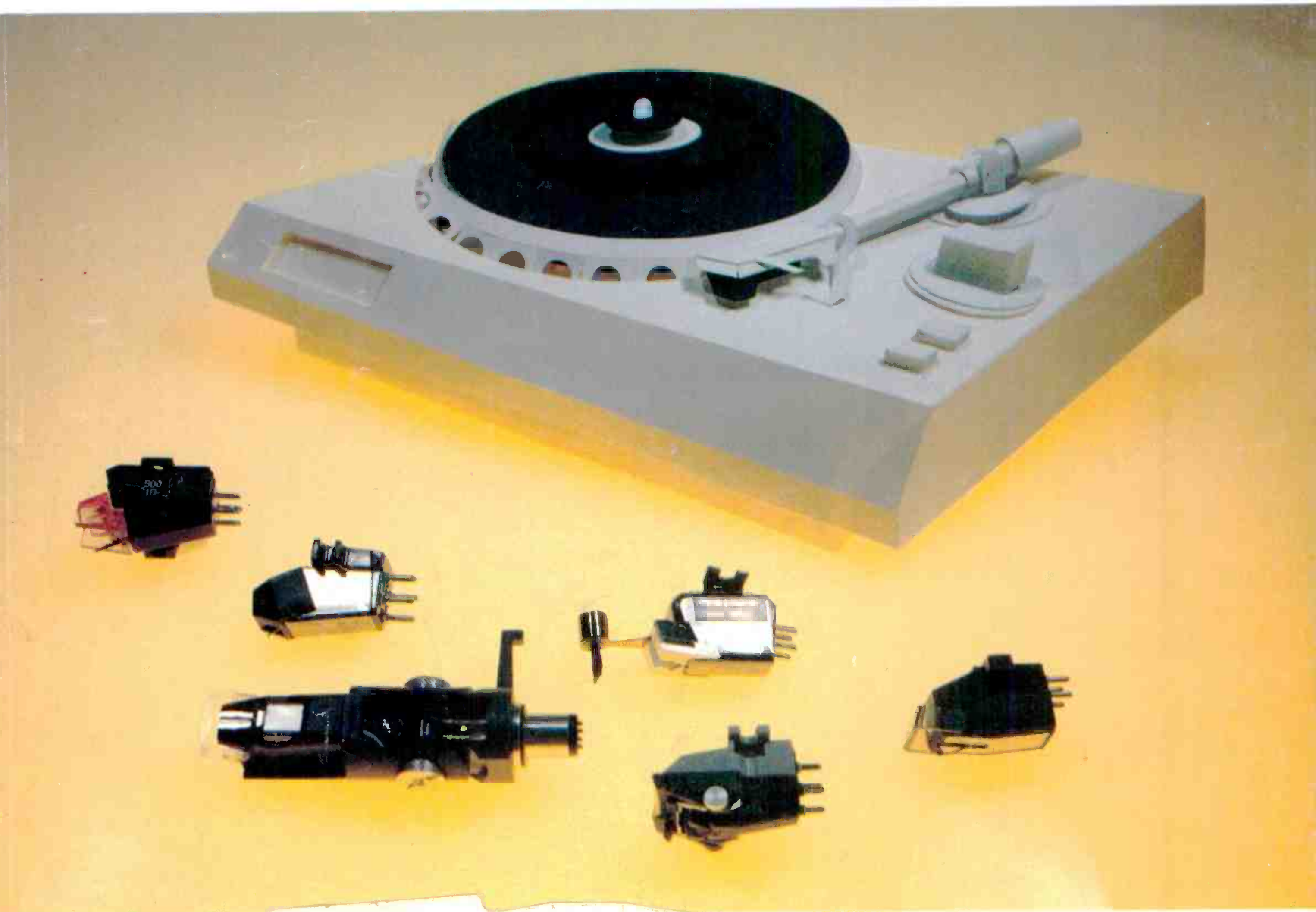
Popular Electronics®

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE SEPTEMBER 1980/ 95¢

TRS-80 Data Tape Conditioner
Degree-Day Meter Monitors Heat Loss
Measuring Large Currents With DMMs

PE Compares Six Phono Pickups



...Month:
...D-440A Cassette Deck

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Popular Electronics


The man, the lig

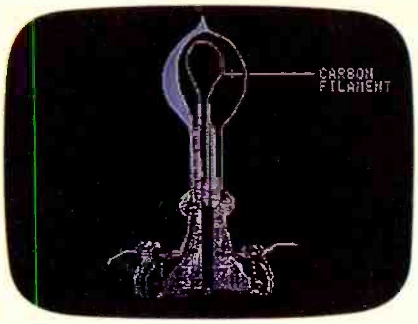
ht and the Apple.

If you could talk to Thomas Edison, he'd tell you what it was like to turn the lights on in 1879. You could tell him about some bright ideas of the 20th century... particularly, a technological phenomenon that can handle everything from solar heat control to lighting your home via voice command. The Apple personal computer.

Expand your own inventiveness with the always-expandable Apple.

Take a look inside your local computer store. There's a range of Apple systems for you... whether you want expansion capabilities of four or eight accessory slots... or memory expandable to 64K bytes or 128K bytes. With this kind of flexibility, the possibilities for creating your own computer system are endless.

Want to add an A to D conversion board? Apple makes it happen. Want to plug into time sharing, news and elec-



With Apple, Edison could've written a program to determine why some filaments burned longer than others.

tronic mail services? Apple does it all. Because Apple is the most popular personal computer with the least complicated interface, over 100 companies supply peripherals for the Apple family... including an IEEE 488 bus for instant control.

Disk drives, a tool kit and creativity in color.

Apple was one of the first to use disk drives for increased performance and application versatility. Today, our 5¼" disk drive offers high density (143K bytes), high speed and low cost. No wonder this drive is the most popular on the market.

But now Apple goes one better with the DOS Tool Kit. A series of utility programs, it gives you the freedom to easily design 280h x 192v graphic displays in a palette of living color... depending on your choice of Apple system.

Edison was first with the movie camera and projector. Now, with Apple's DOS Tool Kit, you can be first to work wonders with colorful creative animation.

Edison had the first movie camera... and Apple has the DOS Tool Kit that takes you into the colorful world of animation.

Imagine the broadest line of software programs ever.

Apple's broad line of peripherals is equalled only by the most extensive line of software you'll find in the personal computing world. Since more than 170 companies offer software for the Apple family, you can have one of the most impressive program libraries ever.

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Edison listened to his voice on a revolutionary phonograph in the 1800s... now you can listen to the sounds of today with Apple's inventive family of personal computers.

Where to find even more illuminating Apple experiences.

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If you're considering a personal computer, stop by the computer store and compare. Apple's reliability, proven performance and recognized technological leadership will help you see the light. Don't let history pass you by. Visit your nearest Apple dealer, or call 800-538-9696. In California, 800-662-9238.

apple computer®

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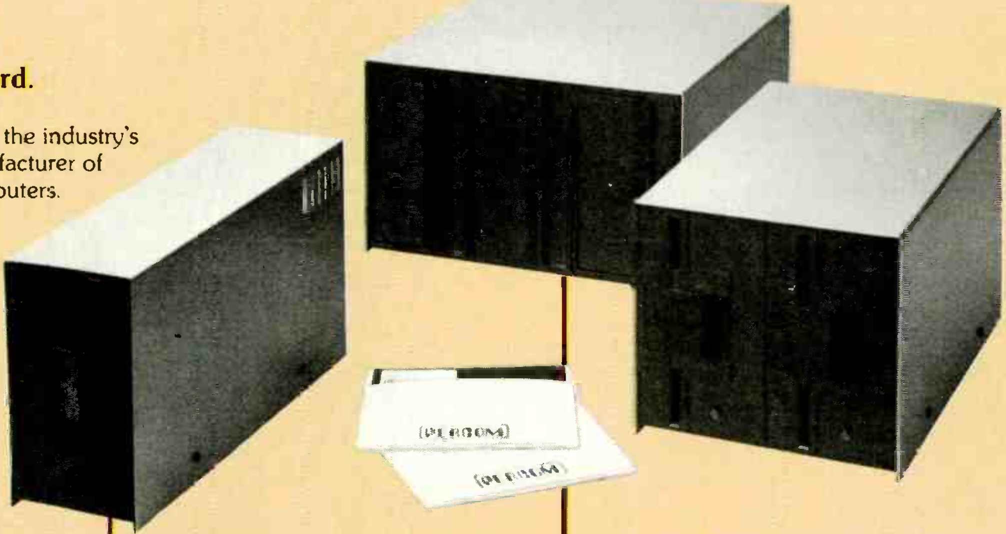

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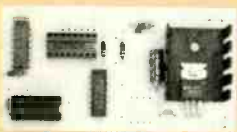
In fact, you store almost one fifth more data on Percom TFD-100™ drives and over two-and-one-fourth times as much on TFD-200™ drives.

Besides extra testing and superior design, you get free, with each system, a software patch on minidiskette that not only upgrades TRSDOS* for operation with the newer 40- and 77-track drives, but also deglitches version 2.1.

Available in 1-, 2- and 3-drive configurations. Percom drives for the TRS-80* computer start as low as $399.

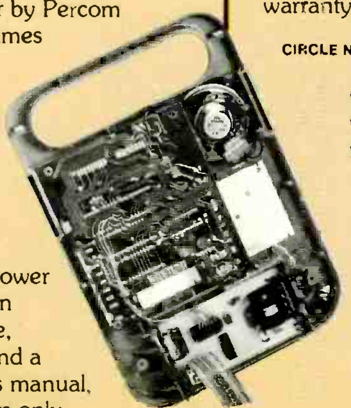
CIRCLE NO. 57 ON FREE INFORMATION CARD

The gift of speech



Called Speak-2-Me-2™, this clever interface module makes a Texas Instruments' Speak & Spell† the voice of your computer — announcing, imploring, commanding with expressions and sentences created from the Speak & Spell† vocabulary.

Speech is controlled either at the keyboard or by your own Level II BASIC programs. Or by Percom minidiskette word games (available soon).



Speak-2-Me-2™ is installed in the battery compartment of your Speak & Spell†, and power is provided from an ordinary calculator power pak. Supplied with an interconnecting cable, operating software and a comprehensive users manual, Speak-2-Me-2™ costs only $69.95. (Speak & Spell™ not included.)

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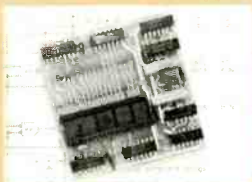
the Separator:™ End "CRC error. Track locked out!"



This plug-in adapter virtually eliminates data read errors, a problem that plagues TRS-80* computer systems. The SEPARATOR™, so called, is installed in the Expansion Interface without modifying the host system. When installed, data and clock signals are reliably separated during playback, an essential function that the separator circuitry of the host computer performs very poorly. Price is only $29.95.

Note. Opening the Expansion Interface may void the Tandy limited 90-day warranty.

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SEPTEMBER 1980 VOLUME 18, NUMBER 3

Popular Electronics®

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

Feature Articles

Construction Articles

Equipment Reviews

Columns

Departments

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Editorial

Fall Electronic Product Preview

ANOTHER summer Consumer Electronics Show has passed. As in other years, manufacturers introduced their upcoming products to dealers, giving us an early view of what stores might carry in the fall and winter. Unlike other times, however, there were fewer design innovations around to excite us. Here are some of the more interesting new developments.

In TV, Zenith showed a "Space Phone" device that allows a color TV set to be used as an extension telephone. Offered on five upcoming color TV models, the system allows an incoming phone call to be switched by the set's remote control to the TV model's speakers, while an activated built-in microphone permits anyone present to talk to the caller. Sanyo showcased a 19" color TV receiver with two 5" black and white screens built in on one side so that viewers can monitor other channels or use the smaller screens for security purposes. Front-loading tape came to video cassette recorders with Sharp Electronics' new six-hour VHS Model VC-7400, perhaps portending a trend. And 2"- and 3"-TV/radio/cassette portables were plentiful.

In the computer field, Lexicon, the company that launched the first language translator (now marketed by Nixdorf) introduced an attractive 300-baud acoustically coupled modem with a battery-powered option. APF Electronics displayed its personal computer with an add-on mini-floppy. System retail price? $995! Ohio Scientific debuted its new C8P-HD personal computer system that has, among other features, a voice recognition capability of several hundred spoken words. Moreover, a hard disk is used to store the phonetic representation of the 3500 most common short words in the English language. Nixdorf introduced its portable data terminal at the show, too. And Panasonic displayed its RL-H1000 hand-held computer system, which uses a 6502 CPU. A new structured software system, SNAP, was developed for the computer. Micro-memory capsules are used. Further, the $2\frac{3}{4}'' \times 15'' \times 8''$ system incorporates a keyboard, mini-printer and acoustic coupler!

There were electronic games, wristwatches and telephone systems galore. Casio's "Melody" wristwatch model caught our ears. The timepiece has seven different musical alarms, one for each day of the week. Moreover, the watch has a date memory for playing selected tunes. As a result, the user can select Happy Birthday or the Wedding March as a reminder when such an event's day is reached. In the telephone product area, Universal Security Instrument's "Intelliphone" was demonstrated to show off its sophisticated features, such as storing 11 numbers in memory, automatic redialing of a busy telephone number for up to ten minutes, HELP button for instant emergency dialing, and resettable elapsed timer, among other functions.

For public-service band buffs, there was Antenna Inc.'s new all-band "Persuader" scanner indoor antenna ($11.95), a welcome hideaway device said to outperform the little telescopic antenna supplied with scanners. Walking through the aisles we spotted Robins Industries' "Whistle Stop" cassette head demagnetizer. It emits a whistling tone when it's demagnetizing. The maker claims that the job is done when the whistle ceases after four to six seconds. We also noted ITT's new one-piece pushbutton telephone, which slides open to engage the line and is squeezed closed to hang up, making for a tidy compact package.

Hal Rodgers observed that updates in audio amplifier technology were few. One of the exceptions was in Sony's high-end Esprit series, with a power amp that works in a modified Class A and uses no output-to-input negative feedback. Standing out among speakers was the $20,000 Infinity Reference System. Each column (there are two per side) measures 7½-feet high. They contain six 12" woofers each, driven by 1.5 kW of amp power. The tweeter/midrange columns each contain 36 electromagnetic induction tweeters and 12 similar midrange drivers. Hal said that the cannon shots from Soundstream's digital tape of Tchaikovsky's 1812 Overture were enough to set your clothing flapping.

For the most part, the rest of audio technology at CES came down to the addition of memory, more digital readouts, and microprocessor control. Perhaps the most elaborate product in this area was the dbx 20/20, a 6502-CPU-based equalizer. Using its internal pink-noise source, it will automatically equalize a room to the flattest setting achievable with 10 bands of EQ. It also "remembers" different settings that can be called up at the touch of a button.

While, the microprocessor continues to spark new developments—even new industries—the more mature section of the industry concentrates on convenience and styling.

Art Salsberg

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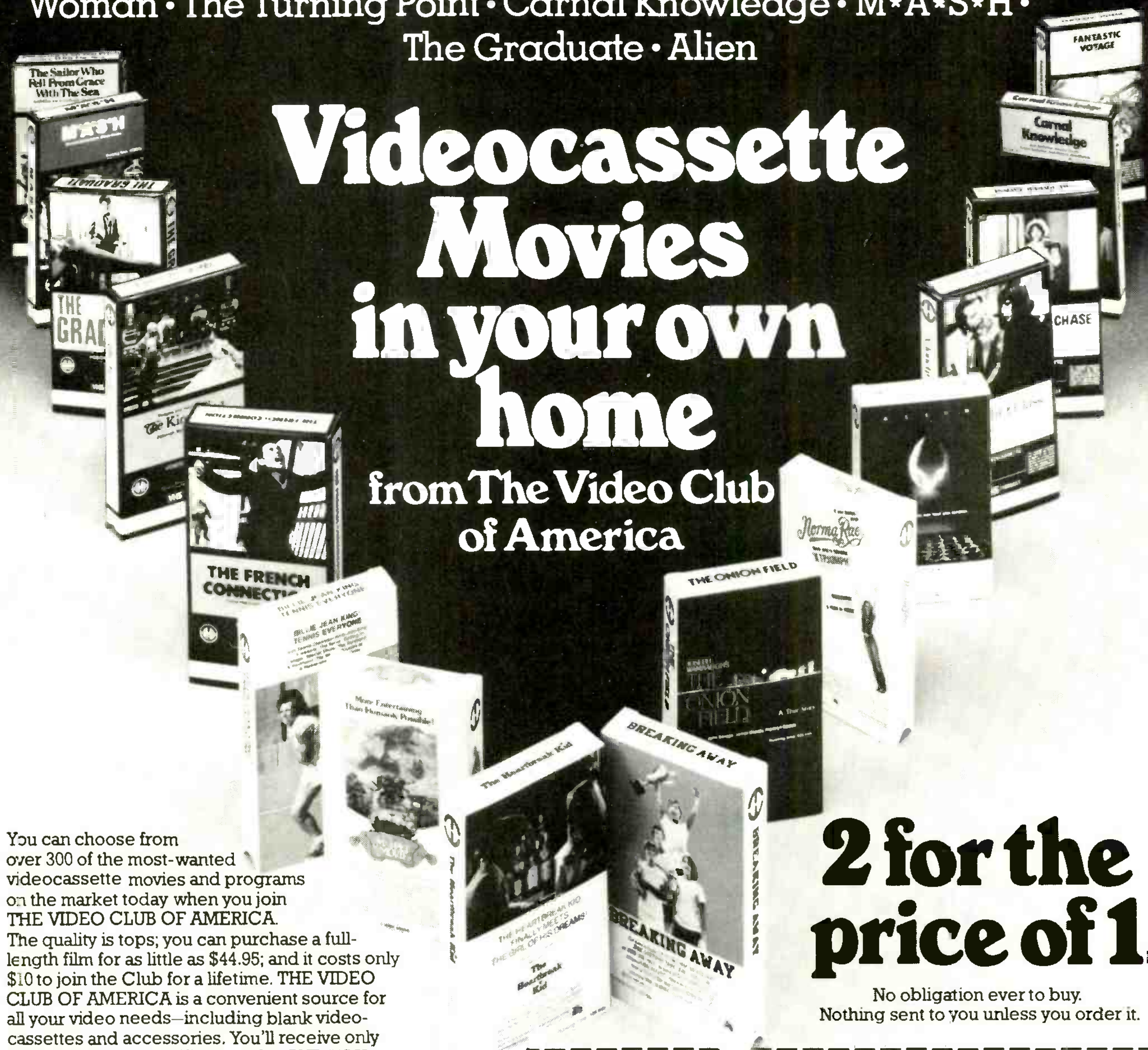

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CIRCLE NO. 77 ON FREE INFORMATION CARD

Letters

What Is the Publishing Schedule?

Your "Microprocessor Applications for the 1980's" series, begun in the May 1980 issue, promises to fill one of my urgent needs. I am very grateful that POPULAR ELECTRONICS has decided to publish such a fundamental and practical training course. But you can imagine my disappointment when neither the June nor the July issue brought the avidly expected continuation of the series. When will future installments appear?—*Ernest Thiersch, Orlando, FL.*

Future installments will appear irregularly owing to the subject's complex nature and the tender loving care we're taking with them. The next one, due to be published in November, will include a fabulous, inexpensive development board system.—Ed.

What Happened To Safety?

In view of POPULAR ELECTRONICS' usually excellent advice on safety practices, I was surprised to see several defects in the "Varmint Zapper" article (June 1980). First, if connected to a trash can, a HIGH VOLTAGE warning label should be placed on the can. Next, a switch should be provided for the trash collector to turn off the power. Then the can should be placed behind a fence where it won't be accessible to children.

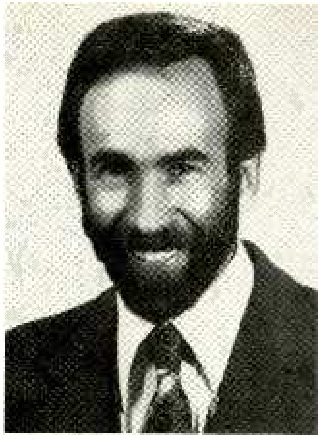
A shock current of up to 50 mA is mentioned. I recall from a PE article of a couple of years ago that 100 mA is generally considered to be lethal to humans. Therefore, shouldn't there be a current-limiting resistor in series with the high-voltage terminal and trash can? Finally, couldn't the short circuit developed when *SCR1* conducts possibly damage the SCR, *D3*, or *T1*—and possibly *S1*?—*Steve O'Neill, Dixon, CA.*

We agree with the safety precautions you list. Note that the Zapper's duty cycle is very low. This being the case, only the instantaneous current might reach 50 mA, but the average current will be only microamperes. Also, the low duty cycle will prevent short-circuit damage to components.—Ed.

A New FM Broadcast Band?

While reading over your August 1980 Editorial, I was surprised to learn that there now exists an FM broadcast band on 88 to 92 kHz. Shouldn't this be 88 to 92 MHz?—*Kris Furstman, New York, NY.*

You're right, of course. Sorry about the typo.—Ed.



"I made it despite myself."

Success Forces

Can you be successful despite yourself? Here's how I did it.

By Joseph Sugarman, President
JS&A Group, Inc.

It's a joke. I'm considered one of America's top copywriters and mail order entrepreneurs.

I never finished college, never took a course in business, advertising or creative writing, and even flunked English.

On top of that, I failed at almost everything I did. My list of failures would fill an encyclopedia.

Now you probably expect me to tell you that it was failure after failure until I hit upon the "wealth formula" or the "secret to success" or some other trite expression. Not true.

ONLY SIX REASONS

What I've found about success is quite opposite the formulas you've read about or the misconceptions you've heard.

I simply took my few successes and many failures and discovered six reasons why I failed and six reasons why I succeeded.

The reasons I succeeded seemed like forces. Whenever I followed them, I achieved success. Whenever I didn't follow them, I failed. I soon called them Success Forces.

I used Success Forces to build my business from the basement of my home into America's largest single source of space-age products. I was successful. But was it a coincidence or was it a direct result of Success Forces? I really didn't know.

MATERIAL THINGS

If you measure success by material things, I achieved quite a bit: several cars, airplanes, snowmobiles, motorcycles, four beautiful homes—all the material things I imagined I'd ever want.

And I had recognition. My success story was written up in several magazines. But it wasn't until after I revealed my Success Forces in a few speeches that I realized my concept would work for others.

I was getting letters from people who told me how one of my Success Forces had changed their lives. Others told me of how they used Success Forces to make extra money or achieve greater happiness. Still others who always thought of themselves as failures, became successful despite themselves.

But the whole thing seemed strange to me. Was Success Forces original? Something like it had to be in some other success book. So I read. I bought every success book I could find. I studied Chinese philosophy. I bought every motivational cassette that was offered. And I thoroughly studied the material.

I then discovered why my concept was indeed different. Success Forces lets you be yourself, and guides you towards making simple choices that can ultimately change your life. If you make the right choices, you are literally forced into success.

MY $2,000 SEMINAR

Although I was convinced that my concept was different, I wanted to be absolutely sure it would work. I decided to conduct a seminar with a select group of 16 people who would be willing to pay handsomely to learn my philosophies. My five-day seminar cost each participant $2,000 and I held eight of them. All were sold out.

The success stories resulting from each seminar are already history. I taught a Texas farmer, a New Zealand rug merchant, a lady from Australia. There were people from all walks of American life, many of whom paid their last $2,000 to attend.

Not all of the participants succeeded. But so many did become successful and so many told me later how I literally changed their lives, that I was convinced Success Forces should be available for everybody to use.

NOW AVAILABLE

I am now making my concept available in a hardbound book entitled "Success Forces." It contains examples from my speeches and the philosophies from my seminar that participants paid $2,000 to hear.

A few of the Success Forces you may already know and have been subconsciously following for years. Others, you may have been fighting, thinking that you would fail when all along you would have succeeded. A few of my Success Forces require action—the type of action that everybody can take and that requires no special skill.

This is not a step-by-step book on how to get into a business that promises "A Lazy Way to Riches," or a way to "Quit Your Present Job." It does not matter if you are in business nor whether you want to work hard, take it easy, or just plain be successful.

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- **Small Business Accounting.** General Ledger. Accounts Receivable. Accounts Payable. Inventory Control. Order Entry.

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Compare the Atari to any personal computer in its price range. Compare built-in features. Compare expandability. Compare peripherals and accessories. Compare programming and formats (ROM cartridge, disk or cassette). And if you run a business, ask your Atari retailer about the Atari Accountant,™ the complete, computerized accounting system for small businesses. At Atari we're building computer systems you won't outgrow.

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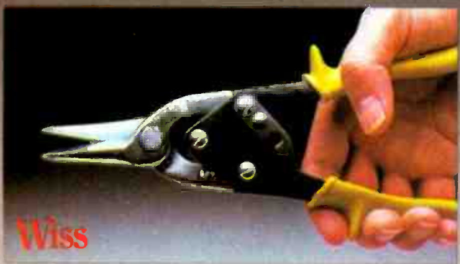

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Xcelite

Take a quick look round this ad and you'll agree that "All together" is no exaggeration. Whether you're making or mending, cutting or joining, measuring or stripping, there's a Cooper tool that's just right for the job. Don't take chances on tools. Specify Cooper and get 'em right the first time!

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CIRCLE NO. 18 ON FREE INFORMATION CARD

New Products

Additional information on new products covered in this section is available from the manufacturers. Either circle the item's code number on the Free Information Card or write to the manufacturer at the address given.

Altec Lansing Speaker System

Altec Lansing's Model 8 speaker system features a 12" woofer, 5" midrange driver, and for the high end an LZT compression driver, radial phase plug, and constant-directivity Mantaray horn. This 8-ohm-impedance speaker system has a vented enclosure, is designed to handle up to 200 watts of driving power, and is specified to deliver a 92-dB sound-pressure level (SPL). Frequency response is rated at 55 to 20,000 Hz ±2.5 dB, while dynamic range is rated at 50 dB. Crossover frequencies are at 700 Hz and 5,000 Hz. The cabinet is covered with a lacquered Endriana wood veneer, with a heavy-knit black fabric covering the drivers. Size is 29½" × 16½" × 14", and weight is 52 lb.

CIRCLE NO. 86 ON FREE INFORMATION CARD

Vocal Voltmeter

The Talking Voltmeter, from Franklin Institute Research Laboratory Inc., is a portable 3½-digit (LCD), dc voltmeter that measures from 0–40 volts with a resolution of 0.1 volt. A synthesized voice duplicates the information in the display, allowing the user to keep his eyes on the circuit under test. Audio output is for loudspeaker or earphones. Dual 6500 microprocessors are used, one performing timing and signal processing. A second selects the required speech elements from a ROM. Foreign-language speech, current and resistance measurement add-ons, and a serial interface for recording data on audio cassette are available. Power is from a rechargeable NiCd battery pack. The instrument measures 2.5" × 10" × 9" (63 × 250 × 225 mm) and weighs 2.5 lb (1.1 kg). $395.

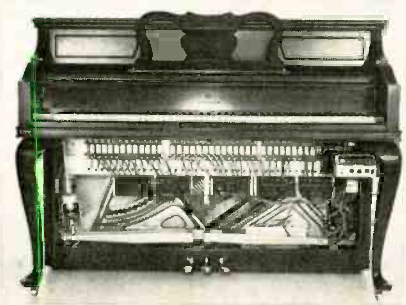
CIRCLE NO. 88 ON FREE INFORMATION CARD

Realistic Programmable Scanner

Radio Shack's Realistic Model PRO-2008 direct-entry programmable scanner can directly access 18,600 frequencies (police, fire, ham radio, etc.) with no need to buy crystals. Desired frequencies are entered via a keyboard, while frequency selections appear in a fluorescent display. Up to eight frequencies from 30 to 50 MHz, 144 to 174 MHz, and 410 to 512 MHz can be entered and scanned at a time. Any channel can be programmed with a scan delay or locked out and skipped when desired. Channels can be scanned automatically or selected manually. Features include: built-in telescoping antenna, jack for external antenna, headphone jack, and reset button that clears all frequencies from the scanner. An optional 9-volt battery prevents loss of programmed frequencies if ac power is interrupted. $259.95.

CIRCLE NO. 89 ON FREE INFORMATION CARD

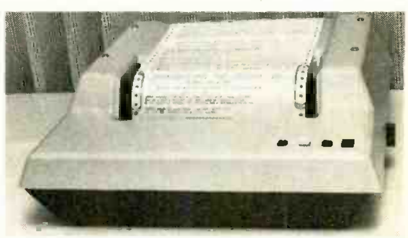
Digital Record/Play Kit for Pianos



"Pianocorder," a do-it-yourself retrofit kit from Superscope, Inc., enables a standard piano to record and play by itself with the touch and interpretation of the recorded pianist. It can be adapted to fit almost any upright, spinet, or grand piano without affecting the instrument's normal functioning. Based on computer technology, Pianocorder uses digital tape cassettes to encode and then reenact a performance as it was originally played. Cassettes are inserted in a small tape recorder that activates the piano keys via a logic circuit board mounted across the open space behind the keys. Prerecorded tapes are also available, including transcribed ones from piano rolls of pianists such as George Gershwin and Scott Joplin. According to Superscope, installation takes 8 to 12 hours. Pianocorder kits start at $1495.

CIRCLE NO. 87 ON FREE INFORMATION CARD

Low-Cost Impact Printer Kit



The 101B-80 Impact Printer Kit from Coosol Inc. is an 80-column, tractor-feed, dot-matrix impact printer that is microprocessor-controlled and programmable with 32 system level commands, graphics, 96 ASCII characters, upper and lower case, and nine software-selectable fonts from 5 × 7 to 10 × 14. It features parallel and serial interfaces, baud rate selectable from 110 to 9600, and adjustable tractor width for paper-size selection.

The 101B-80K kit (without enclosure) is $455; the 101B-80KE (includes enclosure) is $495. Assembled prices: $485 and $545, respectively.

CIRCLE NO. 91 ON FREE INFORMATION CARD

Function Generator

Simpson Electric Co.'s Model 420 Function Generator provides sine, triangle, and square-wave outputs, plus dc and TTL logic-level outputs, over a frequency range from 0.1 Hz to 1 MHz in seven ranges. Signal amplitude is 10 volts peak-to-peak into a 600-ohm load and is continuously variable more than 30 dB. In additon, a fixed attenuator selects 0- or −30-dB attenuation. A continuously variable dc offset is also provided. Frequency accuracy is claimed to be ±3% of full scale from 1 Hz to 100 kHz, with a sine-wave distortion of less than 1% over this range. A special input permits external voltage control of output frequency over a 300:1 ratio. Size is 2.7" × 8.4" × 9". Model 420A for ac line operation, $175; Model 420D line and battery operated, $210.

CIRCLE NO. 92 ON FREE INFORMATION CARD

8000-Baud TRS-80 Cassette Interface

The FCI-80 Fastload Cassette Interface from Microsette plugs into the rear of a TRS-80 Level II, 16K keyboard, or expansion interface to allow the cassette port to operate at 8000 baud—16 times faster than normal. Included is a LED display for proper level settings, and a search capability that allows searching for BASIC programs having names from one to six letters long. Using a modified CTR-41 recorder, programs can be loaded at about one second per kilobyte. The system also can be called from Disk BASIC. $199.

CIRCLE NO. 93 ON FREE INFORMATION CARD

Heathkit Portable Engine Analyzer

The Model CM-1550 is a new portable engine analyzer in kit form from Heath. It is designed to handle several tuneup measurements, including dwell for 4- through 8-cylinder engines, rpm to 10,000 in two ranges, and direct current to 20 amperes. With an optional CMA-1550-1 shunt accessory, the analyzer can also measure starting current and battery charging/discharging current up to 400 amperes. A large liquid-crystal display gives numerical values of all measurements. Heath claims the kit can be assembled in two or three evenings, with only one circuit board to be wired. Calibration is accomplished from internal references. $94.95 for analyzer kit, $13.95 for optional shunt accessory.

CIRCLE NO. 90 ON FREE INFORMATION CARD

President Mobile AM CB Transceiver

Designated the President Model AR 711, the new mobile AM CB transceiver from American Radio Corp. is said to have been designed to the specifications of truckers and other professional users. It features a noise-cancelling microphone with 10' coil cord, 4" external speaker with mounting bracket and 5' cable, instant-select channels 9 and 19 switches, and a HI-CUT tone switch. Other features include: microphone, squelch, volume, and r-f controls; automatic noise-limiter/noise-blanker switch; S/r-f meter; digital numeric channel indicator; transmit and receive indicators; positive/negative grounding system; automatic modulation control; and PA and external-speaker jacks. $139.95.

CIRCLE NO. 94 ON FREE INFORMATION CARD

Fisher AM/FM-Stereo Receiver

Fisher's Model RS270 AM/FM-stereo receiver teams a Class-A-II amplifier with a quartz-controlled PLL digitally synthesized tuning system. The amplifier section is rated at 50 watts/channel rms into 8 ohms from 20 to 20,000 Hz with no more than 0.02% THD. Power output is displayed by LED bar-graph "meters." Standard features in this section are a moving-coil phono amplifier and low- and high-cut filters. The tuner section features a fluorescent numeric display of frequency and scan tuning or instant access to any of 12 preprogrammed stations (six on AM and six on FM). FM sensitivity is rated at 1.9 μV (10.8 dBf), stereo separation at 45 dB at 1 kHz. Stepped LEDs serve as a signal-strength meter, while discrete LEDs highlight the selected operating mode. $549.95.

CIRCLE NO. 95 ON FREE INFORMATION CARD

Shure Communications Microphone

Shure's Model 444D communications microphone retains all the performance characteristics of the previous Model 444, but has added features for ham-radio operators. Among these is a switch that allows selection of either high- or low-impedance operation. A second switch permits alternating between normal and VOX operation. Other features: momentary-action/locking push-to-talk switch bar that actuates the mike and an external relay or control circuit; "Controlled Magnetic" microphone element whose response is claimed to be tailored for maximum intelligibility; and height adjustment. $55.50.

CIRCLE NO. 96 ON FREE INFORMATION CARD

True RMS DMM

Besides the conventional voltage, current, and resistance ranges, Beckman's hand-held Tech 330 3½-digit multimeter features true rms (ac +

(Continued on page 14)

Six new Scanners! New 800 MHz!

Communications Electronics,™ the world's largest distributor of radio scanners, welcomes the addition of Fanon to our product line. Fanon introduces *two* new high performance hand-held scanners. More importantly, Fanon has a complete selection of useful accessories to compliment their *Slimline* models.

Electra Company, manufacturers of *Bearcat* brand scanners introduces *three* new scanners *including* a model that can monitor the exciting 800 MHz. band. The new *Bearcat* models will be available Fall, 1980, so reserve your scanner now!

A new product made by Electra, the *Freedom Phone®* is now available from **CE**. This is the ultimate *cordless* extention phone that can make and take your calls.

Bearcat®† 300

The Ultimate Synthesized Scanner!

Allow 90-120 days for delivery after receipt of order due to the high demand for this product.

List price $519.95/**CE price $339.00**

4-Band, 50 Channel • Service Search • No-crystal scanner • AM Aircraft and Public Service bands. • Priority Channel • AC/DC

Bands: 32-50, 118-136 AM, 144-174, 421-512 MHz.

The new *Bearcat* 300 is the most advanced automatic scanning radio that has ever been offered to the public. The *Bearcat* 300 uses a bright green fluorescent digital display, so it's ideal for mobile applications. The *Bearcat* 300 now has these added features: Service Search, Display Intensity Control, Hold Search and Resume Search keys, Separate Band keys to permit lock-in/lock-out of any band for more efficient service search.

Bearcat® 250

List price $419.95/**CE price $279.00**

50 Channels • Crystalless • Searches Stores • Recalls • Digital clock • AC/DC Priority Channel • 3-Band • Count Feature.

Frequency range 32-50, 146-174, 420-512 MHz.

The *Bearcat* 250 performs any scanning function you could possibly want. With push button ease you can program up to 50 channels for automatic monitoring.

Bearcat® 220

List price $419.95/**CE price $279.00**

Aircraft and public service monitor. *Frequency range 32-50, 118-136 AM, 144-174, 420-512 MHz.*

The *Bearcat* 220 is one scanner which can monitor all public service bands plus the exciting AM aircraft band channels. Up to twenty frequencies may be scanned at the same time.

Bearcat® 211

List price $349.95/**CE price $229.00**

Frequency range: 32-50, 146-174, 420-512 MHz.

The *Bearcat* 211. It's an evolutionary explosion of features and function. 18-channel monitoring. With no-crystal three-band coverage. Dual scan speeds. Color-coded keyboard. Even a digital clock. All at a modest price. More scanning excitement than you bargained for.

NEW! Bearcat® 210XL

This is a new model. Shipments will begin in Fall, 1980.

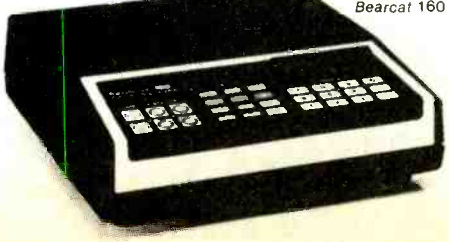
List price $319.95/**CE price $219.00**

18 Channels • 3 Bands • Crystalless

Frequency range: 32-50, 144-174, 421-512 MHz.

The *Bearcat* 210XL scanning radio is the second generation of the world's best selling crystalless programmable scanner–the *Bearcat* 210. It has almost twice the scanning capacity with 18 channels plus dual scanning speeds and a bright green fluorescent display.

NEW!
Bearcat 160



Bearcat® 210

List price $319.95/**CE price $209.00**

10 Channels • 3 Bands • Crystalless

Frequency range: 32-50, 146-174, 420-512 MHz.

Use the simple keyboard to select the 10 channels to be scanned. Automatic search finds new frequencies. The 210 features patented selectable scan delay, push button lockout, single antenna, patented track tuning, AC/DC operation. With no crystals to buy. Ever!

NEW! Bearcat® 160

This is a new model. Shipments will begin in Fall, 1980.

List price $279.95/**CE price $199.00**

16 Channels • 3 Bands • AC only • Priority Dual Scan Speeds • Direct Channel Access

Frequency range: 32-40, 144-174, 440-512 MHz.

The *Bearcat* 160 presents a new dimension in scanning form and function. The keyboard is smooth. No buttons to punch. No knobs to turn. Instead, finger-tip pads provide control of *all* scanning operations, including On/Off, Volume and Squelch. Green easy to read fluorescent display. Requires (2) 9 Volt batteries to retain memory when disconnected from AC Power.

Bearcat® 12

List price $179.95/**CE price $119.00**

10 Crystal Channels • 3 Bands • AC or DC

Frequency range: 33-48, 146-174, 450-512 MHz.

More features, more channels, more action. The *Bearcat* 12 has automatic squelch, individual lockout and more.

NEW! Bearcat® 5/800 MHz

The world's first 800 MHz. scanner!

This is a new model. Shipments will begin in Fall, 1980.

List price $179.95/**CE price $129.00**

8 Crystal Channels • 4 Bands • AC only

Frequency range: 33-50, 144-174, 440-512, 806-870 MHz.

The *Bearcat* 5/800 MHz is the only scanner on the market today that offers coverage of the 800 MHz. public service band and the other public service bands. Individual channel lockout. Scan Delay. Manual Scan.

Bearcat® 5

List price $129.95/**CE price $94.00**

8 Crystal Channels • 3 Bands • AC only

Frequency range: 33-50, 146-174, 450-508 MHz.

The *Bearcat* 5 is a value-packed crystal scanner built for the scanning professional — at a price the first-time buyer can afford. Individual lockout switches.

Bearcat® Four-Six ThinScan™

List price $179.95/**CE price $119.00**

Frequency range: 33-47, 152-164, 450-508 MHz.

The incredible, new *Bearcat* Four-Six Thin Scan™ is like having an information center in your pocket. This three band, 6 channel crystal controlled scanner has patented Track Tuning on UHF. Scan Delay and Channel Lockout. Measures 2¾ x 6¼ x 1." Includes rubber ducky antenna.

NEW! Fanon Slimline 6-HLU

List price $169.95/**CE price $109.00**

Low cost 6-channel, 3-band scanner!

The new *Fanon* Slimline 6-HLU gives you six channels of crystal controlled excitement. Unique Automatic Peak Tuning Circuit adjusts the receiver front end for maximum sensitivity across the entire UHF band. Individual channel lockout switches. Frequency range 30-50, 146-175 and 450-512 MHz. Size 2¾ x6¼ x 1." Includes rubber ducky antenna. Order crystals for each channel.

NEW! Fanon Slimline 6-HL

List price $149.95/**CE price $99.00**

6-Channel performance at 4-channel cost!

Frequency range: 30-50, 146-175 MHz.

If you *don't* need the UHF band, get this model and save money. Same high performance and features as the model HLU without the UHF band. Order crystal certificates for each channel.

FANON SCANNER ACCESSORIES

CHB-6	AC Adapter/Battery Charger	$15.00
CAT-6	Carrying case for Fanon w/Belt Clip	$15.00
AUC-3	Auto lighter adaptor/Battery Charger	$15.00

OTHER SCANNER ACCESSORIES

SP50	AC Adapter	$12.00
SP51	Battery Charger	$12.00
SP58	Carrying Case for *Bearcat* 4-6 ThinScan™	$15.00
FB-E	Frequency Directory for Eastern U.S.A.	$15.00
FB-W	Frequency Directory for Western U.S.A.	$15.00
FFD	Federal Frequency Directory for U.S.A.	$18.00
SM220	Service manual for *Bearcat* 220	$15.00
B-4	1.2 V AAA Ni-Cad's for ThinScan™ and Fanon	$15.00
B-5	Replacement memory battery for Bearcat 210	$6.00
B-7	1.5 V AAA Alkaline battery (Pack of 4)	$4.00
B-9	9 V Alkaline battery	$3.00
A-135cc	Crystal certificate	$4.00

Add $3.00 shipping for all accessories ordered at the same time.

INCREASED PERFORMANCE ANTENNAS

If you want the utmost in performance from your scanner, it is essential that you use an external antenna. We have six base and mobile antennas specifically designed for receiving all bands. Order **#A60** is a magnet mount mobile antenna. Order **#A61** is a gutter clip mobile antenna. Order **#A62** is a trunk-lip mobile antenna. Order **#A63** is a ¾ inch hole mount. Order **#A64** is a ⅜ inch snap-in mount, and **#A70** is an all band base station antenna. All antennas are $30.00 and $3.00 for UPS shipping in the continental United States.

TEST ANY SCANNER FREE

Test any scanner purchased from **Communications Electronics**™ for 31 days before you decide to keep it. If for any reason you are not completely satisfied, return it in original condition with all parts in 31 days, for a prompt refund (less shipping/handling charges and rebate credits).

NEW! Regency®‡ M400

List price $379.95/**CE price $259.00**

30 Channel • Synthesized • Service Search Digital clock • Digital timer • M100 styling Search/Store • Priority Channel • AC/DC

Frequency range: 30-50, 144-174, 440-512 MHz.

The new *Regency* M400 is a compact programmable FM monitor receiver for use at home or on the road.

OTHER REGENCY® SCANNERS

Aircraft Touch 720-A	$229.00
Touch K100	$199.00
Touch M100	$199.00

NEW! Telephone Products

Electra's cordless *Freedom Phone* does everything an ordinary phone does and more. Because it is cordless, you can take it anywhere, inside or outside—on the patio, by the pool, in the garage, in the workshop...even next door at the neighbor's.

Model **FF-500** has pushbutton dialing. Rechargeable ni-cad batteries included. Battery low light. Secure feature. Telescopic antenna. Your cost is $179.00. Model **FF-1500** has the same features as the FF-500 but also includes a charger/cradle that allows the phone's handset to be recharged away from the base station. Your cost for this cordless phone is $199.00. The model **FF-3000** has all the standard features (except charger/cradle) plus interchangeable telescopic and rubber ducky antenna. Redial feature. Belt clip. Carrying case. Greater range. Your cost is $229.00.

World Scanner Association™

The WORLD SCANNER ASSOCIATION is sponsored as a public service by **Communications Electronics**.™ When you join, you'll receive a quarterly newsletter with scanner news and features. You'll also get a wallet I.D. card, an Official WSA Membership Certificate, and more. FREE classified ads for members so you can contact other scanner owners when you want to sell or buy a scanner. FREE membership in the WSA Buyer's Co-op. Your Co-op membership will allow you to get special discounts on scanners and scanner related products. Since the WSA Buyer's Co-op gives you group purchasing power, you can easily pay for your membership dues the first time you make a Co-op purchase. To join, send $12.00 ($17.00 outside U.S.A.) for your membership materials.

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Mail orders to: **Communications Electronics,™** Box 1002, Ann Arbor, Michigan 48106 U.S.A. Add $6.00 per scanner or phone product for U.P.S. *ground* shipping, or $12.00 for faster U.P.S. *air* shipping to some locations. If you have a Master Charge or Visa card, you may call anytime and place a credit card order. **Order toll free** in the U.S.A. 800-521-4414. If you are outside the U.S. or in Michigan, dial 313-994-4444. **Dealer inquiries invited**. All order lines at **Communications Electronics™** are staffed 24 hours.

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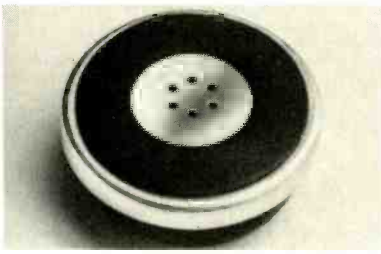
We're first with the best.℠

CIRCLE NO. 1 ON FREE INFORMATION CARD

dc) measurement capability, 10-ampere current ranges, a built-in continuity indicator, complete r-f shielding, and an LCD display. Claimed dc accuracy is 0.1% with a 22-megohm input resistance. True rms capability allows more accurate measurement of nonsinusoidal waveforms such as found in switching power supplies, motor-speed controllers, SCR regulators, and digital systems. Ac measuring accuracy is from ±0.6% of reading at 45 Hz to ±2% of reading at 20 kHz. Ac voltage ranges have the claimed accuracy to 20 kHz for signals having a crest factor (peak/rms) from 1:1 to 5:1. $200.

CIRCLE NO. 97 ON FREE INFORMATION CARD

"Supermike" for Phones



Novation Inc.'s Supermike is an FCC-approved condenser microphone that replaces the conventional carbon microphone element in telephone handsets. It is claimed that this new element reduces second harmonic generation by over 40 dB, improving data transmission clarity up to five times when an acoustic coupler is used. The microphone contains a solid-state preamplifier powered from the telephone circuit. It is said to maintain constant line levels and improve signal-to-noise ratio in all acoustic-type communications. $9.95.

CIRCLE NO. 98 ON FREE INFORMATION CARD

Color Receiver/Monitor

A new color-TV receiver/video monitor with integrated-circuit design, quick-start black-matrix in-line picture tube, automatic fine tuning (aft), and automatic gain control (agc) is available from V.A.M.P. Inc. The 13" diagonal Model VM-1300 can be switched from standard vhf/uhf TV reception to the video-monitor mode by flipping a toggle. In the monitor mode, it accepts standard video. Looping inputs, with switchable 75-ohm termination, are provided to permit linking of multiple monitors. An audio input is also provided. Resolution in the monitor mode is 300 lines horizontal by 350 lines vertical. Price is $449. (A 19" version, the Model VM-1900, is also available for $575.) Address: V.A.M.P. Inc., 1617 El Centro Ave., Los Angeles, CA 90028.

Hi-Fi Component Credenza

A credenza with 1½"-thick sides and divided into two sections, each with three shelves behind bronze-toned safety glass doors, has been introduced by Gusdorf Corp. The upper surface is surrounded, sides and back, by a gallery and is wide enough to accommodate a TV receiver, turntable, or videocassette recorder. Amplifiers, tuners, preamps, tape decks, etc., fit inside the credenza. Record dividers come with the credenza, while a rack-mounting kit is optional. The furniture-grade double-wheeled casters are hooded. The credenza's sides and top are finished in a walnut tone, with additional protection of a Rendura coating. $280.

CIRCLE NO. 99 ON FREE INFORMATION CARD

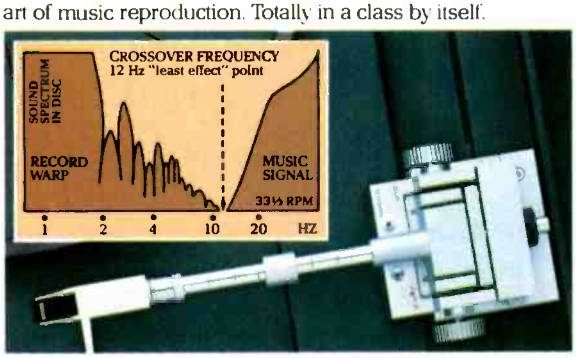
Cushcraft Triband Amateur Beam

Cushcraft's Model A3 is a lightweight, compact Yagi array designed for use on 20, 15 and 10 meters. It has a rated forward gain of 8 dB and an average front-to-back ratio of 25 dB. Nominal feedpoint impedance is 50 ohms unbalanced, (1.2:1 VSWR), average usable bandwidth (VSWR 2:1 or less) is 500 kHz, and rated power-handling capacity is 2000 watts PEP. The antenna weighs 35 lb (15.9 kg), is made of swaged seamless aluminum tubing and G-10 fiberglass, and uses stainless and zinc-plated steel hardware. Tapered tube elements are employed to minimize wind loading and surface area, which is rated at 5.6 ft² (0.5 m²). Turning radius is 15.5 ft (4.8 m). $199.95.

CIRCLE NO. 100 ON FREE INFORMATION CARD

Yamaha's PX-2 linear tracking turntable. A class of one.

Yamaha's new PX-2, the flagship of a remarkable new series of turntables from Yamaha, is destined to become the new standard of the audio industry. It is a masterpiece in the art of music reproduction. Totally in a class by itself.



One of the major performance advancements on the PX-2 is Yamaha's unique optimum mass straight tonearm assembly. This design concept is Yamaha's direct challenge to the industry trend of low-mass tonearms. Among the most significant benefits of optimum mass is that it specifically addresses two of the most critical elements of music signal tonal quality—tonearm resonant frequency characteristics and high trackability with a wide range of cartridges. Tonearm mass is such a critical element in sound reproduction (especially in the low and high frequency ranges) that Yamaha has designed this optimum mass tonearm to insure its resonance frequency is at the "least effect" point. (See graph.) As a further benefit, the vast majority of available cartridges can be effectively matched with the Yamaha tonearm. Even MC types.

But the optimum mass tonearm is only one factor that puts the PX-2 in a class by itself. There's much more. Like an extraordinary 80dB S/N ratio, with incredibly accurate tangential tracking—constantly monitored by an opto-electronic sensor. The PX-2 is also a study in durability with its solid, anti-resonant monolithic diecast aluminum base. And the combined effect of the hefty platter and the heavy-duty DC motor depresses wow and flutter to below 0.01%.

Yet with all this performance, the PX-2 is deceptively easy to operate. All the microprocessor-activated controls are easily accessible—without lifting the dustcover.

The balance of the turntables in our new line (the P-750, P-550, P-450 and P-350) all incorporate this same optimum mass tonearm philosophy. Each will set new standards for performance per dollar invested.

Visit your local Yamaha Audio Specialty Dealer for a personal test of our remarkable PX-2 and the other superb turntables in our new series. You'll hear music that's truly in a class by itself.

For more information write us at Yamaha, Audio Division, P.O. Box 6600, Buena Park, CA 90622.

*Yamaha cartridges shown (MC-1X and MC-7) on both models are optional.

YAMAHA

CIRCLE NO. 78 ON FREE INFORMATION CARD

NRI training in TV and Audio Servicing keeps up with the state of the art. Now you can learn to service video cassette and disc systems.

You build color TV, hi-fi, professional instruments.

Now, in addition to learning color TV and audio systems servicing, you get state-of-the-art lessons in maintaining and repairing video cassette recorders, and the amazing new video disc players, both mechanical and laser-beam types.

Learn at Home in Your Spare Time

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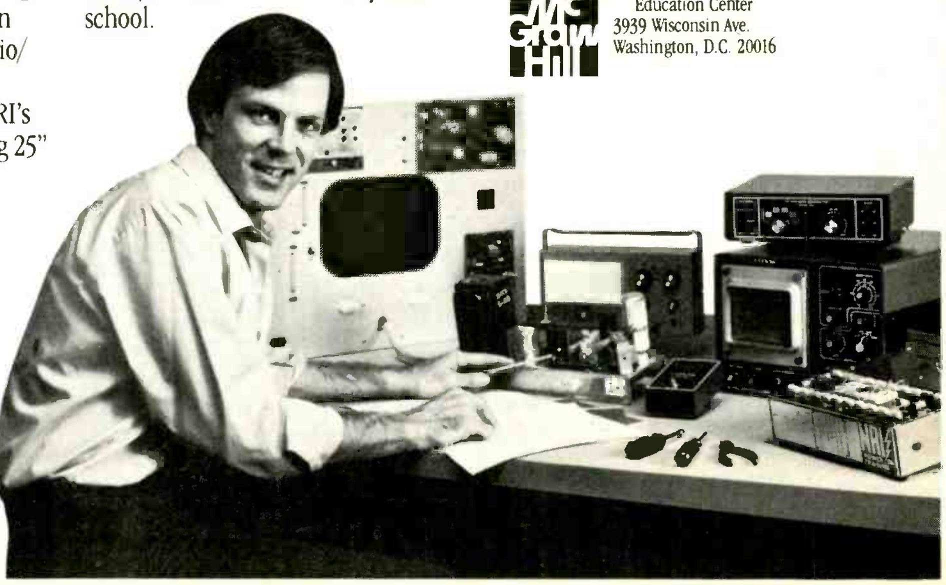
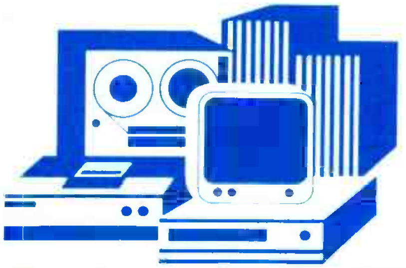


Learn at home at your convenience.



Entertainment Electronics

By Laurence Greenhill

High-End Audio

CONTRARY to the continuing trend of inflation in the 1970s and '80s, the electronics industry has been able to produce calculators, television games, home computers, digital watches, and audio equipment at prices that have remained relatively stable or, in some cases, fallen. This fortunate state of affairs is very likely a result of parts and manufacturing economies gained by using large-volume-production and integrated circuits. The net effect is to give the consumer better value for his money.

In contrast to this, there is a small group of U.S. manufacturers that design and market exquisitely crafted, high-quality stereo components; and their prices have shown an upward trend with time. These so-called high-end companies normally limit their business to separate components and show little interest in receivers and integrated amplifiers. Their products are developed by modifying the basic design of a unit every few years. Production output is generally small, often as little as a few pieces per week, and is sold through a small network of carefully selected retail stores. Mark Levinson Audio Systems, Ltd., Threshold Corporation, and Audio Research are good examples of such "high-end" audio companies.

The high price of equipment sold by these companies clearly sets it apart from the industry mainstream. Let's contrast two different design approaches—a cost-sparing one by Carver Corporation and a "price-no-object" one by Threshold Corporation. Both products, the Carver M-400 and the Threshold Stasis 1, are basic power amplifiers capable of supplying 200 watts per channel, but at that point the similarity between them seems to end. Where Carver supplies two channels of amplification for $350, Threshold equipment to do the same job (two mono amplifiers) will set you back a whopping $7,000! Where Carver has built on the current trend to switching power supplies and variable supply voltage to the output stage in an effort to save weight, space, and power dissipation, Threshold has developed a unique circuit that forces active devices in the output stage to operate in a way that is inherently errorless.

Nelson Pass of Threshold believes that dynamic amplifier distortion can be reduced greatly if an amplifier stage runs with nearly constant voltage and constant current across and through the active device. His original 1978 patent for the Stasis 1 achieved this by connecting two amplifiers. A small, low-impedance, constant-voltage, cascoded, class-A amplifier (the "Stasis" section) feeds low current through the load (the speaker) to a second, high-impedance, high-power, class-AB amplifier of constant current (the current "mirror"). The low impedance of the first, low-power, very-high-quality Stasis amplifier causes it to dominate and to determine the speaker response's sonic quality. The second amplifier, outside of the feedback loop of the Stasis section, serves as a current bootstrap and carries out most of the work through the speaker. Open-loop distortion can be reduced 10 to 30 times, so that no overall system feedback between amplifiers is required. Pass's Stasis design resembles Peter Walker's "current dumping" Quad 405 amplifier, but the Threshold amp does not utilize the 405's impedance bridge to connect the small, superb amplifier to the "large" current source.

To continue the comparison, the Carver weighs 4.5 lb per channel; the Threshold weighs in at 100 lb. Limiters in the Carver hold current flow to 15 amperes; the Threshold will pass pulses of 30 amperes. For other features of the two amplifiers, let's look at their general descriptions, as follows.

Carver M-400 Power Amplifier. Features magnetic-field circuitry that eliminates need for oversized heat sinks, power transformers, and electrolytic capacitors; dual moving-LED vertical-peak level display with VU ballistics; 200 W/ch continuous into 8 ohms from 1 to 20,000 Hz with 0.05% THD and 0.06% IM distortion; frequency response, 1 to 250,000 Hz ± 0.25 dB; S/N, 100 dB (A-weighted); slew rate, 80 V/μs; dynamic range, 50 dB. Brushed champagne gold finish with brown trim; $6\frac{3}{4}$" H × $6\frac{3}{4}$" W × $6\frac{3}{4}$" D.

