clairex photocells			.39
TIL311 Hex			9 50

COMPUTER GRADE CAPS

1600 mfd	200V	4 50
2000 mfd	45V	2 50
3200	50V	2 50
5500	25V	2.50
5800	40V	3 00
6100	40V	3 00
6100	50V	3 00
7700	50V	2.50
8000	55V	2 50
9400	65V	3 00
10000	20V	2.50
12000	30V	3 50
35000	25V	5 00
55000	25V	5.00
82000	15V	6 00
60000	10V	6 00

Auto Clock Kit $15.95
DC clock with 4-.50" displays. Uses National MA-1012 module with alarm option. Includes light dimmer, crystal timebase PC boards. Fully regulated, comp. instructs. Add $3.95 for beautiful dark gray case. Best value anywhere.

RCA Cosmac VIP Kit $229.00
Video computer with games and graphics. Fully assem. and test. $249.00

Not a Cheap Clock Kit $14.95
Includes everything except case. 2-PC boards. 6-.50" LED Displays. 5314 clock chip, transformer, all components and full instructions. Orange displays also avail. **Same kit w/.80" displays.** Red only. **$21.95 Case $11.75**

60 Hz Crystal Time Base Kit $4.40
Converts digital clocks from AC line frequency to crystal time base. Outstanding accuracy. Kit includes: PC board, IC, crystal, resistors, capacitors and trimmer.

Digital Temperature Meter Kit
Indoor and outdoor. Switches back and forth. Beautiful. 50" LED readouts. Nothing like it available. Needs no additional parts for complete, full operation. Will measure −100° to +200°F, tenths of a degree, air or liquid. Very accurate. **$39.95**
Beautiful woodgrain case w/bezel **$11.75**

NiCad Battery Fixer/Charger Kit
Opens shorted cells that won't hold a charge and then charges them up, all in one kit w/full parts and instructions. **$7.25**

PROM Eraser
Will erase 25 PROMs in 15 minutes. Ultraviolet, assembled **$34.50**

Rockwell AIM 65 Computer
6502 based single board with full ASCII keyboard and 20 column thermal printer. 20 char. alphanumeric display, ROM monitor, fully expandable. $375.00. 4K version $450.00. 4K Assembler $85.00. 8K Basic Interpreter $100.00. Power supply assembled in case $60.00.

Multi-volt Computer Power Supply
8v 5 amp, ±18v .5 amp, 5v 1.5 amp, −5v .5 amp, 12v .5 amp, −12 option. ±5v, ±12v are regulated. Kit $29.95. Kit with punched frame $34.95. Woodgrain case $10.00.

Video Modulator Kit $8.95
Convert your TV set into a high quality monitor without affecting normal usage. Complete kit with full instructions.

2.5 MHz Frequency Counter Kit
Complete kit less case **$37.50**

30 MHz Frequency Counter Kit
Complete kit less case **$47.75**
Prescaler kit to 350 MHz **$19.95**

79 IC Update Master Manual $35.00
Complete IC data selector, 2500 pg. master reference guide. Over 50,000 cross references. Free update service through 1979. Domestic postage $3.50. Foreign $5.00. 1978 IC Master closeout $19.50.

Stopwatch Kit $26.95
Full six digit battery operated. 2–5 volts. 3.2768 MHz crystal accuracy. Times to 59 min., 59 sec., 99 1/100 sec. Times std., split and Taylor. 7205 chip, all components minus case. Full instructions.

Hickok 3½ Digit LCD Multimeter
Batt/AC oper. 0.1mv–1000v. 5 ranges. 0.5% accur. Resistance 6 low power ranges 0.1 ohm–20M ohm. DC curr. .01 to 100ma. Hand held, ½" LCD displays, auto zero, polarity, overrange. $74.95.

S-100 Computer Boards

8K Static RAM Kit Godbout	$135.00
16K Static RAM Kit	265.00
24K Static RAM Kit	423.00
32K Dynamic RAM Kit	310.00
64K Dynamic RAM Kit	470.00
8K/16K Eprom Kit (less PROMS)	$89.00
Video Interface Kit	$139.00
Motherboard $39. Extender Board	$8.99

TERMS: $5.00 min. order U.S. Funds. Calif residents add 6% tax. BankAmericard and Master Charge accepted. Shipping charges will be added on charge cards.

FREE: Send for your copy of our NEW 1979 QUEST CATALOG. Include 28¢ stamp.

CIRCLE 33 ON FREE INFORMATION CARD

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!

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

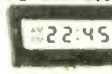
ALL UNITS FACTORY ASSEMBLED AND TESTED—NOT A KIT!

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.

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

FCM 701

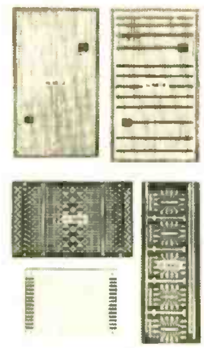
Transformer
$1.75

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 2½" (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 2½" (H) x 8" (D)	26.50
16" (W) x 4" (H) x 8" (D)	33.45
9½" (W) x 2½" (H) x 12" (D)	33 45
9½" (W) x 4" (H) x 12" (D)	24 50
9½" (W) x 4" (H) x 8" (D)	30.25

UNIVERSAL PROTOBOARDS "CIRCUIT FIT"



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	Price Fiberglass	Price 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	3½" x 6"			1.70
H 5616	3½" x 6"			1.70
H 5606	3½" x 5"			1.50
H-5602	2½" x 6"			1.50

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

HICKOK LX303 DIGITAL LCD MULTIMETER

- 3½ 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

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.

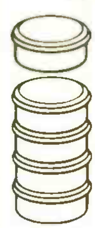
60W + 60W STEREO AMPLIFIER

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.
Power transformer $ 8.50 ea.

BUTTON CELL



NI-CD RECHARGEABLE BATTERIES
225MA/hr 1.2V per cell
7/8"x3/8"

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

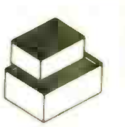
special voltage order accepted at $1.30 per cell rate

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 condensor 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.

FMM2 KIT FORM $7.95

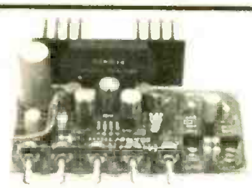
PLASTIC PROJECT BOX



The popular low-cost way to house your ex 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"x2 1/4"x1 3/8"	0.80 EACH
Large size 4"x3"x1 5/8"	1.25 EACH

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

POWER TRANSFORMER $6.50 EACH

CIRCLE 19 ON FREE INFORMATION CARD

SUPER 15 WATT AUDIO AMP KIT

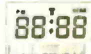
Uses STK-015 Hybrid Power Amp

Kit includes: STK-015 Hybrid IC, power supply with power transformer, front Amp with tone control, all electronic parts as well as PC Board. Less than 0.5% harmonic distortion at full power ½dB response from 20—100,000 Hz. This amplifier has QUASI—Complimentary class B output. Output max is watt (10 watt RMS) at 4Ω.

ONLY $23.50 each

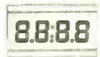
BECKMAN FET LIQUID CRYSTAL DISPLAY

Overall size 2" x 1.2" 0.5" characters reflective type



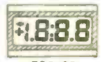
737-01

Model 737-01 — for clock 4 digits with PM, alarm, snooze, colen indicators.



739-04

Model 739-04 — for panel meter 4 digits.



739-03

Model 739-03 — for panel meter 3½ digits with ± sign and over range indicator.

All displays include zeber connectors and front bezel. With data sheets.

Your choice—any model $7.50 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

PROFESSIONAL CASE

CASE 030

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.

MANY SOUND DECISIONS!

$3.60 EACH

Solid state sound indicator operating voltage 6V DC 30μA. Small size approximately ¾" X 1¼".

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

Continuous Slow pulse Fast pulse

POWER SUPPLY KIT

0-30 POWER SUPPLY

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. $10.50 each

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

FLUORESCENT LIGHT DRIVER KIT

12V DC POWERED

Lights up 8 ~ 15 Watt Fluorescent Light Tubes Ideal for camper, outdoor Auto or Boat

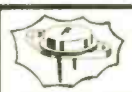
Kit includes high voltage coil, power transistor, heat sink, all other electronic parts and PC Board, light tube not included!

WITH CASE ONLY $6.50 PER KIT

12V DC MINI RELAY

6V	SPDT	2AMP	1.30
12V	SPDT	3AMP	1.60
12V	DPDT	2AMP	2.50
12V	4PDT	3AMP	3.50

5 AMP 5VDC



3 Terminals Positive Voltage Regulator Hard to find! Fairchild 78HO5To-3 Package, Input 8.5 - 20V DC Output +5V DC 5AMP Load Regulation 1%.

