

Radio-^{IND}Electronics[®]

\$1.25 ■ SEPT. 1979

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

Build It Cover Story
PERCUSSION SYNTHESIZER

HI-FI NOISE FILTER
Build for 14-dB improvement

PRINTED-CIRCUIT BOARDS
Which ones are best

ANTI-STATIC SPRAY
Keeps discs dust free

TV VIA SATELLITE
What's up there to watch

PROM PROGRAMMER
You can build it

ALL ABOUT VCR CIRCUITS
Video-signal processing

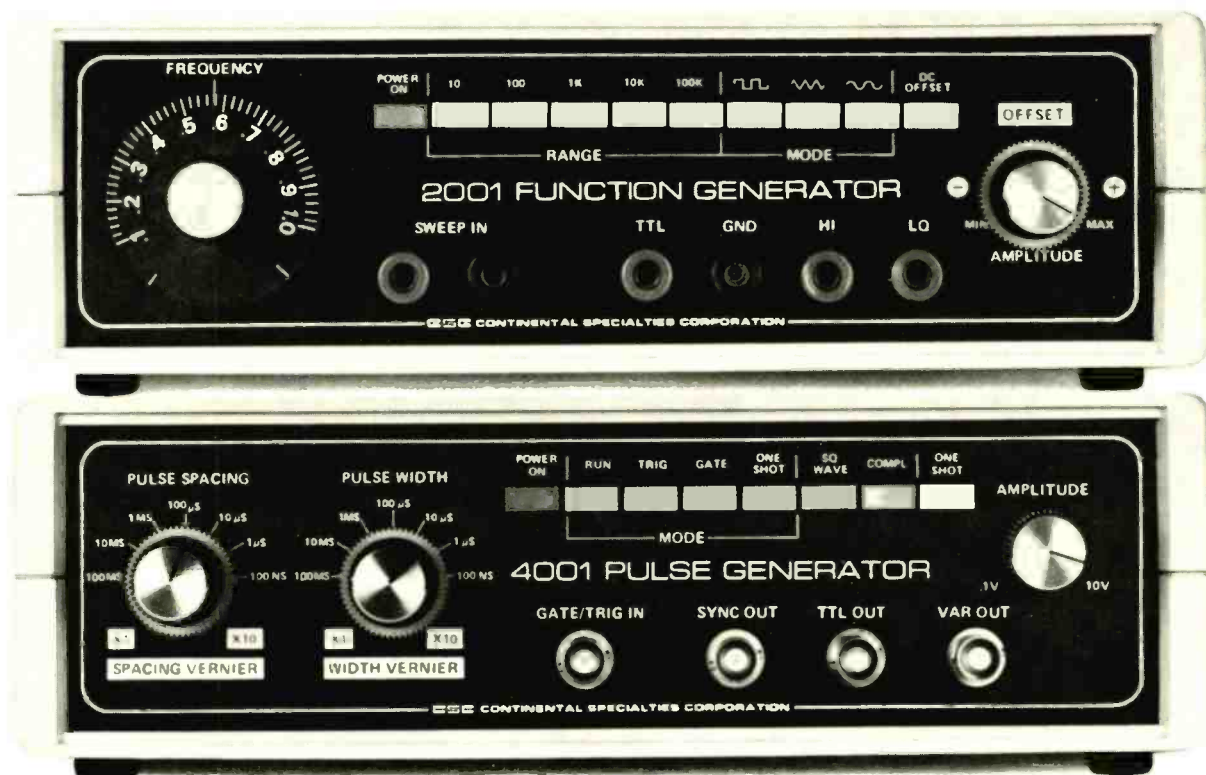
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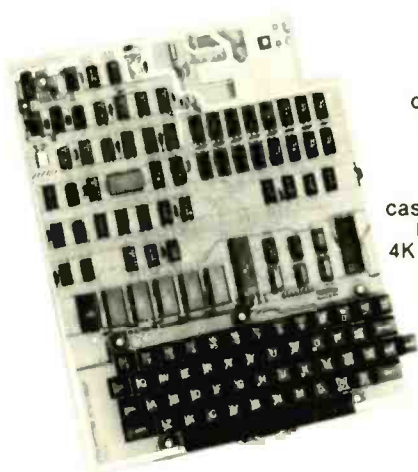
Interface Age April, 1979

"The graphics available permit some really dramatic effects and are relatively simple to program . . . The fact that the system can be easily expanded to include a floppy means that while you are starting out with a low-cost minimal system, you don't have to throw it away when you are ready to go on to more complex computer functions. Everything is there that you need; you simply build on to what you already have. You don't have to worry about trading off existing equipment to get the system that will really do what you want it to do. At \$279, Superboard II is a tough act to follow."

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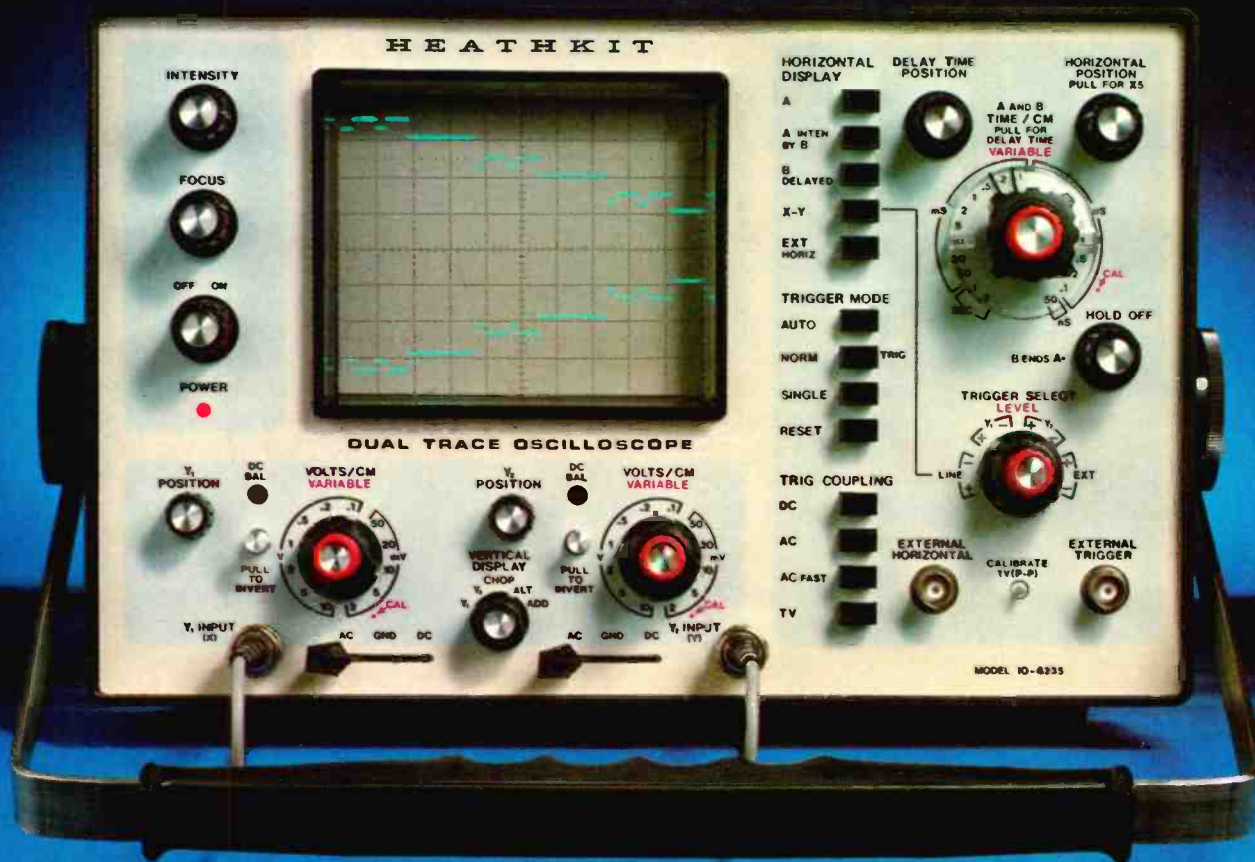


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ON THE COVER

Fascinating percussion synthesizer simulates a variety of percussion instruments. Modular accessories make it even more valuable. Circuits are straightforward....construction is easy....equipment is inexpensive. Full details begin on page 43.



Commercial satellite TV receiving station uses huge dish and supersensitive receiver, but you can build your own. Story starts on page 47.



Build this adaptive noise filter to remove the snap, crackle and pop from your records and tapes.

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looking ahead

TV sound: With all of the 1980 TV models now introduced, it certainly can be said it's "the year of television sound." Last month reported approaches to better sound by RCA, Magnavox and Sylvania. Zenith is capitalizing on improved television audio transmission in several ways. A large percentage of its sets include audio output jacks for attaching to external amplifiers. Some consoles feature four speakers—two on each side. At the high end of the line are sets with separate 10-watt audio amplifiers, including bass and treble cut-boost controls. Quaser, which for several years has featured a pseudo-stereo system known as Audio Spectrum Sound, now extends that feature to several 19-inch sets and six consoles.

Among other trends in the new lines are an increased emphasis on microprocessor tuning systems that eliminate the need to adjust fine tuning even once, and more widespread use of the vertical interval reference (VIR) signal for color set adjusting, as well as comb filters for better color and higher resolution. Zenith has a random-access keyboard tuning system that can tune 105 channels—the standard VHF and UHF channels as well as midband and superband channels used for modern cable systems. Sony introduced the largest direct-view color sets ever offered in this country—with a 26-inch Trinitron picture tube that has a 341-square-inch picture as compared with 315 for a standard 25-inch tube. (The biggest color tube currently being offered commercially, also by Sony—but in Japan—measures 30 inches in viewable diagonal, 32 inches overall. It isn't offered in a color receiver in the U.S.)

Car stereo fracas: Independent auto sound manufacturers have been up in arms about the tendency of car manufacturers to include radios as standard equipment in their new models, and their campaign against the practice is beginning to bear fruit. Aftermarket car sound manufacturers established an organization, the Custom Automotive Sound Association (CASA), to push their campaign. CASA's first major action was an anti-trust suit against General Motors which had indicated that all of its new "X" cars would be factory-equipped with AM radios. The suit never went to trial. In a settlement, GM agreed to allow dealers to delete the radios, not to force them to buy radio-equipped cars and not to make radios standard equipment before 1983. CASA then turned its sights on Toyota and Volkswagen, filing suits against both of them. Presumably reading the handwriting on the firewall, Honda voluntarily decided to delete radios as standard equipment on its 1980 models. CASA also plans to act on the legislative front, testifying before the Senate Anti-trust Subcommittee on the subject.

Computers for everyman: That all-purpose home computer for the non-technical consumer hasn't yet come to pass—but manufacturers still think it will. Texas Instruments has unveiled its long-awaited home computer, a \$1,150 self-contained unit with its own 13-inch color tube (procured from Zenith) with resident extended basic, a 16K RAM, 16-color graphics, a microphone jack, sound synthesizer and cartridges priced from \$10 to \$70 (game software

cartridges at \$20 each will be supplied by Milton-Bradley).

RCA's new VIP-II home and business computer has a full keyboard, 8K RAM, 12K ROM, resident BASIC capability, but no monitor, at around \$400. APF introduced a "docking" computer system at \$500 for its video game with 10K RAM, 12K ROM, resident BASIC, color and sound capability for use with a color TV.

The hand-held "language translators" are rapidly evolving into portable computers. TI announced a language translator with a voice synthesizer for \$300, with \$60 modules containing 1,000 words, all words displayed on the readout and half of them pronounced. The translators offered by Craig and Lexicon increased their versatility with new non-language program modules, including made-to-order custom units. Matsushita announced that it would enter the hand-held computer market through agreement with Friends/Amis, which makes the Craig unit, and its American subsidiaries Quasar and Panasonic quickly said they'd market the units in the U.S. under their own brandnames.

New VCR models: More than 80 different models of home VCR's have now been introduced (including those already superseded by newer versions). Some of them are similar—even identical—except for the brandname, and all are still produced in Japan. For 1980, there are more manufacturers, more brandnames, longer playing time and a host of new features.

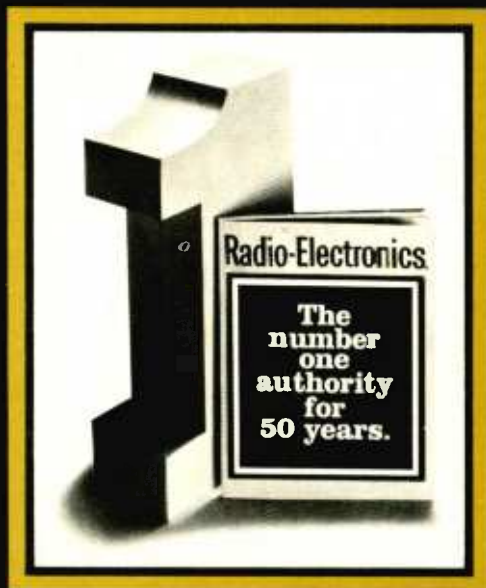
The two new brandnames in the U.S. are Akai and Sharp, both bringing in the first home video recorders produced in their own plants. Akai's is a two-hour-only VHS unit, designed for portable operation, lightweight (15 pounds with battery), but capable of home operation with a companion tuner-timer. The Sharp VHS unit records 6 hours per cassette and is programmable, for seven different recordings seven days in advance, and contains the video version of Sharp's *Auto Program Locate Device* (APLD) that can cue up to 99 different places on the tape for rapid access. Mitsubishi's first own-make recorder will debut under the MGA label, featuring five direct-drive motors, remote control of most functions, with freeze, fast-forward and slow motion, also in the six-hour VHS mode. New Sony-made five-hour Beta models from Sony and Zenith also have complete remote-control systems and permit visible fast-forward and rewind for easy program location. Hitachi will have a portable similar to the one it's making for RCA. JVC, which had stuck with the two-hour single-speed concept in its VHS units, has come up with a new recorder containing four heads (a different pair for each speed), now playing in either the two- or six-hour mode. JVC says the four-head concept permits maximum fidelity in either speed. Its new model permits remote-control of freeze-frame, double- and triple-speed playback, infinitely variable slow-motion, is programmable for seven days. Sanyo and Toshiba both introduced programmable five-hour Beta models with visible fast-forward and reverse.

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

On your newsstand September 18...

**the single most
exciting issue of any
electronics magazine
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Twentieth Century..**

**October 1979
Radio-Electronics
50th
Anniversary Issue**



From "Radio-Craft" in 1929 to Radio-Electronics today, and tomorrow, from the vacuum tube to the chip, from "wireless radio" to interplanetary communication—it's fifty years of history, experiments, and excitement from the pages of America's greatest newsstand electronics magazine, all in the most spectacular issue ever of any electronics magazine—October, 1979 Radio-Electronics.

Don't miss a word of this colorful, extra-special retrospective issue, bursting with all the excitement of all those years—or of our experts' fascinating projections and predictions for "The Next Fifty Years" of our lives.

It's October Radio-Electronics. On your newsstand September 18 ... but not for long. Don't miss it.

what's news



Philips Shows Laser-Scanned 4½-inch Audio Disc

Digital technology, combined with laser-optics, opened a new era in recorded sound at a two-day demonstration at New York's Plaza Hotel. The revolutionary Philips Compact Disc system promises an unprecedented improvement in sound quality and realism of prerecorded material.

Combining videodisc technology with pulse-code-modulation and digital recording techniques; Philips showed a prototype system that puts one hour of extraordinary quality stereo sound on one side of a 4½-inch diameter disc. The system is expected to be ready for the marketplace in 1983. The home player is expected to be of the same size and cost as today's quality players.

The new system converts the original sound into high-density pulse-code-modulation and replaces the playback stylus with a low-power solid-state laser.

Compared to conventional LP and 45-rpm audio discs, the Compact Disc (CD) provides a flatter frequency response; essentially flat from 20 to 20,000 Hz with stereo channel separation of 80 dB. Signal-to-noise ratio and dynamic range are boosted to 85 dB—a substantial improvement over the 60 dB currently available.

An additional advantage is immunity to surface noise and hiss. Since there is no stylus riding in a groove, only a laser light beam touches the disc, there is no surface hiss, clicks, turntable rumble, room vibrations or pickup arm resonances to detract from the recorded sound.

To convert the analog signal into digital form in the CD system, the sound is sam-

pled 44,330 times each second, more than twice the audio bandwidth. These samples are then quantized and converted into binary 14-bit "words" through Pulse Code Modulation techniques.

Each hour-long CD recording is made up of 6-billion bits, encoded along a helical track of pits on this disc. This disc is quite similar to the Philips videodisc described in **Radio-Electronics**, April 1979 issue. The helical track is tightly spaced—separation between tracks is only 1.66 microns and 2½ miles of recording is fitted on each 4½-inch diameter disc.

To retrieve the sound, the disc is inserted track-side down into the playback unit which permits automatic play or manual search for a specific selection. A miniature AlGaAs (Aluminum Gallium Arsenide) diode laser, located below the disc, is focused on the track and converts the encoded material back into an electronic signal. The track is scanned from the center of the record to the outer edge as the disc turns at speeds between 215 to 500 rpm to maintain a constant linear velocity between the disc and laser.

The Philips Compact Disc System is the first of its kind to be designed for the audio market that looks like it may be able to destroy the "distance" (and the difference) between the recording studio and the listeners living room. It's the first to incorporate the digital decoding electronics in the playback unit and, with the laser scanner, it's the first to insure against deterioration of the recorded material as it is played back.

JVC Videodisc Shown

Shown to the press for the first time during the Summer CES Show, JVC revealed their version of a capacitive video disc. It, like the RCA unit (**Radio-Electronics**, April 1979) uses a contact stylus. Unlike the RCA system it does not ride in a groove. Instead it rides over the surface of the disc. Victor claims that capacitive systems tend to be less expensive than optical disc systems.

The capacitive videodisc is made of an electroconductive plastic into which 54,000 spiral tracks consisting of pits in the base material are formed. During playback the stylus, mounted on the end of a cantilevered pick-up arm, is guided along the disc surface following the helical track. The stylus tip contains an electrode that receives information from the disc. It has an anticipated life of 2000 hours and as it wears down, new portions of the electrode are exposed.

The disc spins at 900 rpm, and with accessory optional equipment, can provide a still picture (maximum of one hour playing time), forward and reverse motion at normal speed, variable speed slow motion, variable speed fast motion, and high-speed search.

It is also possible to add on a random-access unit that permits accurate location



and retrieval of desired recorded material and automatic playback in any mode. JVC also demonstrated the ability to use their videodisc player for audio records. To use the player for this purpose a pulse-code-modulation (PCM) decoder is connected to the player. The random-access unit, when combined with the PCM feature provides retrieval of any music selection.

Like both the RCA and Philips videodisc systems a maximum of two hours of playback time, one hour on each side of the disc, is provided. The disc measures 11-7/8 inches in diameter, is 1/16-inch thick and is scanned by a sapphire stylus.

There has been much speculation about the possibility of JVC and RCA agreeing on a format for a capacitive videodisc, but to date this appears to be only speculation. As of this writing there is no such agreement and the two disc systems, while having some similarities, are not compatible, nor is either one compatible with the Philips system.

JVC had no comment on when the players would be available.

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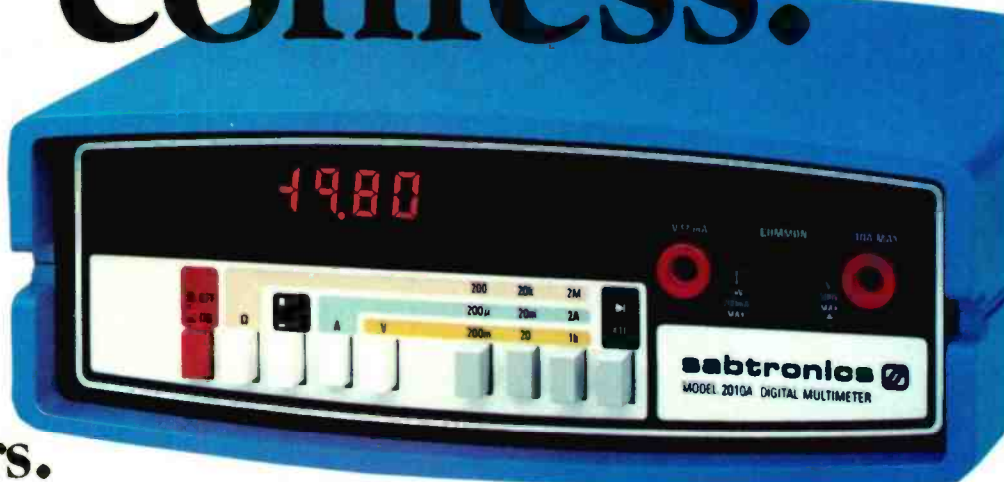
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Brief Specifications

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

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

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

Resistance: 0.1 Ω to 20 M Ω in 6 ranges

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

ACV Frequency Response: 40Hz to 40kHz

Input Impedance: 10 M Ω on ACV and DCV

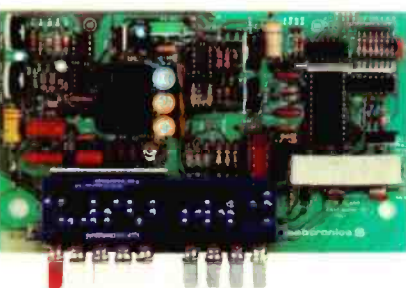
Overload Protection: 1200 VDC or RMS on all voltage ranges except 250 VDC or RMS on 200mV and 2V AC ranges. Fuse protected on ohms and mA ranges.

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what's news



Heath Computer Kits—Heath Data Systems

Computers must be really doing a job for the Heath Company. Now, in addition to their kit line, they've started a new division—Heath Data Systems. This division will market assembled computers through retail outlets such as computer stores.

Along with the announcement is an introduction of several new hardware items. Here's a quick rundown. Shown at the top of this column is the Heath *H89* all-in-one computer. It's available in both kit form for \$1595. Wired and ready to use as model *WH89*, it costs \$2295. It puts into one package floppy disc storage, a smart video terminal, two Z80 microprocessors, 16K RAM expandable to 48K, professional keyboard and a numeric keypad.

The terminal and the computer each have their own Z80, so the terminal never shares processor power with the computer. This makes the terminal capable of a multitude of high-speed functions.

All terminal functions can be controlled by keyboard or software. Eight user-definable keys let your program your own special functions. Baud rates up to 19,200 are keyboard selectable. The 12-inch screen is formatted for 25 lines by 80 characters, upper and lower case, formed by 5×7 dot matrix. Lower case letters with decenders such as "g" use a 5×9 dot matrix. Direct cursor addressing permits inserting or deleting characters and lines anywhere on the screen and gives you line graphics capability from keyboard or computer.

The floppy is a *Wangco 82* single-drive system. Each 5¼-inch diskette has more than 102K bytes of storage area.

Also introduced was the *H19 Smart Video Terminal*. It's \$675 as a kit, or \$995 as

fully wired model *WH19*. The terminal interfaces with either the Heath *H8* or *H11* computers or with any RS-232 interface. It uses a Z-80 microprocessor. Like the *H89* it works at baud rates up to 19,200 (keyboard selectable) and has 8 user-definable keys. Format on the 12-inch screen is 24 lines by 80 characters (with software controlled 25th line).

Included in the products is the *H14* line printer at \$595 in kit form and \$895 as an assembled *WH14*. It is microprocessor controlled and delivers a permanent hard copy printout. The unit prints the standard 96-character ASCII set (upper and lower case) with a 5×7 dot matrix print head. The impact printer uses readily available ½-inch wide nylon ribbon on 2-inch spools.

Maximum instantaneous print speed is 165 characters per second with a selectable line length of 80, 96 or 132 characters. Line spacing is 6-lines-per-inch with 8-lines-per-inch software selectable. Baud rates are selectable from 110 to 4800. An adjustable width sprocket feeds allows the use of edge-punched fan-fold forms from 2.5 to 9.5-inches wide.

Finally a modem, the *WH13*, is now available for \$195 wired. Use it to let your computer talk to other computers over ordinary telephone lines. Features selectable originate and answer modes. LED display of unit status and special acoustic self testing.

That's the latest on computers from Heath. They promise even more products to be added to the computer line in the months to come. It looks like Heath intends to keep computers as a major product line. That's good news indeed.

Texas Instruments New Computer

It has finally arrived. The *TI-99/4*, the home computer that Texas Instruments has been talking about for the last two years. The new machines using plug-in software modules as ready-made computer programs that provide a wide variety of user capabilities.

The computer consists of a console with 16K RAM, many sound effects, 16 colors for graphic display, extended BASIC as a programming language and a 13-inch color video monitor. The system is priced at



\$1150. Software modules cost between \$19.95 and \$69.95.

Existing modules include Demonstration, Home Financial Decisions, Household Budget Management, Video Chess, Investment Analysis, Early Reading, and Tax and Investment Recordkeeping.



TRS-80 Model II Announced

The *TRS-80* now has a bigger brother, the new *Model II*, designed to meet the needs of many users for more data storage, greater versatility and higher computing speed. The *II* has either 32 or 64K bytes of RAM and a built-in 8-inch floppy. It includes a 12-inch monitor that displays 24 lines of 80 characters either upper or lower case. The price will be \$3450.

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7010 7010.1	145.00 225.00	600 MHz	9	5-20 mV	10-30 mV	20-40 mV to 600 MHz	1-10 mV	(3) 1.1, 10 SEC	.1Hz	1 Hz	10 Hz 600 MHz	1 PPM 0.1 PPM	10 MHz	YES OPTION \$25	YES OPTION \$15
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CIRCLE 20 ON FREE INFORMATION CARD

editorial

The Fight Against Cancer—A Turn Towards Electronics!

If asked, we all pretty much agree that electronics is beneficial to mankind. We point to accomplishments in communications, data processing, energy conservation and generation, automation, entertainment, and on and on. We describe the roles of electronics in the industrial manufacturing process, collision avoidance, vehicular technology, navigation, etc. But strangely enough, most of us would probably overlook one important area—medical electronics.

A news item crossed my desk the other day and it made me feel proud just to be a part of this industry. The item described the use of RF energy in the fight against cancer. The treatment is called RF hyperthermia and is very much experimental. RF energy, ranging in frequency from several megahertz to the microwave area, is used to heat and thus destroy cancerous tumors. Cancer cells appear to be more susceptible to heat than normal cells. There are several theories, but it is more commonly accepted that cancer tumors have a limited blood supply and cannot disperse the heat as readily as normal tissue, making them more susceptible to the heat.

Hyperthermia is not new. Researchers have experimented with raising the temperature of the whole body instead of just the cancer site. They have also experimented with combining hyperthermia with radiation treatments, hoping that less radiation would be required. What is new, is using RF energy to perform the actual heating. By using RF energy, the researchers have much more precise control over temperature and localization.

It must be stressed that *the use of hyperthermia is experimental*. Some researchers argue that the increased blood flow around the heated tumor might actually have a cancer spreading affect. What is needed is far more research. The problem is that very little RF hyperthermia equipment actually exists. As a result, researchers are finding it difficult to experiment with it. For now, RF hyperthermia remains only as a treatment of last resort.

I do find it interesting though, that after all these years of surgery, chemotherapy and radiation treatments, researchers are turning towards electronics. If you are as proud as I am of being a part of this industry, you now have just cause for feeling prouder still.



ART KLEIMAN
MANAGING EDITOR

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letters

RADAR JAMMER

This is in response to your editorial comments concerning speed radar jammers in the December 1978 issue.

I recently received a flyer for a police radar calibrator ("illegal to use to jam police radar") that may be the device you refer to. Such a device can indeed cause a stationary Doppler radar to give a false reading if they are both in the same frequency band (X, K or whatever). However, consider this:

A moving oncoming police radar (for example, Kustom Signals' MR-7) probably will not be adversely affected by the steady tone that would jam a stationary radar. This is because internally the unit has two audio bands—a low Doppler band, representing the police-cruiser speed with respect to the road surface, and a high Doppler band within which the heterodyne signal from the oncoming vehicle will fall. The high-frequency band signal will represent the sum of the speeds of the cruiser and the target.

In real life this sum might be equal to 115 mph (cruiser, 50 mph; target, 65 mph).

In this example, in order to jam the radar, you would need to transmit an indicated speed of 105 mph. Suppose the cruiser slows down to 35 mph; you will pass him and indicate 70 mph. At 105 mph the stationary Smokey will just love you.

Such a moving radar can be jammed by using a glide tone passing through the high Doppler band. This must change at a rate indicating a speed change greater than 3.15 mph. This causes the internal verifier circuits to reject the input. The effect of this technique on a stationary radar is unpredictable and not worth the risk.

There are also serious side effects in transmitting your own signal: 1) your own radar detector is overwhelmed and useless; 2) every detector in the oncoming traffic lanes will be set off, resulting in a mass slowdown. (A recent excursion down an interstate highway while testing a prototype microwave device, not a jammer, pointed

this out. No one could spot the Smokey, so everyone slowed down.)

A practical jammer is feasible, but it would need to be activated only when an incoming signal is present and would have to transmit CW (Continuous Wave) at an offset from the police signal that would produce the desired heterodyne.

Passive methods are possible. Create a plasma screen large enough to hide your vehicle behind, then turn it on and off at the desired rate to modulate the returned microwave energy. A bank of neon or fluorescent tubes on the front would do it. A tuned cavity with a modulating device will return a jamming echo within 50 to 60 feet of a roadside radar. You could coat your vehicle with microwave absorber and then make them think you are a big fuzzy caterpillar.

If these so-called jammers proliferate, the only result will be increased confusion on the highways and the opportunity for government agencies to intrude further

continued on page 22



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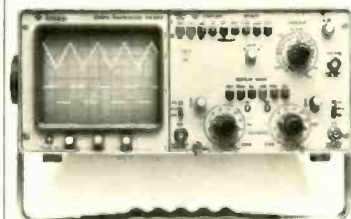
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My father always told me that there were certain advantages to putting all your eggs in one basket. "John," he said, "learn to do one important thing better than anyone else, and you'll always be in demand."

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

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

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

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LETTERS

continued from page 16

into our personal lives. Oh yes, the 55-mph limit has had one good effect: Look at the shot in the arm it gave the electronics industry!

RICHARD L. PEARSON
Pearson Electronics
Gastonia, NC

WIPER DELAY MODIFICATION

The following modifications (shown in the diagrams) to the Digital Windshield Wiper Delay described in the November 1978 issue of *Radio-Electronics* make it possible to operate the device on either switched +12 volts or switched-ground circuits at the flip of a switch (see Fig. 1). I have also

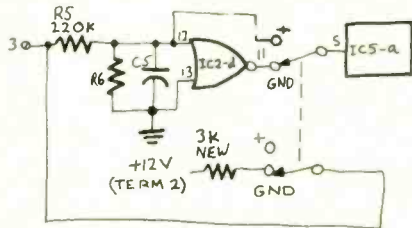


FIG. 1

provided an emergency bypass switch in case it (the device) fails (see Fig. 2). New components required are a 3K resistor, a DPDT switch and an SPDT switch.

(The diagram also shows the cathode of D2 was moved to +12V at terminal 2.)

I installed my unit in a '74 Ford Courier

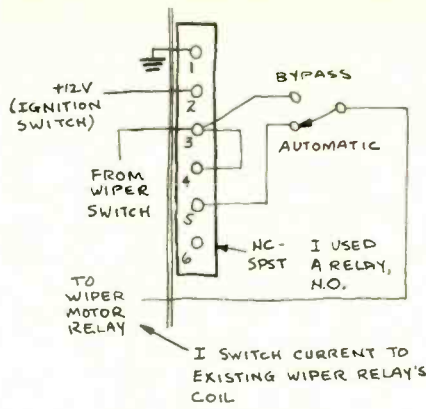


FIG. 2

(switched ground) and it works fine. I've used it in mist for one to two hours total so far. Thanks for the article.

MILES ABERNATHY
Austin, TX

APRIL FOOLS

When I received my April 1979 copy of *Radio-Electronics*, I was agreeably surprised at the three Special April Projects. The One Station Intercom is a *must* for every hermit. The Solar-Powered Night Light needs an ON-OFF switch, otherwise a great deal of energy, which we need to conserve, is wasted.

I assume that Messrs. Weinstein and Gartman are proteges of those two widely known authors of previous years—Mr. Larson E. Rapp (WIOU of Amateur Fame) who wrote for QST such articles as "Negative

Modulation" (thus doubling the number of stations in a given spectrum), "Underground Antennas," "Circular Hamband Theorem," etc.; and your own Mohammed Ulysses Phips who is no doubt best known for his 1962 article "An Electronic Shaver" (cordless yet!). That one had a technician friend of mine actually accumulating the required components for three days until we pointed out that it was not a "construction" article!

I thoroughly enjoy *Radio-Electronics*, have for the past 20 or so years, and hope to continue for the next 20. Keep up the good work.

HERBERT M. PLUMMER
Catharpin, VA

DIGITAL REFERENCE CHARTS

The Digital Reference Charts on page 45 of the November 1978 issue are quite informative. However, according to what I was taught in a digital course I took in college, the sample addition of the two binary numbers 111 and 111 are equal to 1110 and not 1010.

I enjoy your magazine very much.
WILLIAM HAINER
Hazelwood, MO

SOLAR CONTROLLER

With the current interest in solar energy, the article entitled "Solar Controller" (December 1978, page 35) should be of interest to many readers. Further articles on this topic would also be appreciated.