Threshold Stasis 1 Power Amplifier. Mono power amplifier features constant-current/constant-voltage operating system designed to eliminate semiconductor distortion; 72 ultra-high-speed output transistors; adjustable peak and average meter output display with sensitivity readings of peak/average 0 dB at 15 W, 8 ohms and peak/average 0 dB at 150 W, 8 ohms; LED indicators for amp on, error waveform, over temperature, and standby. Dimensions of the Stasis 1, which is rack mountable, are $19\frac{5}{8}$" W × $8\frac{3}{4}$" H × 19" D.

Unlike the Carver amplifier, whose manufacturer limits its application to the home environment, the Stasis 1 can be used for sound reinforcement, by rock groups, or even to drive highly reactive loads represented by cutter heads used in making disc records. Jack Renner of Telarc Records, for example, has used the Stasis 1 to cut lacquers. The monophonic Stasis 1 will also serve as the "flagship" for Threshold's new line of stereo Stasis amplifiers, the 200 watt-per-channel Stasis 2 ($2,450) and the 100 watt-per-channel Stasis 3 ($1,675).

Why would one buy a Stasis 1? Nelson Pass believes that the unique sonic excellence of the Stasis 1 is easily discernable, although its standard distortion figures are no different than those of the Carver. Obviously, the customer considering a Stasis 1 must weigh other factors besides pure performance. Let's examine the elements of such a choice.

Is Price the Main Specification? Purchasing audio equipment can be a great conundrum to the consumer. Excellence abounds in all price categories. Distortion specifications of most midprice separate components match the lower limits of the average test equipment. Since these specifications cannot readily improve, manufacturers set their products apart by stressing appearance, massiveness, ruggedness, quality of individual parts, and complexity of circuit design. As a result, brochures on high-end equipment may offer no numerical specifications. Instead, they focus on chassis construction, design of the output circuit, the number of power output devices, and weight and design of the power supply. Thus, the prospective purchaser may become involved with the product's construction, nameplate engraving, and the degree to which inner parts are overdesigned or derated, more than the product's function of amplifying an audio signal. In a sense, it is as if the audiophile were purchasing an elegant metal sculpture. Often the only available numerical specification, besides power output, is price. It may be that, like many glamourous consumer items, some high-end audio components stress high price to emphasize exclusiveness and quality.

Why does the prospective customer consider purchasing a "super-priced" audio product? Although these devices are touted as delivering the ultimate in sonic quality, lab tests on them fail to reveal uniquely low distortion figures. (But admittedly, basic distortion measurements don't tell all.) Yet, owners of high-end gear frequently report immense satisfaction with the sound that comes from their systems. I personally know several audiophiles who state that their quest for a superb amplifier was reached when they purchased the Mark Levinson ML-2, a 45-watt class-A monophonic amplifier (two are necessary for stereo) costing $2,500 per channel. There have been controlled subjective listening tests on such super components that suggest that the pleasure they give may come from nonsonic influences, for definitive evidence of superior sound has been elusive. On the other hand, reviewers in small audiophile magazines find distinguishing aural characteristics to commend this special class of audio equipment.

Of course, subjective listening musical experiences and the pleasure derived can be modulated by an owner's perception of a unit's appearance, the reputation of the designer, and the expectation of what a cost-no-barrier approach can yield. Similarly, one may have different expectations climbing into a $14,000 Corvette than into a $125,000 Lamborghini for a test drive, even though both qualify as sports cars. These expectations produce powerful psychological effects. Pride of ownership and self-esteem can account for some of the listening pleasure an audiophile obtains from his system.

Those willing or able to pay the price may gravitate to unusual, exotic designs. For example, the helium-atmosphere Plasmatronic speaker, which seems better suited to a physics lab than the living room, stands as an innovative use of plasma technology to produce an outstanding transducer—at a cost of $9,000.

One tangible benefit the audiophile who purchases high-end equipment is likely to receive is outstanding service from the dealer and manufacturer. Often, the customer can call the factory and speak directly with the designer. Further, updates of circuit design are often offered at a fraction of the original purchase price of the equipment, and repairs are easily obtainable. Moreover, some audio dealers who sell such equipment are willing to supply "loaner" electronics, so that your system can continue to operate while a component is being repaired. In summary, those able to own "price-no-object" equipment will own equipment with sound as good as anything available, elegant craftmanship, and conservative engineering that contributes to greater longevity—and receive solicitous service as well. ◇

Audiophile Recordings

By Harold A. Rodgers
Executive Editor

SAINT-SAËNS: ***Symphony No. 3, "Organ."*** Eugene Ormandy conducting the Philadelphia Orchestra; Michael Murray, Organist. Telarc 10051. Well, it has happened at last! Telarc has made the jump into the major leagues. This recording is the young company's first of a major symphony orchestra, and it has been done in fine style. Recorded digitally, of course, the sound encompasses a stunning dynamic range while retaining the subtleties of lightly scored passages. Just occasionally a touch of groove noise obtrudes with a gentle reminder that we are listening to a recording after all, but that is because the immense dynamic range forces the minimum level closer to the noise than would ordinarily be the case. At the other end of the range, more than a few prestigious phono pickups will sound a mite breathless tracking the peak levels. Telarc is here pushing the vinyl, and right to the limits—or awfully close.

Ormandy, Murray, and the orchestra do an excellent job. The opulent sound characteristic of the Philadelphia is well in evidence and well under control. The attacks have just the amount of diffuseness to render the sound warm rather than clinical, yet, at the same time, they are never permitted to lapse into vagueness or inaccuracy. One is tempted to conclude that St. Francis de Sales Church in Philadelphia is a particularly felicitous recording environment. This is a thrilling recording, and, as it should be one of Ormandy's final readings of the work, could easily become a collector's item.

TCHAIKOVSKY: ***Symphony No. 6 in B Minor, Op. 74, "Pathetique."*** Kurt Sanderling conducting the Berlin Symphony Orchestra. Denon OX-7183-ND. Sanderling's approach to this symphony seems to be to take everything right to the limit. He takes the opening about as far in the direction of romantic expressiveness (some would say schmaltz) as anyone I have ever heard, then makes a quick change in mood and renders Tchaikovsky's gimpy 5/4 "waltz" (*Allegro con grazia*) with as much *grazia* as anyone could want. Similarly, the third movement makes much of forcefulness, and the fourth returns to schmaltz.

The recording was made with Denon's PCM (digital) process, and has basically fine sound. The warmth of sound that characterizes many European recordings (in contrast to the more analytical sound preferred by many Americans) is abundantly present. However, whether through some quirk in miking or recording, or, more likely, in the acoustics of Christuskirche in East Berlin, bass frequencies are overrepresented. The entire texture at times becomes excessively turgid and heavy. The problem can be relieved to a large extent with a deft touch on the bass control of your amplifier, which is fortunate, for the performance is well worth hearing.

STEELEYE SPAN: ***All Around My Hat.*** Mobile Fidelity MFSL 1-027. Given the task of choosing a Steeleye Span album for remastering, I think I would have made a different choice—*Parcel of Rogues* and *Now We Are Six* coming to mind as candidates. But this one, although less spectacular than those, to my taste, does have a way of growing on one. There is not a great deal of showing off, but there is much musical expressiveness. And some of the arrangements approach genius.

For those unfamiliar with this now-disbanded group, its stock-in-trade consists of British folk song and dance melded with the modern rock medium in a unique way. It is a pity that Mobile Fidelity includes nothing in the way of program notes other than a description of its manufacturing process and the like. The unfamiliar dialects and odd vocabulary (at least for a modern American listener) cry out for the inclusion of written words of the songs and explanations where necessary. In any case, it would be nice to know more about the background of this delightful material and the group that produced it.

New Releases:

BOÏTO: ***Prologue to Mefistofele;*** VERDI: ***Te Deum.*** The Atlanta Symphony Orchestra and Chorus under Robert Shaw; John Cheek, Bass. Telarc DG-10045.

CHAUSSON: ***Concerto Op. 21.*** Israela Margalit, Piano; Lorin Maazel, Violin; The Cleveland Orchestra String Quartet. Telarc DG-10046.

FOR ELISE—AND OTHER BEAUTIFUL FLOWERS OF PIANO MUSIC. John O'Conor. Denon OX-7177-ND. ◇

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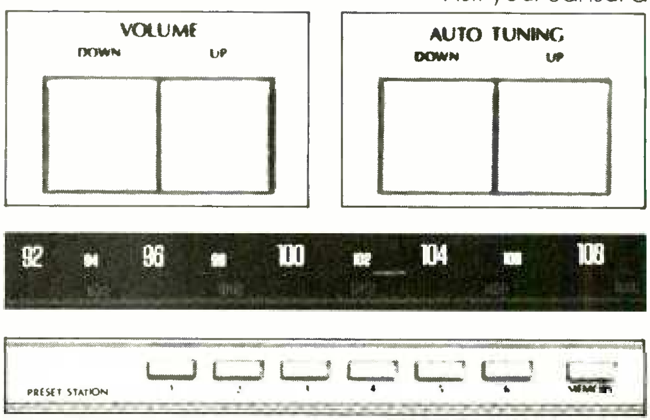
You can't mistune a Sansui synthesized digital receiver. Not even a little. Press the up/down tuning buttons. The digital circuitry ensures that every station received is automatically locked in for lowest possible distortion, with its frequency indicated both on a digital readout and by an LED indicator along an analog type dial.

TOUCH VOLUME CONTROL & LED PEAK POWER LEVEL INDICATOR

The Sansui 5900Z uses a pair of touch-buttons to adjust the listening level. Relative volume control setting is indicated on a fluorescent display. Actual peak power amplifier output is shown by 14-segment LED indicators.



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To make FM and AM tuning still easier, up to 12 user-selected stations may be "stored" in the 5900Z's memory circuits for instant recall. The last station received will be remembered when the tuner is turned on again; and memories are kept "live" even during a power outage.

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The leader in DC technology, Sansui uses a servo-controlled amplifier circuit in all "Z" receivers to eliminate unwanted ultra-low frequencies — like record warps — while maintaining the advantages of direct-coupled circuitry in their amplifier sections. The 5900Z delivers 75 watts/channel, min. RMS, both channels into 8 ohms, from 20-20,000Hz, with no more than 0.03% THD.

And there's more. Like LED's for every important function. Two Muting Modes. AM stereo capability. And much more.

Visit your Sansui dealer and make sure you see all the wonderful stereo receivers in the Sansui "Z" Series. And expect great things. You won't be disappointed.

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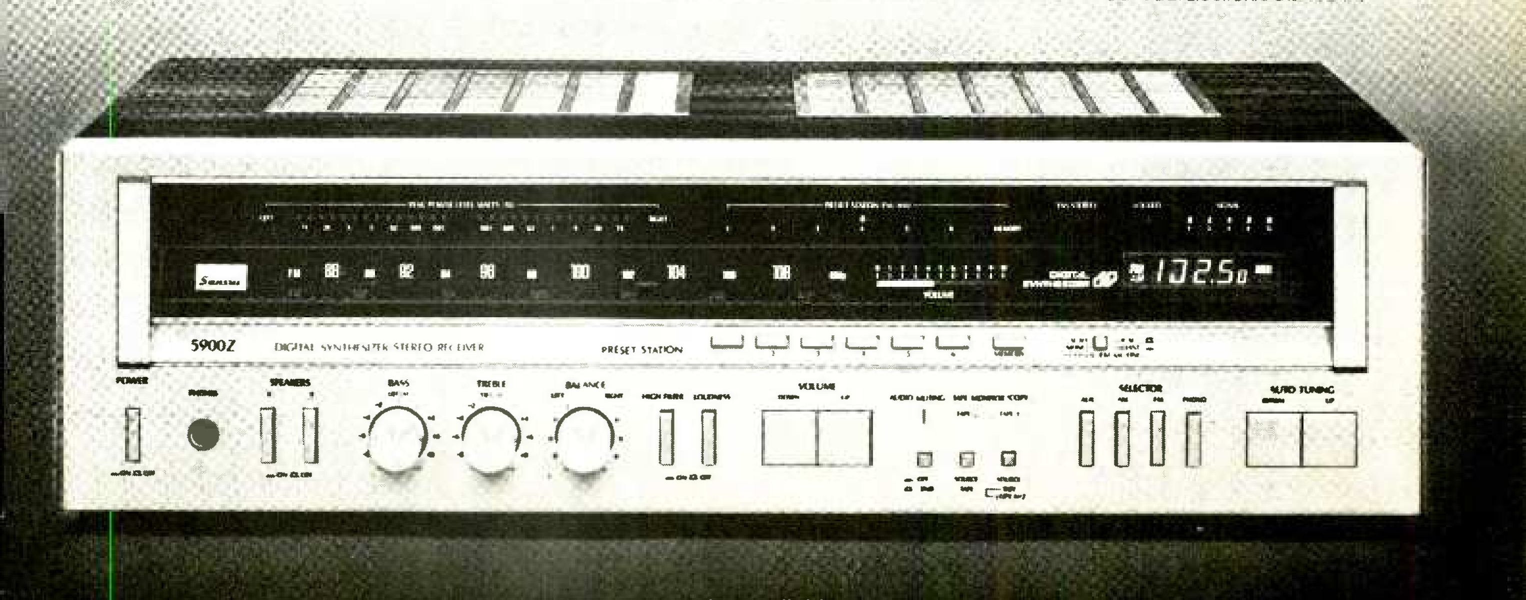

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Audio Product of the Month

CHOSEN BY THE EDITORS OF POPULAR ELECTRONICS

Tandberg Model TCD-440A Cassette Tape Deck

Three-motor, three-head machine has DYNEQ dynamic record EQ and ACTILINEAR recording amplifiers

HEADING the latest line of cassette decks from Tandberg is the TCD-440A, a deluxe three-motor, three-head machine. The TCD-440A incorporates Tandberg's DYNEQ dynamic equalization system for greatly reduced high-frequency tape overload, and the ACTILINEAR recording system that permits effective use of metal alloy tapes without saturation of the recording amplifiers.

The Tandberg TCD-440A can be installed in a vertical or a horizontal position, with removable supporting feet supplied for vertical mounting. The all-black finished recorder measures 18$\frac{5}{16}$" W × 8$\frac{7}{8}$" D × 4" H and weighs 14.5 pounds. The suggested selling price is $1600. An optional infrared remote control unit is $150.

General Description. The transport is controlled by light-touch buttons that operate solenoids. The usual pause feature is lacking, but RECORD can be activated by touching a single button if a separate REC. PRESET button has been previously engaged. Logic circuits make it possible to go directly from any speed or mode to any other. "Flying start" recordings can be made by pressing the RECORD and PLAY buttons while the tape is playing, and releasing PLAY before releasing RECORD.

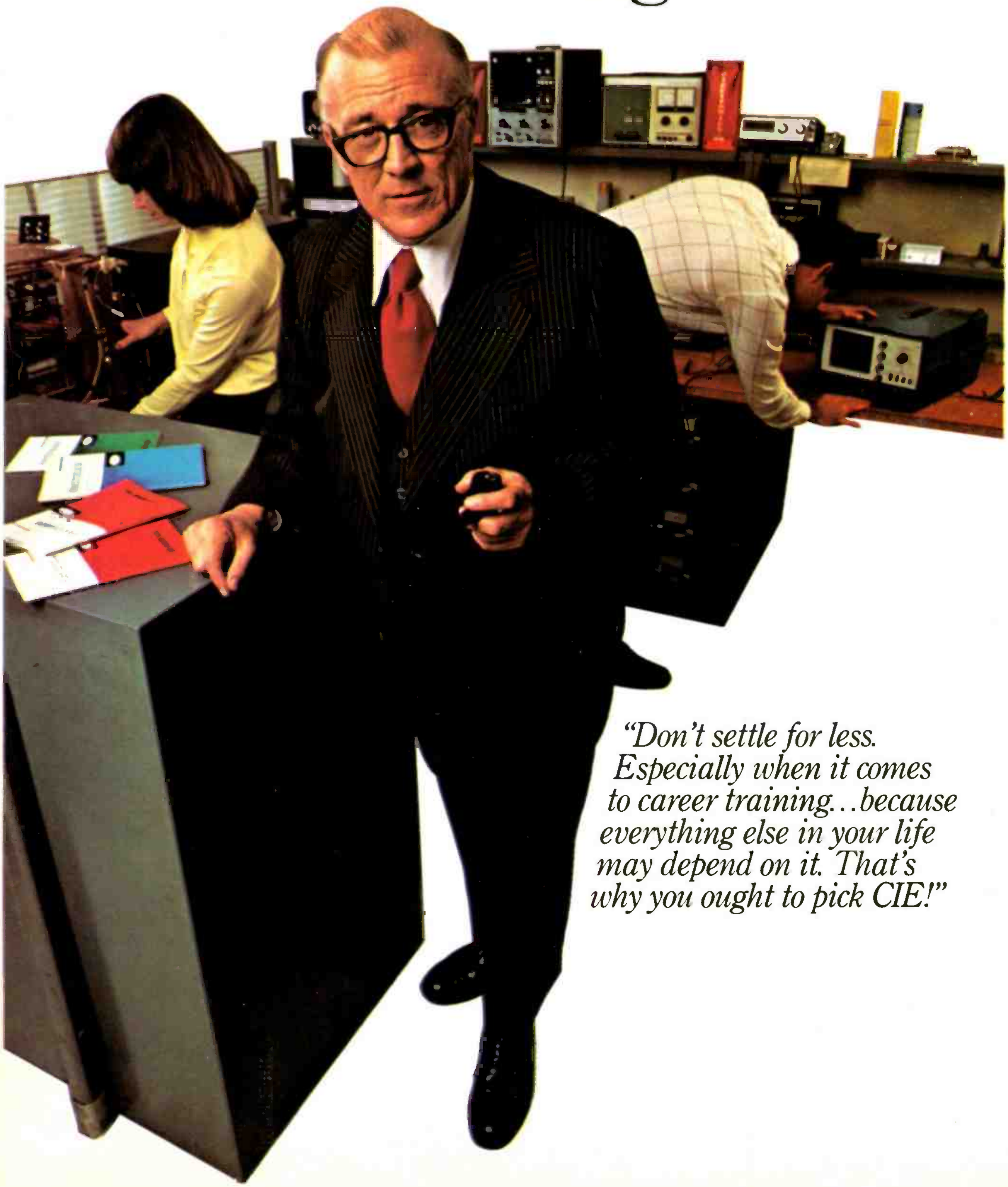
Other pushbutton switches control POWER, DOLBY NR, and internal equalization time constants. A DOLBY FM button, when used in conjunction with the DOLBY NR button, converts the deemphasis time constant of a received FM broadcast from 75 to 25 microseconds before decoding and recording it. Separate pushbuttons set the machine for Type I and Type II tapes. These are IEC designations for general tape classes, respectively, exemplified by ferric oxide (normal) tapes and either CrO_2 or high-bias ferricobalt equivalents. When both buttons are engaged, the machine is set for Type IV (metal) tape. Another button controls source/tape monitoring. An MPX filter can be switched in to attenuate 19-kHz pilot leakage from FM broadcasts being recorded.

Above the control buttons are two illuminated level meters that read peak levels of the equalized signal. They have two scales; the upper one, for Type I and Type II tapes, has its "0 dB" calibration corresponding to a tape flux of 250 nWb/m, while the lower, for metal tape, has its 0 dB set 4 dB higher (400 nWb/m).

Playback output level and recording level are controlled by dual slider potentiometers. A three-position toggle switch sets recording bias for Type I, Type II, or Type IV tapes. Access holes are provided for internal screwdriver adjustments that permit bias to be trimmed for any specific type of tape. This requires instruments and is not a normal user adjustment.

(Continued on page 31)

"If you're going to learn electronics, you might as well learn it right!"



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As your computer skills grow, so does your Heath H8 System. New accessories and software are coming along all the time to make your system do more.

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CP-188

(Continued from page 25)

Also on the panel of the TCD-440A are a headphone jack, a socket for the optional remote control accessory, and two microphone jacks, as well as the tape index counter. The cassette door is hinged vertically and opens from its right side. The EJECT button operates through a solenoid, so that normally the cassette door cannot be opened unless the recorder is powered. If access is required to the cassette with power off, there is a special mechanical ejection lever underneath the recorder.

Pressing on the upper edge of a narrow metal door causes it to swing open and reveal the recording-head azimuth adjustment knob, a TEST switch and instructions for aligning the head before making a recording. The separate record and playback heads are far enough apart for slight tape skewing within the cassette to alter the effective alignment of their gaps. The playback head is factory aligned, but before making a recording it is necessary to adjust recording head alignment for the particular cassette being used. An internal 10-kHz oscillator facilitates this test.

DYNEQ is Tandberg's answer to tape saturation at high frequencies. It monitors the incoming program level—particularly its high-frequency content—and uses the information to control the response of a 20-kHz resonant peaking circuit in the recording amplifier. As the high-frequency energy in the signal increases, the high-frequency boost in the record amplifier is progressively reduced. This minimizes the possibility of tape saturation. High-frequency recorded flux is thus maintained constant over a wide range of input signal levels, resulting in an effective increase of high-frequency response that amounts to about 10 dB at 15 kHz. DYNEQ operates only during recording and yields a tape that is fully compatible with other recorders. In addition, it provides a dramatic reduction of intermodulation distortion.

The ACTILINEAR system isolates the recording amplifier output from the bias signal injected into the recording head, reducing still further any intermodulation between the signal and the bias oscillator. In addition, it allows the recording amplifier some 15 dB of reserve headroom, even with the high signal levels recorded on metal tape.

Laboratory Measurements. Bias levels in the Tandberg TCD-440A have been factory adjusted for Maxell UD-XL 1 (Type I), Maxell UD-XL II (Type II), and Fuji Metal (Type IV) tapes, which we used in our tests. Playback equalization was first measured using TDK, Teac, and BASF test cassettes for both 120- and 70-μs equalization. There were the expected minor differences between the different tapes, but the playback response was typically within 2 dB from 40 Hz to the upper limit on the tape (either 10 or 12.5 kHz).

Record/playback frequency response was measured with each of the basic tapes, using levels of 0, −20, and −30 dB on the recorder's meters. The response of the TCD-440A is specified at a −30-dB level relative to 250 nWb/m, although most other cassette recorders are rated at a −20- or −26-dB level. We found negligible difference between the −20- and −30- dB curves, and those were confined to the range above 15,000 Hz.

The TCD-440A is exceptionally free of the low-frequency "head bumps" that are present in the playback response of almost every cassette deck. Its response could be specified as ±1.5 dB from 20 to 18,000 Hz with *any* of the tapes we used, at either a −20- or a −30-dB level. The 0-dB response curves began to roll off above 3 to 4 kHz, regardless of the tape. However, they did not fall to −20 dB until 18 to 20 kHz and never went below that. On most cassette decks, metal tape will give superior high-frequency response at high lev-

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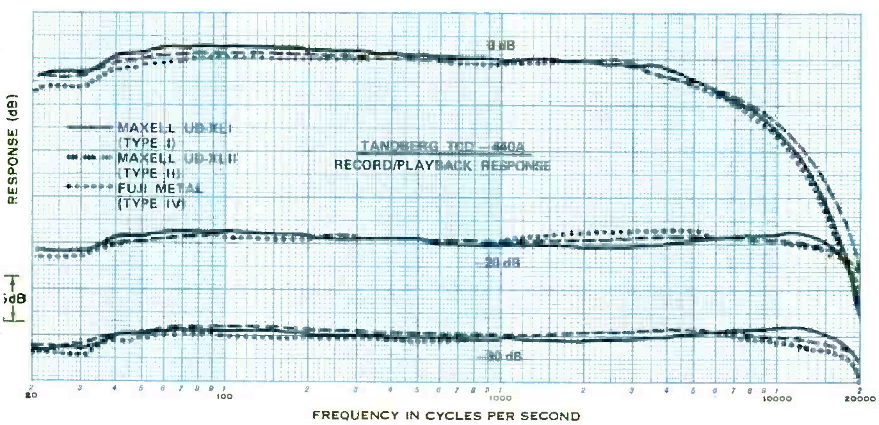
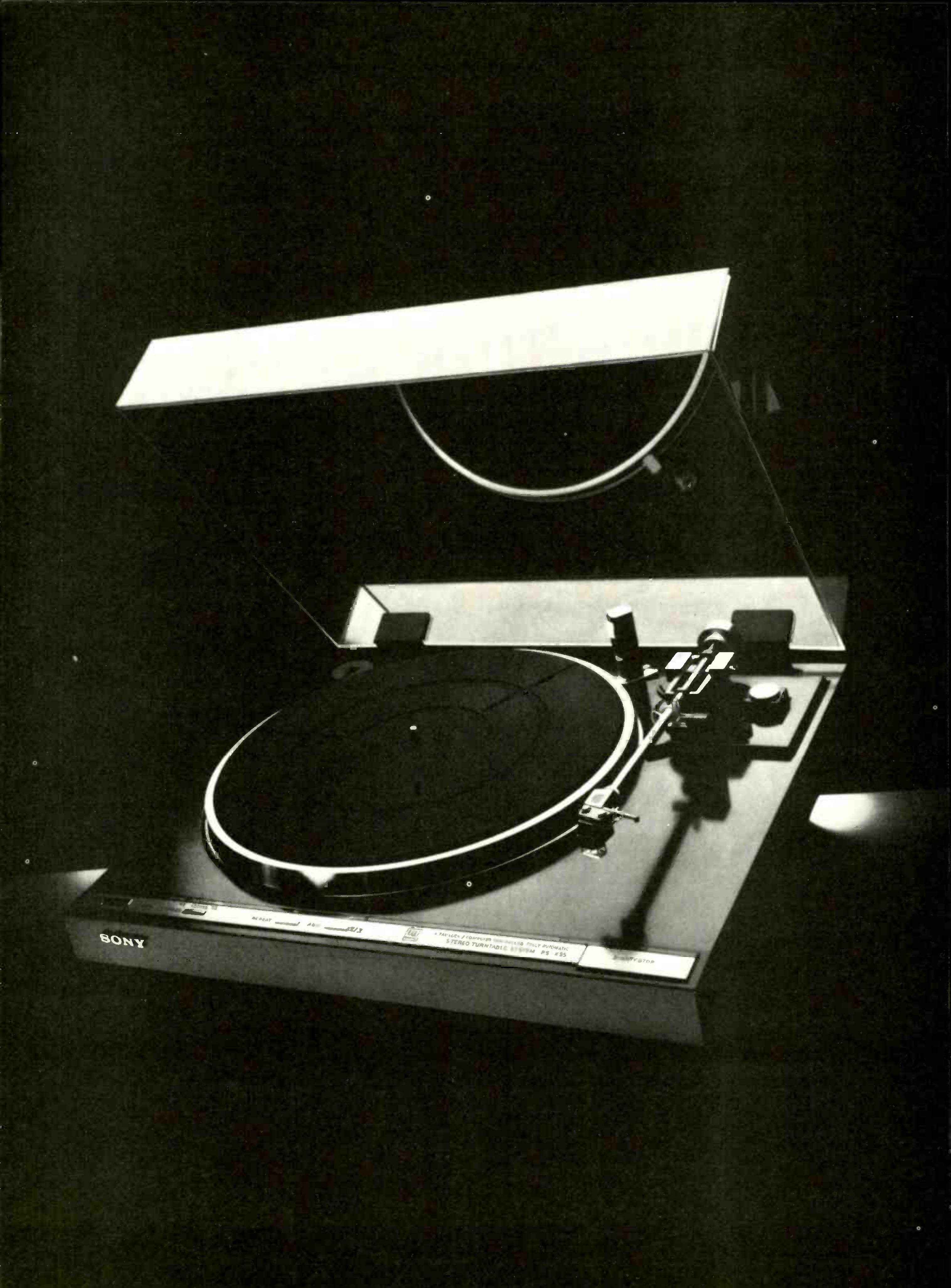


Frequency-response curves for three types of tape.


SONY
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FULLY AUTOMATIC
STEREO TURNTABLE

SONY ELIMINATES THE MOST DISTURBING VARIABLES IN TURNTABLE PERFORMANCE, STARTING WITH THE WAY IT TURNS.

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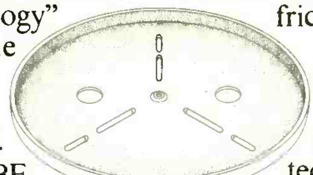
By applying "Total System Technology" we've eliminated the headaches that plague the turntable. And developed the first state-of-the-art turntable that won't put you in a state of bankruptcy. The PS-X55.



A DRIVE SYSTEM THAT'LL BE ACCURATE BEYOND THE YEAR 2000.

In order to insure your records turn at the prescribed speed, utterly smoothly and without fluctuation, Sony has improved its already advanced direct-drive system with an electronic speed-control circuit that works like a quartz watch.

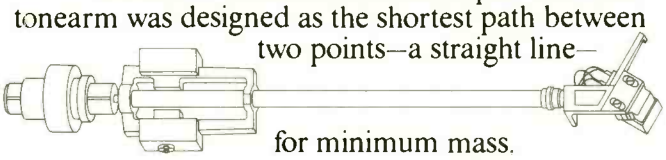
This gives the X55 up to 10 times more speed monitoring "pulse points" than competitive models, so it can better compensate for wow and flutter. We call this system "quartz-lock Magnedisc servo control." The audiophiles call it brilliant.

And unlike direct-drive motors found in competitive turntables, the X55's is both brushless and slotless. Which means it's even more accurate.

A NEW ANGLE ON THE TONEARM. STRAIGHT.

Sony engineers have paid meticulous attention to the X55's tonearm and its suspension.

Instead of the conventional shapes, the X55's tonearm was designed as the shortest path between two points—a straight line—



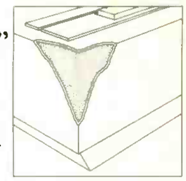
for minimum mass. Minimizing mass maximizes compatibility with the widest range of cartridges, including the most advanced high-compliance types.

The tonearm pivot is supported in two places, not one. So it's virtually free of tonearm resonance, friction and side play.

And to let the platter motor do its job without interference, the X55 even has a separate motor that operates the tonearm during its automatic cycles. A technological advancement that's hard to find on any turntable at any price.

THE STANDARD BY WHICH ALL BASES WILL BE JUDGED.

Instead of using an inexpensive plastic, wood or cast-aluminum base, like many of our competitors, the X55 is made of a Sony-patented inorganic "Bulk Molding Compound," which sharply reduces feedback.



And because loudspeakers produce vibrations that can be transmitted to the turntable through its feet, Sony created special gel-filled feet which absorb energy so effectively that the X55 will perform flawlessly even when your music is loud enough to rattle the walls.

Yet the X55's advancements don't stop here. A special muting device eliminates the "pop" that normally occurs when the stylus touches down or lifts up—something you'll particularly appreciate when transferring records to tape. There's even an electric eye that automatically measures the disc size.

But the bottom line is this. Once you compare the Sony X55 for specifications, features and price, you'll come to an inescapable conclusion. There's only one thing you need to know about high fidelity.

It's Sony.

SONY®
High Fidelity

FEATURES AND SPECIFICATIONS: Fully automatic direct-drive turntable system/Linear BSL motor/Quartz-lock Magnedisc servo speed control/Electromagnetic braking/Sony Bulk Molding Compound anti-resonance base/Low-mass Duralumin tonearm/Logic IC function sequencing/Discrete tonearm servo motor/Speed accuracy ± 0.003%/Wow and flutter (WRMS) 0.025%/Rumble (DIN B) –78 dB/Effective tonearm mass 8 grams.

CIRCLE NO. 71 ON FREE INFORMATION CARD

(Continued from page 31)
els, but the DYNEQ circuit seems to extract almost identical response from any kind of tape.

The Dolby circuits "tracked" well, resulting in a net response change of no more than 1 dB up to 10 kHz, or 2 dB between 10 and 15 kHz, between the Dolby "on" and "off" conditions, at recording levels of −20, −30, and −40 dB.

Depending on the tape used, a 0-dB meter reading required a recording input of 65 to 92 millivolts at 1 kHz. The corresponding maximum line playback levels were between 1.15 and 1.82 volts. At a 0-dB recording level, the playback third harmonic distortion was 0.8% with Type I, 0.5% with Type II, and 1.6% with Type IV tape (the latter being recorded to *its* 0-dB reference level, 4 dB higher than the others). The recording levels corresponding to 3% playback third-harmonic distortion were respectively +5.4 dB, +6 dB, and +2.5 dB for the three tapes.

Unweighted signal-to-noise ratios (S/N) referred to the 3% distortion signal level, were, respectively, 52.8 dB, 55.7 dB, and 56.1 dB for Type I, Type II, and Type IV tape. Using the Dolby system and CCIR/ARM weighting, these figures improved to 63.8, 67.5, and 67.3 dB. Through the microphone inputs, noise increased by 7 dB at maximum recording gain with a 1-kΩ input termination. (Gain of the microphone amplifier is a function of source impedance.) The crosstalk between channels at 1 kilohertz was −60 dB.

Standard test tapes confirmed that a flux level of 250 nWb/m produced a 0-dB meter reading in playback. Dolby calibration marks are at −2 dB (corresponding to a 200-nWb/m level), and Dolby test tapes gave meter readings of −1 and −1.5 dB on the two channels. The meters responded very rapidly to transients, reading 100% of steady-state values on 0.3-second tone bursts.

The tape transport ran 0.5% fast. Weighted rms (JIS) flutter was 0.07% and the weighted peak (CCIR) flutter was ±0.1%. On a combined record/playback measurement, these readings increased to 0.1% and 0.15% respectively. In fast forward and rewind, a C-60 cassette was moved from end to end in the very fast times of 43 and 50 seconds, respectively. The transport slows the tape near the end of a fast wind to lessen the stress on the tape leader in stopping suddenly.

User Comment. The performance specifications of the Tandberg TCD-440A are listed in some detail in the product literature, and in every case where we were able to make a measurement, performance of the test sample met or surpassed its ratings.

In spite of—or perhaps because of—its unconventional control and operating features, the TCD-440A is easy to use. Our only criticism of its design concerns the cassette door, which does not swing open far enough for easy loading or unloading of a cassette. In installations where access to the right side of the recorder is limited, the process becomes quite clumsy, since the cassette must be moved beyond the right edge of the recorder to clear the door when loading and unloading.

A standard subjective test we apply to cassette decks is to record interstation hiss from an FM tuner and compare the playback to the incoming signal. With many good recorders, the two sound almost exactly alike—except for minor midrange colorations. But this degree of accuracy can only be realized when the recording level is kept below −20 dB (−10 dB on a few of the better machines).

With very careful matching of the signal levels being compared, we heard no difference between the tuner hiss and the playback of the TCD-440A's recording, even at a 0-dB level! This is remarkable performance for a cassette recorder, especially since identical results were obtained with each of the basic tape formulations used.

The other aspect of the DYNEQ system—reduced intermodulation distortion and bias oscillator beats—is more difficult to verify because there is no way to compare the performance of the machine with DYNEQ to that of the same machine without DYNEQ. Fortunately, Tandberg has made a demonstration cassette in its laboratories, using a TCD-440A modified so that DYNEQ can be switched in or out, that leaves no doubt of the effectiveness of the system. It contains various test signals, recorded with the DYNEQ being switched on and off at a slow rate.

How much of this improvement will be apparent in recordings made on a TCD-440A depends largely on the program material. We are convinced that it is *capable* of making cleaner recordings of program material rich in high-frequency energy than most other cassette recorders. Even if that capability is not always in demand—or realized in practice—this recorder removes much of the worry from making recordings when the dynamic range is not known in advance. If the meter readings do not exceed 0 dB except for brief peaks, first rate recording is hard to avoid. Our experience suggests that metal tape is rarely necessary with this machine. A good Type II tape seems to extract virtually all the performance of which the machine is capable—and that is more than most people will ever need.—*Julian Hirsch.*

CIRCLE NO. 101 ON FREE INFORMATION CARD

Popular Electronics Tests

General Electric's 19" Table-Top Color TV

GENERAL ELECTRIC has a few interesting design modifications in its upcoming 1980-1981 TV receivers. In truth, though, there are no design "breakthroughs" that significantly affect viewing and listening qualities. Changes that are made essentially enhance operating convenience, and, perhaps, reliability.

Accordingly, we felt free to examine a 19" table-top color model in the company's 1979-1980 line to give readers insight into what GE TV sets are like this year and next year in design and performance. (Besides, 1980-1981 receivers were not yet off the production line, let alone on dealers' shelves.) We'll note upcoming minor changes that will occur in '80-'81 models as we go along.

The model examined here is 19EC0770W, which features VIR II color control, dual-mode remote control, room-light sensor, frequency-synthesized tuning that eliminates the need for a fine-tuning control, power consumption reduced by about 30% compared to GE's earlier chassis, black matrix in-line picture tube, and digital LED channel readout. Combine the foregoing with an attractive 27"W × 18"H × 18⅞"D cabinet that's walnut finished on high-impact plastic, modular chassis for easy servicing, and a "tilt out" control bin, and you'll better understand why General Electric is an important factor in the TV marketplace.

Remote Control. This receiver, which uses a series EC-A chassis, comes with a dual-mode, 82-channel remote control that is especially noteworthy, as pictured in Fig. 1. It is versatile (smooth up/down volume, up/down audio mute, keyboard channel selection or channel scan) and quiet (uses infrared beam). GE's upcoming E-line chassis, which is substantially the same as this one, has an even more advanced remote system. For one, it adds nine channels—all for midband cable TV—and its remote receiver section's memory can accommodate all 91 channels for scanning purposes, while the 1979-1980 model tested here handles up to 20 channels in memory. Otherwise, they're the same. Let's take a detailed look at how this sophisticated system works.

A block diagram of the remote transmitter, which is designated MP-82 for the receiver tested and MP-91 in 1980-1981 models, is shown in Fig. 2. They're powered by a nine-volt battery and emit a pulse-modulated beam of infrared.

Tuning commands are loaded in parallel form into 8-bit shift register *IC30* by a 10-element keyboard and a diode matrix. These commands are either direct-address or scan. Depressing one or two digit keys (corresponding to the desired channel number) and then depressing the ENTER key loads a direct-address command into the register. Depressing either the CHANNEL UP or CHANNEL DOWN buttons constitutes a scan command and causes the appropriate 8-bit word to be loaded into shift register *IC30*.

An oscillator whose operating frequency is determined by a 566-kHz ceramic resonator generates a master clock signal for the transmitter that is processed by multistage counter *IC10*. First, the counter divides the input signal by 2048 to generate a 276.37-Hz pulse train. This signal is used to clock the 8-bit word serially out of the shift register. Counter *IC10* also generates pulses having frequencies of 141.5 kHz (÷4), 70.75 kHz (÷8), and 35.38 kHz (÷16). These signals are combined by an AND gate with the eight-bit data stream to form a composite pulse train with a nominal frequency of 35.3 kHz and a duty cycle of 12.5%. The pulse train modulates an array of three infrared LEDs that radiate a diffused beam of invisible light. It is this beam that's sensed and processed by the re-

(Continued on page 40)

Fig. 1. The remote-control system (the Transmitter is shown here in the inset) is versatile and quiet. It operates on an infrared beam and controls 82 channels.

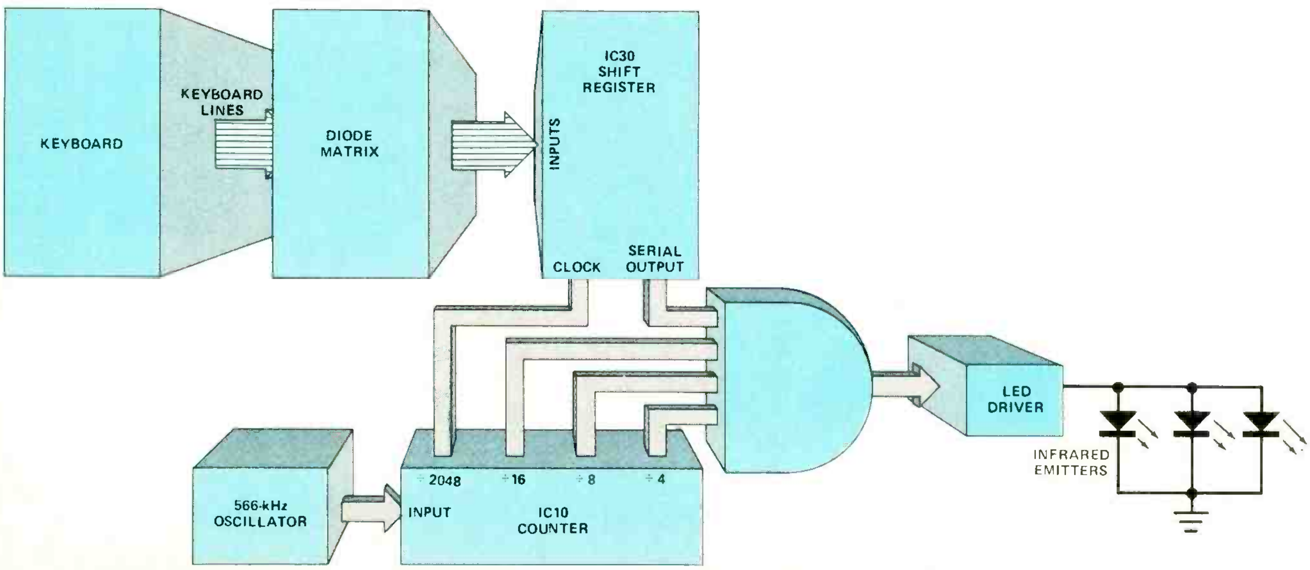


Fig. 2. Block diagram of the MP-82 remote transmitter. The MP-91 for 1980-81 models will be the same. The outputs of the shift register and counter are combined in the AND gate to form a composite pulse train.

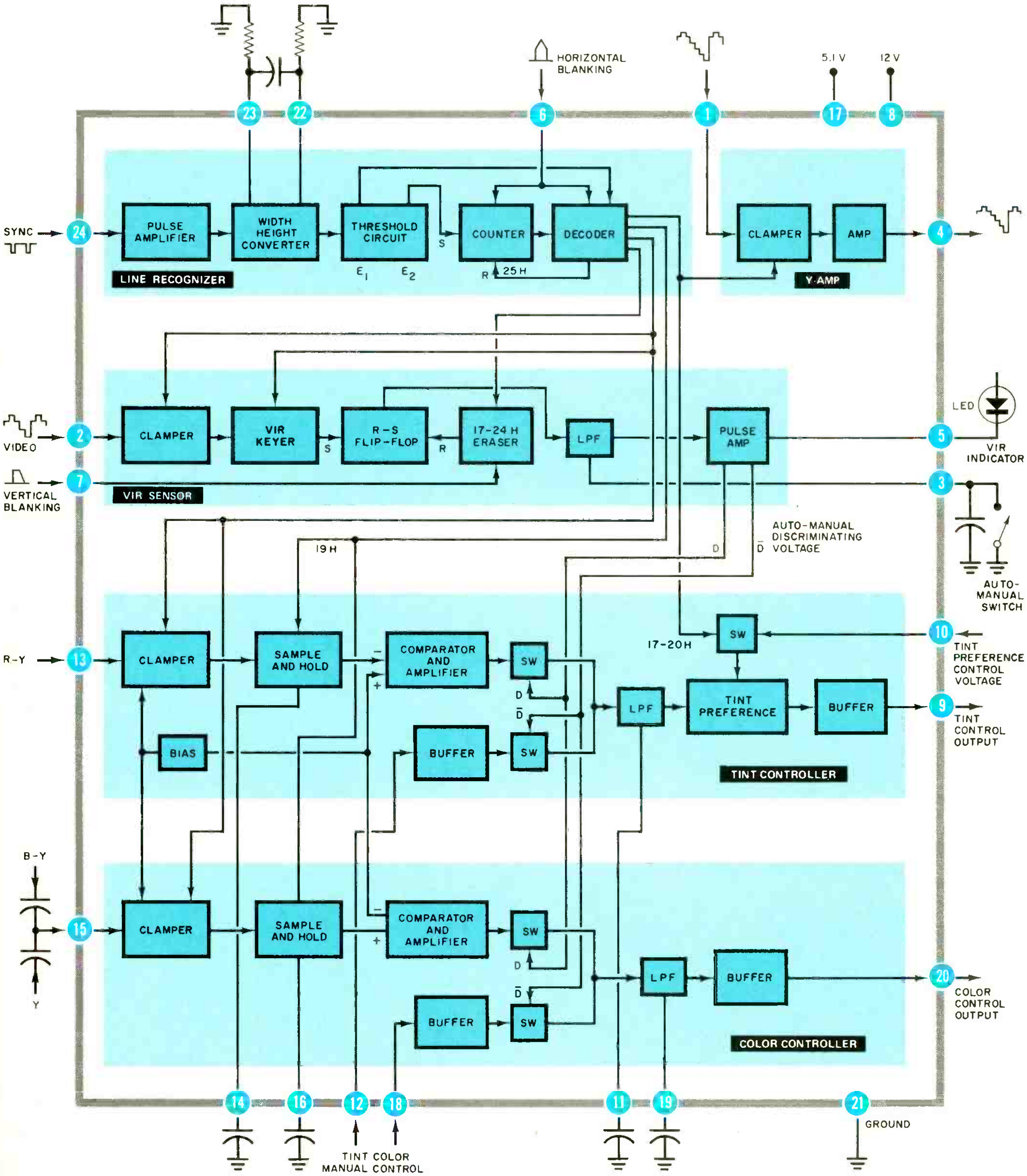


Fig. 3. Block diagram of the AN5330 IC used in the VIR II decoder. Control signals are derived from information tramsmitted on video line 19 (see Fig. 4).

mote-control receiver into commands for the tuner and several other stages in the TV receivers.

Infrared radiation from the remote transmitter passes through an optical filter (which screens out visible light) and excites a PIN diode. This component recovers the 35.3-kHz pulse train and passes it through a tuned circuit to the first of several amplification stages.

A Schmitt trigger samples the output of the last amplifier stage and changes state when it senses reception of a pulse-modulated infrared carrier. When this happens, detected pulses are routed to the TUNER CONTROL module. This module also accepts commands from the channel-select keyboard mounted on the television receiver. The module then passes commands to the tuner, phase-locked-loop synthesizer, master power on/off relay, audio control circuit and LED channel readout interface.

A microprocessor is at the heart of the

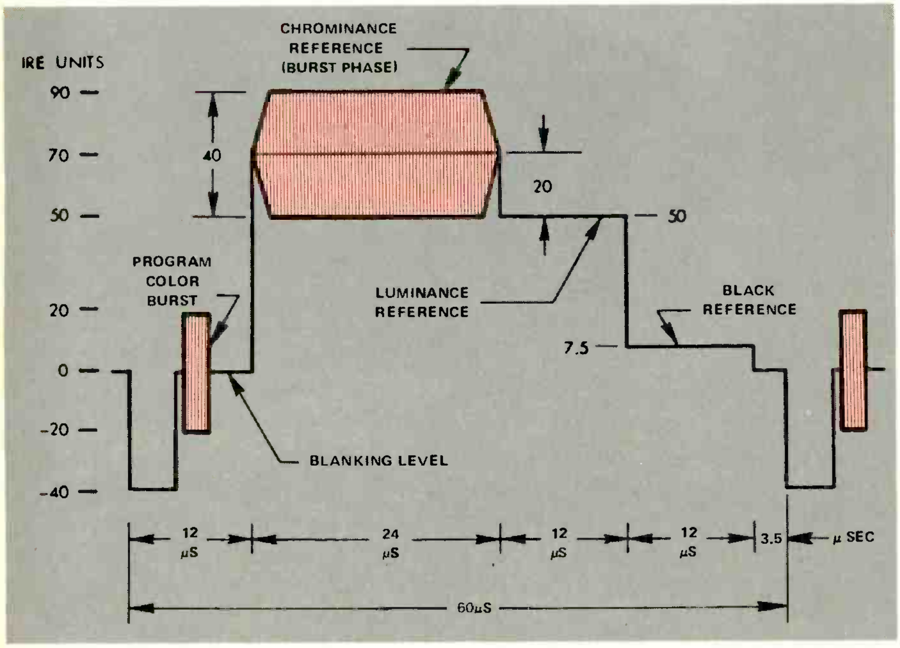


Fig. 4. Video line 19 is part of the 1.4-ms vertical blanking interval. It contains, among other things chrominance, luminance and black-reference information.

TUNER CONTROL module. The processor chip contains 2048 8-bit bytes of ROM, 128 4-bit nibbles of RAM, and various registers, output latches and buffers. Latching pulses permit retention of channel numbers for subsequent processing and delivery to the READOUT INTERFACE. The interface drives a pair of large seven-segment LED readouts that display the selected channel number.

Phase-Locked Loop. Working in tandem with and under control of the microprocessor-based TUNER CONTROL module is the PLL module. This is one of the key elements in GE's frequency-synthesized tuning system, eliminating the need for a fine-tuning control.

The bulk of this module's functions are performed by two ICs—a PRESCALER chip and a PLL TUNER CONTROL IC. Stages in the PRESCALER IC include vhf/uhf tuner control logic, several amplifiers, and a ÷256 counter. The PLL TUNER CONTROL chip in the 1979-1980 PLL module contains a 4-MHz oscillator (whose frequency is controlled by an external quartz crystal), a ÷2048 counter, a 15-bit latch and shift register, a programmable divider, a phase comparator, and various control logic. Similar stages are used in the 1980-1981 module's chip, though the counter has a modulus of 1024. This counter generates a low-frequency (either 3906-Hz or 1953-Hz, depending on the modulus of the counter) reference signal for the phase-locked loop's phase comparator.

When the viewer makes a channel selection, a string of 16 bits is presented to the serial DATA input of the PLL TUNER CONTROL chip by the TUNER CONTROL module. Of these 16 bits, 13 are applied to the modulus-select inputs of the chip's internal programmable divider. Another bit is used as a vhf high-band/low-band switching command, another as a vhf/uhf select signal, and the remaining bit is a start bit. The modulus of the programmable divider assumes the value appropriate for the channel selected, and the divider scales down the frequency of the tuner's voltage-controlled oscillator (which has been preconditioned by the PRESCALER chip). The frequency-divided vco output signal is applied to one input of the phase comparator, and the frequency-divided reference oscillator output is applied to the comparator's second input.

If the two signals applied to inputs of the phase comparator are not exactly equal in phase and frequency, a series of

". . . combines good color picture performance with a host of convenience extras."

pulses appears at the output of the phase comparator. A discrete low-pass active filter smooths these pulses into a dc level. Another discrete active filter removes any residual ripple at the clock frequency (1953 or 3906 Hz). The resulting dc error voltage is supplied to the tuner's voltage-controlled local oscillator. This closed-loop system obviates the need for an afc circuit and a fine-tuning control.

VIR decoding capability, pioneered by GE in 1977, is a significant feature of General Electric's large-screen color receivers. Not every television station transmits a VIR-encoded signal, of course. However, when stations do, the same tint and chroma levels are automatically reproduced by the receiver CRT in a viewer's home. (This system also has the potential for automatic controls of overall brightness and video levels.) A second-generation VIR system, known as VIR II, employs a decoder produced in IC form by the Matsushita Electric Company. It is this decoding circuit that is employed in the GE receiver we tested.

A block diagram of this IC decoder appears in Fig. 3. The decoder derives its control signals from information transmitted on video line 19, which is part of the 1.4-ms vertical blanking interval. As can be seen in Fig. 4, this line contains chrominance, luminance, and black-reference information, as well as a burst of 3.579545-MHz color subcarrier and an 11.1-μs horizontal line-blanking interval with a 4.76-μs horizontal sync pulse.

The VIR II decoder functions in the following manner. The LINE RECOGNIZER section accepts the composite sync presented to the IC and the horizontal-blanking pulses applied to pin 6. The VIR SENSOR section accepts the composite video signal at pin 2 and the vertical-blanking pulses appearing at pin 7. Blue-minus-luminance (*B-Y*) and luminance (*Y*) signals are summed by two capacitors and are applied to the COLOR CONTROLLER section via pin 15, while the red-minus-luminance (*R-Y*) signal is applied to the TINT CONTROLLER section via pin 13.

Composite sync pulses applied to the LINE RECOGNIZER section are amplified and processed by a width-to-height (duration-to-amplitude) converter. When the output of this converter exceeds a predetermined level, an enabling command (actually, a vertical sync pulse generated by the threshold circuit) is applied to one of the control inputs of the counter. The counter tallies the number of horizontal-blanking pulses applied to it. When it has reached a count corresponding to video line 19, the counter is reset by the decoder. The decoder is driven by the output of the counter, the horizontal-blanking pulses, and a second output of the threshold circuit, a pulse of 20-μs duration that appears at the end of each horizontal-blanking pulse. Four decoder output lines keep track of the progression through the vertical-blanking interval: the line-19 output; the lines-17-through-20 output; the lines-17-through-24 output; and a line-25 reset output. The logic levels appearing on these output lines govern operation of key elements in the rest of the VIR II decoder chip.

The VIR SENSOR section receives external video and vertical-blanking inputs as well as two outputs developed by the

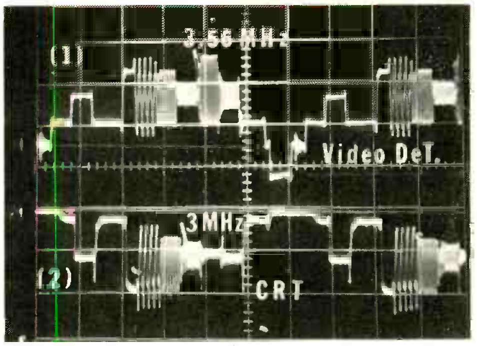


Fig. 5. Waveform photo of video detector and CRT responses from 75 to 4.08 MHz multiburst.

on-chip decoder just described. Composite video is clamped to the black level and is applied to the signal input of the VIR KEYER. When the luminance-reference component of line 19 exceeds a certain level, the VIR KEYER sets the RS flip-flop. This causes the VIR INDICATOR LED to glow, alerting the viewer that a VIR-encoded signal is being received (it's also defeatable by the viewer). The vertical-blanking pulse at pin 7 causes the 17-24 H eraser circuit to reset the flip-flop before line 17 and after line 24.

The combined *B-Y* and *Y* signal is applied to the COLOR CONTROLLER's input section and is level-shifted by a biased clamper. The clamper's output is sampled during the interval that the line-19 output of the LINE RECOGNIZER decoder is activated. A sample-and-hold circuit stores the instantaneous signal level and presents it to a biased comparator/amplifier stage. Any voltage difference between the bias and signal levels is amplified and passed by a transmission gate to a low-pass filter, which generates a color-control voltage. This voltage is buffered and routed to pin 20 of the IC. It is then used to control the amplitude of the *B-Y* signal so that the chroma level (color) reproduced by the receiver CRT matches that in the broadcast studio.

Operation of the TINT CONTROLLER section is similar to that of the COLOR CONTROLLER. A biased clamper level-shifts the *R-Y* signal applied to pin 13, and a sample-and-hold circuit evaluates and stores the clamped signal level. The signal is then compared to a fixed bias level and any difference is amplified and routed through a transmission gate to a low-pass filter. The filter's output is gated with a manually determined TINT PREFERENCE CONTROL VOLTAGE. A buffer passes the selected gate input signal to pin 9, where it is designated the TINT CONTROL OUTPUT. When the chrominance and black-reference levels are equal in amplitude at the receiver's *R-Y* output, the chroma phase (tint) conforms to that of the transmitted reference signal. Any amplitude discrepancy results in generation of a voltage that's applied to the control input of the receiver's 3.579545-MHz oscillator. This causes tint correction.

Color Monitor. When VIR-encoded signals are *not* being received, General Electric's "Color Monitor" circuit controls color and tint of the reproduced image. Like other automatic color-control circuits, the Color Monitor shifts yellows, oranges, reds and magentas to an "ideal" flesh-tone area about 50° into the second quadrant of a vector diagram with 0° or 360° burst. Also, it enlarges the angle of demodulation from the normal quadrature to approximately 105°. However, in contrast to a number of other designs, General Electric's Color Monitor circuit is dynamic, not static, in its operation. So let's examine this module's circuit.

The COLOR MONITOR module accepts inputs from the brightness limiter, the three chroma-demodulator output lines (*R-Y*, *B-Y*, and *G-Y*), and an automatic/manual selector switch. During the horizontal-blanking interval, the ZERO CHROMA REFERENCE BIAS stage samples the *B-Y* output of the chroma demodulator and generates a dc voltage corresponding to a zero-color level. The CHROMA AVERAGING BRIGHTNESS TRACKING stage then samples *R-Y* and *B-Y* outputs of the chroma demodulator and compares them with the output of the ZERO CHROMA REFERENCE BIAS stage. The CHROMA AVERAGING BRIGHTNESS TRACKING stage also generates a control voltage that is applied to the CHROMA GAIN CONTROL stage.

Tint correction is achieved in the following manner: The R-Y BOOST and two MATRIX stages sample the three outputs of the CHROMA DEMODULATOR stage. These stages then generate control signals for the current sinks. The sinks limit amplitudes of the *R-Y*, *B-Y*, and *G-Y* chroma-demodulator outputs. An *R-Y* red boost compensates the *R-Y* and *G-Y* outputs to prevent any tendency toward color desaturation, especially in the yellows. And a current sink on the *B-Y* line subtracts any excess magenta component from the flesh tone that is produced by the receiver CRT.