Only $8.75 ea

HEAVY DUTY CLIP LEADS

10 pairs — 5 colors Alligator clips on a 22" long lead. Ideal for any testing.

$2.20/pack

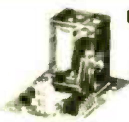
1Watt AUDIO AMP

All parts are pre assembled on a mini PC Board

Supply Voltage 6 ~ 9V D.C.

SPECIAL PRICE $1.95 ea.

ELECTRONIC SWITCH KIT



CONDENSER TYPE

Touch On Touch Off uses 7473 I.C. and 12V relay

$5.50 each

"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

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.

$15.50

SOUND GENERATOR I.C.

T176477

Creates almost any type of sound—gun shot, explosion, train, car crash, star war, birds, organ ext. A built-in audio amplifier provides high level output. Operates from one 9V battery, 28 pin dip; we supply the datas. $2.90 EACH

MINI-SIZED I.C. AM RADIO

Size smaller than a box of matches! Receives all AM stations Batteries and ear phone included

Only $10.50

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 sw on top, can be used for many projects. We give you the circuit data as well

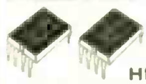
VERY SPECIAL PRICE 2 for $4.99

Sub-Mini Size PANEL METER

500 UA

ONLY $1.20 ea

NUMERIC AND HEXADECIMAL LED DISPLAY WITH LOGIC



HP 5082 - 7300

- 4 x 7 Dot Matrix 0.4" Digit
- With On Board Decoder/ Driver and Memory.
- TTL Compatible
- BCD Input

SPECIAL $9.90 Each

Sub-Mini Size CONDENSER MICROPHONE

FET Transistor Built-in $2.50 each

HARD TO FIND!! 12V 4PDT RELAY

3 Amp Contact

$3.50 Each

ELECTRONIC ALARM SIREN

AU - 999

COMPLETE UNIT

Ideal for use as an Alarm Unit or hookup to your car back up to make a reverse indicator.

Light Output up to 130dB

Voltage Supply 6 ~ 12V $7.50

TRANSFORMERS

ALL 117 VOLT INPUT

30V	4AMP	$7.50 EA
36V CT	3AMP	$8.50 EA.
48V CT	3AMP	$8.50 EA.
24V CT	3AMP	$8.50 EA.
24V CT	0.8AMP	$1.80 EA.
12V CT	0.5AMP	$1.80 EA.
12V CT	120MA	$1.25 EA.

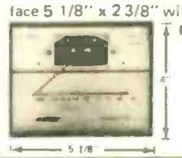
AC POWER SUPPLY

Wall Type Transformer

12V AC	Output	200MA	$2.75 EA.
16V CT AC	Output	100MA	$2.10 EA.
6V DC	Output	120MA	$1.90 EA.
12V DC	Output	100MA	$1.90 EA.

GIANT SIZE VU METER

1MA movement 3 1/2" scale length. Scale in VU -20db to +3db. Meter face 5 1/8" x 2 3/8" with a "smoke" plastic cover.



SPECIAL

$8.50 Each

SOUND ACTIVATED SWITCH

All parts completed on a PC Board. SCR will turn on relay, buzzer or trigger other circuit for 2 — 10 sec (adjustable). Ideal for use as door alarm, sound controlled toys and many other projects.

Supply voltage 4.5V ~ 9V D.C.

$1.75 ea./2 for $3.00

CDS LIGHT CONTROL SWITCH KIT

High Sensitivity Darlington Circuit, operated with a 9V D.C. supply to control lights or use it for burglar alarm, shooting game, visitor buzzer, product counting, flash-light slave unit or automatic door opener and many more. The potentiometer is to adjust the sensitivity and the relay in the circuit can handle up to 200 watts.

$4.50 ea. kit

LINEAR SLIDE POT

500KΩ SINGLE

Metal Case 3" Long

2 FOR $1.20

FLASHER LED

Unique design combines a jumbo red LED with an IC flasher chip in one package. Operates directly from 5V-7V DC. No dropping resistor needed Pulse rate 3Hz @ 5V 20 MA.

2 for $2.20

PROFESSIONAL PANEL METERS

A. 0-50UA	8.50 ea
B. 0-30VDC	8.50 ea
C. 0-50VDC	8.50 ea
D. 0-3ADC	9.00 ea
E. 0-100VDC	9.00 ea

Type MU-52E

All meters white face with black scales. Plastic cover.

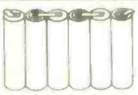
PUSH-BUTTON SWITCH

N/Open Contact

Color Red, White, Blue, Green, Black 3/$1.00

N/Close also Available 50¢ ea.

LARGE QTY AVAILABLE



Rechargeable NI-CD Batteries Pak

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

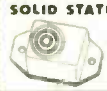
$5.25 PER PACK

I.C. TEST CLIPS

Same as the E-Z clips With 20" Long Leads In Black and Red Colors

$2.75 per pair

SOLID STATE ELECTRONIC BUZZER



Supply voltage 1.5V — 12V Ideal for Alarm or Tone Indicator

$1.50 each

BATTERY POWERED FLUORESCENT LANTERN

$10.50 EACH
MODEL 888 R

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 - 1.5V UM 1 (size D) dry cell battery
- Easy sliding door for changing batteries.
- Stainless reflector with wide angle increasing lumination of the lantern

FORMULA INTERNATIONAL INC.

6/79

	SHIPPING AND HANDLING CHARGES Under $50.00 purchase	Over $50.00 purchase
Inside California	10%	5%
Outside Calif. (includes Mexico & Canada)	15%	10%
Overseas	25%	20%

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1781 Dual Floppy	39.95
1791 Dual Floppy	44.95

TV INTERFACES

Pixie Verter	8.50
TV-1 Video Interface	8.95
Microverter	35.00
M&R Modulator	35.00

ATTENTION PET USERS

BETSI-pet expansion to S100 .... 105.00 Kit/160.00
PET Connector Kit Includes (4) Connectors for memory expansion, IEEE 488 I/O, cassette I/O and parallel user port 7.95/set
Video Buffer (converts to Std. Video) 29.95
Petunia (Music Board) 29.95
Combo (Video & Petunia) 49.95
Beeper (signals tape load) 24.95

ATTENTION APPLE II USERS

Apple II w/16K	$1045.00
16K Upgrade Kit	89.95
Floppy Disk II w/Interface	595.00
Floppy Disk II	495.00
Firmware Card	180.00
Printer Centronics P-1 w/cont	595.00
Printer Centronics P-1	395.00
Printer Centr. 779 w/cont	1445.00
Apple II Proto Board	24.00
Parallel I/O Card	180.00
Communications I/O Card	180.00
Coresident Assembler Cass	19.95
Heuristics Robot Car	249.00
Heuristics 20A Speechlab	189.00
Dow Jones Stock Quote Pkg.	25.00
AJ A242 Coupler	325.00
I/O to transmit over existing wiring	189.00 A/T
• Trencom w/IO 40 col. printer	$406.00
• Lower case adapter	49.95

TV CHIPS

AY38550-1 6 Games Color w/8515	$8.95
AY38500-1 6 Games B/W	4.95
AY38515 Color Converter	2.95
AY38603-1 Roadrace Game	8.95
AY38605-1 Warfare Game	9.50
AY38606-1 Wipeout Game	9.50
AY38607-1 Shooting Gallery	8.95
AY38610-1 10 Games Color w/8615	9.50
AY38615 Color Converter	2.95
AY38910 Game Cricket Sound Generator	12.95
SN76477 TI Sound Generator	3.95
MM5320/21 TV Synch Gen	9.95
MM5369 Prescaler	3.95
LM1889 RF Modulator	3.95
MM57100 NSC Color TV Game	6.95
MM57104 Clock Gen	3.75
RF Modulator w/Audio	8.95