Probably many readers have noticed that the control, labeled "Hysteresis" in Figs. 5

continued on page 24

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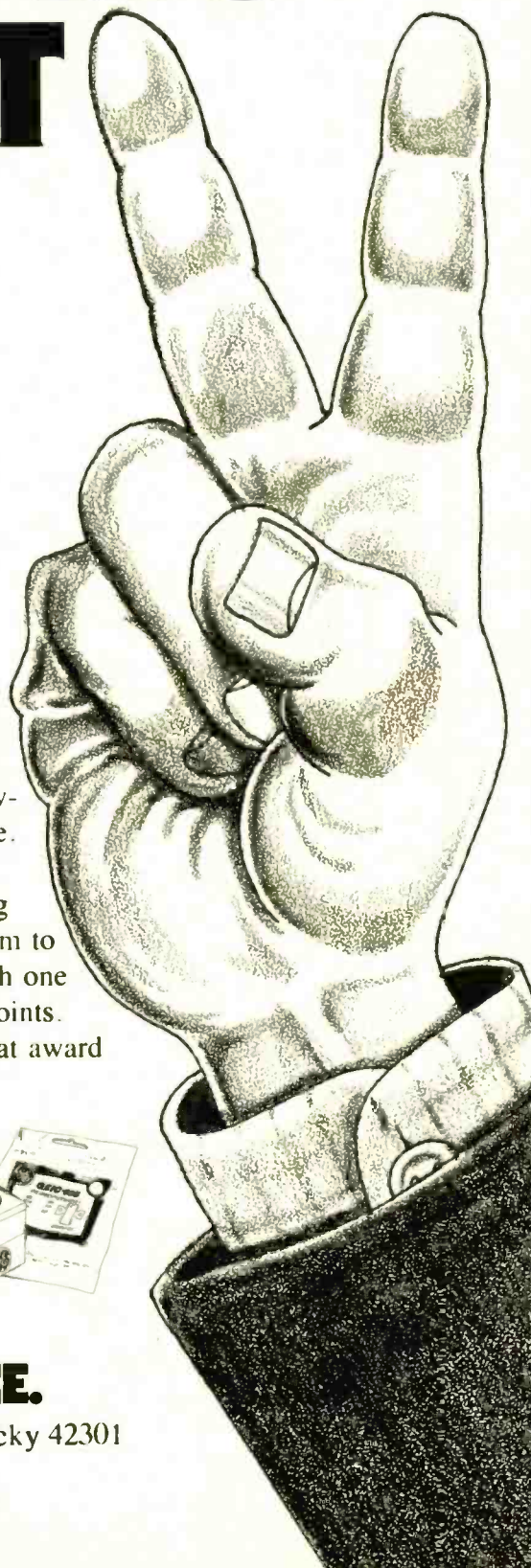


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LETTERS

continued from page 22

and 7, is actually a "Trip Point" setting and that the circuit has no hysteresis. A suitable hysteresis effect can be achieved with the addition of two resistors (see diagram).

For a hysteresis of 5°F to 10°F , the resistance ratio would be on the order of $R_1 = 240 R_2$. The exact values can be determined in the experiment Mr. Kreuter describes on page 37. The 47-ohm resistor should be increased somewhat to insure that minimum turn-on minus hysteresis is greater than zero. A change in the value of hysteresis will affect the calibration of the trip point.

CYRUS W. ROTON
China Lake, CA

RADAR DETECTORS

Radar detectors are, in my opinion, a good thing. I've been running a *Micronta X-K* (Radio Shack) detector for a little over nine months now, and I am well pleased.

I do not condone speeding; I just like to know where the police radar is. There are many times the police (all of whom I know personally) in my town will issue a traffic citation for going 37 mph in a 35 mph zone.

As for the miniradar transmitter you mentioned, it is a neat idea, but to be effective it would have to be in continuous operation what with the new radars now being in moving police cars. These police radars automatically deduct the speed of the po-

lice car, and register the speed of the clocked vehicle. The officer can turn off the radar until the suspicious car is just within range, turn it on, clock your speed and have you pulled over before you know what happened.

Some people I know have taken a 10,000-MHz amateur transceiver (a frequency range where pulse transmission is FCC-authorized) and modified them to work from 9320 MHz-9500 MHz (police X-band) or 10,500 MHz-10,750 MHz (approximate police K-band) with pulse transmission. Bear in mind that the normal police radar transceiver works at approximately 100-mW output from the transmitter, and the same amount comes back to the receiver. The modified amateur transceiver has output at either 1 watt or 10 watts, depending upon operator preference. The police radar does not stand a chance.

I guess we have only two alternatives. We can drive at the speed limit, or we can enter the countermeasure war, in which each side will have to spend huge sums of money to try to win. But if you have a detector and still get chased, don't blame the detector or the police—it is nobody's fault but your own.

ROBERT E. WILLIAMS
Port Angeles, WA

Entering the "countermeasures war" by adding an illegal device, be it a transmitter or whatever, is not the answer. Many of us like to drive fast. But isn't it more important to have fuel available and drive slowly, than to have NO fuel available and be unable to drive at all! Or perhaps you believe that our

crude oil supplies will last forever? Why not put the effort being expended on countermeasures into something productive, like a new fuel source or at least a more efficient power converter—Editor

TECHNOLOGICAL PREDICTIONS

It is true that technology is advancing at a staggering rate, but it is not "almost impossible to keep up with (it)." We are the masters; and whatever our needs, technology and human ingenuity will answer them.

The next 10 years will give us a magnitude of change equal to that of the past 100 years. We will see giant solid-state television panels that when switched off will display a mural or painting. We will see completely solid-state TV camera/receiver/recorder combinations that use no tape at all. Digital memories will store audio as well as video. There will be thousands of public communications and information channels. Medic-alert sensors will be built into our wrist calculator/watches that will be tied into central computer banks for cardiac monitoring. We will have central processing units capable of retrieving any type of information.

We will be limited only by our imaginations. But we must not become the slaves of technology; it is a tool for our survival and the key to our future. These are exciting times we live in.

JOHN SOWERS, JR.
Petersburg, VA

OK, that takes care of tomorrow, but what about next week?—Editor **R-E**

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equipment reports

ATV Research Model MVX-500 Micro-Verter RF Modulator



CIRCLE 101 ON FREE INFORMATION CARD

AS REPORTED IN THE AUGUST AND SEPTEMBER 1978 issues of *Radio-Electronics*, many video modulators are being offered for sale in kit

form and assembled. Frequently called RF modulators, these devices are used to convert a video signal from a computer, video game, video recorder or video camera into a modulated RF signal at a frequency that can be fed directly to the antenna terminals of a TV receiver. All the units described had an output in the low VHF range—Channels 2–6. However, most microcomputers radiate harmonics into this frequency range, causing interference and degradation of the TV picture. This is especially true in color systems, depending on the TV receiver or computer used, the placement of the cables and the RF modulator.

The model *MVX-500 Micro-Verter* (Computer Video to RF Interface) overcomes this problem by operating in the UHF frequencies well above the range of the computer generated harmonics. While specifically designed for use with the Apple II microcomputer to provide worm-free color displays, the *Micro-Verter* interfaces easily with other microcomputers and any color or monochrome TV receiver capable of tuning in the UHF channels above Channel 14. The *Micro-Verter* may

also be used with any standard NTSC-format video source.

This small (3¼ W × 2½ H × 4 inches D) unit comes completely assembled (without batteries) in a black-wrinkle-finished steel cabinet with four rubber feet. The front and rear panels are silver with blue trim. The front panel contains an on-off toggle switch, while the rear panel has RCA-type video input and RF output jacks. The unit comes with a short, 1-cm (approximately ½-inch) stub coupler that plugs into the RF output jack, thus acting as a short-range antenna. The *Micro-Verter* comes with a 10-foot-long shielded cable with RCA-type plugs on each end. If your microcomputer is not an Apple II, or if you use the *Micro-Verter* with some other video source, a different connector or adapter at one end of this cable may be necessary.

Operation is simple. Just plug one end of the cable into the video input connector on the back of the *Micro-Verter* and connect the other end of the cable to your video source. Now, set the *Micro-Verter* on the TV receiver near the UHF loop antenna or UHF antenna terminals. The RF output is radiated from the stub coupler on the back of the unit, so no direct connection to the antenna terminals is necessary except in cases of high interference.

The *Micro-Verter* does not come tuned to a specific channel, but generally will be operating between Channel 15 and Channel 25. Tuning to a particular channel is accomplished with a screw adjustment that is accessible through a hole in the bottom of the case.

Unfortunately, a video input-level control is not included in the *Micro-Verter*. If the video output of your source is not adjustable and is too high, a small series resistor (typically from 15 ohms to 150 ohms) is needed in the video line to drop the signal to a level that will not overdrive the *Micro-Verter*.

The *Micro-Verter* is ruggedly constructed; no glue or double-sided tape is used, and everything is either bolted or soldered together. A small PC board holds all the working parts except for the switch, batteries and video-input bypass capacitor. Power is supplied by four AA penlight batteries mounted in a spring-loaded holder to provide 6 volts. The batteries will last for over 1000 hours of operation since the circuit draws less than 1 mA in use.

We tested the device using three video sources—a TRS-80 microcomputer, a black-and-white video camera and a color video recorder; in all cases, using both color and black-and-white TV receivers. When the camera or recorder were used, the TV pictures were as good as when using a typical direct-connection video monitor. However, the computer image was still not as good as when a direct monitor connection was used. This is not surprising, since most microcomputers need a 6-MHz bandwidth to display all the characters and graphics sharply, and a TV front-end and

continued on page 32

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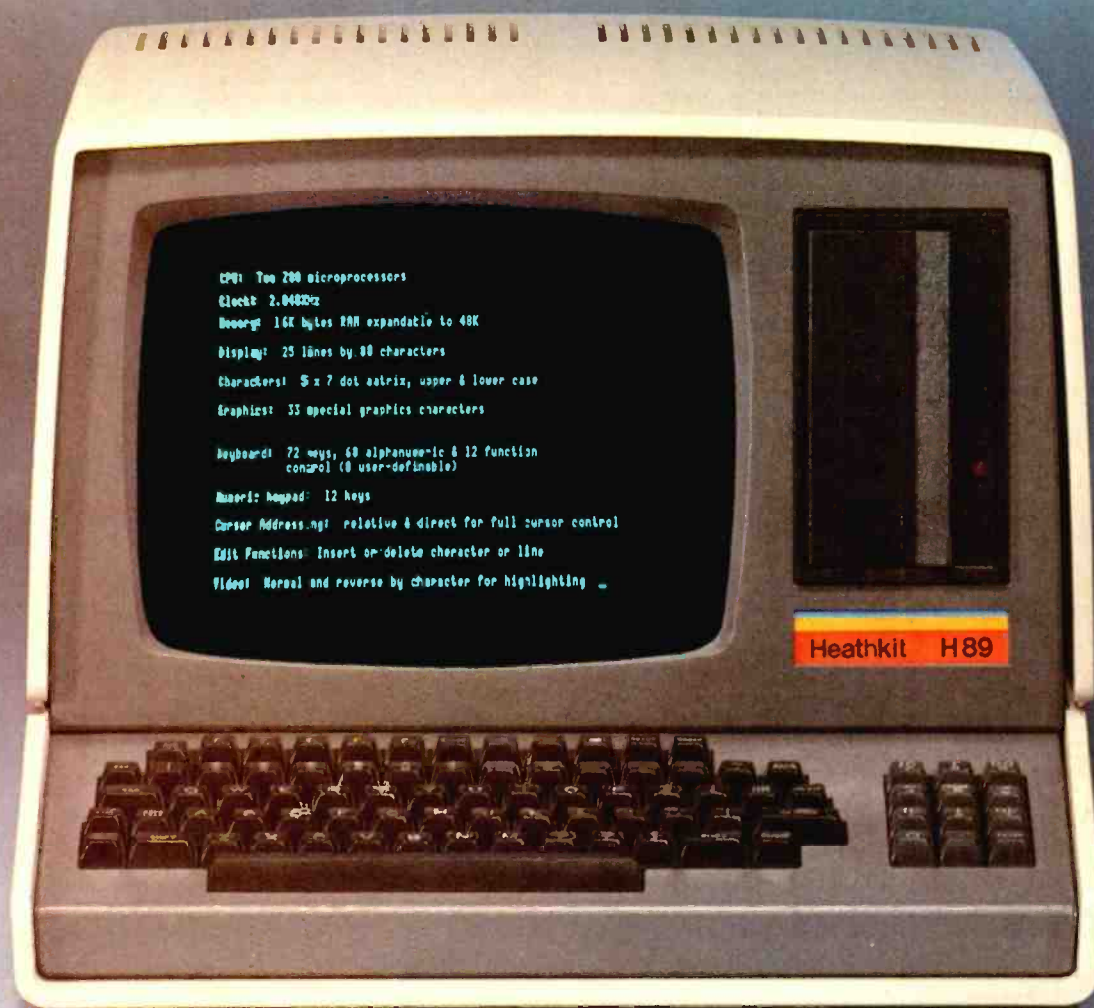
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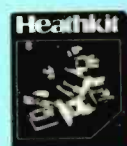
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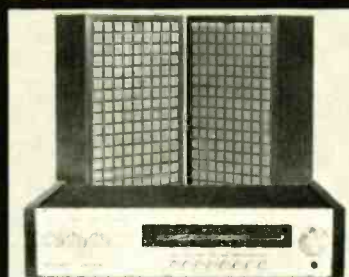


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CIRCLE 54 ON FREE INFORMATION CARD

EQUIPMENT REPORTS

continued from page 26

IF section have only about a 4.5-mHz band-pass. However, no interference was noted—an improvement over the VHF modulators. Also, the coupling stub provides a very simple connection to the TV receiver. Unfortunately, the lack of a video input-level control was inconvenient, since a dropping resistor was needed with each source tested.

The detailed instruction sheet that accompanies the Micro-Verter has four lengthy paragraphs describing the FCC rules regarding Class I TV Devices, and the precautions to be followed in their use.

The model MVX-500 Micro-Verter sells for \$35 from ATV Research, Dept. R, 13th and Broadway, Dakota City, NE 68731 (postpaid in the U.S., Canada and Mexico). It is also available at many computer dealers nationwide. **R-E**

**American Antenna Model
K-40 CB Antenna**



CIRCLE 102 ON FREE INFORMATION CARD

PROBABLY FEW CB ANTENNA PRODUCTS HAVE has as much laboratory computer design and extensive field testing as the model K-40 developed by American Antenna (1945 South Street, Elgin, IL 60120).

According to the manufacturer, an intensive two-year development period coupled with in-field evaluation, preceded the product's appearance on the market. Over 700 active CB mobile operators participated in the in-field test, of which only about 5% reported no improvement over their present antennas. In contrast, the manufacturer claims 95% noted better performance over their present antennas.

The field tests confirmed the manufacturer's lab tests. The CB'ers reported an average 30% improvement in range over competitive antennas.

Much of the instrument's high performance can probably be attributed to its loading coil; it is carefully designed, wound over a hollow core (American Antenna calls it an "isolation chamber") and rigidly molded.

The adjustable steel whip has a rounded tip, making unnecessary the usual antistatic ball that is inevitably lost to a tree or low bridge! The hollow coil permits two inches of whip adjustment, allowing correction for a wide SWR range. The coil-and-whip assembly

continued on page 34

PLUG IT IN AND TAKE COMMAND



X-10 Remote Control For Lights and Appliances

NO WIRES NO HASSLES

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

TOTAL CONVENIENCE

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

Think of the money you can save on electric bills with System X-10. Turn off heaters or appliances from any location in your home without a lot of running around.

DELUXE ULTRASONIC COMMAND SYSTEM

The Console controls all modules from its built-in keyboard, plus it completely controls all modules from its wireless hand held ultrasonic control unit. Simply aim the hand held unit at the Console, press any appropriate Command button to turn on and off, dim and brighten lights, or turn on and off appliances. Hand held unit operates at distances of up to thirty feet, line of sight of console (does not operate through walls). A worthwhile addition to any existing X-10 system or an excellent way to begin.

STANDARD COMMAND CONSOLE

Fully controls all modules as above system, but will not respond to hand held remote unit commands - may be intermixed with the deluxe Command System or used separately to form independent control systems.

MICROPROCESSOR BASED DESIGN

The BSR X-10 System uses the latest digital techniques for trouble-free operation. Digital pulse codes are sent through the house power lines to assure reliable control throughout the system. Amazingly compact; The Command Consoles measure only 4 3/4" X 3 1/2" X 3 1/2".

LAMP MODULE

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



APPLIANCE MODULE

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



WALL SWITCH MODULE

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



GETTING STARTED

Deluxe Ultrasonic starter kit includes: 1-Deluxe Ultrasonic Command Console, 1-Hand Held Remote Unit, 2-Lamp Modules, 1-Appliance Module. Only \$112.95

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quickly disconnects from the base. A spring-loaded bayonet system permits rigid contact while mounted, but the unit can be easily removed for storage, for a car wash, or as theft protection. The K-40 comes ready to mount on a trunk lip, hatch back, or through the roof.

The antenna has a double guarantee: a 1-year warranty against defects, and a promise to perform *better* than any other mobile antenna (the antenna also comes with a full-length 9-foot whip). An 18-foot length of low-loss RG-58A/U coaxial cable is provided that is terminated with a soldered (not crimped-on) PL-259 connector. And both the coaxial cable and chrome-plated mount meet military specifications.

The optional *Uni-Mount* universal mounting bracket allows the *model K-40* to be attached to virtually any imaginable mobile fixture—from mirrors to luggage racks. Another optional accessory is the *Magna-Mount*, an 8-pole, 120-lb.-pull magnetic mount. Not only will this mount stay in place tightly under normal driving conditions, but, when used with the *model K-40*, it is guaranteed to outperform any mobile antenna, including the *K-40* mounted *without* it!

So with all these boasted claims, we had to try one. A Cobra CB was connected through an SWR meter into a coaxial antenna switch. The switch, in turn, could select between the *K-40* and another antenna, both of which were magnetically mounted. To prevent interaction between the antennas, only one antenna at a

time was in place in the center of the roof of the vehicle.

A portable receiver with an S-meter was used to measure the relative signal strengths of the two antennas. When in place, the SWR on the *model K-40* was 1.5:1; that of the competitive antenna was 1.2:1. In theory, there should be little difference in performance if SWR were the only factor.

The results of our tests showed that, in three different positions of the monitoring receiver, the *model K-40* equaled or outperformed the competitive antenna. Apparently, American Antenna's advertising is not merely Madison Avenue showmanship.

Considering the performance, the workmanship and the price, we believe the *model K-40* is an excellent high-quality mobile CB antenna. Suggested retail prices are: The *model K-40* antenna, \$38.50; the *Uni-Mount*, \$8.95; the *Magna-Mount*, \$15.95. **R-E**

Electra Model BC220 Programmable Scanner

ANOTHER PROGRAMMABLE SCANNER INNOVATION has been released from Electra. The *model BC220* covers the VHF-low, VHF-high and UHF FM land mobile services. In addition, it can receive the VHF AM aircraft band, 118–136 MHz.

As with previous keyboard-entry scanners, it has a dual 120 VAC/12 VDC power supply. The unit's steel cabinet provides superior shielding. Accessory jacks are provided for an external speaker and antenna.

The *BC220* provides 20 programmable channels. Similar to the *BC250*, these channels



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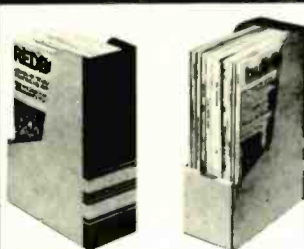
can be selected or locked out in two banks of 10 channels each. Individual channels can also be locked out. Regardless of the setting of the channel band switch, when the receiver is turned on only the first bank will be operational.

Specifications

The FM frequency ranges are: 32–50 MHz, 144–174 MHz and 420.450–512.450 MHz. Sensitivity is very good on the FM ranges: 0.4 µV on VHF and 0.8 µV on UHF. Aircraft AM specifications display poor sensitivity: 1 µV on the 118–136-MHz range. IF selectivity is a sharp 55-dB down ± 25 kHz.

An on-the-air evaluation of the compact *model BC220* verified the aircraft band's low sensitivity; signals that were received quite strongly on a competitive receiver were noticeably weaker on the *model BC220*. Clearly, the design of the aircraft-band circuits is first-

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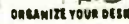


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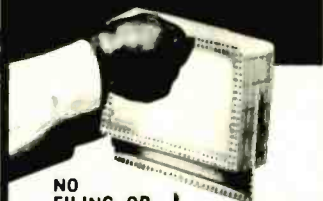
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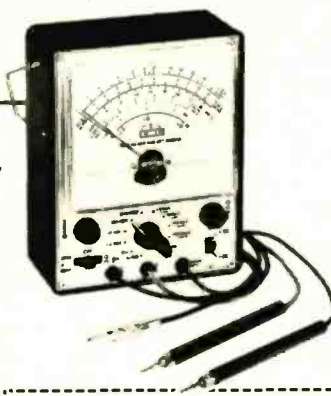
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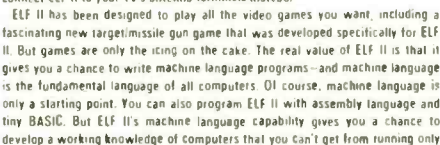
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equipment than a miniature pinball machine.

A large, bright LED channel indicator is easily visible. The S-meter serves also as a relative power output indicator and SWR meter. Separate IF and RF gain controls allow some reduction of background interference. A noise blanker effectively suppresses sharp pulse noise from nearby spark and ignition sources. A continuously variable ANL control allows various levels of noise suppression without distortion from harsh clipping.

Speaker audio is unusually good. Voice pass-band is emphasized from the speaker, and the loud audio available should be adequate for even the noisiest mobile environments. A PA switch allows the audio power to be put to use for public address applications.

The *Electroscan* feature refers to the built-in digital logic that provides a number of auto-



CIRCLE 104 ON FREE INFORMATION CARD

matic channel-searching functions. Pushbuttons on the microphone permit the user to step up or down, channel-by-channel, or switch channels rapidly. By using the built-in scan feature, the rig may automatically look for busy channels or open channels, at the user's discretion.

A memory feature permits up to ten chan-

nels to be memorized and scanned separately from the other thirty. Channel 9 will always be in memory unless it is purposely replaced by another tenth channel. When memorized channels are erased, channel 9 will remain in memory. Scan rate is rapid; all ten channels are sampled in less than one second.

The *Electroscan* is securely packaged. It includes a variety of mounting hardware and literature. Warranty/service booklets, FCC licensing information and applications, a complete set of operating instructions, and even a set of operational exercises to help you familiarize yourself with the *Electroscan* features are included. Additionally, a complete schematic diagram is provided.

In spite of the unusually-large selection of features, the *Electroscan* is no more difficult to install than any other CB transceiver. Simply mount the unit, connect power and an antenna, and you're on the air! Everything is self-contained.

Microphone audio is unusually crisp and natural. You may custom-adjust mike gain for your operating conditions with a thumbwheel control located on the mike.

Although the initial reaction of a new CB'er seeing all of those awesome controls might be fright, the *Electroscan* is really quite simple to operate. Virtually every control is independent of the others, and even the automatic features may be defeated at the touch of a button.

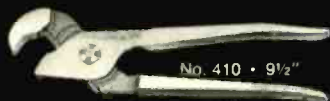
Sensitivity of the receiver is quite good. Although no specifications came with our sample, the unit seemed to perform as well as any we had previously tested. The two separate noise limiters proved to be very useful in combination. The variable ANL control allows adjustable suppression of moderate hash interference, with the Extender (noise blanker) switch reduces sharp impulse noise dramatically. Both controls worked efficiently without degrading the intelligibility of received signals.

A series of LED status lights provides visible indication of various transceiver functions. A modulation light flashes as the operator speaks into the microphone, providing a rough modulation level reference. Other LED's announce receive, memory, and scan modes operating at the moment.

Our sample unit had one apparent defect. Even with volume and all gain controls turned down, an annoying crackling sound issued constantly from the speaker. We assume that this was unusual, and not common to all radios of this series. If such a problem were encountered in the field, the user should exercise his warranty.

Although all of the features available on the *Electroscan* are not likely to be used by all operators, each has a legitimate application to CB communications. The Motorola *Electroscan* is well-engineered and thoughtfully designed for the serious CB user. For additional information about the model CM540 *Electroscan* CB transceiver, write Motorola, Inc., Automotive Products Division, 333 Northwest Avenue, Northlake, IL 60164. R-E

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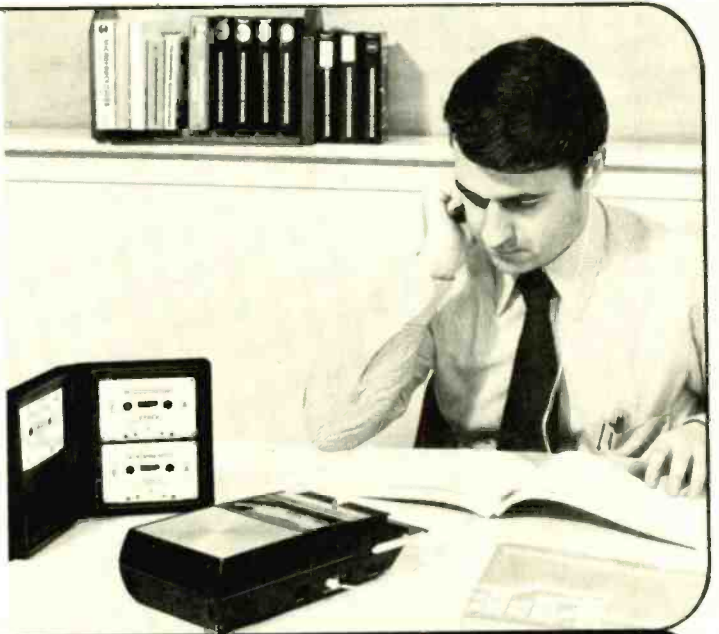
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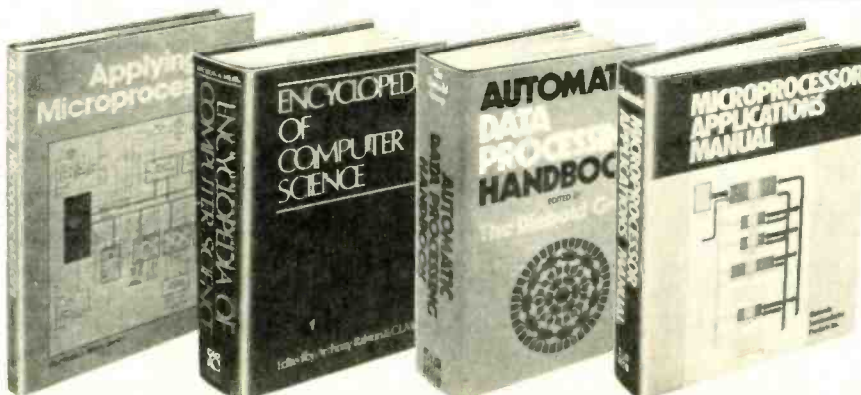
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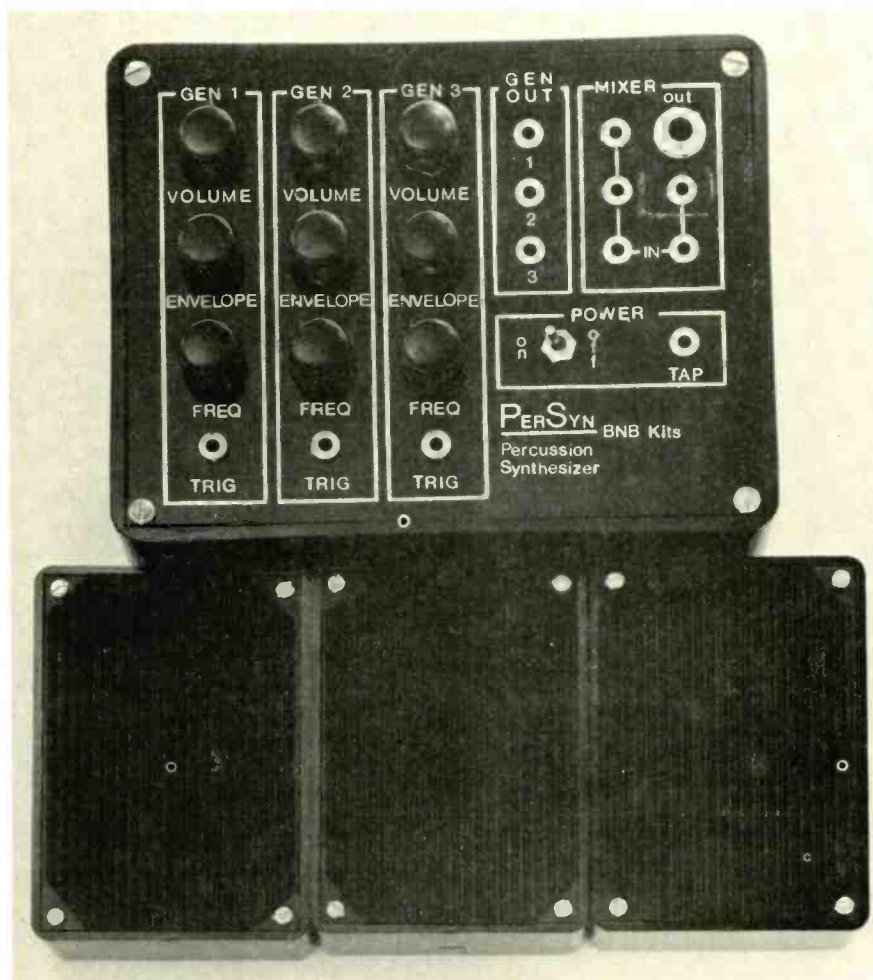
JAMES J. BARBARELLO

TECHNICALLY SPEAKING, PERSYN (PRO-nounced "Person") is a manually and/or automatically triggerable, polytonic percussion synthesizer. This fully electronic device contains three independent striking surfaces that, when struck, cause percussion sounds to be synthesized. Each striking surface controls its own percussion sound generator and each surface is adjustable as to the required striking force. Each sound generator is fully adjustable for frequency, envelope and volume of the sound synthesized. Each can also be automatically triggered (by way of the TRIG input/output jack) with a squarewave generator for automated or special effects. Any generator can be combined in the mixer with other signals or processed by special effects devices (such as a balanced modulator for gong and chime effects). Almost all standard percussion effects, such as conga, bongo, bell, wood block and timpani can be generated. The device can also be used with a special interface module (that will be described later) to allow triggering by the amplitude envelope of a conventional electrified instrument, such as an electric guitar.

PerSyn is powered by two 9-volt batteries, uses readily available parts and can be constructed for about \$60.00 (see parts list for complete kit availability).

How it works

Referring to the schematic diagram in Fig. 1, we see one of three identical



THE PERCUSSION SYNTHESIZER with the three striking-surface boxes. Note that the output plug on the center box is centered; on the others the plugs are offset to right and left.

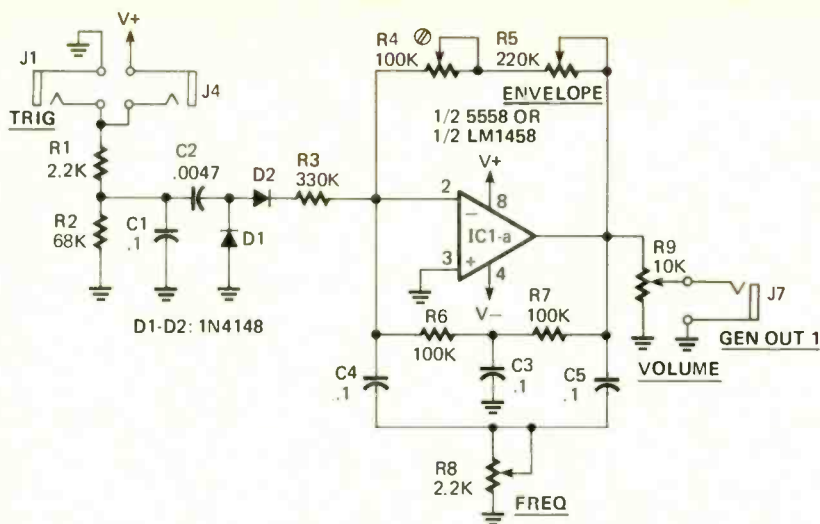


FIG. 1—SCHEMATIC of one of the three identical tone generators.

generator circuits built around two 5558 or 1458 dual op-amps (IC1 and IC2). (Table 1 compares the codes and IC pin connections of Generators 2 and 3 to Generator 2 in Fig. 1.) Using the IC1-a circuit as an example, we see that shorting J4 (or providing a positive voltage level to trigger jack J1) quickly charges C1 through R1. This positive transition is transmitted through C2 as a positive-going pulse. Diode D2 clips the lower portion of the pulse. When the positive voltage provided by J1 or J4 is removed, C1 discharges through R2 and produces a negative-going pulse through C2. This negative pulse is blocked by D2 so that only a single trigger pulse is generated.

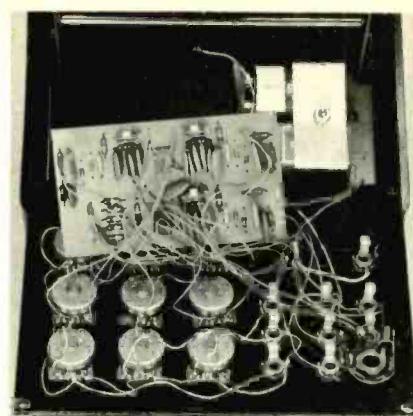
This pulse is applied through R3 to IC1-a, a high-gain inverting amplifier. Feedback loops R4-R5 and R6-R7-C3 and C4-C5-R8 (a twin-T notch filter) control the gain of the amplifier. The twin-T filter attenuates a specific frequency selected by R8. Therefore, if only the twin-T filter were used as a feedback loop, the amplifier would produce a continuous oscillation at the notch frequency. When R4-R5 feedback loop is added, the amplifier gain is reduced to the point where oscillation cannot be sustained. However, when the input trigger pulse is applied, it provides enough "kick" to create a damped oscillation. How long this oscillation lasts (envelope) is determined by the values of R4 and R5. With the values indicated, effects ranging from a short click to continuous oscillation are possible. A portion of the output signal is tapped off VOLUME control R9 and provided to J7 (GEN OUT 1).