Comments. There are a number of features incorporated into this GE color receiver that are noteworthy, but that have not been detailed thus far. Among them are a very-fast-warmup picture tube, high-voltage shutdown, electronic vertical/horizontal centering, and stiffly regulated power supplies. Of the highlights that we did examine carefully, VIR II and the infrared-remote and manual PLL-synthesized tuning system are true standouts.

Our experience with the receiver's remote control was that it is a delight to use. It offered the fastest up/down sequential scan that we have ever seen! Happily, picture and sound were exactly synchronized and always appeared at their preselected levels as quickly as we could enter the tuning commands by pressing the appropriate pushbutton.

Although the audio output is actually delivered at one of 63 discrete levels, the flow of audio up or down was very smooth to the ear. When volume was set at a certain level, the receiver turned off, and then turned on again, the volume returned to the preselected level. If line power failed and then returned, the audio output was at a median level the next time the receiver was turned on.

The fast-acting VIR II (or the Color Monitor, which backs up VIR II when VIR-encoded signal is being received) performed its task of automatically adjusting color and luminance extremely well. This made using the remote control even more convenient and enjoyable. Finally, we were pleased to note that commands to wireless garage-door openers, the jingling of keys, and stray signals from other sources did not disturb the

MODEL 19EC0770W RECEIVER LABORATORY DATA

Parameter	Measurement
Tuner/receiver sensitivity (before onset of snow):	vhf: −60 dBm uhf: −54 dBm
Voltage regulation (line varied from 105 to 130 V, r-f signal applied to input):	Low voltage: 120V supply (99%) 15V supply (99%) High voltage: 27 kV (98%)
Luminance bandpass at CRT:	3 MHz
S/N at CRT:	40 dB
Chassis power requirements (signal applied):	100 W
Horizontal overscan:	18%
Direct coupling (or dc restoration):	Approximately 90%
Convergence:	Greater than 95%
Audio bandpass (−3-dB points):	120 Hz to 8.8 kHz

infrared remote-control link in the least.

Rumor has it that General Electric might offer an optional add-on luminance/chroma comb filter later this year. This would result in a considerable increase in the video passband present at the control electrodes of the receiver's CRT, thereby improving resolution further. As can be seen in the oscilloscope photo of Fig. 5, the video passband at the output of the video detector (upper trace) exceeds that at the CRT (lower trace) by almost a full megahertz. Because this and other similar General Electric receivers have no color-killer circuit, the large 3.56-MHz component at the fourth multiburst in the upper trace would produce even better resolution were it permitted to proceed (after some reduction in amplitude) directly to the CRT without an inordinate amount of trapping.

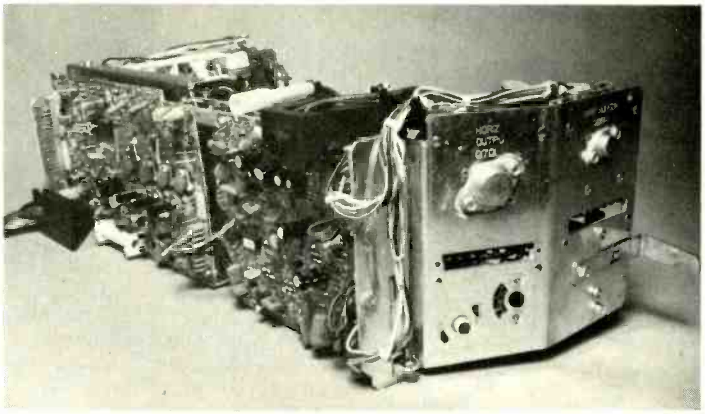


Fig. 6. Modular boards are mounted on both sides of an aluminum chassis. Boards are easily removed for service.

From a practical view, the method of chassis construction employed in this receiver might present some servicing problems. Modular boards are mounted on both sides of an aluminum chassis that offers no quick access to board bottoms. (See Fig. 6.) Boards are easily removable, though.

In all, the present GE TV receivers combine good color picture performance with a host of convenience extras. One rarely has to fiddle with the tint and color controls, for example, since it's all done automatically. The quartz-controlled channel tuning is precise, so there is no fine tuning required. And excellent chairside control is naturally a delightful feature for viewers who often switch from channel to channel. Also, the automatic room-light sensor maintains the right color intensity, contrast and brightness the user prefers in different ambient lighting conditions. Its level is manually adjustable, too.

If you're connected to cable TV, the not-yet-available 1980-1981 version would be desirable; if not, the present model beats inflationary increases. Should your interest lie in a larger screen size, General Electric's 1980-1981 25-inch-screen series EM chassis will replace its present YM chassis. The EM chassis uses the cooler-running construction employed in the 19" set just reviewed. Moreover, it will use a ferroresonant transformer to provide isolation and a degree of ac voltage regulation, as well as solid-state dc regulators. The company's top-of-line 1980-1981 25" console will include an audio amplifier rated at 10 watts at 0.5% THD for better sound quality.

Of interest, too, is that GE, through stressing burn-in tests for large-quantity production-line samples, says that repair rates on its TV products are down 54 percent in just three years. Also, the company claims it now holds the number 3 U.S. market position, with some 10,000 employees in its TV divisions in Virginia and overseas. —*Stan Prentiss.*

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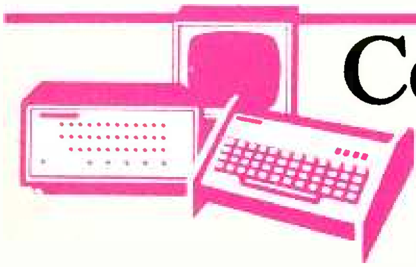


Computer Bits

By Carl Warren

New Equipment and Handy Hints

THIS past May, the latest model of Apple computer was introduced to the world. The new model, dubbed the Apple III, is designed for the small business field and, unlike the ubiquitious Apple II which had a base price tag of $1195, comes for a much healthier $4400. But look what you get besides expected graphics functions:

☐ An enhanced 6502 microprocessor that permits addressing up to 128K bytes of memory.

☐ 96K bytes of RAM, a built-in 5.25-in. floppy disk, a typewriter keyboard with 13-key numeric keypad, a 12-in black-and-white Sanyo monitor, and two built-in printer interfaces.

☐ What the company terms the Sophisticated Operating System (SOS). Features of this system include an integrated file system, and a device and event management system. Application software consists of Personal Software's Visicalc III, and a Mail list Manager. A Business BASIC is also included.

Apple III includes CPU, disk drive, keyboard, and video monitor.

A Sanyo color monitor, a letter-quality printer, and additional disk drives are also available as options. Customer deliveries of the system began this past June.

Apple isn't the only one making new system introductions. Motorola, has introduced its Exorset 30, a 6809 based machine. It carries a $5995 price tag and offers some very impressive features. Among these are: two built-in 5.25-in. floppy disks, a CRT display that can handle both alphanumeric and graphics, programmable timer for a real-time clock, and 48K bytes of RAM.

The built-in CRT on the Exorset 30 is of the 9-in. type and permits a 80 × 22 character presentation; for graphics a 256 × 320 dot pattern. You can also add a printer, and a very powerful BASIC is included. It would appear from all indications that this machine could very definitely become one of the major business machines—of course, this assumes full application software support is available.

Boards That Make Things Work. If you have a daisy-wheel printer that does just about everything you need but not all, then you might want the Daisy Brain®, from Wilker, Inc. This board is for the Diablo HyType or Qume daisy-wheel-type printers. The unit comes with 3K ROM, a 2K byte RAM buffer and a Z-80 microprocessor. What it does is give your printer the ability to handle right-margin justification, centering, columns, true proportional spacing, super- and subscripting, bold face, shadow printing, and underlining. The Daisy Brain, also permits both vector plotting and simple user control plotting. The board is priced at $1100.

Those of you that have the Radio Shack TRS-80 Model I and a yen to make use of the several hundred option boards designed for the S-100 bus will possibly be interested in the 8100 Bus adapter motherboard. Manufactured by California Computer Systems, the 8100 has six S-100 card slots, and a 2-MHz programmable baud rate clock. You will have to contact the company directly about prices since there are a variety of options available.

If you're planning a project where 6-bit A/D conversion at a fast rate is required (in the realm of 33 ns), then TRW LSI has the answer with its latest evaluation board. Called the TDC1014PCB, this board is priced at only $168 and contains the firm's TDC1014J A/D converter chip. The unit has 63 parallel differential comparators that look at the analog input simultaneously, then compare it with a reference voltage. The comparator outputs are translated into a binary code by means of a 63:6 encoder. This evaluation board requires a power supply capable of delivering +5 and ±15 V.

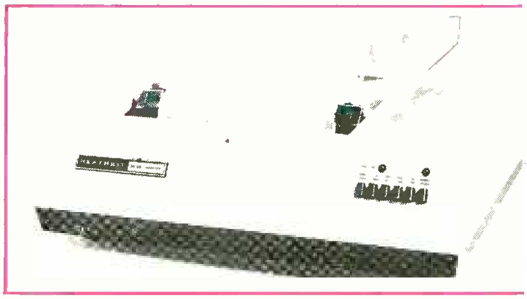
With the current interest in 16-bit microprocessors, it's not surprising to find an S-100 compatible board from Godbout Electronics. But this is not just a board with a single processor; instead, it contains both the Intel 8085 8-bit processor and the Intel 8088 byte-oriented 16-bit processor for only $295.

What Godbout has done, by implementing the dual processor design, is to give software designers the ability to develop software using the 8-bit 8085, and existing software such as CP/M, and Microsoft's 8080/8086 macro cross-assembler.

Both of the processors run at 5 MHz, and a software switch permits dynamic switching of the processors. This board is not for the beginner, and to use it correctly requires a great deal of understanding of both 8-bit and 16-bit processor operation.

Completing Your System. If you have been bitten by the computer bug, you probably are always in need of that one new item that will just complete your system. The following may fall into your price range and needs.

The H-14 dot-matrix printer from Heath is priced at $635 kit, or $895

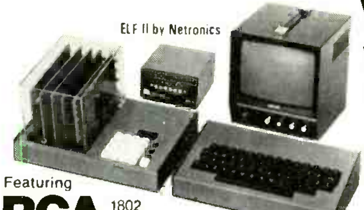


Heathkit H-14 dot-matrix printer has variable baud rate to 4800 bps.

factory built and tested. This unit took me over 30 hours to build and can't be considered a beginner's project. According to Heath, this printer was designed to be a low-cost alternative to higher-priced units.

C. Itoh Electronics, a Japanese trading company, has two entries in the printer family. The first is the Comet 80-column dot matrix printer, priced at $995, which puts it on a par with most of the units currently being offered. It has a print speed of 125 CPS, bidirectional printing (a not so common feature). The Comet can handle baud rates from 110-9600.

The second unit, called the Starwriter 25 CPS Daisy-wheel printer, is priced at $2195 (about $500 less than comparable systems). It can print 136 columns with a pica pitch or 163 with elite. Both printers are manufactured



Write and run programs—the very first night—even if you've never used a computer before!

You're up and running with video graphics for just $99.95 — then use low cost add-ons to create your own personal system that rivals home computers sold for 5-times ELF II's low price!

Featuring **RCA** 1802 COSMAC CPU

Own a powerful home computer system, starting for just $99.95—a price that gets you up and running the very first night...with your own TV for a video display. $99.95 ELF II includes RCA 1802 8 bit microprocessor addressable to 64k bytes with DMA, interrupt, 16 registers, ALU, 256 byte RAM, full hex keyboard, two digit hex output display, stable crystal clock for timing purposes, RCA 1861 video IC to display your programs on any video monitor or TV screen *and 5-slot plug-in expansion bus (less connectors) to expand ELF II into a giant!*

ELF II Explodes Into A Giant!

Master ELF II's $99.95 capabilities, then expand with GIANT BOARD ... KLUGE BOARD ... 4k RAM BOARDS ... TINY BASIC ... ASCII KEYBOARD ... LIGHT PEN ... ELF-BUG MONITOR ... COLOR GRAPHICS & MUSIC SYSTEM ... TEXT EDITOR ... ASSEMBLER ... DISASSEMBLER ... VIDEO DISPLAY BOARD ... *and*, another great reason for getting your ELF now—

BREAKTHROUGH!

Netronics proudly announced the release of the first 1802 FULL BASIC, written by L. Sandlin, with a hardware floating point RPN math package (requires 8k RAM plus ASCII and video display boards), $79.95 plus $2 p&h. Also available for RCA VIP and other 1802 systems. Board includes area for a ROM version.

Master This Computer In A Flash!

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

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

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

Get Started For Just $99.95, Complete!

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

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

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

ELF II Gives You The Power To Make Things Happen!

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

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

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

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

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

ELF II Tiny BASIC

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

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

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

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

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

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

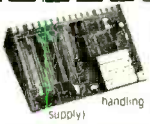
Now Available!

☐ **A-D/D-A Board Kit** includes 1 channel (expandable to 4) D-A, A-D converters, **$39.95** plus $2 postage & handling.

☐ **PILOT Language**—A *new* **text-oriented** language that allows you to write educational programs on ELF II with speed and ease! Write programs for games...unscrambling sentences...spelling drills..."fill in the missing word" tests, etc.! PILOT is a must for any ELF II owner with children. *PILOT Language on cassette tape, only $19.95 postpaid!*

☐ **Game Package** on cassette tape (requires 4k RAM), **$9.95** plus $2 postage & handling.

Clip Here and Attach to Your Order Below!



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☐ RCA COSMAC ELF II kit at $99.95 plus $3 postage and handling (requires 6.3 to 8 volt AC power supply)

☐ Power Supply (required) $4.95 postpaid

☐ RCA 1802 User's Manual $5 postpaid

☐ Tom Pittman's **Short Course On Microprocessor & Computer Programming** teaches you just about everything there is to know about ELF II or any RCA 1802 computer. Written in non-technical language, it's a learning breakthrough for engineers and laymen alike. $5 postpaid

☐ **Deluxe Metal Cabinet** with plexiglas dust cover for ELF II, $29.95 plus $2.50 p&h

☐ I am also enclosing payment (including postage & handling) for the items checked below!

☐ **I want my ELF II wired and tested with power supply, RCA 1802 User's Manual and Short Course—all for just $149.95 plus $3 p&h.**

Total Enclosed $ ________
(Conn. res. add tax)

CHARGE IT! Exp. Date ______
☐ Visa ☐ Master Charge (Bank # ________)

Account # ____________

ALSO AVAILABLE FOR ELF II

☐ **GIANT BOARD™** kit with cassette I/O, RS 232-C/TTY I/O, 8-bit P I/O, decoders for 14 separate I/O instructions and a system monitor/editor **$39.95** plus $2 p&h

☐ **Kluge** (Prototype) **Board** accepts up to 36 IC's **$17.00** plus $1 p&h

☐ **4k Static RAM kit**. Addressable to any 4k page to 64k **$89.95** plus $3 p&h

☐ Gold plated **86-pin connectors** (one required for each plug in board) **$5.70** ea. postpaid

☐ **Expansion Power Supply** (required when adding 4k RAM) **$34.95** plus $2 p&h

☐ **Professional ASCII Keyboard** kit with 128 ASCII upper/lower case set, 96 printable characters, onboard regulator, parity, logic selection and choice of 4 handshaking signals to mate with almost any computer **$64.95** plus $2 p&h

☐ **Deluxe metal cabinet for ASCII Keyboard**, **$19.95** plus $2.50 p&h

☐ **Video Display Board** kit lets you generate a sharp professional 32 or 64 character by 16 line upper and lower case display on your tv screen or video monitor—dramatically improving your unexpanded $99.95 ELF II. (Fits inside ASCII Keyboard cabinet.) **$89.95** plus $2 p&h

☐ **ELF II Tiny BASIC** on cassette tape. Commands include SAVE, LOAD, ±, ×, ÷, (), 26 variables A-Z, LET, IF/THEN, INPUT, PRINT, GO TO, GO SUB, RETURN, END, REM, CLEAR, LIST, RUN, PLOT, PEEK, POKE. Comes fully documented and includes alphanumeric generator required to display alphanumeric characters directly on your tv screen without additional hardware. Also plays tick-tack-toe plus a drawing game that uses ELF II's hex keyboard as a joystick. 4k memory required. **$14.95** postpaid

☐ Tom Pittman's **Short Course on Tiny Basic** for ELF II **$5** postpaid

☐ **ELF-BUG™ Deluxe System Monitor** on cassette tape. Allows displaying the contents of all registers on your tv at any point in your program. Also displays 24 bytes of memory with full addresses, blinking cursor and auto scrolling. A must for the serious programmer! **$14.95** postpaid

☐ **Text Editor** on cassette tape gives you the ability to insert, delete or edit lines and words from your programs while they are displayed on your video monitor. (Add printer and you can use ELF II to type error-free letters plus insert names and addresses from your mailing list.) **$19.95** postpaid

☐ **Assembler** on cassette tape translates assembly language programs into hexidecimal machine code for ELF II use. Mnemonic abbreviations for instructions (rather than numerics) make programs easier to read and help prevent errors. **$19.95** postpaid

☐ **Disassembler** on cassette tape takes machine code programs and produces assembly language source listings to help you understand and improve your programs. **$19.95** on cassette tape

SAVE $9.90—Text Editor, Assembler & Disassembler purchased together, only **$49.95!** (Require Video Display Board plus 4k memory.)

☐ **ELF II Light Pen**, assembled & tested, **$7.95** plus $1 p&h

☐ **ELF II Color Graphics & Music System Board** kit **$49.95** plus $2 p&h

☐ ELF II connects directly to the video input of your tv set without additional hardware. To connect ELF II to your antenna terminals instead, order **RF Modulator**, **$8.95** postpaid

Coming Soon: A-D, D-A Converter, Controller Board and more!

Print Name ____________

Address ____________

City ____________

State ______ Zip ______

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By Netronics

ASCII/BAUDOT, STAND ALONE

Computer Terminal

COMPLETE FOR ONLY... $149.95

The Netronics ASCII/BAUDOT Computer Terminal Kit is a microprocessor-controlled, stand alone keyboard/terminal requiring no computer memory or software. It allows the use of either a 64 or 32 character by 16 line professional display format with selectable baud rate, RS232-C or 20 ma. output, full cursor control and 75 ohm composite video output.

The keyboard follows the standard typewriter configuration and generates the entire 128 character ASCII upper/lower case set with 96 printable characters. Features include onboard regulators, selectable parity, shift lock key, alpha lock jumper, a drive capability of one TTY load, and the ability to mate directly with almost any computer, including the new Explorer/85 and ELF products by Netronics.

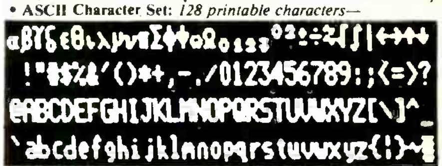
The Computer Terminal requires no I/O mapping and includes 1k of memory, character generator, 2 key rollover, processor controlled cursor control, parallel ASCII/BAUDOT to serial conversion and serial to video processing—fully crystal controlled for superb accuracy. PC boards are the highest quality glass epoxy for the ultimate in reliability and long life.

VIDEO DISPLAY SPECIFICATIONS

The heart of the Netronics Computer Terminal is the microprocessor-controlled Netronics Video Display Board (VID) which allows the terminal to utilize either a parallel ASCII or BAUDOT signal source. The VID converts the parallel data to serial data which is then formatted to either RS232-C or 20 ma. current loop output, which can be connected to the serial I/O on your computer or other interface, i.e., Modem.

When connected to a computer, the computer must echo the character received. This data is received by the VID which processes the information, converting to data to video suitable to be displayed on a TV set (using an RF modulator) or on a video monitor. The VID generates the cursor, horizontal and vertical sync pulses and performs the housekeeping relative to which character and where it is to be displayed on the screen.

Video Output: *1.5 P/P into 75 ohm (EIA RS-170)* • **Baud Rate:** *110 and 300 ASCII* • **Outputs:** *RS232-C or 20 ma. current loop* • **ASCII Character Set:** *128 printable characters—*



BAUDOT Character Set: *A B C D E F G H I J K L M N O P Q R S T U V W X Y Z - ? : • 3 $ # ( ) . , 9 0 1 4 ! 5 7 ; 2 / 6 8 •* **Cursor Modes:** *Home, Backspace, Horizontal Tab, Line Feed, Vertical Tab, Carriage Return. Two special cursor sequences are provided for absolute and relative X-Y cursor addressing* • **Cursor Control:** *Erase, End of Line, Erase of Screen, Form Feed, Delete* • **Monitor Operation:** *50 or 60Hz (jumper selectable.*

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Please send the items checked below—

☐ **Netronics Stand Alone ASCII Keyboard/Computer Terminal Kit, $149.95** plus $3.00 postage & handling.

☐ **Deluxe Steel Cabinet** for Netronics Keyboard/Terminal In Blue/Black Finish, **$19.95** plus $2.50 postage and handling.

☐ **Video Display Board Kit** alone (less keyboard), **$89.95** plus $3 postage & handling.

☐ **12" Video Monitor** (10 MHz bandwidth) fully assembled and tested, **$139.95** plus $5 postage and handling.

☐ **RF Modulator Kit** (to use your TV set for a monitor), **$8.95** postpaid.

☐ **5 amp Power Supply Kit In Deluxe Steel Cabinet** (±8VDC @ 5 amps, plus 6-8 VAC), **$39.95** plus $2 postage & handling.

Total Enclosed (Conn. res. add sales tax) $________
By—
☐ Personal Check ☐ Cashiers Check/Money Order
☐ **Visa** ☐ **Master Charge** (Bank # ______)

Acct. # ____________

Signature ____________ Exp. Date ______

Print Name ____________

Address ____________

City ____________

State ______ Zip ______

☐ **Send Me More Information**

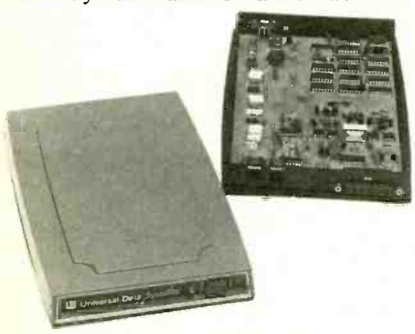
by Toyko Electric Co. (TEC) for C. Itoh following its specifications, and are available now.

The Starwriter Daisy-wheel printer provides 136 columns of pica type.

C. Itoh also has 5.25- and 8-in. double-sided double-density disk units. The maxi-flexi and mini-flexi line of disk drives are made by Toshiba and have a fairly good reputation as being reliable drives. The 8-in unit sells for $725, which is about $25 cheaper than a comparable Shugart drive. The 5.25-in drive is $450, about the same as a Shugart drive.

In the July "Computer Bits," I mentioned Lobo's winchester package. Well, they have taken it just one step further with a Model 1850 dual fixed/floppy disk memory system. This unit puts the IMI 8-in. winchester drive in the same box as a 1.6M byte floppy. For the configuration of a 10M byte fixed disk drive, double-density floppy, chassis, and power supply, the price is a respectable $4695. Although this may appear high, it's actually low by about $1400 compared to similiar systems. The unit, as designed, is for the TRS-80 and Apple computers.

Communications Items. I'm a big proponent of electronic mail, and the benefits it brings to the computer user. I also keep an eye out for those items such as modems, that are a definite must to the use of these systems. One such modem is from Universal Data Systems and is called the 202



Universal 202 LP is a 1200-baud asynchronous communications modem.

LP. The unit is a certified FCC model, which allows for direct connection to the dial-up telephone network with-

MORE INFORMATION

For additional information about products and services mentioned here, contact the companies directly.

Apple Computer, Inc.
10260 Bandley Dr.
Cupertino, CA 95014
408-996-1010

California Computer Systems
250 Caribbean Dr.
Sunnyvale, CA 94086
408-734-5811

Compuserve (MicroNet)
Personal Computing Div.
5000 Arlington Centre Blvd.
Columbus, OH 43220
800-848-8990

C. Itoh Electronics, Inc.
5301 Beethoven St.
Los Angeles, CA 90066
213-390-7778

CompuPro/Godbout Electronics
Bldg. 725, Oakland Airport
Oakland, CA 94614
415-562-0636

Heath Co.
Dept. 010-684
Benton Harbor, MI 49022

Lobo Drives Intl.
935 Camino Del Sur
Goleta, CA 93017
805-685-4546

Micro Peripheral Corp.
Box 529
Mercer Island, WA 98040
206-454-3303 (voice)
206-723-DATA (modem)
70210,205 on MicroNet

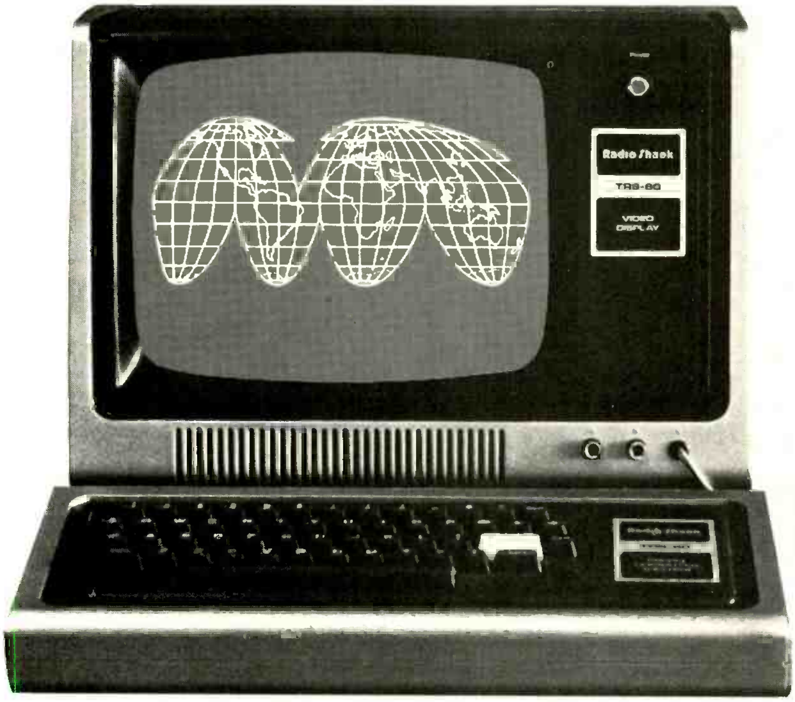
Motorola Semiconductor Products Inc.
Box 20912,
Phoenix, AZ 85036
602-962-2209

TRW LSI Products
2525 E. El Segundo Blvd.
El Segundo, CA 90245
213-535-1831

Universal Data Systems
5000 Bradford Dr.
Huntsville, AL 35805
205-837-8100

CONNECTION LISTING 1—BASIC PROGRAM

```
100 REM **CONNECT SAS**
110 REM DICK BARKER 3/21/80
120 REM EXAMPLE OF SETUP AND USE OF THE 'CONNECTION'
130 CLEAR 2000
140 DEFINT B,H-Z
150 TM$=STRING$(38," ")
160 '****** SETUP 8251 FOR 8 BIT WORD , NO PARITY , 1 STOP BIT
170 OUT 241,7              'SEND IT ANYTHING WITHOUT BIT 6
180 FORJ=1TO10:NEXT        'NEED SHORT DELAY
190 OUT 241,64             'SEND RESET
200 OUT 241,78             'MODE SETUP
210 OUT 241,7              'COMMAND INSTRUCTION
220 Q=INP(240)             'CLEAN OUT REC BUFFER
230 GOSUB 10000                        'SETUP USR ROUTINE IN TM$
240                      'FOR DISK SYSTEMS, REPLACE THE FOLLOWING
      LINE WITH DEFUSR=K
245 POKE 16526,PEEK (VARPTR(TM$)+1):POKE 16527,PEEK (VARPTR(TM$)+2)
250 REM SEND DATA TO CONNECTION AS USR ARGUMENT
260 REM GET DATA FROM CONNECTION BY USING ZERO FOR USR ARGUMENT
270 'OUT254,1          'CLOCK SPEEDUP IF INSTALLED


1000 REM **** TERMINAL EXAMPLE *****

1010 CLS:PRINT"  SIMPLE TERMINAL PROGRAM FOR THE CONNECTION":
     PRINT"USE SHIFTED CHARACTERS FOR CONTROL CHARACTERS":PRINT
1020 I$=INKEY$:I=0:T=96:R=0:O=0:LF=10:PRINTCHR$(14);
1030 REM FOR HALF DUPLEX CHANGE X=USR(I) TO ?CHR$(USR(I));
      ON LINE 1040 IN TWO PLACES.

                         PROGRAM LOOPS THROUGH NEXT LINE WHEN RUNNING:

1040 PRINTCHR$(USR(O));:I=O:I$=INKEY$:IFI$<>""THENI=ASC(I$):
IFI>TTHENI=I-T:X=USR(I):GOTO1040ELSEX=USR(I):GOTO1040:ELSE1040

9999 REM **** POKE USR ROUTINES TO TM$ ****
10000 X=VARPTR(TM$)+1:A=PEEK(X)+256*PEEK(X+1):
                IFA>32767THENK=A-65536 ELSE K=A
10001 FOR I=0 TO 37:READ J:POKEK+I,J:NEXT:RETURN
10002 DATA 205,127,10,125,183,40,10,219,241,203
10003 DATA 71,40,250,125,211,240,201,33,0,0
10004 DATA 219,241,203,79,40,5,219,240,230,127
10005 DATA 254,10,40,1,111,195,154,10
10006 END
```



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CompuServe

CompuServe is a major computer services company that has been serving top industrial and governmental clients for more than a decade. Now we're also applying our extensive computing capacity to the delivery of information services to your personal computer.

The Information Service

This exciting service is available in more than 250 cities between 6 p.m. and 5 a.m. weekdays, all day weekends and most holidays. Cost? Only $5.00 per hour billed in minutes. All you need is a 300 baud modem, and our complete information service is only a local phone call away.

Welcome to CompuServe's information service.

- *News. Weather. Sports.* Major regional newspapers. Plus international news services.
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- *Entertainment.* Theatre, book, movie and restaurant reviews. Plus opera, symphony, ballet, dance, museums, galleries...
- *Electronic Mail.* Create, edit, send and receive messages from any other CompuServe user ... nationwide.
- *Home & Educational Reference Service.* Anything you want to know... from encyclopedia information to household tips.
- *CompuServe User Information.* In case you need technical help ... and information on new services as they become available.
- *MicroNET.* For the computer hobbyist. Software Exchange, line printer art gallery, challenging games, programming languages, word processing, business & educational programs ... and much, much more.

And this is just the beginning. CompuServe is continually adding to its list of available services. The world of electronic information isn't coming tomorrow. It's here today.

CompuServe is Available at Radio Shack® Stores

Your local Radio Shack® Store Sells CompuServe's information service. There are more than 6,000 Radio Shack® Stores and Dealers nationwide. Check with the outlet nearest you.

Radio Shack is a division of Tandy Corporation.

CompuServe

Information Service Division
5000 Arlington Centre Blvd.
Columbus, Ohio 43220
(614) 457-8600

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out a Data Access Arrangement (DAA). It is only 1.25-in. thick, fits under the telephone, and requires only two snap-in connections. The 202 LP provides 1200-baud half-duplex asynchronous communication for $295.

Also supporting the use of microcomputers for communication and data acquisition is the Peripheral

Periperal's Connection is a direct-coupled modem for TRS-80.

people, located in Mercer Island, WA. This small company has developed a $249 modem, called the Connection®, that turns a 4K Level I TRS-80 into an intelligent remote terminal. This 300-baud model connects to the TRS-80 via the screen printer port and directly to the telephone lines via an FCC type-approved connector.

A very striking and important feature of the Connection is that it is provided with full software support to permit autodialing and data transfer. Also, the folks at Mercer Island have made available (for free) software that can be used to make the Connection, or for that matter any modem, work with general-purpose micros. An example of this software, is shown in Listings 1 and 2.

Listing 1 is a BASIC program for use on a TRS-80, with the Connection. This is ready to run—just type it in and go! Should you have a need to modify it, specifically the user routines in lines 10000-10006, Listing 2 is a complete Z-80 source listing of those data items.

As an added benefit and helpful tool (incidently you can use this whether or not you engage in telecommunications) is Listing 3. This FIXIT program allows you to add or delete line numbers from a text file. You will find this function important for editing purposes since you can then reference a specific line number for changes. Then, after the text is updated, remove the numbers before submitting the source to an assembler or a text formatter. All of these programs can be obtained on-line with MicroNet by typing in: DIR [70210,205] FIXIT.BAS. The program as shown in Listing 3 will be displayed on your terminal.

Along with the software and modem offering, the Peripheral People have made available, through MicroNet, an on-line HAM system. To use this system, enter: IRUN [70210,205] HAMGAB.SHR. You will now be able to operate in much the same manner as you would on 20-meter RTTY.

If you have been considering subscribing to MicroNet, but think it might be too difficult to use, you will be glad to know that the service has been simplified. Now users are greeted with a selection menu which allows for a choice of functions, such as news, weather, sports, financial, and MicroNet.

The menu system allows you to quickly obtain up-to-date information on the various categories. The MicroNet service will, however, function pretty much the same; but some exciting enhancements are planned for it also, and should be in place by the end of this year.

If you are using the MicroNet service now and have been wondering how to get the most out of it, say for word processing, here is a suggestion that may work. First, assume that you have developed a text or data file off-line and, for whatever reason, now want to transfer it to a file in your MicroNet working area. Using a communication package such as MCS from Heath users group, you will call and sign into MicroNet. Be sure to set the correct lower-case option (in my case for an H-89 I, type TER LCT off, which permits entering of upper and lower case characters). Next, set up a file using the File command of: FIL (file name. ext); then return to

CONNECTION LISTING 2—Z-80 SOURCES

```
SCONUSR ; CONBAS/ASM
 ; DICK BARKER 3/21/80 COPYRIGHT 1980 MICRO PERIPHERAL
;DICK BARKER 3/21/80
;300 BAUD, 8 BIT WORD, NO PARITY, 1 STOP BIT
;********************************
; THIS IS WRITTEN AS A RELOCATABLE ROUTINE
;WITH ONLY ONE ENTRY POINT AND MAY BE USED
;WITH DISK OR NON-DISK LEVEL II MACHINES
;*********
;TO SEND A CHARACTER PASS THE ASCII VALUE AS
;THE ARGUMENT FOR THE USR ROUTINE.
;*********
;TO GET A CHARACTER PASS A ZERO TO THE USR
;ROUTINE. IF NOTHING IN BUFFER A ZERO WILL
;BE RETURNED , ELSE THE 7 BIT ASCII VALUE
;WILL BE RETURNED.
;***********************************
DPORT       EQU     240         ;DATAPORT
SPORT       EQU     241         ;STATUS PORT
    ORG     8000H
;***********************************
;SEE IF USR WANTS TO SEND OR GET A CHARACTER
;***********************************
    CALL    0A7FH               ;GET USR ARGUMENT IN HL
    LD      A,L
    OR      A                   ;UPDATE STATUS
    JR      Z,GETCH             ;NO CHARACTER TO SEND SO
                                ;NEED TO GET ONE
;************************************
;SEND CHARACTER THAT IS IN L REG.
;************************************
BZY         IN      A,(SPORT)
    BIT     0,A                 ;CHECK TX BUFFER
    JR      Z,BZY               ;WAIT IF BUZY
    LD      A,L
    OUT     (DPORT),A           ;SENDIT
    RET
;************************************
;GETCHAR ROUTINE FOLLOWS
;************************************
GETCH       LD      HL,0   ;MAY NEED TO RETURN A NULL
    IN      A,(SPORT)
    BIT     1,A                 ;CHECK REC BUFFER
    JR      Z,FIN               ;NOTHING THERE
    IN      A,(DPORT)           ;GET CHAR
    AND     07FH                ;STRIP PARITY
    CP      10                  ;IS IT A LINEFEED?
    JR      Z,FIN               ;LF NOT WANTED
    LD      L,A                 ;VALUE TO RETURN
FIN          JP      0A9AH              ;BACK TO BASIC
ZEND         EQU     $
    END     402DH
```

Announcing . . .
The Phone Ranger

The cordless phone that works like a regular phone up to 300 feet from your house. Use it in your own back yard with our compliments. Keep it, if you wish, for ONLY $119.95!

I live on five acres. And I keep four horses in my back yard. Used to be, if I got a call while I was down at the corral, one of the kids would yell out the kitchen window and I'd do the hundred-yard dash to the nearest house phone.

No more. With The Phone Ranger I can groom Laird, my Palomino gelding, with one hand and call my broker with the other.

Take or make calls up to 300 feet away.

Maybe you don't keep horses. But if you've got a pool, patio, garden, workshop, tennis court or garage—and you'd like the phone to come to you instead of you going to it—this is the answer.

Try The Phone Ranger for 15 days. Send it back if you want. If you decide to keep it, the best news is the price!

Units that look like toys sell for up to $495.00!

There's a unit called "ROVAPRO" that looks like my son's toy walkie-talkie—not like a real phone at all—and it goes for a cool $495.00.

Then there's "MURAPHONE." It's $149.95. But it's even more like a toy walkie-talkie. You have to push a button to talk and release to listen—with all that "Roger, over to you" stuff in between. Not like a real phone at all.

The Phone Ranger looks like a real phone, rings like a real phone, dials out like a real phone . . . has a range of 300 feet . . . and it's only **$119.95** plus $5.95 shipping and handling. If you'd prefer a range of a full 750 feet, order the deluxe version for only $189.95 plus $5.95 shipping and handling.

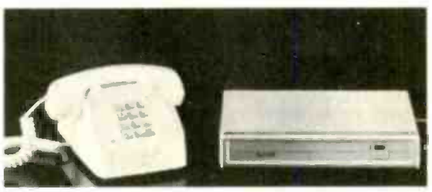
Doubles as an extra extension phone.

When you're not using it outside, use it as an extra extension phone without paying monthly charges to the phone company.

Works so simply.

Plug base unit into phone jack and into AC house current. Then plug The Phone Ranger into base unit to charge battery. Now unplug The Phone Ranger and you're ready to use it to take or make calls up to 300 feet away (750 feet if you choose the

deluxe version). Red indicator light tells you when it's time to recharge.



If you don't have a phone jack, the phone company will install one for a nominal one-time charge. If you have an old-fashioned, 4-prong jack, The Phone Ranger comes with an adaptor you can use. Even if you live in an area with rotary dialing, the pushbutton system on your Phone Ranger will work. And the entire unit is FCC approved.

Includes amazing "last number" memory!

No need to re-dial when you get a busy signal. Just press the # or the * button and The Phone Ranger automatically redials the last number you called!

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If you're using your credit card, use our toll-free number. If you prefer, send your check to Roy Thomas & Associates, Inc. at the address below. (Illinois residents add 6% sales tax.)

You must be completely satisfied with The Phone Ranger. If for any reason you're not, return it within 15 days for a full refund, no questions asked. Use the carton it comes in to return it.

I know you'll have fun with it. Order now.

Roy Thomas
& ASSOCIATES, INC.
733 Lee Street, Dept. 15-9500
Des Plaines, IL 60016

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CONNECTION LISTING 3—FIXIT PROGRAM

```
10 REM ** COPYRIGHT 1979 BY THE PERIPHERAL PEOPLE **
20 REM ** FIXIT **
30 CLS:CLEAR 1000:Z$=STRING$(31,"*"):PRINTCHR$(23)
40 PRINTZ$:PRINTTAB(4)"* * * F I X I T * * *":PRINTZ$:PRINT
50 PRINT"THIS PROGRAM WILL ADD LINE NUM-"
60 PRINT"BERS TO A TEXT FILE OR DELETE"
70 PRINT"THEM FROM AN ASCII SAVED FILE.":PRINT
80 LINEINPUT"FILENAME TO BE CONVERTED? ";X$:PRINT
90 INPUT"ADD (1) OR DELETE (2) NUMBERS";X:IFX<1 OR X>2 THEN 90
100 CLS
110 OPEN"I",1,X$
120 OPEN"O",2,"TEMPFILE"
130 IFX=2THEN200 ELSE 300
200 REM ** DELETE LINE NUMBERS FROM ASCII FILE **
210 IFEOF(1)THEN280
220 LINEINPUT#1,A$
230 IFLEFT$(A$,1)<>" " THEN A$=RIGHT$(A$,LEN(A$)-1):GOTO230
240 A$=RIGHT$(A$,LEN(A$)-1)
250 PRINTA$
260 PRINT#2,A$
270 GOTO210
280 GOTO400
300 REM ** ADD LINE NUMBERS TO TEXT FILE **
310 N=10
320 IFEOF(1) THEN 400
330 LINEINPUT#1,A$
340 A$=STR$(N)+" "+A$
350 A$=RIGHT$(A$,LEN(A$)-1)
360 PRINTA$
370 PRINT#2,A$
380 N=N+10
390 GOTO320
400 REM ** REWRITE ORIGINAL FILE **
410 CLOSE 1,2
420 OPEN"O",1,X$
430 OPEN"I",2,"TEMPFILE"
440 IFEOF(2) THEN 480
450 LINEINPUT#2,A$
460 PRINT#1,A$
470 GOTO440
480 CLOSE1,2
490 KILL"TEMPFILE"
500 PRINT"NOW, LOAD FILE ";X$;" AND EDIT IT IN THE NORMAL MANNER"
510 PRINT"WITH YOUR TRS-80 EDITOR.  WHEN DONE, BE SURE TO SAVE
     THE FILE IN ASCII (";X$;",A)".
```

your communication package (for MCS type a control B); then send the file to MicroNet.

You must be sure to return back to MicroNet control and issue an "EX" to save the file. Now the file is available for manipulation in the MicroNet system. As an example of this, this month's column was written and edited off-line, then transferred to MicroNet for formatting via its text processor RUNF10. The processed file, which now has a .DOC extension, was then downloaded to my system and played out on hardcopy. If your concern is over cost, this whole process cost me (and this includes the $2/hr tymnet charge) about $3.00. The key here was that most of the work was prepared off-line using the functions of my computer.

If you just want to have some fun with MicroNet, they have implemented a user talk system that is patterned after Citizens Band Radio. You can now monitor pseudo CB channels 1-40 and break in and have a chit-chat. The MicroNet people have also built in a scrambler so you and a friend can carry on private conversations via your computer.

Information and Fun Books. It's always a good idea to have information resources in your library, and two books that are important to have, are: Radio Shack's *The Engineer's Notebook*, and *Electronics Designer's Casebook No. 3*. The first is written by PE's own Forrest Mims and is a collection of circuits from amplifiers to LED oscilloscopes. This book is available from any Radio Shack store for only $1.99. *The Designer's Casebook*, is a collection of design projects from *Electronics* magazine from Feb. 16, 1978 to January 4, 1979. This book covers circuits from audio to signal sources and is available from McGraw-Hill for $5.

Just for fun, Radio Shack has made available, free, a comic book about how a TRS-80 helps Superman save Metropolis. Although the story is a little improbable, so is Superman. It's fun reading and for comic book fans makes an important addition to that priceless collection. ◇

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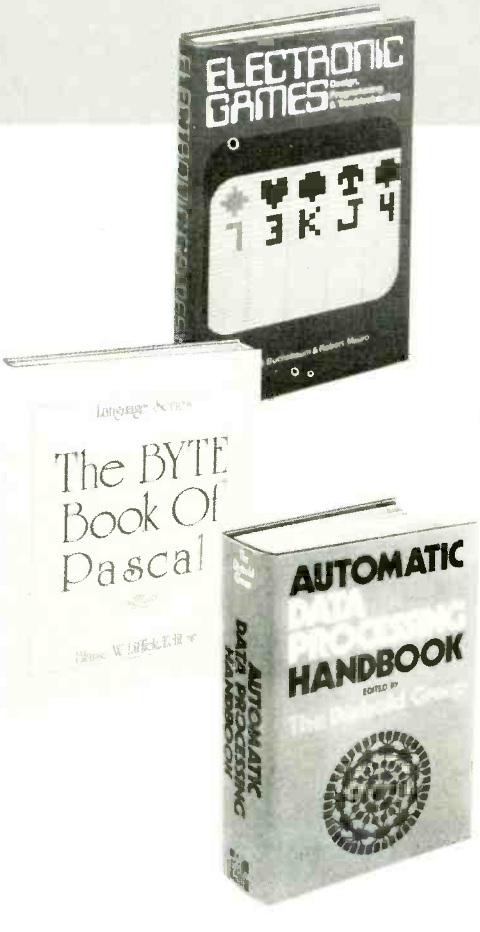

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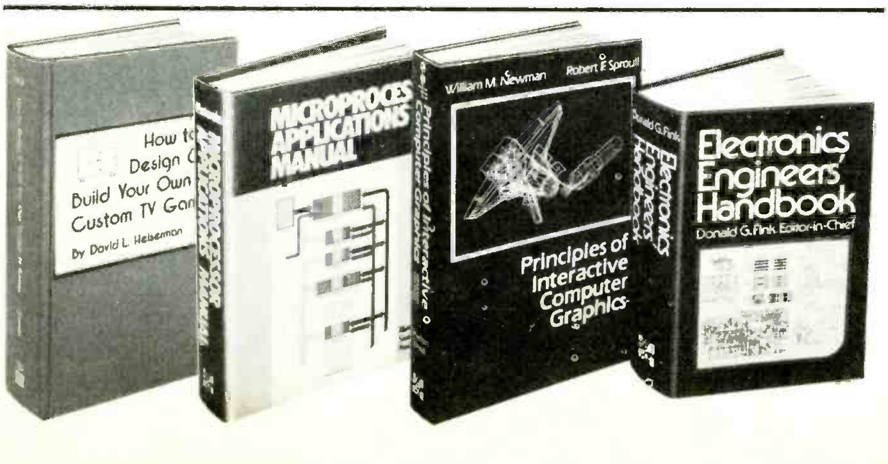

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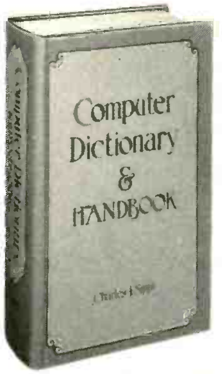

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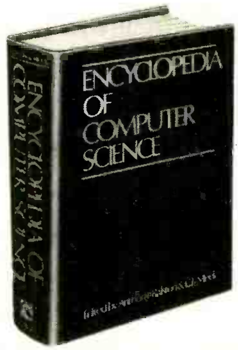

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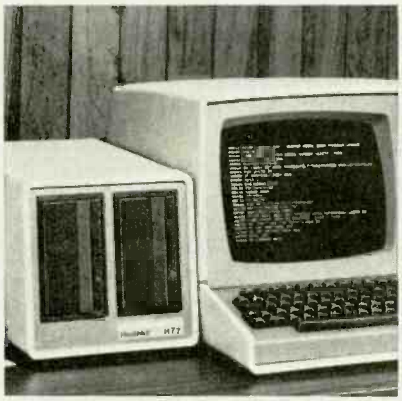
Computer Sources

By Leslie Solomon
Senior Technical Editor

Hardware

TRS-80 STD Bus. The Hartmann-Lang TRS-80/STD bus peripheral connects directly to the TRS-80, and allows all STD bus devices to be used with this popular machine. Hartmann-Lang makes available a 6-slot STD bus motherboard; 16-channel 10- and 12-bit A/D converters; 4-channel, 12-bit DAC; 8-channel reed-relay output; 8-channel triac output; 8-port I/0; 44K dynamic RAM; 16K static RAM; 16K EPROM; parallel interface for line printer compatible with TRS-80 software; and various breadboard cards. Software includes hex dump to video (source and object), cassette dump to video, decimal/ASCII dump to video in BASIC, hex to decimal to hex conversion in BASIC, monitor, single step for TBUG, relocator for TBUG, 6502 emulator with disassembler, and cassette tape utility. Address: Hartmann-Lang, Box 693, Chatham, NJ 07928.

Heath Floppy Accessory. The Heathkit H-77 Floppy Disk System is an accessory for the H89 All-In-One computer from this company. When used, three floppy disk drives are available with their extended storage

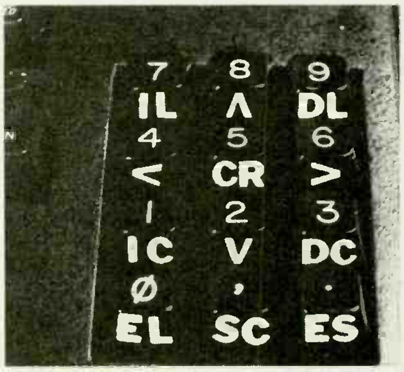


space. The new accessory uses 5.25-inch, hard-sectored, 40-track diskettes, each capable of storing 100K bytes of data. The Seimens 82 disk drive is used; typical random sector access time is less than 250 milliseconds. Kit price with one disk drive is $595, with the second drive at $325. Factory assembled and tested with two drives the WH-87 system is $1195. The H-88-6 Adapter kit at $50 is required to install the WH-87. Address: Heath Company, Benton Harbor, MI 49022.

S-100 I/O Board. The Multi-I/O board, an S-100 plug in, contains two independent sync/async serial ports with RS232 or 20-mA, one strobed 8-bit parallel port, three 8-bit parallel ports user configured, three independent 16-bit timers, an 8-level priority interrupt controller, and two software programmable baud rate generators. All ICs are socketed. $375. Address: I/O, Box 2119, Canyon Country, CA 91351 (Tel: 805–252–7666).

Analog Apple. The AI-02 Analog Input card for Apple II computers monitors 16 analog channels with 8-bit resolution. Channels are individually addressable and conversion time is 70 microseconds. The system can be operated from BASIC. The AO-03 Analog Output card is available in 2-, 4-, or 8-channel configurations. This card accepts an 8-bit quantity (0 to 255) and produces an output of 0 to 10 or −5 to +5 volts (jumper selectable). This card, together with the Analog Input card provides a control and measurement facility for the Apple. Address: Interactive Structures, Inc., Box 404, Bala Cynwyd, PA 19004 (Tel: 215-667-1713).

Hazeltine 1500 Editing. A firmware modification using a ROM that is plugged into a Hazeltine 1500 Terminal converts the latter's numeric keypad into a screen-editing pad. This allows the user to control up, down, left, and right cursor; insert and delete a character in a line; insert and delete a line; erase to end of line/screen; and block transmit of a single line up to 80



characters in length. Toggling between normal and editing modes is via the SHIFT key. Visual inspection of the cursor indicates mode with a triangular cursor for normal mode and a block cursor for block operation.

ROM, stick-on labels for keys, and user manual are $100. Address: Koch Computing Inc., Box 160478, Miami, FL 33116. (Tel: 305-595-5491).

Commodore Floppy. The CBM 2030 Series are 5¼" floppy disk drives that can handle 130K bytes of storage, and can be upgraded in the field to a dual-drive version for 260K bytes. They are compatibile with any PET or CBM computer. The CBM 2030 cabinet, which can house two drives, measures 13½" × 8" × 6½". The single-drive CBM 2031 is $595. Address: Commodore Business Machines, Inc., 3330 Scott Blvd., Santa Clara, CA 95051 (Tel: 408-727-1130).

S-100 21-Card Cage. Model CCK100 holds 21 S-100 cards on ¾" centers and is fabricated from 0.081" anodized aluminum sidewalls and extruded cross members. An S-100 motherboard can be mounted on the rear. It measures 19" wide, 12.2" high, and 8.9" deep. The adjustable cross members accommodate circuit boards from 4" to 8" long, and from 10" to 11.5" wide. The snap-in plastic guides may be placed on centers with multiples of 0.25". With the guides placed on 0.5" centers, 31 cards can be accommodated. Space is available for a front panel or a fan. With 21 pairs of card guides, the cage is $49.80. Address: Vector Electronic Co., 12460 Gladstone Ave., Sylmar, CA 91342. (Tel: 213-365-9661).

Software

Atari Educational Software. A series of educational programs for grades 1 through 6, written for the Atari 400 and 800, is now available. These include Guessword (grades 6 and above), Fishing for Homonyms (grades 3–6), Wanted (grades 4–8), Word-Mate (grades 3–6), and Word Scramble (grades 1–4). On cassette with study guide. Address: THESIS, Box 147, Garden City, MI 48141 (Tel: 313–595–4722).

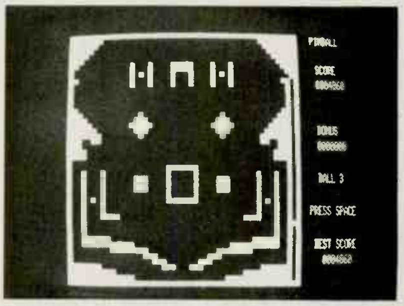
TRS-80 Editor/Assembler. The Editor/Assembler-Plus, is said to provide all the features of the Radio Shack Editor/Assembler and T-Bug, as well as the ability to assemble directly into memory, conditional assembly and macro facility. It also includes expression evaluation, automatic origin, improved symbol table, printout and quash command and other enhancements. The Z-Bug, in addition to the existing T-Bug, allows eight breakpoints, single step execution, direct execution in the calculator mode, and symbolic references among other features. Editing features MOVE, COPY, SUBSTITUTE, EXTEND. EDIT and FIND. It requires Level-II BASIC and 16K of RAM. Cassette and manual is $29.95. Address: Microsoft Consumer Products, 10800 Northeast Eighth, Suite 819, Bellevue, WA 98004 (Tel: 206-454-1315).

CP/M Master Catalog. This system can keep track of all files on any diskette in use. It produces a listing of all file names in alphabetic order, and the name of the diskette containing that file. Selective listings may also be made in a manner similar to that used by CP/M "DIR" command. Besides sorting the directory in alphabetic order, the system also removes non-"ERA"-able files. Also included are two programs that list the directory in three or four columns with each file size and the available space left on the diskette. Source and object program, $10. Address: Elliam Associates, 24000 Bessemer St., Woodland Hills, CA 91367.

6502/6800 Cross Assemblers. The XASM65 and XASM68 are cross assemblers that can be used on 8080/8085/Z80 machines using CP/M. Each assembler supports the microprocessor manufacturer's mnemonics and will supply a symbol table and paginated listings. Complete range of pseudooperations make conditional assemblies and test "includes." These pseudooperation commands handle complete arithmetic expression (addition, subtraction, multiplication, division) and Boolean operations (shift, and, or, etc.). $200. Address: Lifeboat Associates, 2248 Broadway, New York, NY 10024 (Tel: 212-580-0082).

Transistor Design. Available on a North Star single-density diskette, SPDES uses NS BASIC and is an interactive program for the design of small-signal r-f transistor amplifier circuits. Given the two-port scattering matrix measured at a single frequency, and at a given dc bias level, the program computes the stability factor and, if stable, calculates maximum gain, optimum load and source reflection coefficient; converts reflection coefficient to impedance; and computes single-frequency micro-stripline matching for the device with a resistive load and source impedance. If potentially unstable, the program computes the parameters of the source and load stability circles and, for a specified gain, the parameters of the gain circle. You can use a Smith Chart at this point, or the program will compute all load reflection coefficient points on the gain circle and determine if the load is in the stable area of the load stability circle. If the load is stable, the program calculates the source reflection coefficient. The program will then calculate the impedance values of the load and source reflection coefficient. Given the stripline parameters, a series and shunt stripline matching network will be calculated for the desired gain at a single frequency. $45. Address: Kask Labs, 1207 E. Secretariat Dr., Tempe, AZ 85284.

TRS-80 Pinball. Pinball is a real-time game written in machine language. It includes flippers, bumpers, rollovers, runs, and bonus points. Once in play, both ball speed and acceleration depend on the contact with the various elements including the "Bermuda Square." Full graphics are used. Cassette is $14.95, diskette is $20.95. Address: Acorn Software Products, Inc., 634 North Carolina Ave., S.E., Washington, DC 20003 (Tel: 202–544–4259).