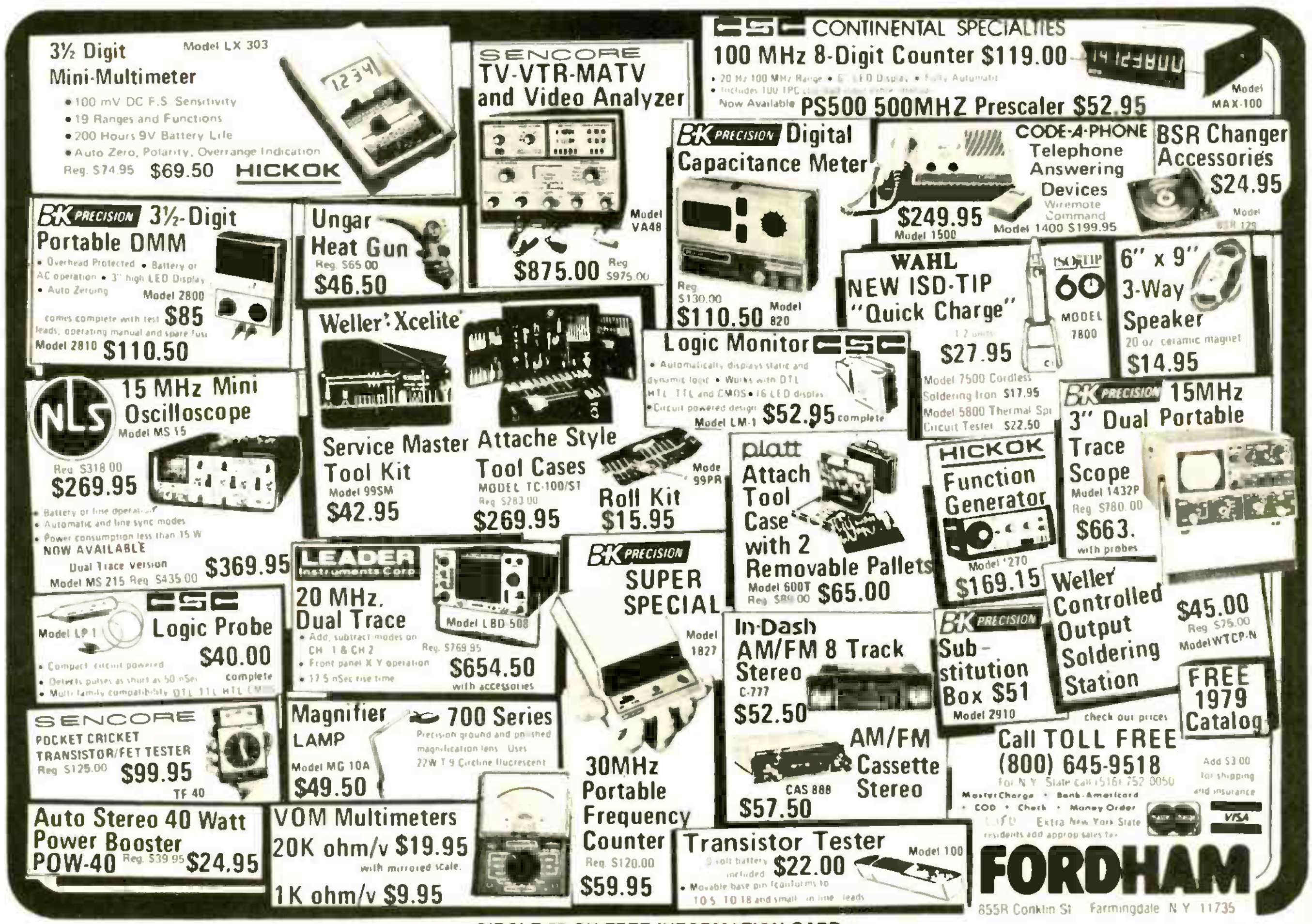
All Shipments FCM or UPS. Orders under $100.00 add 5% handling and postage. Orders over $100.00 add 2.5% handling & postage. Mastercharge/Bank americard/COD accepted w/25% deposit. California Residents add 6% tax. Foreign Orders add 8% handling. All parts prime factory tested guaranteed. Same day shipment. Add 25 cents for Data.

Retail pricing may vary from Mail Order Pricing. All pricing subject to change without notice.

P. O. BOX 17329   Irvine, California 92713   Phone (714) 558-8813   TWX: 910-595-1565

Retail Store Open Mon. – Sat. Located at 1310 "B" E. Edinger, Santa Ana, CA 92705

CIRCLE 18 ON FREE INFORMATION CARD



CIRCLE 55 ON FREE INFORMATION CARD

7400 TTL

SN7400N	16	SN7470N	29	SN74160N	89
SN7401N	18	SN7472N	29	SN74161N	89
SN7402N	18	SN7473N	35	SN74162N	1 95
SN7403N	18	SN7474N	35	SN74163N	89
SN7404N	18	SN7475N	49	SN74164N	89
SN7405N	20	SN7476N	35	SN74165N	89
SN7406N	29	SN7479N	5.00	SN74166N	1 25
SN7407N	29	SN7480N	50	SN74167N	1 95
SN7408N	20	SN7482N	99	SN74170N	1 59
SN7409N	20	SN7483N	59	SN74172N	6 00
SN7410N	18	SN7485N	79	SN74173N	1 25
SN7411N	25	SN7486N	35	SN74174N	89
SN7412N	25	SN7489N	1 75	SN74175N	79
SN7413N	40	SN7490N	45	SN74176N	79
SN7414N	70	SN7491N	59	SN74177N	79
SN7416N	25	SN7492N	43	SN74179N	1 95
SN7417N	25	SN7493N	43	SN74180N	79
SN7420N	20	SN7494N	65	SN74181N	1 95
SN7421N	29	SN7495N	65	SN74182N	79
SN7422N	39	SN7496N	65	SN74184N	1 95
SN7423N	25	SN7497N	3 00	SN74185N	1 95
SN7425N	29	SN74100N	89	SN74186N	9 95
SN7426N	29	SN74107N	35	SN74188N	3 95
SN7427N	25	SN74109N	59	SN74190N	1 25
SN7429N	39	SN74116N	1 95	SN74191N	1 25
SN7430N	20	SN74121N	35	SN74192N	79
SN7432N	25	SN74122N	39	SN74193N	79
SN7437N	25	SN74123N	49	SN74194N	89
SN7438N	25	SN74125N	49	SN74195N	69
SN7439N	25	SN74126N	49	SN74196N	89
SN7440N	20	SN74132N	75	SN74197N	89
SN7441N	89	SN74136N	75	SN74198N	1 49
SN7442N	49	SN74141N	75	SN74199N	1 49
SN7443N	75	SN74142N	2 95	SN74S200	4 95
SN7444N	75	SN74143N	2 95	SN74251N	1 79
SN7445N	75	SN74144N	2 95	SN74279N	79
SN7446N	69	SN74145N	79	SN74283N	2 25
SN7447N	59	SN74147N	1 95	SN74284N	3 95
SN7448N	79	SN74148N	1 29	SN74285N	3 95
SN7450N	20	SN74150N	89	SN74365N	69
SN7451N	20	SN74151N	59	SN74366N	69
SN7453N	20	SN74152N	59	SN74367N	69
SN7454N	20	SN74153N	59	SN74368N	69
SN7459A	25	SN74154N	99	SN74390N	1 95
SN7460N	20	SN74155N	79	SN74393N	1 95
		SN74156N	79		
		SN74157N	65		

C/MOS

CD4000	23	CD4028	89	CD4070	55
CD4001	23	CD4029	1 19	CD4071	[illegible]
CD4002	23	CD4030	49	CD4072	19
CD4006	1 19	CD4035	99	CD4076	1 39
CD4007	25	CD4040	1 19	CD4081	23
CD4009	49	CD4041	1 25	CD4082	23
CD4010	49	CD4042	99	CD4093	99
CD4011	23	CD4043	89	CD4098	2 49
CD4012	25	CD4044	89	MC14409	14 95
CD4013	39	CD4046	1 79	MC14410	14 95
CD4014	1 39	CD4047	2 50	MC14411	14 95
CD4015	1 19	CD4048	1 35	MC14419	4 95
CD4016	49	CD4049	49	MC14433	19 95
CD4017	1 19	CD4050	49	MC14506	75
CD4018	99	CD4051	1 19	MC14507	99
CD4019	49	CD4053	1 19	MC14562	14 50
CD4020	1 19	CD4056	2 95	MC14583	3 50
CD4021	1 39	CD4059	9 95	CD4508	1 95
CD4022	1 19	CD4060	1 49	CD4510	1 39
CD4023	23	CD4066	79	CD4511	1 79
CD4024	79	CD4068	39	CD4515	2 95
CD4025	23	CD4069	45	CD4518	1 39
CD4026	2 25			CD4520	1 79
CD4027	69			[illegible]	2 75

74C00

74C00	39	74C85	2.49	74C163	2 49
74C02	39	74C90	1 95	74C164	2 49
74C04	39	74C93	1 95	74C173	2 60
74C08	49	74C95	1 95	74C192	2 49
74C10	39	74C107	1.25	74C193	2 49
74C14	1 95	74C151	2 90	74C195	2 49
74C20	39	74C154	3 00	74C922	5 95
74C30	39	74C157	2 15	74C923	6 25
74C42	1 95	74C160	2 49	74C925	8 95
74C48	2 49	74C161	2 49	74C926	8 95
74C73	.89			80C95	1 50
74C74	89			80C97	1 50