The mixer (Fig. 2) circuit has IC2-b connected as a standard unity-gain inverting mixer with a very low output impedance (typically 75 ohms). This low-impedance output can drive most any standard amplifier. Two transistor batteries (Fig. 2-b) provide ± 9 volts (that is also available at the TAP jack, J16).

Construction

We recommend constructing the cir-

cuit on a PC board, the layout and components placement for which are shown in Figs. 3 and 4. All controls, jacks and the power switch should be mounted in a suitable enclosure (see Fig. 5 for a



INTERIOR of the percussion synthesizer. See Fig. 6 for the hook-up of pots and jacks.

typical layout of components on the enclosure panel). Jack, control and power switch interwiring should be performed at this point as indicated in Fig. 6. Upon completion, the 21 wires from the PC board (identified as "A" through "U") are connected to the control plate. If solid wire is used, the PC board will be well

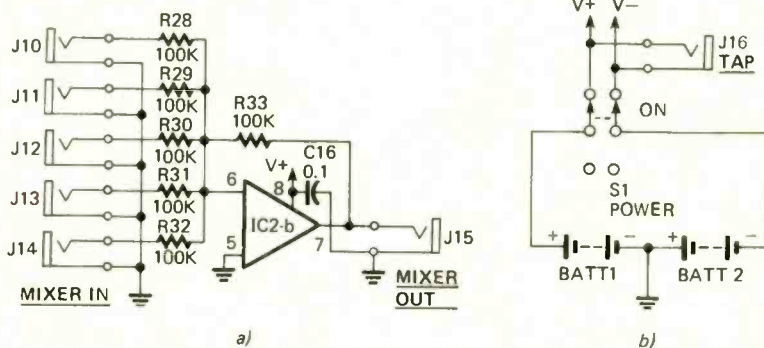


FIG. 2—DIAGRAM of the five-input mixer. Circuit uses an op-amp connected as a unity-gain inverter. The output impedance is approximately 75 ohms.

TABLE 1 CORRESPONDING PARTS IN GENERATORS 1, 2 AND 3

Generator 1	Generator 2	Generator 3	Value
IC1-a	IC1-b	IC2-a	
R1	R10	R19	2.2K
R2	R11	R20	68K
R3	R12	R21	330K
R4	R13	R22	100K trimmer
R5	R14	R23	200K pot
R6	R15	R24	100K
R7	R16	R25	100K
R8	R17	R26	2.2K pot
R9	R18	R27	10K pot
IC1-a	IC1-b	IC2-a	1/2 5558 or 1/2 LM1458
D1	D3	D5	1N4148
D2	D4	D6	1N4148
C1	C6	C11	0.1
C2	C7	C12	.0047
C3	C8	C13	0.1
C4	C9	C14	0.1
C5	C10	C15	0.1
J1	J2	J3	
J4	J5	J6	
J7	J8	J9	

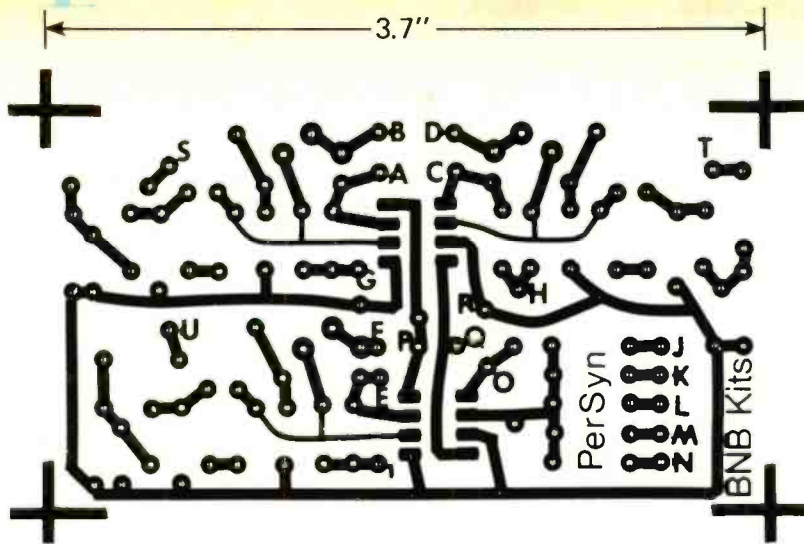


FIG. 3—FOIL PATTERN of the percussion synthesizer printed-circuit board. You can etch your own or get them in the complete kit of parts that is available.

supported by the interconnection wiring and no separate mounting is required.

The two 9-volt batteries (connected as in Fig. 2-b) should be mounted in the case. They can be held in place by a 1 by 3-inch piece of aluminum with a hole drilled in the center. By drilling a corresponding hole in the case bottom, a $\frac{1}{32}$ X 1-inch screw can be passed through the case, between the batteries and through the aluminum plate. A nut tightened down will then keep the batteries from moving.

PARTS LIST FOR PERCUSSION GENERATOR (Figs. 1 and 2)

Resistors $\frac{1}{4}$ watt, 5% unless otherwise noted

- R1, R10, R19—2200 ohms
- R2, R11, R20—68,000 ohms
- R3, R12, R20—330,000 ohms
- R4, R13, R22—100,000 ohms, trimmer potentiometer
- R5, R14, R23—220,000 ohms, miniature potentiometer
- R6, R7, R15, R16, R24, R28—R33—100,000 ohms
- R8, R17, R26—2200 ohms, miniature potentiometer
- R9, R18, R27—10,000 ohms, miniature potentiometer
- Capacitors, disc ceramic, 10 volts or higher
- C1, C3—C6, C8—C11, C13—C16—.01 μ F
- C2, C7, C12—.0047 μ F
- D1—D6—1N4148
- IC1, IC2—1458 or 5558 (8-pin DIP dual op-amp)
- J1—J14, J16—miniature phone jack
- J15—phone jack (full size)
- S1—DPDT switch
- BATT1, BATT2—battery, 9 volts

Note: A complete PerSyn kit, consisting of all required parts as listed above, all predrilled and marked enclosures and complete assembly instructions (Kit PS-1) is available for \$59.95 from BNB Kits, R.D. 1, Box 241H, Tennent Road, Englishtown, NJ 07726.

The above price includes U.S. postage and handling. Canadians add \$1.50 additional per order. New Jersey residents add 5% sales tax. No C.O.D. orders. Please allow 4 to 6 weeks for delivery.

Accessories

To fully use the capability of the device, three striking surface boxes should be constructed. The striking surface box contains a trigger switch assembly (see Fig. 7) and a thin plastic cover plate. (When assembled as shown, the

adjusting screw can be rotated to force the PC board upward. This movement depresses the calculator switch to the point where a slight depression of the cover (striking surface) will close the switch contacts and generate a trigger pulse. The PC pattern is in Fig. 8a; Fig. 9 shows how the calculator switch goes on.)

The wires from the trigger switch assembly are connected to a phono jack or plug mounted in the case side (if the phono plug is used, the box can be plugged in directly to J4, J5 or J6). A piece of rubber should be used to cover the cover plate to lessen the noise when it is struck. The rubber can be secured with double-faced tape.

Initial adjustment and checkout

Place all controls and trimmers to mid-position. Short J7 (GEN OUT 1) to J10 (MIXER IN) and connect J15 (MIXER OUT) to your amplifier. Place a phone plug in J4 and turn on the power. (Note: If you hear a continuous oscillation, proceed to

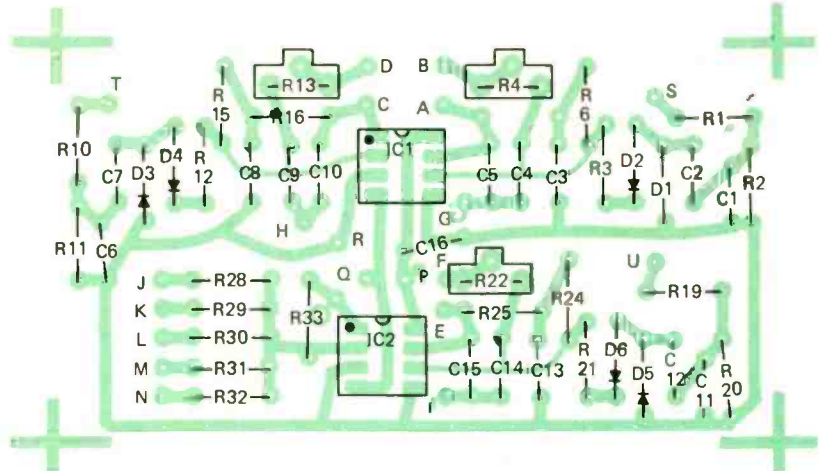


FIG. 4—COMPONENT LAYOUT for the percussion generator. Pads marked by letters A-U are for connections to the switch, pots and jacks on the panel.

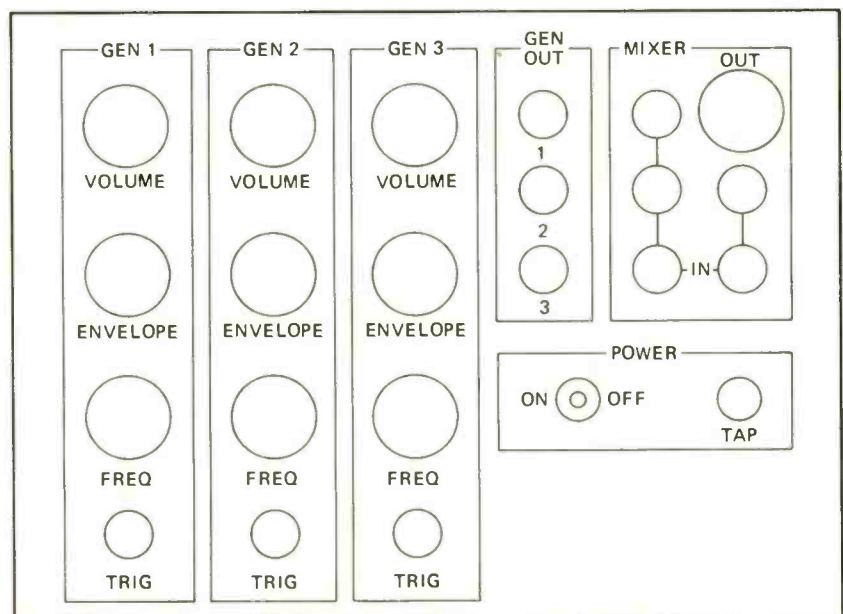


FIG. 5—TYPICAL LAYOUT for the components that are mounted on the front panel of the generator. Grouping of components makes the instrument easy to use.



JACK LEGEND

NOTE:
① POINTS A-U
CONNECT TO
CORRESPOND-
ING POINTS ON
PC BOARD
② B1 & B2
ARE 9-VOLT
TRANSISTOR
BATTERY
CONNECTORS.

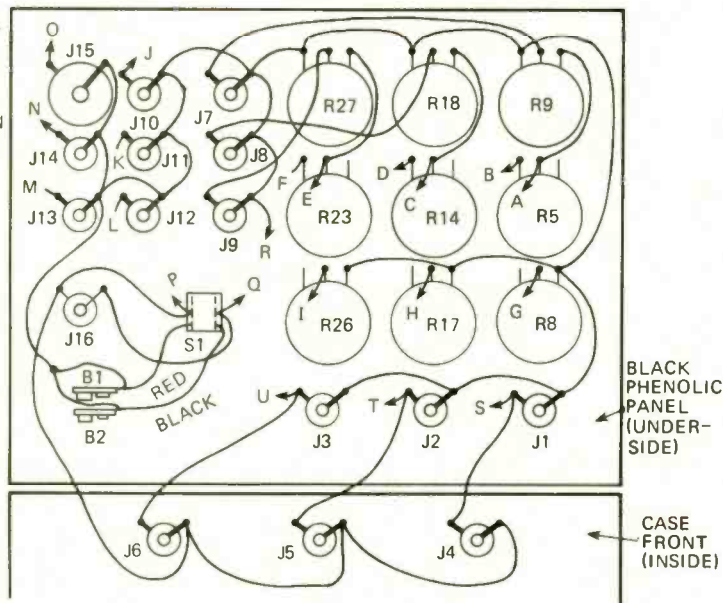
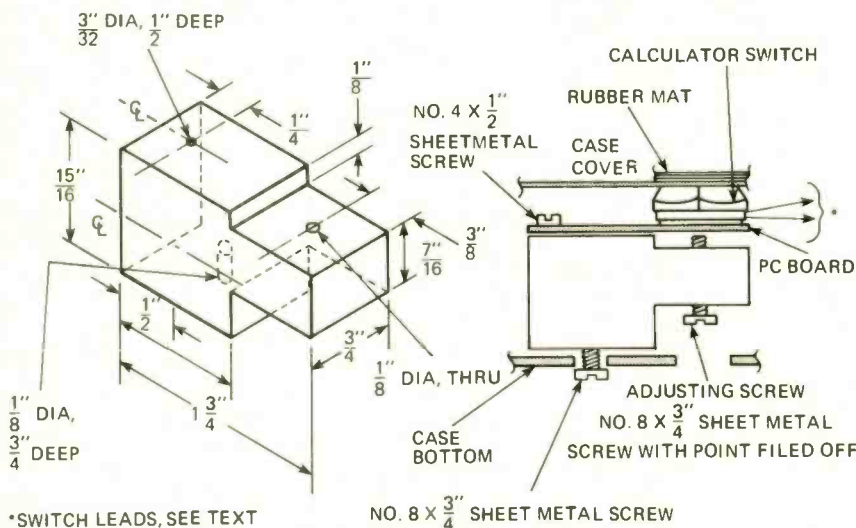


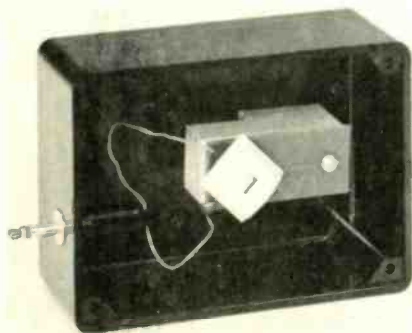
FIG. 6—INTERWIRING of the components on the control panel of the instrument. The points marked "A" through "U" are for making connections to the PC board.



*SWITCH LEADS, SEE TEXT

NOTE: DIMENSIONS SPECIFIED ARE FOR USE WITH KEYSTONE ELECTRONICS CASE NO. 703, BLACK PHENOLIC PANEL CATALOG NO. 2042 AND OAK CALCULATOR SWITCH NO. 7302.

FIG. 7—MECHANICAL CONSTRUCTION of the three striking blocks. Leads from the switches go to miniature phone plugs mounted on the end panels of the small enclosures.



INSIDE THE STRIKING BLOCK. This particular block is on the right in lead photo.

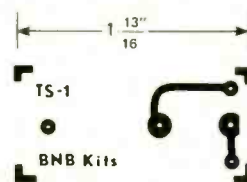
the R4, R5 adjustment.) Momentarily short the contacts of the plug in J4 and note if an output is heard. Rotate R5 (EN-

VELOPE) fully clockwise. Rotate trimmer R4 until a steady oscillation is heard. Back off R4 until the oscillation ceases, or to minimum resistance if oscillation does not cease. Reset R5 to midposition. Repeat this procedure for generator 2 (J5, J8 (GEN OUT 2), J11 (MIXER IN) trimmer R13 and R14 (ENVELOPE)) and generator 3 (J6, J9 (GEN OUT 3), J12 (MIXER IN), trimmer R22 and R23 (ENVELOPE)). Also use J13 and J14 (MIXER IN) to insure they are functioning.

Place a phone plug in J16 (TAP) and a phone plug in J1 (GEN 1 TRIG). Short the tips of the two plugs and note the presence of an output. Repeat this procedure using J2 (GEN 2 TRIG) and J3 (GEN 3 TRIG). If a voltmeter is available, measure

approximately 18 volts between the phone plug tip and body in J16.

Connect a striking surface box to J4. Rotate the adjusting screw clockwise until an output is generated. If nothing is heard, the screw may be advanced too far.



TRIGGER SWITCH P.C. BOARD

FIG. 8—SIMPLE PC PATTERN for the striking block.

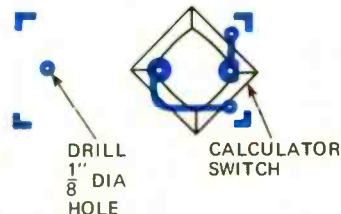


FIG. 9—CALCULATOR SWITCH positioned on the PC board. See photo on this page.

Back off the screw a few turns and begin again. After a sound is generated, back off the adjusting screw about a quarter turn. Tap the cover plate and note the presence of an output. Adjust the screw to obtain the sensitivity desired. Repeat this adjustment for the remaining two striking surface boxes.

Use

Once the initial adjustments have been completed as above, the basic operation of the device should be clear. Experiment with all controls and note their effect on the sounds created. When the unit is not being used, turn the power off to conserve battery life.

There are a few modifications you might like to make. The minimum setting of the frequency control may not produce a low enough frequency output to synthesize sounds such as a bass drum. If this is the case, you may wish to modify one or more of your generators in the following manner: Remove the three 0.1-μf capacitors in the twin-T notch filter section (C3, C4 and C5 for generator 1) and replace them with 0.2-μf units (0.2-μf units may be created by paralleling two 0.1-μf capacitors). This modification should lower the complete frequency range.

There are several options that can increase the capability of the PerSyn. Among them are a pulse generator that will automatically trigger the PerSyn at a rate adjustable from around 1 Hz to 500 Hz, a balanced modulator for producing chimes and similar metallic sounds and a trigger interface for triggering the PerSyn in step with the keying of another musical instrument. These options and details on their use and construction will be covered in the following issue. R-E



LAST MONTH WE GOT A LOOK AT EARTH satellites and how they are used in domestic and world-wide communications. Now we'll conclude with a look at the "birds" that carry TV programming of interest.

40-plus TV channels

Imagine you're sitting in your living room on a Sunday afternoon trying to decide what you want to watch. On local TV (or "terrestrial" as we'll call it from this point onward) there are a couple of network-selected regional professional football games, an old movie and a PBS program on how to prepare fall bulbs for planting. The two football games don't include any team you are really interested in, so, let's see what's on the satellites.

We'll start on the eastern edge of the active U.S./Canadian orbit belt with the WESTAR I at 99 degrees west:

Transponder 1 has a pro football game being relayed via satellite to who knows where; Transponders 2, 6 and 10 also feature football games, none of which are on terrestrial TV. Transponders 8, 9 and 11 present three separate PBS programs, one matching the local PBS channel. Transponder 12 is showing a professional soccer game originating in Minneapolis and relayed to Los Angeles. Next, ANIK III, the prime Canadian satellite, is stationed at 114 degrees. On Transponder 4 the CBC is running a "pre-network feed" for a program to be viewed on terrestrial TV later that evening in Canada. Transponder 8 shows a French language movie. Transponder 10 features a Canadian Football League football game, while Transponder 12 is showing a hockey game from Vancouver.

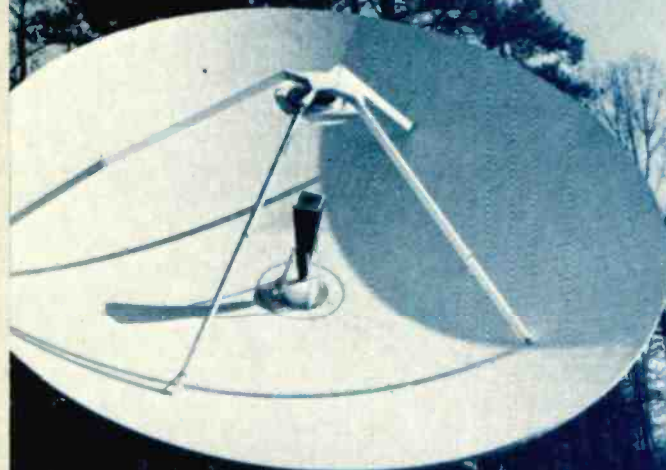
Moving on to RCA SATCOM F2 (at 119 degrees) Transponders 4, 10, 16 and 20 are showing more pro football games. One of these games is being shown on your local NBC affiliate; the other three are not available locally. On Transponder 8, there is an NBC network prefeed of

that evening's Walt Disney program, beamed from Los Angeles to New York for network viewing several hours later. Transponder 18 has another prefeed for NBC; this one is a news report for the next day's "Today Show". On Transponder 22 a golf match is being relayed live from a South Carolina locale where it is being transmitted to major-market independent TV stations. Finally, Transpon-

Home Reception via SATELLITE

Part 2—The conclusion of a story on domestic satellite communications and its use in distribution of TV programs.

ROBERT B. COOPER, JR.



der 23 is carrying a special program presented by the Alaskan Native's Federation being relayed via satellite to approximately 50 Alaskan "Bush Terminal" sites.

Our next stop is WESTAR II at 123.5 degrees west. Between WESTAR I and SATCOM II we've already run into eight professional football games. Eleven will be played that afternoon so we are not

surprised to see engineers, technicians and announcers preparing for one more on transponder 3. Transponder 1 carries New York City's WOR-TV, (a highly rated independent station) which is being fed to cable systems, and is showing an old black-and-white Bogart film. On Transponder 4 Chicago's station WGN is showing *Star Trek* to cable systems. Transponder 7 shows a bullfight, direct from Mexico City's station XEW-TV. Transponder 7 carries an average of 12 hours of Spanish language programming per day, much of which is transmitted directly from Mexico City to a handful of U.S. Spanish language TV stations in Miami, San Antonio and Los Angeles. Way up on Transponder 12 station KTTV in Los Angeles, another independent station being fed to cable systems nationwide, is wrapping up the Dodgers' baseball season. Since this station televises around 100 live Dodger games each year, this broadcast of a Dodger game fits its format.

There's still "nothing to watch," so you head for "the big one," RCA's SATCOM F1 (at 135 degrees west). You run through one of the three ATT/GT&E "telephone company" birds, COMSTAR 1, at 128 degrees west. Normally, they don't have much video on them but you check anyway. There on Transponder 14 are a couple of people talking. It seems to be one-half of a conversation. Up on Transponder 18 you find the other half: a group of scientists in Honolulu are talking with politicians in San Juan.

You're not interested, so you now move the antenna round the last notch to SATCOM F1. Surely here you will find something interesting to watch. After all, there are 20 separate almost full time video channels on F1!

On Transponder 1 station KTVU from San Francisco, another independent station, is showing a movie. Transponder 2 carries PTL, a 24-hour-per-day religious-based family entertainment service. Transponder 3 is showing Chicago's WGN broadcast of *Star Trek* again. On Transponder 5 you find "Nickleodeon," a 13-hour-per-day Children's Television Network created by Warner (Brothers) Cable. Transponder 6 carries Atlanta's "Super Station" WTCG, with wrestling. On Transponder 7 "ESP," a New England regional service, is showing playbacks of the area's college football games. Then on Transponder 8 you tune into CBN (Christian Broadcasting Network) the original 24-hour-per-day, satellite-transmitted religious-family channel.

Transponder 9 gives you Knicks basketball game direct from Madison Square Garden (there are more than 1000 hours of Madison Square Garden events on this transponder per year). During the week and in the daytime, Transponder 9 televises U.S. House of Representatives sessions live from Washington, which also totals about 1000 hours per year.

On Transponder 10 you find the West Coast feed for "Showtime," a 12-hour-per-day movie and entertainment service; they are running a current children's (G-rated) hit movie. Tuning to Transponder 11 you find Warner's "Star Channel," a 14-hour-per-day movie and entertainment service, showing a Tom Jones nightclub act from Las Vegas.

Transponder 12 gives you "Showtime's" East Coast channel and a Burt Reynolds movie. One nice thing about having an East and West Coast feed from SHOWTIME (and HBO) is that if you don't have the time to sit down and watch Burt Reynolds now you can come back in three hours and catch it on the West Coast channel at that time. Transponder 13 is running some engineering equipment tests. Transponder 14 also is showing the 24-hour-per-day religious channels—KTBN or Trinity Broadcasting. Only this channel, unlike PTL (Transponder 2) or CBN (Transponder 8), is a regular broadcast TV signal that happens to be sent out via satellite. (CBN and PTTL are special feeds created just for the satellite) On Transponder 16 you find, "Fanfare," a southwestern U.S. regional pay cable service specializing in late-release movies, nightclub and stage acts, and regional sports. Transponder 18 shows some digitally transmitted news from Reuters, on which, with a special receiver adapter, you can watch the latest world news. Transponder 20 is running a movie epic on oil exploration. Transponder 22 has the West Coast feed for HBO (*Home Box Office*), and as you tune in they are previewing the day's movie and

Are people actually watching all these programs? They sure are, and with their own backyard receiving systems.

They all must be millionaires, you might think. To be sure, a few had to be able to afford the prices being charged for "cable television grade receive terminals" back in 1977 or even early 1978. But let's back up a few steps again and take a look at some of the satellite specifications.

Microwave in the sky

A satellite is a combination of microwave electronics, solar-powered electronics and rocketry. Stripped of all of its mind-boggling exotic details, a satellite is nothing more than an unattended relay station. It has one set of antennas to receive the transmissions originating on earth (called uplink signals), and another set of antennas to retransmit those signals back to earth (called downlink signals). The uplink signals are between 5.9 GHz and 6.4 GHz (5900 MHz to 6400 MHz), and the downlink signals are between 3.7 GHz and 4.2 GHz (3700 MHz and 4200 MHz).

The uplink and downlink frequencies divided into (typically) 40-MHz-wide channels; and since the up and down frequency bands are 500 MHz wide, there is room for 12.5 such channels both up and down. This results in a maximum capacity of twelve 40-MHz-wide channels, plus some room for ground-to-satellite command signals, satellite-to-ground acknowledgment signals, and a couple of "beacons" to help ground control measure exactly where in space the satellite is located at any given moment. (See Fig.

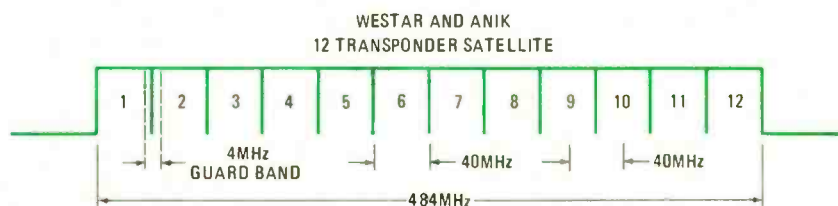


FIG 4—THE DOWNLINK BAND is 500 MHz wide from 3.7 to 4.2 GHz and is divided into 12 channels. Each channel is 40 MHz wide.

special fare. Transponder 23 has the HBO family-program service called "Take Two"; and a recently released Walt Disney movie. Finally, in the last transponder position, HBO's East-Coast feed service gives you the movie you wanted to watch. Decisions, decisions: Should you watch the movie now or catch it later on West Coast Transponder 22?

From Canadian hockey live from Vancouver to a bullfight telecast live from Mexico City, you have a choice of 11 professional football games, a motorcycle race from Houston or a soccer match from Minneapolis. These broadcasts are shown with such clarity and resolution that you almost feel compelled to reach out and touch the screen. That's what satellite TV means to those equipped to receive it.

4.) There can be more than 12 channels on a single satellite, however, and we'll see why that's possible in a later article.

The electronics inside most of today's satellites is fairly similar in design up to the output stages and the transmitting antennas. The uplink signals (between 5.9 GHz and 6.4 GHz) are received via fairly wide-beam "sculptured" antennas that cover all the service area fairly efficiently. Being directional antennas, they have a pattern, and in satellites the center of the antenna pattern is called the "boresight point." The boresight point on the receive antenna is where maximum gain occurs, as well as on the downlink transmitting antenna. All received signals are processed by a broadband (5.9—6.4 GHz) front end. The signals are amplified and fed into a converter stage that translates

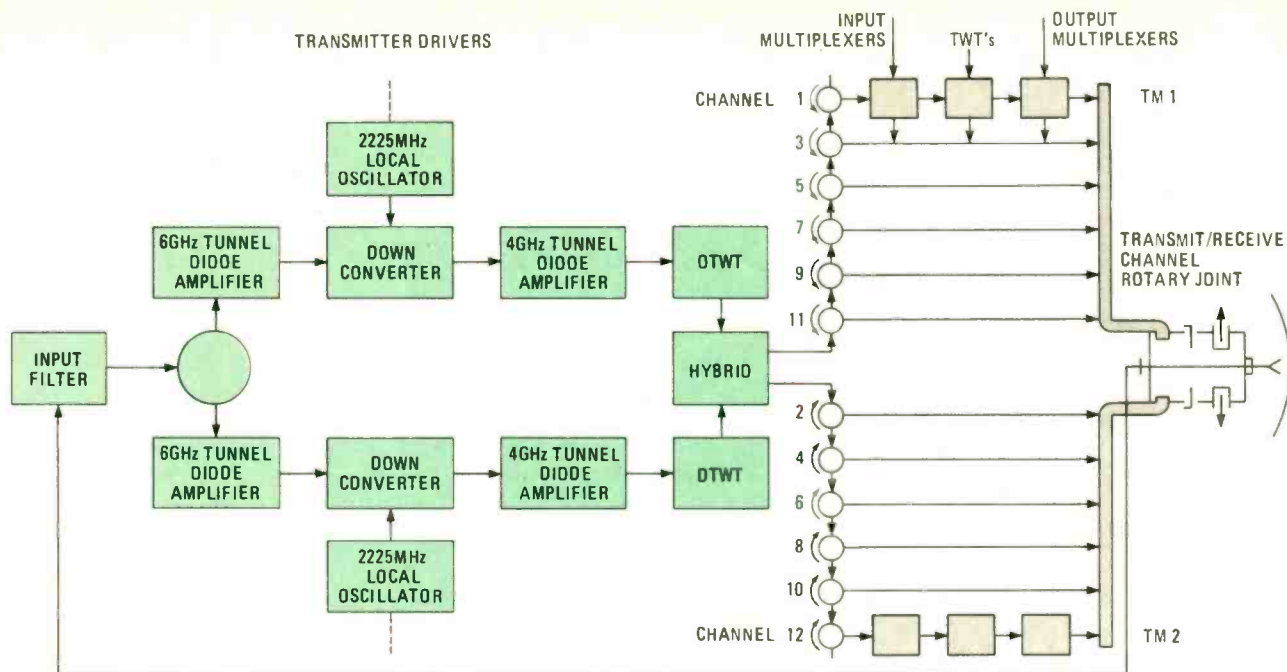


FIG. 5—12 CHANNEL SATELLITE designed by Hughes Aircraft.

their incoming frequency down directly to the appropriate area in the 3.7- to 4.2-GHz range.

Figure 5 is a block diagram of a typical 12-transponder satellite, in this case, the ANIK series. Note that the input side is redundant; this is a security measure in case something in this broadband circuit area should fail prematurely. Once the signals have been translated down to the 4-GHz range, they are fed into the appropriate output-amplifier stages; individual TWT (Traveling Wave Tube) output-amplifier stages are included for each transponder. The peak power at this point is 5 watts (+7 dBw, or decibels above 1 watt) and from there the 5 watts are coupled into the appropriate downlink transmit antennas. The transmit antennas have gain (with reference to a dipole or isotropic source) and the gain added by the directional transmit antenna measured in dB's is added to the power-output level of the TWT amplifier. This results in an effective radiated power (EIRP) for the downlink system. At boresight on the transmit antenna, the power generated is in the +34-dBw to +37-dBw range; this varies slightly from satellite to satellite.

The ground-to-satellite signal path (in the 6-GHz range) requires substantial transmitter power (i.e., 1 kW to 3 kW) plus large antenna gains (50 dB to 60 dB) to saturate the input of the satellite with high-quality (noise-free) signals. Like any relay station, the signal quality returning to earth is only as good as that initially transmitted to the satellite. On the uplink path, free space loss approximates 198 dB.

Our primary interest is in the downlink path since that is where we can participate. Figure 6 shows how the ANIK satellite views Canada:

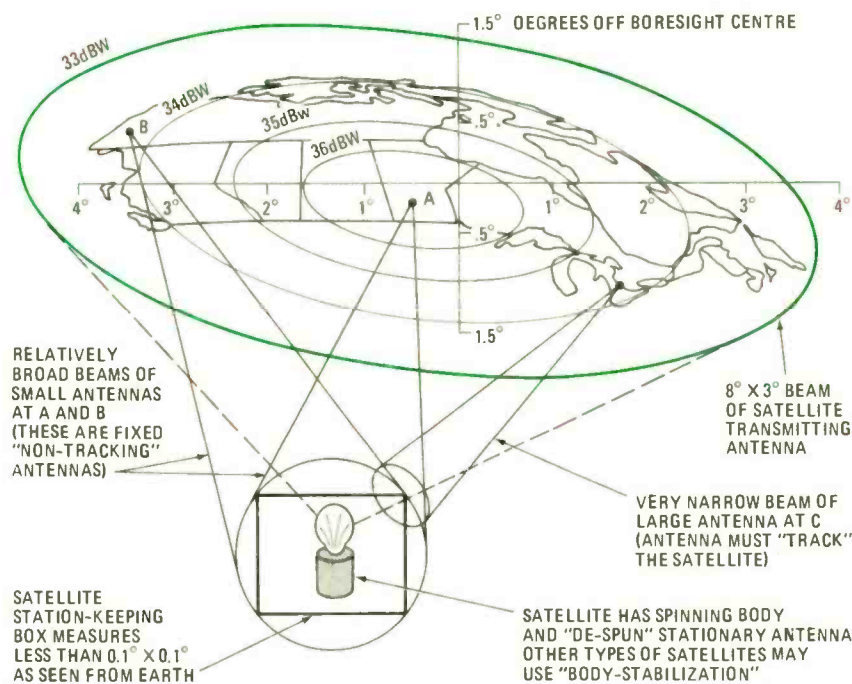


FIG. 6—TYPICAL COVERAGE of the earth's surface by a satellite. Two different approaches to receiving antennas are shown. Small antennas with a broad beam can be non-tracking while large antennas with a narrow beam must track the satellite.