New Radio Shack Releases. Radio Shack has recently released three new pieces of software for its TRS-80 machines. One is K-8 Math supplied in five cassettes and three disks in a binder with teacher's manual and record-keeping forms. Designed for kindergarten to 8th grade, the program features hundreds of different math problems with automatic grading. Requires a 16K Level II. $199. SCRIPSIT is a full-feature word processor. In conjunction with a special "control" key and 14 regular keys, it allows moving of words or paragraphs, insert, delete, or edit of material. Press-on key labels are provided. Document chaining allows merging, inserting, and other text operations. Automatic page numbers, page headings, footnotes, paragraph indent, changes in line width, and centered text are features. Requires TRS-80 Model I 16K Level II and Line Printer II or WP-50 daisy-wheel printer. $69.95 for tape, $99.95 for disk. The third, Radio Shack COBOL, includes a one-pass compiler that generates an object code for direct execution, full-screen formatting, full ANSI Level 2 I/O, program linkage and segmentation. It is $299 from Radio Shack Stores and Computer Centers. ◇

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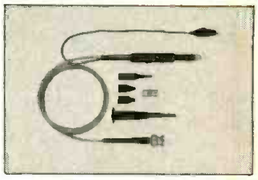

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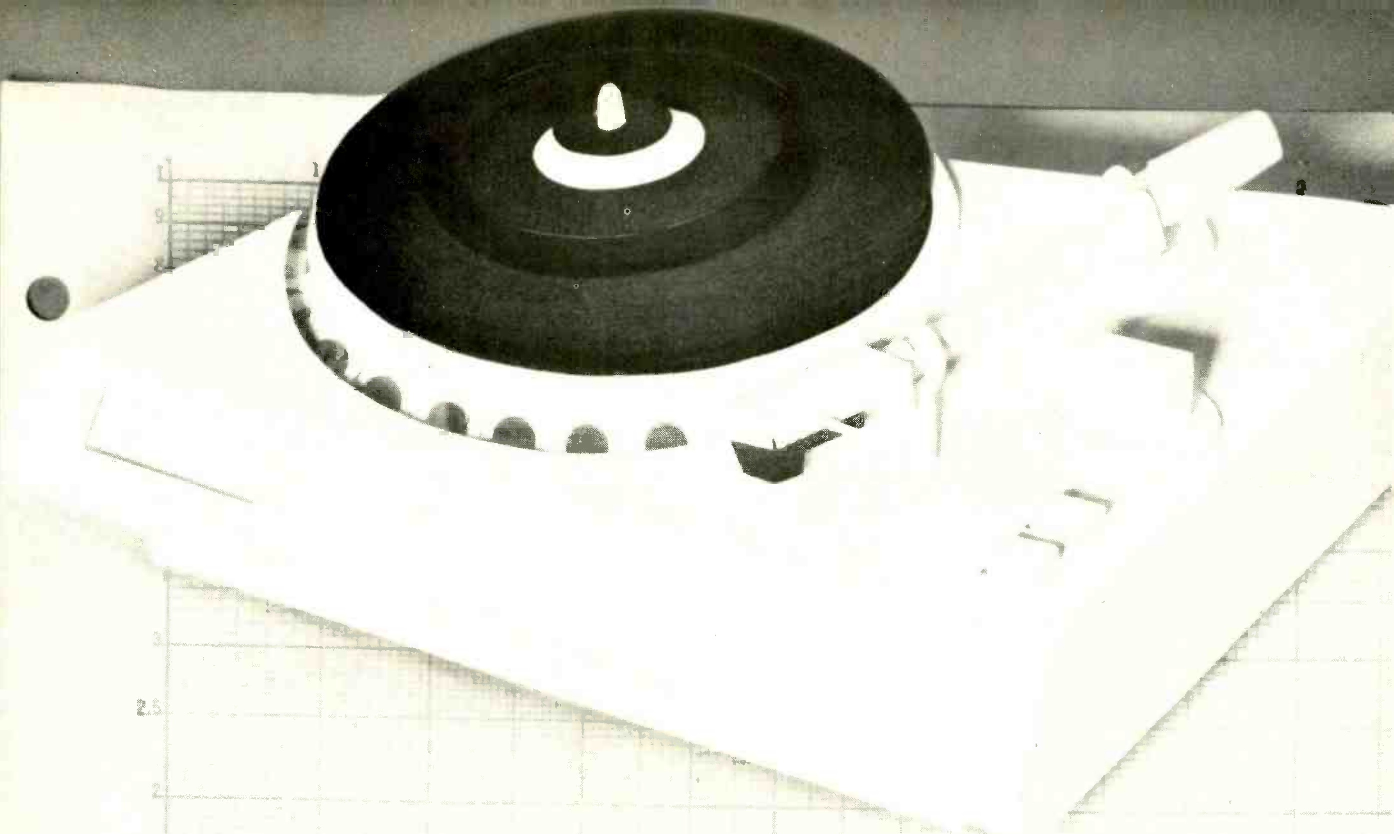


PE REVIEWS

Six Stereo Phono Cartridges

Results of listening and laboratory tests on a sampling of units from six different manufacturers

Shure Brothers

M-97HE

Empire

500ID

Audio-Technica

AT-30E

Sonus

Dimension 5

BY HAROLD A. RODGERS, Executive Editor
with data provided by Hirsch-Houck Laboratories

PHONO cartridges, like other electromechanical devices, are traditionally known as weak links in the audio playback reproduction chain. There is some justification for this, as advanced cutting techniques, such as operating at half speed, have made it possible to cut discs that playback systems cannot readily handle. Moreover, electronic amplifiers have progressed to the point where distortion is beyond the measuring capability of all but the most sophisticated test instruments.

The foregoing does not mean, however, that the erstwhile weak sisters have not gotten better. Indeed they have! Furthermore, we examined six phono cartridges ranging in suggested retail price from $112 to $250 and discovered that, though there are differences in measurements, we were hard pressed to *hear* truly significant aural changes between them except, perhaps, in the high end of the frenquency range.

The Participants. The phono cartridges chosen for the test include late models from five of the largest manufacturers of this category of equipment—Shure Brothers, Audio Technica, Pickering, ADC, and Empire—and one from Sonus, a smaller manufacturer. Prices of the units range from $112 to $250, with the majority clustered around $125. The Sonus Dimension 5, at $250, represents a deluxe model, and the Audio-Technica AT-30E ($125), being a low-output moving-coil type, will require a step-up transformer or head amplifier. (Audio-Technica's AT-630 step-up transformer is available for $95.) Completing the line-up are the Shure M-97HE ($112), the Pickering XSV-4000 ($160), the ADC Integra XLM III ($130), and the Empire 500ID ($125).

Three of the cartridges have elliptical styli. The others—Shure's Hyperelliptical, Pickering's Stereohedrone, and the Sonus Lambda—have modified elliptical shapes that give an extended contact area with the groove wall and a very small tracing radius for improved high-frequency performance.

All of the cartridges tested track in the light to moderately light ranges of vertical force, as follows: ADC Integra XLM III, 1.2 ± 0.3 grams; Audio-Technica AT-30E, 1.4 to 2.0 grams; Empire 500 ID, 1.5 grams, −0.25, +0.5; Pickering XSV-4000, 1 gram ± 0.25 net (1 gram extra is used to compensate for the weight of the brush); Shure M-97HE, 0.75 to 1.5 grams (0.5 grams extra is added to compensate for its "dynamic stabilizer" brush); Sonus Dimension 5, 1 to 1.5 grams.

The Integra XLM III from ADC has an integral carbon-fiber headshell, the total mass of the combination being 12 grams. A special feature of the Integra headshell is that it incorporates adjustments for overhang and vertical tracking angle.

Laboratory Testing. Tests of frequency response and separation were run on the six cartridges, yielding the results shown in Figs. 1 through 6. Each cartridge was coupled to the load (a parallel combination of resistance and capacitance) indicated by the graph. As would be expected from a low-impedance pickup, even when working through a transformer, the Audio-Technica's frequency response was almost independent of its load. (Using a head amp would make the loading an entirely negligible factor.) Load capacitance is hardly significant for the Sonus and has but a slight effect on most of the others. The Empire, with a small peak at 10 kHz that is exaggerated by excess load

Pickering

XSV-4000

ADC

Integra XLM III

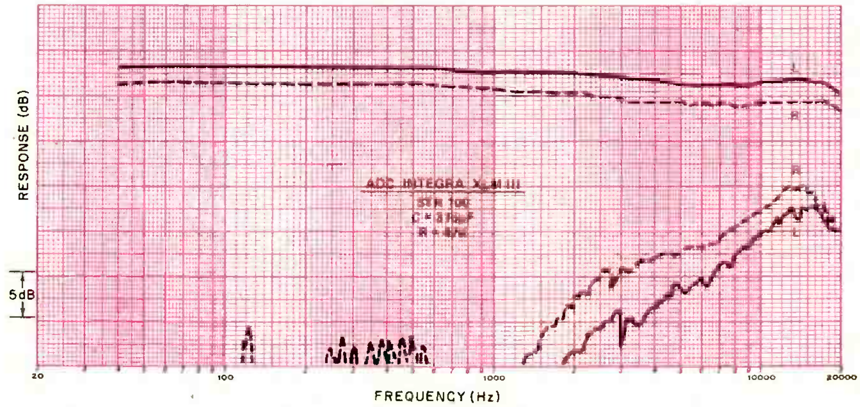
capacitance, is the most sensitive. This will hardly ever be a problem except in old turntables with high-capacitance wiring.

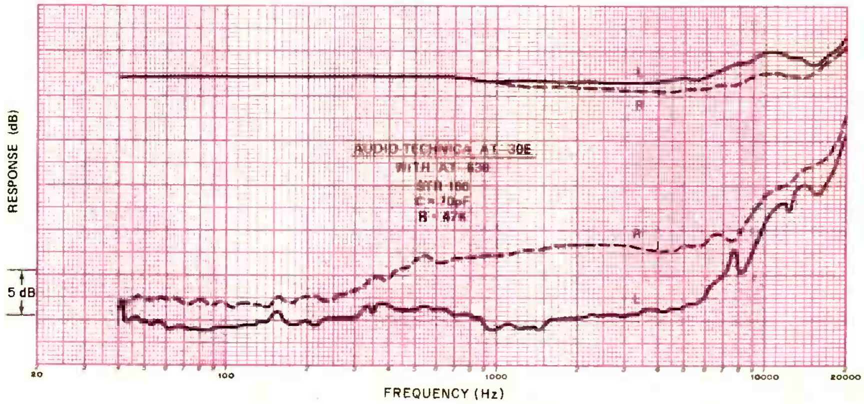
In general, the frequency-response curves are flat enough that their errors are of small concern. (As a matter of fact, since frequency-response results on cartridges have been shown to vary as a function of the test record chosen, the precise amounts by which these curves vary from perfection is a matter of doubt.) Crosstalk results also depend to a degree on how well the angle (nominally 90°) separating left and right modulation of the recording matches the corresponding angles in the cartridge. They are also sensitive to the angle (also nominally 90°) between the stylus and the disc surface when the cartridge is viewed from the front. Although there are differences in separation (freedom from crosstalk) between the units tested, in no case did we find it inadequate.

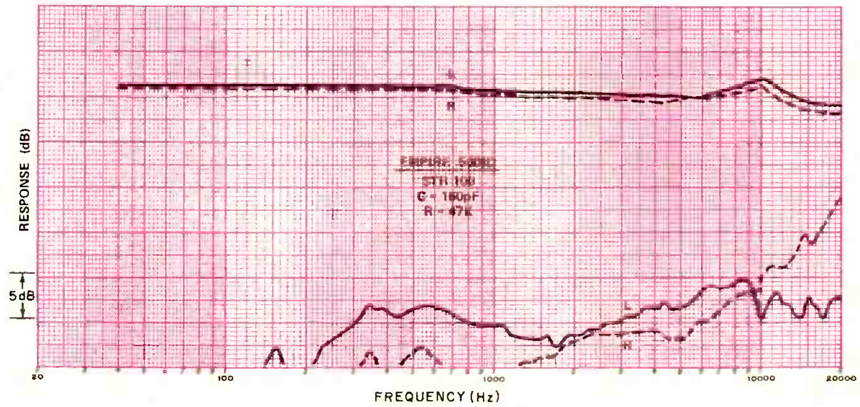
Distortion data, both for steady-state intermodulation and 10-kHz tone bursts is given in Tables I and II. Unfortunately, the correlation between distortion and listening quality is obscure in the case of phono cartridges. (The reasons why this is the case are complex and beyond the scope of this article.) Consequently, even though differences with respect to distortion were revealed by the testing, we cannot discuss the ways in which they might relate to performance. It seems noteworthy, however, that at their most linear, phono cartridges, like loudspeakers, produce levels of distortion that are gross compared with those generated by electronics.

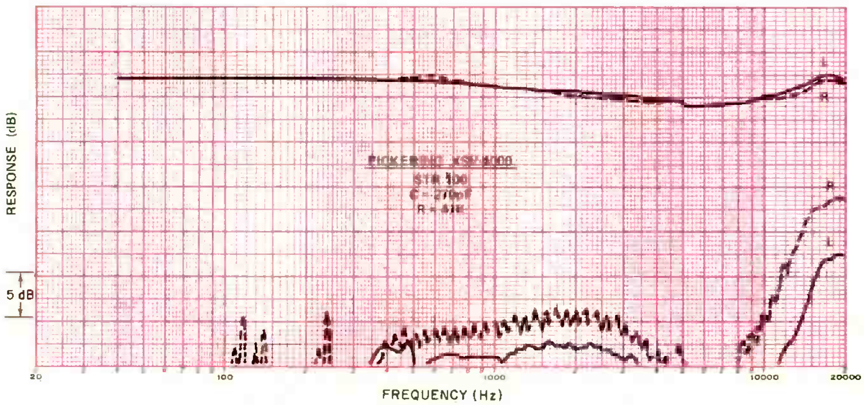
Table III gives output voltages of the left and right channels of the cartridges, together with a figure in decibels that expresses the relative imbalance between the two. This measurement is made at 1 kHz. Since the frequency response typically varies by an amount comparable to the imbalance, it may not apply across the audio spectrum. Even the relatively large imbalance noted for the Sonus cartridge was not deemed serious, a conclusion that listening tests tend to support. Also, it's a simple task to adjust an amplifier's balance control to compensate for any imbalance.

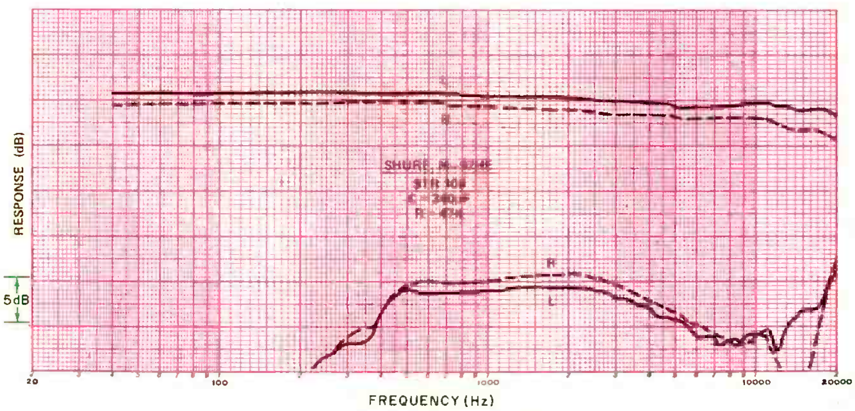
The final column of Table III gives a measured value for vertical tracking angle. While the nominal standard for this parameter has been set at 20°, the measured data cluster fairly closely around an average of 23°. Though it has been shown that errors in vertical tracking angle can lead to excess distortion, the low correlation between distortion and listening quality would suggest that differences would be hard to hear. Our

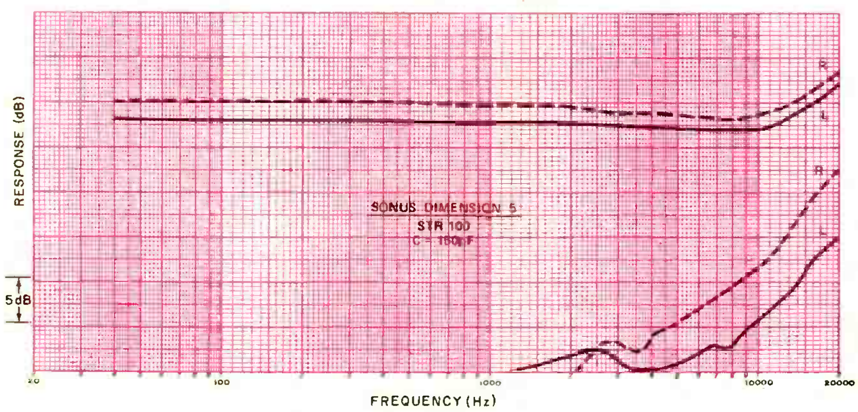












Figs. 1 through 6. Plots of frequency response and crosstalk for the six cartridges tested. Note that the lower limit of measurement is 40 Hz.

listening tests tend to reinforce this view, uncovering no real differences that relate to vertical tracking angle.

Perhaps the most significant lab data from a practical point of view are those given in Table IV. The scores represent the highest-amplitude bands that could be tracked on the Shure "Era III and Era IV Audio Obstacle Course" discs. Some controversy has erupted around this test, partly on the ground that with monophonic modulation only in the test bands, the pickups are exercised in the lateral plane only, with the vertical plane neglected. Nevertheless, there appears to be a reasonably good correlation between a pickup's behavior in this test and how it works with "real-world" records.

As it turns out, data from this test is tightly clustered. A perfect score—which was achieved by two units—is 45, while the lowest score turned up was 40. Average score for the group was 42.8. Since the least capable cartridge in the test did about 89% as well as the best, tracking capability provides little in the way of a basis for choosing between them. Hirsch-Houck Laboratories, incidentally, defined mistracking in this test on the basis of audibility.

Listening Tests. Performing listening tests on six of anything puts the tester in an interesting bind. The same program material must, obviously, be used for all six components; otherwise there is no basis for comparison. On the other hand, as the listener becomes better acquainted with the program material through repetition, the psychological parameters of the test change willy-nilly. Is a certain "subtle clarity" heard in, say, the third unit tested a characteristic of the unit—or does the tester hear it that way because he now knows the music better?

To answer these questions, it would be necessary to repeat the test at least six times, rotating the order in which the units are tested and choosing a different selection of program material each time. This arrangement would perforce shorten the time spent listening during each trial, making it likely that factors that might be fatiguing in long-term listening will be missed. Also, because of the complex mechanical and electrical setup it would require, A-B testing also was not a viable alternative.

We finally settled on listening to each cartridge for a fairly extended period (three record sides) and noting any annoying characteristics that were heard. To be certain that these characteristics were presented as vividly as possible, listening was done through high-quality headphones, which we have found, through experience, to exaggerate minor faults.

In no case did we find that a pickup annoyed us noticeably. The six certainly do not all sound alike, but none of them is offensive. Interestingly, they seem to agree well for about 90% or so of what one hears; the differences are concentrated in the other 10% of reproduced sounds, lying, by and large, toward the upper end of the audio spectrum. All were capable of tracking the loudest passages of a Telarc digitally mastered disc without mistracking or obvious strain. We could have lived happily with any of the cartridges in the test. Were it not inappropriate in a test based on criteria as objective as possible, we might have chosen a personal favorite. We suspect, however, that even a choice as arbitrary as this might well vary from day to day.

The only oddities we observed were minor. Anti-skating force must be set quite carefully for the Pickering if the stylus is not to be dragged out of the groove by the brush. Also, the Shure brush (officially a "dynamic stabilizer") plays the grooves ahead of the stylus, creating a very faint pre-echo that can be heard when the stylus is in an unmodulated groove. We would not expect this to be problematic, for any modulation at all and even surface noises in some cases will mask the pre-echo. And if you are listening over speakers, the pre-echo will doubtlessly be swallowed up by ambient room noise. The dynamic stabilizer can be defeated, but then the aid it offers to tracking of warped discs will be lost.

TABLE I—INTERMODULATION DISTORTION
(in percent, average of both channels)

Velocity (cm/s)	ADC Integra XLM III	Audio-Technica AT-30E	Empire 500ID	Pickering XSV-4000	Shure M-97HE	Sonus Dimension 5
27.1	6.0	6.0	4	5	2.4	3
22.6	2.5	4.0	3	2.5	2.7	1.5
17.9	1.5	4.0	2.7	2.2	3.5	1.7
14.3	2.3	3.0	2.2	1.7	4.3	1.6
11.3	4.0	2.0	2.8	1.3	3.5	2.0
8.7	3.0	1.7	2.0	1.1	2.4	2.0
6.9	2.0	2.5	1.1	0.8	1.7	1.5

Tested with Shure TTR102 record

TABLE II—TONE BURST DISTORTION
(in percent, average of both channels)

Velocity (cm/s)	ADC Integra XLM III	Audio-Technica AT-30E	Empire 500ID	Pickering XSV-4000	Shure M-97HE	Sonus Dimension 5
30.	6.3	8.5	2.5	7.3	1.2	2.3
23.8	0.89	3.0	1.6	1.8	0.83	1.1
18.9	0.79	0.62	1.0	0.92	0.68	0.92
15.0	0.89	0.63	0.84	0.67	0.74	0.83

Tested with Shure TTR 103 record

TABLE III—OUTPUTS, IMBALANCE AND TRACKING ANGLE

Cartridge	L output (mV)	R output (mV)	Imbalance (dB)	Vertical Angle
* ADC Integra XLM III	5.5	4.6	1.5	24°
• Audio-Technica AT-30E w/ AT-630 transformer	4.4	4.2	0.4	18°
• Empire 500ID	4.2	4.0	0.4	22°
• Pickering XSV-4000	4.2	4.2	0	24°
• Shure M97HE	4.5	3.8	1.4	26°
• Sonus Dimension 5	2.6	3.4	2.3	24°

* CBS STR-100 record
**CBS STR-160 record

TABLE IV—CARTRIDGE TRACKING OF SHURE AUDIO OBSTACLE COURSE RECORDS

Cartridge	Vertical force	ERA III Bells	ERA III Sibilance	ERA III Drum	ERA III Violin	ERA IV Bells	ERA IV Flute	ERA IV Harp	ERA IV Harp/Flute	ERA IV Flute/Bells	Total
• ADC Integra XLM III	1.5	5	5	4	5	4	5	4	3	5	40
• Audio-Technica AT-30E	2	5	5	5	5	4	5	5	4	5	43
• Empire 500ID	1.5	5	4	5	5	4	4	5	4	5	41
• Pickering XSV-4000	1	5	5	5	5	5	5	5	5	5	45
• Shure M97HE	1.5	5	5	5	0	5	5	5	5	5	45
• Sonus Dimension 5	1.5	5	4	5	5	4	5	5	5	5	43

Numbers refer to maximum level on record that can be tracked without audible distortion.

In Conclusion. We can sympathize a little with the disgruntled reader who is about to ask: "Have you lead me through all this data and verbiage only to tell me that you can't find reason to prefer one of these cartridges over another?" But we would still answer: "Yes, that's the way it is, at least as far as what we can test is concerned." But that shouldn't bother you too much, for you now know that you can't go too wrong. And we suspect that the price spread could be opened up a good deal more before any significant differences would be heard.

The price of a phono cartridge depends not necessarily on its performance, but on how costly it is to produce. It is almost as if one is dealing with art—if you like what you hear from a certain model and that one pleases you above all others, then it is the one for you, and price is a secondary issue. And in some cases, you may not be able to narrow the choice *that* far. (That's why they make interchangeable headshells.) In any case, phono pickups seem to be getting better and better, and as they do, they will undoubtedly sound more and more alike. ◊

CIRCLE NO. 68 ON FREE INFORMATION CARD

Audio Time Delay Systems

CONCLUDED

Build a Digital Audio Delay Line

Computer-type RAM memory and both A/D and D/A converters are used in this second approach

BY JOHN NEVES, STEVE KOLUPAEV, AND DEBBIE DELAHANTY

IN the first two parts of this series, we described an audio delay system based on analog techniques using bucket-brigade devices as the principal active elements. This month we will concentrate on the use of digital techniques to achieve the same purpose.

The project described here uses A/D (analog-to-digital) and D/A (digital-to-analog) converters, random access memory (RAM), and a time base that provides the necessary synchronization for the digital system as well as determining the length of the delay.

Overall Operation. As shown in Fig. 1, the audio input is fed to a filter and amplifier combination that attenuates frequencies above 10 kHz (to prevent aliasing problems) and scales the signal level for the A/D converter.

An 8-bit A/D converter performs a companding conversion that increases the digital signal resolution to an equivalent 11 bits plus sign, giving a dynamic range of approximately 70 dB. The converter operates under the control of synchronization pulses from the clock/controller. Digital information at the output of the A/D converter passes to a 4096 (4K in computer jargon) × 8-bit RAM as a series of 8-bit "words." Timed by pulses from the clock/controller, the stream of digital words cycles through a desired number of memory locations, up to the maximum of 4096. At any point in the cycle, as an old sample is read from the data latch and passed to the D/A converter, a new sample is written into the memory.

The length of delay is determined by the number of memory locations through which each sample passes and the length of each sampling interval. (The number of locations traversed is set by the manual switches.) For example, if the sampling frequency is 25 kHz, one sampling interval is 1/25,000 second or 40 microseconds. Therefore, if all 4096 memory locations are used, the total delay will be 4096 × 40 (μs) or 163.84 milliseconds. A 20-kHz rate would give a delay of 204.8 milliseconds.

Setting the memory address counter to some number between 1 and 4096 by means of the thumbwheel switches allows the delay to be varied while holding the sampling rate constant. Since the sampling rate also determines system bandwidth, changing the delay in this fashion does not affect frequency response. The fact that digital data is not degraded as it passes through the RAM means that the noise and distortion content of the output signal is also independent of the delay.

After the user-selected storage period, the digital data is read out of the memory and temporarily stored in a latch circuit that holds the digital data steady for the following D/A converter. Upon receipt of an appropriate timing pulse, the latch passes the digital data to the D/A converter where it is converted back into analog form. This analog sig-

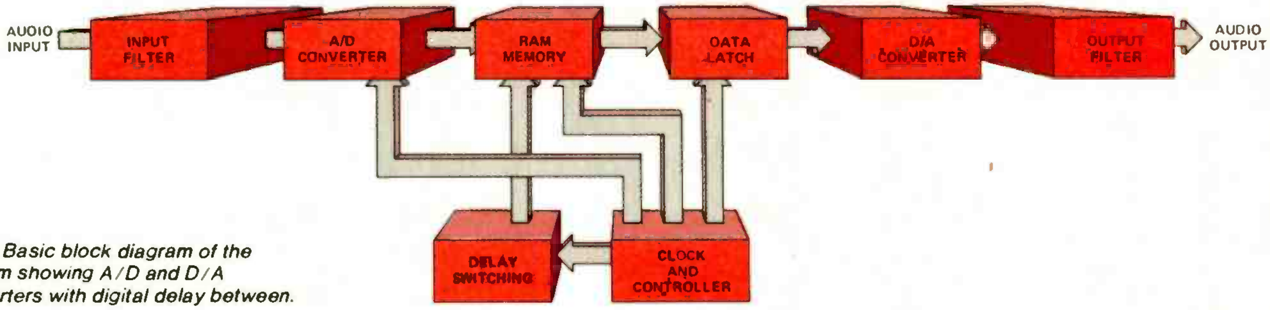


Fig. 1. Basic block diagram of the system showing A/D and D/A converters with digital delay between.

nal, now delayed, is filtered to remove any sampling components above 10 kHz that may be present. After filtering, the audio signal is amplified to bring it up to a level (about 1 volt) that can drive an audio amplifier.

Like the analog unit, the digital delay system is intended to be used with one or two auxiliary power amplifiers and loudspeakers. Ideally, there should be two delay units, one per channel. The signal should be delivered to your listening area at a level about 10 dB below that of the undelayed sound. For reasons detailed in Part 2, less expensive speakers and amplifiers can be used for the delayed sound channels.

To further economize, a single amplifier, speaker, and delay unit can be used. Audio from the two main channels can be resistively mixed and fed to a single delay unit as shown in Fig. 2.

The length of the delay produced by the unit can be adjusted in small increments to tailor it to the acoustics of your listening area. Start with about 20 milliseconds and experiment from there. Provision has been made to feed some of the output signal back to the input to generate reverberation. But if there is too much feedback, oscillation will occur.

Circuit Description. Due to its complexity, the circuit has been broken up into small, functional units. The individual circuits are interconnected by mating "letters-in-a-circle."

Input Filter and A/D Conversion. As shown in Fig. 3, *IC1A* and *IC1B* form a low-pass filter that amplifies all signals below 10 kHz. A comparator formed by *IC1C* monitors the amplified signal and turns on *LED1* when the audio reaches the optimum four volts peak-to-peak.

The amplified signal from IC1B (pin 7) is passed to an A/D converter consisting of *IC2A, IC18, IC22, IC24* and two of the gates in *IC23*. Timed by a "start conversion" pulse from the clock/controller, the incoming analog audio is converted into 8-bit binary code that is presented to the RAM for temporary storage. The converter performs a companding action, making the resolution of the digital signal equivalent to an 11-bit word plus sign. Dynamic range is thus approximately 70 dB.

Memory and Latch. This circuit, shown in Fig. 4, uses eight conventional 4096 (bits) by 1 (bit) static RAMs (IC3 through *IC10*) arranged to form a 4096 (bits) × 8 (bits) array. Static RAM is used to avoid the refresh cycles needed by dynamic RAM.

Each RAM element has its own unique address identified by the "*An*" (*n* stands for a digit) symbol above each RAM address line pin. Each RAM also has one pin (pin 8, R/$\overline{W}$) that enables the RAM to accept data when the signal on this pin is in one logic state, and output the data when the pin is in the opposite logic state. Thus, under control of pulses from the clock/controller, the RAM can read in external data, or write out the data contained within its cells. The eight bits of data passed out of the RAM go to a pair of four-input data latches (*IC11* and *IC12*) that hold the data in their internal flip-flops until a properly timed pulse from the clock/controller causes it to pass to the D/A converter.

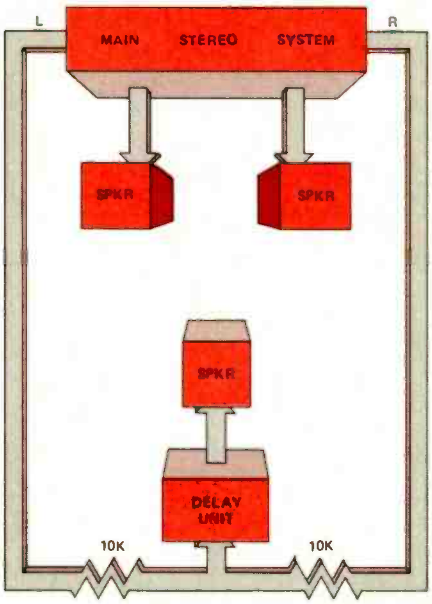


Fig. 2. Audio signals from the two main channels are mixed in resistors and applied to delay unit and a single speaker. Delay is adjusted to suit acoustics.

D/A Converter and Output Stages. The data from the RAM/latch circuit is applied to *IC13*, a D/A converter, as shown in Fig. 5. The reconstructed output signal from the D/A converter is almost identical to the filtered analog input, except that it is multiplied by a small scaling factor (due to amplification), contains a small amount of "quantization" noise caused by the D/A conversion, and, of course, is delayed.

After amplification in *IC25A* brings the signal up to about 1-volt peak-to-peak, the analog signal is passed through an active low-pass filter composed of *IC25B* and *IC25C*. The filter cuts off at 10 kHz, and attenuates any sampling frequency components that may remain in the signal. The output of *IC25C* is then used to drive the external audio amplifier.

Clock and Controller. The system clock, implemented by *IC19* in Fig. 6, is the basic timing control for the system. Its main element is a vco (voltage-controlled oscillator) whose frequency is determined by the setting of *R21*. Varying the clock rate allows the user to experiment with effects such as vibrato, flanging, or frequency modulation. Keep in mind that the vco not only affects delay time but system bandwidth as well.

Counter *IC17* accepts the clock signal and is configured to generate the four timed trigger pulses used by the A/D converter, RAM memory, and data latch. The four outputs are buffered by elements of *IC20* and *IC21* to convert the low-current CMOS outputs of *IC17* into signals capable of driving TTL.

As shown in Fig. 6, the four timing pulses are identified as P1, P2, P3, and P4. Pulse P1 commands the start of an A/D conversion in *IC18* (Fig. 3), while P2 increments (by 1) the memory address counter of Fig. 7. The resulting memory address points to the oldest stored sample. A new conversion will be completed eight clock pulses after P1.

The RAM is normally in the read mode, which means that the memory

(Figures 3 and 4 are on page 70. Text continues on page 73.)

PARTS LIST

C1,C4,—0.005-µF capacitor
C2—220-pF capacitor
C13—470-pF capacitor
C5—10-µF, 16-V electrolytic
C6,C7,C19—0.1-µF ceramic capacitor
C8 through C11,C16 through C18—1-µF, Mylar, tantalum, or electrolytic
C12—0.033-µF disc capacitor
C3,C14—0.001-µF, Mylar or ceramic
C15—330-pF ceramic capacitor
C20—47-pF ceramic capacitor
C21,C22—5000-µF, 20-V electrolytic
D1—1N914 diode
D2 through D5—1N4002 or similar diode
IC1,IC25—LM324 quad op amp
IC2—LM311N comparator
IC3 through IC10—4K × 1 static RAM, MM5257, TI4044, EMM4044, IM7141, MCM2141, 4104, 2613, HM4315, HM4847, or similar
IC11, IC12—7475, 74LS75, four-bit latch
IC13,IC22—DAC-76, DAC-88 companding D/A converter (Precision Monolithics or American MicroDevices)
IC14,IC15,IC16—74193, 74LS193 up-down synchronous 4-bit counter
IC17—4017 CMOS decade counter
IC18—DM2502 successive approximation register (National or American MicroDevices)
IC19—4046 CMOS phase-locked loop
IC20—4010 CMOS-TTL buffer
IC21—74LS00 quad two-input NAND gate
IC23—7486, 74LS86 quad exclusive-OR
IC24—7474, 74LS74 D flip-flop
IC26—320T-12, negative 12-volt regulator
IC27—340T-12, positive 12-volt regulator
IC28—340T-5, positive 5-volt regulator
J1,J2—Phono connector
LED1—Light emitting diode
The following are ¼-watt, 5% resistors unless otherwise noted:
R1—47 kΩ
R2—18 kΩ
R3—39 kΩ
R4,R23,R28 through R39,R40,R41—10 kΩ
R5—680 kΩ
R6—3.3 kΩ
R7,R10,R25—22 kΩ
R8—820Ω
R9,R18,R20—4.7 kΩ
R11,R24—51 kΩ
R12,R13,R15,R16,R26,R27—2.7 kΩ
R14—500Ω potentiometer
R17,R19—13 kΩ
R21—10 kΩ potentiometer
R22—2.2 kΩ
R42—33 kΩ
R43,R44,R45—100 kΩ potentiometer
S1—Spst switch
T1—24-V CT, 1-A (1.5-A for stereo)
Misc.—Hex 2-digit thumbwheel switch (2) or 16-pin DIP switches, suitable enclosure (Mod-U-Box MBS 4-10-10 available from Intra Fab, 425 Queens Lane, San Jose, CA 95112 or similar), knobs, press-on type, mounting hardware, etc.

***Note:** The following are available from Videoart, Box 10327, Stanford, CA 94305: etched and drilled pc board at $18; DM2502 successive approximation register at $6.80; DAC-88 converter at $7.50; set of eight memory ICs at $50. California residents please add 6.5% sales tax.*

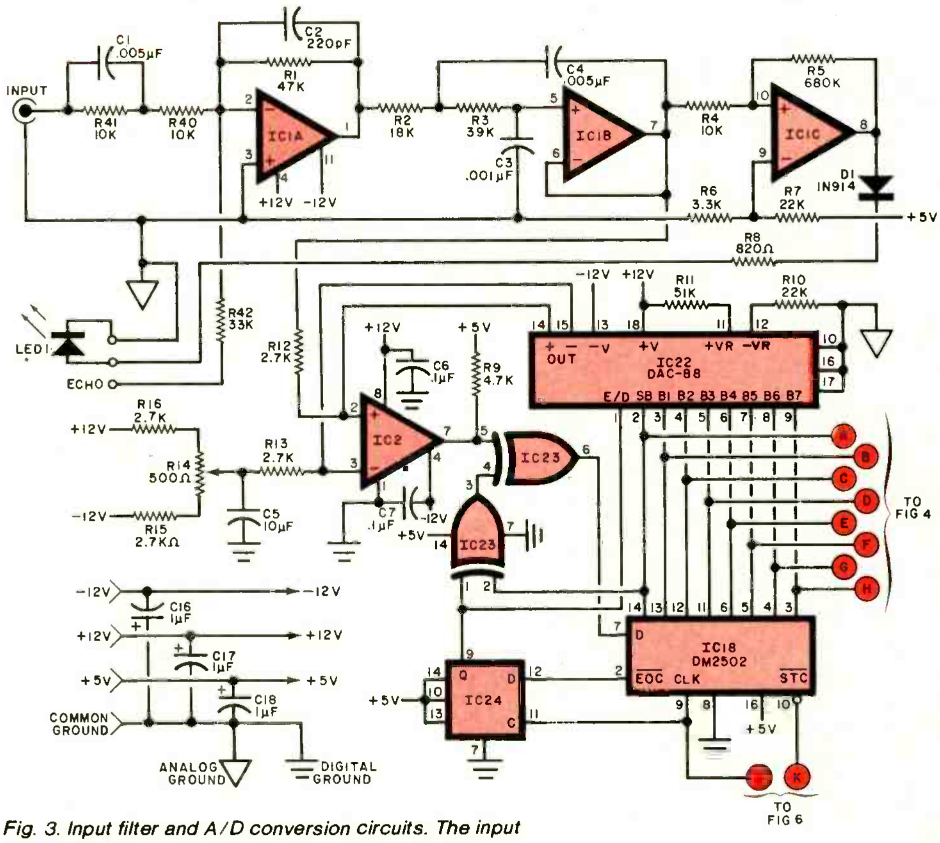


Fig. 3. Input filter and A/D conversion circuits. The input is filtered and amplified first and then converted to 8-bit binary code at the output to Fig. 4. A companding action makes the output equivalent to an 11-bit word plus sign.

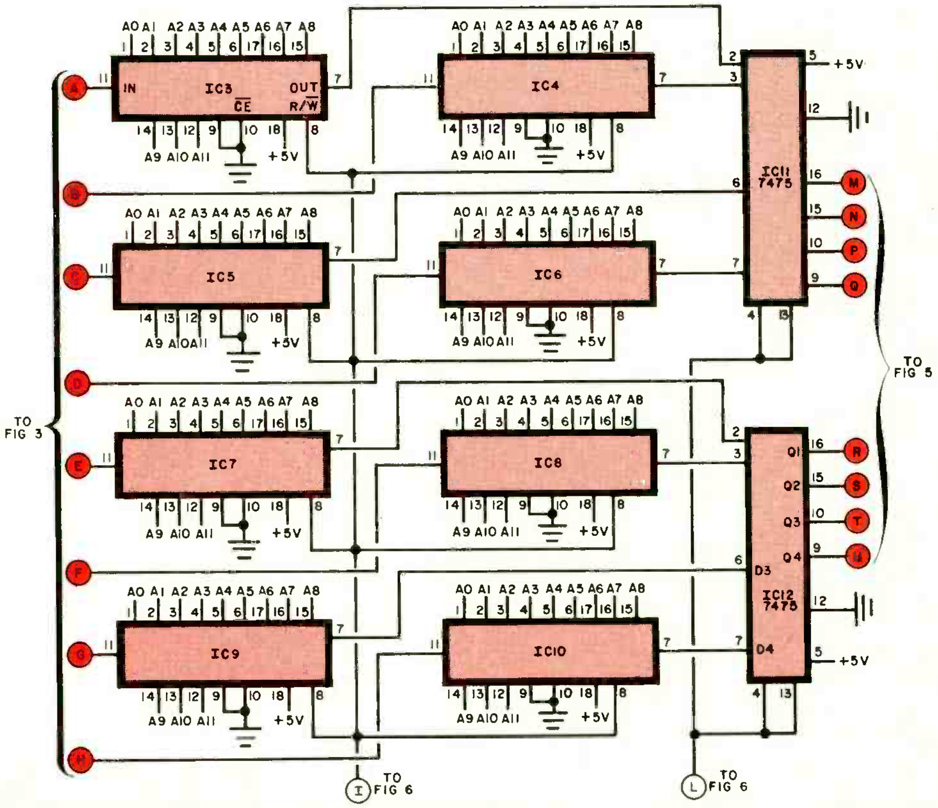


Fig. 4. Memory and latch circuits. Eight static RAM units (IC3 through IC10) are used to form a 4096 by 8 array. Each RAM can read in or write out data as determined by pulses from the clock/controller. Output is held in latches IC11 and IC12.

Digital IC Probe & Logic Pulser

PRB-1 DIGITAL LOGIC PROBE

Compatible with DTL, TTL CMOS, MOS and Microprocessors using a 4 to 15V power supply. Thresholds automatically programmed. Automatic resetting memory. No adjustment required. Visual indication of logic levels, using LED's to show high, low, bad level or open circuit logic and pulses. Highly sophisticated, shirt pocket portable (protective tip cap and removable coil cord).

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Compatible with all logic families 4-15 VDC • 10 Nsec. pulse response
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Open circuit detection • Automatic resetting memory
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PLS-1 LOGIC PULSER

The PLS-1 logic pulser will superimpose a dynamic pulse train (20 pps) or a single pulse onto the circuit node under test. There is no need to unsolder pins or cut printed-circuit traces even when these nodes are being clamped by digital outputs.

PLS-1 is a multi-mode, high current pulse generator packaged in a hand-held shirt pocket portable instrument. It can source or sink sufficient current to force saturated output transistors in digital circuits into the opposite logic state.

Signal injection is by means of a pushbutton switch near the probe tip. When the button is depressed, a single high-going or low-going pulse of 2μ sec wide is delivered to the circuit node under test. Pulse polarity is automatic: high nodes are pulsed low and low nodes are pulsed high. Holding the button down delivers a series of pulses of 20 pps to the circuit under test.

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Input over voltage protection +50 volts • Automatically programmed output level
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Multi-family RTL, DTL, TTL, CMOS, MOS and Microprocessors.

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CIRCLE NO. 53 ON FREE INFORMATION CARD

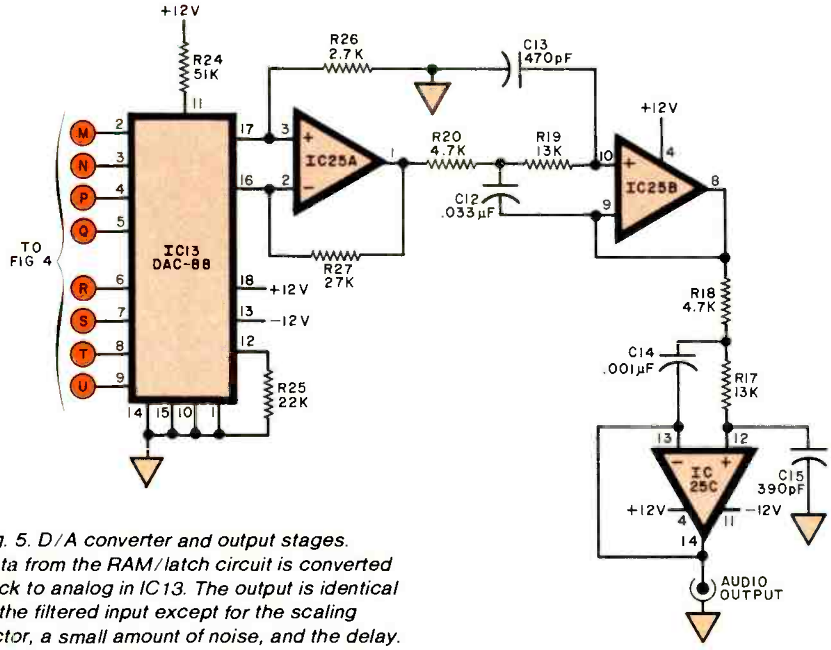


Fig. 5. D/A converter and output stages. Data from the RAM/latch circuit is converted back to analog in IC13. The output is identical to the filtered input except for the scaling factor, a small amount of noise, and the delay.

constantly displays the 8-bit code stored at the address pointed to by the memory address counter at its output. The third pulse, P3, is applied to the data latches (Fig. 4), causing them to load the result of the read operation and hold it stable for D/A conversion by *IC13* (Fig. 5), which takes place in less than one microsecond. The last pulse, P4, causes a memory write operation that overwrites the old sample with the 8-bit code currently available at the A/D converter output.

Delay Switching. The delay switching uses three ICs to select the RAM memory addresses dialed in via the user-accessible switches as shown in Fig. 7.

Programmable counters *IC14*, *IC15*, and *IC16* are cascaded with the clock input presented to *IC16*. Its "carry" output drives *IC15*, which in turn drives *IC14*. These counters can be preset to any desired modulo output by entering the control data on the input pins—in this case, voltage or ground from the user-selectable switches connected to *S2* and *S3*. Thus, the outputs of each IC will agree with the manually preset count, independent of the clock frequency. Since there are 12 address lines, the count can reach a maximum of $2^{11} + 2^{10} + 2^9 \ldots + 2^0 = 2^{12} - 1 = 4095$ and the delayed bits can pass through any desired number of memory locations.

Power Supply. The power supply, shown in Fig. 8, uses a full-wave rectifier in conjunction with −12, +12, and +5-volt regulators. The system draws 450 mA at +5 volts, and about 20 mA from each of the 12-volt supplies.

The 5-volt power requirement can be reduced by using "LS" or "C" versions of *IC11*, *IC12*, *IC14*, *IC15* and *IC16*. Do not use "L" devices because these usually have different pinouts. Regulators *IC27* and *IC28* should be supplied with heat sinks.

Construction. Given the complexity of the circuit, construction is best implemented by using either Wire-Wrap Techniques or a printed circuit board. In the former case, care should be exercised concerning the ground connections. As shown in the schematics, the analog digital grounds should be isolated from each other and merge only at the power supply common point.

Due to their size, etching and drilling guides and component layout for a double-sided pc board for the project are not reproduced here, but can be obtained by sending a self-addressed 9-by-12 envelope with two units of first-class postage to Dept. DDL, Editorial, POPULAR ELECTRONICS, One Park Ave., New York, NY 10016.

Outputs of the address counters (*IC14*, *IC15*, and *IC16*) should be kept as short as possible and as far away as possible from the input and output op amps. The use of IC sockets is recommended, and the proper installation of polarized elements must be observed.

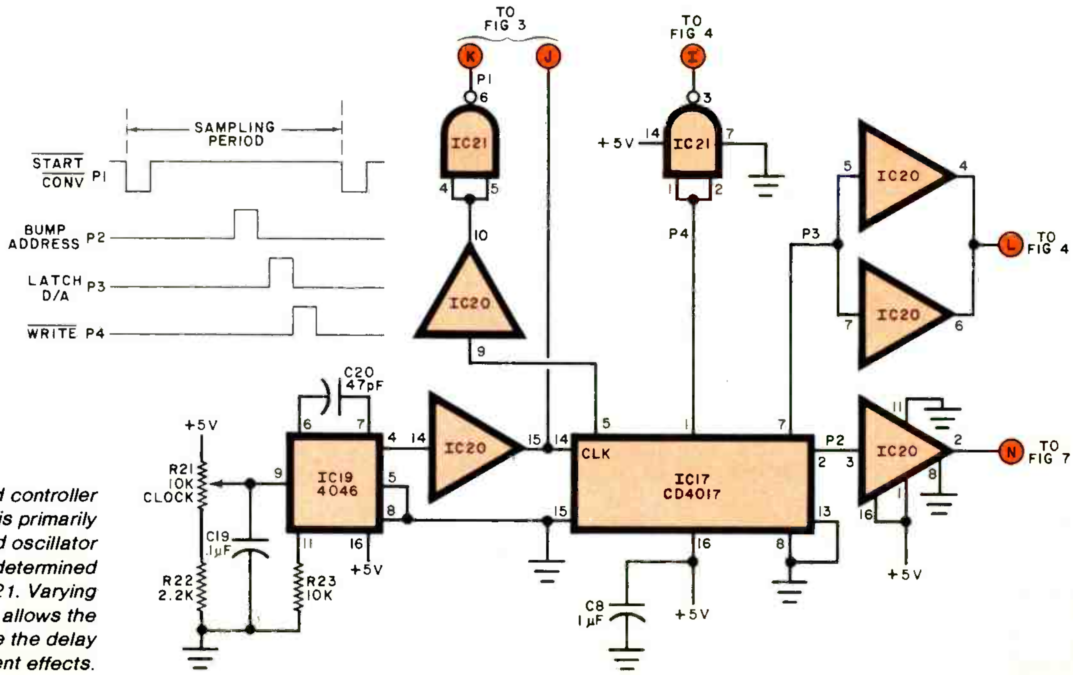


Fig. 6. Clock and controller circuits. This is primarily a voltage-controlled oscillator whose frequency is determined by the setting of R21. Varying the clock rate allows the user to change the delay and get different effects.

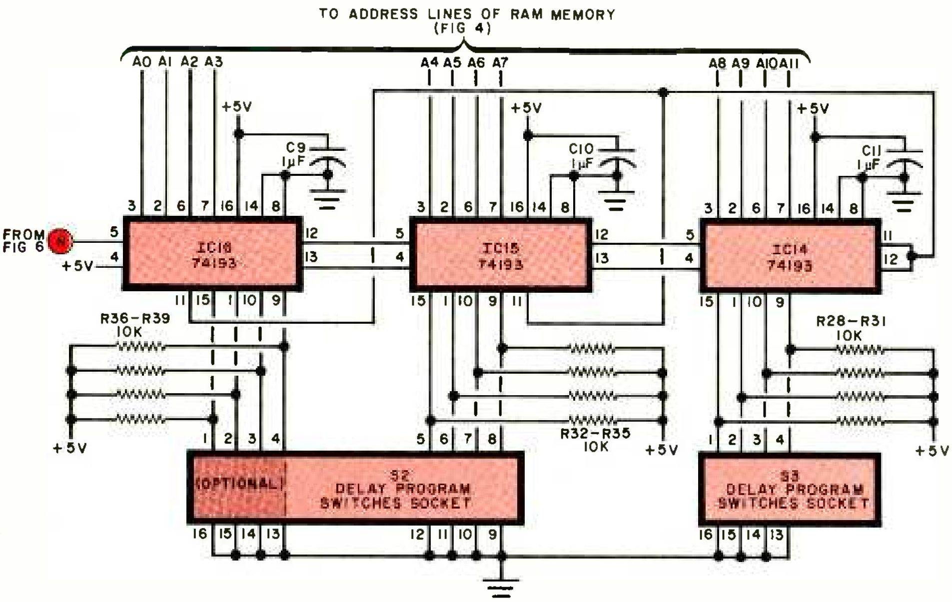


Fig. 7. Delay switching circuits. Three ICs are used to select the RAM memory addresses dialed in by the program switches S2 and S3.

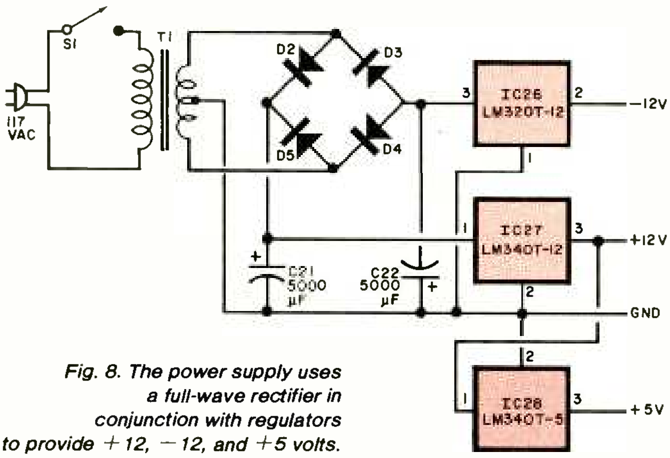
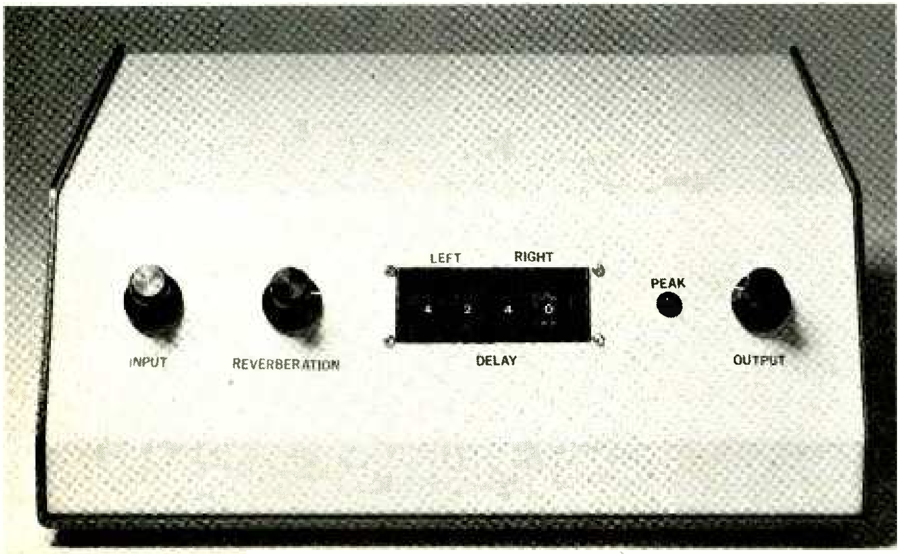


Fig. 8. The power supply uses a full-wave rectifier in conjunction with regulators to provide +12, −12, and +5 volts.



Front view of prototype showing input, output, and reverberation adjustments (see Fig. 9 on next page) and thumbwheel switches to determine delay for two channels.

After the board is completed, it can be installed in a suitable metal enclosure and interconnected as shown in Fig. 9. Although this illustrations shows a pair of thumbwheel switches used to select the delay, DIP switches, such as those used in computer boards, can be substituted. The input gain control, *R43*, output gain control, *R44*, reverberation control, *R45*, audio connectors, *J1* and *J2*, peak indicator, *LED1*, and the two delay-select switches can be mounted on the front panel. For stereo, dual potentiometers are used for *R43* through *R45*, along with two sets of thumbwheel switches and two peak indicator LEDs.

Adjustment. With the delay unit connected to an audio system as shown in Fig. 2, set *R14* and *R21* to their center positions. Place the delay switches (*S2* and *S3*) in the minimum configuration (all switches open). Then adjust echo (reverb) potentiometer *R45* for its minimum resistance, and the audio input control (*R43*) to its center rotation position.

Apply a 1-kHz sine-wave signal to the audio input (*J1*), and an oscilloscope to the *J2* audio output connector. With power turned on, adjust output control *R44* for a convenient scope display.

Increase the audio input level, either by adjusting *R43* or the audio signal generator's level control, until some clipping is noted on the output waveform. Successively adjust the input level and *R14* to obtain a symmetrically clipped sine wave. Then reduce the input level to just below clipping, so that a clean sine wave is displayed.

Increase the sine-wave input frequency to 5 kHz and adjust *R21* to minimize any serrated edges on the displayed waveform. Besides reducing noise, this adjustment also controls the sampling frequency (and bandwidth).

If an oscilloscope is not available, you can perform these adjustments by ear. Preset switches *S2* and *S3* for the desired amount of delay. Use a source of actual program material in place of the signal generator and your ears as "distortion monitors." Adjust the potentiometers for best audible performance. The results obtained by this method will, of course, be less accurate, but will be useful if care is taken in performing the adjustments.

With proper audio input levels, a 4-volt peak-to-peak signal should be seen at pin 7 of *IC1B* (A/D converter input). If you should require more gain, the value of *R1* (feedback resistor for *IC1A*) can be increased.