LINEAR

78MG	1 75	LM340K-18	1 35	LM710N	79
LM106H	99	LM340K-24	1 35	LM711N	39
LM300H	.80	LM340T-5	1 25	LM723N/H	55
LM301CN/H	35	LM340T-6	1.25	LM733N	1 00
LM302H	75	LM340T-8	1 25	LM739N	1 19
LM304H	1 00	LM340T-12	1.25	LM741CN/H	35
LM305H	60	LM340T-15	1 25	LM741-14N	39
LM307CN/H	35	LM340T-18	1 25	LM747N/H	79
LM308CN/H	1 00	LM340T-24	1 25	LM748N/H	39
LM309H	1 10	LM358N	1 00	LM1310N	2.95
LM309K	1 25	LM370N	1 95	LM1458CN/H	59
LM310CN	1 15	LM373N	3 25	MC1488N	1 39
LM311N/H	.90	LM377N	4 00	MC1489N	1 39
LM312H	1 95	LM380N	1 25	LM1496N	95
LM317K	6 50	LM380CN	99	LM1556V	1 75
LM318CN/H	1 50	LM381N	1 79	MC1741SCP	3 00
LM319N	1 30	LM382N	1.79	LM2111N	1 95
LM320K-5	1 35	NE501N	8 00	LM2901N	2.95
LM320K-5.2	1 35	NE510A	6 00	LM3053N	1 50
LM320K-12	1 35	NE529A	4 95	LM3065N	1 49
LM320K-15	1 35	NE531H/V	3 95	LM3900N(3401)	49
LM320K-18	1 35	NE536T	6 00	LM3905N	89
LM320K-24	1.35	NE540L	6 00	LM3909N	1 25
LM320T-5	1 25	NE544N	4.95	MC5558V	59
LM320T-5.2	1.25	NE550N	1 30	8038B	4 95
LM320T-8	1 25	NE555V	39	LM75450N	49
LM320T-12	1 25	NE556N	99	75451CN	39
LM320T-15	1 25	NE560B	5.00	75452CN	39
LM320T-18	1 25	NE561B	5 00	75453CN	39
LM320T-24	1 25	NE562B	5 00	75454CN	.39
LM323K-5	5 95	NE565N/H	1 25	75491CN	79
LM324N	1 80	NE566CN	1 75	75492CN	89
LM339N	99	NE567V/H	.99	75493N	89
LM340K-5	1.35	NE570N	4 95	75494CN	89
LM340K-6	1.35	LM703CN/H	69	RC4136	1 25
LM340K-8	1 35	LM709N/H	29	RC4151	2 85
LM340K-12	1 35			RC4194	5 95
LM340K-15	1 35			RC4195	4 49

74LS00TTL

74LS00	29	74LS47	89	74LS138	89
74LS01	29	74LS51	29	74LS139	89
74LS02	29	74LS54	29	74LS151	89
74LS03	.29	74LS55	29	74LS155	89
74LS04	.35	74LS73	45	74LS157	89
74LS05	35	74LS74	45	74LS160	1 15
74LS08	29	74LS75	59	74LS161	1 15
74LS09	35	74LS76	45	74LS162	1 15
74LS10	29	74LS78	49	74LS163	1 15
74LS11	75	74LS83	89	74LS164	1 25
74LS13	59	74LS85	1 25	74LS175	99
74LS14	1 25	74LS86	45	74LS181	2 49
74LS15	35	74LS90	59	74LS190	1 15
74LS20	29	74LS92	75	74LS191	1 15
74LS21	35	74LS93	75	74LS192	1 15
74LS22	35	74LS95	99	74LS193	1 15
74LS26	35	74LS96	1 15	74LS194	1 15
74LS27	35	74LS107	45	74LS195	1 15
74LS28	35	74LS109	45	74LS253	99
74LS30	.29	74LS112	45	74LS257	89
74LS32	35	74LS123	1 25	74LS258	1 75
74LS37	45	74LS125	89	74LS260	69
74LS40	35	74LS132	99	74LS279	75
74LS42	89	74LS136	49	74LS367	75
				74LS368	75
				74LS670	2 49

EXCITING NEW KITS!

Regulated Power Supply 5 to 15 VDC

NEW

- Full 1.5 amp at 5-10V output – Up to .5 amp at 15V output
- Heavy duty transformer
- 3 terminal I.C. Volt. Reg.
- Heat sink provided for cooling efficiency
- PC Board construction
- 120 VAC input
- Size: 3½"W x 5"L x 2"H

JE210 5 to 15 VDC **$19.95**

Digital Thermometer Kit

NEW

- Dual sensors—switching control for in-door/outdoor or dual monitoring
- Continuous LED .8" ht. display
- Range: -40°F to 199°F / -40°C to 100°C
- Accuracy: ±1° nominal
- Set for Fahrenheit or Celsius reading
- Sim. walnut case – AC wall adapter incl.
- Size: 3-1/4"H x 6-5/8"W x 1-3/8"D

JE300 ....$39.95

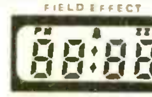
DISCRETE LEDS

	.200" dia.				.125" dia.		
XC556R	red	5/$1		XC209R	red	5/$1	
XC556G	green	4/$1		XC209G	green	4/$1	
XC556Y	yellow	4/$1		XC209Y	yellow	4/$1	
XC556C	clear	4/$1					
	.200" dia.				.185" dia.		
XC22R	red	5/$1		XC526R	red	5/$1	
XC22G	green	4/$1		XC526G	green	4/$1	
XC22Y	yellow	4/$1		XC526Y	yellow	4/$1	
	.170" dia.			XC526C	clear	4/$1	
MV10B	red	4/$1			.190" dia.		
	.085" dia.			XC111R	red	5/$1	
MV50	red	6/$1		XC111G	green	4/$1	
				XC111Y	yellow	4/$1	
				XC111C	clear	4/$1	

INFRA-RED LED 1/4"x1/4"x1/16" flat 5/$1

TIMEX T1001 LIQUID CRYSTAL DISPLAY

FIELD EFFECT



4 DIGIT – .5" CHARACTERS
THREE ENUNCIATORS
2.00" X 1.20" PACKAGE
INCLUDES CONNECTOR

T1001-Transmissive $7.95
T1001A-Reflective 8.25

DISPLAY LEDS

TYPE	POLARITY	HT	PRICE	TYPE	POLARITY	HT	PRICE
MAN 1	Common Anode-red	270	2 95	MAN 6730	Common Anode-red ±1	560	99
MAN 2	5 x 7 Dot Matrix-red	300	4 95	MAN 6740	Common Cathode-red-D.D.	560	99
MAN 3	Common Cathode-red	125	25	MAN 6750	Common Cathode-red ±1	560	99
MAN 4	Common Cathode-red	187	1.95	MAN 6760	Common Anode-red	560	99
MAN 7G	Common Anode-green	300	1.25	MAN 6780	Common Cathode-red	560	99
MAN 7Y	Common Anode-yellow	300	99	DL701	Common Anode-red ±1	300	99
MAN 72	Common Anode-red	300	99	DL704	Common Cathode-red	300	99
MAN 74	Common Cathode-red	300	1 25	DL707	Common Anode-red	300	99
MAN 82	Common Anode-yellow	300	99	DL728	Common Cathode-red	500	1 49
MAN 84	Common Cathode-yellow	300	99	DL741	Common Anode-red	600	1 25
MAN 3620	Common Anode-orange	300	99	DL746	Common Anode-red ±1	630	1 49
MAN 3630	Common Anode-orange ±1	300	99	DL747	Common Anode-red	600	1 49
MAN 3640	Common Cathode-orange	300	99	DL749	Common Cathode-red ±1	630	1 49
MAN 4610	Common Anode-orange	300	99	DL750	Common Cathode-red	600	1 49
MAN 4640	Common Cathode-orange	400	99	DL338	Common Cathode-red	110	35
MAN 4710	Common Anode-red	400	99	FND70	Common Cathode	250	69
MAN 4730	Common Anode-red ±1	400	99	FND358	Common Cathode ±1	357	99
MAN 4740	Common Cathode-red	400	99	FND359	Common Cathode	357	75
MAN 4810	Common Anode-yellow	400	99	FND503	Common Cathode(FND500)	500	99
MAN 4840	Common Cathode-yellow	400	99	FND507	Common Anode (FND510)	500	99
MAN 6610	Common Anode-orange D.D.	560	99	5082-7730	Common Anode-red	300	1 30
MAN 6630	Common Anode-orange ±1	560	99	HDSP-3400	Common Anode-red	800	2 10
MAN 6640	Common Cathode-orange-D.D.	560	99	HDSP-3403	Common Cathode-red	800	2 10
MAN 6650	Common Cathode-orange ±1	560	99	5082-7300	4 x 7 sgl. Digit-RHDP	600	19 95
MAN 6660	Common Anode-orange	560	99	5082-7302	4 x 7 Sgl. Digit-LHDP	600	19 95
MAN 6680	Common Cathode-orange	560	99	5082-7304	Overrange character (±1)	600	15 00
MAN 6710	Common Anode-red-D.D.	560	99	5082-7340	4 x 7 Sgl. Digit-Hexadecimal	600	22 50