TVRO terminals

TVRO (TeleVision Receive-Only) terminals really came into being when satellite relay service was inaugurated for cable TV companies. Since September 1975 their development has followed closely the established criteria for the big (and expensive) Intelsat stations.

When the first cable TV use of satellites started the present gold rush in the sky, the FCC had no ready system for handling the explosion. Because Intelsat stations were more often than not both reception and transmission systems, they naturally required FCC licenses. Domestic terminals that were first installed by

RCA, Western Union and (in Canada) by Telesat were both transmit and receive terminals. RCA, for instance, built ground-station terminals near major metropolitan centers and used terrestrial microwaves to link into and out of these centers. The New York City area is served from a location near Sussex, NJ, called Vernon Valley. This site (close to two other major uplink and downlink control sites) is the "first north-south valley location west of New York City where there is terrain shielding" from terrestrial microwave emissions.

This is important because the downlink frequency band in use (3.7 GHz to 4.2

GHz) is a shared band, that is, it is also used as the heavy microwave trunk route for the Bell Telephone Company (and other phone systems) throughout the U.S. Because the telephone company microwave circuits criss cross the country in the same frequency band as the downlink signals from the satellites, there exists a potential for interference. Fortunately, because of the highly directional characteristics of the parabolic antennas used in satellite reception (and the point-to-point "thin-line path" design of terrestrial telephone circuits) the two can operate closely without interference. What interference there is results from transmissions from the terrestrial circuits to the satellite-receive terminals since the latter do not transmit. (My own terminal is only 2.4 miles from a major Bell Company relay site, but we have never experienced any interference at our receiving TVRO.)

This does indicate however that occasionally a nearby terrestrial microwave transmitter, located either very close to you and to the side or out in front of you (i.e., on a line towards your satellite heading), could cause some interference with satellite reception. We'll look at solutions to this problem in a later article.

One of the manageable things about the satellite-to-earth system is its high degree of signal-level predictability. Between the excellent station keeping by the "flight engineers" and the well-known parameters of space loss between the satellite and earth, engineers with calculators or enthusiasts with TRS-80 computers can determine within 0.1 dB the type of signal level that can be expected at a given location. Adjusting to 0.1-dB signal-level steps is part of adjusting to satellite technology.

The satellite's signal is contained within a 36-MHz-wide frequency bandwidth. The video signal is frequency-modulated (FM) and the audio signal is also FM, being transmitted as a subcarrier signal at either 6.8 MHz or 6.2 MHz. Because this is an FM/FM system, several important factors must be considered that are not part of normal AM (terrestrial TV) transmission. The foremost factor is called "the FM threshold." Let's simplify what that is:

1. When an FM signal (on an FM set, a two-meter amateur radio, etc.) reaches "full quieting," all background noise is gone.
2. As long as the signal stays above the "threshold of noise," you have no way of judging (without some complicated meter measurement) how close you are to the noise since in "full quieting" there is no noise.
3. The signal may be far above quieting (into heavy limiting) or it may be simply right on the ragged edge (on the plus side) of noise; it all sounds the same.
4. However, when you fall out of full

quieting (that is, the signal level slips down in level and there is no limiting action) noise appears quite suddenly and often very dramatically.

This indicates that if the frequency-modulated satellite video signal could be maintained just above the noise threshold and if the satellite signal was very stable, you could get by with a "low-margin" (for fading) receive system that would to all normal eyeball testing give the same apparent picture quality as a signal that is many many dB stronger than full quieting. When you include in your calculations a parameter called the FM advantage (along with the other parameters of this particular system), a noise-free picture occurs when there is a 48-dB signal-to-noise ratio, as measured at the base-band video signal. FM advantage derived from this type of service, with normal receivers, is around 37 dB (give or take a few tenths of dB's). If you subtract 37 dB (the FM advantage) from the noise free video signal-to-noise ratio (48 dB) this gives you the type of 4-GHz-range carrier-to-noise ratio your receiver must attain: in this case, $48 - 37 = 11$ dB. Some fine tuning can be done with these values, but for now they are close enough.

When you go through all the system's mathematical components (satellite EIRP minus free-space loss minus receiver-noise value plus antenna gain) for 48 dB video signal-to-noise pictures, you need a 10-foot parabolic dish antenna with a 2.6-dB noise figure signal preamplifier, also called a low-noise amplifier (LNA). This is if you are within a 36-dBw contour and use a receiver with an adjusted IF bandwidth of 27 MHz.

Let's leave you with this bit of reassurance. If you sat down with an order form from established, reputable manufacturers selling hardware to the CATV (etc.) commercial users and bought everything you need for this type of reception already assembled (you would do the actual installation), you could buy everything necessary for 48-dB video signal-to-noise-ratio reception for less than \$5500. And that includes a 24-channel tuneable receiver.

While a far cry from the \$100,000 early turnkey cable systems of 1975, it may still be too rich for your blood. So, let's add this postscript: If you built your own antenna and LNA, and assembled your own receiver from prewired and tested modules, it would cost about \$3000. Still too much? Here's the bottom line for this month: A California hobbyist assembled his own system for under \$1500, using lots of ingenuity and a good knowledge of surplus equipment. And a fellow in Sheffield, England, built his private terminal for under \$1000. We'll dig into all this with some enthusiasm in a future article.

R-E

HOBBY

L. STEVEN CHEAIRS

AS ELECTRONIC PROJECTS HAVE GROWN IN complexity, the problems of interconnecting the components have grown as well. When I first started building projects, point-to-point wiring was the most common method of interconnection. Today the most common interconnections are copper traces on a printed-circuit board. As the transition occurred, a number of "how-to" electronic hobbyist magazine articles were published. Unfortunately, none of the articles I have read ever discussed the topic of printed-circuit design; instead they dealt with PC fabrication or artwork generation. So, let's take a more general look at PC design starting with the choice of board material.

Choosing PC stock

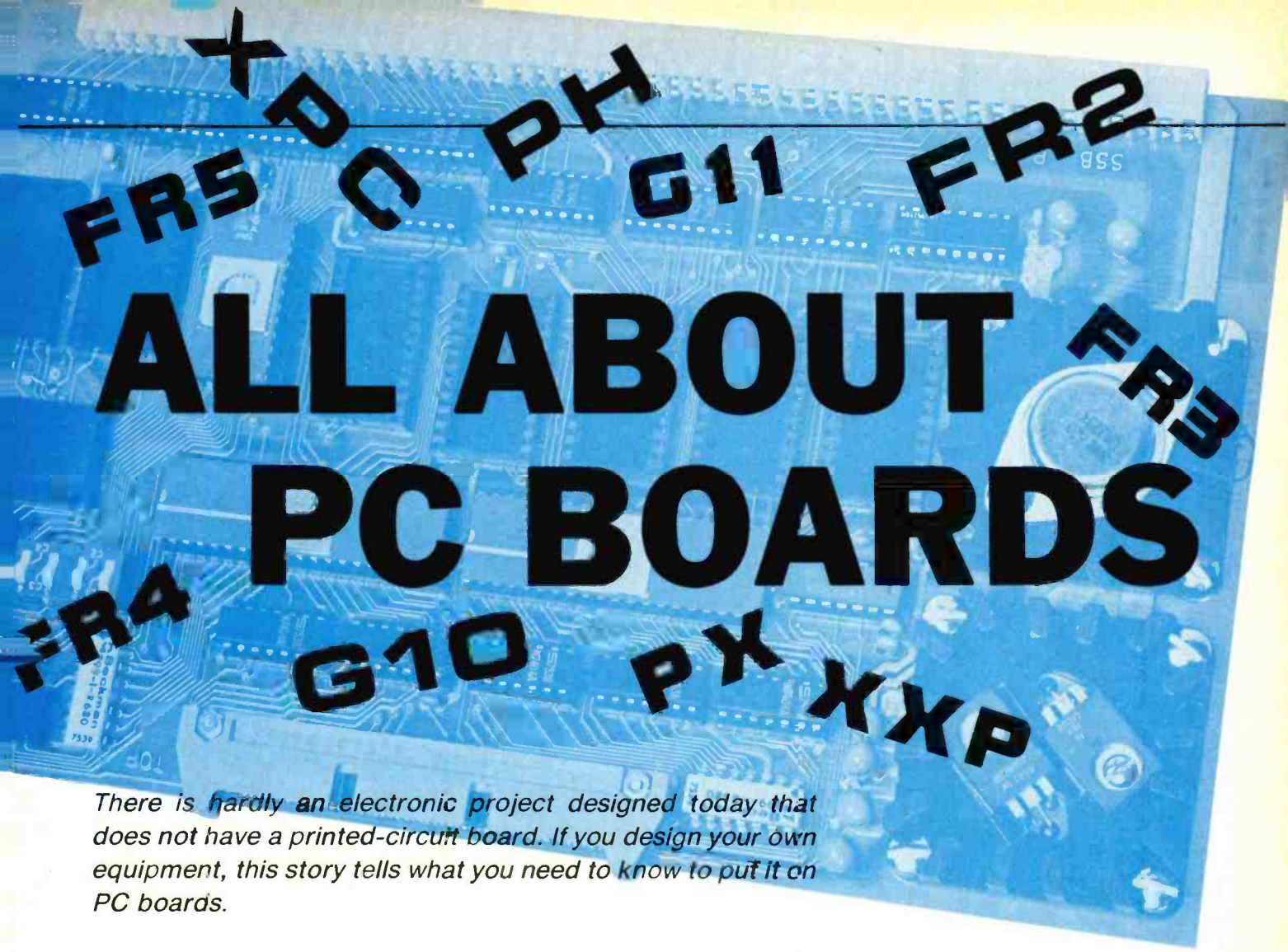
There are seven general classes of copper-clad stock used today; three of them are a phenolic paper base and four are a type of glass epoxy. The first phenolic paper material has two subclasses—designated XXXP and XXXPC—where the only difference in their characteristics is that the XXXPC material must be punched in a temperature range of 73 °F to 140 °F (for a board-thickness range of $\frac{1}{16}$ to $\frac{1}{8}$ inch).

The PC board is made using a paper-base stock that is impregnated with phenolic resin. Generally, the material is opaque with a medium-brown color.

The second material is made of flame-retardant paper phenolic and is designated FR-2. The color ranges from medium to dark brown.

The third paper-based material is FR-3 laminate impregnated with epoxy resin. There are two subclasses—PX and PH. This laminate is translucent (for $\frac{1}{16}$ -inch or less thickness) and usually is a light yellow or white color. Epoxy paper is flame-retardant and self-extinguishing. The PX laminate is generally used when holes are cold-punched; the PH laminate on the other hand is hot-punched.

The remaining materials are of the glass-epoxy type. The first is G-10 stock which is the standard general-purpose grade. It is formed from a glass-base continuous-filament cloth that is then impregnated with an epoxy-resin binder. The board is semitransparent and is usually a medium-green color. The G-10 stock is used only in the range of normal ambient room temperature. It should not be used to mount heat sinks or in unventilated enclosures where heat is being generated or dissipated.



ALL ABOUT PC BOARDS

FR5 G PH G11 FR2
FR4 G10 PX XXXP

There is hardly an electronic project designed today that does not have a printed-circuit board. If you design your own equipment, this story tells what you need to know to put it on PC boards.

The second is the G-11 material which is temperature-resistant grade. The material retains at least 50% of its room-temperature flexural strength at an elevated temperature of 150 °C for one hour. The third glass-epoxy material is the FR-4 laminate which is a flame-retardant epoxy glass. This material is generally a yellow-green to medium-green color. Some manufacturers market dark opaque versions of varying colors.

The final type of laminate is of flame-retardant and temperature-resistant glass-epoxy stock. Its NEMA (National Electrical Manufacturers Association) designation is FR-5. The material can be recognized by its semitranslucent brown to dark green color; some varying opaque colors are also manufactured. Now that you are familiar with what materials are available and how to identify them, we'll look at their individual characteristics.

Physical characteristics

An important feature of any laminate is its capability to withstand deformation under load. It is this characteristic that defines how well components that are bolted or riveted to the board can withstand the board's tendency to deform and thus loosen the connection. Nowadays,

voltage regulators are generally mounted on the board. When a TO-3-type case is used, two screws act as one of the electrical terminals; if they become loosened after assembly, then erratic operation of the complete assembly will surely result.

Another consideration is that the board acts as a shock amplifier. In this case the loosened bolts would leave the massive TO-3 case suspended by two pins. These pins are insulated from the package by glass seal rings—thus, one good-sized shock and you may need a new voltage regulator. If the laminate materials discussed above were subjected to 24 hours of a 4000 PSI load at 70 °C, the following deformation characteristics would be observed:

XXXP.....	1.7% deformed
FR-3.....	1.5% deformed
G-10.....	0.3% deformed
G-11.....	0.1% deformed
FR-4.....	0.2% deformed
FR-5.....	0.1% deformed

The modulus of elasticity is the amount of stress that a material can be subjected to without permanent deformation. The stress capability of the XXXP and the FR-3 materials is identical (about 1,300,000 PSI); that of the G-10 and FR-4 types is about twice that of the XXXP

and FR-3; and the G-11 and FR-5 types are a bit more resistant yet. Flexural strength, or the load the laminate will stand without fracture, is about 12,000 PSI for the XXXP material. The FR-3 laminate is about twice as hard to break, and the glass epoxy is over twice the flexural strength of the FR-3 laminate.

The FR-3 copper-clad material resists delamination (the copper clad separating from the base material) for 5 seconds at 500 °F; the glass epoxies resist delamination at the same temperature for 20 seconds. The maximum continuous operating temperature of the XXXP and FR-3 materials is 120 °C; the G-10 and FR-4 glass-epoxy materials can operate at up to 130 °C; and the G-11 and FR-5 laminates can withstand 150 °C. The glass-epoxy materials can withstand fungus, the paper-phenolic types will not.

The remaining laminate characteristics are those that affect the electrical circuit. The dielectric strength (i.e., an insulator's capability to resist the passage of an electric current) is 740 volts-per-mil for XXXP; 550 volts-per-mil for FR-3; 510 volts-per-mil for G-10; 600 volts per mil for G-11; 500 volts-per-mil for FR-4; and 490 volts-per-mil for FR-5 stock. The dielectric breakdown for 1/16-inch-thick

material is 15 kV for XXXP; and 30 kV for FR-3, G-10, G-11, FR-4 and FR-5 materials.

The dielectric constant is the ratio of the capacitance of a capacitor with a given dielectric material to that of the same capacitor with air as a dielectric. The dielectric constant varies with temperature, humidity and frequency. The following data is shown for material tested at 1 MHz that has been preconditioned by being soaked in distilled water for a day at room temperature. The XXXP is 5.3, the FR-3 is 4.8 and the glass-epoxy boards are 5.4. The dissipation factor is the ratio of total power loss to the product of the voltage and current in a capacitor in which the laminate is used as a capacitor. The glass-epoxy materials have a dissipation factor of 0.035, the FR-3 materials, 0.040 and the XXXP material, 0.050.

Drilling holes

Holes are generally drilled in the PC board, as opposed to being die-punched, when low-production quantities are encountered or where higher quality with better tolerance is needed. The drill tolerances will be about -0.002 inch for all holes under $3/32$ of an inch in diameter; the tolerance will be -0.003 inch for holes between $3/32$ -inch and $1/4$ -inch in diameter; and -0.004 inch for holes larger than $1/4$ -inch in diameter.

For the paper-phenolic materials, almost any high-speed drill bits can be used. When drilling through paper phenolic, best results are obtained with a point angle around 70 degrees; however, burrs occur on the copper foil, so a compromise angle of 100 degrees is generally used.

Glass-epoxy laminate is another story—high-speed drill bits, chrome-plated or even nitrided drills, seem to melt away before your eyes. Solid-carbide drill bits are a must; these bits will produce from 10,000 to 30,000 holes (that is, if you don't break them) for G-10 and FR-4 materials. The FR-5 or G-11-type laminate will yield about 2000–5000 holes. Carbide drill bits are very brittle and easy to break. When drilling it is also recommended that you place a piece of board of same type as that being drilled under the PC board to keep the pressure on the bit constant.

Electrical parameters

A critical parameter of low-impedance circuits is the resistance of a printed-circuit trace. The TTL circuits and linear-voltage regulators that are commonly used by hobbyists are low-impedance circuits. If a conductive path becomes long—let's say it connects components on one side of an S-100 bus board to components on the other side—then close attention must be given to loads on that line or erratic operation may result. For 2-oz. copper stock, the resistance in ohms per

linear inch, R , can be calculated as a function of line width (W , in inches) by the following equation:

$$R = \frac{0.000277}{W}$$

This calculation must be made for all power circuits and low-impedance logic arrays with long lead lengths.

If high-frequency circuits are to be constructed, then capacitance becomes very important. At high frequencies any distributed capacitance between conductors on opposite planes must be accounted for. A working guide can be obtained from

$$C = (0.00235) \frac{Wd}{s}$$

where C is the capacitance in picofarads-per-inch, W is the conductor width in mils, d is the dielectric constant, and s is the thickness of the laminate in mils. The capacitance between parallel conductors on the same plane is a function of width, thickness, the spacing of the conductors, and the board material, as shown by the equation:

$$C = \frac{t}{3.23 W} + \left(\frac{1+d}{4.35} \right) \log_{10} \left(1 + \frac{2W}{s} + 2 \times W + \frac{W^2}{s^2} \right)$$

where t is the conductor thickness in inches; all other symbols are the same as the previous equation.

Consideration should be given to any conductor located over a ground plane, since the entire length of the track is capacitance-coupled to the plane; as a result they are coupled to other lines with a similar relationship. It should be noted that for high frequency operation where critical circuits are involved, single-sided boards are unusable; ground planes and strip-line construction are mandatory. The ground plane significantly reduces the coupling between two adjacent single lines by as much as ten times.

One final electrical parameter that must be considered is the current flow with respect to temperature. Figure 1 shows a set of current vs. cross-sectional area curves, each of which represents the temperature rise above ambient. There-

fore, it is possible for the designer to choose an acceptable temperature rise and the desired maximum current level for a PC trace and determine a cross-sectional area. Next, you must find the minimum trace width by dividing by the copper-foil thickness (0.004 inch for 3-oz. stock, 0.0027 inch for 2-oz. stock, 0.00135 inch for 1-oz. stock, and 0.00067 inch for $1/2$ -oz. stock). Using the above data assures having minimum conductor widths without sacrificing reliability. Trace spacing is a function of the printed-circuit process and breakdown voltage. For low-voltage logic circuits, traces can be placed within 15 mils or less.

Structural characteristics

Earlier it was stated that a circuit board is a shock amplifier. This section discusses general PC mounting.

The two common board-mounting methods are: one end fixed, say, in an edge connector, with rails providing minimal support on the two sides; and a board clamped on both ends by rails or standoff insulators. The mechanical resonant frequency of the board depends upon the fastening method used and on its modulus of elasticity, its thickness, weight per-square-inch and length. The curve shown in Fig. 2 is a plot of board length vs. resonant frequency (where the modulus of elasticity equals 1,800,000 PSI; the thickness is $1/8$ -inch, and the board's weight per-square-inch is 0.016 PSI). Using the equation of Fig. 2, an S-100 bus board using G-10 glass epoxy would have a 101-Hz resonant frequency. If this board were clamped on the free end, its resonant frequency would become about 655 Hz. If paper-phenolic XXXP stock were used, the S-100 bus board (unclamped) would become resonant at about 70 Hz.

The vibration factor

Why is mechanical resonance so important? Most electronic equipment is subject to shock or vibration, even if only during shipping. A few decades ago when jet airplanes were just arriving on the scene, a new technology was discovered—

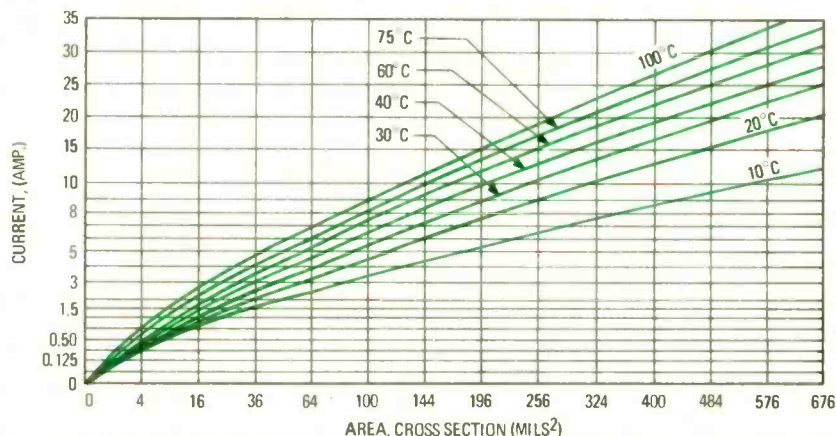


FIG. 1—CONDUCTOR CROSS-SECTIONAL AREA vs. current flow for safe temperature rise above ambient.

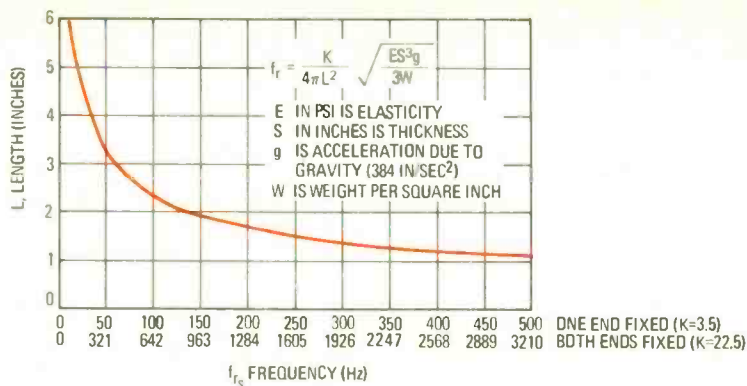


FIG. 2—RESONANT FREQUENCY as a function of board length.

the study of material fatigue. If your equipment is to be installed in a car, you should definitely give a thought to material fatigue. The best way to avoid problems is to design the resonant frequency of your board so that it is outside the band of vibration to which it will be subject. A ship or boat has a constant vibration of about one-third of a G between 0 Hz and 11 Hz; from 11 Hz–30 Hz it rises to about two-thirds of a G; throughout this frequency range, sporadic vibrations of just less than 1 G may occur. For aircraft a constant 1-G vibration between 0 and 50 Hz is observed; between 50 Hz and 300 Hz, vibrations of up to three G's are experienced; sporadic vibrations of two G's occur between 0 and 12 Hz; between 12 Hz–125 Hz, a linear curve ranging from 2 G's to 20 G's exists; and from 125 Hz to 300 Hz, sporadic vibrations with an amplitude of 20 G's occur.

Another fact to consider is that an electronic component mounted on a PC board may experience a higher G-force than the equipment as a whole. This G-level is determined by both the resonant frequency and the amplitude of the vibration. Since the G force is directly proportional to the amplitude of the vibration, if a vibration frequency is 0.9 times the resonant frequency, the G-level the component experiences is about 5 1/4 times greater than the G-level the equipment undergoes. This is expressed by

$$M = \frac{1}{1 - (f_v/f_r)^2}$$

where M is the amplitude multiplier transmitted to the component; f_v is the frequency of the incoming vibration; and f_r is the resonant frequency of the circuit board. The amplitude of the vibration transmitted to the component is the product of the amplitude of the vibration frequency and the value of M. Finally, several transmissibility-type functions may cascade, creating a supershock. For example, a circuit board may be mounted in a slot in a 19-inch card rack sitting in your lab area; a truck drives by, the building vibrates; this vibrates the rack, the card cage and, finally, the circuit board. Each vibration may increase in amplitude depending upon the individual resonant frequencies of each stage.

Component layout

One of the first steps in laying out a circuit board is to decide what its size will be and how many conductive layers are needed. If the circuit is simple and requires only a few interconnections, then a small single-sided board can be designed. But if it is a complex circuit with a mass of interconnections, a larger double-sided board is needed. It should be pointed out that the larger a board becomes, the fewer the connections to the board itself, but at the expense of warping or bowing (and also a lower resonant frequency is obtained).

The method I use for determining both predefined and undefined areas is to calculate the total area that will be taken up by all the components, and then multiply by a "cheat" factor. For example, if a circuit uses ten 14-pin IC's, three 16-pin IC's, fifteen 1/4-watt resistors and fourteen bypass capacitors, the following equation would result:

$$A_C = 10 A_{IC14} + 3 A_{IC16} + 15 A_R + 14 A_C$$

Since, $A_{IC14} = 0.257$ sq. in.; $A_{IC16} = 0.264$ sq. in., $A_R = 0.045$ sq. in., and $A_C = 0.060$ sq. in., then $A_C = 4.9$ square inches. Next, multiply by the interconnecting factor (I use a value ranging from 3 to 5, depending on circuit complexity). If yours is a complex digital circuit with a large number of interconnections, use a factor of 5. This gives an area of $24\frac{1}{2}$ in.²; a board that is one-half the size of an S-100 bus is required. Another method would be to use a Bishop Graphics *Pupper* design kit; this contains scaled cutouts that, by intuition and trial-and-error, can be used to develop both conductor paths and board size.

Next, choose the laminate. Then, define the copper thickness—3 oz., 2 oz., 1 oz. or 1/2 oz.—which will depend upon the current requirements. The width of the conductors also depends on the current, but is limited by the board size. Keep the conductors less than 1/2-inch wide since large areas may cause warpage or solder-blistering. If wider conductors are needed use a ground plane. If space is no problem use 0.031-inch-wide conductors for low-voltage logic paths and 0.050-inch-wide trace for power. Make sure the conductors are spaced far enough apart to with-

stand the peak voltage between them; when possible, leave 0.031 inch between all traces. If narrow conductors and spaces are used, then consider the error factor in your construction process.

Lay all components out along the horizontal and vertical axes; use a grid system to place all components and holes (a 0.1-, 0.05-, or 0.025-inch grid is recommended). First, using a well-drawn schematic, make a trial layout with the same parts proximity. Next, if there are some components that must be located at some particular point on the board due to mechanical requirements or because of signal input/output, move them to the required location. The closer you can make the layout look like the schematic the better, since this generally avoids unwanted couplings. Make sure that no physical interference exists between component bodies. Now, stop and look at your layout and consider the possibility of parasitic coupling between circuit elements; add any necessary bypass-circuit capacitors or move components about to reduce these effects.

Now, consider the routing of the conductors. Remember, however, that grounding the conductors is of the highest priority. Cross-talk is most often a ground problem. Try to generate a single ground at one point.

In order to reduce unwanted feedback, keep inputs and outputs of a device far apart. Another rule is to try to make conductor routes as short and direct as possible; in order to achieve this, some leads will become longer than desired. However, with a bit of thought these problems can be solved. Don't be afraid to use a jumper (for double-sided boards as well) because sometimes this results in a better-performing circuit than when a conductor has been routed all over a board in order to obtain a free path. If there's a noisy signal line near a low-level high-impedance line, try to run a ground line between them. Any ground planes should be formed using a striped or checkered pattern of 50-mil conductor (50% of the area must be nonconductive).

Although some designers lay out the conductors in smooth graceful lines, I prefer straight lines that change direction with sharp corners—between 90 and 135 degrees. Never use less than a 90-degree angle or delamination may occur. Another important point to consider when laying out your circuit is to leave test points at key circuit locations; you will be thankful you did.

Most boards require a number of different-size holes. Never space the holes closer than a distance equal to the board thickness. Never make overlapping holes—this is a good way to break expensive drill bits. A minimum hole-pad size should be 62 mils.

Every jumper, component lead or ter-

Continued on page 91

Adaptive Noise Filter



Part 2—Simple to build and operate, this dynamic variable-cutoff low-pass filter can be used to remove that annoying snap, crackle and pop from your records and tape.

**TIM SKORMOND AND
GENE GARRISON**

LAST MONTH WE INTRODUCED THE Adaptive Noise Filter and discussed its operation. Now, we'll see how to put one together.

Construction

Printed-circuit construction techniques should be followed in the assembly of the filter and the associated bar-graph display. Two suitable printed-circuit boards are used; their patterns are shown in Figs. 7 and 8. Parts are placed as shown in Figs. 9 and 10. All components are mounted on the printed-circuit board with the exception of the sensitivity potentiometer, R19, the optional switches, jacks and the power transformer. Sockets or *Molex* strips will simplify IC installation.

The front panel may be drilled and punched to accommodate the bar-graph display and printed-circuit board. Mounting holes are provided at the four corners of the PC board for this purpose. The LED's are mounted on 1/4-inch centers, with the hole diameter dependent upon the individual LED's used. The three switches and the sensitivity control are mounted on the front panel and eight phono jacks, J1-J8, on the rear panel.

Figure 11 shows a wiring format for the finished unit as seen looking down into the inside of the box. Switch S1 represents the POWER switch; S2, the PRE TAPE/BYPASS switch; and S3, the POST TAPE/BYPASS switch.

The jumpers across S2 and S3 should be wired before the boards or transformer

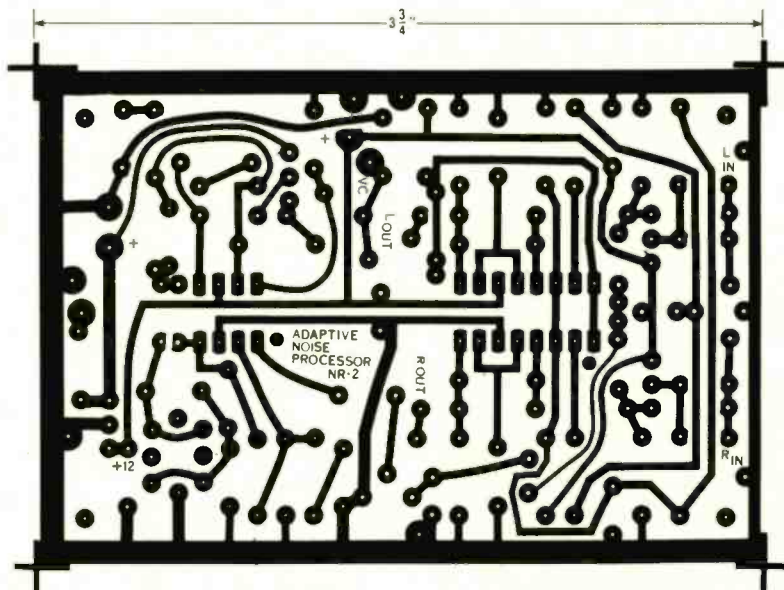


FIG. 7—FULL-SIZE FOIL pattern for the main board in the noise filter. The circuit on top half of board is for left channel; right channel is on lower half.

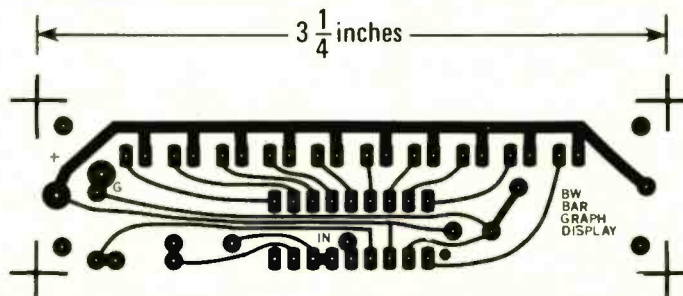


FIG. 8—THE BAR-GRAPH is made by mounting rectangular LED's in this PC board along with the IC that drives the individual elements.

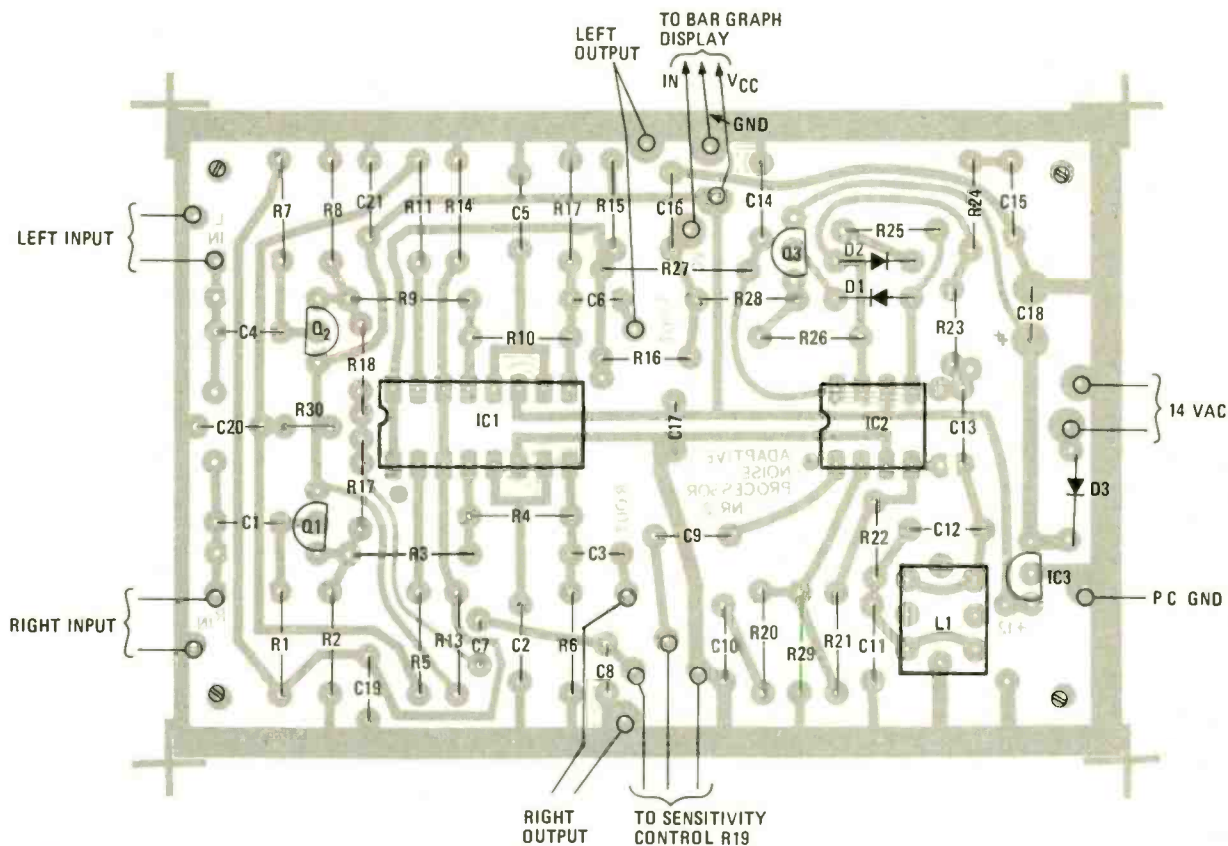


FIG. 9—HOW PARTS ARE POSITIONED on the filter's main circuit board. Patterns on the left side of board are almost mirror images because they are for right- and left-channel inputs.

are installed. These jumpers should be insulated wire but need not be shielded. The four wires to connect S2 and S3 to the PC board should be soldered to the switches and cut to length but not yet connected to the board; these wires should be shielded cable with the shield grounded at the PC board.