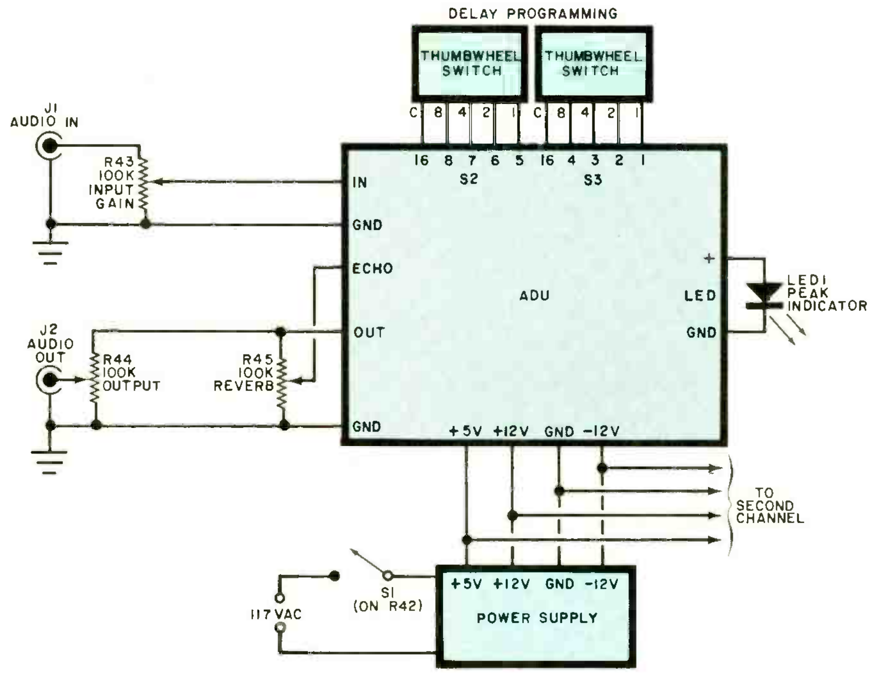
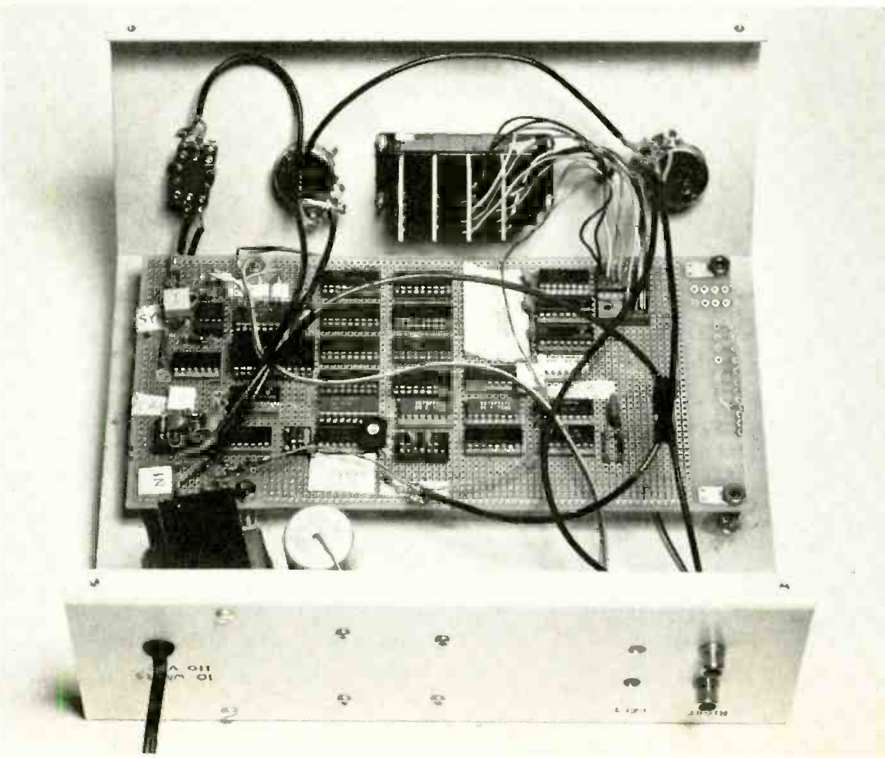


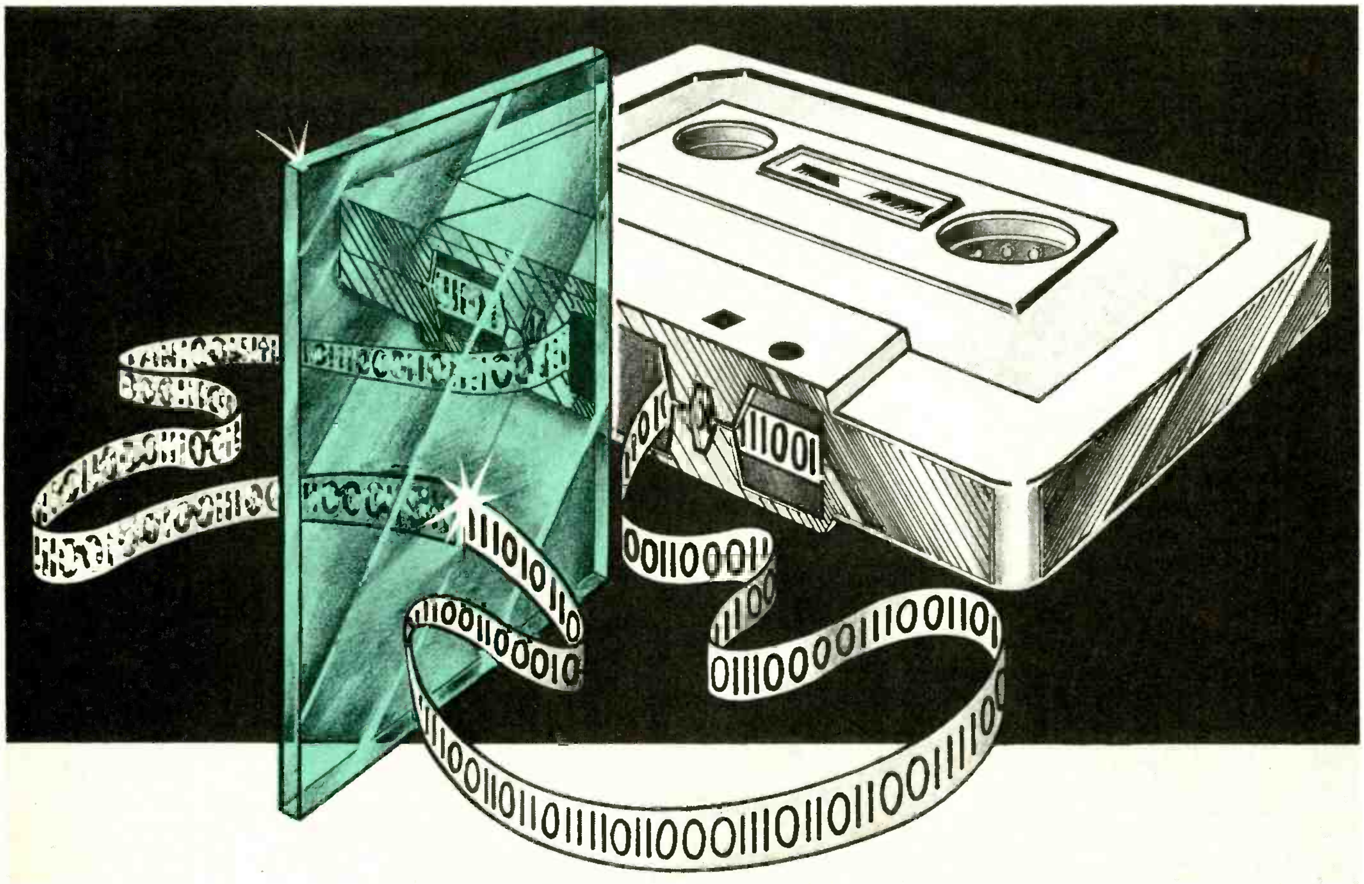
Fig. 9. Schematic of components that are not mounted on the printed circuit board. See photos below and on previous page for ways in which to locate the components.

The memory address counter (*IC14*, *IC15*, *IC16*) can be checked by setting *S2* and *S3* for maximum delay. This causes each of these IC's to count down by 16. An oscilloscope or frequency counter can then be connected to the A0 through A11 outputs of these ICs to note the decreasing frequencies.

A scope can also be used to follow the audio signal through to the A/D converter. The digital outputs of *IC18* vary with the applied audio signal. If a dc voltage level from zero to about 1 volt is applied to the input, the bit changes can be observed as the input voltage level is changed. Zero volts will produce all zeroes and 1 volt will create all ones, with 254 binary states between the two. ◇



Internal view of prototype shows arrangement of board and components on front panel.



HARDWARE-SOFTWARE TAPE CONDITIONER FOR TRS-80 COMPUTERS

BY CASS R. LEWART

Reshaping and retiming data pulses ends cassette-tape loading problems for BASIC and SYSTEM data

WHEN difficulties occur in loading data from a cassette tape into a microcomputer, it is usually because the commercial tapes being used are poorly duplicated. This is further compounded by the quality of the tape itself and even the inadequacies of home tape machines. In the case of the popular TRS-80, a narrow tape level setting range and fussy timing requirements exacerbate the problem. Though the "Peak-Reading Meter" in the February 1980 issue of POPULAR ELECTRONICS enables one to set the proper level quickly, it does not correct for poorly shaped pulses or timing jitter, both of which are major obstacles to successful loads. The Tape Regenerator project described here has been designed for this purpose.

The Regenerator is an advanced breed of tape-conditioning device. It is for use with TRS-80 Level II BASIC and machine language (SYSTEM) programs. Unlike other commercially available conditioners, it uses both hardware *and* software. As a result, the computer itself is used for curing timing problems. This permits properly timed backup copies to be made on a second recorder, which, without internal retiming, would produce backup copies that retain or worsen timing jitter.

How It Works. The ideal signal waveform and typical "good" and "poor" waveforms found on commercial copies of Level II programs are shown in Fig. 1. As shown in Fig. 1C, superimposed noise, power-line hum, amplitude distortion, and ringing and displacement of the data pulse relative to the clock pulse (timing jitter) can make it likely that the computer will lose bits. And a single lost bit, of course, makes the entire program useless.

Once a BASIC program has been properly loaded, a back-up copy of it can be made using the CSAVE command. Similarly, a backup copy of a machine language (SYSTEM) program can be

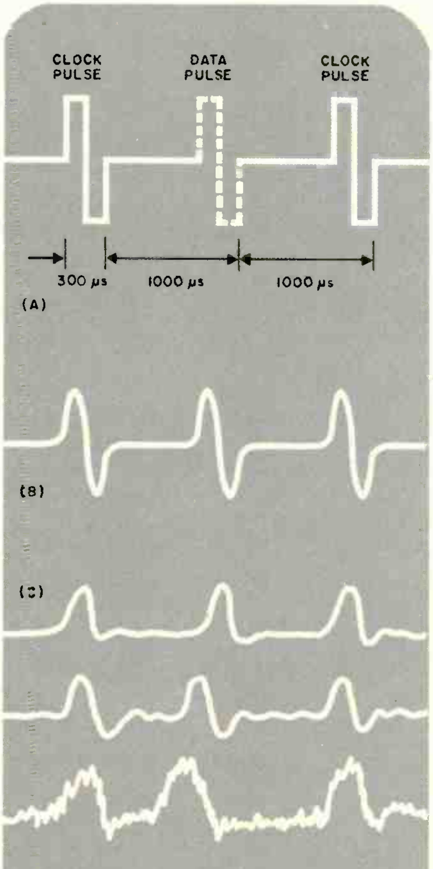


Fig. 1. Waveform (A) is "ideal." That at (B) is a good recording, while those in (C) show various distortions that can occur.

made with a monitor program, e.g. Radio Shack T-BUG. However, the original program must be readable and short enough to fit into memory without overwriting a monitor program.

The Tape Regenerator and the associated program, DUB3 (see Table), overcome these limitations by reshaping and retiming the pulses to produce new tape that the TRS-80 can easily read.

Multiple-segment programs (some programs feature a separate loader) or several programs on a single tape pose no problems for the Regenerator either. Operating on one pair of clock/data pulses at a time without storing the whole program in RAM as monitor programs do, the Regenerator allows even a TRS-80 computer with only 4K of RAM to make back-up copies of arbitrarily large programs and handle tapes containing multiple programs in a single cassette pass.

To test soundness of the Tape Regenerator design, the author created five generations of the same program and found that the fifth-generation tape would load as easily as the original.

Circuit Description. The circuit shown in Fig. 2 reshapes the clock and data pulses received from the tape recorder and feeds them to the computer. Audio transformer *T1* provides dc isolation between the tape recorder and the Regenerator circuit. Switch *S1* and diodes *D1* and *D2* allow selection of the "better" half of the pulse (see Control Adjustments later on), while zener diode *D3* and transistor *Q1* further shape the incoming signal. One OR gate in *IC1* decodes the IN command from the computer (via the *P1* connector) indicating that the computer is ready to accept data. When the command occurs, *IC1* (pin 8) then activates *IC2* (via pin 15) to allow the amplified tape recorder signals to pass via the connector *P1* and the expansion port to the computer data bus. Indicator *LED2* and optional meter *M1* indicate that the tape recorder is sending data at the proper level, and *LED3* glows when regenerating program DUB3 is up and running. If no back-up copies are required, *J2* provides a "quick and dirty" direct output to the TRS-80 via the tape-recorder plug. The signal at this point is not retimed and is only partially reshaped. This limited processing may make a tape readable.

Power for the circuit (Fig. 3), is provided by transformer *T2* in conjunction with voltage regulator *IC3*, bridge circuit *RECT1*, and capacitors *C1* and *C2*. Power on is indicated by *LED1*.

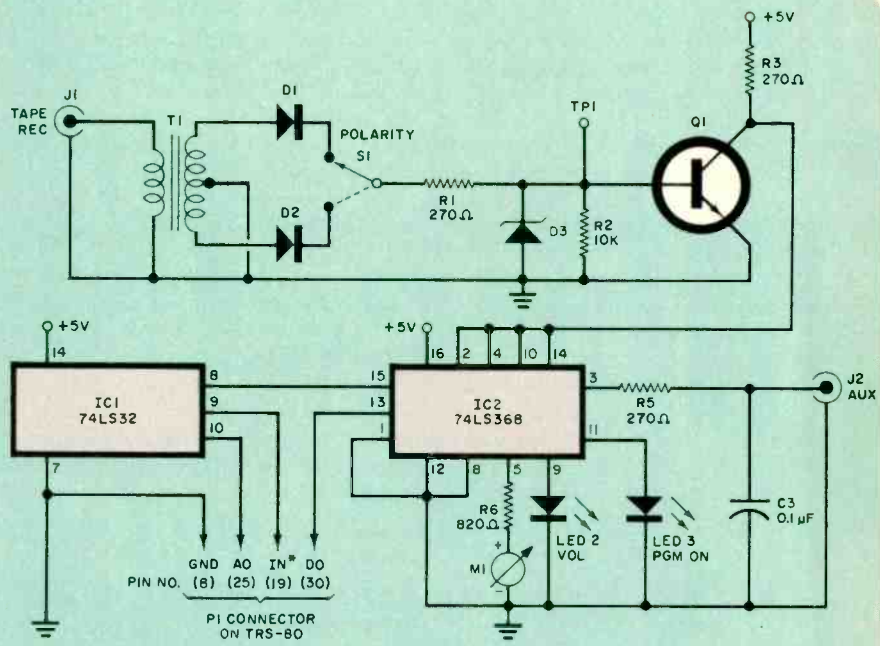


Fig. 2. The Tape Regenerator is controlled by signals from the TRS-80 that are determined by the DUB3 program. A second recorder is connected to the auxiliary output at jack J2.

PARTS LIST

C1—200-μF, 35-V electrolytic
C2,C3—0.1-μF disc capacitor
D1,D2—1N914 silicon diode
D3—3.9-V zener diode
IC1—74LS32 quad OR gate
IC2—74LS368 hex tri-state buffer
IC3—7805 +5-volt regulator
J1,J2—Miniature phone jack
LED1,LED2,LED3—Red light-emitting diode
M1—1-mA meter (Radio Shack 270-1752 or similar)
P1—2 × 20 edge connector on 0.1" centers to fit expansion port on TRS-80 keyboard or expansion interface
Q1—Npn Darlington Transistor (HEPS9100 or similar)
R1,R3,R5—270-Ω, ½-W resistor
R2—10-kΩ, ½-W resistor
R4,R6—820-Ω, ½-W resistor (optional)
RECT1—50-V, 1-A bridge rectifier
S1,S2—Spdt switch
T1—Audio transformer (Radio Shack 273-1380 or similar)
T2—12-volt transformer (Radio Shack 273-1385 or similar)
Misc.—Suitable enclosure, 2 DIP sockets (14 pin and 16 pin) line cord, solder, etc.

Note—The following is available from Southwest Technical Products, 219 W. Rhapsody, San Antonio, TX 78216, Dept. TR-1: complete kit of parts including a pc board and listing of DUB3 program in BASIC to allow POKEing into memory, but excluding M1, at $29.95 postpaid. Texas residents, add 4% sales tax.

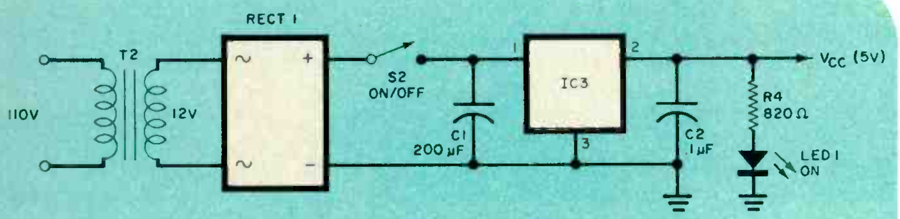


Fig. 3. The power supply is a simple rectifier-regulator circuit as shown here.

Construction. The circuit can be assembled on a small pc board, or Wire-Wrap techniques can be used. Keep all leads as short as possible. As only four contacts are used on the 40-pin TRS-80 connector, the remaining pins can be expanded with a screwdriver to make plug insertion easier. Before turning the power on, recheck all wiring, especially the leads to the computer expansion port.

Control Adjustments. To properly read a poorly recorded tape, polarity switch *S1* of the Tape Regenerator and the volume control of the tape recorder have to be set. These settings will vary from tape to tape. However, back-up tapes made by the Tape Regenerator or CSAVE command should all work with the same settings.

To determine the proper settings for an unknown tape, observe *LED2* and milliameter *M1*, or connect a scope to *TP1*. Play the tape at medium setting of the recorder volume control. Flip polarity switch *S1* and leave it in the position corresponding to a stronger signal as evidenced by a brighter LED, higher reading on the meter, or a cleaner pulse display on the scope. Optimum setting of the recorder playback level is found by advancing the volume control until *LED2* glows brightly, then backing off slightly. If optional meter *M1* is included in the circuit (see Fig. 2) adjust the volume control for a reading between 0.5 and 0.6 mA. As a final alternative, connect an oscilloscope to *TP1* and adjust the control for the cleanest, widest pulses you can.

Regenerator Program DUB3. The reshaping and retiming of Level-II clock and data pulses as received via the *P1* connector is performed by the DUB3 program.

After clearing the screen and displaying a message, the DUB3 program searches for a clock pulse. When one is found, the time interval to a second pulse is checked to make sure that the first was not a spurious transient. When the clock pulse is confirmed, it is output after a 200-µs delay using subroutine OUTPUT. This subroutine produces a clean signal lasting 300 µs as shown in Fig. 1A. A search for the data pulse now begins. The delay of 500 µs excludes any residual ringing from the preceding clock pulse. If no data pulse is found during the following 700-µs window, a search for the next clock pulse begins. If a data pulse is detected in the window, it is checked again to exclude a transient

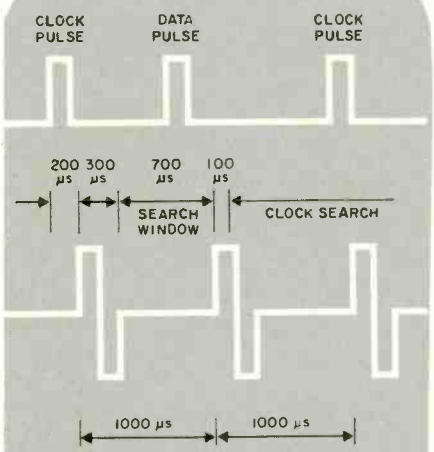


Fig. 4. Timing diagram of DUB3 program. Input at TP1 is at top. Below is output from computer.

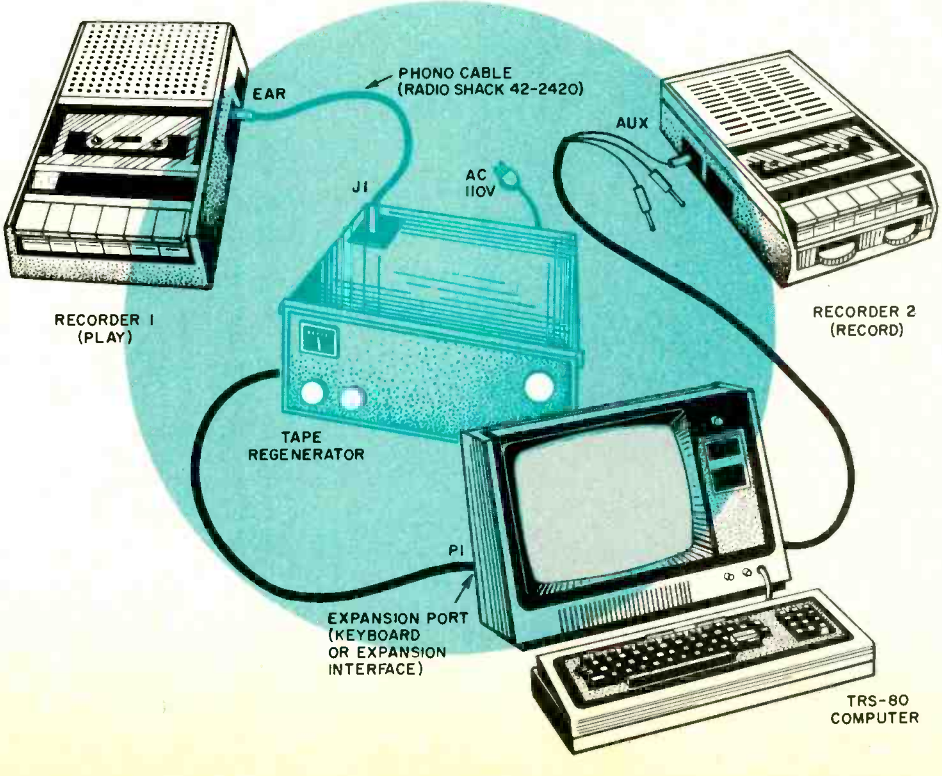


Fig. 5. Electrical interconnection of the Tape Regenerator to the TRS-80 computer and two tape recorders.

TABLE—LISTING OF DUB3 PROGRAM

```
PORT     EQU   00H
CENTER   EQU   04H
HIGH     EQU   05H
LOW      EQU   06H
DL100    EQU   0CH
DL150    EQU   12H
LEN1     EQU   14H
DL200    EQU   1AH
DL700    EQU   22H
LEN2     EQU   22H
CASS     EQU   0FFH
CLS      EQU   01C9H
LINE1    EQU   3DD6H
LINE2    EQU   3E0FH
         ORG   4A00H
DUB3     CALL  CLS           ;CLEAR SCREEN
         LD    HL,TAB1       ;DISPLAY LINE1
         LD    DE,LINE1
         LD    BC,LEN1
         LDIR
         LD    HL,TAB2       ;DISPLAY LINE2
         LD    DE,LINE2
         LD    BC,LEN2
         LDIR
START    LD    B,DL100       ;100 MICS DELAY
DEL0     DJNZ  DEL0
SRCHC    IN    A,(PORT)      ;START CLOCK PULSE SEARCH
         RRA
         JR    NC,SRCHC      ;CLOCK PULSE FOUND?
         IN    A,(PORT)      ;YES, TRANSIENT ONLY?
         RRA
         JR    NC,SRCHC      ;YES, KEEP SEARCHING
         LD    B,DL200       ;NO, SET 200 MICS DELAY
DEL1     DJNZ  DEL1
         CALL  OUTPUT        ;PUT OUT CLOCK PULSE
         LD    B,DL700       ;START 700 MICS READ WINDOW
SRCHD    IN    A,(PORT)      ;SEARCH FOR DATA PULSE
         RRA
         JR    C,FOUND1      ;FOUND?
         DJNZ  SRCHD         ;NO, WINDOW TIMED OUT?
         JR    START         ;YES, SEARCH FOR CLOCK PULSE
FOUND1   IN    A,(PORT)      ;TRANSIENT ONLY?
         RRA
         JR    C,FOUND2      ;NO
         DJNZ  SRCHD         ;YES, WINDOW TIMED OUT?
         JR    START         ;YES SEARCH FOR CLOCK PULSE
                             ;DATA PULSE FOUND,
FOUND2   INC   IX            ;WASTE 10 CYCLES
         BIT   3,(HL)        ;WASTE 12 CYCLES
         DJNZ  FOUND2        ;WINDOW TIMED OUT?
         CALL  OUTPUT        ;YES, PUT OUT DATA PULSE
         JR    START         ;SEARCH FOR CLOCK PULSE
OUTPUT   LD    A,HIGH        ;PULSE OUTPUT
         OUT   (CASS),A      ;PULSE HIGH
         LD    B,DL150       ;150 MICS DELAY
DEL2     DJNZ  DEL2
         LD    A,LOW
         OUT   (CASS),A      ;PULSE LOW
         LD    B,DL150       ;150 MICS DELAY
DEL3     DJNZ  DEL3
         LD    A,CENTER
         OUT   (CASS),A      ;RESTORE TO CENTER
         RET
TAB1     DEFM  'TAPE BACK-UP PROGRAM'
TAB2     DEFM  'COPYRIGHT (C) 1980 CASS R. LEWART'
         END   DUB3
```

and, if confirmed, is output at the end of the 1-ms interval that started at the beginning of the preceding clock pulse (Fig. 4).

A data pulse appearing any time between 500 μs and 1.2 ms after a clock pulse is thus correctly retimed to occur exactly 1 ms after the clock pulse. After a 100-μs delay, the program continues with the search for the next clock pulse. The DUB3 program can be loaded using the Radio Shack Editor/Assembler or by keying in the Z80 instructions. For a BASIC version of the DUB3 program which will POKE the instructions into memory see the Parts List.

Operating Instructions. The electrical interconnection between the Tape Regenerator, both tape recorders and the computer is shown in Fig. 5. Turn the computer and Tape Regenerator power off when plugging or unplugging the 40-pin connector at the rear of the TRS-80 keyboard.

If you have the Expansion Interface connected to your computer, use the Expansion Port on the left side of the Expansion Interface instead of the Expansion Port at the rear of the keyboard. When power is applied to computer and Tape Regenerator, *LED1* should glow and the MEMORY SIZE? prompt should appear on the video monitor. If the prompt does not appear, check connections, in particular the 40-pin connector, between the Tape Regenerator and TRS-80. Load the DUB3 program and run it. Light *LED3* (PGM ON) should glow as long as DUB3 is running. The program is in an infinite loop and will run until you depress the RESET pushbutton on the rear of the TRS-80, or turn the computer off.

For initial adjustment, start reading tape from tape recorder 1 and set polarity switch *S1* and the Tape Recorder volume control as explained under "Control Adjustments."

Rewind tape recorder #1 and start it in the play mode while starting tape recorder #2 in the record mode with a clean tape. When the program on tape recorder #1 is finished, *LED2* (VOL) will extinguish and meter *M1* will indicate close to zero. This is the signal for you to turn both tape recorders off. You can continue with as many tapes as desired. When finished, open *S2* to turn the Tape Regenerator power off, press the RESET button to return to BASIC, or turn the computer off. The 40-pin connector *P1* can be left plugged permanently into the Expansion Port as it does not interfere with the normal computer operation. If the pulse amplitude on the original tape is very unsteady or the pulses are imbedded in noise, regenerating the tape may not be possible. ◇

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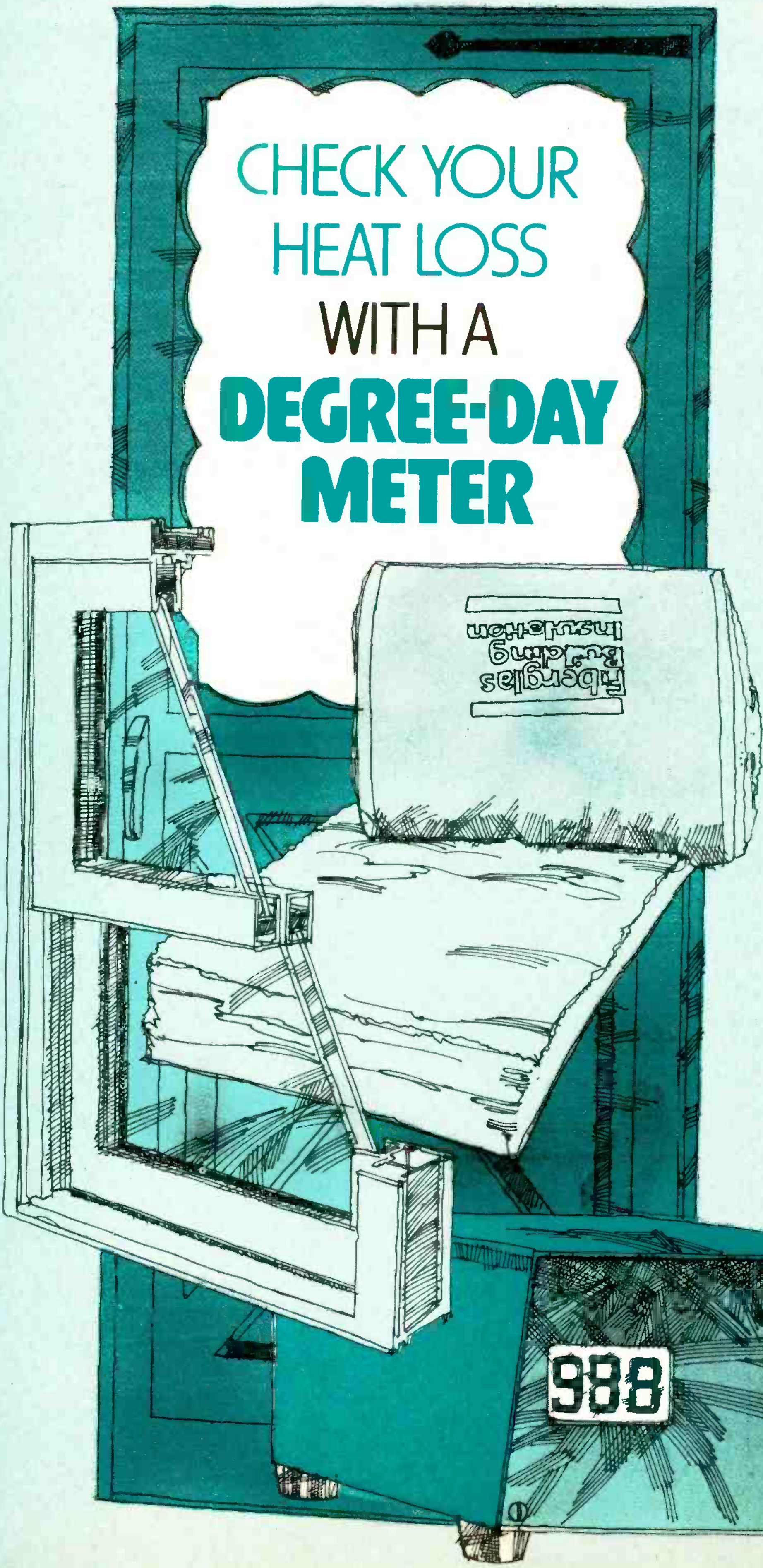
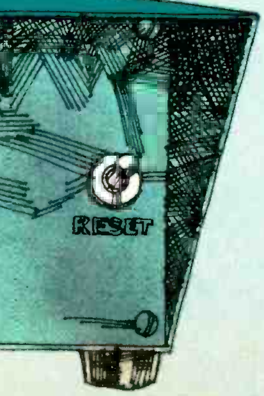




BY RUSH W. HOOD

Find out how well your weatherproofing and insulation work

Large amounts of money are being spent by homeowners today on insulation, storm windows and other means of reducing energy use and cost for heating homes. Gauging the effectiveness of these improvements, however, often requires months or even years of tabulations. Data garnered from supplier bills are often misleading owing to changing weather conditions that directly affect the amount of energy needed to maintain a desired temperature. The degree-day meter described here will allow you to compensate for changing weather and assess the true efficiency of your home's added weatherproofing. Moreover, using this device, only a day or two of observation will be needed to determine the effect of any improvement in insulation you have made.

Theory of Heat Flow. Were your home perfectly insulated, it would maintain a constant temperature without drawing on a source of additional energy. The temperature of an object is a function of the heat energy it contains, and cannot change without an inward or outward flow of energy. Unless artificial means (e.g. refrigeration) are used, heat always flows from a warmer reservoir to a cooler one, and at a rate proportional to the difference in temperature.

Insulation impedes the flow of heat between the two reservoirs. The situation is analogous to the flow of current in an electric circuit. The temperature difference, $T_{high} - T_{low}$, is equivalent to voltage; heat flow, Q, to current; and insulation value, R, to resistance. Thus, the equation $Q = (T_{high} - T_{low})/R$ resembles Ohm's law.

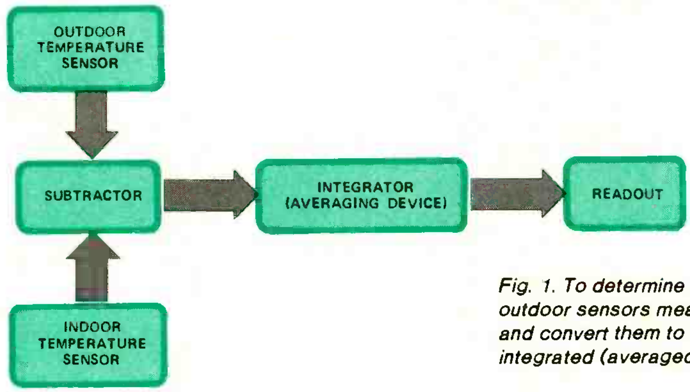


Fig. 1. To determine degree-days, the indoor and outdoor sensors measure temperatures and convert them to voltages, which are subtracted, integrated (averaged) and applied to readout.

If the temperatures inside and outside your home were constant for a long period of time, you could simply measure the temperature difference and the rate of energy use by reading the gas or electric meter and calculate the average insulation value of your building. Because the temperature of the outside air changes too rapidly to allow such procedure, the degree-day was devised.

A degree-day is computed from temperature readings taken at frequent, regular intervals throughout the day. These readings are subtracted from a reference temperature, usually 68°F, and the differences are averaged over one day. If a day is reported to have had 15 degree-days, for example, the energy needed to heat your home would have been the same as if outside had been 15 degrees cooler than inside all day.

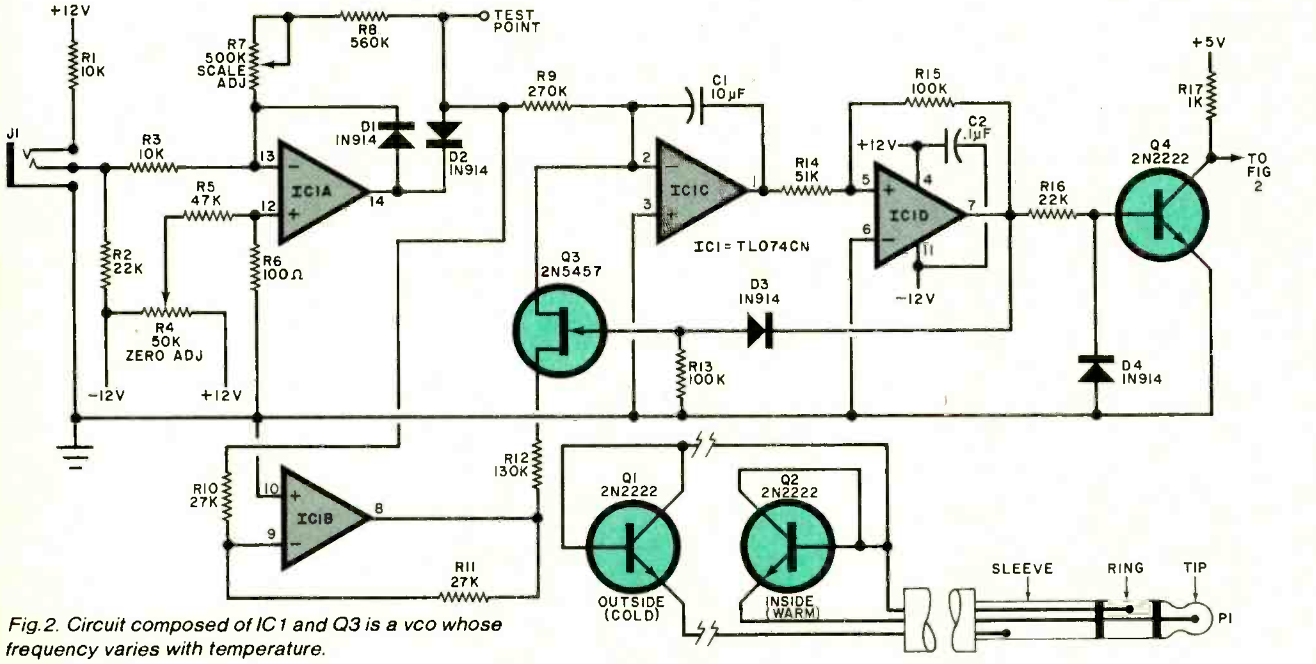


Fig. 2. Circuit composed of IC1 and Q3 is a vco whose frequency varies with temperature.

PARTS LIST

C1—10-μF, 25-V Mylar or polyester capacitor
C2—0.1-μF ceramic capacitor
C3—1000-μF, 25-V electrolytic
C4—100-μF, 25-V electrolytic
C5,C6—0.33-μF, 25-V tantalum capacitor
D1 through D4—1N914
D5,D6—1N4001 1-A, 50-V rectifier
DISP1,DISP2,DISP3—Common-anode display (MAN4610 or similar)
F1—1-A, fast-blow fuse
IC1—TL074CN quad BIFET op amp
IC2—74LS93 binary counter
IC3,IC4,IC5—74LS90 BCD counter
IC6,IC7,IC8—74LS47 BCD-to-seven segment decoder
IC9—7812 + 12-V regulator
IC10—7805 +5-V regulator
IC11—7912 −12-V regulator
J1—Open-circuit stereo phone jack
P1—Stereo phone plug
Q1,Q2,Q4,Q5—2N2222 transistor
Q3—2N5457 FET transistor (Radio Shack 276-2028)
The following are ¼-W, 5% carbon resistors unless otherwise noted:
R1,R3—10 kΩ
R2,R16—22 kΩ
R4—50 kΩ trimmer potentiometer
R5—47 kΩ
R6—100 Ω
R7—500 kΩ trimmer potentiometer
R8—560 kΩ
R9—270 kΩ
R10,R11—27 kΩ
R12—130 kΩ
R13,R15—100 kΩ
R14—51 kΩ
R17,R18—1 kΩ
R 19—4.7 kΩ
R20 through R41—1.2 kΩ
S1—Spst normally open pushbutton switch
T1—12.6-V, 1-A transformer
Misc.—Aluminum enclosure, printed circuit or perforated board, IC sockets, red plastic for display window, line cord and plug, strain relief, etc.

Note: The following is available from HLW, P.O. Box 1026, Beaverton, OR 97075: complete kit of parts for $97.50, plus $3.50, postage and handling. Also available from the same source is an etched and drilled printed circuit board for $9.00.

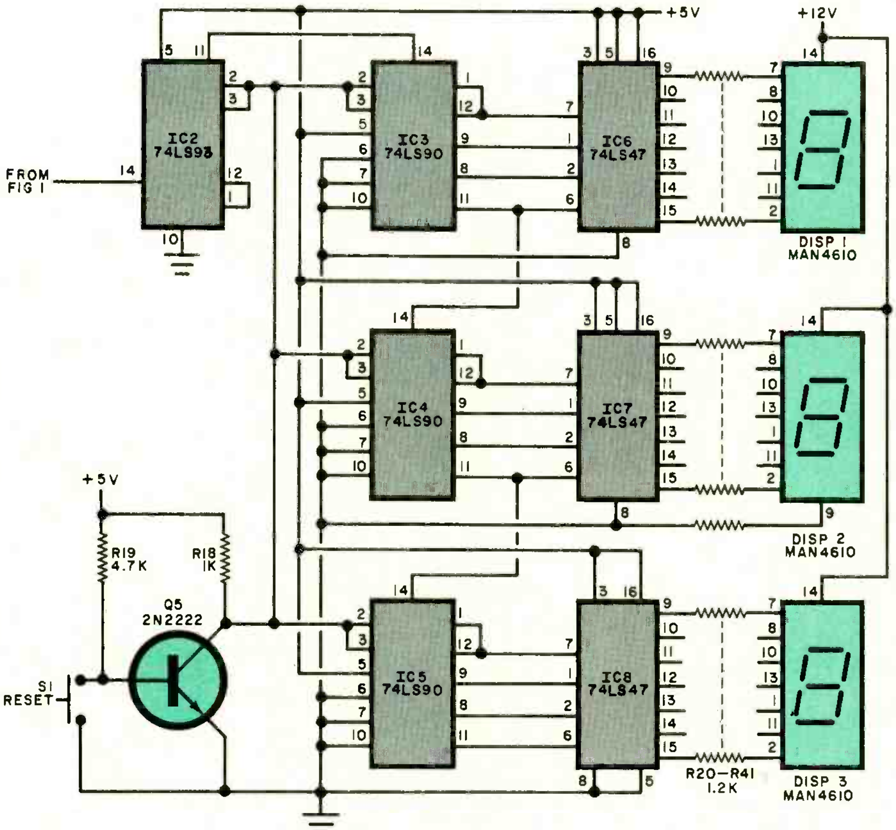


Fig. 3. Other than the divide-by-16 counter (IC2), digital circuit is conventional 3-digit counter, decoder and display.

Degree-days reported by your local weather service can be useful, but they may not be sufficiently accurate for critical measurements. Your inside temperature may not be the standard 68 degrees, and may vary through a 24-hour period. This degree-day meter project calculates the degree-days from the temperatures inside and outside your particular home.

How it Works. The meter continuously senses the indoor and outdoor temperatures, subtracts them and integrates the difference. Analog and digital circuit techniques are used to maintain the integration accuracy over long periods of time and to provide a numerical readout. The block diagram in Fig. 1 summarizes, in an easy-to-follow method, the device's operation.

Circuit Design. The subtracting and integrating circuits are shown in Fig. 2. Indoor and outdoor temperatures are sensed by silicon transistors *Q1* and *Q2*, which are connected as diodes. A constant current passing through a silicon diode junction develops a voltage drop that varies approximately linearly with temperature at a rate of 1.2 mV/°F. The two sensors are connected in series opposition, so that the voltages across them are subtracted. The difference voltage taken from the junction of the two transistors is proportional to the difference between the two temperatures.

Integrated circuit *IC1A* supplies enough gain to boost the difference signal so that it varies at a rate of 100 mV/°F. It also acts as a half-wave rectifier, making the meter insensitive to situations in which the outside temperature exceeds the inside temperature, which could happen on sunny days. Sections, B, C, and D of *IC1* and FET *Q3* with its associated components form a voltage-controlled oscillator (VCO) whose average output frequency is 160 cycles per degree-day. The output of *IC1A* is coupled to the inverting (−) input of integrator *IC1C* (which averages the signal) via R9 and to inverter *IC1B* through *R10*. The output of *IC1B* is coupled through *R12* and FET switch *Q3* directly to the inverting input of *IC1C*. When *Q3* is turned on, its drain-to-source channel resistance, coupled with *R12*, is one-half the value of *R9* and the *IC1B* signal to *IC1C* is twice that from *R9* and is of the opposite polarity. Thus, the integrator is fed with either a plus or minus 100-mV/°F signal depending on the state of switch *Q3*. A negative voltage applied to the gate of *Q3* turns the transistor off.

The integrator output is coupled to comparator *IC1D*, which has a hysteresis of 10 volts. The output of *IC1D* at pin 7 is either +10 V or −10 V depending on the polarity of the input signal with respect to ground. This output is coupled to the gate of *Q3* through diode *D3*. Assume that the integrator is developing a positive-going ramp at its output. When this reaches the trigger voltage of the comparator, the latter rapidly switches to its maximum positive output, which reverse biases *D3*. This turns *Q3* on and routes the inverted signal to the integrator, which now develops a negative-going ramp until the comparator switches to its maximum negative output. This turns off *Q3*, and the cycle is repeated.

The output of comparator *IC1D* is converted into a TTL-level signal by *Q4*. Diode *D4* is used to limit the negative-going signal to the base of *Q4*, while *R16* is the base-current limiting resistor.

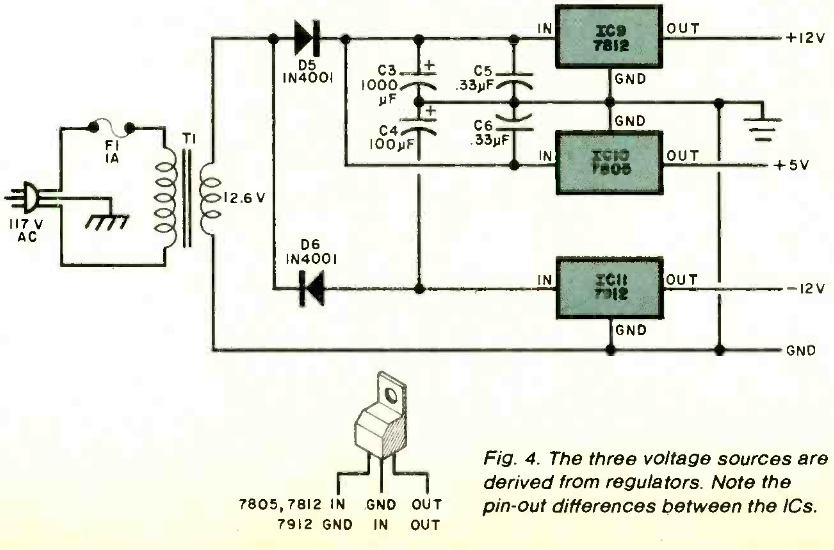


Fig. 4. The three voltage sources are derived from regulators. Note the pin-out differences between the ICs.

The TTL signal is used to drive the conventional 3-digit counter, decoder and display shown in Fig. 3.

The 160 cycles per degree day output from *Q4* is divided by 16 in *IC2* to provide a square wave having one cycle per tenth of a degree day. This signal is coupled to pin 14 of LSB counter *IC3*. Zero set is provided by depressing RESET pushbutton *S1* which places a ground on pins 2 and 3 (reset to zero) of the four counting ICs. Note that *DISP2* has its decimal point (pin 9) permanently activated by a resistor to ground.

The power supply, shown in Fig. 4, provides +5 volts for the TTL logic, ±12 volts for the analog circuit, and +12 volts for the seven-segment common-anode readouts. Be sure to observe the pin-out difference between the regulator ICs.

Construction. The meter can be constructed using the foil pattern shown in Fig. 5, or perforated board and Wire-Wrap techniques. If you design your own layout, arrange it so that the digital portion—especially *IC6*, *IC7* and *IC8*—are along one long edge. In this way, the three-digit display can be mounted on a separate small board that uses the display current-limiting resistors for electrical and mechanical interconnection.

Select an enclosure large enough to accommodate the circuit board and *T1*. A rectangular front-panel cutout (covered by a red filter) should be made for the three-digit display. RESET switch *S1* is also mounted on the front panel. Jack *J1*, the fuseholder and an insulating grommet for the line cord can be mounted on the rear apron. The 5-volt regulator *IC10* and +12-volt regulator *IC9*, which handle appreciable power, should be mounted to the rear apron to allow this wall to act as a heat sink. Capacitors *C5* and *C6* can be soldered directly to the respective pins on their regulators.

The sensor circuit (Fig. 2) is made by soldering the base and collector of each transistor together to form one lead. Select a length of slender two-conductor zipcord having sufficient length to reach the meter from each selected location. At one end, separate the leads for an inch or so. Remove about ¼-inch of insulation and slip a short length of narrow heat-shrinkable tubing on each lead, solder one to the base-collector lead and the other to the emitter lead. Slide the heat-shrinkable tubing down over the soldered connection and shrink it. The outdoor sensor (*Q1*) can be encapsulated in epoxy if it is not mounted in a weatherproof location. After both sensors are fabricated, connect the far ends of both pairs to the stereo-type phone plug.

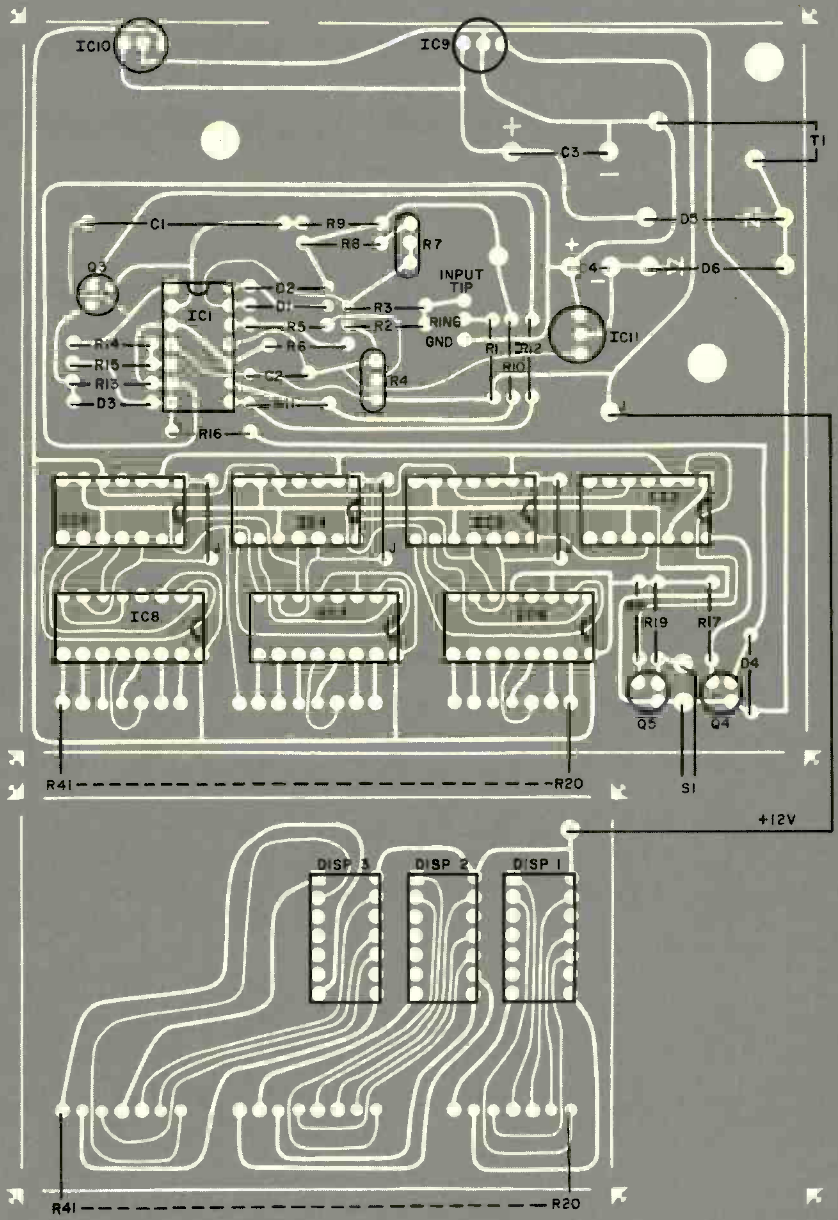
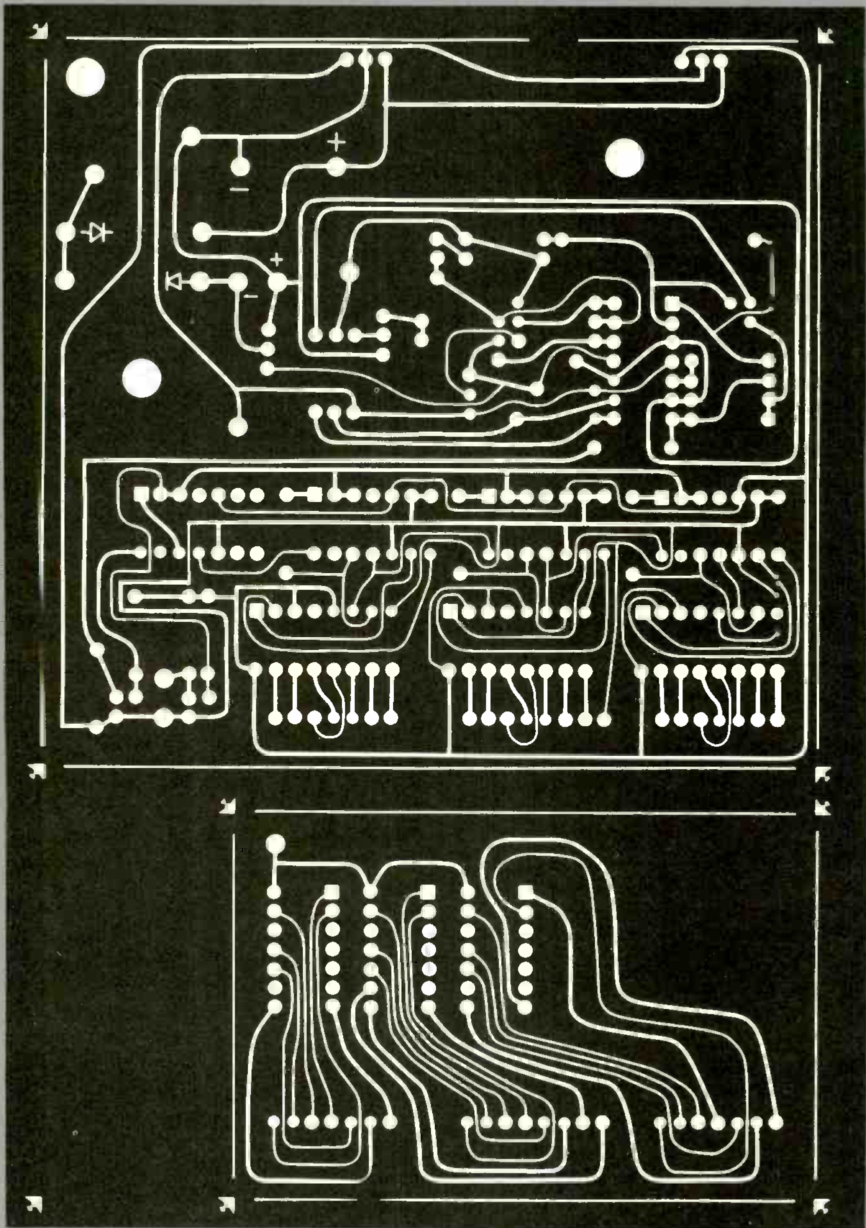


Fig. 5. The large foil pattern (opposite) is for the electronic circuit, while the smaller board below it is for the display. The two boards are interconnected by the current limiting resistors. Installation of these and other components is shown above.



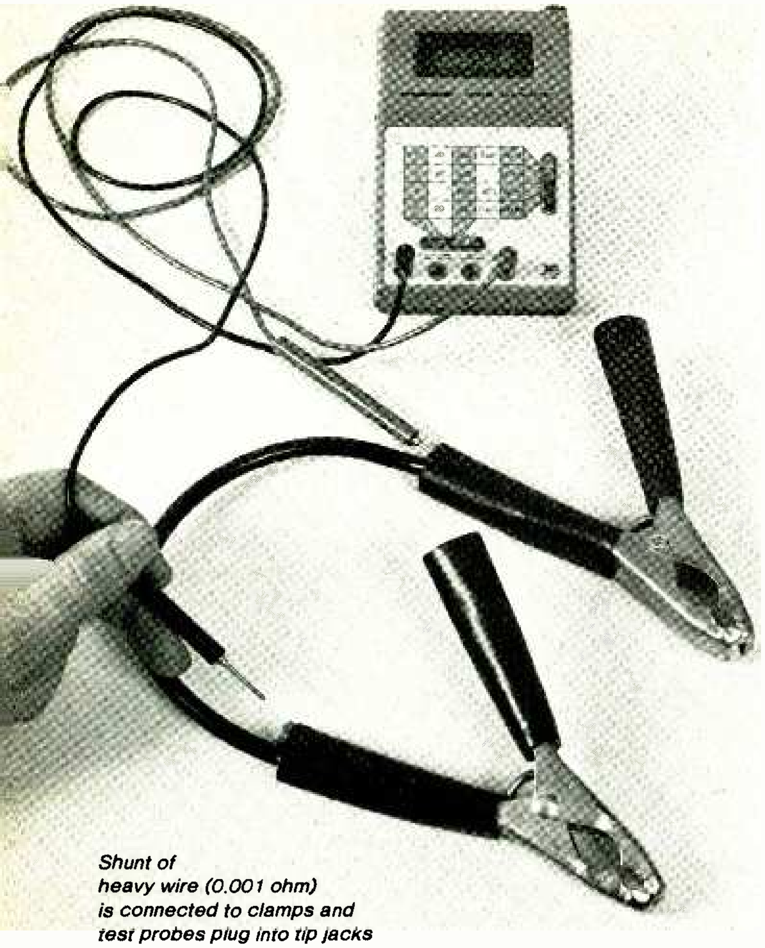
Operation. To calibrate the degree-day meter, all you will need is a dc voltmeter and an ordinary thermometer. Then proceed as follows: Connect the voltmeter between the test point shown in Fig. 2 and ground. Set the voltmeter for its most sensitive dc voltage range, and place the sensors close to each other. Turn on the degree-day meter, allow it to stabilize for 10 to 15 minutes, and then adjust *R4* for exactly zero volts on the dc voltmeter. Then place the outdoor sensor in a cool place (outdoors or in the refrigerator), and adjust *R7* until the voltmeter indicates −0.1 volt for every degree of difference in the temperatures between the sensors. For example, if the inside temperature is 70°F and the outside sensor is at 40°F, adjust *R7* for (70−40) × −0.1 or −3.0 volts at the test point. Install the sensors where desired and you're ready to measure degree-days. The outside sensor should be mounted in a shaded location away from the house and protected from the weather. The inside sensor should be mounted in a central location away from heat sources.

To start a measurement, depress RESET push button *S1*. The display should be "00.0" and should be observed to increment through the day if the outside sensor is cooler than the inside sensor. The greater the temperature difference between outside and inside, the faster the display will increment.

To measure actual energy efficiency of your home, you must measure the energy used over the same time interval that you measure degree-days. Your utility company can tell you how to read your gas or electric meter, or an elapsed-time meter may be connected to measure the total length of time the furnace is heating. Simply divide the energy (therms, BTUs, or kilowatt hours) by the degree-days to obtain a figure in energy per degree-day. This number should be nearly constant from day to day, and any improvement you make in your building's heat retention will lower this factor.

The degree-day meter can also be used to check your home's heat gain while air-conditioning is in use. Simply reverse locations of the inside and outside sensors. It is suggested that regular records be kept throughout the season to enourage conservation. It will be obvious from the efficiency determinations when real improvements are made in the weatherization of your home. (Note that frequent opening and closing of doors is tantamount to a reduction in insulation efficiency.)

Use of the degree-day meter can help a homeowner accurately estimate the payback period on money spent weather-proofing his building. ◇



Shunt of heavy wire (0.001 ohm) is connected to clamps and test probes plug into tip jacks in clamp handles to measure large currents.