RCA LINEAR

CA3013T	2 15	CA3082N	2 00
CA2023T	2 56	CA3083N	1 60
CA3035T	2 48	CA3086N	85
CA3039T	1 35	CA3089N	3 75
CA3046N	1 30	CA3130T	1 39
CA3059N	3 25	CA3140T	1 25
CA3060N	3 25	CA3160T	1 25
CA3080T	85	CA3401N	49
CA3081N	2 00	CA3600N	3 50

CALCULATOR CHIPS/DRIVERS

MM5725	$2 95
MM5738	2 95
DM8864	2 00
DM8865	1 00
DM8887	75
DM8889	75
9374 7 seg C.A. LED driver	

CLOCK CHIPS

MM5309	$4 95
MM5311	4 95
MM5312	4 95
MM5314	4 95
MM5316	6 95
MM5318	9 95
MM5369	2 95
MM5387/1998A	4 95
MM5841	9 95

MOTOROLA

MC1408L7	$4 95
MC1408L8	5 75
MC1439L	2 95
MC3022P	2 95
MC3061P	3 50
MC4016(74416)	7 50
MC4024P	3 95
MC4040P	6 95
MC4044P	4 50

IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin LP	$.17	16	.15	22 pin LP	$ .37	36	35
14 pin LP	20	19	.18	24 pin LP	38	37	36
16 pin LP	22	.21	20	28 pin LP	.45	.44	.43
18 pin LP	.29	28	27	36 pin LP	60	59	.58
20 pin LP	34	.32	30	40 pin LP	63	62	.61
SOLDERTAIL STANDARD (TIN)							
14 pin ST	$.27	25	.24	28 pin ST	$ .99	90	.81
16 pin ST	.30	.27	25	36 pin ST	1.39	1 26	1 15
18 pin ST	35	32	30	40 pin ST	1.59	1.45	1 30
24 pin ST	49	.45	42				
SOLDERTAIL STANDARD (GOLD)							
8 pin SG	$ 30	.27	24	24 pin SG	$ .70	.63	.57
14 pin SG	35	32	29	28 pin SG	1 10	1.00	90
16 pin SG	38	35	32	36 pin SG	1 65	1.40	1.26
18 pin SG	52	47	.43	40 pin SG	1 75	1.59	1.45
WIRE WRAP SOCKETS (GOLD) LEVEL #3							
8 pin WW	$ 39	38	.31	22 pin WW	$ .95	.85	.75
10 pin WW	45	.41	.37	24 pin WW	1.05	.95	.85
14 pin WW	39	38	.37	28 pin WW	1.40	1 25	1.10
16 pin WW	43	42	.41	36 pin WW	1.59	1.45	1.30
18 pin WW	75	68	.62	40 pin WW	1.75	1.55	1.40

1/4 WATT RESISTOR ASSORTMENTS – 5%

ASST. 1	5 ea	10 OHM 12 OHM 15 OHM 18 OHM [illegible] OHM / [illegible] OHM 33 OHM 39 OHM [illegible] OHM 56 OHM	50 PCS	$1.75
ASST. 2	5 ea	68 OHM 82 OHM 100 OHM 120 OHM 150 OHM / 180 OHM 220 OHM 270 OHM 330 OHM 390 OHM	50 PCS	1.75
ASST. 3	5 ea	470 OHM 560 OHM 680 OHM 820 OHM [illegible]	50 PCS	1.75
ASST. 4	5 ea	[illegible]	50 PCS	1.75
ASST. 5	5 ea	[illegible] 68K [illegible] 100K [illegible]	50 PCS	1.75
ASST. 6	5 ea	150K 180K 220K [illegible] / 390K 470K 560K 680K 820K	50 PCS	1.75
ASST. 7	5 ea	1M 1.2M 1.5M 1.8M 2.2M / [illegible] 3.3M 3.9M 4.7M 5.6M	50 PCS	1.75

ASST. 8R Includes Resistor Assortments 1-7 (350 PCS.) $9.95 ea.

$10.00 MINIMUM ORDER — U.S. Funds Only
California Residents — Add 6% Sales Tax
Spec Sheets – 25¢
1979 Catalog Available—Send 41¢ stamp

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AY-5-9200	Repertory Dialler	14.95
AY-5-9500	CMOS Clock Generator	4.95
AY-5-2376	Keyboard Encoder (88 keys)	14.95
HD0165	Keyboard Encoder (16 keys)	7.95
74C922	Keyboard Encoder (16 keys)	5.95

ICM CHIPS

ICM7045	CMOS Precision Timer	24.95
ICM7205	CMOS LED Stopwatch/Timer	19.95
ICM7207	Oscillator Controller	7.50
ICM7208	Seven Decade Counter	19.95
ICM7209	Clock Generator	6.95

NMOS READ ONLY MEMORIES

MCM6571	128 X 9 X 7 ASCII Shifted with Greek	13.50
MCM6574	128 X 9 X 7 Math Symbol & Pictures	13.50
MCM6575	128 X 9 X 7 Alphanumeric Control Character Generator	13.50

MISCELLANEOUS

TL074CN	Quad Low Noise bi-fet Op Amp	2.49
TL494CN	Switching Regulator	4.49
TL496CP	Single Switching Regulator	1.75
11C90	Divide 10/11 Prescaler	19.95
95H90	Hi-Speed Divide 10/11 Prescaler	11.95
4N33	Photo-Darlington Opto-isolator	3.95
MK50240	Top Octave Freq. Generator	17.50
DS0026CH	5Mhz 2-phase MOS clock driver	3.75
TIL308	.27" red num. display w/integ. logic chip	10.50
MM5320	TV Camera Sync. Generator	14.95
MM5330	4½ Digit DPM Logic Block (Special)	3.95
LD110/111	3½ Digit A/D Converter Set	25.00/set

LITRONIX ISO-LIT 1
Photo Transistor Opto-Isolator (Same as MCT 2 or 4N25)
2/99¢

SN 76477
SOUND GENERATOR
Generates Complex Sounds
Low Power – Programmable
3.95 each

TV GAME CHIP AND CRYSTAL
AY-3-8500-1 and 2.01 MHZ Crystal (Chip & Crystal includes score display, 6 games and select angles, etc. **7.95/set**

EXAR

XR205	$8.40			XR2242CP	1.50
XR210	4.40			XR2264	4.25
XR215	4.40			XR2556	3.20
XR320	1.55	JE2206KA	14.95	XR2567	2.99
XR-L555	1.50	JE2206KB	19.95	XR3403	1.25
XR555	.39	XR1800	3.20	XR4136	1.25
XR556	.99	XR2206	4.40	XR4151	2.85
XR567CP	.99	XR2207	3.85	XR4194	4.95
XR567CT	1.25	XR2208	5.20	XR4202	3.60
XR1310P	1.30	XR2209	1.75	XR4212	2.05
XR1468CN	3.85	XR2211	5 25	XR4558	.75
XR1488	1.39	XR2212	4.35	XR4739	1 15
XR1489	1.39	XR2240	3.45	XR4741	1.47