The eight connections to the rear-panel jacks may now be made using shielded wiring with the shields grounded at the jacks. The jacks are shown in Fig. 11. The "J" code numbers correspond to the numbers on the eight switch poles. These wires should be placed so that they will lie under the main board.

The PC boards and transformer may now be installed, and the AC line cord, fuse, power switch and transformer wiring connected. The SENSITIVITY pot is connected to the board through shielded cables with the shields grounded at the board. The three connections from the bar-graph display to the main board need not be shielded. Be sure to tie the ground for the jacks (chassis) to the board.

Using the filter

The Adaptive Noise Filter can now be connected in the tape monitor loop of a

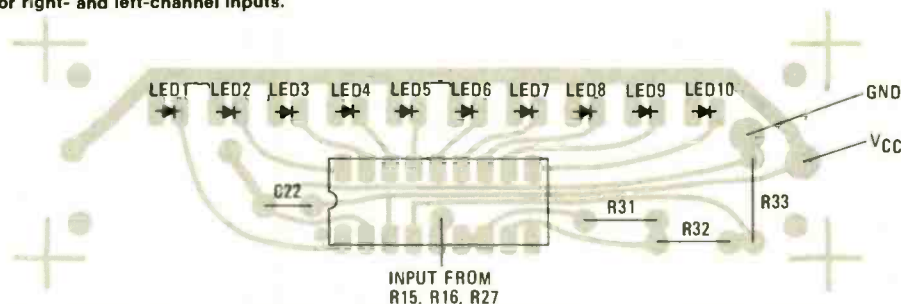


FIG. 10—COMPONENT LAYOUT for the display board. The rectangular LED's in the bar-graph protrude through a narrow slot that is cut in the front panel.

receiver or amplifier. The SENSITIVITY control, R19, should be turned down completely and the source material placed in an area with no musical content (between cuts, for instance).

All but the first LED should be off in this condition. The sensitivity control is then advanced until the next LED just begins to flicker. This is an indication that the filter is barely opening on the noise floor and is capable of reaching full bandwidth on musical information above this level. Alternatively, the control may be advanced until there is a barely perceptible increase in the noise level and then backed off very slightly.

The 19-kHz multiplex pilot tone pre-

sent in all stereo FM broadcasts is attenuated by L1 and C12. The presence of this pilot tone will limit the noise reduction capability since the noise filter will sense the level of the pilot tone rather than the level of the noise source.

The inductor provided with the kit of parts described in the parts list is pre-tuned and should not be altered. If, however, you purchase L1 separately, then it must be tuned to within about ± 20 Hz of the 19-kHz pilot tone. The simplest way to obtain this reference frequency is directly from the FM broadcaster. Tune your FM receiver and wait for a quiet (no audio signal) interlude. Tune L1 for minimum noise filter band-

PARTS LIST

All resistors 5%, 1/4 watt unless otherwise noted

R1, R7—100,000 ohms
 R2, R6, R8, R12—3000 ohms
 R3, R4, R9, R10—22,000 ohms
 R5, R11—51,000 ohms
 R13—15,000 ohms
 R14, R26, R27—10,000 ohms
 R15—200,000 ohms
 R16—3900 ohms
 R17, R18—20,000 ohms
 R19—100,000 ohms, miniature pot, audio taper (Clarostat 389 N 100K-Z)
 R20, R32—3300 ohms
 R21—330,000 ohms
 R22, R25—100 ohms
 R23—1000 ohms
 R24—10 ohms
 R28—27 ohms
 R29—91,000 ohms
 R30—5100 ohms
 R31—750 ohms
 R32—360 ohms

Capacitors

C1, C4, C20—1 μ F, 16 volts electrolytic, radial leads
 C2, C5—.0047 μ F, 50 volts, Mylar, 10%
 C3, C6—5 μ F, 10 volts, electrolytic, radial leads
 C7, C8—.001 μ F, 50 volts, ceramic disc
 C9, C10—.01 μ F, 50 volts, ceramic disc
 C11, C14, C15, C17, C21, C22—.01 μ F, 50 volts, Mylar
 C12—.015 μ F, 50 volts, Mylar, 5%
 C13—.033 μ F, 50 volts, Mylar
 C16—6.8 μ F, 25 volts, tantalum, 10%, radial leads
 C18—470 μ F, 25 volts, electrolytic, radial leads
 C19—10 μ F, 10 volts, electrolytic, radial leads

Semiconductors

D1, D2—1N914
 D3—1N4002
 Q1, Q2, A3—2N4401
 IC1—LM13600 dual operational transconductance amplifier (National)
 IC2—LM387N dual low-noise preamplifier (National)
 IC3—LM78L12CZ (National)
 IC4—LM3915N logarithmic bar-graph display driver (National)
 LED1—LED10—NSL57124 rectangular LED for bar graph (National)

Miscellaneous

S1—miniature SPST toggle switch
 S2, S3—miniature 4PDT toggle switch
 T1—power transformer, 14 VAC, 250 mA (Triad F-112X)
 L1—adjustable inductor, 4.7 mH, Q = 35 at 19 kHz (TOKO CLN20 740 HM)
 J1—J8—panel-mount RCA-type phono
 F1—1/4-amp slow-blow fuse
 Fuse holder, line cord, PC boards, control knobs, hardware

The following parts are available from Advanced Audio Systems, PO Box 24, Los Altos, CA 94022:

DX-244 (NR-2) complete kit including case—\$69.95

DX-245 (NR-2) main and display PC boards—\$19.95

DX-247 (NR-2) component kit; includes D1, D2, D3, IC1, IC2, IC3, IC4, Q1, Q2, Q3 and L1—\$27.50

California residents add state and local taxes, as applicable.

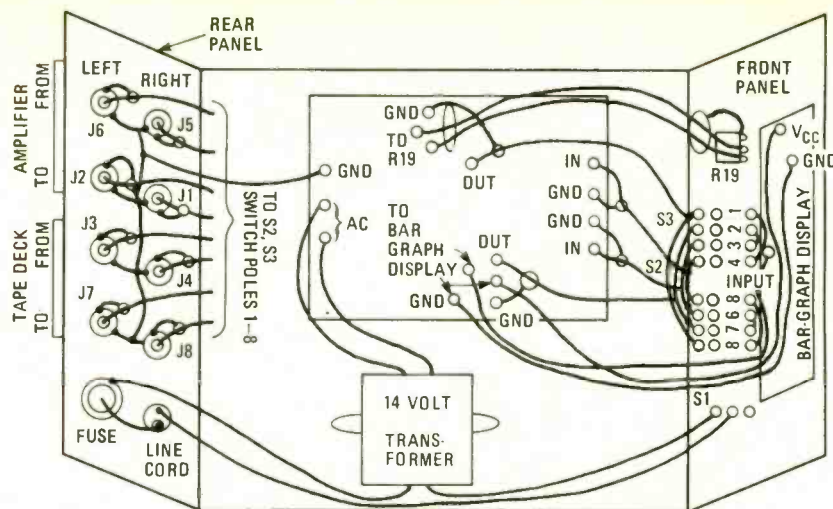
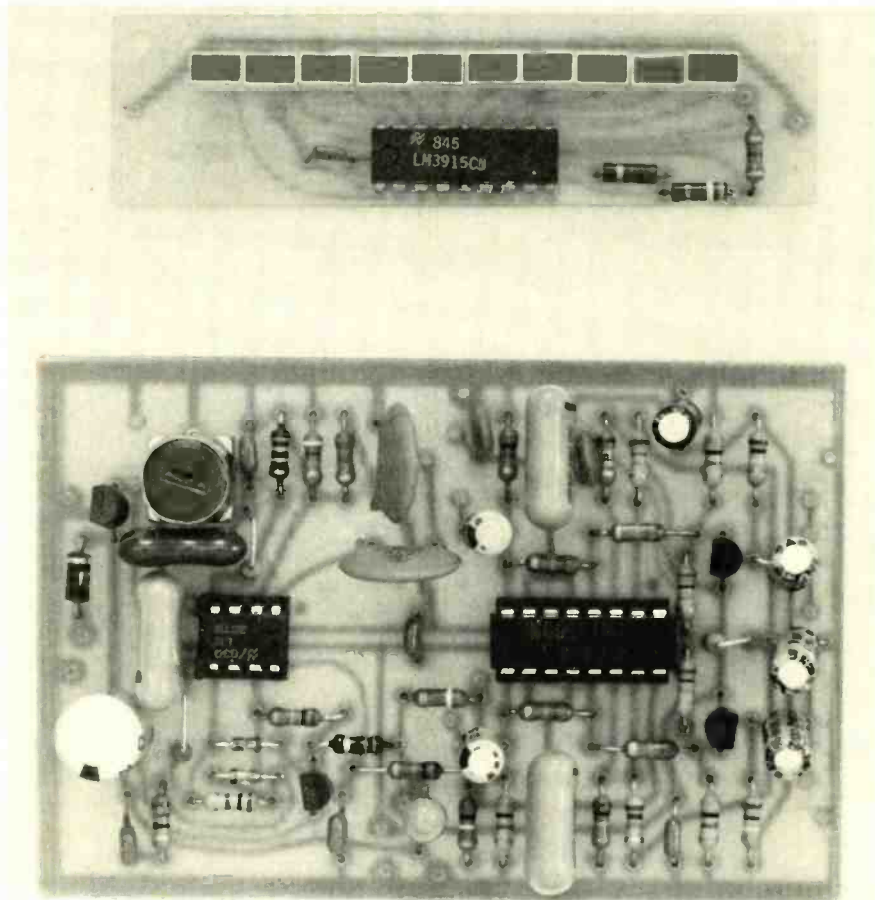


FIG. 11—WIRING LAYOUT shows connections between the main circuit board, the components on the back panel and the switches, pot and display board on the front panel.



TOP VIEWS of the two circuit boards and their components. Translucent board material makes it easy to insert components in correct places and simplifies circuit tracing.

width as monitored on the LED display.

The bypass switch can be toggled between the BYPASS and FILTER positions to compare the action of the adaptive filter with that of a full system response. The difference should be quite dramatic, giving a subjective improvement in S/N of 12 to 14 dB. The action of the filter is most apparent between cuts where it removes nearly all of the annoying hiss.

You should be aware of a psychoacoustic effect that is common to all noise-reduction systems. The addition of high-frequency noise (such as tape hiss) to a music signal will seem to increase the

high-frequency content of the music. Thus, upon first auditioning the Adaptive Noise Filter using noisy source material, the user will seem to hear a degradation of the music's high-frequency content. The system's actual effect on the high-frequency information can be observed by using a source with a good initial S/N and by switching the filter in and out.

It should be noted that the filter is designed for a 1-volt RMS average input level. Some tape decks are capable of much larger output levels at "0 VU" and should be attenuated accordingly to prevent overloading the filter inputs. R-E

ANTISTATIC RECORD CARE

Electrostatic charges on phono records can be the direct and indirect causes of the "snap" and "crackle" that you hear. Here's word of an effective remedy.

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

SOME MONTHS AGO, A REPRESENTATIVE OF a British-based company called Milty Products, Ltd., asked me if I would be willing to test a new antistatic product in my audio lab that his company had developed. The product, he claimed, would completely and permanently reduce static charges on phonograph records with a single application. While this seemed incredible to me, I agreed to perform the tests. Of course, I had no way of accurately measuring static charge on a record. The Milty representative agreed to lend me an instrument to measure electrostatic surface charge. This device is called a "field mill."

Figure 1 shows the field mill, a cleverly designed test instrument that features a motor-driven rotating blade in the front that effectively "chops up" the electrical field into a number of pulses, making it easy to measure the charge in volts-per-meter or volts-per-centimeter using built-in alternating voltage detection and metering techniques.

The field mill's rear panel is equipped with a zero-centered meter, enabling the user to read both positive and negative charge voltages. In use the rotating-blade end of the device is held a few centimeters from a surface whose charge voltage is to be measured.

Since the meter is equipped with sensitivity scales $\times 1$, $\times 10$ and $\times 100$, full-scale maximum readings equal 10,000 volts. However, to arrive at a voltage-per-centimeter reading, you must multiply the observed reading by the distance (in centimeters) from the surface being measured. Accordingly, holding the device at some 5 centimeters from the surface, you

could measure charge voltages as high as 50,000!

Equipped with this field mill, I was astounded to find that in low-humidity conditions (such as are normally found in homes during the winter) merely removing a brand-new record from its protec-

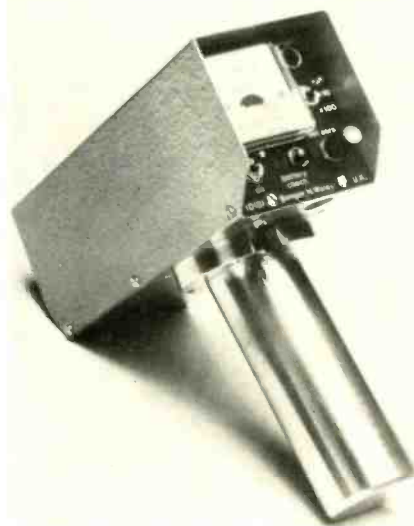


FIG. 1—FIELD MILL DEVICE measures electrostatic surface charge. Reading is in volts-per-centimeter.

tive sleeve induces a charge of between 3,000 volts to 10,000 volts! The charges were found to be negative in all cases with vinyl LP records.

Effect of static charges

There are several undesirable effects that occur when highly charged records are played on a high-quality high-fidelity

component system. When Shure Brothers, Inc. first introduced the *model V-15 Type IV* phono cartridge, we reported (*Radio-Electronics*, September 1978) on the unusual destaticizing and stabilizing carbon-filament brush on the cartridge, which, among other things, discharges the voltage on record surfaces. In connection with the cartridge, Shure had done a good deal of research into static voltage build-up on records.

For one thing, it was discovered that if the charge voltage exceeds a certain value, called the threshold voltage, pickups that have a grounded metal shield and a grounded stylus may cause "discharge" of the static voltage build-up, thus giving rise to crackling, popping or frying noises during playback. Such pickups were found to have threshold voltages ranging from 4000 to 5000, a voltage value that is often exceeded in dry weather on disc surfaces.

In addition, the electrostatic charge can actually increase stylus force, owing to the extra attraction of the cartridge to the record. It was found that a 4200-volt charge adds an extra $\frac{3}{8}$ gram to the stylus force! This additional force can increase record wear or, at the very least, change the intended groove tracking conditions significantly.

Since the natural voltage charge on a record is not uniform over the entire surface, the added force can be cyclical in nature, causing the tracking angle of the stylus to vary cyclically with an attendant increase in apparent wow-and-flutter.

Perhaps the most serious effect created by electrostatic charges on records is that dust and dirt are attracted to the record

surface, producing additional wear and playback noise.

Lab tests

The tests I conducted for Milty Products were *not* designed to prove that the company's antistatic product reduced static charges to zero. The company was perfectly capable of proving that to their own satisfaction. Rather, I was asked to investigate whether applying the antistatic product to a record surface in any way degraded the sonic or musical performance obtained *from* the record during playback.

The tests I conducted involved playing treated and untreated test records for a total of 100 plays, and measuring such specifications as harmonic distortion obtained from playback of test tones, frequency response, and any increase in background surface noise. I was able to report that with respect to any of the foregoing parameters, no deterioration of performance occurred. If anything, the treated record exhibited a somewhat lower surface noise level after 100 plays than the untreated control record.

As for the claimed permanency of the treatment, I have had the treated test record for over six months, and it still produces no electrostatic charge when pulled from its sleeve or played on a turntable.

The Stanton Magnetics Company (101 Sunnyside Blvd., Plainview, NY 11803) recently agreed to become the American distributor for this product, which has been given the name *Permostat*. And, in a presentation, Stanton presented further dramatic evidence of the effectiveness of the antistatic compound.

Using an identical field mill to the one I used in my tests, Stanton confirmed that, no matter how hard you tried (including rubbing a record surface treated with *Permostat* with a silk handkerchief), no charge could be induced. Untreated records given the same test had induced charges as high as 15,000 volts.

Other antistatic devices have been available for some time, perhaps the most familiar being the so-called active ionizer, which is shaped like a pistol. Such destaticizers produce positive ions when the

trigger is pulled and negative ions when the trigger is released. As Shure Brothers had learned in earlier tests (and, as Stanton confirmed), the ion-gun is fairly effective for large charges, but it is difficult to avoid leaving residual charges of somewhat lower intensity on the record since there is no way of detecting the zero-charge condition (unless you own one of those sophisticated test instruments such as Stanton and I used in our tests). Even if the ion-gun does reduce the charge to virtually zero, the destaticized condition is temporary, and the record would have to be treated each time it is removed from its protective sleeve, and played.

To demonstrate the practical effectiveness of *Permostat*, Stanton unveiled a specially designed "dust chamber," shown in Fig. 2. Three records were suspended vertically within this chamber;

Fig. 2 was equipped with electrically operated blower fans that injected simulated dust particles consisting of two oppositely charged fluorescent pigments having an average particle size of 2.5 microns to 3 microns. These particles were circulated within the test chamber parallel to the plane of the records. This created what amounted to a miniature dust storm. Once the dust had settled, the records were then examined for dust pickup.

Figure 5 clearly shows what happened to the untreated record, which previously had measured a static charge of 15,000 volts, readily attracted a considerable amount of dust. The record treated with the ion-gun registered much lower static charges but still attracted a significant amount of dust. Only the record treated with *Permostat* showed a zero static charge (as before) and picked up no dust.

Usually, leaving an untreated record exposed for a day or so in a normal envi-



FIG. 3—PERMOSTAT LIQUID is applied directly to record surface via a hand pump.



FIG. 4—BUFFING PAD is used to evenly spread Permostat solution over record surface.

one was untreated (on the left), one was treated with an ion-gun destaticizer (center) and one was treated with *Permostat* (on the right). The method of treatment using *Permostat* is similar to applying *Sound Guard*, a record preservative. *Permostat* liquid is applied by a hand-spray pump (see Fig. 3). The fine spray is directed around the record; about 8 to 10 sprays are required to coat one side. It is essential that *both* sides of the record be treated for the *Permostat* to do its job effectively, even if only one side is to be played.

A buffing pad is then used to spread the solution evenly over the surface of the record and to remove any excess fluid. (See Fig. 4.) The dust chamber shown in



FIG. 5—UNTREATED RECORD after being exposed in dust chamber.



FIG. 6—PERMOSTAT-TREATED RECORD after being exposed in dust chamber.

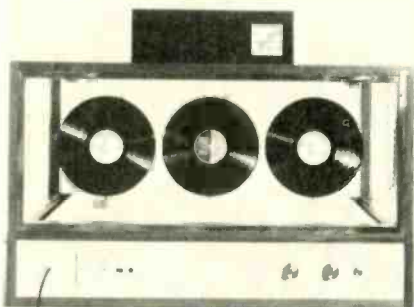


FIG. 2—DUST CHAMBER produces a dust storm that is used to demonstrate anti-static effectiveness.



FIG. 7—SINGLE RECORD GROOVE of untreated record after 100 plays as viewed through electron microscope.

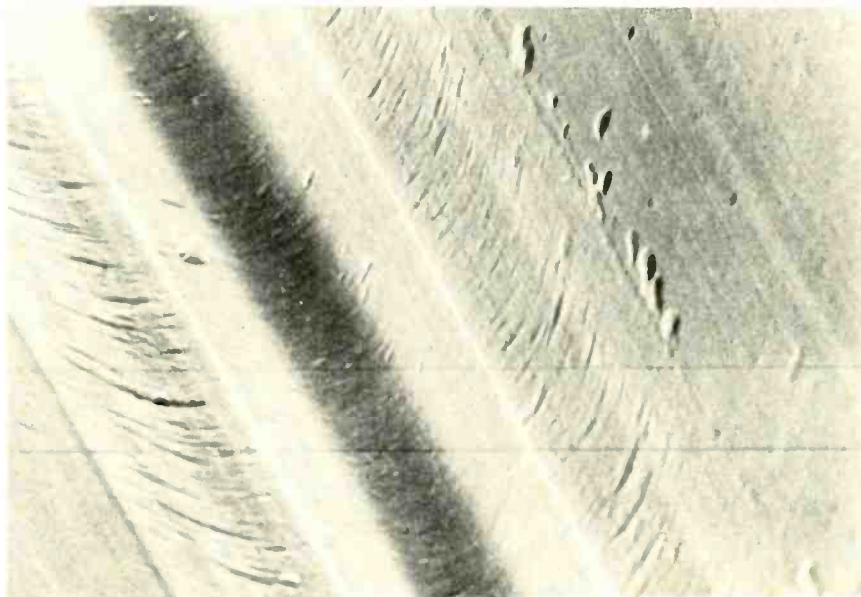


FIG. 8—PERMOSTAT-TREATED record groove after 100 plays.

reduce overall friction between the pick-up stylus and the record groove, thereby reducing record groove wear.

Regardless of the reasons, my results were directly derived from measuring playback performance of treated and untreated disc samples. Stanton's engineers were in a more advantageous position in that they own a scanning electron-beam microscope. The photo of Fig. 7 shows a highly magnified view of a single groove of an untreated record after being played 100 times with an elliptical stylus pickup using a 3-gram vertical tracking force. The serratations or breakup of the groove walls are evident. By contrast, Fig. 8, shows a magnified view of a single groove of a record that has been treated with the new product after 100 playings using the same pickup, stylus shape and vertical tracking force. While some damage to the groove is still visible, it is far less than that seen in Fig. 7. Figures 7 and 8 offer direct proof of reduced mistracking caused by the static charge.

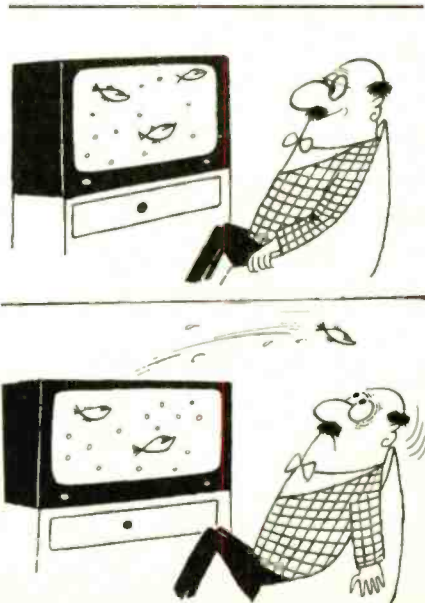
The *Permostat* kit to be offered by Stanton is not inexpensive. It contains a 3-fluid-oz. bottle of fluid, a pump sprayer, a record buffing pad and record identification self-adhesive tabs so that you can identify discs that have been treated. The 3-oz. bottle of fluid is enough to treat both sides of about 25 records, 30 records if you are very careful and don't overuse the material. The complete kit carries a suggested retail price of \$19.95, with refills available for \$15.95. That amounts to about 67 cents-per-disc for the first 30 records, and 53 cents-per-disc once you start using the refills. This may seem a high price to pay for reducing static charges on records if you are a casual record collector and listener. But for many audiophiles who are fussy about their precious records and have been frustrated in their attempts to permanently de-staticize them, *Permostat* may be just what they have been waiting for. **R-E**

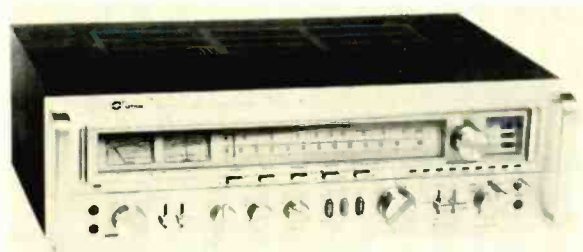
ronment results in an appreciable collection of dust and debris on the disc surface. If such phonograph records are highly charged, it becomes extremely difficult to dislodge the dust. In the case of a record whose charge has been neutralized to zero volts, whatever dust does accumulate can be easily dislodged, often by merely shaking the record before playing or, at worst, by using a properly designed dry brush to lift off the nonadhering dust particles.

Figure 6 shows the *Permostat* treated disc, after their emergence from the dust-chamber test. In the course of the demonstration conducted by Stanton, several pertinent questions were asked regarding the use of *Permostat* with other preparations, such as cleaning liquids and preservatives. We learned that *Permostat* is soluble in water. Thus, if a product such as *Discwasher* were used strictly as a record cleaner after a record had been

treated with *Permostat*, it would "wash off" the *Permostat* solution. The correct procedure would be to use such cleaners first and then treat the record with *Permostat*. The same holds true in applying record preservatives such as *Sound Guard*; apply them first, then apply *Permostat*.

My earlier lab tests led me to the conclusion that applying *Permostat* also reduced record wear in some unknown manner. I reached these conclusions by measuring surface noise and distortion during multiple playback of treated and untreated discs. The reasons for the apparent decrease in record wear are not fully known. Obviously, if less dust is being attracted to the disc, then the stylus is less apt to grind such dust particles into record grooves with repeated playings; that, in and of itself, would reduce record groove wear. Furthermore, it is conceivable that the *Permostat* coating acts to





CIRCLE 106 ON FREE INFORMATION CARD

Setton Model RS-660 Stereo Receiver

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

SETTON INTERNATIONAL, LTD. (60 REMINGTON Blvd., Ronkonkoma, NY 11779) is a relative newcomer to the high-fidelity field. The company's entry into the world hi-fi market has included no less than three receivers, a pair of stereo amplifiers, a separate preamplifier, a tuner, a turntable, a novel car stereo amplifier, and a three-way car speaker. The *model RS-660* stereo receiver is their highest-powered and most expensive model.

This rugged-looking, integrated receiver, shown in Fig. 1, comes with a pair of integral carrying handles and a well-styled, three-dimensional front panel with enough knobs, switches and lights to delight any control-

happy audiophile. The upper section of the panel has a softly illuminated dial area with signal-strength and center-of-channel tuning meters on the left, linearly calibrated FM and conventional AM dial scales in the center, an easy-to-grip tuning knob on the right and a "security panel" arrangement of three indicator lights that warn you when the amplifier is driven into clipping, when output circuits are overheating, or when the protection relay circuits have been activated. At turn-on, all lights illuminate briefly to show that they are working.

Centered just below the dial area are a series of oval-shaped pushbuttons for defeating the

RADIO-ELECTRONICS AUDIO LAB

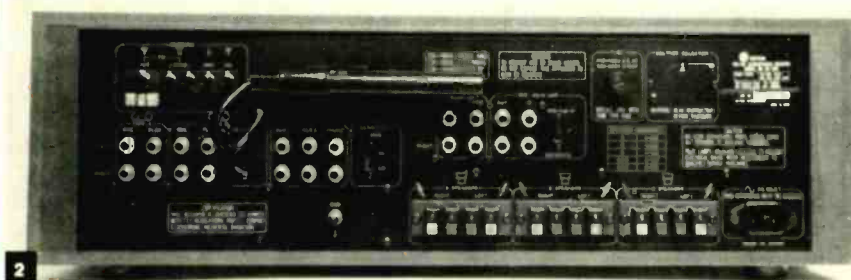
R.E.A.L. SOUND

RATES

SETTON RS-660

EXCELLENT

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MANUFACTURER'S PUBLISHED SPECIFICATIONS:

FM TUNER:

Usable Sensitivity: mono, 10.3 dBf; stereo, 18.0 dBf. **50-dB Quieting:** mono, 16.0 dBf; stereo, 38 dBf. **S/N Ratio:** mono, 72 dB; stereo, 67 dB. **Harmonic Distortion, 1 kHz:** mono, 0.1%; stereo, 0.15%. **Selectivity:** 80 dB. **Capture Ratio:** 1.0 dB. **IF Rejection:** 95 dB. **Image Rejection:** 85dB. **Spurious Rejection:** 100 dB. **Stereo Separation:** 50dB at 1 kHz. **Muting Threshold:** 14 dBf. **Subcarrier Rejection:** 65 dB. **Frequency Response:** 30 Hz to 15 kHz, +0.5, -1.5 dB.

AM TUNER:

Usable Sensitivity: 25 μ V. **Image Rejection:** 60 dB. **Selectivity:** 45 dB. **S/N Ratio:** 45 dB. **Frequency Response:** -6 dB at 2.3 kHz.

AMPLIFIER AND CONTROL:

Power Output: 120 watts-per-channel into 8 ohms, 20 Hz to 20 kHz at 0.035% rated harmonic distortion. **IM Distortion:** 0.035%. **Frequency Response:** phono, N/A; auxiliary inputs, 20 Hz to 20 kHz, ± 0.5 dB. **Damping Factor:** 45. **Input Sensitivity:** phono, 2.5 or 5.0 mV; high level, 150 mV; mike, 6.0 mV. **S/N Ratio:** phono, referenced to 10 mV, "A"-weighted, 85 dB, high-sensitivity position; high level, 90 dB. **Maximum Phono Input Voltage:** high sensitivity, 180 mV. **Bass Control Range:** ± 10 dB at 62 or 125 Hz (depending upon turnover setting). **Treble Control Range:** ± 10 dB at 10 kHz or 20 kHz. **Mid-Range:** ± 6 dB at 1 kHz. **Audio Muting:** -20 dB. **High-Cut Filter:** 7 kHz or 12 kHz (-12 dB-per-octave). **Low-Cut Filter:** 15 Hz or 40 Hz (-12 dB-per-octave).

GENERAL SPECIFICATIONS:

Power Requirements: 110/130/220/240 volts (switchable), 50 to 60 Hz, 450 watts maximum. **Dimensions:** 22.4 W $\times$ 6.7 H $\times$ 13.8 inches D. **Weight:** 37 lb. **Suggested Retail Price:** \$879.95.

tone-control circuits, choosing bass or treble turnover frequencies (250 Hz or 500 Hz for the bass; 2.5 kHz or 5 kHz for the treble), selection of either the mono or the stereo mode, and selecting an external FM/Dolby circuit. An external adapter must be connected for Dolby FM decoding, but pressing the Dolby switch does introduce the required 25- μ s FM de-emphasis. To the right of these pushbuttons are a series of tiny indicator lights that denote program sources and speaker selection as well as stereo FM signal reception and activation of the Dolby FM switch. A matching power-on light is on the extreme left of the front panel.

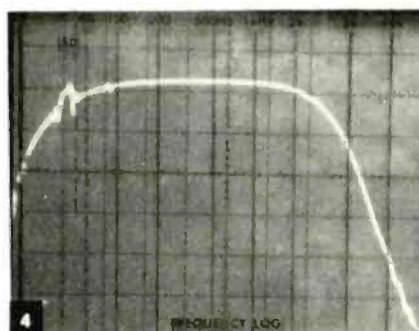
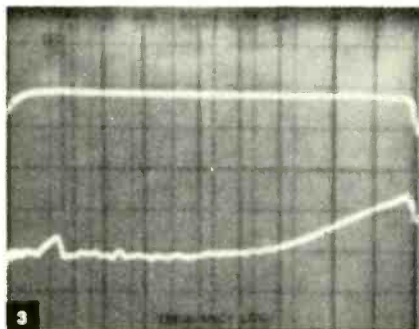
The lower portion of the panel contains two phone jacks; a speaker selector switch (up to three sets of speakers can be connected to the *model RS-660*, with up to two sets operable at one time); two high-cut and low-cut filter lever switches (each filter has two selectable cut-off frequencies); BASS, MID-RANGE and TREBLE detent-stepped tone controls; pushbuttons for FM muting, audio muting and loudness compensation; a dual concentric volume and balance control; lever switches for tape monitoring and dubbing; a program selector switch; and a stereo microphone input jack with a level control.

The rear panel of the *model RS-660*, shown in Fig. 2, contains 300-ohm and 75-ohm FM/AM antenna terminals, just below which are dual pairs of tape-output and tape-input jacks and a DIN connector for the Tape B input and output circuits. Alongside these jacks are the auxiliary (high level) and phono input jacks and a slide switch that varies phono input sensitivity to accommodate a wide variety of cartridges. The Dolby input and output jacks

and preamplifier-output/main amplifier-input jacks are located near the center of the rear panel; below these jacks are the three sets of color-coded speaker terminals. The model RS-660 receiver can be used abroad thanks to a voltage selector switch located behind a cover plate and a separate power-cord receptacle that can accept the different line cords required by each country. An AM-ferrite loopstick antenna and a chassis ground terminal complete the rear-panel layout. Auxiliary equipment that can be used includes three speaker systems, two tape decks and a Dolby adaptor.

FM performance measurements

Table 1 summarizes the measurements made for the FM section of the RS-660 receiver. Although harmonic distortion levels were a bit poorer than claimed at 1 kHz (the published specifications do not include figures for harmonic distortion at the other test points called for by the IHF Tuner Measurement Standards), they were nevertheless quite low and remained low at the more difficult 6-kHz test frequency, with readings of 0.12% for mono and 0.22% for stereo. What's more important, there was no evidence of "beats" when checking the recovered 6-kHz stereo waveforms. Frequency response in stereo FM is shown as the upper trace of Fig. 3, while separation is shown as the difference in dB between the upper and lower traces. Each



vertical division in this scope photo is equal to 10 dB.