Measuring Large Currents with a DMM

By using the proper shunt, a DMM can measure up to hundreds of amperes

BY ROBERT H. JOHNS

THE current-measuring function of digital multimeters (DMMs) is usually limited to 1 or 2 amperes at most. How then can one use a DMM to measure the tens or hundreds of amperes that may be associated with automotive starter and battery-charging systems, or heavy-duty appliances? The answer is: use a high-current shunt.

A DMM set to its current function really measures the voltage developed by a current in a known shunt resistance. Since all DMMs measure dc voltages, an internal rectifier is used to convert ac voltages to dc. Even though the DMM is operating as a voltmeter, the current function display is calibrated in milliamperes or amperes.

If the resistance of the shunt is low, a large current through it will develop only a small voltage drop. For example, as shown in Fig. 1, a shunt resistor of 0.001 Ω (one milliohm) will produce a drop of 0.001 volt for each ampere that flows through it. If a DMM is capable of displaying 0.001 volt at the least-significant digit (the one on the extreme right), this range can be interpreted directly in amperes. Thus, a display of 0.028 represents 28 amperes flowing through the 0.001-Ω shunt resistor.

Then there is the matter of wattage. Since the shunt is a resistor, a current flowing through it will develop heat that the resistor must dissipate. The power dissipated as heat can be calculated as $W=I^2R$, where I is the current and R the resistance of the shunt: thus a current of 50 amperes would develop 2500 milliwatts of heat.

Note that the shunt is, for all practical purposes, a short circuit and should not be connected directly across a power source. *Always place the shunt in* **series** *with the load!*

In all metallic elements including copper wire, resistance increases with temperature. Therefore, the thicker the wire the less the resistance change and the better the tolerance to I^2R heat build-up. Ambient temperature also affects conductor resistance. Commercial shunts often use manganin, an alloy that was specially developed to have very little resistance change with temperature. The typical experimenter may not have access to a manganin shunt, but he can use a heavy-duty cable specifically designed for very high current work—automotive jumper cables using multi-strand #10 wire.

Shunt Construction. Remove the clamps from one of the jumper cables and cut the cable to exactly 13.5 inches. Then, as shown in Fig. 2, remove 1.5 inches of the heavy plastic insulation from each end, being careful not to nick the wire strands. This leaves 10.5 inches of insulated wire. The electrical connections should be 11.0 inches apart, yielding a resistance of 0.001 ohm, taking into account the resistance of the clamps and soldered connections. Carefully separate one or two strands of wire from each end and cut them so that the ends are as close as possible to 11.0 inches apart. (Bear in mind that different samples of this wire may have slightly different resistances due to variations in manufacture.)

Carefully tape a tip-jack connector (see Figs. 2 and 3) to the end of the plastic insulation, then solder the loose wire strands to the electrical connector. Do the same at the other end.

Carefully solder together and mount the remaining bundle of wires to the hand clamp. Use a high-wattage soldering iron to make a secure electrical connection. Replace the heavy plastic sleeve over the connection. Do the same at the other end.

If desired, smaller clamps, or even banana plugs can be used at the ends of the shunt cable as shown in Fig. 4. Regardless of the termination used, make sure that the high current flows in the shunt and its end connectors and not through

(Continued on page 94)

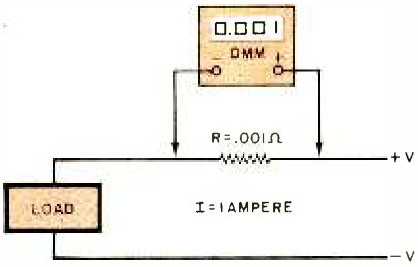


Fig. 1. Current can be read by measuring voltage drop across a known resistance.

PARTS NEEDED

Automotive jumper cables, tip jacks (Lafayette 32A65105, Allied 920-0292, Calectro F2-879 or 30-1080, or similar), or combination tip jack-and-banana connector (Lafayette 32A64850, Calectro F2-883, or similar), 50-ampere clamps (Mueller PK46A or similar), electrical tape, solder.

Note: A 0.001-Ω shunt is available for $5.95 plus $1 shipping and handling from R. H. Johns Scientific Instruments, 3379 Papermill Rd., Huntingdon Valley, PA 19006. Pennsylvania residents, please add 6% sales tax.

the jacks that feed the DMM.

If your DMM does not indicate to tenths of a millivolt, a 0.01-ohm shunt having a current sensitivity of 0.1 ampere per millivolt can be built. With this shunt, a DMM indication of 0.016 volt represents a current flow of 1.6 amperes. Use the same approach as previously described, but use 66 inches of #12 stranded copper wire with the tip jacks 65 inches apart.

To measure ac current, a conventional ac outlet box having one or two appliance sockets mounted on it with the 0.001-ohm shunt in series with one of the leads can be used. There is enough room within the enclosure to allow the shunt to be placed inside and the two tip jacks to be mounted on the upper plate. This approach is shown in Fig. 5. In this mode, use the ac voltage function of the DMM. Keep in mind that the tip connectors may be "hot" to ground so take all safety precautions when using this method of current measurement.

Accuracy. The shunt described in this article will be accurate to within approximately ± 3%. This value is dependent on the actual ohmic value of the shunt and resistance changes due to heating (I^2R losses).

The shunts' accuracy can be improved by connecting the shunt in series with a lab-grade ammeter, a suitable load and a power source capable of delivering several amperes. With a known value of current flowing (lab ammeter indication), note the DMM readout. It should be the same as the ammeter display. If not, the shunt can be trimmed until the two meters coincide. The amount of current flowing is not important, but the two meters should display the same readout. It is a relatively easy job to re-adjust the contact position of the tip jack connectors on the shunt to adjust the DMM indication.

If you wish to build your own "standard" resistor, consult the wire tables in any engineering book, or the ARRL *Radio Amateurs Handbook*. These list the

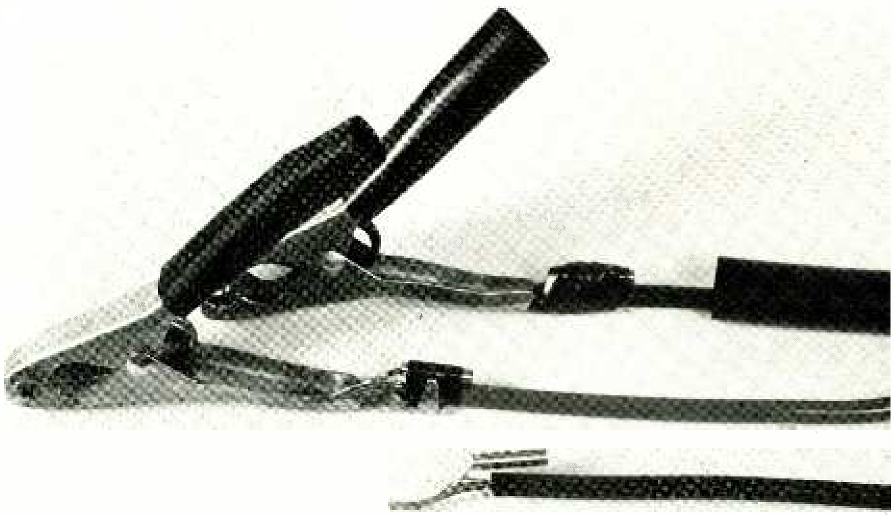


Fig. 3. Assembly of the tip jack and shunt cable to the clamp. After soldering, the large plastic sleeve is placed over the joint and clamp handle.

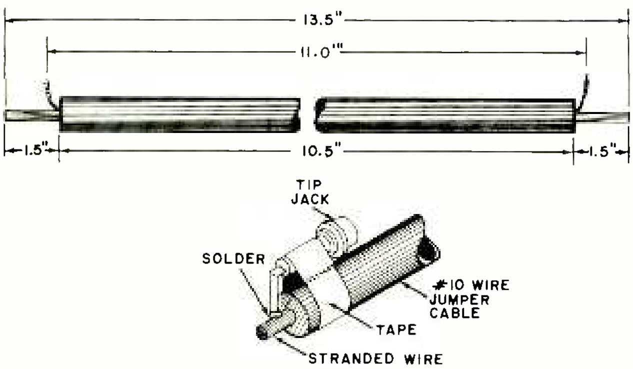


Fig. 2. As described in the text, a 0.001-ohm, high-power shunt can be constructed as shown here from a conventional battery jumper cable and a pair of standard tip jacks.

Fig. 4. Shunts can be terminated in banana plugs or small clips as shown here.

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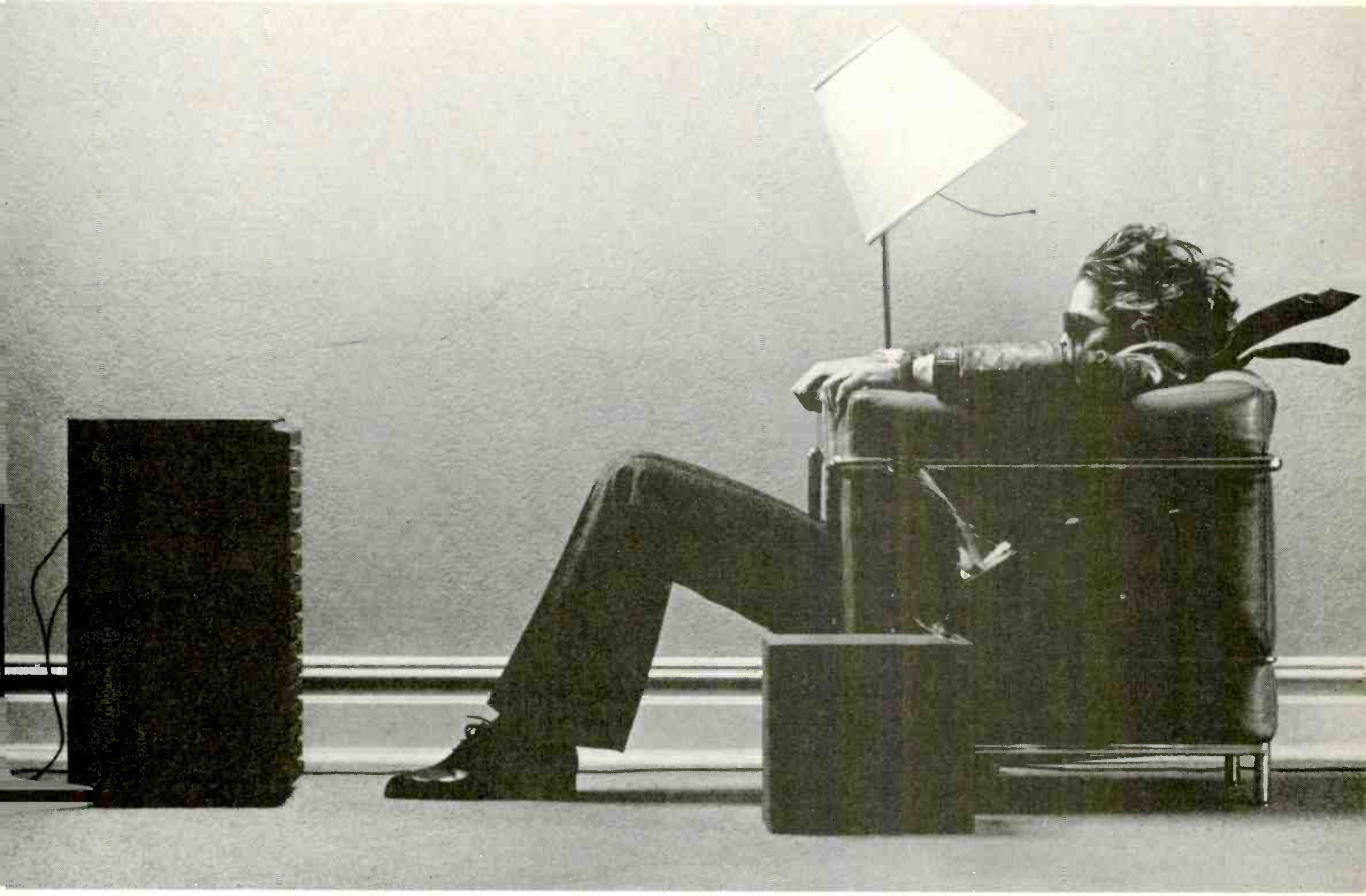

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Fig. 5. To measure ac current, the shunt can be coiled inside a conventional ac outlet box and the two tip jacks mounted on the top plate.

resistance of solid copper wire to four significant digits. For example, a 0.001-ohm resistor can be fabricated from 10 parallel strands of #16 Formvar or enamel-insulated copper wire, each strand 30.6 inches long. Scrape about 1/4 inch of the insulation from each end and, after affixing a flexible bare wire to make the connections to the tip jacks, solder the bundle together. To calibrate other shunts, connect them in series with your "standard" and adjust the lengths of the meter connections until both resistors generate the same voltage. Although a DMM is accurate on dc, on the ac functions, signals that are not sine waves can produce measurement errors. One common source of error is the unfiltered dc output from an automotive battery charger. The current measured across a shunt from the 60-Hz rectified charger can be as much as 18% low. However, the high-frequency, 3-phase rectified output from an automotive alternator is only a few percent low, not enough to worry about.

Although readers are encouraged to build for their own use the shunt technique described, many features described here are covered in patent applications now pending. ◇

SPECIAL COUNTER CIRCUITS FOR EXPERIMENTERS

Various combinations of the basic J-K flip-flop circuits provide many useful digital counting schemes

BY PATRICK J. DELANEY

WHEN the need for counting events in an electronic system arises, the most common solution is to use an asynchronous digital ripple counter. This circuit, shown in Fig. 1, consists of a group of J-K flip-flops set to toggle with each applied Clock pulse. The flip-flops are connected in cascade so that each Clock input is driven by the Q output of the preceding stage. The circuit provides a sequential binary-up count ranging from zero to one less than 2^N where N is the number of flip-flops in the circuit. While this arrangement finds wide use, it is only one of many useful digital counting schemes.

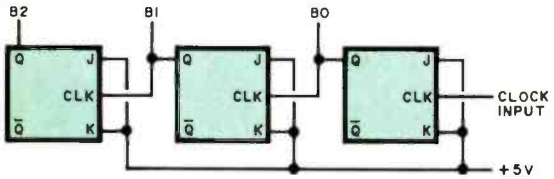
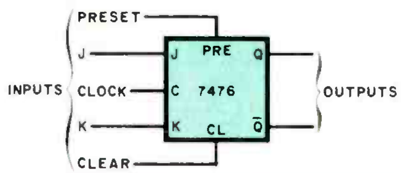


Fig. 1. Basic three-stage synchronous ripple counter.

Special counters make up a major class of flip-flop circuits. However, before these advanced configurations can be described in detail, a review of the J-K flip-flop is in order. A 7476 will be used as an example.

As shown in Fig. 2, a J-K flip-flop typically has five inputs and two outputs. The five inputs are Preset, Clear, Clock, J and K, while the two outputs are variously referred to as Q and not-Q, or some other alphabetic labels indicative of a variable and its complement. When a chain of flip-flops is used, the outputs are identified by a succession of alphabetic labels—A and not-A, B and not-B, etc.



INPUTS		OUTPUTS
PRESET	CLEAR	Q
0	0	Indeterminate (never used)
0	1	1 (SET)
1	0	0 (RESET)
1	1	Determined by J, K, and clock

Fig. 2. Details of the 7476 flip-flop and its truth table.

Preset and Clear inputs take precedence over all other inputs and are active low. This means that logic zero applied to the Preset input forces the Q output high (1). Alternately, Q would be forced low (0) by applying a logic zero to the Clear input. If both the Preset and Clear inputs are 1, the flip-flop's state will be determined by the J, K, and Clock inputs.

The last of the four possible combinations of these inputs is 0 for both Preset and Clear. This is contradictory in that it attempts to force Q high and low simultaneously (an impossible condition). The logic state of Q is thus indeterminate. The operation of the Preset and Clear inputs is summarized by the truth table shown in Fig. 2.

The J, K, and Clock inputs together form the second means by which the outputs may be changed. When these inputs are to be used, the Preset and Clear terminals are both tied high. When the J and K inputs are supplied signals as shown in Fig. 3, each time the Clock input is forced to switch from a logic 1 to a logic 0 (a negative edge), outputs take on the appropriate values. It should be noted that the J and K inputs alone have absolutely no effect on the flip-flop's output state. These two levels are clocked into the flip-flop by a one-to-zero transition at the Clock input. Figure 3 illustrates the effect of the four possible combinations of the J and K inputs on the Q output.

INPUTS			OUTPUT
CLOCK	J	K	Q
↓	0	0	Previous value
↓	0	1	0 (RESET)
↓	1	0	1 (SET)
↓	1	1	TOGGLE

Fig. 3. Effect of the J-K inputs on the Q output of the 7476.

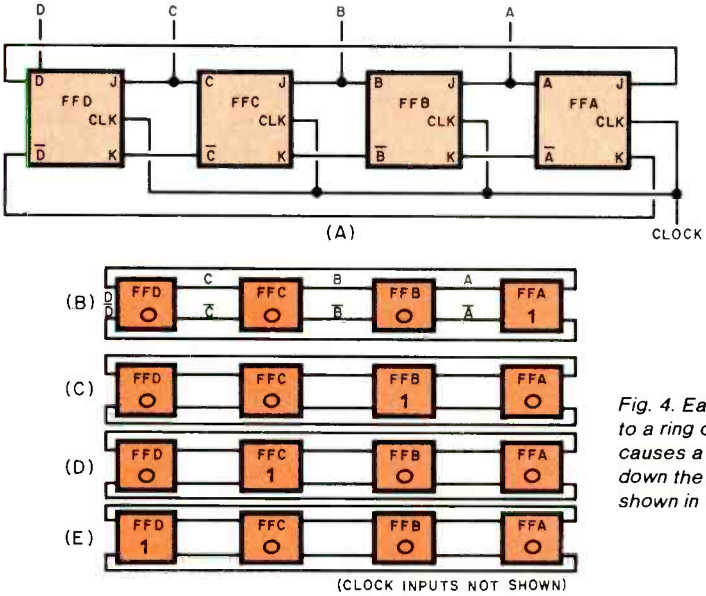


Fig. 4. Each clock pulse to a ring counter (A) causes a logic 1 to "walk" down the counter as shown in (B), (C), (D), and (E).

If both J and K equal 0, and a negative-going Clock pulse occurs, the Q output will remain unchanged. If J is equal to 1 and K equals 0 during the Clock edge, Q will become a logic 1 (set). When J equals 0 and K equals 1, a Clock pulse will force Q to equal 0 (reset). Finally, if J and K equal 1, the Clock will force Q to change its state or toggle. That is to say: if Q had been 0, it becomes 1 and if Q had been 1, it becomes 0.

Now that the operation of the J-K flip-flop is firmly within grasp, let us examine one of the special counters.

Ring Counter. A simple synchronous ring counter is shown in Fig. 4A. Note that the outputs of flip-flop D are fed back to the J and K inputs of flip-flop A, thus forming a "ring." The clock feeds all four clock inputs simultaneously. This circuit differs from most other counters in that its entire operation depends on the initial (power-up) states of its flip-flops. If, for example, output A equals 1 while outputs B, C and D equal 0 as in Fig. 4B, then the application of a single Clock pulse will set B, but Reset A, C and D because the J and K inputs of B were 1 and 0 (the condition for Set) the instant before the Clock pulse, but the J and K inputs of all of the other flip-flops were 0 and 1 respectively. The new condition is shown in Fig. 4C. The next Clock pulse will set C and reset A, B and D, as shown in Fig. 4D. Figure 4E shows how a third Clock pulse will Set D and Reset A, B and C. The final Clock pulse will cause A to set once again, and the cycle will repeat. Note that a lone 1 is shifted from right (A) to left (D) and then back around again. This changing pattern is responsible for the circuit's name. The 4-bit pattern shifted through the group of flip-flops, or register as they are collectively called, is not limited to a single 1, but can be any one of many patterns. These bit patterns can be forced into the register, before the application of Clock pulses, by the use of the Preset and Clear inputs. More complicated bit patterns can be generated by using more flip-flops.

CLOCK	D	C	B	A
1	0	0	0	1
2	0	0	1	0
3	0	1	0	0
4	1	0	0	0
5	0	0	0	1
6	0	0	1	0
7	0	1	0	0
8	1	0	0	0
9	0	0	0	1
10	0	0	1	0
11	0	1	0	0
12	1	0	0	0

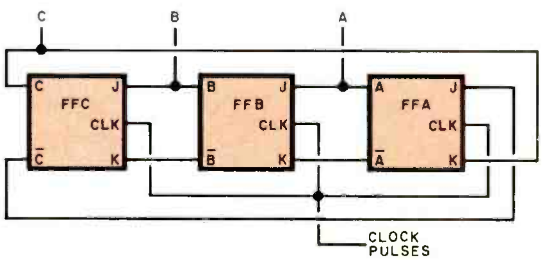
Fig. 5. Ring counter truth table shows how a 1 moves through the counter with successive clock pulses.

Ring counters are used primarily in the production of complex waveforms that generate timing pulses for computers, music synthesizers and similar systems. The voltage-versus-time waveform resulting from the truth table in Fig. 5 is easily obtained by simply turning the column on its side, and drawing a 5-volt waveform for each 1 and a zero-volt waveform for each 0. Note that the negative-going edge of the Clock triggers each transition of the outputs.

Shift Counters. A small change in the feedback from the last to the first flip-flop of a basic ring counter produces the shift counter shown in Fig. 6A. Unlike the ring counter, the shift counter is usually used as a synchronous event counter rather than as a waveform generator. Shift counters can easily produce any even modulus (number of states) count at extremely high rates of speed, with illegal states and high power consumption and component count being the only drawdacks. Another difference between the ring counter and the shift counter is that the latter does not have to be Preset to a specific pattern or starting state. The shift counter can naturally fall into the correct counting sequence.

A typical count sequence for a three-bit shift counter is shown in Fig. 6B. Whenver a Clock pulse occurs, the feedback connection between flip-flops C and A causes the inverse of the state of flip-flop C to be loaded into flip-flop A. This means that, when C = 0 before a Clock pulse, A will become the opposite of C (1) after the pulse ends. Conversely, if C is a 1 just before the Clock pulse, A will become a 0. This odd, but repetitive count scheme will produce the decimal count 1,3,7,6,4,0, which is obtained by converting each three-bit number in Fig. 6B to its decimal equivalent.

One question that often arises is: "What will happen if the state 010 or 101 occurs?" Since neither of these two states is part of the normal counting sequence, their effects should be determined. It has aready been established that the state of flip-flops A and B will ultimately be shifted to flip-flops B and C respectively, and that the inverted contents of C will be shifted into A after each Clock pulse. It is clear, then, that the state 010 (decimal 2) will force B to become the former state of A, C to become the former state of B, and A to become the inverse or opposite of C. It is



CLOCK	C	B	A	DECIMAL
↓	0	0	1	1
↓	0	1	1	3
↓	1	1	1	7
↓	1	1	0	6
↓	1	0	0	4
↓	0	0	0	0
↓	0	0	1	1

Sequence begins again

Fig. 6. Note the feedback from the last flip-flop to the first in a shift counter (left) with the truth table shown at right.

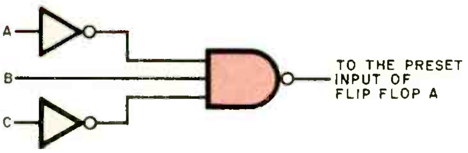


Fig. 7. Illegal state detector works in conjunction with the ring counter to avoid possible oscillation between 010 (decimal 2) and 101 (decimal 5).

as if all of the bits have shifted left by one position, while the most significant bit became complemented and replaced bit A. Thus, illegal state 010 (decimal 2) gives way to state 101 (decimal 5), while state 101 (decimal 5) gives way to the original state 010 (decimal 2). This means that either state, once entered, will cause an oscillation back and forth from decimal 2 to decimal 5, and the normal six-state count sequence will never be entered.

Since the initial application of power to a series of flip-flops creates a random state, it is possible that one of the two undesirable, illegal states will be entered at power-up. To prevent the 2-5-2-5 oscillation from persisting, a series of gates must be added to the basic shift counter. The purpose of this gating arrangement is to detect one of the illegal states and force legal counting to resume. Once the legal counting sequence begins, it continues to exclude the two undesired states.

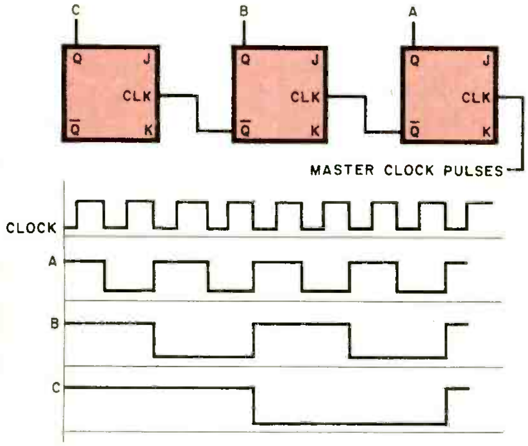
Logic state 010 can be detected by the arrangement shown in Fig. 7. The output of the NAND gate will become zero only when state 010 occurs at inputs A, B and C. This low level will instantly Preset flip-flop A, thus causing the state 011, or decimal-3 to be entered. From this point on, the shift counter will operate only in its legal six-state sequence.

Just as with the ring counter, a shift counter may employ any number of flip-flops. One or more count sequences containing a number of states equal to twice the number of flip-flops will always occur. Illegal states will also frequently exist and must be prohibited from occurring through the use of circuits similar to that of Fig. 7. It is left to the reader as an experiment to prove that a four-bit shift counter would produce two eight-bit sequences, one of which would generate very odd waveforms indeed!

Up/Down Counters. The last type of circuit falling into the category of special counters is the up/down counter. In its simplest form, the up/down counter is a variation of the basic ripple counter. In this circuit, each clock pulse causes a group of outputs to take on a binary value one larger than that existing previously. The primary reason for the ever-increasing count is the connection from the Q output of each flip-flop to the clock input of the next flip-flop. If the not-Q output of each flip-flop were used for this purpose, the count would decrease rather than increase. Occasionally, of course, the count would reach zero, at which point it would begin to decrease from the highest count again.

The logic and truth table for a down count are shown in Fig. 8. Note that all the flip-flops are wired so as to toggle with each input clock pulse. The toggle occurs on the negative-going trailing edge of the transition from 1 to zero. For example, the not-Q output of flip-flop A acts as a clock pulse for flip-flop B. Flip-flop B will not toggle (change state) each time the master clock input produces a negative edge, but rather when the not-Q output of flip-flop A switches from 1 to zero. In much the same fashion, flip-flop C responds only to the negative clock edges provided by the output of flip-flop B. The resulting count can clearly be seen to decrease rather than increase in the manner of a standard up ripple counter. A counting circuit that counts solely up or down can often be useful, but a circuit with the ability to count both up and down would in general, be even more useful. The previous discussion indicates that any ripple counter can be changed from count up to count down through simple rewiring.

However, true versatility can be achieved only by electronic control of the counting direction, using a circuit such as that shown in Fig. 9. This circuit makes use of the gating, or switching property of AND gates E and F. That property can best be summarized as follows whenever one input to the AND gate is a logic 1, the gate is said to be enabled, and the remaining gate input will be switched through to the output as if the gate were a piece of conducting wire. The inverter at the count up/down input will cause only the E pair of AND



CLOCK	C	B	A
1	1	1	1
2	1	1	0
3	1	0	1
4	1	0	0
5	0	1	1
6	0	1	0
7	0	0	1
8	0	0	0

Fig. 8. Three-stage down counter, its truth table and waveforms illustrating how counting takes place on the negative-going edge of the clock pulse.

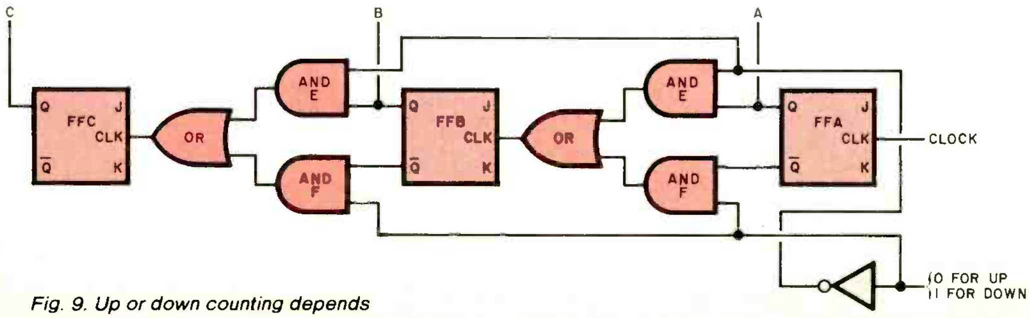


Fig. 9. Up or down counting depends on the signal applied to the inverter.

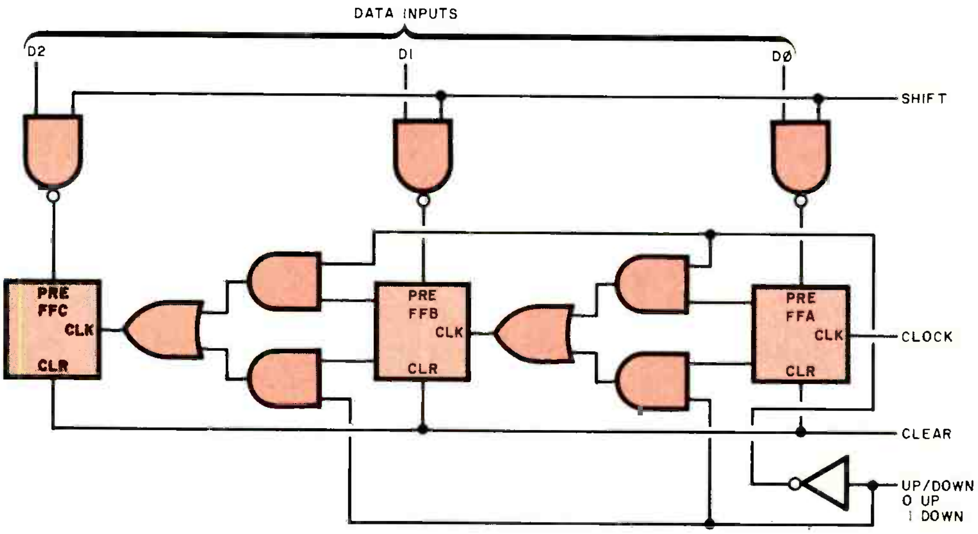


Fig. 10. One method of parallel data entry into an up/down counter. Data input can come from thumwheel or fixed switches, other digital logic, or even from a computer.

gates or the F pair of AND gates (but not both) to be enabled at any given instant. If the E pair is enabled, the Q output of each flip-flop serves as the clock input for the next flip-flop, since the F input to each OR gate will always be at logic 0, and the OR gate output will simply take on the value of the previous flip-flop Q output. This coupling of A to B clock and B to C clock will result in an up count.

If the count input is set to logic 1, the F-pair of AND gates will be enabled and each OR gate output will take on the value of the previous not-Q output. This is electrically similar to the circuit of Fig. 8. A down count will result because A is effectively gated to B clock, while B is effectively gated to C clock.

If the capability to load a given count into the up/down counter is provided, the utility of the circuit will be greatly enhanced. One approach which could be used to achieve parallel entry of data into an up/down counter is shown in Fig. 10. The application of a logic 0 to the normally high clear (CLR) line forces the Q output of all four flip-flops to a logic 0. This would be followed by a brief logic-1 shift pulse to load binary 1's into the appropriate flip-flops. The sequential application of clock pulses will now force the circuit to count up or down from this initial value. The operation of this circuit can essentially be duplicated by a conventional TTL 74193 IC with two small exceptions. The 74193 is an up/down decade counter and, as such, will count only to 1001 (decimal 9) before resetting to 0000. The second minor difference between the circuit of Fig. 10 and the 74193 is the method of parallel data entry. The IC abandons the cumbersome, two-step Clear-Shift approach for a simple one-pulse load technique.

The combination of a 74193 and a BCD-thumbwheel switch (for ease of entry of the initial count) can be used to produce a handy count down timer using the logic shown in Fig. 11. If the clock period is one minute, the circuit will require a number of minutes equal to the initial setting of the thumbwheel switch to reach the 0000 state. The BCD outputs of the 74193s are also used to activate a transistor (*Q1*) and alarm circuit. Thus, the parallel-loading down counter can be used as a presettable timer. Notice that the eight counter outputs are effectively NORed by diodes *D1* through *D8* and *Q1*. If any counter output is at logic 1, transistor *Q1* will be held on and will bypass the alarm. Only when all counter outputs are at logic 0 will *Q1* switch off and permit current to flow to the alarm. ◇

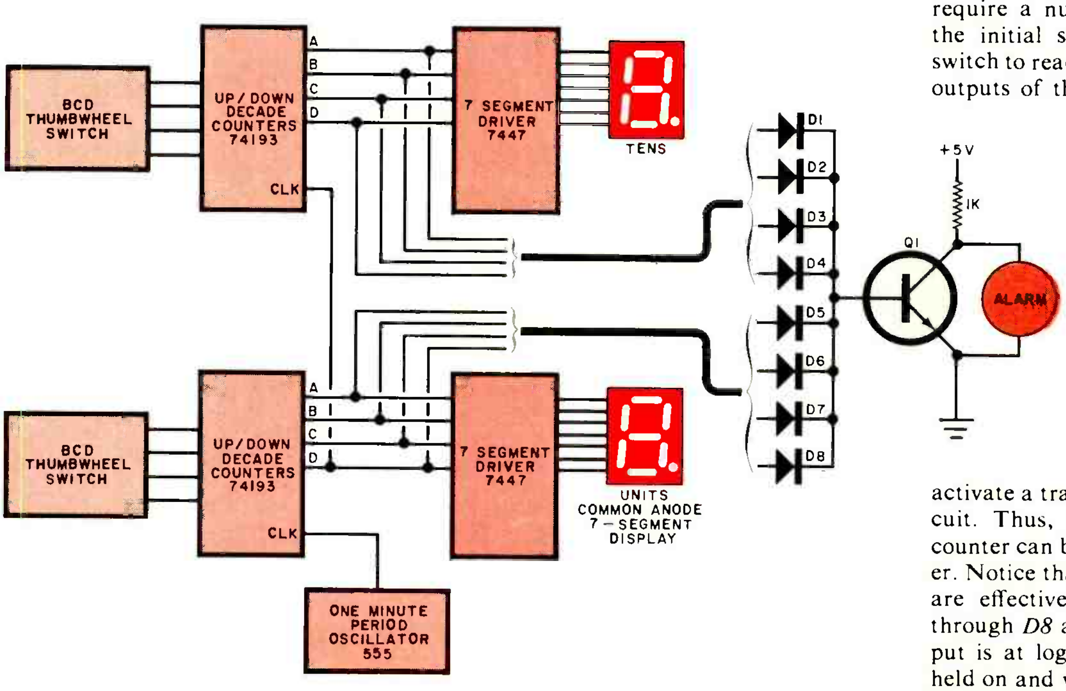


Fig. 11. Down counter sounds the alarm when the counters decrement to zero from the data inserted via the thumbwheel switches. In this case, there will be one decrement per minute.

ACTIVE FILTER
IMPROVES MORSE CODE READABILITY

BY LOU DEZETTEL

Outboard filter for low-cost rigs improves selectivity and reduces interference

FOR learning or brushing up on Morse Code skills, it's hard to beat listening to and trying to "read" CW transmissions right off the air. Even though high transmission speeds and, sometimes, sloppy keying may make these signals frustrating for beginners, machine-perfect code at calibrated speeds is sent by W1AW, home station of the American Radio Relay League. The schedule of transmissions is given in the table; all you need to listen in is a general-coverage receiver with a bfo—providing that it is selective enough.

If your receiver is not selective enough, the Code Filter described in this article should help. It is meant to be connected between a receiver's audio output and a user's headphones (or audio amplifier) to sharpen the apparent selectivity and eliminate the interference that would otherwise make CW hard to read. The design is active, with a bandpass centered on 600 Hz and narrow enough to greatly reduce the effect of interference at neighboring frequencies. The center frequency of 600 Hz was chosen to provide a pleasant, nonfatiguing tone for the user.

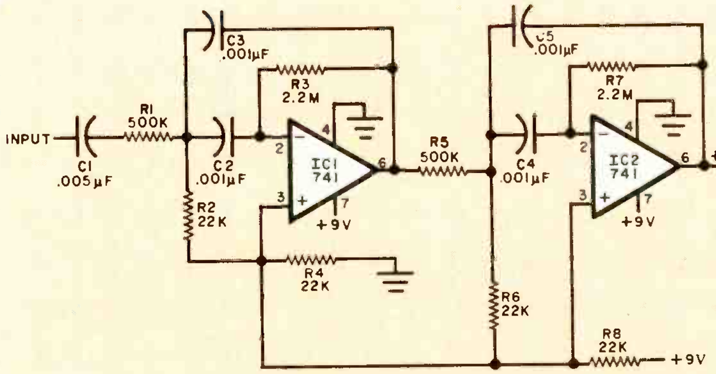


Fig. 1. Circuit for the Code Filter consists of cascaded pair of active stages formed by op amps IC1 and IC2.

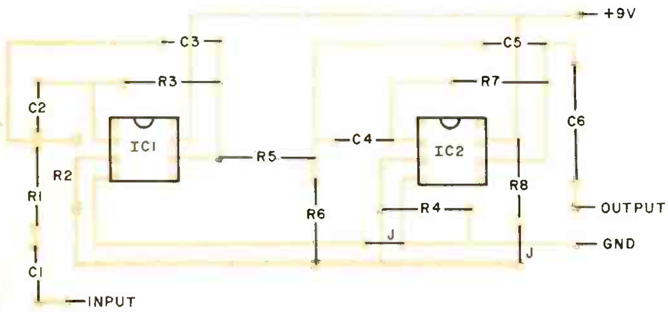
PARTS LIST

C1—0.005-μF capacitor
C2,C3,C4,C5—0.001-μF capacitor (C3 and C5 must be closely matched)
C6—5-μF, 25-V electrolytic
IC1,IC2—741 op amp
R1,R5—500-kΩ, ¼-W resistor
R2,R4,R6,R8—22-kΩ, ¼-W resistor
R3,R7—2.2-MΩ resistor (must be closely matched)
Misc.—8-pin IC socket (2, optional), spst switch (optional), battery holder and connector, suitable connector for audio jack, small enclosure, mounting hardware, etc.

Circuit Operation. The circuit, shown in Fig. 1 consists of a cascaded pair of active stages formed by op amps *IC1* and *IC2*. With the component values shown, the bandpass peaks at about 600 Hz and is 100 Hz wide at the −6-dB points.

The frequency-determining components are *R2*, *R3*, *C2*, and *C3* connected to *IC1*, and *R6*, *R7*, *C4* and *C5* with *IC2*. Corresponding components of each stage should be closely matched to keep the two filters at the same peak frequency and bandpass. Components not affecting frequency may have ±20% tolerance in their values.

Because of its high input impedance,



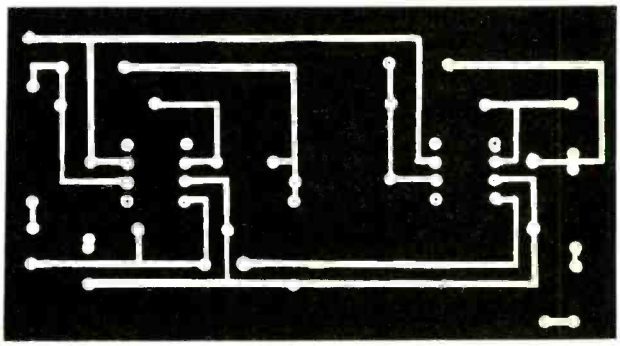


Fig. 2. Component placement guide for the Code Filter is shown at left, and actual-size pc board foil pattern is at right.

the filter will not appreciably load any circuit to which it is connected. The audio output can feed loads as low as 300 ohms without degrading the filter performance. (Most hi-fi phones have lower impedances and will not work.)

Construction. Although a pc board is not a necessity, an actual-size foil pattern and component installation is shown in Fig. 2. If desired, the circuit can be created using Wire-Wrap or any other assembly technique.

Since the circuit requires only 1.2 mA when operating, a conventional 9-volt battery will have a reasonably long life. If the receiver being used for code reception has a power supply between 5 and 30 volts, this voltage can be used to power the filter. Keep in mind, that if more than 20 volts or so is used, the rating of *C6* will have to be increased accordingly. Maximum supply voltage for the op amps is 30 V. An optional power switch may be used to remove the voltage from the filter when not in use.

The filter can be mounted within the receiver case or in a small outboard enclosure. Audio input can be taken from the earphone jack, if provided with the receiver, from the loadspeaker connections, or from a low-level audio circuit.

W1AW CODE PRACTICE SESSIONS

Speeds: 5, 7½, 10, 13, and 15 wpm

	EST	PST
Mon.	9 a.m., 7 p.m.	6 a.m., 4 p.m.
Tues.	4 p.m., 10 p.m.	1 p.m., 7 p.m.
Wed.	9 a.m., 7 p.m.	6 a.m., 4 p.m.
Thur.	4 p.m., 10 p.m.	1 p.m., 7 p.m.
Fri.	9 a.m., 7 p.m.	6 a.m., 4 p.m.
Sat.	4 p.m., 10 p.m.	1 p.m., 7 p.m.
Sun.	4 p.m. 10 p.m.	1 p.m., 7 p.m.

Speeds: 10, 13, 15, 20, 25, 30, and 35 wpm

	EST	PST
Mon.	4 p.m., 10 p.m.	1 p.m., 7 p.m.
Tues.	9 a.m., 7 p.m.	6 a.m., 4 p.m.
Wed.	4 p.m., 10 p.m.	1 p.m., 7 p.m.
Thur.	9 a.m., 7 p.m.	6 a.m., 4 p.m.
Fri.	4 p.m., 10 p.m.	1 p.m., 7 p.m.
Sat.	7 p.m.	4 p.m.
Sun.	7 p.m.	4 p.m.

Frequencies: 1.835, 3.58, 7.08, 14.08, 21.08, 28.08, 50.08, 147.555 MHz.

Use. With the filter connected to the receiver audio, and a suitable amplifier or headphones connected to the filter output, tune in the desired CW transmission, and note the very sharp "peak" that occurs with filter use. It becomes very easy to "fine tune" the receiver, or its bfo, to produce a clean CW signal at the filter output. A dramatic falloff of interfering signals indicates that the filter is working properly. ◇

NOW AVAILABLE!

WATT WIZARD™

*POWER FACTOR CONTROLLER CUTS THE COST OF RUNNING ELECTRIC APPLIANCES BY AS MUCH AS 50% -- AND YOU CAN EVEN **SEE** THE SAVINGS!*

MERCURY 1980©

National Aeronautics and Space Administration Patent No. 4,052,648

For over a year now, in magazines and newspapers the world over, there have been enthusiastic write-ups on a remarkable new device that can cut your electric bill while helping the U.S. save huge quantities of fuel.

"The NASA/Nola power saver," wrote a **Popular Science** senior editor, "was developed by Frank Nola at NASA's Flight Center in a program to reduce power consumption in space-craft motors. Nola calls it a PFC — power-factor controller. I prefer to call it a power saver, however, because that's what it does."

NASA TESTED IT

According to NASA documents, "The device has been tested at Marshall Center on over 40 types of motors, with power savings ranging up to 60%, depending on the loading. The motors tested were both single-phase and three-phase, ranging from ½ H.P. to 5 H.P. Most motors will show up to 40 — 50% savings when running lightly loaded or unloaded, and some will show 5-to-7% savings at rated load."

NASA's Technical Support Package showed that "The Power Factor Controller applies to induction type electric motors — the most commonly used type in all major home appliances and the most commonly used by industry."

HOW IT SAVES POWER

Popular Electronics explained it this way: "AC induction motors characteristically run at a nearly constant speed that's fixed by power-line frequency and independent of load and supply voltage. When heavily loaded, the motor draws line current that is nearly in phase with the applied voltage...Under light load conditions, the motor develops less torque by allowing more lag between the voltage and the current. This reduces the power factor while leaving the current essentially the same in magnitude.

"To minimize this waste, Nola's device monitors the motor's power factor and when it detects light load conditions, it reduces the supply voltage...... The current, now more nearly in phase with the voltage, therefore does as much useful work as before, but it and the voltage are smaller, resulting in a net savings of electric power."

THE SAVINGS CAN ADD UP

The cost of electric power keeps going up. In 1980-81 and beyond you'll pay more and more for the privilege of running your electric appliances.

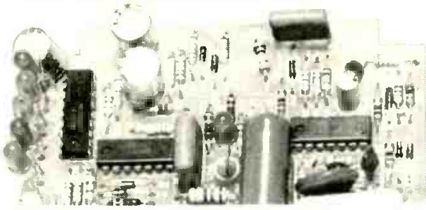
Right now, the typical consumer pays about $8 per month to operate a 16.5 cu. ft. frost-free freezer...$10 to run a 17.5 cu ft. frost-free refrigerator...and about $60 for an air conditioner used during summer months. That's what you're paying to run just **one** of these appliances per year.

Nola's power saver can soon pay for itself, then start reducing your electric bills. Until now, the device has not been **available** — except for industrial models priced at $80 or more.

INTRODUCING THE WATT WIZARD

Cynex, an American manufacturer of electrical and electronic products and a prime contractor for the U.S. Army, has been licensed by NASA to manufacture Frank Nola's power saver. Cynex calls it the Watt Wizard.

The "Watt Wizard" says Ray Beauchea, the firm's **Marketing Director**, regulates the voltage fed into an induction motor making the motors run more efficiently and quieter, while lengthening motor life.



The Watt Wizard features a unique, constant power saving readout. So you can constantly monitor you're energy savings.

SIMPLE TO USE

Cynex makes several models of the Watt Wizard (all with solid state design), including the 110 v. AC plug-in model we're offering. It's for single phase fractional H.P. motors (less than 1 H.P.) used in most freezers, refrigerators, fans, swimming pool pumps, vacuum cleaners, sewing machines, etc.

Simply plug the Watt Wizard into any electrical outlet, then plug the appliance into the Watt Wizard. There's no wiring required. Unlike some competitor's models (if and when available), the appliance does **not** have to be turned on before being plugged into the power saver. You can leave the appliance — whether on or off — plugged into the Watt Wizard all the time. Or you can move the Watt Wizard to various locations.

OTHER MODELS AVAILABLE

Air conditioners, washers and dryers require wire-in model. If you lack mechanical skill, you probably need an electrician to install it. We also offer it in 220 VAC single or three-phase.

EXCLUSIVE ADVANCE FEATURES

The Watt Wizard also includes two more unique features which no **competitor** has. It's fused so if you accidently overload the device, it won't burn out. Just change the fuse, which is available at any auto supply store.

And Watt Wizard features a unique LED readout, so you can actually tell, at any moment, exactly how much power you're saving — 10%, 20%, 30%, 40% or 50%. This feature is **available only on the Watt Wizard.**

There's a **"power-on"** light, too. And the Watt Wizard comes with the manufacturers 1 year limited warranty.

LOW COST — AND A TAX CREDIT

We're offering the Watt Wizard for only **$39.95, with immediate delivery.** Want two? Then its just **$37.95** each. Or splurge and get three at **$34.95** each. Wire-in models for heavy duty motors are **$6** more for each unit. Add just **$2.50** postage/handling for each **order** (not each unit).

And next year, when you fill out your tax return, you can deduct a full 15% energy tax credit - for additional savings.

30-DAY MONEY-BACK GUARANTEE

Try the Watt Wizard for up to 30 days. If not completely satisfied, return it (insured) for a full refund.

The sooner you send for the Watt Wizard, the more you can save on your electric bills. To order, send your check or money order to the address below. Or charge it to your Visa, MasterCharge, American Express, or Carte Blanche credit card. If using your charge card, you can also order via our toll-free phone number:

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(In New Jersey, Call: **800-322-8650**)
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Solid-State Developments

By Forrest M. Mims

A Solid-State Detective Story

THE successful development of high-density 4K and 16K RAMs has many important implications for solid-state electronics. For a couple of years, however, a mysterious problem has plagued high-density RAMs. Finding the cause of the bug required some skilful solid-state detective work by Tim May and Murray Woods of Intel Corp.

Several years ago Intel began noticing "soft" errors in its 4K and 16K RAMs. In contrast to a "hard" error, which is a permanent chip malfunction, a soft error is the seemingly random loss of an isolated bit stored in the memory chip. Earlier, Intel had found its CCD memories were also susceptible to soft errors.

Intel began a major in-house effort to discover their cause. At first it was thought cosmic rays might be the villain, so Intel tried shielding some operating memory chips with lead. The soft errors continued unabated.

Eventually it was discovered that the ceramic DIPs in which the chips were installed were slightly radioactive! They emitted *alpha* particles.

In case your knowledge of radiation is a little rusty, alpha particles consist of two protons and two neutrons and are therefore equivalent to the nucleus of a helium atom. Alpha particles are but one of three possible emanations from a radioactive source, the remaining two being *beta* particles and *gamma* rays. Beta particles are electrons traveling at very high speeds. Gamma rays are electromagnetic rays having a wavelength only about 1/100 that of x-rays.

How do alpha particles cause soft errors? Research is underway at Intel, Zilog, Siemens, Bell Labs and elsewhere, and results so far indicate both memory cells *and* bit lines that address the cells are susceptible to alpha particle impacts. For example, a hit on a memory cell's capacitor or its diffused bit line can change a 0 bit stored in the cell to a 1. A hit on a nonselected bit line can change a 1 to a 0.

The obvious solution to the soft-error problem would be to remove the radioactive contaminants, which happen to be thorium and uranium, from ceramic DIPs. Unfortunately there is no economically practical way of accomplishing this. Naturally occurring radioactive substances are much more common than most people realize. Even a teaspoon of ordinary dirt may emit several particles per hour—or even more. Consequently construction materials such as brick, cement and ceramic may be slightly radioactive.

One way to prevent the alpha particles emitted by a ceramic DIP from reaching a memory chip is to apply an alpha-absorbing barrier coating to the inside of the package lid or the top of the chip itself. It's not necessary to protect the bottom side of the chip since alpha particles are absorbed by a few tens of micrometers of silicon and, therefore, never reach the circuits photolithographed on the top side of the chip.

Barrier coatings turn out to be expensive since they must be capable of stopping alpha particles without interfering with the purity or hermeticity of the IC package. An excellent alternative solution is to monitor the alpha emission rate of raw ceramic *before* it is made into DIPs. This way, *warm* ceramic (i.e., that which emits more than some minimum number of alpha particles) can be rejected.

Engineers at Zilog have found that alpha-induced soft errors can also be reduced by designing chips with metal rather than diffused bit lines. Larger memory cell capacitors also help. These steps won't aid existing chips, but Zilog has also discovered that soft errors can be reduced by powering chips near their maximum allowable operating voltage.

One way IC makers test the vulnerability of their memory chips to soft errors is to place them near a calibrated, high-rate alpha-particle emitter and count the number of soft errors during a fixed time interval. If the much lower alpha-emission rate of the memory chip's ceramic package is also known, a soft-error figure can then be determined by extrapolation.

While preparing this column, I tried a rather crude experiment to see if it might be possible to induce soft errors in an Intel 2101 RAM. This 1K RAM is organized as 256 4-bit words and is used by hobbyists in various microcomputer and controller projects.

Not having access to a high-rate alpha emitter, I used a very low-rate emitter that you can buy at any hardware or sporting goods store: a mantle used in camping lanterns such as those made by Coleman and others. These lamp mantles are impregnated with radioactive thorium and emit alpha particles. A check with a homemade geiger counter revealed an alpha rate of several counts per second from a square-centimeter sample of mantle material.

(continued overleaf)

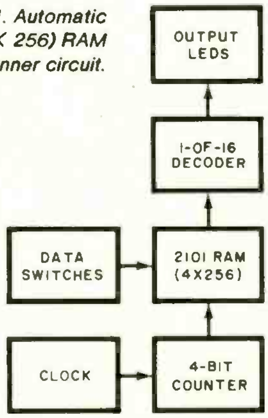
SOLID STATE *cont'd*

To perform the test, I connected the RAM into a simple programming circuit that allows any combination of bit patterns to be loaded and then recycled out to a bank of sixteen readout LEDs. Figure 1 is a diagram of the circuit.

I then loaded half of the addresses with 0000 and the remaining half with 1111. This caused the highest and lowest order readout LEDs to flash back and forth at 1/8 the clock speed. If any other LED flashes on, a soft error has occurred.

During the test, a folded lamp mantle was placed directly on top of the RAM; no soft errors were detected during a 24-hour test run. This negative result probably has more to do with the relative immunity of 1K RAMs to alpha-induced soft errors than to the low emission rate of the lamp mantle. If time permits, I'll repeat the test with an Intel 4K RAM and report on it in the future.

Fig. 1. Automatic 1K (4 X 256) RAM scanner circuit.



In the meantime, if you've ever experienced any mysterious soft errors in a microcomputer or other project that incorporates high-density RAMs you may want to investigate the alpha-particle problem in more detail. Lots of technical papers on the subject have recently appeared, including four at the International Reliability Physics Symposium held April 8-10 earlier this year.

The best general article I've seen on the subject is "Hardening RAMs Against Soft Errors" by Mark Brodsky of Zilog (*Electronics*, April 24, 1980, pp. 117-122).

Component News. National has announced a new three-terminal temperature sensor specifically designed to measure temperatures from −55°C to +100°C, but capable of operation up to +200°C. If you've ever used thermistors as temperature sensors, you'll be delighted to learn that this new sensor can be calibrated with a single trimmer for an accuracy of 1°C over its entire operating range.

Figure 2 shows a typical operating circuit for the new sensor. The chip is designated the LM335, and a recent National ad says it's available for only 95¢. Expect to pay more than that from distributors since the advertised price is probably for 100- or even 1,000-unit quantities.

Spectronics, a major manufacturer of

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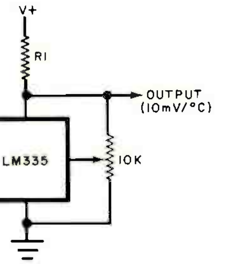

Fig. 2. LM335 temperature sensor with circuit for calibration.

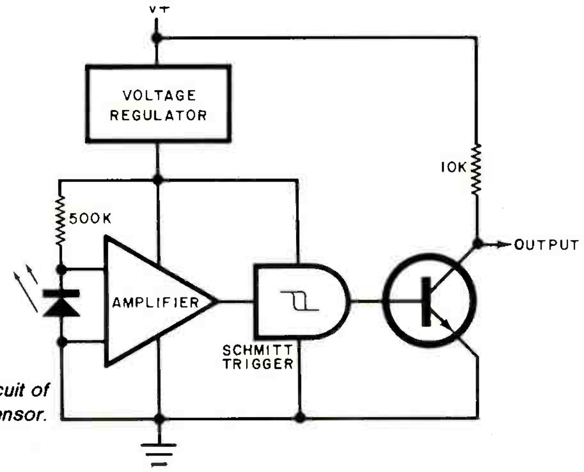

Fig. 3. Internal circuit of SDP 8600 light sensor.

infrared-emitting diodes and now a subsidiary of Honeywell, has announced an important new light sensor designated the SDP 8600. The sensor is actually an integrated circuit that includes a photodiode, self-contained voltage regulator, amplifier, Schmitt trigger and output stage, all of which are connected as shown in Fig. 3.

The best feature of the SDP 8600 is the photodiode since photodiodes have much faster response times than the more commonly used phototransistors. The SDP 8600 has a 50-nanosecond rise time which means it would make a much more efficient detector than a phototransistor for a pulsed single-heterostructure (SH) injection laser. SH lasers are now available for less than $10 from several electronic parts dealers.

Another bonus of the SDP 8600 is the Schmitt trigger. It snaps on and off when the input signal exceeds or falls below a set threshold value. While this means the chip cannot be used to detect intensity-modulated light waves, it should be ideal for detecting pulsed signals and provide a high degree of noise immunity. Figure 4 summarizes the response of the SDP 8600 to both fast- and slow-rising incoming pulses. For more information about this new chip, write Spectronics at 830 East Arapaho Road, Richardson, TX 75081.

Another new optoelectronic component of interest to experimenters is a fiber-optic transceiver module containing a LED made of gallium-arsenide-phosphide (GaAsP) mounted on a silicon photodiode. This unique component makes possible two-way data transmission over a single bundle of optical fibers or a large-diameter single fiber. Four versions of the transceiver are available, each of which includes a 1-, 3-, 7-, or 10-meter Dupont Crofon® 1040 fiber-optic cable.

The generic part number for the transceiver is OPB 950. The specific part number for a transceiver with one of the four available lengths of fiber cable is obtained by adding to the generic number XX00, where XX is the length of the cable. Thus, OPB 950–0700 specifies a transceiver unit with an attached 7-meter fiber-optic cable.

The OPB 950 is made by Optron, a semiconductor manufacturer near Dallas, TX, specializing in optoelectronics. It was recently acquired by TRW, Inc. For more information about the OPB 950, write the company at 1201 Tappan Circle, Carrollton, TX 75006 and request Product Bulletin 2034.