DIODES

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
1N746	3.3	400m	4/1.00	1N4002	100 PIV 1 AMP		12/1.00
1N751	5.1	400m	4/1.00	1N4003	200 PIV 1 AMP		12/1.00
1N752	5.6	400m	4/1.00	1N4004	400 PIV 1 AMP		12/1.00
1N753	6.2	400m	4/1.00	1N4005	600 PIV 1 AMP		10/1.00
1N754	6.8	400m	4/1.00	1N4006	800 PIV 1 AMP		10/1.00
1N757	9.0	400m	4/1.00	1N4007	1000 PIV 1 AMP		10/1.00
1N759	12.0	400m	4/1.00	1N3600	50	200m	6/1.00
1N959	8.2	400m	4/1.00	1N4148	75	10m	15/1.00
1N965	15	400m	4/1.00	1N4154	35	10m	12/1.00
1N5232	5.6	500m	28	1N4305	75	25m	15/1.00
1N5234	6.2	500m	28	1N4734	5.6	1w	28
1N5235	6.8	500m	28	1N4735	6.2	1w	28
1N5236	7.5	500m	28	1N4736	6.8	1w	28
1N5242	12	500m	28	1N4738	8.2	1w	28
1N5245	15	500m	28	1N4742	12	1w	28
1N456	25	40m	6/1.00	1N4744	15	1w	28
1N458	150	7m	6/1.00	1N1183	50 PIV 35 AMP		1.60
1N485A	180	10m	5/1.00	1N1184	100 PIV 35 AMP		1.70
1N4001	50 PIV 1 AMP		12/1.00	1N1185	150 PIV 35 AMP		1.70
				1N1186	200 PIV 35 AMP		1.80
				1N1188	400 PIV 35 AMP		3.00

SCR AND FW BRIDGE RECTIFIERS

C36D	15A @ 400V	SCR(2N1849)	$1.95
C38M	35A @ 600V	SCR	1.95
2N2328	1.6A @ 300V	SCR	50
MDA 980-1	12A @ 50V	FW BRIDGE REC	1 95
MDA 980-3	12A @ 200V	FW BRIDGE REC	1 95

TRANSISTORS

C106B1	50			2N3904	4/1.00
MPSA05	30	2N3055	89	2N3905	4/1.00
MPSA06	5/1.00	MJE3055	1.00	2N3906	4/1.00
TIS97	6/1.00	2N3392	5/1.00	2N4013	3/1.00
TIS98	6/1.00	2N3398	5/1.00	2N4123	6/1.00
40409	1 75	PN3567	3/1.00	PN4249	4/1.00
40410	1 75	PN3568	4/1.00	PN4250	4/1.00
40673	1 75	PN3569	4/1.00	2N4400	4/1.00
2N918	4/1.00	MPS3638A	5/1.00	2N4401	4/1.00
2N2219A	2/1.00	MPS3702	5/1.00	2N4402	4/1.00
2N2221A	4/1.00	2N3704	5/1.00	2N4403	4/1.00
2N2222A	5/1.00	MPS3704	5/1.00	2N4409	5/1.00
PN2222 Plastic	7/1.00	2N3705	5/1.00	2N5086	4/1.00
2N2369	5/1.00	MPS3705	5/1.00	2N5087	4/1.00
2N2369A	4/1.00	2N3706	5/1.00	2N5088	4/1.00
MPS2369	5/1.00	MPS3706	5/1.00	2N5089	4/1.00
2N2484	4/1.00	2N3707	5/1.00	2N5129	5/1.00
2N2906	4/1.00	2N3711	5/1.00	PN5134	5/1.00
2N2907	5/1.00	2N3724A	.65	PN5138	5/1.00
PN2907 Plastic	7/1.00	2N3725A	1.00	2N5139	5/1.00
2N2925	5/1.00	2N3772	2 25	2N5210	5/1.00
MJE2955	1.25	2N3823	1.00	2N5449	3/1.00
2N3053	2/1.00	2N3903	5/1.00	2N5951	3/1.00

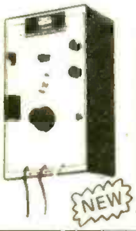
CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-99	100		1-9	10-99	100
10 pf	.05	.04	.03	.001µF	.05	.04	.035
22 pf	.05	.04	.03	.0047µF	.05	.04	.035
47 pf	.05	.04	.03	.01µF	.05	.04	.035
100 pf	.05	.04	.03	.022µF	.06	.05	.04
220 pf	.05	.04	.03	.047µF	.06	.05	.04
470 pf	.05	.04	.035	.1µF	.12	.09	.075
100 VOLT MYLAR FILM CAPACITORS							
.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22
+20% DIPPED TANTALUMS (SOLID) CAPACITORS							
.1/35V	.28	.23	.17	1.5/35V	.30	.26	.21
.15/35V	.28	.23	.17	2.2/25V	.31	.27	.22
.22/35V	.28	.23	.17	3.3/25V	.31	.27	.22
.33/35V	.28	.23	.17	4.7/25V	.32	.28	.23
.47/35V	.28	.23	.17	6.8/25V	.36	.31	.25
.68/35V	.28	.23	.17	10/25V	.40	.35	.29
1.0/35V	.28	.23	.17	15/25V	.63	.50	.40
MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS							
Axial Lead				**Radial Lead**			
.47/50V	.15	.13	.10	.47/25V	.15	.13	.10
1.0/50V	.16	.14	.11	.47/50V	.16	.14	.11
3.3/50V	.14	.12	.09	1.0/16V	.15	.13	.10
4.7/25V	.15	.13	.10	1.0/25V	.16	.14	.11
10/25V	.15	.13	.10	1.0/50V	.16	.14	.11
10/50V	.16	.14	.12	4.7/16V	.15	.13	.10
22/25V	.17	.15	.12	4.7/25V	.15	.13	.10
22/50V	.24	.20	.18	4.7/50V	.16	.14	.11
47/25V	.19	.17	.15	10/16V	.14	.12	.09
47/50V	.25	.21	.19	10/25V	.15	.13	.10
100/25V	.24	.20	.18	10/50V	.16	.14	.12
100/50V	.35	.30	.28	47/50V	.24	.21	.19
220/25V	.32	.28	.25	100/16V	.19	.15	.14
220/50V	.45	.41	.38	100/25V	.24	.20	.18
470/25V	.33	.29	.27	100/50V	.35	.30	.28
1000/16V	.55	.50	.45	220/16V	.23	.17	.16
2200/16V	.70	.62	.55	470/25V	.31	.28	.25

CIRCLE 29 ON FREE INFORMATION CARD

Transistor Checker



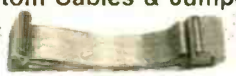
— Completely Assembled —
— Battery Operated —

The ASI Transistor Checker is capable of checking a wide range of transistor types, either "in circuit" or out of circuit. To operate, simply plug the transistor to be checked into the front panel socket, or connect it with the alligator clip test leads provided. The unit safely and automatically identifies low, medium and high-power PNP and NPN transistors. Size 3½ x 6¾" x 2". "C" cell battery not included.

NEW

Trans-Check $29.95 ea.

Custom Cables & Jumpers



NEW NEW

DB 25 Series Cables

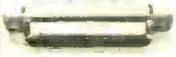
Part No.	Cable Length	Connectors	Price
DB25P-4-P	4 Ft	2-DP25P	$15.95 ea
DB25P-4-S	4 Ft	1-DP25P 1-25S	$16.95 ea
DB25S-4-S	4 ft	2-DP25S	$17.95 ea

Dip Jumpers

DJ14-1	1 ft	1-14 Pin	$1.59 ea
DJ16-1	1 ft	1-16 Pin	1.79 ea
DJ24-1	1 ft	1-24 Pin	2.79 ea
DJ14-1-14	1 ft	2-14 Pin	2.79 ea
DJ16-1-16	1 ft	2-16 Pin	3.19 ea
DJ24-1-24	1 ft	2-24 Pin	4.95 ea

For Custom Cables & Jumpers, See JAMECO 1979 Catalog for Pricing

CONNECTORS



25 Pin-D Subminiature

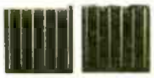
DB25P (as pictured)	PLUG (Meets RS232)	$2.95
DB25S	SOCKET (Meets RS232)	$3.50
DB51226-1	Cable Cover for DB25P or DB25S	$1.75

PRINTED CIRCUIT EDGE-CARD

156 Spacing-Tin-Double Read Out — Bifurcated Contacts — Fits .054 to .070 P.C. Cards

15/30	PINS (Solder Eyelet)		$1.95
18/36	PINS (Solder Eyelet)		$2.49
22/44	PINS (Solder Eyelet)		$2.95
50/100 (.100 Spacing)	PINS (Wire Wrap)		$6.95
50/100 (.125 Spacing)	PINS (Wire Wrap)	R681-1	$6.95

Solar Cells 2x2cm



- 0.4 volts
- 100mA
- 41 MW

Can be added in series for higher voltage or parallel for higher current.

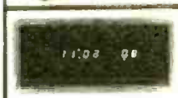
#SC 2x2 $1.95 ea. or 3/$5.00

the 3rd Hand

MAKES CIRCUIT ASSEMBLY A BREEZE!

Lets you work with both hands. Sturdy Aluminum Construction. **$9.95 ea.**

- Clamp "3rd Hand" on edge of bench, table or work-board. Insert circuit board, position components.
- Flip circuit board to flat position for soldering and clipping.