Setton is one of the few manufacturers of stereo receivers that is willing to disclose the AM frequency response of their products. As it turns out, although the stated response range is nothing to be proud of, it was somewhat exceeded in our test sample as is shown in the response trace of Fig. 4. The -6-dB rolloff point actually turned out to be 3.0 kHz as opposed to the 2.3 kHz claimed. It should be noted that such limited frequency response range of AM is typical of most of today's stereo "high fidelity" receivers.

TABLE 1
RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: Setton International

Model: RS-660

FM PERFORMANCE MEASUREMENTS

SENSITIVITY, NOISE AND FREEDOM FROM INTERFERENCE	R-E Measurement	R-E Evaluation
IHF sensitivity, mono (μ V) (dBf)	2.0 (11.2)	Very good
Sensitivity, stereo (μ V) (dBf)	4.2 (17.6)	Excellent
50-dB quieting signal, mono (μ V) (dBf)	3.1 (15.0)	Very good
50-dB quieting signal, stereo (μ V) (dBf)	40 (37.2)	Fair
Maximum S/N ratio, mono (dB)	73	Very good
Maximum S/N ratio, stereo (dB)	68	Very good
Capture ratio (dB)	1.0	Excellent
AM suppression (dB)	60	Excellent
Image rejection (dB)	88	Excellent
IF rejection (dB)	95	Superb
Spurious rejection (dB)	100+	Superb
Alternate channel selectivity (dB)	81	Excellent

FIDELITY AND DISTORTION MEASUREMENTS

Frequency response, 50 Hz to 15 kHz ($\pm$ dB)	1.0	Very good
Harmonic distortion, 1 kHz, mono (%)	0.12	Excellent
Harmonic distortion, 1 kHz, stereo (%)	0.18	Very good
Harmonic distortion, 100 Hz, mono (%)	0.14	Excellent
Harmonic distortion, 100 Hz, stereo (%)	0.25	Good
Harmonic distortion, 6 kHz, mono (%)	0.12	Excellent
Harmonic distortion, 6 kHz, stereo (%)	0.22	Very good
Distortion at 50-dB quieting, mono (%)	0.32	Excellent
Distortion at 50-dB quieting, stereo (%)	0.24	Excellent

STEREO PERFORMANCE MEASUREMENTS

Stereo threshold (μ V) (dBf)	2.5 (13.2)	Superb
Separation, 1 kHz (dB)	40	Excellent
Separation, 100 Hz (dB)	42	Superb
Separation, 10 kHz (dB)	30	Very good

MISCELLANEOUS MEASUREMENTS

Muting threshold (μ V) (dBf)	2.5 (13.2)	Excellent
Dial calibration accuracy ($\pm$ kHz at MHz)	Perfect	Superb

EVALUATION OF CONTROLS, DESIGN AND CONSTRUCTION

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

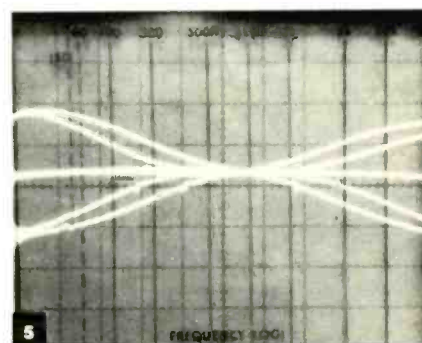
OVERALL FM PERFORMANCE RATING Very good

Amplifier measurements

Results of our amplifier measurements are summarized in Table 2. In general, the power amplifier circuitry exceeded published specifications by a wide margin and might well have been rated at 130 watts-per-channel for its rated harmonic distortion of 0.035%. At its presently rated output of 120 watts-per-channel, mid-frequency harmonic distortion was a very low 0.01% while IM distortion was almost as low, with readings of 0.027%. Dynamic Headroom (per the new IHF Amplifier Measurement Standards) was on the high side, with readings of 1.8 dB. This means that with short-term burst input signals, the amplifier can be expected to reproduce peaks of 180.0 watts without undergoing clipping.

Signal-to-noise and sensitivity measurements shown in Table 2 are in accordance with the new IHF Amplifier Measurement Standards, and will therefore not correlate with this manufacturer's published specifications. The measurements should therefore be judged on their own merits and should be compared with similarly obtained figures for competitive products.

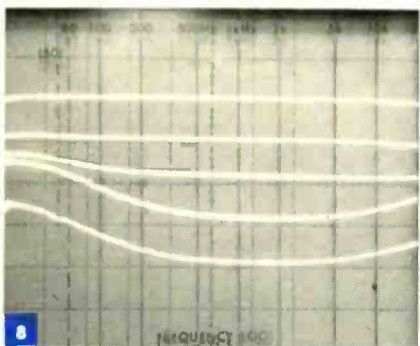
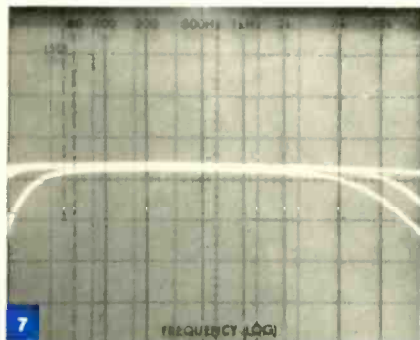
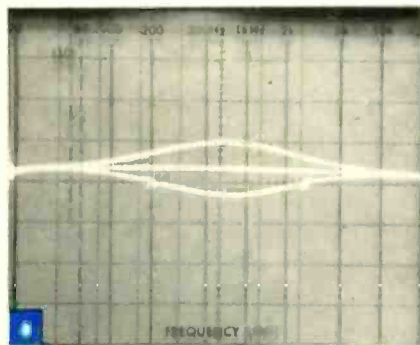
Figure 5 depicts the range of the BASS and TREBLE tone controls when each is set to either of its available turnover frequency points. The availability of these alternate turnover settings



clearly provides increased tone control flexibility that is further augmented by the MID-range tone control whose maximum boost and cut range is shown in the scope photo of Fig. 6.

Figure 7 shows the response of the low-cut and high-cut filters. All slopes are at 12-dB-per-octave as claimed. The scope display does not show the subsonic filter characteristic simply because our frequency sweep on this display extends only from 20 Hz to 20 kHz, whereas the subsonic filter cuts off at 15 kHz. Separate testing disclosed that it, was accurately designed and provides the same 12 dB-per-octave slope below 15 Hz.

Figure 8 is a plot of the action of the loudness compensation circuitry, taken at various settings of the master volume control. Action begins at around 30 dB below the maximum



setting of the volume control and consists primarily of bass boost at that level. At lower settings of the volume control (—40 dB and —50 dB), treble boost is also incorporated, though more moderately than the bass boost.

Summary

Table 3 provides an overall product evaluation of this high-powered receiver from Setton International, as well as our summary comments regarding its performance and ease of use. The RS-660 is, above all else, an extremely flexible and well-thought-out receiver that delivers enough clean power for just about any home high-fidelity requirements. Although physically large, its depth has been kept reasonably short, permitting it to be used on a shelf as well as a table top—something that many high-powered receiver manufacturers seem to ignore these days. For its power output, control features, performance level and overall flexibility, the receiver seems to us to be fairly priced, and its features surpass those of many similarly priced receivers, not to mention separate components costing much more. **R-E**

TABLE 2

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: Setton International

Model: RS-660

AMPLIFIER PERFORMANCE MEASUREMENTS

	R-E Measurement	R-E Evaluation
POWER OUTPUT CAPABILITY		
RMS power/channel, 8-ohms, 1 kHz (watts).....	140.3	Excellent
RMS power/channel, 8-ohms, 20 Hz (watts).....	133.0	Excellent
RMS power/channel, 8-ohms, 20 kHz (watts).....	130.0	Very good
RMS power/channel, 4-ohms, 1 kHz (watts).....	N/A	N/A
RMS power/channel, 4-ohms, 20 Hz (watts).....	N/A	N/A
RMS power/channel, 4-ohms, 20 kHz (watts).....	N/A	N/A
Frequency limits for rated output (Hz-kHz).....	10-55	Superb
Dynamic Headroom (dB).....	1.8	Excellent

DISTORTION MEASUREMENTS

Harmonic distortion at rated output, 1 kHz (%).....	0.01	Superb
Intermodulation distortion, rated output (%).....	0.027	Superb
Harmonic distortion at 1-watt output, 1 kHz (%).....	0.0045	Superb
Intermodulation distortion at 1-watt output (%).....	0.08	Very good

DAMPING FACTOR AT 8 OHMS, 50 HZ	44	Good
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PHONO PREAMPLIFIER MEASUREMENTS

Frequency respons (RIAA $\pm$ dB).....	+0.1 —0.8	Good
Maximum input before overload (mV).....	160	Very good
Hum/noise, "A" -weighted, referenced to 1W or 0.5V output, for 5-mV input (dB).....	77	Excellent

HIGH LEVEL INPUT MEASUREMENTS

Frequency response (Hz-kHz, $\pm$ dB).....	8.5—94, 3.0	Superb
Hum/noise "A" -wt'd, re: 0.5 or 1W out, 0.5V in (dB).....	76	Very good
Residual noise, "A" -wt'd, minimum volume, re 1W out (dB).....	81	Good

TONAL COMPENSATION MEASUREMENTS

Action of bass and treble controls.....	See Fig. 5	Excellent
Action of secondary tone controls.....	See Fig. 6	Very good
Action of high- and low-frequency filters.....	See Fig.7	Excellent

COMPONENT MATCHING MEASUREMENTS

Input sensitivity, phono 1/phono 2, re: 1W or 0.5V out (mV).....	0.22/0.44	Good
Input sensitivity, high level, re: 1W or 0.5V out (mV).....	15	Good
Output level, tape outputs, at rated output (mV).....	150	Good
Output level, headphone jack, at rated output (mV or mW).....	90 mW	Good

EVALUATION OF CONTROLS,

CONSTRUCTION AND DESIGN

Adequacy of program source and monitor switching.....	Excellent
Adequacy of input facilities.....	Excellent
Front panel layout.....	Excellent
Action of controls and switches.....	Excellent
Design and construction.....	Very good
Ease of servicing.....	Good

OVERALL AMPLIFIER PERFORMANCE RATING	Excellent
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TABLE 3

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: Setton International

Model: RS-660

OVERALL PRODUCT ANALYSIS

Retail price.....	\$879.95
Price category.....	High
Price/performance ratio.....	Excellent
Styling and appearance.....	Very good
Sound quality.....	Excellent
Mechanical performance.....	Excellent

Comments: The model RS-660 was obviously designed for the stereo receiver user who desires all of the flexibility of "separates" but has limited installation space and cannot afford the \$1200 to \$1500 that might have to be expended to acquire a separate amp and tuner having equal power capability and features. Not that the RS-660 is in any way miniaturized or compact. It is, very deliberately, a large unit for its rated power output, constructed in an extremely rugged manner, with careful attention paid to a logical layout of the front-panel controls, internal circuit board layout and long-term reliability. Individual components are top-grade. Intermodule wiring is kept to a minimum, and most of the potentiometers and switches on the front panel are directly mounted to their respective circuit boards. The three-way "security" light panel on the face of the receiver is a novel idea that lets the user know that all is well with the internal circuits and even indicates when the amplifier is being driven into clipping levels.

This conservatively rated 120-watt-per-channel receiver is not likely to go into clipping, however, even when driving relatively inefficient speaker systems such as those we used in our extended listening tests of the unit. The amplifier's performance is truly awesome, with reproduced sound extremely transparent and devoid of any audible transient intermodulation distortion, noise or other unwanted sonic coloration. The tuner section, while not quite as "state-of-the-art" as the amplifier and control sections, was nevertheless of high enough quality so that most of our FM listening evaluations were limited by the quality of broadcast signals rather than by any limitations of the tuner circuitry itself.

TELEVISION

Quickie

Course in VCR Video



Although the results are similar, the video signal in the Beta and VHS systems is handled quite differently. Here's a look at the recording and playback video circuitry of these two systems.

FOREST BELT

YOU PROBABLY DO NOT NEED A lengthy discourse about television electronics. But VCR electronics *does* deserve some attention. Video may be video; yet it's not handled the same in video cassette recorders as in TV receivers.

The two popular video cassette formats—VHS and Beta—bear strong similarities, at least in their video. A brief familiarization should carry you through the video electronics in either kind of machine. You will see briefly how a color VCR processes luminance and chrominance signals in preparation for laying them down magnetically on a video tape. None of these processes are really very complicated.

You will note a considerable difference between how chroma is handled and how luminance is handled. They are treated separately, as individual functions, each in its own circuitry.

Chrominance, as it accompanies regular composite video, actually consists of various-phased 3.579545-MHz sidebands signals. For reasons we needn't go into here, it is impractical in video recording to keep the chroma at that frequency.

So conversion stages beat these sidebands down to much lower frequencies. In VHS machines, chroma ends up as 629.36-kHz sidebands. That's the fre-

quency of the color signal that goes to the recording head and is impressed magnetically upon the tape. In Beta systems, conversion brings the chroma sidebands down to 688.362 kHz. In that form, chroma signals are impressed on the tape.

Luminance is handled differently—yet virtually alike in both machine formats. Composite video, minus color information, goes through a certain amount of frequency equalization. This is followed by clipping that prevents sync tips from reaching too far “black” and video from going toward “white” enough to compress or to overmodulate.

Video and sync then frequency-modulate an FM oscillator. The center frequency of the “luminance” oscillator is chosen so that, in VHS equipment, negative-going sync tips swing the frequency down to 3.4 MHz, while maximum video white raises it to 4.4 MHz. Beta systems permit a slightly greater modulation swing—from 3.5 MHz to 4.8 MHz.

These signal-handling techniques are called “color under.” Summing them up: chrominance information goes on the tape as sidebands at 629 kHz or 688 kHz, depending on the VCR's format. Black-and-white video and sync are frequency-modulated, centered at a frequency of around 4 MHz. The exact frequency swing for 100% video modulation depends on the format.

In case you've been wondering, TV sound is not involved in either of these two processes. Sound is brought into the recorder electronics separately, is handled by itself, and then is recorded as one narrow track along the top of the tape. In all these respects, a VCR handles sound just like any audio cassette recorder.

The bottom of the video tape has another narrow track, used to record control pulses. These control signals operate the synchronizing and servo systems during playback.

Beta recording sections

The block diagram of Fig. 1 shows the major sections in a Beta format VCR that deal with luminance, sync and chrominance signals during the Record function. Some very complicated stages and circuits make up these sections. But the interrelationships among the sections are fairly simple.

Sections make a good level at which to start understanding a VCR. With a little study, you should be able to commit this entire diagram to memory. Doing so will greatly speed your thought processes later when you begin troubleshooting or diagnosing electronic malfunctions.

Composite video input signal comes from either a color camera (a monochrome camera omits chrominance) or from a video detector in the tuner/IF section of the VCR. (All consumer VCR's now have tuners and IF stages.)

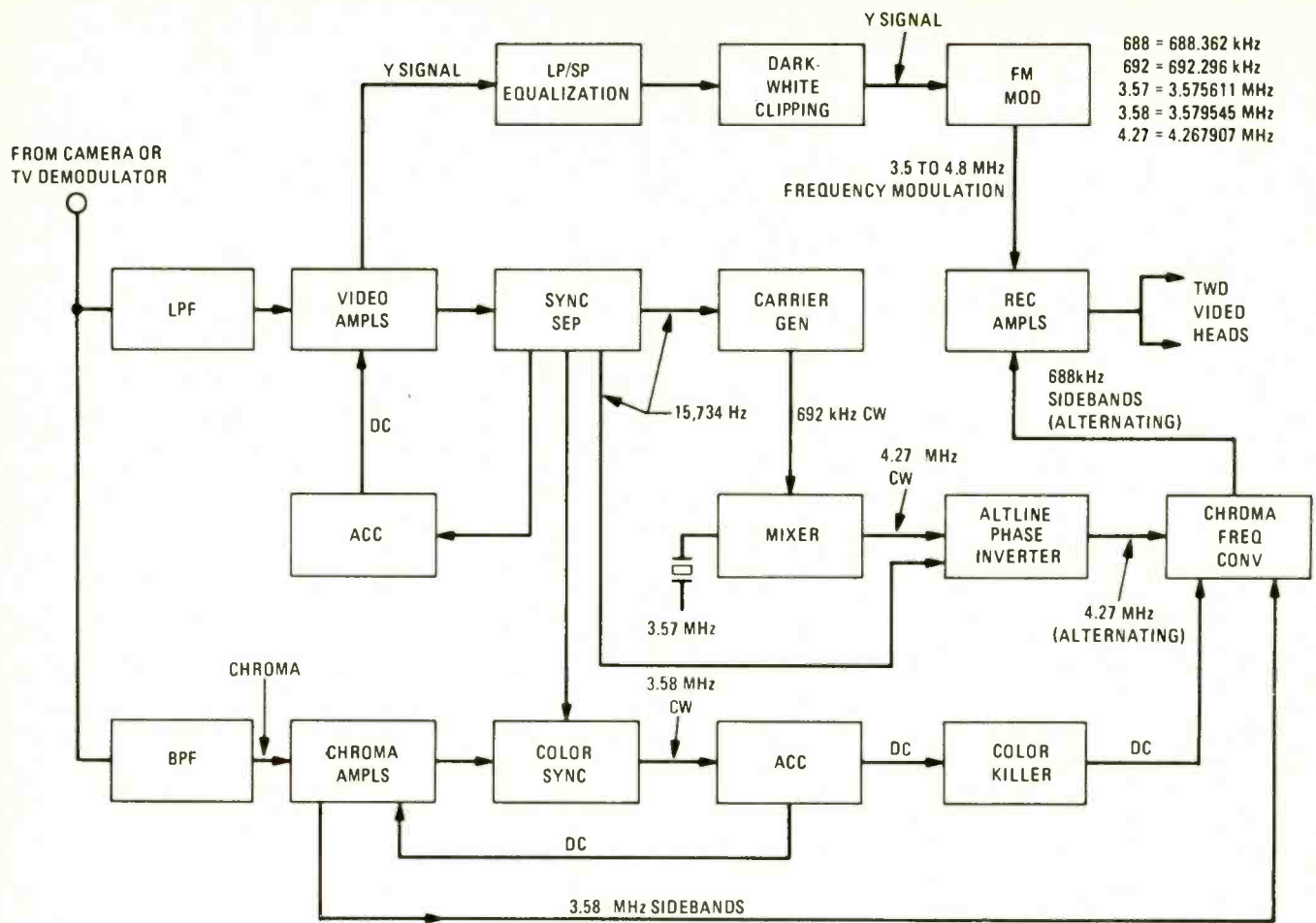


FIG. 1—BETA recording function

A bandpass filter separates out all 3.58-MHz burst and sideband signals and sends them to chroma amplifiers. A low-pass filter blocks the chroma, and sends video and sync signals to the video amplifiers.

Follow the video or luminance signal first since it is the simplest. Video from the video amplifier section goes through some equalization to prepare it for either standard-speed or long-play recording. In two-speed Beta format, this is the 1-hour/2-hour switch. (Long play, with a new 750-foot cassette, now gives 3 hours of Beta recording and playback time.)

A clipping section prevents sync from reaching too far black or the video from going too far white. This leveled luminance signal feeds an FM modulator. The 3.5- to 4.8-MHz FM signal goes to the recording amplifiers and from there to the video recording heads.

The signal back at the video amplifier section also goes to a sync separator. Horizontal sync tips are used in an AGC system that controls gain in the video amplifiers.

The sync separator supplies 15,734-Hz signals to several other sections in the VCR. Instead of dealing with these sections at this point, save your study of each until you see its purpose. For now, just go back and follow what happens to the

3.58-MHz-chrominance (chroma) sidebands and burst signals.

A bandpass filter separates the color signals from the incoming composite signal and feeds them to a chrominance amplifier section. A color sync section recovers the burst. Horizontal sync from the sync separator gates this section only during the burst portion of the chroma signal. The 3.58-MHz burst thus separated out tightly controls a color oscillator inside the section. A phase-locked 3.58-MHz continuous-wave (CW) signal feeds the automatic color control (ACC) section.

A DC voltage goes back from the ACC section to level out the gain of the chroma amplifiers. The ACC also puts out a sensing voltage to the color-killer section. The killer lets a frequency converter operate—or, in absence of a color signal, not operate.

Meanwhile, the chroma amplifier section amplifies 3.58-MHz sidebands. It then feeds them to the chroma frequency converter. There the color sidebands convert to sidebands of a 688-kHz signal.

To understand how this conversion occurs, you must go back to another group of sections. A carrier generator section takes a sample 15,734-Hz sync signal. Inside the carrier section, a control loop phase-locks a VCO at exactly 44 times

the horizontal sync frequency. The output of this section is a signal tightly held at 692.296 kHz.

Next, this CW signal mixes with a crystal-controlled 3.575611-MHz signal in a mixer section. The additive heterodyne of the two makes 4.267907-MHz signal that also is CW (no modulation).

Meanwhile, another part of the signal from the sync separator triggers an alternate-line phase inverter. The entire function of this inverter section is to reverse the phase of the CW signal at intervals that correspond to every alternate horizontal line. The purpose lies in the way chroma signal must be laid down on the tape. Lines fit very closely together. The phase of chroma information is reversed for each line as it is laid down on the tape. This counters crosstalk between adjacent lines.

The inverter section alternately reverses the phase of the 4.27-MHz CW signal that is fed through it. This signal mixes subtractively with the 3.58-MHz chroma sidebands in the chroma frequency converter. In exact megahertz, 4.267907 minus 3.579545 equals 0.688362. The result, therefore, is 688.362-kHz sidebands reversed in phase for every alternate horizontal line.

This 688-kHz color sideband signal

what to expect during playback. Figure 3 shows the playback sections involved in a Beta-format machine. Try to memorize the signal-handling sequence:

The two spinning video heads pick up signals from the diagonal magnetic tracks on the video tape. Timing and positioning of the two heads is taken care of precisely by the control track and by the tape deck's servoelectronics. The heads pick up signals in a precisely synchronized pattern.

First, let's consider recovery of the luminance signal. The 3.5- to 4.8-MHz FM signal comes from the head amplifiers to a section called the *dropout compensator*. Slight oxide flaws in the tape cause specks to be seen during video playback. The compensator senses the dropped-out video and replaces the emptiness with whatever signal just precedes that spot on the line. The result is a more solid picture.

Next, the FM signal is demodulated. Recovered luminance video runs through de-emphasis according to the tape speed that the control track sets the machine to playing. Finally, the luminance (Y signal) goes to a Y-C matrix where it rejoins recovered chroma.

Before you get to the chroma recovery stage, note that the luminance signal at the Y-C matrix also goes to a sync separator section. The horizontal sync

that accompanies the video is needed to control a number of color-recovery stages.

For example, it feeds horizontal sync pulses to the same carrier generator section used for recording. As you recall, the output is a steady 692.296 kHz (this is 44 times the horizontal sync frequency). The CW signal goes to a mixer.



RCA MODEL VCT400

Meanwhile, the sync separator also feeds a signal to a color-sync automatic phase control (APC) section. The output

of the APC section, a 3.579545-MHz signal that is phase-locked to the burst signal from the chroma amplifiers, goes to the mixer.

In the mixer, the 692.296-kHz signal and the 3.579545-MHz signal heterodyne to form a 4.271841-MHz signal. This CW signal goes through an alternate-line phase inverter that is also controlled by the sync separator. The signal phase reverses during the time of every other line. This alternate-line-reversed 4.27-MHz signal is then fed to a frequency-conversion mixer. The same converter receives the 688-kHz color-sideband signal from the head amplifiers.

Remember that the 688-kHz signal was recorded in such a way that alternate lines are in opposite phase on the tape. Therefore, 688-kHz sidebands played back to the conversion mixer change phase every other line. Feeding an alternate-line-inverted 4.27-MHz signal to the frequency converter counters this. The 3.58-MHz signal heterodyned from the converter thus regains its original form. Going to the chroma amplifier are the original 3.58-MHz chroma sidebands.

Any jitter in the chroma signal appears also in burst signals that go to the APC section. An inverse jitter finds its way from the APC section to the frequency converter. This counteracts any tendency

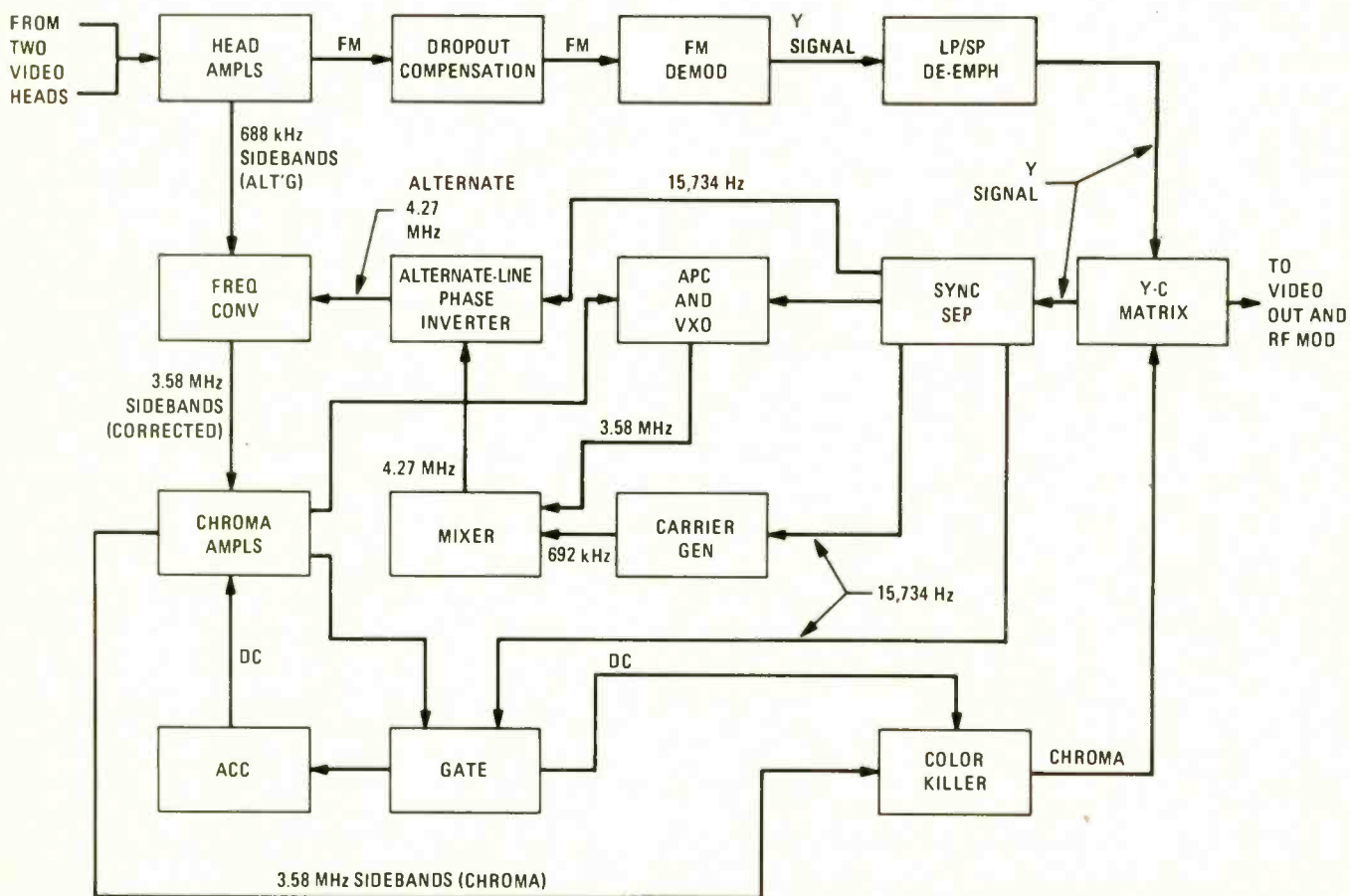


FIG. 3—BETA playback function

PROM PROGRAMMING

Programmable-read-only-memories can perform many logic functions and at the same time reduce circuit complexity. The key to using a PROM, however, is the ability to program it.

A read-only memory (ROM) is a random access memory in which data is mask-programmed during the manufacturing process. A programmable ROM, or PROM, is also a read-only memory; however, memory patterns are programmed into it by the user after manufacture. Read-only memories act as code converters that accept input codes and generate arbitrarily assigned output patterns. They are logically equivalent to truth tables in which the number of input variables equals the number of ROM address inputs and the number of output functions equals the number of ROM outputs. For example, an 8K PROM organized as 1024 x 8 bits implements the truth table for eight functions of ten variables.

Techniques for programming PROMs differ according to the technologies used to implement the devices. Certain types of MOS PROMs (EPROMs) can be erased and reprogrammed, but bipolar TTL PROMs can be programmed only once. In either case, the user can custom-program PROMs and, when necessary, make system changes without facing the substantial mask charges, manufacturing turn-around time, and need to maintain inventories of different patterns that are required by ROMs.

Bipolar TTL PROMs offer access times in the 25 ns to 50 ns range and ECL devices are available with access times in the 10 ns to 20 ns range, while MOS is slower than either type. Although MOS has historically been available in larger bit configurations than bipolar, advances in bipolar memory technology are narrowing the gap. Isoplanar Schottky PROMs, for example, offer densities between those of PMOS

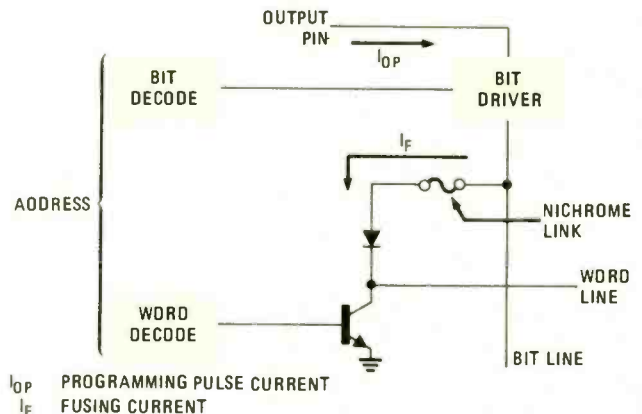


Fig. 1 Programming Current Path

and silicon-gate NMOS. They are also cost- and performance-competitive not only with ROMs, but also with standard TTL on a per-function basis.

Isoplanar Schottky PROMs in various sizes and configurations are available from Fairchild, with high performance guaranteed across both commercial and military temperature ranges. These devices include the 93417/93427 256 x 4-bit, the 93436/93446 512 x 4-bit, the 93438/93448 512 x 8-bit, the 93452/93453 1024 x 4-bit, and the 93450/93451 1024 x 8-bit PROMs. They are completely TTL compatible, include fully decoded addressing, and are available with open-collector or 3-state outputs. A 256 x 4-bit Isoplanar ECL PROM with a typical access time of 11 ns is also available.

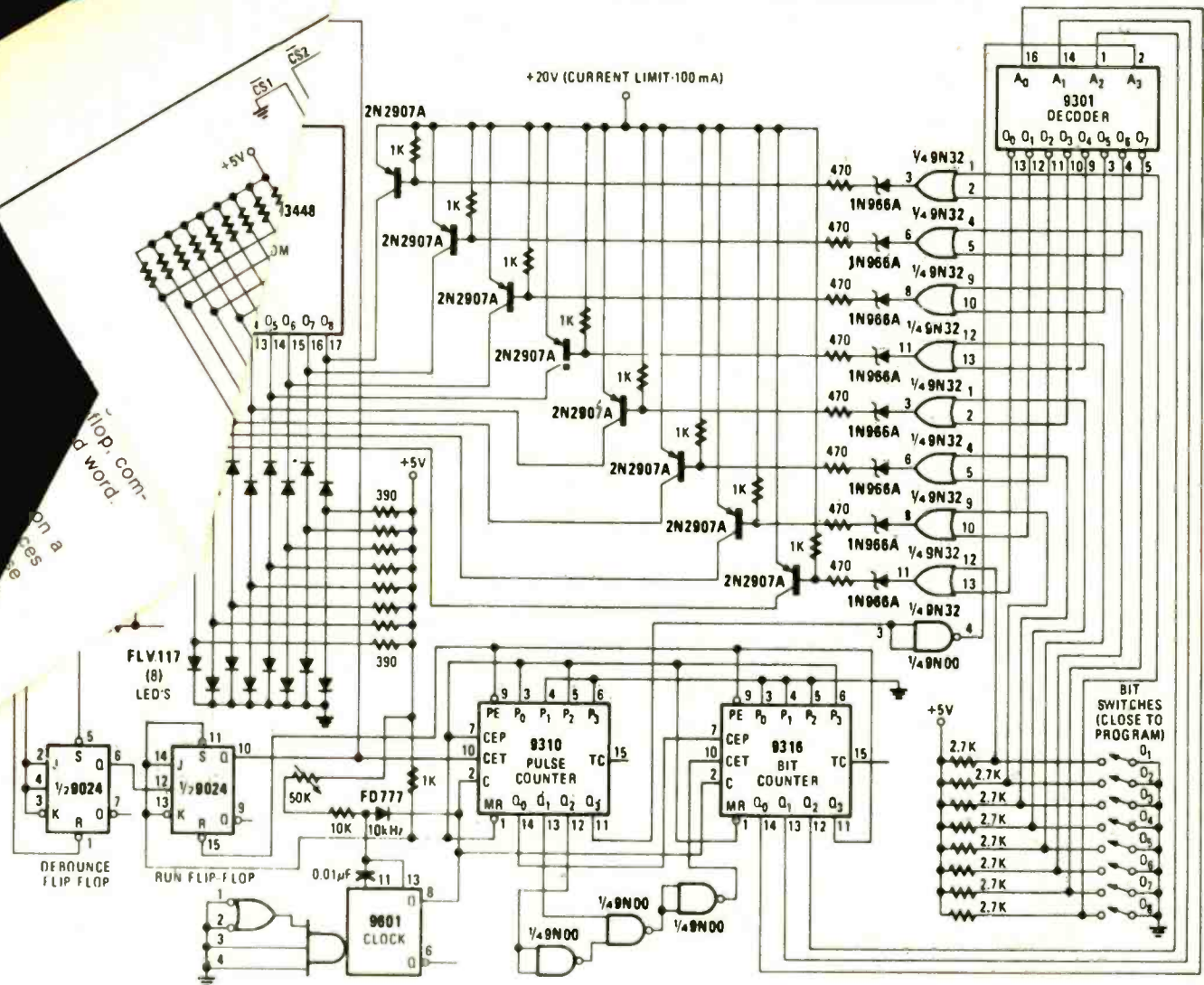


Fig. 2 PROM Programming Circuit

APPLICATIONS

Programmable ROMs are widely used today in microprogrammed computers ranging from the largest mainframe systems to microcomputers. They are also finding increased use as replacements for random logic in peripheral controllers, digital controllers, instruments, and terminals. Circuit applications include fixed data and instruction storage in computers, microprogrammed system control storage, look-up and decision tables, and address and priority mapping. Other applications include character/vector generation, encoding/decoding and sequential controllers. Many of these functions will, in time, be performed by field-programmable logic arrays (FPLAs); because of their large memory capabilities, however, PROMs will remain important elements in mass storage applications.