Readers interested in phase-locked loops (see the July and August, 1980 installments of "Experimenter's Corner") will want to contact Doug Tashino at Motorola Semiconductor (P.O. Box 20912, Phoenix, AZ 85036) to find out more about the MC145155 and MC145156. These chips are apparently intended for synthesis of frequencies up to 500 MHz, and the divide-by-N value can exceed 131,000. Cost for the plastic MC145155 is $4.95 in 100 quantities, certainly reasonable in view of the chip's very wide frequency range.

While this chip would make a super-wide-range frequency synthesizer, from the very preliminary data I've seen, it might also be suited for phase-shift optical rangefinding. In this application, a laser or LED is modulated at a fixed, high-frequency rate. The modulated light is then directed toward a target at an unknown range. Frequency of the light reflected from the target is then compared with the frequency of the light when it leaves the source. The frequencies will be shifted by a couple of nanoseconds per foot of distance to the target.

Panasonic has announced the MN6221, a programmable melody/alarm generator that can be programmed to play up to seven different

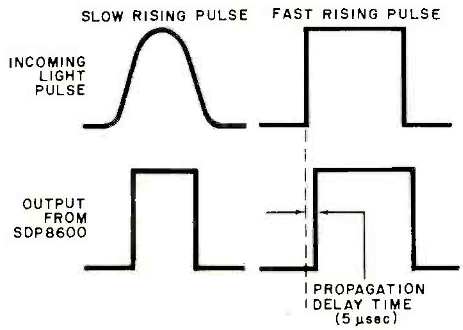

Fig. 4. Response of SCP 8600 to slow and fast rising pulses.

tone patterns. This chip may not be available in single quantities for some time since Panasonic's price of $2.50 per chip is for quantities of 50,000. While this means the MN6221 is intended for OEM (original equipment manufacturer) users, hopefully some of the parts dealers who advertise in POPULAR ELECTRONICS will stock it. If they do, be sure to find out the tunes or alarm sounds programmed into the chip before parting with your money.

R&D News. Some remarkable new solid-state transducers are being developed at laboratories around the world. Included are sensors that detect moisture, dew point, pressure, acceleration, and gas and liquid flow.

One of the most interesting new sensors is a miniature accelerometer developed at Stanford University. This novel transducer consists of a silicon substrate with a recessed cavity containing a movable silicon beam. A piezoelectric strain gauge is attached to the flexible beam to measure the movement of the beam in response to acceleration. A second strain gauge serves as a reference. It is attached to a fixed piece of silicon and permits the first strain gauge to be compensated for temperature effects.

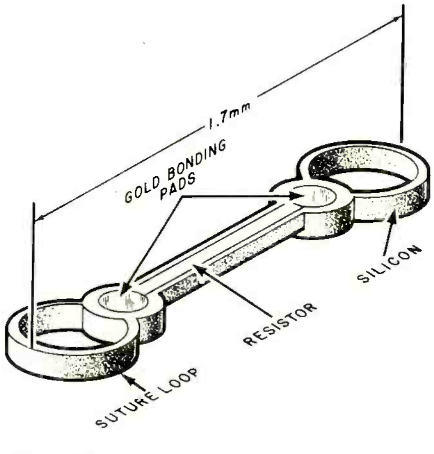

Fig. 5. Miniature force transducer developed at Stanford University.

Stanford has also developed a miniature force sensor designed specifically for biological implantation. The 1.7-mm long sensor includes a pair of silicon rings connected by a bar-shaped silicon resistor whose resistance varies as the bar is bent. The rings, which are called *suture loops*, permit the sensor to be attached to the organ of interest.

Both these new sensors are unique in that the silicon is selectively etched completely through by hydrofluoric acids. In the case of the force sensor, a 5-cm-diameter silicon wafer yields up to 1,000 usable sensors which sink to the bottom of the acid bath as they are etched away from the wafer. Figure 5 shows how the new sensors are made.

In future columns I'll describe several other unusual sensors as well as some novel gyroscopes, accelerometers and acoustic sensors using optical fibers. ◇

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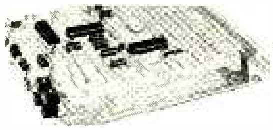

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System Monitor (Hex Keypad/Display Version): Tape load with labeling . . . tape dump with labeling . . . examine/change contents of memory . . . insert data . . . warm start . . . examine and change all registers . . . single step with register display at each break point . . . go to execution address. Level "A" in this version makes a perfect controller for industrial applications, and is programmed using the Netronics Hex Keypad/Display. It is low cost, perfect for beginners.

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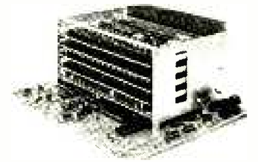

Explorer/85 With Level "C" Card Cage.

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Level "D" provides 4k of RAM, power supply regulation, filtering decoupling components and sockets to expand your Explorer/85 memory to 4k (plus the original 256 bytes located in the 8155A). The static RAM can be located anywhere from ØØØØ to EFFF in 4k blocks.

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Hobby Scene Q&A

By John McVeigh, Technical Editor

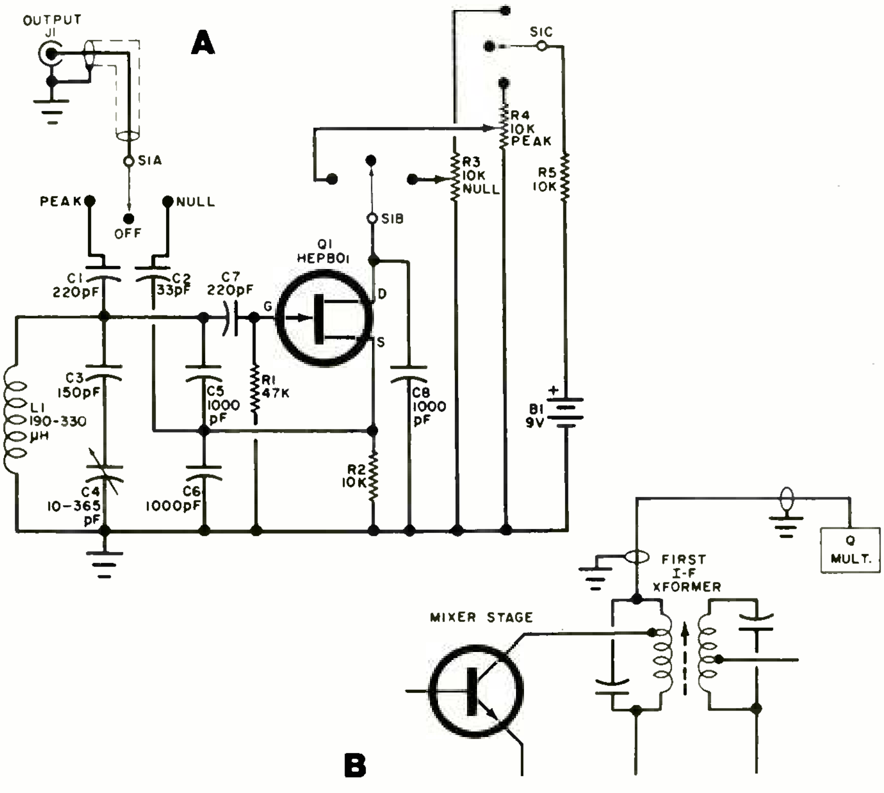
Improving Receiver Selectivity

Q. ***Last November, I purchased a Realistic DX-300 communications receiver. I have found it to be quite adequate in terms of sensitivity and selectivity for the reception of AM broadcast signals. However, the receiver's selectivity is not high enough for reception of SSB signals under crowded band conditions, and CW is almost impossible to copy—even when the receiver's audio bandwidth control is set to its narrow position. Could you describe an external audio filter (Q-multiplier) that can be added to the receiver to narrow its bandwidth from the existing 5 to 6 kHz?—C. F. Baker, Jenison, MI.***

A. As the product test report that appeared in the November 1979 issue revealed, the Realistic DX-300 is a fine receiver for AM broadcast listening but isn't up to the critical demands of SSB and CW reception. Part of the problem is that the unit does not (apparently) employ a product detector, and its nonadjustable bfo frequency is too far removed from the suppressed carrier frequency for proper demodulation. Also, as you have noted, it lacks sufficient selectivity.

The first two shortcomings can be dealt with by appropriate internal modifications—the addition of a good product detector and a means of varying the beat oscillator's frequency (such as by adding a variable capacitor or a Varactor diode to the bfo's frequency-determining tuned circuit). Insufficient selectivity can be improved by any of several means, some internal modifications and some involving the addition of external devices. For example, replacing the existing i-f filter with a sharper mechanical or crystal filter can yield dramatic improvements. Another approach is to connect a Q-multiplier to the receiver's maximum-selectivity stage (usually the final i-f amplifier). A third method of improving reception of SSB and CW signals is totally external—the insertion of an active audio filter between the audio output of the receiver and the monitor loudspeaker or headphones. Note that the latter two methods are distinct from one another. A Q-multiplier is *not* an audio filter. Rather, it is a regenerative stage that operates at the receiver's intermediate frequency.

Shown in Figure A is the schematic diagram of a Q-multiplier that you can build and use with a receiver having a 455-kHz i-f. It is essentially a 455-kHz Colpitts oscillator that can be adjusted in and out of oscillation by means of potentiometers *R3* and *R4*. When the



circuit oscillates, the Q (selectivity) of the tuned circuit comprising *L1* and C3 through *C6* is determined primarily by the passive components employed. However, when the circuit is adjusted to a regenerative point just short of oscillation, the positive feedback offsets the losses of the passive components. The overall selectivity increases to many times its normal value.

If the circuit is placed in parallel with the receiver's 455-kHz i-f transformer (see Fig. B) and mode switch *S1* is placed in its PEAK position, the receiver's i-f passband can be reduced greatly. Potentiometer *R4* can be adjusted to tune the multiplier and peak any signal in the original passband. Placing *S1* in its NULL position alters the way the Q-multiplier is connected to the i-f transformer and makes it possible to leave the original i-f response unaltered except for the introduction of a sharp notch. This notch is tunable so that unwanted signals can be nulled out.

To use the Q-multiplier, connect it to the receiver using a short length (no more than 24 inches) of coaxial cable. Turn the receiver to a quiet spot on one of the broadcast bands and place *S1* in its PEAK position. Adjust *C4* for mid-capacitance (plates half meshed), place *R4* in its fully clockwise position (maximum resistance above ground), and tune *L1* until you hear a signal. If the Q-multiplier is tuned to the receiver's i-f, the signal will be heard across the band, with a beat note when the receiver is tuned across a transmitted signal. The Q-multiplier can thus be used as a bfo.

Then place *S1* in its NULL position and adjust *C4* until a signal is again heard with *R3* set fully clockwise. (It might be necessary to make a compromise adjustment of *L1* so that the settings of *C4* in the PEAK and NULL modes fall as close to midcapacitance as possible.) Finally, adjust the Q-multiplier so it is just short of oscillating and adjust the receiver's i-f transformer for optimum response.

It takes some practice to learn how to use the Q-multiplier efficiently Adjusting *R4* more and more clockwise increases selectivity and decreases the i-f bandwidth. Greatest selectivity will occur just before the onset of oscillation, which is indicated by a ringing sound as the receiver is tuned across a signal. In the NULL mode, the notch is made sharper as *R3* is adjusted progressively clockwise. A very noticeable decrease in amplitude will be heard as the notch is centered (by means of *C4*) on an offending signal. Further information on construction and operation of this Q-multiplier can be found in the April 1974 issue of POPULAR ELECTRONICS, in an article by Joe A. Rolf. ◇

Have a problem or question in circuitry, components, parts availability, etc? Send it to the Hobby Scene Editor, POPULAR ELECTRONICS, One Park Ave., New York, N.Y. 10016. Though all letters can't be answered individually, those with wide interest will be published.

Experimenter's Corner

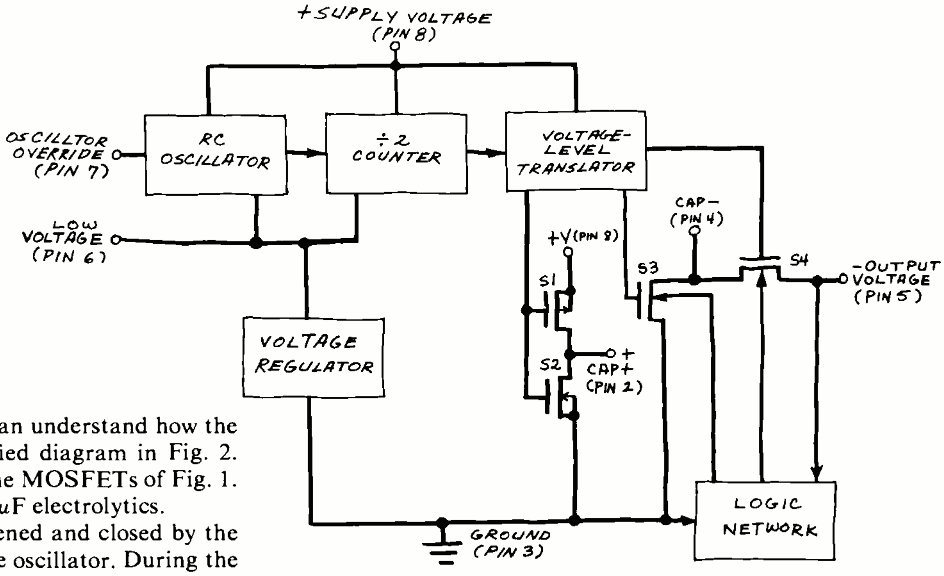
By Forrest M. Mims

An Integrated Polarity Converter

EVERY few years, one of the semiconductor manufacturers introduces a new IC that quickly becomes a standard building block. Three classic examples are the 741 op amp, the 555 timer and the LM109 5-volt regulator. Recently, Intersil introduced its ICL7660 voltage polarity converter, which is sure to become a standard building block IC. The ICL7660 is a useful power-supply chip which generates a negative voltage from a positive input voltage. If you've ever wanted to employ a circuit that required a dual-polarity power supply in an application where only a single-ended supply was available, you can readily appreciate the practical implications of this new chip.

About the ICL7660. A block diagram of the ICL7660 appears in Fig. 1. It shows what might at first seem to be a relatively complex circuit. Actually, the operation of the ICL7660 is straightforward, and you can understand how the chip works by referring to the simplified diagram in Fig. 2. Switches *S1* through *S2* in Fig. 2 are the MOSFETs of Fig. 1. Capacitors *C1* and *C2* are external 10-μF electrolytics.

Fig. 1. Block diagram showing how the ICL7660 functions as a voltage polarity converter.



In operation, *S1* through *S4* are opened and closed by the switch logic at a rate determined by the oscillator. During the first half of the operating cycle, *S1* and *S3* are closed, and *S2* and *S4* are open. This allows *C1* to charge to the positive supply voltage. During the second half of the cycle, *S1* and *S3* are open, and *S2* and *S4* are closed. This inverts the connection of *C1* with respect to ground so that the output voltage is now equal in magnitude to the positive supply voltage but opposite in signal (polarity). The switches also connect *C2* in parallel with *C1*, thus causing *C2* to draw charge from *C1*. This enables *C2* to serve as a reservoir of charge during the first half of the cycle, when *C1* is being charged.

The MOS switches, which occupy most of the ICL7660 chip's real estate, required clever design techniques—although this might not be immediately obvious. The channels of *S3* and *S4* must remain nonconductive to prevent device latchup when power is first applied and when the output is short-circuited. The logic network (Fig. 1) monitors the output voltage, and the voltage-level translator applies bias when necessary to keep both switches (*S3* and *S4*) nonconductive. Without this precaution, Intersil reports that high power loss and device latchup (presumably resulting from overheating) would occur.

Using the ICL7660. The pinout diagram of the ICL7660 appears in Fig. 3. The chip can be powered by a supply voltage of +1.5 to +10 volts. It has a typical open-circuit voltage conversion efficiency of 99.9% and a power efficiency of 98%.

The output of the internal voltage regulator can be shorted to ground to improve low-voltage operation. This is accomplished by connecting pin 6, the LV (low-voltage) terminal, to pin 3. Note, however, that if the power-supply voltage is greater than +3.5 volts, the LV pin must *not* be grounded or device latchup might occur.

If the supply voltage exceeds +6.5 volts, a diode (*D1* in Fig. 4) should be connected in series between pin 5, the output terminal, and the load. Of course, this will reduce the voltage delivered to the load by an amount equal to the diode's voltage drop—about 0.6 volt for a silicon diode and 0.3 volt for a germanium diode. However, the addition of the diode permits the

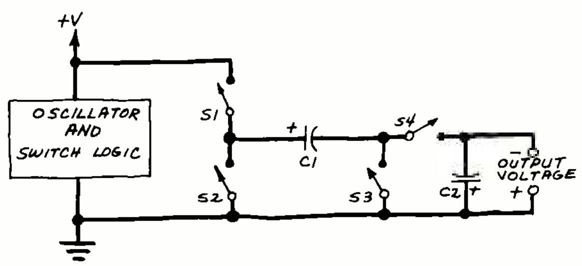


Fig. 2. Simplified version of Fig. 1.

chip to operate over its entire rated temperature range at a supply voltage with a maximum of 10 volts without the possibility of device latchup.

The oscillator frequency of the ICL7660 is typically 10 kHz. If this frequency of oscillation causes interference to circuits powered by or close to the ICL7660, it can be changed. To *lower* the frequency of the oscillator, connect a capacitor (*C3*) between pins 7 and 8. The installation of a 100-pF capacitor will lower the frequency from 10 kHz to 1 kHz. This reduction in frequency must be accompanied by an increase in the capacitance of *C1* and *C2* by the same factor the frequency is reduced. Because 1 kHz is one-tenth of 10 kHz, *C1* and *C2* must be increased by a factor of ten(to 100 μF).

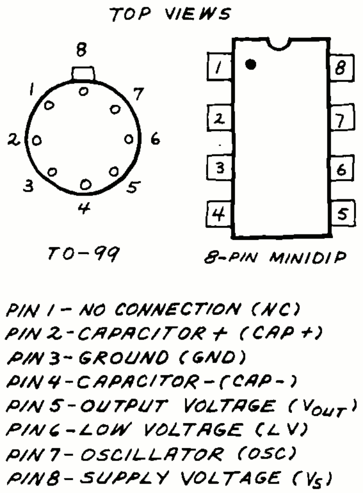


Fig. 3. Pin outlines of the ICL7660.

The frequency of oscillation can be *increased* by overdriving the internal oscillator with an external clock or oscillator. In this case, however, the values of *C1* and *C2* need not be reduced. Figure 5 shows how to connect CMOS or TTL circuits to the OSCILLATOR OVERRIDE input (pin 7) of the ICL7660.

Finally, keep in mind that the ICL7660 is a CMOS chip. Standard CMOS handling precautions should be observed. Don't use an ungrounded soldering iron. Also, be sure to protect the chip from static voltages when installing it.

Applications. The ICL7660 is a brand new chip, so it might not yet be available from parts suppliers who advertise in POPULAR ELECTRONICS. If not, contact an Intersil sales office or an Intersil distributor. (Distributors are listed in the Yellow Pages under "Electronic Equipment and Supplies.") Don't attempt to order chips directly from Intersil because the company cannot process retail orders. The ICL7660 sells for $1.95 in lots of 100, so you will have to expect to pay more for single quantities.

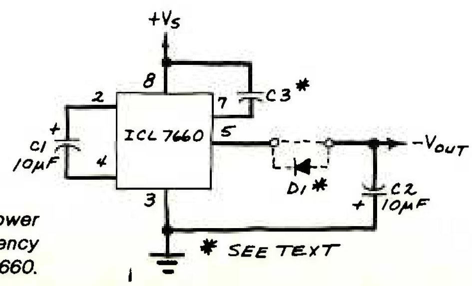


Fig. 4. How to lower the oscillator frequency of the ICL7660.

The circuits which follow will give you some ideas about how to use the ICL7660 in specific applications. The chip is so easy to use that you should have few, if any, problems when you try the circuits on your own.

Basic Polarity Converter. Figure 6 shows a simple voltage-polarity converter employing a single ICL7660. The circuit has two design variations which are dependent upon the magnitude of the supply voltage. When $+V_S$ is less than 3.5 volts,

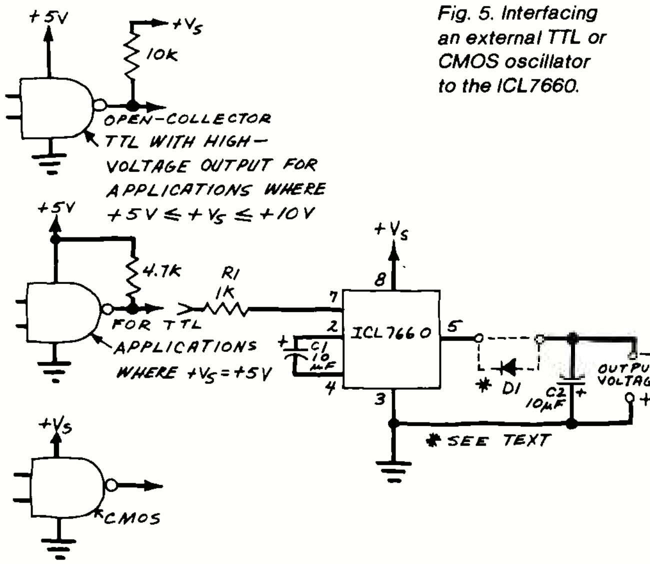


Fig. 5. Interfacing an external TTL or CMOS oscillator to the ICL7660.

pin 6 should be grounded. When the supply voltage is greater than +6.5 volts, *D1* should be connected to pin 5 as shown. In no case should any pin be connected to a voltage higher than the supply voltage or below circuit ground. Otherwise, the chip might be destroyed.

Voltage Multiplication. Figure 7 shows how to cascade two ICL7660's to double the negative voltage available from a single chip. When the supply voltage exceeds +6.5 volts, *D1* and *D2* must be included. This will reduce the output voltage by the sum of the voltage drops across each diode. Thus, when a 10-volt supply is used and both *D1* and *D2* are silicon diodes, the voltage out will be −18.8 volts.

You can cascade up to ten ICL7660's using the cascade configuration shown in Fig. 7. Assuming that the $+V_S$ terminal of the first ICL7660 is connected to a +10-volt supply and that a silicon diode is connected in series with each IC's output terminal, the output voltage at the end of the multiplier string will be −94 volts!

Until now, all of the circuits we have described have had outputs whose polarity has been inverted with respect to the power supply (a positive supply voltage and a negative output voltage). The next circuit to be shown is a voltage multiplier whose output is of the *same* polarity as the supply. The circuit shown in Fig. 8 provides positive voltage multiplication using a single ICL7660. Capacitor *C1* charges to the supply voltage less the voltage drop across *D1*. The sum of the voltage across

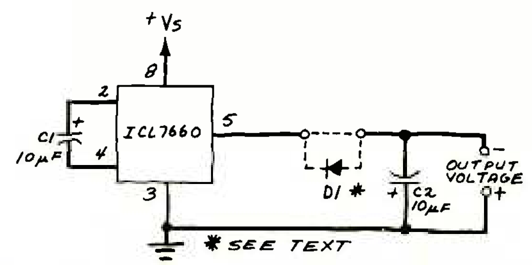


Fig. 6. Ultra-simple voltage polarity converter.

C1 and the supply voltage then charges *C2* through *D2*. The resulting output voltage is twice the supply voltage less the sum of voltage drops across the two diodes.

Dual-Output Supply. The circuit shown in Fig. 9 performs positive voltage multiplication and negative voltage conversion using a single ICL7660. This configuration can provide

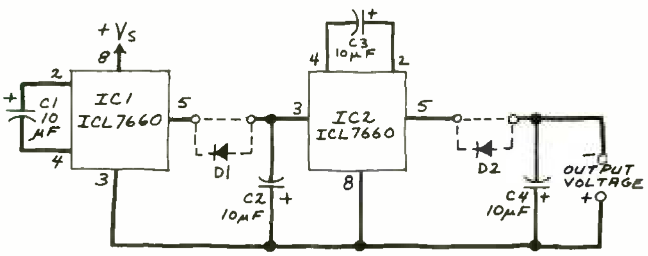


Fig. 7. Negative voltage multiplication by cascading ICL7660s.

several different combinations of output voltage from a single positive supply. The voltage level appearing across the negative output is an inverted version of the positive supply voltage (less one diode drop if the supply voltage exceeds 6.5 volts, in which case *D1* must be included). The voltage level across the positive output is twice the positive supply voltage less the sum of two diode drops with *no* polarity inversion.

The high efficiency of the ICL7660 is apparent from an inspection of the following table. It is a list of output voltages that I measured when a sample chip was powered with a given sequence of positive supply voltages.

$+V_S$	Negative Output	Positive Output
+1.5	−1.5 V	+ 1.8 V
+3.0	−3.0 V	+ 4.2 V
+5.0	−5.0 V	+ 8.8 V
+6.0	−6.0 V	+10.8 V
+9.0	−8.4 V	+16.8 V
+10.0	−9.4 V	+18.8 V

Note that the voltage drops across *D2* and *D3* prevent the positive output level from approaching twice the positive supply voltage, especially at low supply voltages. Also, *D1* was included when $+V_S$ was raised above +6.5 volts, so the negative output levels measured when $+V_S$ was +9 and +10 volts reflect the forward voltage drop across the diode. This circuit can be made more versatile by adding one or more ICL7660s to multiply the negative output voltage level.

Square-Wave Oscillator. The ICL7660 is ideally suited for supplying the negative voltage to op-amp circuits that require a bipolar supply. Such a circuit is the square-wave oscillator appearing in Fig. 10. The circuit provides a true ac square wave that is *not* riding on a dc level. It can be powered by a single-ended 5-volt supply or a 9-volt battery.

The component values shown result in a square-wave frequency of approximately 900 Hz. Changing the values of *R1*, *C1* or both *R1* and *C1* will change the frequency of oscillation. More precisely, the frequency equals the reciprocal of the product of ($2R1C1$) and the natural logarithm of the quantity ($2R2/R3+1$).

The value of resistor *R2* should be approximately one-third

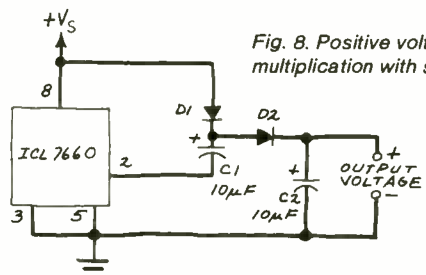


Fig. 8. Positive voltage multiplication with single ICL7660.

that of *R1*. The resistance of *R3* should be from two to ten times that of *R2*. For those readers who lack access to scientific calculators or sophisticated slide rules, the component values specified in Fig. 10 cause the expression $\ln(2R2/R3 + 1)$ to equal 0.5068. Therefore, the frequency of oscillation equals $1/(10{,}136)(C1)$.

Here are some results that I obtained using a breadboarded version of the circuit where f_O is the output frequency:

Nominal value of C1	Calculated f_O	Measured f_O
1 µF	98.65 Hz	95.8 Hz
0.1 µF	986.5 Hz	908 Hz
0.01 µF	9865 Hz	7768 Hz

As you can see, the calculated or predicted output frequency becomes less accurate as the value of *C1* decreases and the frequency of oscillation increases.

I originally built this circuit as part of an experimental high-voltage power supply. Connecting the secondary of a 6.3-volt filament transformer between pin 6 of the 741 and ground will cause 80 volts of ac to appear across the transformer's primary when the circuit is powered by a +6-volt supply. Increasing the supply voltage to +9 volts will boost the voltage induced across the primary of the transformer output to 160 volts ac. You can connect a diode-capacitor voltage multiplier to the output of the transformer to obtain even higher *dc* voltages.

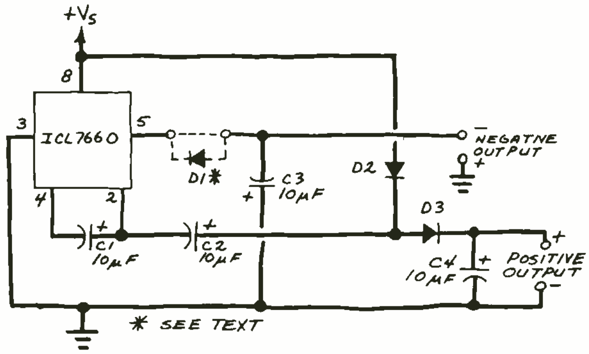


Fig. 9. Combined positive and negative voltage multiplication.

Use caution if you add the transformer (and possibly a voltage multiplier) to the oscillator shown in Fig. 10. Such a combination can deliver a *hefty* shock!

Going Further. The ICL7660 is intended primarily for use in microprocessor, controller and data-acquisition systems which have a +5-volt supply for the digital circuits and require a negative voltage for analog stages. It's also ideal for providing −5-volt body bias for dynamic RAMs. Perhaps the basic circuits described in this column will give you some ideas for many other applications. ◇

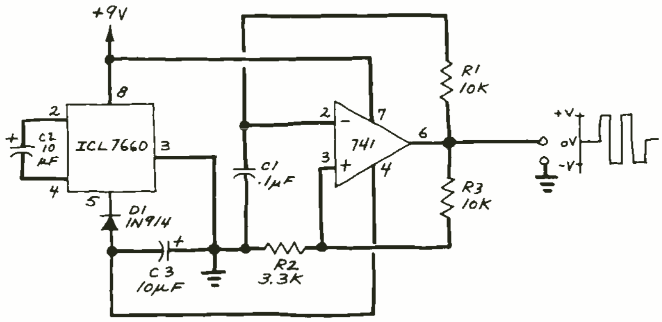
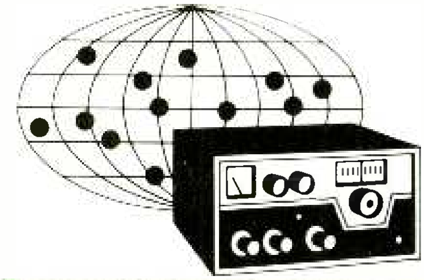


Fig. 10. Circuit for a square-wave oscillator.



DX Listening

By Glenn Hauser

USAF Starts Radar on Shortwave Broadcast Bands

SHORTWAVE listeners, already plagued by U.S. military tactical communications, radioteletype, jamming, the "Russian woodpecker" and interference among SWBC stations themselves, which are crammed into about one third of the spectrum they need, now are faced by a new threat. The United States Air Force has decided that its Over-The-Horizon Backscatter (OTHB) radar system will transmit on the bands supposedly reserved worldwide for nothing but international broadcasting.

This plan is explained in some detail in the April 1980 issue of *QST*. Hams are naturally pleased that the USAF OTHB radar system has decided not to operate on amateur bands; any interference there should be only incidental and is to be handled by a "good-neighbor policy." Also excluded are portions of the shortwave spectrum between 6.8 and 22 MHz, which are allocated to aeronautical and maritime communications, and standard frequencies. This leaves only those bands designated as "fixed" (point-to-point) and broadcasting.

Without a doubt there are many times more shortwave listeners than there are amateurs. Unfortunately, we are not as well organized as the hams, nor do we have a powerful lobby looking out for our interests like the hams' ARRL. Consequently, SW listening is easier to step on.

Though the OTHB radar system does need access to a wide range of frequencies, no evidence has been presented that it is essential for it to use both the fixed bands—where it obviously belongs as a "utility" service—and the broadcast bands, where it obviously does not belong and can only cause harmful interference to shortwave programming.

Indeed, it is easy to make the case that, if OTHB needs more spectrum than the fixed bands can provide, it should be allowed in the ham bands rather than broadcast bands. The amateur bands are already occupied by non-voice signals, such as radioteletype, CW, slow-scan television, facsimile, etc. Hams have the great advantage of being able to change frequency on short notice to avoid interference, while SWLs have to put up with whatever nonbroadcast garbage is interfering with frequencies that can be changed only on a delayed and long-term basis. Furthermore, amateur radio has always been the place for experimentation in new uses of radio, which this certainly is.

There is some hope, though. The USAF OTHB system is allegedly not as disruptive as the 10-per-second millisecond-length pulses coming from the Soviet equivalent, which has been disrupting all shortwave bands for several years. The USAF supposedly uses a narrower bandwidth and automatically selects a "clear" frequency. (This is done for its own effectiveness, and not as a consideration for other users of the spectrum). But a frequency that's "clear" to the OTHB receiving site may be just the frequency on which a listener elsewhere is trying to hear a weak signal.

The sound of the USAF OTHB radar is quite different from the "Soviet woodpecker." The USAF OTHB is described as sounding on an AM receiver like powerline hum at any of several modulation frequencies from 20 to 60 Hz. It is extremely important not to confuse the two. We do not have any say about what the USSR does; we do in the U.S.

The military organization controlling the OTHB system in Maine (with another one to be activated on the West Coast), evidently cares nothing about interference to shortwave listeners. It has, however, invited amateurs experiencing interference to file complaints and has set up an address for this.

To get our views across too, I urge shortwave listeners not only to complain about every instance of interference actually observed, but to complain now against the idea that OTHB should be allowed in the SWBC bands at all. The address is: OTH Radar Office, USAF Electronic Systems Division, Code OCUE, Hanscom AFB, MA 01731. Also send copies to your congressman, senators and the FCC. Let the authorities know we indeed care enough to protect our shortwave broadcasting bands!

Third-Language Services. Most countries involved in international broadcasting transmit in English to North America, for obvious reasons. They also beam programs here in their native language, which also makes sense (a few diehards, such as Denmark and France, broadcast to us *only* in their native language—this is easier to sell in the home country on the grounds that it will reach expatriates or emigrants rather than foreigners). Spanish and French are also legitimately targeted on North America, since they are widely understood in portions of this continent.

But there are some oddball broadcasts which are in other languages neither native to the country of origin, nor understood by more than a tiny fraction of the SWL audience.

Russian is a good example; until May of this year, Israel beamed it toward New York every night at 0300 GMT. It was dropped due to budget problems. Since the difficulties in Iran, Israel has stepped up its broadcasts in Persian, but also beamed one of the broadcasts to the U.S.—1530-1625 GMT on 21675 kHz. It should be noted that both these transmissions involve simulcasting programs to the more obvious destinations.

HCJB, Ecuador, is another station with Russian to North America, at 0130-0200 GMT on 11810 (frequently changed). However, HCJB is well aware that part of the USSR lies just beyond North America from the viewpoint of Ecuador. HCJB also broadcasts in Russian to Australia and in German and Japanese to South America. Former broadcasts in Eskimo to North America were also carried on a frequency aimed at the South Pacific.

HCJB's experimental transmission on 26020 kHz results in some strange combinations: German at midnight, Nordic languages at 2000 and 2100, Japanese at 2200, and Portuguese at 2300, all to North America.

Another evangelical, Trans World Radio, sees fertile ground among language minorities, with broadcasts from Bonaire to South America in Russian, and from Swaziland to South and Southwest Africa in German. FEBC from the Philippines has German to the USSR.

Radio Free Europe's Czechoslovak Service has a 10-minute weekly commentary in English, which serves several purposes. The enemy does not bother to jam one of its frequencies, since it's only on the air for that segment; and it allows English-speakers to hear and understand RFE, however briefly. It's Fridays at 2050-2100 GMT during the summertime in Europe, 2150-2200 the rest of the year, on frequencies in the 19- or 25-meter bands (most recently 15420 kHz), via Portugal.

Radio Sofia, Bulgaria, has broadcasts in Greek and Turkish not only to Greece and Turkey, but also to western Europe, where there are lots of guest workers from those countries.

One of Radio Nederland's several broadcasts in Indonesian is also for western Europe, probably Holland itself, where there is a considerable Indonesian-speaking minority.

Radio Sweden has German not only for Europe but for Africa, and a broadcast in French to South Asia. Both Germany and France once had colonies in these areas. Chile also had broadcasts to Africa in Italian and German, but these appear to have been dropped. Radio Korea has one Spanish broadcast to southeast Asia, presumably for Spanish-speaking remnants in the Philippines. Interestingly, Radio Pyongyang has a broadcast in Russian to the Near and Middle East! (Do they know something we don't know?)

Norway has a weekly 5-minute Spanish segment in its transmissions to all parts of the world, whether or not there are any Spanish-speaking countries in the individual target zones.

While in a slightly different category, an oddball service worthy of note is Radio Portugal's Spanish broadcast at 0230-0300, specifically for Venezuela. It's safe to say this is the only shortwave broadcast on the air especially for that country and not its many Spanish-speaking neighbors.

Radio Cairo broadcasts in Afar, Amharic, Somali and Swahili not only to East Africa, but to South Africa too. These oddball broadcasts have been compiled from schedules issued by the stations or appearing in the *World Radio-TV Handbook*. Not included are such anomalies as the Voice of America broadcast from California to the Philippines in Swahili, since it is intended to be relayed on from there to East Africa.

Changes at Voice of America. VOA is about to complete phasing in a satellite-feed system to its overseas transmitters, meaning that there will be less need for domestic sites except during emergencies. Dixon, California was mothballed last year, and the same is about to happen to Bethany, Ohio (that antenna farm is readily visible east of I-75, just north of Cincinnati). This will reduce VOA interference to domestic shortwave listeners, but it will also make it harder for us to hear VOA programs. Bethany has been heavily used for secondary services, such as AFRTS, the Voice of the OAS, and United Nations Radio. These will presumably be shifted to Greenville, N.C, unless Bethany receives a reprisal.

The VOA relay in Liberia survived the April coup intact, but VOA had already signed an agreement with Botswana to build another station there. However, it is planned to operate on 621 kHz (mediumwave) only. Part of the agreement is that Radio Botswana gets to use it for domestic services during 12 hours of daytime.

Owing to delays in funding and in finding qualified personnel, the VOA has been slow to react in adding new languages that suddenly become strategically important. VOA plans to add a service in Azeri (understood in Azerbaijan SSR and parts of Iran), and has been criticized for not broadcasting in the primary language of Afghanistan, Pashto. Meanwhile, funding was approved for increased broadcasts to the USSR on Radio Liberty from sites in Israel and Egypt, before those countries had agreed to such an operation. ◇

Right Out Of Electronic Counterintelligence . . .

THE HIERONYMUS MACHINE™

Voice Stress Computer

It's almost beyond belief. This tiny solid-state instrument measures 3" x 6" x1½" and fits in a pocket. Yet it contains sophisticated electronic circuitry, a microphone, and three red diodes. It analyzes the human voice for stress.

Once you learn, in about 30 minutes, how to use the Hieronymus Machine, you will be able to discover whether a person is calm or stressful — merely by monitoring his or her voice.

DEFINITELY NOT A "LIE DETECTOR"

The Hieronymus Machine is not a lie detector. Nor is it a "truth" device. Even the famed polygraph machine is not a lie detector, plain and simple. The polygraph can be used to monitor a person's pulse, respiration, blood pressure, and galvanic skin response, bodily functions affected by stress.

And in the hands of a skilled operator, the polygraph can be used to gain insights about a person's stress levels when talking about certain topics. But a very real part of the polygraph's usefulness is the "Hieronymus Effect," which we'll get to in a moment.

SPIES AND COUNTERSPIES

During wartime, counterintelligence experts wondered if science could come up with something simpler than the polygraph to help ferret out spies. Researchers became attracted to the theory that human voices emit "micro-tremors," low-frequency vibrations that are generally inaudible or masked by other voice components.

An article in **Popular Electronics** (April 1980) describes the theory in detail. But the short story is that after spending millions of dollars, researchers developed a voice stress analyzer. Now, the authors of the definitive article in **Popular Electronics** have perfected a personal voice stress analyzer, which we call the Hieronymus Machine.

WHAT IT DOES, HOW YOU USE IT

The Hieronymus Machine electronically measures changes in voice micro-tremors. The read-out is simple: one red diode indicates normal, two show moderate stress, and three reveal greater stress, ranging from mild to severe anxiety.

You, as the operator, could use the Hieronymus Machine like a thermometer, checking the "fever level" of stress. As you gain skill, your judgment will improve, enabling you to pursue or avoid a line of questioning or discussion that produces stressful responses.

MANY USES AT HOME OR WORK

You can use the Hieronymus Machine at home to have fun with your family. You'll discover how it responds to different people's voices, what effect laughter and singing have on it, and even evaluate politicans' speeches over TV or radio. It works quite well on transmitted voices, as well as over the telephone or with tape recordings.

Next, try it on friends. See how well someone's favorite fish story holds up when you point out that the Hieronymus Machine doesn't believe a word of it. And watch that poker face disappear as the "stress" diode steadily insists you're not getting the whole story.

BIOFEEDBACK FOR YOU

If you're required to talk in front of groups or need to speak convincingly to one person at a time, you can use the Hieronymus Machine to monitor your voice and learn a more relaxed, self-assured, persuasive style of delivery. If you wanted to learn hypnotism, a relaxed voice would be a real asset — and the Hieronymus Machine could help you achieve it.

At work, there are numerous situations in which the Hieronymus Machine could work wonders. Here's how: Hieronymus Bosch was a 15th-century painter known for his startling originality. He was also something of a medical practitioner, and he believed that patients could be cured by passing stones over their bodies. Bosch achieved success because his patients **believed** that a cure was taking place.

Nearer our own time, a couple of science fiction writers concocted a devise they named after Bosch: it produced varying sensations in the user depending on where a dial was set, from zero to 100. The amazing thing was that this machine worked on subjects even when it wasn't plugged in — a perfect Hieronymus Effect!

Now we have a true Hieronymus Machine, the Voice Stress Analyzer. It actually works, and among other things of a scientifically verifiable nature, it produces the Hieronymus Effect. In its presence, people suddenly become more forthright. In some cases, with such a machine present, employees being asked about office theft became very cooperative in answering questions truthfully. Naturally, you'll want to use the Hieronymus Machine in plain sight and tell people what it does. This actually gets more cooperation from them.

30-DAY TRIAL, MONEY-BACK GUARANTEE

The potential uses of the Hieronymus Machine are limited only by your imagination. Try it at no risk for 30 days. We'll send you one or more with complete instructions (9v. battery not included). You'll be able to try it, experiment, even conduct your own "investigation."

Governments and police departments and huge corporations are already using large (briefcase-sized) versions of this kind of machine, and they have to pay $3,000 or so for theirs. But you can have a personal Hieronymus Machine for only **$119.95.** If you're not satisfied, send it back (insured) for a full refund, no questions asked. If you want two, the cost is **$109.95** each. And if you want three or more for business use, it's only **$99.95** each. You're also protected by a 1-year parts and labor warranty.

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CIRCLE NO. 48 ON FREE INFORMATION CARD

Tips & Techniques

Low-Cost Pulse Detector

Logic transitions (pulses) are the lifeblood of a digital circuit or system. Presented here is a simple pulse detector than can be used to monitor such transitions in TTL networks. Despite its simplicity, the circuit is an effective pulse catcher. It can be assembled from junkbox components in a half-hour or less, and its modest power requirements can be satisfied by the circuit to be monitored. This further simplifies its design.

As shown in the diagram, two of the four NAND gates (*IC1A* and *IC1B*) contained in a 7400 TTL IC are interconnected to form an RS flip-flop. The remaining two gates function as inverters—*IC1D* inverts the logic level at the input probe and *IC1C* inverts the output of the flip-flop. When the output of *IC1C* is logic zero, current flows through *R2* and *LED1*, causing the LED to glow.

The circuit functions in either the HOLD or VIEW mode, depending on the position of *S1*. In the HOLD mode, a logic transition at the input probe changes the state of the flip-flop. The flip-flop remains in the changed state until it is reset by the user. In the VIEW mode, the flip-flop functions as a follower, changing state in step with the input signal.

The LED is a visual indicator of the state of the flip-flop's output. If the circuit is in its VIEW mode and the input signal is a pulse train, the LED will blink on and off. Limitations in the response of the human eye must be considered, however. If the duration of each pulse is very brief and the interval between pulses relatively large, the eye will not see the brief flashes of light from the LED. If the duty cycle and frequency of the pulse train are sufficiently high, the LED will appear to be on continuously when in fact it is rapidly flashing on and off. It is only at relatively low frequencies and large duty cycles that the user will see the LED blinking on and off.

Switch *S2* routes either an inverted or noninverted version of the signal appearing at the input probe to the flip-flop. Switch *S1* selects the operating mode and also functions as a reset switch when the circuit is in HOLD.

The Inexpensive Pulse Detector's circuit is so simple that it can be easily reproduced using perforated board, solder, and point-to-point wiring techniques. Wrapped-wire construction is also suitable. Mount the circuit in any small enclosure.

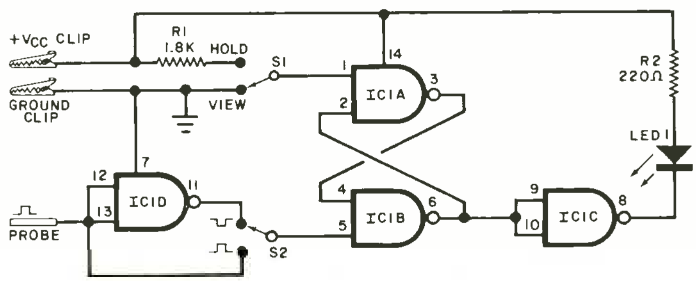
The most convenient housing for the project is a plastic cigar tube. The tube can be drilled to accommodate the LED, input probe, and power leads. (No power source need be included in the project because it can tap the current it needs from the supply of the circuit being monitored.) The circuit board and LED can be secured to the interior of the cigar tube using plastic cement. Two holes should be drilled at either end of the tube—one at the rounded end for the input probe and one in the cap for the power leads. The leads should be terminated with alligator clips and have color-coded insulation. A standard pin jack is the best choice for use as the input probe.

What follows is a description of how the circuit behaves when logic signals are applied to its input probe for the four combinations of switch positions.

If *S1* is in its VIEW position and *S2* in its noninverting position, the LED will remain dark as long as the probe is left floating or connected to a circuit node at logic one. When the input signal changes from logic one to logic zero (or when the probe is touched to a point at logic zero), the LED starts to glow. It will continue to glow until the signal returns to logic one or the probe is removed from the circuit.

If *S1* is in VIEW but *S2* in its inverting position, the LED will glow as long as the probe is left floating or connected to a circuit node at logic one. When the input signal changes from logic one to logic zero (or the probe is touched to a point at logic zero), the LED will go dark. It will remain dark until the input logic level changes from zero to one or until the probe is removed from the circuit node being monitored and is left floating.

The HOLD mode differs from the VIEW mode in that the LED will not flash on and off in step with the input logic signal. Rather, the circuit will be triggered by the first logic transition of the proper



polarity. The LED will be either turned off or on by this transition, depending on the position of *S2*, and will remain on (or off) until the circuit is reset. This is accomplished by momentarily placing *S1* in its VIEW position.

If *S1* is in its HOLD position and *S2* is in its noninverting position, the LED will remain dark as long as the input probe is left floating or is applied to a circuit node at logic one. When the circuit node goes from logic one to logic zero, the LED starts to glow. It will continue to glow until *S1* is momentarily placed in its VIEW position. Note that if the circuit has not yet been triggered, the LED will start to glow as soon as the input probe is touched to a point in the circuit at logic zero. This happens because the project perceives that a negative logic transition has taken place when in fact the circuit node to be monitored has not changed state at all. To reset the circuit so that it can catch and hold the next negative logic transition, simply toggle *S1* to VIEW and then back to HOLD.

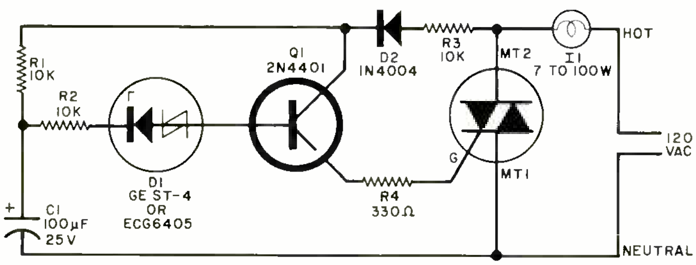
Now assume that *S1* is placed in its HOLD position and *S2* in its inverting position. If the input probe is floating or touched to a circuit node at logic one, the LED will glow and continue to glow even if *S1* is placed in its VIEW position. However, if the probe is in contact with a circuit node that is at logic zero *before* *S1* is placed in its HOLD position, the LED will remain dark until a positive logic transition (zero to one) occurs. Once the circuit has been triggered by a positive logic transition, the LED will continue to glow until the input probe is placed at logic zero and *S1* is toggled from HOLD to VIEW.—*Richard Towle, Bedford, MA.*

Simple Flasher

Shown here is a simple flasher circuit that can be assembled from standard, readily available parts. With the component values shown, the flash rate is approximately once per second. The incandescent lamp used as a load glows at half brightness for about one-third of the total flasher period and is off for the remaining two thirds.

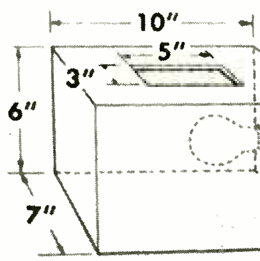
Electrolytic capacitor *C1* charges up during the positive half-cycle of the ac waveform through *R1, R3* and *D2*. When the voltage across the capacitor reaches the breakover voltage of silicon asymmetrical switch *D1* (either 9 or 18 volts), the capacitor starts to discharge through *R2, D1, Q1, R4* and *Q2*. Emitter follower *Q1* is driven by the discharge current from *C1* and in turn provides gate drive for triac Q2. Thus, *Q2* conducts and *I1* glows only while *C1* is discharging. The lamp goes dark when *C1* is depleted of charge and remains dark until the ac power waveform goes positive again and charges the capacitor sufficiently.

Transistor *Q1*, nominally a type 2N4401, can be any medium-current, high-beta npn silicon device with a V_{CEO} rating of 40 volts or more. A triac used for *Q2* should be rated to handle 10 amperes, to withstand 400 volts rms and should be triggered into conduction by a gate current of no more than 5 mA. In many applications, the triac will not have to be heat sinked. The flash rate can be varied by changing the capacitance of *C1*. Using more capacitance results in a slower flash rate, and less capacitance in a faster flash rate.—*Bertram A. Thiel, Frostburg, MD*



PC Board Viewer

The enclosure shown in the figure is a very handy printed circuit board viewer. It was made out of ¼-inch (6.4-mm) plywood, and the interior was lined with aluminum foil. A 25-watt incandescent bulb and bulb holder were installed to illuminate the inside of the box. In operation, the lamp's line cord is plugged into a power outlet and the printed circuit board to be observed is positioned over the opening on the top of the box. A visual inspection of the board for minute cracks can then be made. The box is also helpful when looking for unbonded foil (blisters) caused by excessive application of heat during soldering, for shorts or causes of leakage paths, for the exact solder point when removing miniature components from densely packed pc boards such as those found in transistor radios, and when performing general circuit tracing. —*Harry J. Miller, Sarasota, FL.*



Electronics Library

The Radio Amateur's Handbook 1980 (Fifty-Seventh Edition)

by the ARRL Headquarters Staff

This latest incarnation of the venerable *Radio Amateur's Handbook* continues the trend of recent editions in its increased emphasis on physics concepts in the presentation of such topics as transmission lines, antennas, shielding, etc. Also, the increased use of VMOS devices, toroidal inductors and transformers, linear and digital ICs, doubly balanced mixers and other components in the circuits presented in the Handbook reflect the evolution of communications electronics.

Published by the American Radio Relay League, 225 Main Street, Newington, CT 06111. 576 pages. Hard cover $15.75 in the U.S., $18 in Canada and elsewhere. Soft cover $10 in the U.S., $11 in Canada, and $12.50 elsewhere.

The BASIC Handbook

by David A. Lien

This new book can prove to be an invaluable aid in getting published BASIC programs to run in your computer. It lists the various BASIC statement/command words and existing variations used in 78 popular BASICs. An explanation of the word tells what it is and does. Then a program allows you to determine if your computer's interpreter or compiler recognizes and makes use of the word and how the computer might respond if it does. Helpful hints on simplifying a program to achieve a higher level of reliability are then noted.

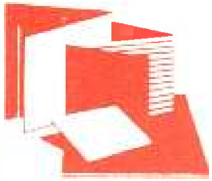
Published by Compusoft Publishing, P.O. Box 19669, San Diego, CA 92119. Soft cover. 360 pages. $14.95.

Audio Servicing

by Andy J. Wells

Here's a book that delivers just what its title implies, considering that its subtitle is "Theory and Practice." (It is designed to be used with a companion Lab Manual that is available for $4.95.) By itself, *Audio Servicing* can be a very useful book for any audio-equipment owner to have, as well as the service technician. With numerous photos, schematic diagrams, and other illustrations, backed up by well-written and easy-to-understand text, it succeeds in explaining every part of an audio system in nontechnical terms.

Published by Gregg/McGraw-Hill Book Co., 1221 Ave. of Americas, New York, NY 10020. Soft cover. 228 pages. $8.95.



New Literature

Reference Manual for The Imagination Machine

A Technical Reference Manual on APF Electronics' Imagination Machine includes chapters on memory maps, memory usage for programs and variables, and entering and using machine language. Appendices include schematics and parts layout. Written for The Imagination Machine purchaser who would like to have more knowledge about how it works. Send $2, postage and handling, to APF Electronics Inc., 444 Madison Ave., New York, NY 10022.

Dolby HX Literature

In a four-page pamphlet, Dolby Laboratories describes the theory and operation of its new Headroom Extension (HX) circuit configuration now appearing in cassette decks on the audio market. Through signal-controlled variation of a deck's recording bias and equalization, Dolby HX is said to achieve a dynamic-range increase on the order of 10 dB at high frequencies. Address: Dolby Laboratories, 731 Sansome St., San Francisco, CA 94111.

Printed-Circuit Design Bulletin

An updated Bulletin (Vol. III, No. 1) from Bishop Graphics features new printed-circuit artwork patterns recently introduced by the company. Included are solder mask artwork patterns, feed-through conductor patterns for creating multi-color DIP stikons, dual in-line patterns, multipurpose prespaced pads, and templates. Address: Bishop Graphics, 5388 Sterling Center Dr., Box 5007, Westlake Village, CA 91359.

Gas-Discharge Displays

A four-page brochure from Boston Electronics Corp. covers its Optnix series of planar gas-discharge displays. Included are descriptions of the 2-inch and 3.1-inch high digits, typical circuitry, and tables of electrical and mechanical properties. Address: Boston Electronics Corp., 68 Harvard St., Brookline, MA 02146.

Hard-to-Find Tool Catalog

A new catalog of tools for electronic assembly and precision mechanics from Jensen Tools Inc. includes over 2,000 tools. Included are micro-tools, test and soldering equipment, tweezers, screwdrivers, cutters, drafting supplies, power tools, and a line of kits and cases. Address: Jensen Tools Inc., 1230 South Priest Dr., Tempe, AZ 85281.

Operation Assist

If you need information on outdated or rare equipment—a schematic, parts list, etc.—another reader might be able to assist. Simply send a postcard to Operation Assist, POPULAR ELECTRONICS, 1 Park Ave., New York, NY 10016. For those who can help readers, please respond directly to them. They'll appreciate it. (Only those items regarding equipment not available from normal sources are published.)

Bell & Howell model 34 oscilloscope. Need schematic and alignment information. Charles Kneiblher III, 1751 New Ashland City Hwy., Clarksville, KY.

Jackson Electric Co., TV sweep/marker generator. Need schematic and any available information. Douglas Young, 4314 Wyoming Ct., Virginia Beach, VA 23456.

Precision series E-400 sweep generator. Need operating manual. Norman Schmidt, 3301 Rollingwood Dr., Gastonia, NC 28052.

Zenith model 8B01 wavemagnet AM radio. Need schematic and parts list. Robert M. Shuster, 210 Briar Ave., North Canton, OH 44720.

Approved Electronic Instrument Corp., model A-200 r-f signal generator. Need schematic or address of company. Dan Bleicher, 8820 Van Nuys Blvd. #6, Panorama City, CA 91402.

Stromberg-Carlson No. 920-H radio receiver. Need schematic or specifications on power transformer. Charles Cline, 6334 Ben Ave., N. Hollywood, CA 91606.

Olympic model CT-400 (chassis CT-1990) TV. Need high voltage transformer part #TRJ-61442. William J. Maida, 341 Isabella Dr., Longwood, FL 32750.

Simpson model 310 signal generator. Operating manual and schematic needed. Elden Perry, Box 441, Nashville, MI 49073.

Thordarson type T11K16 oscilloscope. Need schematic. Nicholas Mulchin, 232 Willow St., Meadville, PA 16335.

Electro Instruments, Inc., model 405 digital voltmeter. Need schematic, manual, any available information and company address. Frank Nally, 1127 Berkeley Sq., Louisville, KY 40213.

Precision Apparatus Co., series ES-500A oscilloscope. Manual and schematic needed. Dewey Parlier, 3311 Wide Country Rd., Pfafftown, NC 27040.

Lear, Inc., model ADF-12, ADF-12C, ADFL-12 orienter. Need schematic and manuals. Greg Woods, PO Box 69, Moosomin, SK, S0G 3N0 Canada.

Dumont model 3044 oscilloscope. Need instruction manual. L.E. Weiss, Sr., 14518 S. Disney Ave., Norwalk, CA 90650.

Alaron model B606 reel-to-reel tape recorder. Need schematic and manuals. E.R. Gamble, 1053 Elm St., Clinon, IN 47842.