- Bright .300 ht. comm. cath ode display
- Uses MM5314 clock chip
- Switches for hours, minutes and hold modes
- Hrs. easily viewable to 20 ft
- Simulated walnut case
- 115 VAC operation
- 12 or 24 hr. operation
- Incl. all components, case & wall transformer
- Size: 6¾" x 3-1/8" x 1¾"

JE701

6-Digit Clock Kit $19.95

REMOTE CONTROL TRANSMITTER & RECEIVER

$19.95

INSTRUMENT/CLOCK CASE

This case is an injection molded unit that is ideal for uses such as DVM, COUNTER, or CLOCK cases. It has dimensions of 4½" in length by 4" in width by 1-9/16" in height. It comes complete with a red bezel.

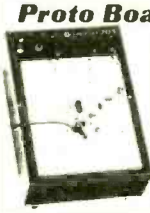
PART NO: IN-CC $3.49 each

MICROPROCESSOR COMPONENTS

8080A 8080A SUPPORT DEVICES			
8080A	CPU		$9.95
8212	8 Bit Input/Output		3.25
8214	Priority Interrupt Control		5.95
8216	Bi-Directional Bus Driver		3.49
8224	Clock Generator/Driver		3.95
8226	Bus Driver		3.49
8228	System Controller Bus Driver		5.95
8238	System Controller		5.95
8251	Prog. Comm. I/O (USART)		7.95
8253	Prog. Interval Timer		14.95
8255	Prog. Periph. I/O (PPI)		9.95
8257	Prog. DMA Control		19.95
8259	Prog. Interrupt Control		19.95
6800 6800 SUPPORT DEVICES			
MC6800	MPU		$14.95
MC6802CP	MPU with Clock and Ram		24.95
MC6810AP1	128x8 Static Ram		5.95
MC6821	Periph. Inter. Adapt (MC6820)		7.49
MC6828	Priority Interrupt Controller		12.95
MC6830L8	1024X8 Bit ROM (MC68A30-8)		14.95
MC6850	Asynchronous Comm. Adapter		7.95
MC6852	Synchronous Serial Data Adapt		9.95
MC6860	0-600 bps Digital MODEM		12.95
MC6862	2400 bps Modulator		14.95
MC6880A	Quad 3-State Bus. Trans. (MC8T26)		2.25
MICROPROCESSOR CHIPS—MISCELLANEOUS			
Z80(780C)	CPU		$19.95
Z80A(780-1)	CPU		24.95
CDP1802	CPU		19.95
2650	MPU		19.95
8035	8-Bit MPU w/clock, RAM, I/O lines		19.95
P8085	CPU		19.95
TMS9900JL	16-Bit MPU w/hardware, multiply & divide		49.95
SHIFT REGISTERS			
MM500H	Dual 25 Bit Dynamic		5.50
MM503H	Dual 50 Bit Dynamic		50
MM504H	Dual 16 Bit Static		50
MM506H	Dual 100 Bit Static		50
MM510H	Dual 64 Bit Accumulator		50
MM5016H	500/512 Bit Dynamic		89
2504T	1024 Dynamic		3.95
2518	Hex 32 Bit Static		4.95
2522	Dual 132 Bit Static		2.95
2524	512 Static		99
2525	1024 Dynamic		2.95
2527	Dual 256 Bit Static		2.95
2528	Dual 250 Static		4.00
2529	Dual 240 Bit Static		4.00
2532	Quad 80 Bit Static		2.95
2533	1024 Static		2.95
3341	Fifo		6.95
74LS670	4x4 Register File (TriState)		2.49
UART'S			
A-Y-5-1013	30K BAUD		5.95
MICROPROCESSOR MANUALS			
M-Z80	User Manual		$7.50
M-CDP1802	User Manual		7.50
M-2650	User Manual		5.00
ROM'S			
2513(2140)	Character Generator(upper case)		$9.95
2513(3021)	Character Generator(lower case)		9.95
2516	Character Generator		10.95
MM5230N	2048-Bit Read Only Memory		1.95
RAM'S			
1101	256x1	Static	$1.49
1103	1024x1	Dynamic	99
2101(8101)	256x4	Static	3.95
2102	1024x1	Static	1.75
21L02	1024x1	Static	1.95
2111(8111)	256x4	Static	3.95
2112	256x4	Static MOS	4.95
2114	1024x4	Static 450ns	9.95
2114L	1024x4	Static 450ns low power	10.95
2114-3	1024X4	Static 300ns	10.95
2114L-3	1024X4	Static 300ns low power	11.95
5101	256x4	Static	7.95
5280/2107	4096x1	Dynamic	4.95
7489	16X4	Static	1.75
74S200	256x1	Static Tristate	4.95
93421	256x1	Static	2.95
UPD414 (MK4027)	4K	Dynamic 16 pin	4.95
UPD416 (MK4116)	16K	Dynamic 16 pin	14.95
TMS4044 45NL	4K	Static	14.95
TMS4045	1024x4	Static	14.95
2117	16,384x1	Dynamic 350ns (house marked)	9.95
MM5262	2Kx1	Dynamic	4:1.00
PROM'S			
1702A	2048	FAMOS	$5.95
TMS2516 (2716)	16K*	EPROM (Intel 2716)	49.95
	*Requires single +5V power supply		
TMS2532	4KX8	EPROM	89.95
2708	8K	EPROM	10.95
2716 T.I.	16K**	EPROM	29.95
	**Requires 3 voltages —5V, +5V, +12V		
5203	2048	FAMOS	14.95
6301-1(7611)	1024	Tristate Bipolar	3.49
6330-1(7602)	256	Open C Bipolar	2.95
82S23	32x8	Open Collector	3.95
82S115	4096	Bipolar	19.95
82S123	32x8	Tristate	3.95
74186	512	TTL Open Collector	9.95
74188	256	TTL Open Collector	3.95
74S287	1024	Static	2.95

CSC CONTINENTAL SPECIALTIES PROTO BOARDS

Proto Board 203



PB 203 $75.00

Proto Board 203A

PB 203A $124.95

Model Number	L x W x H (Inches)	Price
PB-6	6.0 x 4.5 x 1.4	$15.95
PB-100	6.0 x 4.5 x 1.4	$19.95
PB-101	6.0 x 4.5 x 1.4	$22.95
PB-102	7.0 x 4.5 x 1.4	$26.95
PB-103	9.0 x 6.0 x 1.4	$44.95
PB-104	9.8 x 8.0 x 1.4	$54.95

B&K PRECISION 3½-Digit Portable DMM

- Overload Protected
- 3" high LED Display
- Battery or AC operation
- Auto Zeroing
- 1mv, 1Va, 0.1 ohm resolution
- Overrange reading
- 10 meg input impedence
- DC Accuracy 1% typical

Ranges: DC Voltage 1-1000V; AC voltage 0-1000V; Freq. Response 50-400 Hz; DC/AC Current 0-100mA; Resistance 0-10 meg ohm; Size 6.4 x 4.4 x 2

Model 2800 $99.95

Comes with test leads, operating manual and spare fuse

Accessories:

AC Adapter BC-28	$9.00
Rechargeable Batteries BP-26	20.00
Carrying Case LC-28	7.50

CSC 100 MHz 8-Digit Counter

- 20 Hz-100 MHz Range
- 8 LED Display
- Crystal controlled timebase
- Fully Automatic
- Portable — completely self-contained
- Size — 1.75 x 7.38 x 5.63
- Four power sources, i.e. batteries, 110 or 220V with charger, 12V with auto lighter adapter and external 7.2-10V power supply

MAX-100 $134.95

ACCESSORIES FOR MAX 100:

Mobile Charger Eliminator — use power from car battery — Model 100 — CLA $3.95

Charger/Eliminator — use 110 V AC — Model 100 — CAI $9.95

REGULATED POWER SUPPLY NEW

JE200 5V-1 AMP POWER SUPPLY

- Uses LM309K
- Heat sink provided
- PC Board construction
- Provides a solid 1 amp @ 5 volts
- Can supply up to ±5V, ±9V and ±12V with JE205 Adapter
- Includes components, hardware & instructions
- Size: 3½"x5"x2"H

JE200 $14.95

JE205 ADAPTER BOARD

— Adapts to JE200 — ±5V, ±9V and ±12V

- DC/DC converter w/ +5V input
- Toriodal hi-speed switching XMFR
- Short circ. protection
- PC Brd. construction
- Piggy-back to JE200 board
- Size: 3½"x2"x9/16"h

JE205 $12.95

$10.00 Minimum Order — U.S. Funds Only
California Residents — Add 6% Sales Tax

Spec Sheets — 25¢
1979 Catalog Available—Send 41¢ stamp

FREE 1979 Catalog

Jameco ELECTRONICS

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MAIL ORDER ELECTRONICS — WORLDWIDE
1021 HOWARD AVENUE, SAN CARLOS, CA 94070
ADVERTISED PRICES GOOD THRU JUNE

The Incredible "Pennywhistle 103"

$139.95 Kit Only

The Pennywhistle 103 is capable of recording data to and from audio tape without critical speed requirements for the recorder and it is able to communicate directly with another modem and terminal for telephone, hamming, and communications. In addition, it is free of critical adjustments and is built with non-precision, readily available parts.