PROGRAMMING TECHNIQUE

The basic technique for programming a PROM having fusible links is to provide the amount of current necessary to permanently open the link associated with a selected bit, thereby programming the bit to a logic "0" or a logic "1", depending upon the circuit design.

Several materials are used to provide the programmable links within bipolar PROMs, including nichrome, tungsten, titanium, and doped polysilicon. The nichrome fuse link is the most popular because of extensive past experience with this material, high programming yield, and reliability. In Fairchild PROMs, the fuse is a thin-film nichrome link with a small, square notch that concentrates the fusing energy in a central neck during programming, ensuring a wide, clean gap.

Fairchild Isoplanar Schottky TTL PROMs are manufactured with all bits in the HIGH, or logic "1", state. When a programming current pulse (I_{OP}) is applied to an output pin, fusing current (I_F) is driven through the selected bit, as shown in Figure 1. Because of careful device design, almost all of the fusing energy is delivered to the nichrome link, opening the link and programming the bit to a LOW, or logic "0", state. Minimal losses to leakage paths and intermediate circuits permit the link to open rapidly with a low-energy pulse, which improves reliability. The nichrome links actually program on the rise time of the pulse; this permits the reduction of programming pulse width for high-speed, low-energy device programming. Table 1 gives programming specifications for Fairchild PROMs.

PROGRAMMING PROCEDURE

The following steps, performed with reference to *Table 1*, can be used to program one bit at a time:

1. Apply the proper power by supplying $V_{CC} = +5\text{ V}$ and ground.
2. Select the word to be programmed by applying the appropriate levels to the Address pins.
3. Select the chip for programming by disabling the outputs: apply a HIGH to the active LOW Chip Select inputs and a LOW to the active HIGH inputs, if present. All PROMs have active LOW Chip Select inputs; the 93438/93448 512 x 8-bit and 93450/93451 1024 x 8-bit PROMs have active HIGH Chip Select inputs as well.
4. Apply a programming pulse to the output pin associated with the bit to be programmed. The other outputs may be left open or tied to any HIGH. Note that only one output at a time can be programmed.
5. To verify a LOW in the bit just programmed, remove the pulse from the output pin and sense the pin after applying a LOW to the active LOW Chip Selects and a HIGH to the active HIGH Chip Selects, if any.
6. Repeat steps 2 through 5 as necessary for each bit to be programmed.

PROGRAMMERS

Most PROM programming is done with commercially available programmers. An alternative is simpler programmers with manual switches; for example, the circuit shown in *Figure 2*, designed for PROMs having eight outputs, is capable of sequentially programming all bits in words of up to 8-bit length. The address of the word to be programmed is entered by the address switches, and the desired bit pattern for that word is set up on the bit switches. The contents of the PROM at the selected address are displayed on the eight FLV117 LEDs as long as the program switch is open. When the program switch is open, the PROM is enabled and, for every bit in the HIGH state, the associated LED is on; for every bit in the LOW state, the associated LED is off. Closing the program switch disables the chip and all of the LEDs are simultaneously turned on by current supplied through the

390 Ω resistors. The 1N4002 diodes isolate the LEDs from the 21 V programming pulse.

One-half of a 9024 dual in-line package (DIP) switch debouncer, while the other half is used as a switch to initiate programming pulses. When the switch debouncer sets, this clock flip-flop is used as a switch to initiate programming pulses. The pulse counter is a 9601 20% duty factor, and the bit counter is a 9301 20% duty factor. When the chip enable and scan, the bit counter goes from state 3 to state 4. The OR gate is a high-voltage driver to the programming transistors upon closed bit switch. When the last bit has been programmed, the counter presets itself and resets the run flip-flop, completing the programming sequence for the selected word.

BOARD PROGRAMMING

It is often convenient to program PROMs mounted on a circuit board in wired-OR configurations. Fairchild devices are particularly convenient for board programming because only the Chip Select and output pins need to be accessed to program the part. *Figure 3* shows a circuit used for board programming. The programmer is connected to the output bus as shown and the Chip Selects are driven by a decoder with elevated voltage levels. Thus, all that is required for board programming is to raise V_{CC} , V_{EE} , and the Device Select inputs on the decoder to 7.6 V above their normal operating levels. The standard 21 V programming pulse then programs bits in the PROM having an active LOW Chip Select input of approximately 7.8 V, which is high enough to disable the PROM outputs. The following steps are used to program board-mounted PROMs with this circuit:

1. Connect the common output bus of PROMs 0 through n as shown in *Figure 3*.
2. On 93417, 93438, 93450, 93451, 93452, and 93453 PROMs, connect either $\overline{CS}_1$ or $\overline{CS}_2$ to 0V. Connect the other active LOW Chip Select inputs to the active LOW outputs of the TTL decoder.

PARAMETER	SYMBOL	MIN	RECOMMENDED VALUE	MAX	UNITS	COMMENTS
Power Supply Voltage	V_{CC}	4.75	5.0	5.25	V	
Address Input	V_{IH}	2.4	5.0	5.0	V	Do not leave inputs open
	V_{IL}	0	0	0.4	V	
Chip Select	$\overline{CS}_1$ $\overline{CS}_2$	2.4	5.0	5.0	V	Either or both
	CS_3 CS_4	0	0	0.4	V	
Programming Pulse Voltage	V_{OP}	20	21	21	V	Applied to output to be programmed
Programming Pulse Current	I_{OP}			100	mA	If pulse generator is used, set current limit to this max value.
Programming Pulse Width	t_{pw}	0.05	0.18	50	ms	
Programming Pulse Duty Cycle			20	20	%	Maximum duty cycle to maintain $t_c < 85^\circ\text{C}$
Programming Pulse Rise Time	t_r	0.5	1.0	3.0	μs	
Number of Required Pulses		1		4		
Case Temperature			25	85	$^\circ\text{C}$	

Table 1. Programming Specifications

3. On 93436 and 93446 PROMs, connect the Chip Select inputs to the TTL decoder outputs.

4. On 93438, 93448, 93450 and 93451 PROMs, connect the CS₃ and CS₄ inputs to a HIGH or leave them unconnected.

5. To program a bit in one of the PROMs, simultaneously raise the TTL decoder supply voltages to V_{CC} = 12.6 V and V_{EE} = 7.6 V and select the desired PROM via the TTL decoder Address inputs (HIGH = 10.0 V, LOW = 7.6 V).

6. Close the bit switch associated with the bit to be programmed and raise the programming pulse voltage to 21 V. The selected PROM, the active LOW Chip Select input of which is at approximately 7.8 V, programs. The active LOW

Chip Select inputs of all other PROMs are at approximately 10.6 V; these PROMs remain deselected, and do not program.

7. To verify a LOW in the bit just programmed, remove the programming pulse and sense the PROM output bus after simultaneously lowering the TTL decoder supply voltages to V_{CC} = 5.0 V and V_{EE} = 0 V and lowering the TTL decoder Address inputs to their normal levels (HIGH = 2.4 V, LOW = 0.4 V).

8. Repeat the procedure for other bits, following the normal programming sequence.

9. To select a different PROM on the board, change the TTL decoder address.

R-E

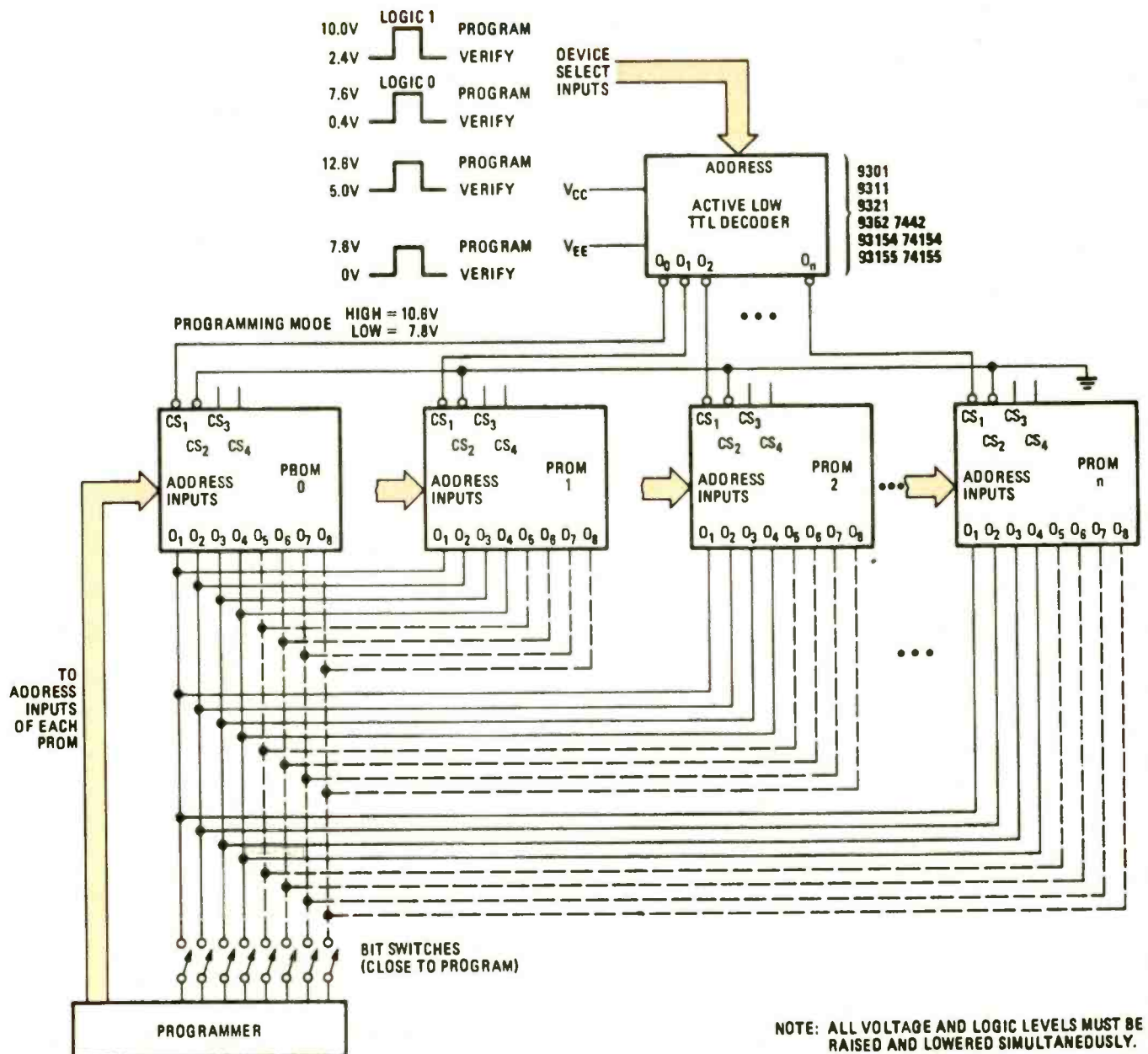


Fig. 3 Board Programming

YOUR SECOND CHANCE

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HOBBY CORNER

The programmable calculator can find many interesting applications in electronics.

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

THIS MONTH WE'RE GOING TO GET AWAY from the usual "how-to" info and talk a bit about an instrument that can be a great help in the "how-to" department. We all own soldering irons, VOM's and so on, but how about the forgotten programmable calculator?

The field of electronics is strange in many ways. Consider, for example, how microcomputers have captured the attention of hobbyists. This is quite understandable since they are awe-inspiring, and some of them can even talk!

However, the rush to microcomputers has overshadowed other electronic developments for many hobbyists; calculators are a case in point. A calculator was considered an impossible achievement just a few short years ago, and now it is practically ignored. I paid \$365 for my first book-sized "four-banger"; nowadays, dealers almost pay you to take them.

Calculators have become so commonplace that I, for one, can't even add $2 + 2$ without punching it out to find the answer. We all know that sophisticated calculators are available for a few tens of dollars. At this point, you may ask, so what? Well, something happened to calculators while you weren't looking.

What happened was the appearance of the scaled-up calculator—or stripped-down microcomputer, depending upon your point of view. The *programmable* calculator fits squarely between the two instruments and does not deserve to be forgotten.

Programmable calculators

Just what is a programmable calculator? It's a smart calculator that can learn; it is a dumb microcomputer that doesn't know the alphabet. If you stick with numbers, there is no limit (almost) to what it can do!

With just a few key-pushes, you can perform complex statistical analyses in a minute or two that would take hours or days on a conventional calculator. A programmable calculator can solve quadratic equations, multiple resistor networks, or inductor/capacitor frequency and impedance problems in *seconds*. It can also play

a variety of games.

A programmable calculator makes it a snap to solve all kinds of involved problems. Equally important, it can perform simple or complex calculations repeatedly just by your punching in new values and then pressing the RUN key. Imagine the trial-and-error time you can save when you substitute values in a filter, for example.

If the programmable calculator doesn't already know how to do a particular job, it learns how just as quickly as you can press the keys. It is a *real* time-saver. As long as you stick with numbers, it performs as well as most microcomputers and better than some. Program it how to figure the bias resistors for one transistor and it will compute three or three hundred more resistors as fast as you can key in the conditions.

Programming it consists of nothing more than pressing a key labeled LEARN and then punching through the operational sequence of the problem. Of course, you should know how to do the problem in the first place. However, if you don't, programmable calculators come preprogrammed and/or with libraries of programs that have been figured out for you.

Let's take a look at several low-cost units that are currently available and find out what they can do for the electronics hobbyist. I have worked with three of these devices. You can find more sophisticated models, but they are definitely designed for mathematicians and engineers. In fact, even the least expensive one has capabilities (and programs) that are way over my head.

The *model TI-58* (Texas Instruments, about \$130), and the *models EC-4000* and *EC-4001* (Radio Shack, \$60.00 and \$40.00, respectively) are three first-rate instruments. The most striking feature about them is that all three come with *books* of instructions.

It isn't that they are that difficult to use. The manufacturers simply don't want to leave *anything* out. They assume you don't know anything about them and proceed from there. In addition to *complete* instructions and numerous exam-

ples, the manuals provide libraries of programs (even the *model EC-4001* comes with 290 programs). If you can read, there is no way to go wrong.

The *model TI-58* has several features not found on the other two. It contains connections for adding a printer. In addition, it incorporates a removable module containing 25 prerecorded programs that can be called up from the keyboard (other modules are also available).

The *TI-58* provides more functions than the other two calculators. It contains 45 keys, 42 of which are dual-purpose, thus actually providing 87 keys. The *model EC-4000* has 40 keys (27 of them are dual-purpose) for a total of 67 keys. The little *model EC-4001* has only 19 keys, but 6 are double, 11 are triple and 1 is a four-purpose key; this gives an effective total of 50 keys.

Actually, the three calculators are much more alike than they are different. They are all battery- or AC-operated; capable of conditional and unconditional branching or looping programs; and can provide regular or scientific notation, log and trig functions, etc.

For an electronics hobbyist, perhaps the most practical difference between them is the number of memories and steps they have available for holding programs. Although they can be varied, the *TI-58* normally has 20 memories and 320 potential program steps; the *EC-4000* has 8 memories and 50 program steps; and the *EC-4001* has 1 memory and 36 steps. In evaluating these figures, don't be misled. The number of *problem* steps to a solution can greatly exceed the maximum number of *program* steps. At first glance, this may seem impossible but it often happens through the proper and normal use of various types of branching. For example, in this manner the *EC-4000* is *not* limited to calculations with 50 or fewer steps.

Overall, it seems unlikely that a hobbyist/experimenter would need the power and capacity of the *model TI-58*. However, if you are a student who is planning to go on to engineering or advanced math studies, the *TI-58* (or better) would be the calculator to choose.

However, don't get the idea that the *EC-4000* and *EC-4001* are toys (remember the latter comes with 290 "canned" programs). These instruments will do

Continued on page 78

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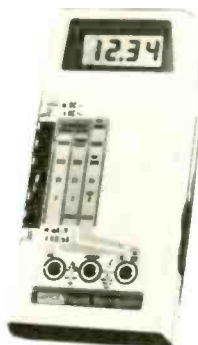
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See Page 24

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HOBBY CORNER

continued from page 76

almost anything an electronics hobbyist, experimenter, ham or CB'er will ever want.

Uses

Now, what can you and I do with a programmable calculator? The general answer is, anything that involves numerical calculations. A programmable calculator operates straight from the keyboard just like any calculator, but its programmability is the factor that makes it pay off. It really comes through whenever you must perform the same calculation more than once.

For example, let's take any game—black jack, dice-toss, number guessing, moon landing, submarine, cannonade, biorhythm, or whatever. In each case you program the calculator to perform the math automatically and display the answer(s). Then, you simply key in your play, press the RUN keys, and the calculator does the rest—over and over as long as you want.

School assignments in math and science are another use. Bank statements, mortgage computations, interest comparisons and discounts are but a few of the business world applications.

In electronics the list of applications is a long one. A few examples are: in filters (power supply, audio, RF, bandpass,

high-pass, low-pass); in networks (resistor, capacitor, inductor, combinations, tuned circuits); in antennas (dimensions, radiation, matching); and in transistor and tube-operating parameters.

Learning to use a programmable calculator provides a hidden advantage. Programming is simpler and easier to learn than for a microcomputer. Yet the principles are the same. If you become proficient in programming a calculator, you will be well ahead when you obtain your first microcomputer.

A hobbyist who builds slavishly from plans or an experimenter who sticks in different parts "just to see what will happen" doesn't need one; it would be only an interesting plaything. If you want to know *why* and *how* things operate, you have to dig a little deeper into circuits and a programmable calculator will help here. If you want to design and/or modify either simple or complex circuits, it can be as useful as meters and solder.

Coming attractions

If you've gotten the idea that I am "anti-microcomputer," it just *ain't* so. To prove it I'm preparing a rundown on a new, inexpensive microcomputer/controller, and we'll discuss it in a future "Hobby Corner."

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communications corner

A new super-loop antenna system for DX'ing the broadcast band and a true SWR meter.

HERB FRIEDMAN, COMMUNICATIONS EDITOR

FOR MANY SWL'S THE REAL ACTION IS DX'ing on the broadcast band. But in today's world, between housing lots 60 X 100 feet or smaller, local ordinances against "transmitting" antennas, and crackpot neighbors who claim any visible wire radiates "emissions" that produce ghostly voices from their teeth, it's almost next to impossible to get up a longwire antenna that can really pull in the DX signals.

But there is a way to electronically boost the weak signals that can be picked up by a loop antenna, and at the same time "tune out" local stations that interfere with the DX. Fact is, with a Palomar Engineers *Loop Antenna System* you can tune your SW receiver to what appears to be a "dead" part of the broadcast band, and then make it spring to life with signals packed from end to end. And if a local broadcast gives you any trouble, you can simply tune it out. Sound fantastic? Well, it really does work. The *Loop Antenna System* consists of two sections that plug together. (See Fig. 1.) The base section contains a tuning capacitor, broadband amplifier, on/off switch, and a 9-volt "transistor" battery. Into the top of the cabinet you plug a loop antenna mounted on an unusually large, oversize, pivoting metal support. The support is calibrated to $\pm 90^\circ$, with 0° representing a horizontal loop position. The entire assembly can also be rotated through 360° , and the top of the cabinet has a 360° compass for reference.

The loop is tuned by the capacitor in the base section, so the circuit consists of a tuned loop followed by a broadband amplifier. The amplifier's output is fed through a short length of coax cable (any type) to your SW receiver.

Obviously, signals received by the loop will be "peaked" when the loop is tuned by the capacitor, and then amplified. What isn't obvious is that the loop is directional in the familiar figure-8 dipole pattern. If the loop is adjusted for maximum sensitivity, signals arriving $\pm 90^\circ$ into the loop are sharply attenuated, so interference with the desired signal can be reduced.

Next, imagine you can hear a weak DX

signal but it's buried under a local broadcast. Now comes magic. Skip signals have no distinct polarization; reflections produce a combined vertical/horizontal wavefront. Groundwave signals, however—such as from a local station—are vertically polarized; there is essentially no horizontal component. By careful adjust-

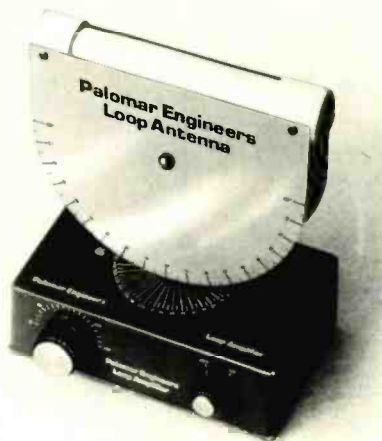


FIG. 1

ment of the rotational position (compass heading) and the tilt of the loop itself, it is possible to almost totally null out a local station. While this might reduce the reception of the DX signal, the signal will still be received if an adjacent or nearby local is sharply or completely nulled out.

So you have two options when it comes to the loop's position: either you can adjust for maximum received signal, or for nulling of local interference. (The null effect is very broad on skywaves—if at all—because of what is effectively dual polarization of the signal caused by sky/ground reflections.)

The broadband amplifier is rated by Palomar Engineers at a nominal 20 dB gain. In comparison with a receiver having a built-in broadcast band loop antenna, the *Loop Antenna System* produced a direct signal improvement of about 15 dB to 35 dB. The extra "gain" is explained by extra sensitivity of the high-Q loop/tuning capacitor circuit in the Palomar Engineer's device.

The only limitation on use of the *Loop*

Antenna System is that the receiver used for broadcast band DX'ing must have external antenna terminals.

Obviously, if you have room, or some way to string a real longwire antenna, the *Loop Antenna System* offers little or no advantage, unless nulling of local signals is an important consideration. And if you have no way to string a longwire, the Palomar system is about the only way to bring a "dead band" to life.

You can get additional information by writing to Palomar Engineers at Box 455, Escondido, CA 92025.

SWR really means power

Though there is some *mystique* concerning SWR (Standing Wave Ratio), it is simply the antenna impedance divided by the transmission line impedance, or vice versa; the values being arbitrarily arranged to produce a value greater than 1. For example, if the antenna is 300 ohms and the line is 50 ohms the SWR is $300 \div 50$ or 6:1 (the "1" being the reference value, and meaning the mismatch is 6:1). If the antenna was 50 ohms and the line 300 ohms we would rearrange the figures so again we get $300 \div 50$, or 6:1. There is no such thing as an SWR less than 1:1; we cannot have $50 \div 300$ or 0.166:1.

Now the antenna to line ratio is all there is to antenna system SWR. There are no other considerations. Unfortunately, there is no convenient way to measure the antenna and line impedance where the two are connected together. Even if we had the instruments, how many of us are willing to climb to the top of a tower, or hang suspended from a wire dipole, to measure the impedance values?

Fortunately, there are other ways to accomplish the same end. If there is a line to antenna mismatch, some of the power fed into the line by the transmitter is not transferred to the antenna: it is *reflected* (Aha!) back towards the input end of the line, setting up standing voltage waves along the line. (There are no standing waves when the line is perfectly matched to the load as all power flows into the load.) It is easy to build a device that will measure the standing wave on the line. The device that measures voltage standing wave ratios is the VSWR meter, which is often mistakenly termed an "SWR meter". Switching is generally

Continued on page 82

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COMMUNICATIONS CORNER

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provided so we can set the *forward* voltage reading to full scale. The *reflected* voltage reading is then read, and a calibrated scale interpolates the meter pointer position into a VSWR or SWR value.

Now Ohms Law tells us that if we know the voltage and impedance values we can calculate current, or power. Fact is, professional forward/reverse indicators are calibrated in power, and the user employs a special chart to calculate SWR values. This might not seem important when you're using a 4-watt CB rig, but imagine a 300 kW TV transmitter with a 2:1 SWR. That's almost 10% of the forward power output, or 30 kW, coming back down the line that's got to go somewhere. Part of it is dissipated as heat in the transmission line; the remainder gets dissipated as heat in the transmitter's output circuit. Given a high enough SWR, you can literally burn up an output stage.

Imagine if you will, a 1 kW amateur radio linear or other final. With a 2:1 SWR you've got about 200 watts coming back down the line. When you think in terms of "200 watts" it becomes a little more unsettling than "a 2:1 SWR". You can afford to lose a little in the way of radiated signal, but can you afford to replace components that might burn up?

It is precisely for this reason that many commercial stations use meters that indicate the forward and reflected power, with the SWR calculated from special charts. To avoid the calculations, some stations employ a dual power meter consisting of two independent meter movements in a single case, with the movements located at each bottom corner. This causes the pointers to cross, and the scale is calibrated in SWR at the crossing location. In fact, the entire central area of the meter is calibrated in SWR so that regardless of the forward and reflected powers, and the meter pointer positions, they will always indicate the correct SWR value.

Formerly limited to commercial installations, the dual-purpose power/SWR meter (which dates back to the 1930's) is now available for amateur and low power commercial use as the DAIWA CN-720, distributed by the J. W. Miller Division of Bell Industries (through your local amateur equipment distributor). Covering the frequency range of 1.8 to 150 MHz, with switch-selected full scale forward power ranges of 1kW, 200 W, and 20 W, and LED indicators visually indicating the selected power range, the CN-720 (and a smaller "junior" version, the CN-710) is designed for 50-ohm antenna systems employing coaxial cable transmission lines. A switch in the rear permits the output of the meter to be directed to the antenna or a dummy load

(I assume for calibration checks).

The photographs illustrate the actual operation of the CN-720 working into a deliberate mismatch producing an SWR of about 2.4:1. In Fig. 2 the transmitter is

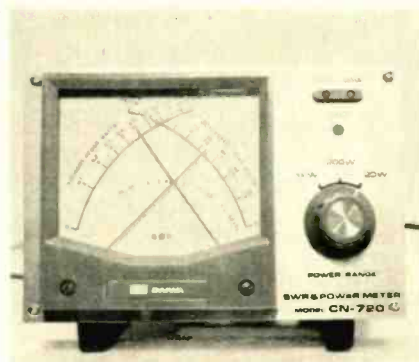


FIG. 1

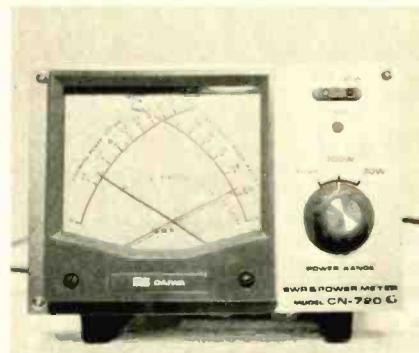


FIG. 2

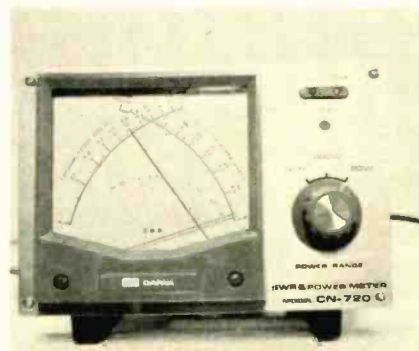


FIG. 3

delivering 10 watts forward power; there are about 1.5 watts reflected power. The pointers cross at about 2.4. In Fig. 3 the meter sensitivity has been upranged and the output power increased. Though the pointers indicate lower on the power scales, they still cross on a "line" representing an SWR of 2.4:1 (don't get confused by the pointers' shadows). Figure 4 shows the transmitter's 10-watt output being fed into an almost perfectly matched antenna system. The pointers now cross at about 1.2:1. Also note the almost unmeasurable reflected power that is causing the "low SWR" pointer crossing.

Best place for additional information on the CN-720 is your local amateur radio equipment distributor. If they can't help you write to the J. W. Miller Div., Bell Industries, 19070 Reyes Ave., Compton, CA. 90224.

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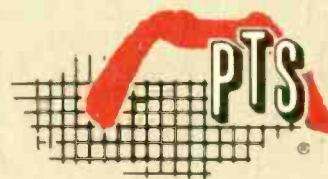
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service clinic

Vertical and convergence oriented problems can often be traced to a single capacitor.

JACK DARR, SERVICE EDITOR

THERE ARE MANY PARTS IN TV SETS THAT cause frequent problems. However, my candidate for the most versatile and infuriating component is an easy winner. I've had problems with it for years, as have other technicians. The infuriating thing about this particular part is its ability to cause so many *different* kinds of problems.

You've probably guessed that I'm talking about the little 50- μ F or 100- μ F electrolytic capacitor found in the cathode circuit of the vertical-output tube of many color tube-type TV sets. Many different makes of sets use this circuit. So we run into problems in lots of sets from different manufacturers—all with the same cause.

Although at first glance this capacitor looks like a stock cathode-bypass capacitor, it really isn't. It has multiple functions, which is why it can cause so many different problems. It does serve as a cathode bypass, and also acts as a coupling capacitor. It feeds the parabolic pulses developed by this cathode circuit over into the convergence circuits.

So now we have the opportunity for all kinds of problems. If this "little monster" goes bad it can cause poor vertical linearity; loss of height; severe misconvergence; and in some cases a complete loss of convergence, and so on and on.

The actual problems depend on the type of defect. When they first appeared, low-voltage electrolytic capacitors weren't all that reliable. If the capacitor opens, this causes a complete loss of convergence. If it shorts, it upsets the impedance in the vertical-output cathode and results in loss of height, linearity or both. If the capacitor develops a high-power factor, this can cause many different troubles. If this happens you can't fix it by the old method of bridging it with a good capacitor! In all cases the surest method is to take the capacitor out and put in a new unit.

Very poor convergence or convergence drift can be due to leakage in the capacitor, to a high-power factor, or to many other causes. One quick check is to use a scope to display the waveform on the cathode. Normally, this waveform will be from 30–35 volts P-P with a parabolic

shape that has the sharp points facing up. Follow this waveform through the capacitor to make sure that the signal is getting to the convergence board undistorted and with correct amplitude.

Reader Tom Davenport (Bellevue, OH) informs me that he had an RCA model CTC-63 with a terrible convergence problem. The picture was so far distorted that a vertical line pattern looked like a bunch of letter "C's" of different colors facing in opposite directions. The set's controls had no effect at all. He cured it by replacing this electrolytic capacitor; it was evidently completely open.

In many cases, I've told technicians to look for this capacitor to service and check it, and they couldn't find it! It is usually located on the chassis near the vertical-output tube; in quite a few sets it is mounted on the convergence board! If you trace the circuit from the convergence board back to the vertical-output cathode, you'll find that it's in the usual place.

Finally, there is always a chance that the capacitor can be an intermittent! This can really run you up the wall unless you think of it. Intermittent loss of convergence or convergence drift can be a real headache. Always check or replace the electrolytic capacitor if you run into this problem. There's only one other component that can cause this, and I've seen it in only three sets: it's a thermal-convergence diode unit. It doesn't take long to check; just squirt coolant on it when the problem shows up. (Incidentally, this little component can also be thermal and go bad when it gets warmed up.) Most often however an electrolytic is the culprit since these capacitors love to develop intermittents when the contact between the terminal tab and the foil roll oxidizes or loosens up.

This problem has been showing up ever since the development of the dry electrolytic capacitor way back in the year 5! (In the year 1, electrolytics were wet and about the size of a quart of oil. Had a nasty habit of getting the vent stopped up and exploding.)

To repeat, this is one of those oddball things that can be very simple to trouble-

shoot if you remember and so very hard when you forget! So, any weird problems that crop up anywhere in either the vertical or convergence circuitry, check out this capacitor. This may solve your whole problem.

R-E

service questions

NO HIGH VOLTAGE, SOUND OK

This Sylvania model E40-3 plays for about 30 minutes, then loses the high voltage. The sound is still OK. After many tests, I found that pulling the high-voltage limiter, Q402, let the set work. When the high voltage goes, the +125-volt supply jumps to +185 volts. I then played the set for five hours with limiter Q402 removed. There were no apparent ill effects! However, I don't want to send it back like this. Any help would be appreciated.—C.L., Whitehall, PA.

Apparently, when the +120-volt line goes up, this triggers high-voltage shutdown. From the voltages you show, this is what's happening (the high voltage is controlled by regulating the DC supply voltage).

Check the +120-volt supply regulator, Q412, and its circuitry. Try plugging the set into a variable-voltage line transformer, and bringing the line up until the +120-volt line shows exactly +120. In the fault condition, see if the high-voltage adjust control is working. This control varies the bias on the base of Q410 and *should* control high voltage by setting the +120-volt supply to the right value.

(Feedback: "Bingo! Regulator Q412 was leaky! I put a new regulator in; the set works perfectly!")