Pilot model TV 37 television. Need kinescope 3KP4. Barry Dalton, 10354 Danube Ave., Granada Hills, CA 91344.

Philco model 610 radio. Need antenna transformer (original part #32-1669). Glen Steinman, 7915 E. Michigan Ave., Jackson, MI 49201.

Hallicrafters SX-100 receiver. Need schematic, operating manual and any available information. Alan Herbach, 27200 Franklin Rd., Apt. 622, Southfield, MI 48034.

Simpson model 480 genescope. Need manuals, schematics and calibration data. Emil Huddy, 45541 Rd. 200, North Fork, CA 93643.

Grunow model 501 AM radio. Need schematic, parts list and service information. Doug Lobb, 6815 X St., Lincoln, NB 68505.

Jackson model TVG-2 TV sweep/marker generator. Schematic and manuals needed. Ted Wilson, Isabell Enterprises, 12439 So. Giles St., Las Vegas, NV 89119.

(Continued on page 127)

OPERATION ASSIST *cont'd*

Burroughs model #B-9352, serial #A-60203 CRT terminal. Need user and maintenance manuals. Larry L. Hoglin, 5624 Morgan Ave. So., Minneapolis, MN 55419.

Radio Shack model #STA-76 AM/FM stereo receiver. Need schematic. Luis Rullan Castillo, Buzon 656 El Quenepo, Quebrada Grande, Mayaguez, PR 00708.

Micro Match model #263.11 watt meter. Need repair/service manuals and schematics. Nick Marsala, AB5M, 5339 East 97th Street South, Tulsa, OK 74136.

Accurate Instrument Co., Inc., model 157 tube tester. Need operation manual and set up charts. **Harvey Wells** bandmaster Z match. Need calibration graph. S.A. Schreiber, 2607 Meadow Lane, La Marque, TX 77568.

Concord model #MK8 8 track recorder. Need service manuals and schematics. Harry F. Robertson, 5309 N.W. 108 Terrace, Oklahoma City, OK 73132.

RCA model 160-B oscilloscope. Need schematic and manuals. Henry M. Cantor, 21 Friendly Court, Babylon, NY 11702.

RCA Victor model R-4 radio. Need service data, tubes and dial parts. Len Powell, 1800 Crestview Rd., Baltimore, MD 21239.

Superior Instrument Co., model 670-A multimeter. Need manuals. Merle W. McMahom, 3327 S. Northern Blvd., Independence, MO 64052.

Electronic Measurements Corp., model 300 VTVM and **Precision Apparatus Co.**, model E-200 signal generator. Need schematics and owner's manuals. Louis D. Antuono, Saint John's University Amateur Radio Club, Jamaica, NY 11439.

Sound City model 200 guitar amplifier. Need schematic. Tony Fox, 8460 Narrow Gauge Road, Beulah, MI 49617.

Technical Material Corp., model MSR 4 mode selector receiver and **Allen B. Dumont Laboratories, Inc.**, cathode ray oscillograph model 224-A. Need operation and service manuals. Paul C. Gunn, 1396 South Fourth St., Aurora, IL 60538.

Motorola model 41E radio. Need schematic. B. Grimes, Rt. 1, Box 2006, Ft. McCoy, FL 32637.

Sylvania type 400 television oscilloscope and **Akai** 3000 D tape recorder. Need manuals and schematics. Leo P. Stone, R.D. #4, Bath, NY 14810.

Hewlett-Packard model 400C generator. Need schematic. M.D. Chedester, 2507 SE 20th Pl, Cape Coral, FL 33904.

Knight Kit star roamer II short wave receiver. Need schematic and/or assembly manual. R. Tomeo, Box 2362, San Diego, CA 92112.

Facit Electronic type 1121 #103.469 calculator. Need operator and maintenance manual. E.P. Eardley, 4002 Rose Lane, Annandale, VA 22003.

Tektronix type 531 oscilloscope. Need manual or schematic. Ross Hansohn, 841 E. Sheridan, Phoenix, AZ 85006.

Sonar model H tube type CB transceiver. Need schematic, alignment procedure and parts source. Douglas Weeks, 1617 Maurice St., Monroe, NC 28110.

Tektronix model 533 oscilloscope. Need schematic and operation manual. Ernest Koenderink, 9 Begonia St., 2565 SP The Hague, Netherlands.

Dressen Barnes model 1K-500B power supply. Need service information. J.A. Call, 1876 E. 2990 S., Salt Lake City, UT 84106.

Knight Electronics model KG-415 tape deck. Need assembly manual, schematics or any available information. David Taylor, 2179 Lake Village Dr., Kingwood, TX 77339.

Solar model CE-2U capacity analyzer. Need schematic and operating instructions. R. J. Seyler, 312-186 Edinburgh Rd., Guelph, Canada NIG 2H9.

Furst Electronics model 115R.A. wow meter, **Waveforms** model 452A transmission measuring set, and **Ballantine** model 300 and 305 ac voltmeters. Need schematics and operating manuals. Ken deGruchy, 281 Eastbrook Rd., Ridgewood, NJ 07450.

Bell Sound Systems, Inc. model #2254 FM tuner and model #2256 amplifier. Need schematics and service manuals. F. Lee Moratzka, Box 725, Hoffman Estates, IL 60195. ◇

PROJECT OF THE MONTH

X100 Frequency Multiplier

BY FORREST M. MIMS

LOW-FREQUENCY signals are more difficult to measure than you might think. First of all, you must have a frequency counter whose amplifier has a response that goes far enough down toward dc. Many counters are rated to 50 or 100 Hz, and will display meaningless information when driven by lower-frequency signals. Secondly, no degree of precision can be obtained unless your frequency counter has a gate time of 10 or more seconds. Even a 10-second gate time gives an accuracy of only one decimal place (0.1 Hz). To make matters worse, a 10-second gate time means that the display is updated only six times a minute. This can make critical circuit adjustments tedious.

Figure 1 shows schematically a simple but very useful ×100 frequency multiplier or *prescaler*. This device dramatically simplifies low-frequency measurements by inserting a divide-by-100 counter between the vco and the wideband phase comparator of a CMOS 4046 phase-locked loop. With the component values shown, the circuit will multiply signals at frequencies ranging from less than one to a few hundred hertz up to a range that even counters with relatively restricted low-frequency responses can accommodate.

In operation, properly conditioned pulses are applied to the input of the 4046. The loop generates an error voltage which is filtered and applied to the input of the vco, thus beginning the capture process. Because a divide-by-100 counter is placed between the output of the vco and the phase comparator's second input, the vco frequency will be exactly 100 times that of the input signal when the loop is phase-locked. The signal frequency can then be measured to an accuracy of one decimal place (0.1-Hz resolution) with a standard frequency counter having a one-second gate time.

The capture time of this phase-locked loop prescaler can easily exceed several seconds, especially when very low frequencies are applied to its input. If you intend to use the circuit to measure frequencies consistently higher than 50 Hz, you can speed up the loop's capture time by reducing the value of *C2* to 0.22 μF.

If the signals to be multiplied are noisy or have slow rise and fall times, it will be necessary to condition them before they are applied to the input of the 4046. Figure 2 shows a simple snap-action comparator made from a BiMOS CA3130 op amp that can be used for this purpose. This circuit can process signals with frequencies as high as 50 kHz. Other op amp types can be used in place of the CA3130.

In Fig. 1, a 4518 is used as a divide-by-100 counter. This IC was selected principally because it includes two decade counters in a single DIP, but other counter arrangements can also be used. A pair of 4017 decade counters, for example, can be cascaded to form a suitable divide-by-100 counter.

Applications for this month's project are plentiful because the circuit can be used to multiply virtually any low-frequency signal. Of particular interest is the measurement of such low-frequency biological signals as brain waves and cardiac-pulse, respiration and blink rates. Other possibilities include measuring the revolution rates of wind turbines, bicycle wheels and low-speed motors. ◇

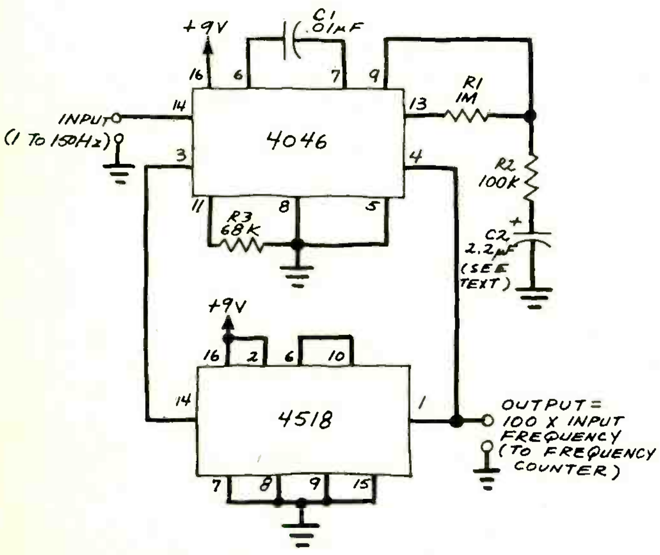


Fig. 1. A X100 prescaler for low-frequency measurements.

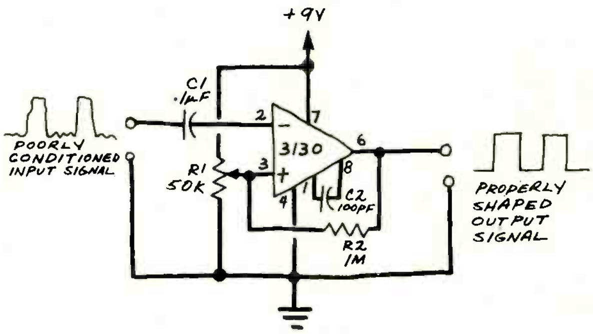


Fig. 2. A snap-action comparator made from a BiMOS op amp that can be used as a pulse shaper.

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7414N	70
7420N	20
7422N	39
7430N	20
7442N	58
7445N	74
7447N	58
7448N	77
7450N	20
7474N	35
7475N	49
7485N	88
7489N	1 85
7490N	43
7492N	43
7493N	43
7495N	69
74100N	1 20
74107N	35
74121N	34
74123N	59
74125N	45
74145N	77
74150N	1 20
74151N	69
74154N	2 00
74157N	69
74161N	87
74162N	1 25
74163N	87
74174N	96
74175N	95
74190N	1 15
74192N	87
74193N	85
74221N	2 75
74298N	1 65
74365N	89
74366N	89
74367N	89
74LS00 TTL	
74LS00N	35
74LS02N	35
74LS04N	55
74LS05N	40
74LS08N	45
74LS10N	45
74LS13N	55
74LS14N	1 25
74LS20N	45
74LS22N	45
74LS28N	45
74LS30N	45
74LS33N	75
74LS38N	75
74LS74N	1 25
74LS75N	1 00
74LS90N	1 00
74LS93N	1 00
74LS95N	1 10
74LS107N	65
74LS112N	65
74LS113N	45
74LS132N	89
74LS136N	65
74LS151N	1 10
74LS155N	1 10
74LS157N	1 10
74LS162N	1 65
74LS163N	1 65
74LS174N	2 00
74LS190N	1 25
74LS221N	2 50
74LS258N	1 60
74LS367N	1 65
LINEAR	
CA3045	90
CA3046	1 10
CA3081	1 80
CA3082	1 90
CA3089	2 95
LM301AN/AH	35
LM305H	87
LM307N	35
LM308N	1 00
LM309K	1 50
LM311H/N	90
LM317T/K	3 75
LM318	1 35
LM320K-5	1 50

LM323K 5	5 95
LM320K 12	1 50
LM320K 15	1 50
LM320T 5	1 35
LM320T 8	1 35
LM320T 12	1 35
LM320T 15	1 35
LM324N	1 40
LM339N	1 00
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
LM350	7 50
LM377	3 50
LM379	5 00
LM380N	1 00
LM381	1 60
LM382	1 60
LM703H	65
LM709H	28
LM723H/N	50
LM733N	85
LM741CH	35
LM741N	38
LM747H/N	75
LM748N	35
LM1303N	1 75
LM1304	1 10
LM1305	1 27
LM1307	2 00
LM1310	2 75
LM1458	47
LM1812	7 50
LM1889	3 00
LM2111	1 75
LM2902	2 25
LM3900N	60
LM3905	1 75
LM3909N	95
MC1458V	50
NE550N	1 00
NE555V	39
NE556A	85
NE565A	1 00
NE566V	1 50
NE567V	1 00
NE570B	4 75
78L05	60
78L08	60
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	
CD4000	25
CD4001	35
CD4002	35
CD4006	1 10
CD4007	35
CD4008	28
CD4009	45
CD4010	45
CD4011	35
CD4012	28
CD4013	47
CD4014	1 25
CD4015	1 00
CD4016	55
CD4017	1 05
CD4018	94
CD4019	45
CD4020	1 02
CD4021	1 35
CD4022	1 10
CD4023	28
CD4024	75
CD4025	28

CD4026	2 50
CD4027	66
CD4028	85
CD4029	1 35
CD4030	45
CD4035	1 35
CD4040	1 35
CD4042	85
CD4043	85
CD4044	85
CD4046	1 67
CD4049	45
CD4050	49
CD4051	1 13
CD4060	1 42
CD4066	71
CD4068	40
CD4069	40
CD4070	50
CD4071	45
CD4072	45
CD4073	45
CD4075	45
CD4076	1 65
CD4078	40
CD4081	35
CD4082	35
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	2 35
CD4585	1 10
CD40192	3 00
74C00	35
74C04	40
74C10	35
74C14	1 95
74C20	35
74C30	35
74C48	2 25
74C74	85
74C76	1 75
74C90	1 75
74C93	1 75
74C154	3 00
74C160	2 00
74C175	1 35
74C192	2 25
74C221	2 50
74C905	6 00
74C906	75
74C914	1 95
74C922	6 00
74C923	6 00
74C925	7 50
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	2 95
2102-1	95
2102AL-4	1 34
2102AN-2L	1 60
2104A-4	4 95
2107B 4	3 75
2111 1	3 75
2112 2	3 95
2114L 300ns	6 75
2114L 450ns	5 95

4116 200ns	7 95
8/4116 200ns	49 00
2513B	6 30
MM5262	40
MM5280	3 00
MM5320	9 95
MM5330	5 94
PD411D-3	4 00
PD411D-4	5 00
P5101L	8 95
4200A	9 95
82S25	2 90
91L02A	1 50
HD0165-5	6 95
MM57100	4 50
GIAY38500-1	9 95
MCM66751A	9 95
9368	3 50
410D	10 00
416	16 00
CLOCKS	
MM5311	5 50
MM5312	3 90
MM5314	3 90
MM5369	2 10
MM5841	14 45
MM5865	7 95
CT7010	8 95
CT7015	8 95
MM5375AA/N	3 90
MM5375AG/N	4 90
7205	16 50
7207	7 50
7208	15 95
7209	4 95
DS0026CN	3 75
DS0056CN	3 75
MM53104	2 50
MICROPROCESSOR	
6502	10 95
6504	9 95
6522	9 95
6800	6 95
6802	11 95
6820	4 95
6850	5 95
8080A	5 95
8085	12 95
8086	75 00
Z80	9 95
Z80A	11 95
8212	2 90
8214	3 95
8216	2 90
8224	3 45
8228	4 95
8251	6 95
8253	15 00
8255	5 75
8257	10 95
8259	14 95
1802CP plas	13 95
1802DP plas	17 95
1861P	11 50
CDP1802CD	28 95
CDP1802D	35 00
CDP1861	15 95
UART/FIFO	
AY5 1013	5 50
AY5 1014	7 50
3341	6 95
PROM	
1702A	4 95
2513B upper case	8 75
2708	7 75
2716T1	18 00
2716 Intel	23 00
8/2716 Intel	160 00
2732	65 00
2758	22 50
8741A	60 00
8748	65 00
8748-8	60 00
8755A	55 00
N82S23	2 95
N82S123	6 50
N82S126	3 75
N82S129	8 50
N82S131	8 50
N82S136	8 75
N82S137	8 75
DM8577	2 90
8223	2 90

CONNECTORS

30 pin edge	2 50
44 pin edge	2 75
100 pin edge	4 50
100 pin edge WW	5 25

IC SOCKETS
Solder Tin Low Profile

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

2 level 14 pin ww 20

WIRE WRAP LEVEL 3

PIN		PIN	
14	32	24	86
16	33	28	1 00
18	57	40	1 23

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 Hz	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

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AY5-2376	512 50
AY5-3600	17 95
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Metal Enclosure	29 95

LEDS

Red TO18	15
Green Yellow TO18	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
Complete line of AP Products in stock

SPECIAL PRODUCTS

MM5865 Stopwatch Timer with 10 pg spec	9 00
PC board	7 50
Switches Mom Pushbutton	27
3 pos slide	25
Encoder HD0165-5	6 95
Paratronics 100A Logic Analyzer	$425.00
Model 10 Trigger Expander Kit	$229 00
Model 150 Bus Grabber Kit	$369 00
Clock Calendar Kit	$23.95
2.5 MHz Frequency Counter Kit	$37.50
30 MHz Frequency Counter Kit	$47 75

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
12V 500 ma wall plug	4 75
12V 1 amp wall plug	5 50
10/15 VAC 8/16 VA wall plug	9 75

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
10 digit display			1 25
7520 Clairex photocells			39
TIL311 Hex			9 50
MAN3640	CC	30	1 10
MAN4610	CA	40	1 20
MAN4640	CC	40	1 20
MAN4710	CA	40	95
MAN4740	CC	40	1 20
MAN6640	CC	56	2 95
MAN6710	CA	60	1 35
MAN6740	CC	60	1 35

MA1002A	8.95
MA1002E	8.95
MA1012A	8.95
102P3 transformer	2.25
MA1012A Transformer	2.25

RCA Cosmac 1802 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, Full Basic, ASCII Keyboards, video character generation, etc.**

Before you buy another small computer, see if it includes the following features: ROM monitor; State and Mode displays; Single step; Optional address displays; Power Supply; Audio Amplifier and Speaker; Fully socketed for all IC's; Real cost of in warranty repairs; Full documentation.

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 8 LED indicators.

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 slot for PC cards and a 50 pin connector slot 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 R&D.

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. All metal Expan**sion Cabinet, painted and silk screened, with room for 5 S-100 boards and power supply **$57.00. NiCad Battery Memory Saver Kit $6.95.** All kits and options also completely assembled and tested.

Questdata, a software publication for 1802 computer users is available by subscription for $12.00 per 12 issues. Single issues $1.50. Issues 1-12 bound $16.50.

Tiny Basic Cassette **$10.00**, on ROM **$38.00,** original Elf kit board **$14.95. 1802 software;** Moews Video Graphics **$3.50.** Games and Music **$3.00,** Chip 8 Interpreter **$5.50.**

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, (relocatable 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. 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. 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 $15.25 for easy connection between the **Super Elf** and the **Super Expansion Board.**

Power Supply Kit for the complete system (see Multi-volt Power Supply).

Announcing Quest Super Basic— *SECOND GENERATION*

A new enhanced version of **Super Basic** now available. Quest was the first company worldwide to ship a full size Basic for 1802 Systems. A complete function **Super Basic** by **Ron Cenker** including floating point capability with scientific notation (number range $\pm .17E^{38}$), 32 bit integer ± 2 billion; multi dim arrays, string arrays; string manipulation; cassette I/O, save and load, basic, data and machine language programs; and over 75 statements, functions and operations.

Enhancements include increased speed, built-in provisions for Stringy Floppy, Floppy Disc, Printer Driver, I/O, user definable command library and statement renumbering.

Easily adaptable to most 1802 systems. Requires 16K RAM minimum for Basic and user programs. Source listing for both Serial and Parallel I/O included.

Super Basic on Cassette $40.00.

Gremlin Color Video Kit $69.95

32 x 16 alpha/numerics and graphics; up to 8 colors with 6847 chip; 1K RAM at E000. Plugs into Super Elf 44 pin bus. No high res. graphics. On board RF Modulator Kit **$4.95**

Elf II Adapter Kit $24.95

Plugs into Elf II providing Super Elf 44 and 50 pin plus S-100 bus expansion. (With Super Expansion). High and low address displays, state and mode LED's optional **$18.00.**

1802 16K Dynamic RAM Kit $149.00

Expandable to 32K. Hidden refresh w/clocks up to 4 MHz w/no wait states. Addl. 16K RAM **$63.00**

Super Elf 44 pin expansion board; 3 female and 1 male bus. Board plus 3 connectors **$22.95**

Tiny Basic Extended on Cassette	**$15.00**
(added commands include Stringy, Array, Cassette I/O etc.)	
S-100 4-Slot Expansion	**$ 9.95**
Super Monitor VI.I Source Listing	**$15.00**

Super Color S-100 Video Kit $129.95

Expandable to 256 x 192 high resolution color graphics. 6847 with all display modes computer controlled. Memory mapped. 1K RAM expandable to 6K. S-100 bus 1802, 8080, 8085, Z80 etc.

Editor Assembler	**$25.00**
(Requires minimum of 4K for E/A plus user source)	
1802 Tiny Basic Source listing	**$19.00**
Super Monitor V2.0/2.1 Source Listing	**$20.00**

PROM Eraser

assembled. 25 PROM capacity **$37.50** (with timer **$69.50**). 6 PROM capacity OSHA/UL version **$69.50** (with timer **$94.50**).

Z80 Microcomputer

16 bit I/O, 2 MHz clock, 2K RAM, ROM Breadboard space. Excellent for control. Bare Board **$28.50.** Full Kit **$99.00.** Monitor **$20.00.** Power Supply Kit **$35.00. Tiny Basic $30.00**

S-100 Computer Boards

8K Static Godbout Econo IIA Kit	145.00
16K Static Godbout Econo XIV Kit	285.00
24K Static Godbout Econo VIIA-24 Kit	435.00
32K Static Godbout Econo X-32 Kit	575.00
16K Dynamic RAM Kit	199.00
32K Dynamic RAM Kit	310.00
64K Dynamic RAM Kit	470.00
Video Interface Kit	**$135.00**

80 IC Update Master Manual $55.00

Comp. IC data selector, 2700 pg. master reference guide. Over 51,000 cross references. Free update service through 1980. Domestic postage $3.50.

Modem Kit $60.00

State of the art, orig., answer. No tuning necessary. 103 compatible 300 baud. Inexpensive acoustic coupler plans included.

LRC 7000 + Printer $389.00

40/20 column dot matrix impact, std. paper. Interface all personal computers.

64/40/32/20 version **$405.00.** Optional cables available.

LRC 7000 printer interface cable for Super Elf with software $26.00

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**

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.**

Special small power supply for AIM65 assem. in frame **$54.00.** Complete AIM65 in thin briefcase with power supply **$499.00.** Molded plastic enclosure to fit both AIM65 and power supply **$47.50.** Special Package Price: 4K AIM, 8K Basic, power supply, cabinet **$599.00**

AIM65/KIM/VIM/Super Elf 44 pin expansion board; 3 female and 1 male bus. Board plus 3 connectors **$22.95.**

60 Hz Crystal Time Base Kit $4.40

Converts digital clocks from AC line frequency to crystal time base. Outstanding accuracy.

Video Modulator Kit $8.95

Convert TV set into a high quality monitor w/o affecting usage. Comp. kit w/full instruc.

Multi-volt Computer Power Supply

8v 5 amp, ±18v .5 amp, 5v 1.5 amp, −5v .5 amp, 12v .5 amp, −12v option, ±5v, ±12v are regulated. Basic Kit **$29.95.** Kit with chassis and all hardware **$43.95.** Add $4.00 shipping. Kit of hardware **$14.00.** Woodgrain case **$10.00.** $1.50 shipping.

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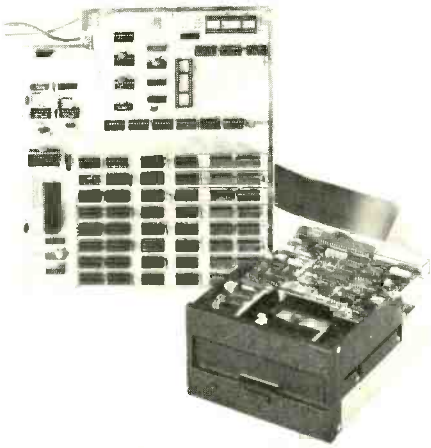
The first complete computer system on a board! Includes keyboard, video interface and audio cassette interface. 8K BASIC-in-ROM, 4K RAM.
Requires power supply of +5V @ 3 amps **$299**

> **"We heartily recommend Superboard II for the beginner who wants to get into microcomputers with a minimum cost. A real computer with full expandability."**
> —POPULAR ELECTRONICS, MARCH, 1979
>
> **"The Superboard II is an excellent choice for the personal computer enthusiast on a budget."**
> —BYTE, MAY, 1979

Buy OHIO SCIENTIFIC's 610 Expander Board and get $99 off reg. $299 price of mini-floppy disk drive (including connector cable). ONLY $200!



610 Expander Board

For use with Superboard II and Challenger 1P. 8K static RAM expandable to 24K or 32K system total. Accepts up to two mini-floppy disk drives.
Requires +5V @ 4.5amps **$298**

Mini-Floppy Disk Drive

Includes Ohio Scientific's PICO DOS software and connector cable. Compatible with 610 Expander Board.
Requires +12V @ 1.5 amps and +5V @ 0.7 amps.

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TOTAL $797

4KP 4K RAM chip set	**$ 79**
PS003 Mini-floppy power supply each	**$ 29**
PS005 5V 4.5 amp open frame power supply	**$ 35**
SAMS manual C1P/Superboard II	**$ 8**
SAMS manual C4P	**$ 16**
OS-65D V3.2 Disk Operating System with 9-digit extended BASIC, random access from sequential files	**$ 49**
C4P computer 8K RAM expandable to 32K RAM	**$ 750**
C4P MF computer Mini-floppy, 24K RAM	**$1795**
C8P computer 8K RAM expandable to 32K and dual 8-inch floppies	**$ 950**
C8P DF computer 32K RAM expandable to 48K, dual 8-inch floppies	**$2895**

NEW! SAMS manual for the Challenger III Series **$ 40**

Attention Superboard II and C1P owners:

You can still take advantage of our summer sale. Purchase the 610 Expander Board for the regular price and get $99 off on the mini-floppy and cable.

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LM320K-24	1.35	NE540	6.00	LM3909N	1.25
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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	NE562B	5.00	75453CN	.39
LM320T-24	1.25	NE565N/H	1.25	75454CN	.39
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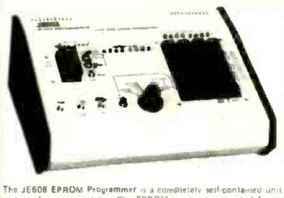
74LS01	.35	74LS54	.29	74LS151	1.05
74LS02	.35	74LS55	.29	74LS155	1.05
74LS03	.35	74LS73	.54	74LS157	1.05
74LS04	.42	74LS74	.54	74LS160	1.15
74LS05	.42	74LS75	.71	74LS161	1.39
74LS08	.35	74LS76	.54	74LS162	1.25
74LS09	.42	74LS78	.49	74LS163	1.39
74LS10	.35	74LS83	1.05	74LS164	1.50
74LS11	.75	74LS85	1.50	74LS175	1.25
74LS13	.59	74LS86	.54	74LS181	2.49
74LS14	1.25	74LS90	.71	74LS190	1.39
74LS15	.35	74LS92	.90	74LS191	1.39
74LS20	.35	74LS93	.90	74LS192	1.39
74LS21	.35	74LS95	.99	74LS193	1.39
74LS22	.35	74LS96	1.15	74LS194	1.39
74LS26	.35	74LS107	.54	74LS195	1.39
74LS27	.35	74LS109	.54	74LS253	1.25
74LS28	.35	74LS112	.54	74LS257	1.05
74LS30	.35	74LS123	1.50	74LS258	1.75
74LS32	.42	74LS125	1.05	74LS260	.83
74LS37	.45	74LS132	.99	74LS279	.90
74LS40	.35	74LS136	.59	74LS367	.75
74LS42	1.05	74LS138	1.05	74LS368	.75
74LS47	1.05			74LS670	2.49

JE608 PROGRAMMER

2704/2708 EPROM PROGRAMMER



- 3 separate Display Registers. 8 LED's for Hex Key entries. 10 LED's (2° 2⁷) for Address Register and 8 LED's for Data Memory Register. The Data Memory Register displays the content of the RAMs from the EPROM Chip.
- Development of microprocessor systems by means of a ribbon cable from the programmer panel test socket to the EPROM socket on the microprocessor board.
- Rapid checking verification of programmed data changes.
- User may move data from a master to RAM's or write into RAM's with keyboard entries.
- Allows manual stepping manipulation (up and down) at any address location.
- Stand alone EPROM Programmer consisting of: A 19 key Hexadecimal Keyboard assembly, Programmer Board assembly with 4 power supplies and a LED/Test Socket Panel Board assembly. The Test Socket is zero force insertion type. Power requirements: 115VAC, 60Hz, 8W.
- Compact desk-top enclosure: Color-coordinated designer's case with light tan panels and molded end pieces in mocha brown. Size: 3¾"H x 11"W x 8¾"D. Weight: 5 lbs.

The JE608 EPROM Programmer is a completely self-contained unit which is independent of computer control and requires no additional systems for its operations. The EPROM can be programmed from the Hexadecimal Keyboard or from a pre programmed EPROM. The JE608 Programmer can emulate a programmed EPROM by the use of its internal RAM circuits. This will allow the user to test or pretest a program for a system, prior to programming a chip. Any changes in the program can be entered directly into the memory circuits with the Hexadecimal Keyboard so that rewriting the entire program will not be necessary. The JE608 Programmer contains a Programmer Board with 25 IC's and including power supplies of −5V, +5V, +12V and +26V. The Hexadecimal Keyboard and LED/Test Socket Panel Board are separate assemblies within the system.

JE608 KIT $399.95
JE608 Assembled and Tested $499.95

DISCRETE LEDS

XC556R	.200"	red	5/$1	MV50	.085"	red	6/$1	XC111R	.190"	red	5/$1
XC556G	.200"	green	4/$1	XC209R	.125"	red	5/$1	XC111G	.190"	green	4/$1
XC556Y	.200"	yellow	4/$1	XC209G	.125"	green	4/$1	XC111Y	.190"	yellow	4/$1
XC556C	.200"	clear	4/$1	XC209Y	.125"	yellow	4/$1	XC111C	.190"	clear	4/$1
XC22R	.200"	red	5/$1	XC526R	.185"	red	5/$1				
XC22G	.200"	green	4/$1	XC526G	.185"	green	4/$1				
XC22Y	.200"	yellow	4/$1	XC526Y	.185"	yellow	4/$1	INFRA-RED LED			
MV10B	.170"	red	4/$1	XC526C	.185"	clear	4/$1	¼"x¼"x1/16" flat			5/$1

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	.75	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	.49	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	.49	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	.99
MAN 6630	Common Anode-orange ± 1	.560	.99	HDSP-3400	Common Anode-red	.800	1.50
MAN 6640	Common Cathode-orange-D.D.	.560	.99	HDSP-3403	Common Cathode red	.800	1.50
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	3.25	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	1.25	CA3401N	.59
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. LED driver	1.50
MM5309	4.95

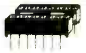
CLOCK CHIPS

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
CT 7001	6.95

MOTOROLA

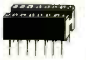
MC1408L7	4.95
MC1408L8	5.75
MC1439L	2.95
MC3022P	2.95
MC3061P	3.50
MC4016(74416)	7.50
MC4024P	3.95
MC4040P	6.95
MC4044P	4.50

LOW PROFILE (TIN) SOCKETS



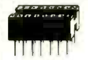
	1-24	25-49	50-100
8 pin LP	.17	.16	.15
14 pin LP	.20	.19	.18
16 pin LP	.22	.21	.20
18 pin LP	.29	.28	.27
20 pin LP	.34	.32	.30
22 pin LP	.37	.36	.35
24 pin LP	.38	.37	.36
28 pin LP	.45	.44	.43
36 pin LP	.60	.59	.58
40 pin LP	.63	.62	.61

SOLDERTAIL STANDARD (TIN)



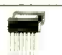
	1-24	25-49	50-100
14 pin ST	.27	.25	.24
16 pin ST	.30	.27	.25
18 pin ST	.35	.32	.30
24 pin ST	.49	.45	.42
28 pin ST	.99	.90	.81
36 pin ST	1.39	1.26	1.15
40 pin ST	1.59	1.45	1.30

SOLDERTAIL (GOLD) STANDARD



	1-24	25-49	50-100
8 pin SG	.39	.35	.31
14 pin SG	.49	.45	.41
16 pin SG	.54	.49	.44
18 pin SG	.59	.53	.48
24 pin SG	.79	.75	.69
28 pin SG	1.10	1.00	.90
36 pin SG	1.65	1.40	1.26
40 pin SG	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3



	1-24	25-49	50-100
8 pin WW	.59	.54	.49
10 pin WW	.69	.63	.58
14 pin WW	.79	.73	.67
16 pin WW	.85	.77	.70
18 pin WW	.99	.90	.81
20 pin WW	1.19	1.08	.99
22 pin WW	1.49	1.35	1.23
24 pin WW	1.39	1.26	1.14
28 pin WW	1.69	1.53	1.38
36 pin WW	2.19	1.99	1.79
40 pin WW	2.29	2.09	1.89

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ASST. 2	5 ea.	68 OHM 180 OHM	82 OHM 220 OHM	100 OHM 270 OHM	120 OHM 330 OHM	150 OHM 390 OHM	50 PCS	1.75
ASST. 3	5 ea.	470 OHM 1.2K	560 OHM 1.5K	680 OHM 1.8K	820 OHM 2.2K	1K 2.7K	50 PCS	1.75
ASST. 4	5 ea.	3.3K 8.2K	3.9K 10K	4.7K 12K	5.6K 15K	6.8K 18K	50 PCS	1.75
ASST. 5	5 ea.	22K 56K	27K 68K	33K 82K	39K 100K	47K 120K	50 PCS	1.75
ASST. 6	5 ea.	150K 390K	180K 470K	220K 560K	270K 680K	330K 820K	50 PCS	1.75
ASST. 7	5 ea.	1M 2.7M	1.2M 3.3M	1.5M 3.9M	1.8M 4.7M	2.2M 5.6M	50 PCS	1.75

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

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ICM7045	CMOS Precision Timer	24.95
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ICM7208	Seven Decade Counter	19.95
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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	10.95
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
MC14433P	3½ Digit A/D Converter	13.95

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XR205	$8.40			XR2242CP	1.50
XR210	4.40			XR2264	4.25
XR215	4.40			XR2556	3.20
XR320	1.55			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	3.95
XR567CP	.99	XR2207	3.85	XR4194	1.45
XR567CT	1.25	XR2208	5.20	XR4202	3.60
XR1310P	1.95	XR2209	1.75	XR4212	2.05
XR1468CN	3.85	XR2211	5.25	XR4558	.75
XR1488	1.95	XR2212	4.35	XR4739	1.15
XR1489	1.95	XR2240	3.45	XR4741	1.47

DIODES

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
				1N4002	100 PIV	1 AMP	12/1.00
1N746	3.3	400m	4/1.00	1N4003	200 PIV	1 AMP	12/1.00
1N751	5.1	400m	4/1.00	1N4004	400 PIV	1 AMP	12/1.00
1N752	5.6	400m	4/1.00	1N4005	600 PIV	1 AMP	10/1.00
1N753	6.2	400m	4/1.00	1N4006	800 PIV	1 AMP	10/1.00
1N754	6.8	400m	4/1.00	1N4007	1000 PIV	1 AMP	10/1.00
1N757	9.0	400m	4/1.00	1N3600	50	200m	6/1.00
1N759	12.0	400m	4/1.00	1N4148	75	10m	15/1.00
1N959	8.2	400m	4/1.00	1N4154	35	10m	12/1.00
1N965	15	400m	4/1.00	1N4733	5.1	1w	28
1N5232	5.6	500m	28	1N4734	5.6	1w	28
1N5234	6.2	500m	28	1N4735	6.2	1w	28
1N5235	6.8	500m	28	1N4736	6.8	1w	28
1N5236	7.5	500m	28	1N4738	8.2	1w	28
1N5242	12	500m	28	1N4742	12	1w	28
1N5245	15	500m	28	1N4744	15	1w	28
1N456	25	40m	6/1.00	1N1183	50 PIV	35 AMP	1.60
1N458	150	7m	6/1.00	1N1184	100 PIV	35 AMP	1.70
1N485A	180	10m	5/1.00	1N1185	150 PIV	35 AMP	1.70
1N4001	50 PIV	1 AMP	12/1.00	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
C36M	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
2N2369A	4/1.00	MPS3705	5/1.00	2N5087	4/1.00
MPS2369	5/1.00	2N3706	5/1.00	2N5088	4/1.00
2N2484	4/1.00	MPS3706	5/1.00	2N5089	4/1.00
2N2906	4/1.00	2N3707	5/1.00	2N5129	5/1.00
2N2907	5/1.00	2N3711	5/1.00	PN5134	5/1.00
		2N3724A	.65	PN5138	5/1.00
2N2925	5/1.00	2N3725A	1.00	2N5139	5/1.00
MJE2955	1.25	2N3772	2.25	2N5210	5/1.00
2N3053	2/1.00	2N3823	1.00	2N5449	3/1.00
		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	.39	.31	.25	1.5/35V	.41	.33	.26
.15/35V	.39	.31	.25	2.2/35V	.51	.41	.33
.22/35V	.39	.31	.25	3.3/25V	.53	.43	.34
.33/35V	.39	.31	.25	4.7/25V	.63	.51	.41
.47/35V	.39	.31	.25	6.8/25V	.79	.63	.50
.68/35V	.39	.31	.25	15/25V	1.39	1.12	.89
1.0/35V	.39	.31	.25	22/6V	.79	.63	.50

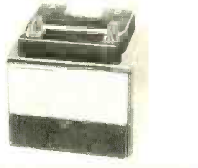
MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS

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	.26

ULTRAVIOLET INTENSITY METER

new

by BLAK-RAY



TWO MODELS:
LONG WAVE
AND
SHORT WAVE

Meter consists of a sensor cell attached to a compact (3" x 3¼" x 3") metering unit. Can be hand-held or placed directly on surface for measuring. Can be used remotely, while connected to a meter housing by a 4-foot extension cord. Two models available — one for long wave and one for short wave ultraviolet. Readings are in microwatts per square centimeter. Weight: 1 lb.

Completely assembled (includes sensor cell, reduction screen, extension cord, contrast filter and certification report.)

J-221 LONG WAVE (300nm-400nm) **$242.00**

J-225 SHORT WAVE (200nm-280nm) **$260.00**

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- Erases 2708, 2716, 1702A, 5203Q, 5204Q, etc.
- Erases up to 4 chips within 20 minutes
- Maintains constant exposure distance of one inch
- Special conductive foam liner eliminates static build-up
- Built-in safety lock to prevent UV exposure
- Compact — only 7-5/8" x 2-7/8" x 2"
- Complete with holding tray for 4 chips

UVS-11E $69.95

Jumbo 6-Digit Clock Kit

- Four .630"ht. and two .300"ht. common anode displays
- Uses MM5314 clock chip
- Switches for hours, minutes and hold functions
- Hours easily viewable to 30 feet
- Simulated walnut case
- 115VAC operation
- 12 or 24 hour operation
- Includes all components, case and wall transformer
- Size: 6¾ x 3⅛ x 1¾

JE747 .... $29.95

- Bright .300 ht. comm. cathode 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

Regulated 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 and instructions. Size: 3½" x 5" x 2"H

JE200....... $14.95

ADAPTER BOARD — Adapts to JE200 — ±5V, ±9V and ±12V

DC/DC converter with +5V input. Toriodal hi-speed switching XMFR. Short circuit protection. PC board construction. Piggy-back to JE 200 board. Size: 3½" x 2" x 9/16"H

JE205 .... $12.95

MICROPROCESSOR COMPONENTS

8080A/8080A SUPPORT DEVICES

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8224	Clock Generator/Driver	3.95
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8228	System Controller/Bus Driver	4.95
8238	System Controller	5 95
8251	Prog. Comm. 1/0 (USART)	7.95
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8257	Prog DMA Control	19 95
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MC6821	Periph. Inter. Adapt (MC6820)	7.49
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MC6830L8	1024X8 Bit ROM (MC68A30-8)	14.95
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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	$13.95
Z80A(780-1)	CPU	15.95
CDP1802	CPU	19 95
2650	MPU	19.95
6502	CPU	11.95
8035	8-Bit MPU w/clock, RAM, 1/0 lines	19.95
P8085	CPU	19.95
TMS9900JL	16-Bit MPU w/hardware, multiply & divide	49.95

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MM500H	Dual 25 Bit Dynamic	$.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
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2518	Hex 32 Bit Static	4.95
2522	Dual 132 Bit Static	2.95
2524	512 Static	99
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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
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

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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	7 95
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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
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UPD416 (MK4116)	16K	Dynamic 16 pin .250ns	7.95
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
2716INTEL	16K*	EPROM	59.95
TMS2516 (2716)	16K*	EPROM	24.95
	*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
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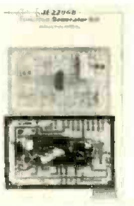
74186	512	TTL Open Collector	9.95
74188	256	TTL Open Collector	3.95
74S287	1024	Static	2.95

Function Generator Kit



Provides 3 basic waveforms: sine, triangle and square wave. Freq. range from 1 Hz to 100K Hz. Output amplitude from 0 volts to over 6 volts (peak to peak). Uses a 12V supply or a ±6V split supply. Includes chip, P.C. Board, components & instructions.

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- Dual sensors—switching control for indoor/outdoor or dual monitoring
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JE300 .... $39.95

DESIGNERS' SERIES
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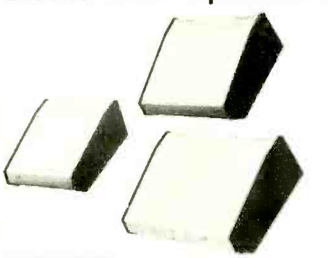
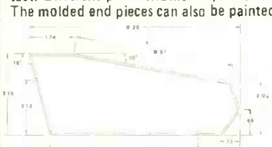


- High strength epoxy molded end pieces in mocha brown finish.
- Sliding rear/bottom panel for service and component accessibility.
- Top / bottom panels .080 thk alum. Alodine type 1200 finish (gold tint color) for best paint adhesion after modification.
- Vented top and bottom panels for cooling efficiency.
- Rigid construction provides unlimited applications.

CONSTRUCTION:
The "DTE" Blank Desk Top Electronic Enclosures are designed to blend and complement today's modern computer equipment and can be used in both industrial and home. The end pieces are precision molded with an internal slot (all around) to accept both top and bottom panels. The panels are then fastened to ¼" thick tabs inside the end pieces to provide maximum rigidity to the enclosure. For ease of equipment servicing, the rear/bottom panel slides back on slotted tracks while the rest of the enclosure remains intact. Different panel widths may be used while maintaining a common profile outline. The molded end pieces can also be painted to match any panel color scheme.



Enclosure Model No.	Panel Width	PRICE
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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

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JE610 ASCII Encoded Keyboard Kit

The JE610 ASCII Keyboard Kit can be interfaced into most any computer system. The kit comes complete with an industrial grade keyboard switch assembly (62-keys), IC's, sockets, connector, electronic components and a double-sided printed wiring board. The keyboard assembly requires +5V @ 150mA and −12V @ 10mA for operation. Features: 60 keys generate the full 128 characters, upper and lower case ASCII set. Fully buffered. Two user-define keys provided for custom applications. Caps lock for upper-case-only alpha characters. Utilizes a 2376 (40-pin) encoder read-only memory chip. Outputs directly compatible with TTL/DTL or MOS logic arrays. Easy interfacing with a 16-pin dip or 18-pin edge connector.

JE610 (Case not included) **$79.95**

Desk-Top Enclosure for JE610 ASCII Encoded Keyboard Kit

Compact desk-top enclosure: Color-coordinated designer's case with light tan aluminum panels and molded end pieces in mocha brown. Includes mounting hardware. Size: 3½"H x 14½"W x 8¾"D.

DTE-AK $49.95

SPECIAL: JE610/DTE-AK PURCHASED TOGETHER (Value $129.90) $124.95

JE600 Hexadecimal Encoder Kit

FULL 8-BIT LATCHED OUTPUT 19-KEY KEYBOARD

The JE600 Encoder Keyboard Kit provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8-bit microprocessor or 8-bit memory circuits. Three additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with 9 LED readouts. Also included is a key entry strobe. Features: Full 8-bit latched output for microprocessor use. Three user-define keys with one being bistable operation. Debounce circuit provided for all 19 keys. 9 LED readouts to verify entries. Easy interfacing with standard 16-pin IC connector. Only +5VDC required for operation.

JE600 (Case not included) **$59.95**

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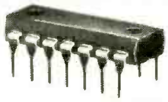

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74LS75	276-1920	.99
74LS90	276-1923	1.19
74LS123	276-1926	1.49
74LS151	276-1929	1.09
74LS157	276-1930	1.19
74LS161	276-1931	1.59
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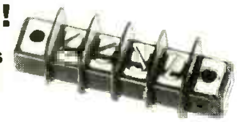

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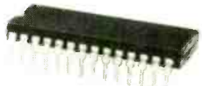

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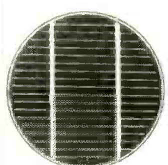

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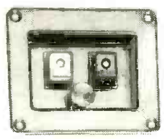

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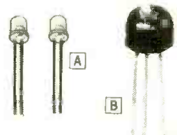

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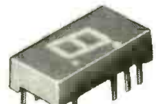

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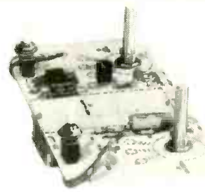

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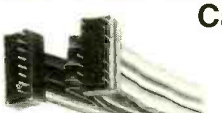

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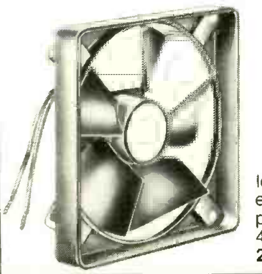

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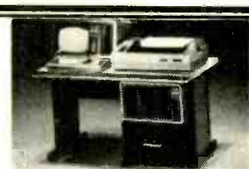

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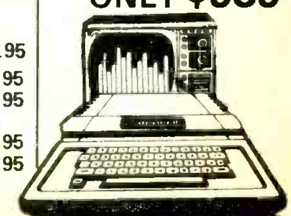

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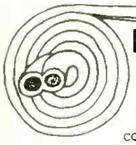

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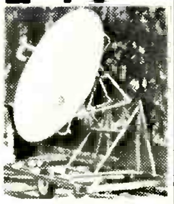

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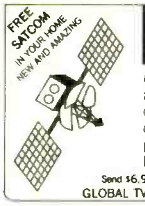

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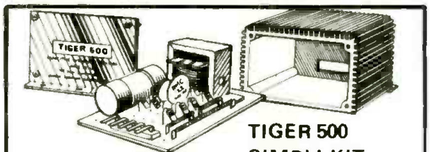

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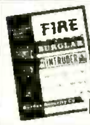

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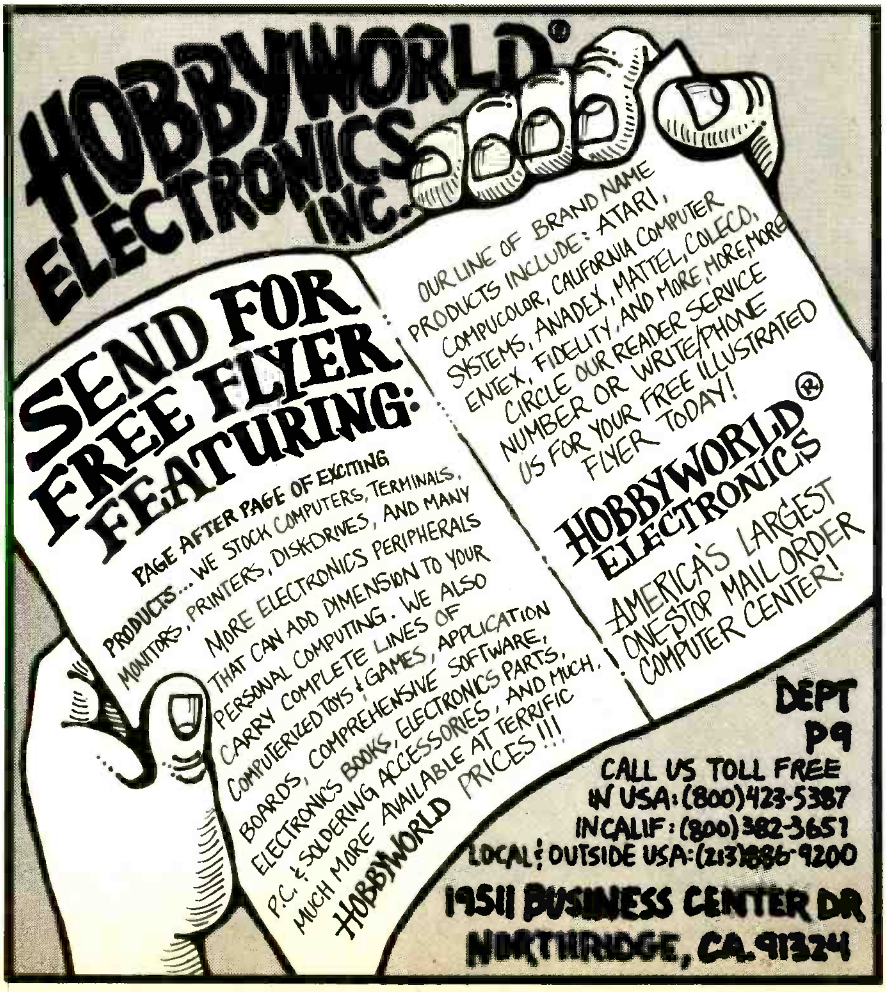

CIRCLE NO. 34 ON FREE INFORMATION CARD

ELECTRONICS WORLD® Personal Electronics News

A WORLD-CHAMPIONSHIP BOXING MATCH was made available, for the first time in cable-TV history, on a pay-per-view basis with the cablecast of the June 20 Sugar Ray Leonard/Roberto Duran fight. The venture was a joint undertaking by Top Rank Productions and Warner Amex Cable Communications, Corp. Warner Amex's two-way QUBE system also allowed viewers to rate the fight during the live cablecast at the end of each round by pressing a button on their home consoles. QUBE's central computer tabulated the results and flashed comparisons of viewer, TV announcer, and official opinions on home TV screens.

AN AUDIO COMPUTER from Crown International, Elkhart, IN, analyzes sound. Called Badap 1, it's designed to replace a series of dedicated test instruments. Uses a color CRT to display data, with all data captured digitally and stored in memory. Even in real-time analysis, all data is processed through memory, enabling users to expand or contract a display to include only that segment of immediate interest. Up to eight data sequences can be displayed at a time through use of a system of bars and dots and four NTSC-compatible colors. The NTSC-compatible display makes it possible to videotape the display or to show it on a larger remote monitor. Since software for the system is on circuit boards, as new routines are developed, Badap 1 owners can simply add boards instead of buying new instruments.

THE WORLD'S LARGEST WRIST WATCH towers over New York's Times Square. The Casio watch on a billboard measures 36 feet across and 64 feet from top to bottom of the band. It displays time in hours, minutes, and seconds (plus a.m./p.m. indication) and, every 15 seconds, switches over to display month, day, and day of week . . . **AND THE WORLD'S THINNEST** is only 0.98 mm thick. The Concord Delerium IV watch's minute and hour "hands" are on two separate discs that revolve on the face of the timepiece. The watch also uses the world's smallest battery, motor, and quartz tuning fork, and a microprocessor for electronic time and time-zone setting. Solid-gold backplate and face are integral parts of the working system. Claimed accuracy is within 10 seconds per month. You can buy the thin one for $15,000.

AN INFORMATION-RETRIEVAL SYSTEM for home and office use has been unveiled by Radio Shack. Users of the equipment will be able to carry on keyboard "conversations" with a central computer over the telephone line and view results on their color or monochrome TV receivers. Information expected to be available include weather, news, stock reports, transportation schedules, library data, electronic banking, software exchange, news and computer games. Called TRS-80 Videotex, the two-way system will be made available in several configurations. One, designed for owners of personal computers, is a software package that converts TRS-80 and several other makes of computer into a Videotex device. Another is a Videotex terminal ("hardware") that attaches to the telephone line and antenna terminals of any TV receiver. Announced prices are $30 for the software package, $400 for the hardware options packages.

MOST USEFUL TV RECEIVER FEATURES, according to a nationwide consumer survey conducted by Venture Development Corp., Wellesley, MA, are high-quality speakers, automatic tuning, and "energy saving." Reduced power consumption was cited more often as "very useful," but it fares only modestly in attracting consumer dollars, its worth averaging only an extra $41. Six out of 10 consumers feel that high-quality TV sound would be worth an extra $66 for better speakers and more than $80 for built-in stereo sound. Automatic tuning through VIR (vertical interval reference) was considered very useful by 41.5% of consumers, who felt it was worth an extra $48. Other high-technology features, didn't fare so well.

AM SPECTRUM OPENED BY FCC makes it possible for 125 new AM stations to get on the air. The new stations will operate on or next to channels now reserved for 25 special nighttime stations. According to the ruling, 100 new stations can operate on channels now occupied by clear-channel stations but must be outside the 750-mile protection radius given to long-distance stations. An additional 25 stations will be on adjacent channels. Fourteen of the latter already share nighttime use of their channels with other stations, but the adjacent channels were previously off limits to other operators.

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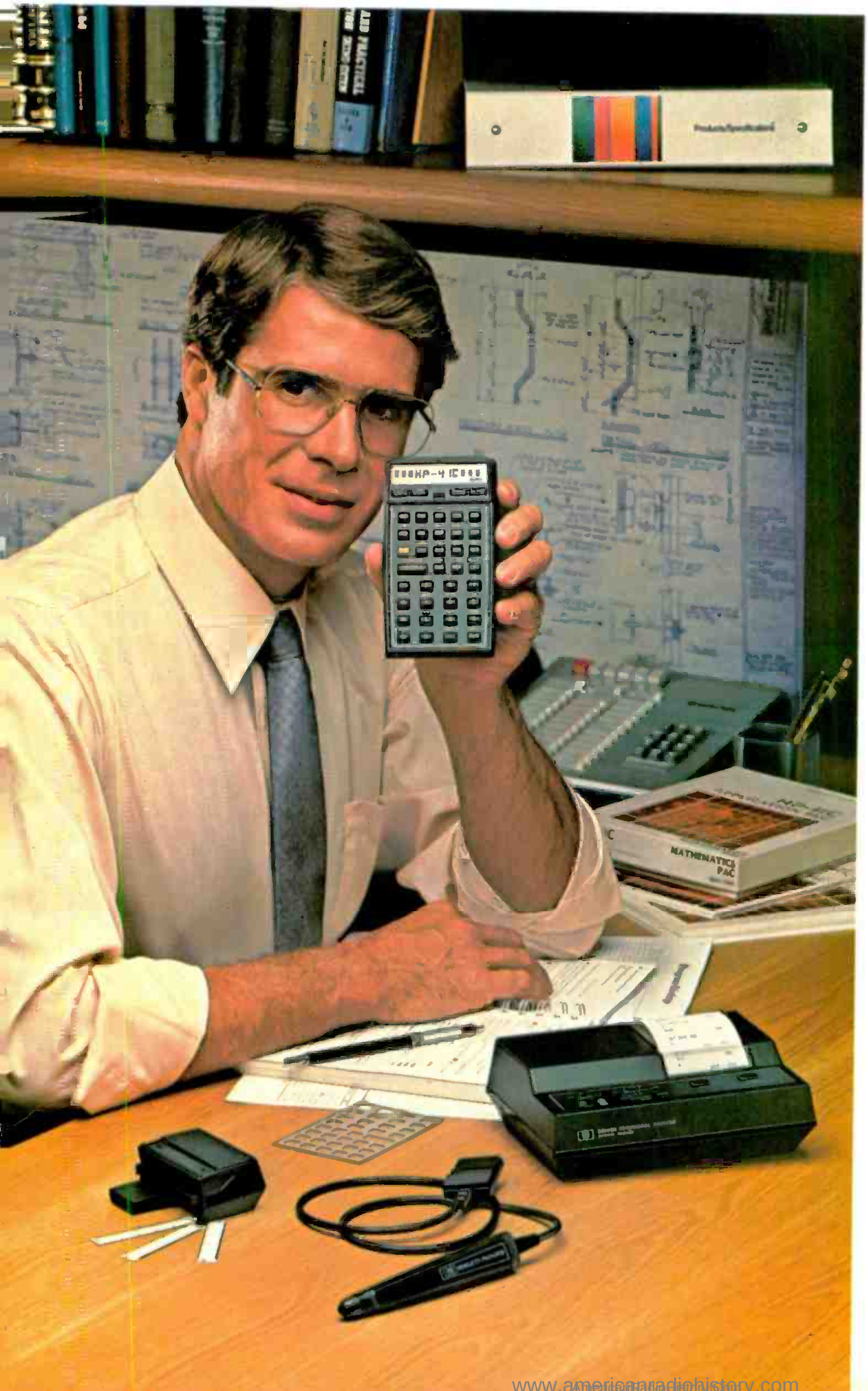

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