Data Transmission Method	Frequency-Shift Keying, full-duplex (half-duplex selectable)
Maximum Data Rate	300 Baud
Data Format	Asynchronous Serial (return to mark level required between each character)
Receive Channel Frequencies	2025 Hz for space, 2225 Hz for mark
Transmit Channel Frequencies	Switch selectable: Low (normal) — 1070 space, 1270 mark; High — 025 space, 2225 mark
Receive Sensitivity	46 dbm accoustically coupled
Transmit Level	15 dbm nominal. Adjustable from 6 dbm to 20 dbm
Receive Frequency Tolerance	Frequency reference automatically adjusts to allow for operation between 1800 Hz and 2400 Hz
Digital Data Interface	EIA RS-232C or 20 mA current loop (receiver is optoisolated and non-polar)
Power Requirements	120 VAC, single phase, 10 Watts
Physical	All components mount on a single 5" by 9" printed circuit board. All components included

Requires a VOM, Audio Oscillator, Frequency Counter and/or Oscilloscope to align

TRS-80 16K Conversion Kit

Expand your 4K TRS-80 System to 16K. Kit comes complete with:

- 8 each UPD416-1 (16K Dynamic Rams) 250NS
- Documentation for conversion

TRS-16K $99.95

COMPUTER CASSETTES

- 6 EACH 15 MINUTE HIGH QUALITY C-15 CASSETTES
- PLASTIC CASE INCLUDED
- 12 CASSETTE CAPACITY
- ADDITIONAL CASSETTES AVAILABLE #C-15-$2.50 ea

CAS-6 $14.95

(Case and 6 Cassettes)

SUP 'R' MOD II

UHF Channel 33 TV Interface Unit Kit

Wide Band B/W or Color System

- Converts TV to Video Display for home computers, CCTV camera, Apple II, works with Cromemco Dazzler, SOL-20, TRS-80, Challenger, etc.

MOD II is pretuned to Channel 33 (UHF)

- Includes coaxial cable and antenna transformer.

MOD II $29.95 Kit

ELIT-WRAP

Model P180 includes 2-100' spools #28 AWG wire wrap wire

Supplies insulated wire from spool to wrap posts without prestripping and precutting using "daisy chain" method.

Model P180 Tool $24.50

P180A Replacement Bit	$12.95
W28-2 Replacement wire (3 spool pkg.)	$2.75 ea.

Specify color: A-green B-red C-clear D-Blue

IDEAL FOR TRS 80 — CASSETTE CONTROLLER

"Plug/Jack interface to any computer system requiring remote control of cassette functions"

The CC100 controls cassette motor functions, monitors tape location with its internal speaker and requires no power. Eliminates the plugging and unplugging of cables during computer loading operation from cassette.

#CC-100 $29.50

63-Key Unencoded Keyboard

This is a 63-key, terminal keyboard newly manufactured by a large computer manufacturer. It is unencoded with SPST keys, unattached to any kind of PC board. A very solid molded plastic 13 x 4" base suits most application. IN STOCK $29.95/each

Hexadecimal Unencoded Keypad

19-key pad includes 1-10 keys, ABCDEF and 2 optional keys and a shift key. $10.95/each

CIRCLE 30 ON FREE INFORMATION CARD

RHYTHM GENERATOR ROM
PRE-PROGRAMMED ROM HAS 8 RHYTHM PATTERNS STORED THAT ARE "WALKED OUT" WITH A CMOS COUNTER. (IE..CD4024). CHANGE RHYTHMS WITH A SWITCH. 6 OUTPUTS. GREAT FUN TO PLAY WITH. WITH DATA.
$1.89

FND-359
0.3" COMMON CATHODE RED LED DISPLAY IS A PERFECT CHOICE FOR THE ICM7208. GOOD BRIGHTNESS. LOW CURRENT.
69¢ 7/$4.30

CRYSTALS

1.000 MHz	.001%	$5.95
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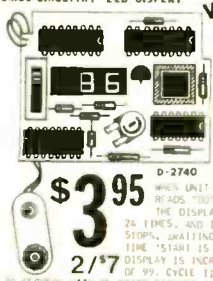

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- POWER WITH 9V BATTERY
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WHEN UNIT IS SWITCHED ON, DISPLAY READS "00"; WHEN 'START' IS PUSHED, THE DISPLAY FLASHES HYPHENS "--" 24 TIMES, AND INCREMENTS TO "01" AND STOPS, AWAITING ANOTHER 'START'. EACH TIME 'START' IS PRESSED CYCLE REPEATS AND DISPLAY IS INCREMENTED 1 COUNT TO A TOTAL OF 99. CYCLE TIME IS VARIABLE APPROX 1-30 SECONDS WITH ON-BOARD TRIMMER (MUCH LONGER BY ADDING SMALL CAPACITOR). GREAT FOR INSTANT PHOTO TIMER, TELEPHONE TIMER ALL SORTS OF GADGETS, LET YOUR IMAGINATION GO!!
ASSEMBLED TIMER-COUNTER INCLUDES 9V BATTERY CLIP, ON-OFF SWITCH, PUSHBUTTON START SWITCH, JUST ATTACH A BATTERY & COUNT!

Build a 7 Digit Portable Counter

WITH 12 PAGES OF DATA. MEASURE FREQUENCY, PERIOD, EVENTS. SINGLE 3-6V SUPPLY! DIRECT DRIVE TO CC LEDS! 0.1 AND 1 SECOND GATE

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ICM 7208
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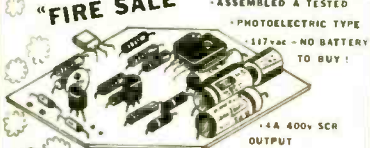

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- Resolution 10 Hz @ 0.1 sec gate, 1 Hz @ 1 sec gate
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- Accuracy adjustable to 0.5 ppm
- Stability 2.0 ppm over 10 to 40 C, temperature compensated
- Input BNC, 1 megohm 20 pf direct, 50 ohm with CT-600
- Overload 50VAC maximum, all modes
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- 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

CT-50, 60 mHz counter kit	$89.95
CT-50WT, 60 mHz counter, wired and tested	159.95
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CB-1, Color TV calibrator-stabilizer	$14.95
DP-1, DC probe, general purpose probe	12.95
HP-1, High impedance probe, non-loading	15.95

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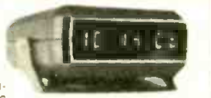
The UN-KIT, only 5 solder connections

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
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PS-1B, 600 mHz prescaler	$59.95
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B1-FET, mini dip, 741 type	10/$2.00

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RE 3216, terminal card	$149.95
RE 6416, terminal card	189.95
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Alarm clock, 12 hour only, DC-8	24.95
12V DC car clock, DC-7	27.95

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567	1.25	7912	1.25
1458	.50	7815	.85
3900	.50	**TTL ICs**	
CMOS ICs		74S00	.35
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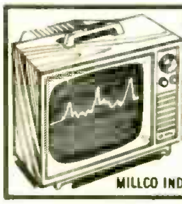

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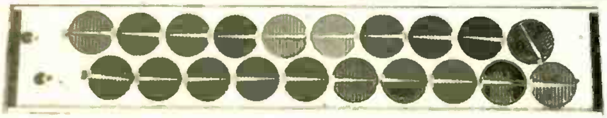

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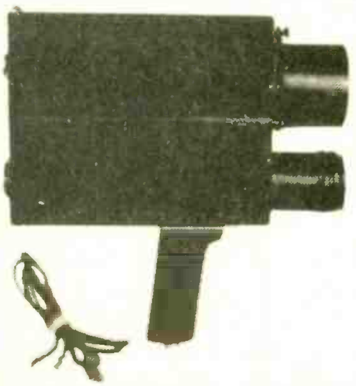

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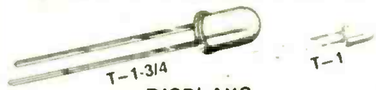

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