OHMMETER CAN TEST SCR'S

Several readers have written to ask if an SCR can be tested with an ohmmeter the same way that transistors can. Trying this test out showed that you can use an ohmmeter, at least with smaller SCR's. First, measure the SCR from the anode to the cathode. This should show an open circuit in both directions. Now, connect the positive lead of the ohmmeter to the anode and short the gate terminal to the anode. This should turn the SCR on. The larger SCR's won't latch on but will conduct when the gate is shorted to the anode.

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new products

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AUTOMATIC DIAL PHONE, Freedom Dialer, replaces a conventional phone. In addition to providing 32-number automatic dialing capability, the unit features an LED clock, elapsed timer,



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month/date calendar and phone-number reminder. Also included are separate pushbuttons for dialing police and fire emergency numbers, plus an automatic redial function. Suggested retail price: \$199.95.—Royce Electronics, 1746 Levee Rd., North Kansas City, MI 64116.

DIGITAL POWER SUPPLY, model DG-1, can be used to substitute voltages in TV's, stereo systems, radios, computers, CB's, and many other electronic devices. The voltage meter provides a



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0.05% accuracy and indicates to 0.1 volt. The unit is housed in a choice of walnut, black or blue vinyl. Dealer net price: \$114.95.—PTS Electronics, Inc., Box 272, Bloomington, IN 47401.

12-MHZ SINGLE- AND DUAL-TRACE SCOPES, model 1021A, 1022A, are mini-sized instruments. Both units (model 1022A shown) have a rectangular CRT and internal graticule with 8 X 10-division display area. Unit specifications: a 5 mV-per-division vertical sensitivity; display modes such as Channels 1 and 2, chopped, alternate and X-Y (model 1022A only); a continuously variable sweep speed from 100 ns-per-division to 100 ms-per-division; X10 magnification; 36-ns

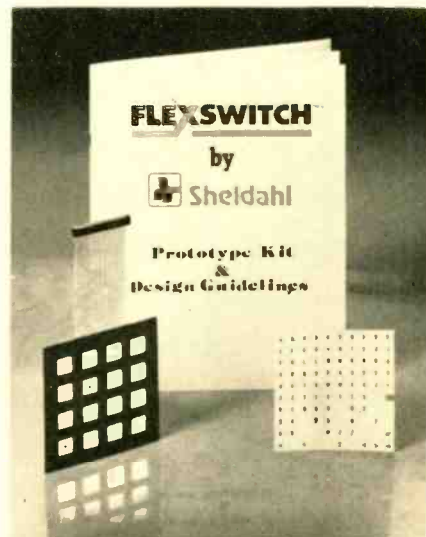
risetime; $\pm 3\%$ accuracy; internal and external triggering. Both units measure 8 W X 7 1/4 D X 3 1/2 inches H; weigh approximately 5 lbs., and operate on 10-16 VDC at less than 1A. Both models come with probes, X10/X1 feature, 115 VAC adapter,



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operator's manual, with other optional accessories available. Prices: model 1022A, \$785; model 1021A, \$595.—Ballantine Laboratories, Inc., P.O. 97, Boonton, NJ 07005.

FLAT SWITCHING PANEL KIT, Flexswitch, is a 16-position, nontactile switching control panel that can be trimmed to a 2- to 16-key water- and dust-resistant keyboard. Pressure-sensitive adhesive on panel back and press-on characters



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provide flexibility in control panel design. When ordering, specify short-to-ground or crosspoint circuit. Comes with 8- or 17-position circuit connector, depending on circuit chosen. Price: Flexswitch, \$10 postpaid by cash or check (no purchase orders).—Sheldahl, Inc., Dept. FSCP, Box 170, Northfield, MN 55057.

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TEMP. STABILITY: .09 PPM/C° (± 1 PPM
20° to 40° typ.)

GATE TIMES: Selectable — 1.0 second
0.1 second

RESOLUTION: 1 Hz - 10 Hz to 20 MHz
10 Hz - 10 MHz to 60 MHz
100 Hz - 10 MHz to 600 MHz (Prescaled)

INPUT IMPEDANCE: 60 MHz - 1 Meg shunted
by 20 pf
600 MHz - 50 ohm

INPUT PROTECTION: Direct input —
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communications products

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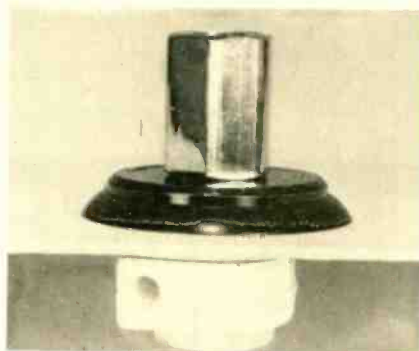
MOBILE SCANNING RECEIVER, model SX-100, suitable for both mobile and home-base operation, is keyboard-programmable—most-used frequencies are entered into 16-channel memory for pushbutton retrieval. Other features include



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variable-speed scan-delay control; seek function to tune to and lock into next programmed channel; digital clock; volume and squelch controls; built-in speaker; and AC/DC operation. List price: \$489.95.—**J.I.L.**, Dept. P, 737 West Artesia, Compton, CA 90220.

CB ANTENNA MOUNT, model 142, model 143, model 144. The model 142 is a heavy-duty roof mount designed for mobile applications. Made of chrome-plated brass, mount accepts any 1/4-inch



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base antenna and fits a 1/4-inch mounting hole. The model 143 is a flat ball-mount bracket, and the model 144 is a flat bracket bent 90° for vertical installation. Brackets accept most ball-type mounts and are corrosion-resistant. Suggested retail prices: model 142, \$5; model 143, \$7.50; model 144, \$8.—**Valor Enterprises, Inc.**, 185 W. Hamilton St., West Milton, OH 45383.

SSB CB BASE TRANSCEIVER, model SB-5400, is a microprocessor-controlled transceiver that provides 5 programmable channel memories, automatic 2-speed 2-mode channel scanning (240 ms-per-channel, or 2 seconds-per-channel), and

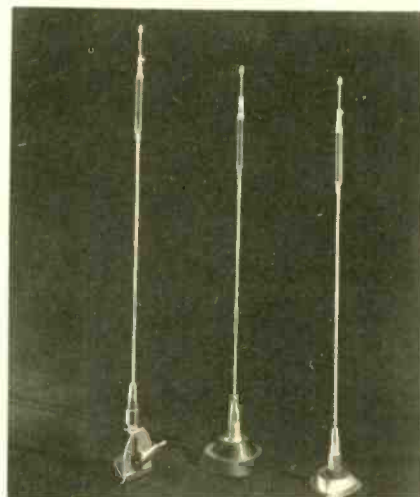
15-pushbutton keyboard. The model SB-5400 also features PLL synthesizer, LED readout, 4-digit LED clock, signal-strength and SWR meters, 40 AM/80 SSB channels, 4 operational modes (AM, USB, LSB, PA), 4-watt AM output, 12-watt PEP SSB, and 100% modulation. Dual-MOSFET receiver has 0.5-μV AM and 0.3-μV SSB sensitivity and -70 dB adjacent channel rejection. Other controls include dual clarifiers, noise blanker and



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limiter, volume, squelch, RF gain, mike gain, SWR calibrate, and speaker and power switches. Built-in power supply provides 12 VDC or 117 VAC operation. Unit comes in simulated woodgrain vinyl-clad aluminum, and carries a list price of \$529.95.—**Robyn International, Inc.**, Northland Dr., P.O. Box 478, Rockford, MI 49341.

MOBILE ANTENNAS, Monitennas, is a line of mobile, four-band scanning antennas that operate on low- or high-VHF and two UHF bands. Each antenna is 24 inches high, is constructed of stainless steel and brass, comes with hermetical-



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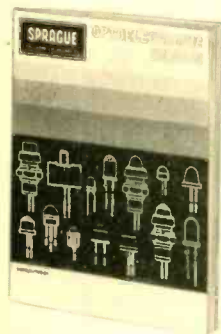
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books

THE "COMPULATOR" BOOK—Building Super Calculators & Minicomputer Hardware with Calculator Chips, by R. P. Haviland. TAB Books, Blue Ridge Summit, PA 17214. 322 pp. 3 X 8 1/2 in. Softcover, \$7.95; hardcover, \$10.95.

This is a step-by-step guide to using calculator IC's to create more efficient calculators with sophisticated functions. All projects have been tested and include easy-to-follow instructions and circuit drawings. Some of the projects teach you how to create a computer interface for log and trig functions, an electronic lock, a Teletype interface, plus how to make giant displays, keep running totals, and many more. Other chapter topics include IC logic levels and voltage requirements, how keyboards operate and how digits are multiplexed. Chapter 10 contains instructions on how to build a tape-controlled calculator, interfacing the calculator circuit to a Teletype terminal.

THE CMOS DESIGNERS' PRIMER AND HANDBOOK, Second Edition, by Robert M. Glorioso and Jack Streater. E&L Instruments, Inc., 61 First St., Derby, CT 06418. 290 pp. 6 X 9 in. Softcover, \$8.50.

This book is an expanded and revised guide to CMOS circuit design geared to engineers, hobbyists and designers. The introductory chapters outline and describe various basic CMOS devices and how to use them. A chapter on "How to Use CMOS Logic" covers power requirements, input protection, TTL interfacing and other topics. Other chapters include data on op-amps and microprocessors, and the reader has an opportunity to perform several experiments. The back of the book contains appendixes of characteristics and pinouts for more than 100 devices, plus a glossary of terms.

AN INTRODUCTION TO MICROCOMPUTERS, VOLUME II, SOME REAL PRODUCTS, by Adam Osborne, with Susanna Jacobson and Jerry Kane. Adam Osborne & Associates, Inc., P. O. Box 2036, Berkeley, CA 94702. 1208 pp. 5 1/2 X 8 in. Softcover, \$15.

This book is the companion volume to *An Introduction to Microcomputers, Volume I, Basic Concepts*, and deals with actual LSI circuits. Covered in this book are such devices as the 8080A, 8085, 8048, MC6800, Z80, 9440, MCS6500, PACE and SC/MP microprocessors. Only instruction set summaries are included, no actual programming descriptions. Each instruction set has two tables, with its own set of symbols, used for those tables alone. A short benchmark program is given to illustrate each program set and the text is augmented by many schematics and tables.

SEMICONDUCTOR REFERENCE AND APPLICATION HANDBOOK No. 276-4002. Radio Shack, Tandy Corp., 1400 One Tandy Center, Fort Worth, TX 76102. 144 pp. 8 1/2 X 11 pp. Softcover \$1.95.

This book contains replacement listings for over 46,000 transistors, diodes and other interchangeable devices. Data and schematic diagrams are also included on such IC's as counters, BCD decoders, op-amps, flip-flops, etc.; there is also a full description (plus schematic) of the 8080A microprocessor CPU. Other sections deal with soldering, case dimensions, and transistor testing; and a glossary of words and expressions is included in the back.

R-E

PC BOARDS

continued from page 53

minimal must have its own hole. The circuit board can have one of two types of holes (or even both types at extra cost)—plated-through and nonplated-through holes. The nonplated-through holes of course will not conduct from one side of the board to the other. These holes are drilled after plating (and quite often after etching). Plated-through holes are drilled before plating; during plating, a reliable interconnection is deposited between the layers on the inside walls of the hole. Since most hobbyists do not have the equipment to plate their own boards, we will only discuss nonplated-through holes.

A nonplated-through hole should be drilled using the following equation:

$$D_{\min} = L_{\max} + T_{\min}$$

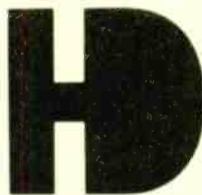
where $D_{\min}$ is the minimum hole diameter, $L_{\max}$ is the maximum lead diameter, and $T_{\min}$ is the tolerance of the drill. Always choose the next larger standard drill size if the calculated diameter falls between two sizes. The largest hole should never be over 20 mils greater in diameter than the lead to be inserted in it.

Summary

Although this article has contained a good many facts and equations, PC de-

sign does not have to be quite so formal. After you've worked with various materials and designed a few systems, you'll develop a certain intuitive expertise. This will reduce the amount of data required during design. Regardless of how the information is used, the procedure outlined in this article should be used if your design is to have any measure of reliability. R-E

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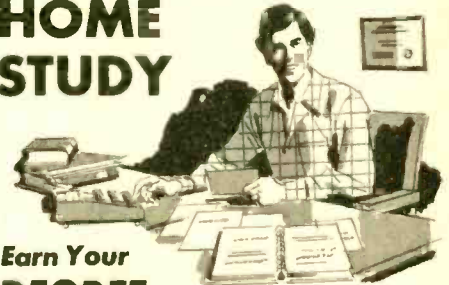
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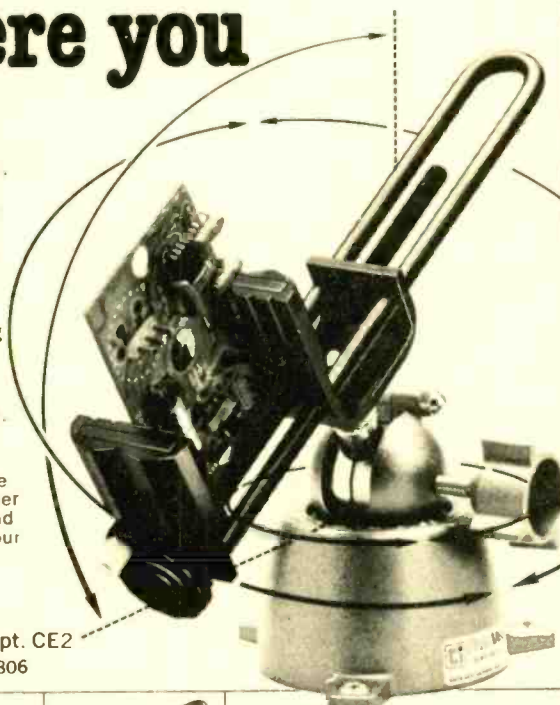
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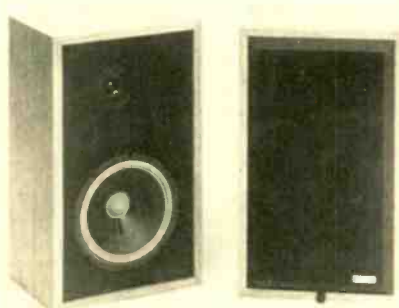


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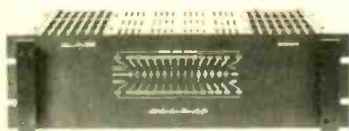
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watt power-handling capacity; sensitivity, 91.5 dB at 1 meter with a 1-watt "pink noise" input. The model CL 2 comes housed in either an oak or walnut-grain cabinet, with black or brown front-grille panel. It measures 23 1/4" H X 14" W X 10 1/2" D. Suggested retail price, \$139.—**KLH Research & Development Corp.**, 145 University Ave., Westwood, MA 02090.

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protection, signal relays, overload protection, and LED indicators to monitor power output. Suggested retail price: \$700.—**Scientific Audio Electronics, Inc.**, 701 E. Macy St., Los Angeles, CA 90012.

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ter, 0.045%. The model M-T01 comes in a gold finish enclosure. Suggested retail price: \$560.—**Mitsubishi**, Melco Sales, Inc., 3030 E. Victoria St., Compton, CA 90221.

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5683R	1.2	.15	.98dia x .275	.68
5684R	1.2	.22	1.36 dia x .207	.78
5682R	1.2	.22	1.36 dia x .308	.88
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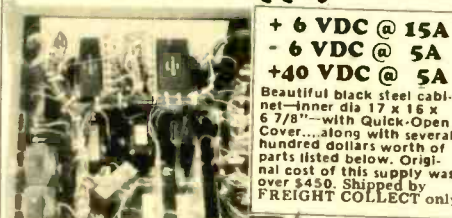
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- 1pc. 40V adjustable 6-position Double Cam Switch
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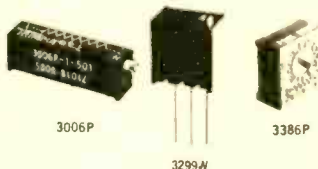
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P = Printed Circuit Pins (flat mounting)
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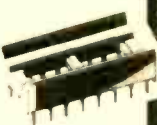


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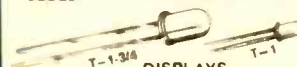
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**TA-1000 KIT
\$51.95**
Power
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X'FORMER



PROFESSIONAL FM WIRELESS MICROPHONE

TCT model WEM-16 is a factory assembled FM wireless microphone powered by an AA size battery. Transmits in the range of 88-108MHz with 3 transistor circuits and an omni-directional electric condenser. Element built-in plastic tube type case; mike is 6 1/4" long. With a standard FM radio, can be heard anywhere on a one-acre lot; sound quality was judged very good. **\$16.50**



sanwa



- COMPACT —
- LIGHTWEIGHT —
- ULTRASLIM —
- BATTERY CHECKER
- LED TESTER —
- T-55D (w/o temp probe) **\$44.50**
- T-55THD (temp probe) **\$66.50**

SPECIFICATIONS:

Range:
DC Voltage: 150mV, 500mV, 1.5V, 5V, 15V, 50V, 250V, 1kV IAL
20k Ω/V
25kV Ω/V (temp probe)
DC Current: 50 μA , 2.5mA, 25mA, 250mA (500mV drop)
AC Voltage: 15V, 50V, 500V (50 Ω/V)
AC Current: 6mA, 6A (2V and 50mV drop)
Resistance: 10k Ω , 100k Ω , 1M Ω , 5M Ω (max. calibr.)
100 Ω , 1k Ω , 10k Ω , 50k Ω (mid scale)
Load Current: 30mA, 3mA, 300mA
Load Voltage: 3V, 3V, 3V
Decibels: -10 to +55dB
Batt Check: 0.9 to 1.5V (10 Ω load) (available)
LED Check: (available)
Temperature: 50 to +100°C and 0 to +200°C (Probe not supplied with T-55D)

Accuracy:
DC Voltage: $\pm 2.5\%$ f.s.d.
DC Current: $\pm 2.5\%$ f.s.d.
Batt Check: $\pm 2.5\%$ f.s.d.
AC Voltage/Power on 1.5V range: $\pm 5\%$ f.s.d.
AC Voltage/Power above 1.5V range: $\pm 3.5\%$ f.s.d.
AC Current: $\pm 5\%$ f.s.d.
Resistance/Temperature: $\pm 3\%$ of arc
Dimensions:
146 x 97 x 28 mm thick
Weight: 240g
Instrument supplied with Batteries 1.5V (UM-3 or R6) x2
Fuse & Spare: 500mA, 250V
Fuse & Spare: 500mA, 250V
Temperature/Temperature: $\pm 3\%$ of arc

HICKOK LX303

DIGITAL LCD MULTIMETER

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

CALL FOR OUR DISCOUNTED PRICE



60W + 60W



COMPLETED UNIT—NOT A KIT!

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

Assembled \$49.50 ea.
\$ 8.50 ea.

Power transformer



POWER TRANSFORMER \$6.50 EACH

30W + 30W STEREO HYBRID AMPLIFIER KIT

It works in 12V D.C. as well! Kit includes 1 PC SANYO STK-043 stereo power amp. IC LM 1458 as pre amp, all other electronic parts, PC Board, all control pots and special heat sink for hybrid. Power transformer not included. It produces ultra hi-fi output up to 60 watts (30 watts per channel) yet gives out less than 0.1% total harmonic distortion between 100Mz and 10KHz. **\$32.50 PER KIT**

MARK IV 18 STEPS LED POWER LEVEL INDICATOR KIT

This new stereo level indicator kit consists of 36 4-color LED (18 per channel) to indicate the sound level output of your amplifier from -36dB ~ +3dB. Comes with a well-designed silk screen printed plastic panel and has a selector switch to allow floating or gradual output indicating. Power supply is 6 ~ 12V D.C. with THG on board input sensitivity controls. This unit can work with any amplifier from 1W to 200W!

Kit includes 70 pcs. driver transistors, 36 pcs. matched 4-color LED, all other electronic components, PC board and front panel.



MARK IV KIT \$31.50

JUMBO 1" LED ALARM CLOCK MODULE

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



Red Display
\$8.50 each
Green Display
\$10.50 each
Transformer \$1.75

SUPER 15 WATT AUDIO AMP KIT

Uses STK-015 Hybrid Power Amp

Kit includes: STK-015 Hybrid IC, power supply with power transformer, front AMP with tone control, all electronic parts as well as PC Board. Less than 0.5% harmonic distortion at full power 1/2dB response from 20—100,000 Hz. This amplifier has QUASI—Complementary class B output. Output max is watt (10 watt RMS) at 4Ω.

ONLY \$23.50 each

REGULATED DUAL VOLTAGE SUPPLY KIT

±4 ~ 30V DC 800 MA adjustable, fully regulated by Fairchild 78MG and 79MG voltage regulator I.C. Kit includes all electronic parts, filter capacitors, I.C., heat sinks and P.C. board.

\$12.50 PER KIT

MANY SOUND DECISIONS!

Solid state sound indicator operating voltage 6V DC 30μA. Small size approximately 1/4" x 1 1/4". Model EB2116 (Continuous) Model EB2126 (Slow Pulse) Model EB2136 (Fast Pulse)

\$3.60 EACH



1Watt AUDIO AMP

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

"FISHER" 30 WATT STEREO AMP

MAIN AMP (15W x 2)

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

Super Buy Only \$18.50

5W AUDIO AMP KIT

2 LM 380 with Volume Control Power Supply 6 ~ 18V DC ONLY \$6.00 EACH

WE FOUND THE CASE FOR THE FM MIC!

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

VERY SPECIAL PRICE 2 for \$4.99

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

ELECTRONIC ALARM SIREN

COMPLETE UNIT

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

SOUND ACTIVATED SWITCH

All parts completed on a PC Board. SCR will turn on relay for buzzer or trigger other circuit for 2 ~ 10 sec. (adjustable) Ideal for use as door alarm, sound controlled toys and many other projects. Supply voltage 4.5V ~ 9V D.C. \$1.75 ea./2 for \$3.00

LINEAR SLIDE POT

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

Rechargeable NI-CD Batteries Pak 6AA NI-CD in a flat pack gives you a total of 7.2V 450MA output \$5.25 PER PACK

BATTERY POWERED FLUORESCENT LANTERN

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

\$10.50 EACH MODEL 888 R

PROFESSIONAL CASE

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

ONLY \$21.50 EA.



CASE 030

POWER SUPPLY KIT



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

12V DC MINI RELAY

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



SUB-MINI SIZE SPDT RELAY

Ideal for use in mini circuits, contact rated at 1amp 125V A.C. Coil resistance 300Ω, standard 0.1" lead spacing allows it to plug into a 14 pin I.C. socket!

12V DC type \$2.50 ea.
5V DC type \$3.50 ea.

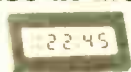


ULTRA SONIC SWITCH KIT

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

\$15.50

LCD CLOCK MODULE !



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

NIC1200 \$24.50 EA.

I.C. TEST CLIPS

Same as the E 2 clips With 20" Long Leads In Black and Red Colors \$2.75 per pair



BECKMAN FET LIQUID CRYSTAL DISPLAY

Overall size 2" x 1.2" 0-5" characters reflective type

88:88

737-01

88:88

739-04

88:88

739-03

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

Model 739-04 — for panel meter 4 digits.

Model 739-03 — for panel meter 3 1/2 digits with ± sign and over range indicator.

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

Your choice—any model **\$7.50 EACH**

FLUORESCENT LIGHT DRIVER KIT

12V DC POWERED Lights up 8 ~ 15 Watt Fluorescent Light Tubes Ideal for camper, outdoor Auto or Boat



Kit includes high voltage coil, power transistor, heat sink, all other electronic parts and PC Board, light tube not included! WITH CASE ONLY \$6.50 PER KIT

MINI-SIZED I.C. AM RADIO

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

Only \$10.50



SOUND GENERATOR I.C.

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

T176477

Sub Mini Size PANEL METER 500 U.A. ONLY \$1.20 ea

ELECTRONIC SWITCH KIT CONDENSER TYPE Touch On Touch Off uses 7431 IC and 12V relay \$5.50 each

TRANSFORMERS ALL 117 VOLT INPUT
30V 4AMP \$7.50 EA.
36V CT 3AMP \$8.50 EA.
48V CT 3AMP \$8.50 EA.
24V CT 3AMP \$8.50 EA.
12V CT 0.5AMP \$1.80 EA.
12V CT 0.5AMP \$1.80 EA.
12V CT 120MA \$1.25 EA.

AC POWER SUPPLY Wall Type Transformer
12V AC Output 200MA \$2.75 EA.
16V CT AC Output 100MA \$2.10 EA.
6V DC Output 120MA \$1.90 EA.
12V DC Output 100MA \$1.90 EA.

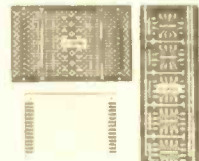
PROFESSIONAL PANEL METERS

A. 0-50UA 8.50 ea
B. 0-30VDC 8.50 ea
C. 0-50VDC 8.50 ea
D. 0-3ADC 9.00 ea
E. 0-100VDC 9.00 ea
TYPE MU-52E ALL METERS WHITE FACE WITH BLACK SCALES, PLASTIC COVER.

HEAVY DUTY CLIP LEADS

10 pairs — 5 colors Alligator clips on a 22" long lead. Ideal \$2.20/pack for any testing.

UNIVERSAL PROTOBOARDS "CIRCUIT FIT"



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

H-5612	3 1/2" x 6"	1.70
H-5616	3 1/2" x 6"	1.70
H-5606	2 1/2" x 6"	1.50
H-5602	2 1/2" x 6"	1.50

GIANT SIZE VU METER

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

\$8.50 Each

PUSH-BUTTON SWITCH

N/Open Contact Color Red, White, Blue, Green, Black. 3/\$1.00 N/Close also Available 50c ea. LARGE QTY. AVAILABLE

FORMULA INTERNATIONAL INC.

9/79

	SHIPPING AND HANDLING CHARGES	
	Under \$50.00 purchase	Over \$50.00 purchase
Inside California	10%	10%
Outside Calif. (includes Mexico & Canada)	15%	20%
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Send \$1.00 For Detailed Catalogue



IS RADIO CONTROL YOUR HOBBY?

Then here's the perfect opportunity to make your hobby your job. Mattel, the world's foremost toy manufacturer, is seeking enterprising people with experience in radio control systems, including linear experience up to 100Mhz. Selected applicants will work with the most advanced technology in radio control today.

Degree in Electronics or Electrical Engineering is preferred. Start putting your skills and knowledge to work in an exciting new job - send us a resume or letter detailing your background and capabilities to:

Dennis Marchand
Dept. RE

MATTEL ELECTRONICS

5150 Rosecrans Ave.
Hawthorne, CA 90250

Equal Opportunity Employer

HOUSE MARKED DARLINGTON TRANSISTOR
15 AMPS 60 VOLTS
150 WATTS
Specify NPN or PNP
\$1.50 each

HEAVY DUTY 12 VOLT RELAY
• Clear Plastic Enclosed
• 3 PDI
• 12 Amp Contacts
\$3.00 each

10 MEG POTS
• Standard 1/4 Watt Size
• 3/8" Long Shaft
4 for \$1.00

SPRITE COOLING FAN
• Used But Fully Tested
• 115 vac 9 watts
• 3 1/8" x 3 1/8" x 1 5/8"
\$8.00 each

MAGNETICALLY ACTUATED SWITCH
• N.O. V/Magnet Engaged
• Installs in 1/8" Hole
• Magnet Included
75c each

ALCO MINATURE SWITCH
• S.P.D.I.
• 6 amps @ 125 volts
\$1.15 each

HOUSE MARKED DARLINGTON POWER TRANSISTOR
SPECIFY 5 AMPS 65 WATTS
80 VOLTS
SIMILAR TO TIP 121 PNP
TIP 126 PNP T0270
75c each

INDOOR-OUTDOOR PAGING HORNS
• 8" SIZE/30 WATTS \$24.95
• 6" SIZE/15 WATTS \$17.95
• 5" SIZE/5 WATTS \$6.50

SPECIAL SALE
1000 MFD 16VDC
4 for \$1.00

P.N.P. GER. TRANSISTOR
2N1038 TO -39
40 volts 8 amps 20 watts
\$1.00 each

ALLIED CONTROL
Miniature P.C. Relay
• 4PDT
• 12 VDC @ 960 MW
• 150 ohms \$2.50 each

MALLORY COMPUTER GRADE
150,000 MFD 15VDC
• 3 Dia 5 High
• 18V Surge \$3.50 each

ALL ELECTRONICS CORP.

SEND FOR OUR FREE FLIER

905 S. Vermont Ave.
Los Angeles, CA 90006
(213) 380-8000

Store & Warehouse Hours
9 AM - 5 PM
Monday thru Friday

- Quantities Limited
- Min. Order \$5.00
- Add \$1.50 Shipping USA
- Calif. Res. Add 6%
- Same Day Shipping with Cert. Check or M/O

CIRCLE 42 ON FREE INFORMATION CARD

MORE SALE.

Part of preparing for the Fall is making room for a bunch of new products, so we're clearing out some of our inventory at reduced prices. Limited quantities.

MA1003 CLOCK MODULE \$10.50 \$13.20

20% off our very best clock module. Internal crystal timebase, fluorescent readouts that don't wash out, simple assembly just add 2 time-set switches and +12V DC, much more. Perfect for car, mobile use (documentation included). Matching case with mounting hardware & optical filter. add \$5.95.

16K MEMORY EXPANSION CHIP SET \$109 \$87.20

20% off one of our all-time best sellers. For Radio Shack-80, Exidy Sorcerer, Apple computers. 250 ns access time, low power parts, DIP shunts included, 1 year limited warranty, and easy-to-follow instructions that make memory expansion a snap.

WE BREAK THE 1c/BYTE BARRIER!!

We're offering low power 21L02 1K static memory chips, guaranteed to run with any 2 MHz system, at the very low price of 10c/59.90...that's under 1c per byte! Stock up now, we can't predict how much longer we'll have the last of these prime parts available for sale.

TERMS: Calif. add tax. Orders under \$15 add \$1 handling. Allow 5% shipping, excess refunded. VISA/Mastercharge call 24 hr order desk at (415) 562-0636. COD OK with street address for UPS.

GODBOUT

BILL GODBOUT ELECTRONICS
BOX 2355, OAKLAND AIRPORT, CA 94614

FREE FLYER: We have what you're looking for, and it's worth your while to send for our flyer. Just give us your name and address, we'll take care of the rest. For 1st class mail, include 4c in stamps.

CIRCLE 48 ON FREE INFORMATION CARD

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1001	22	4023	22	4069	45	74C93	1	75	
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4007	27	4025	22	4072	35	74C157	1	75	
4009	45	4027	45	4518	00	74C160	1	70	
4010	45	4028	20	4520	00	74C165	1	75	
4011	22	4029	35	74C09	27	74C112	1	70	
4012	22	4030	35	74C02	27	74C114	1	70	
1013	40	4035	97	74C08	30	74C115	1	70	
4014	120	4044	85	74C10	27	74C901	1	50	
4015	100	4042	85	74C10	27	74C901	1	50	
4016	45	4049	75	74C47	90	74C902	50		
4017	105	4050	45	74C23	75	74C914	1	90	
4018	30	4051	110	74C74	50				
4019	45	4053	110	74C83	130				
4020	110	4065	125	74C86	50				
4021	110	4066	70	74C90	95				
4022	100								
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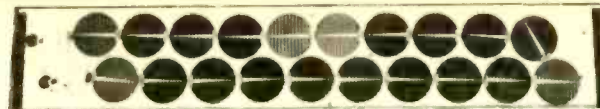
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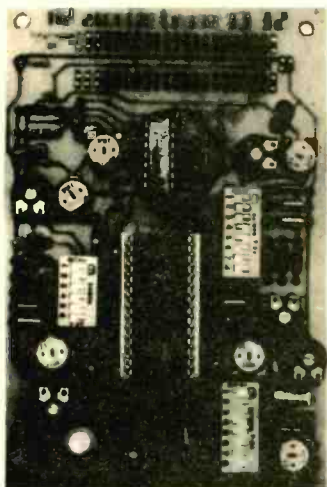
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2SA 483	2.00	2.20	2.50	2SB 367	1.10	1.25	1.40	2SC 696	1.00	1.20	1.30	2SC 1237	1.80	2.00	2.25	2SD 235	60	70	80
2SA 484	1.50	1.75	1.95	2SB 368B	1.80	2.00	2.25	2SC 708	1.30	1.45	1.60	2SC 1239	2.20	2.70	2.90	2SD 261	35	40	45
2SA 485	1.40	1.60	1.80	2SB 379	70	80	90	2SC 710	20	27	30	2SC 1279	50	55	60	2SD 287	2.50	2.70	2.90
2SA 489	1.10	1.25	1.40	2SB 381	30	35	40	2SC 711	20	27	30	2SC 1306	1.30	1.45	1.60	2SD 300	4.50	5.00	5.60
2SA 490	70	80	90	2SB 400	30	35	40	2SC 712	20	27	30	2SC 1307	1.90	2.10	2.40	2SD 313	60	70	80
2SA 493	45	53	59	2SB 405	30	35	40	2SC 715	30	35	40	2SC 1310	20	27	30	2SD 315	60	70	80
2SA 495	30	35	40	2SB 407	80	90	1.00	2SC 717	35	40	45	2SC 1312	20	27	30	2SD 325	60	70	80
2SA 496	50	64	70	2SB 415	30	35	40	2SC 727	1.00	1.20	1.30	2SC 1313G	20	27	30	2SD 330	60	70	80
2SA 497	1.00	1.20	1.30	2SB 434	80	90	1.00	2SC 730	3.00	3.20	3.40	2SC 1316	4.20	4.40	4.90	2SD 350	3.80	4.00	4.40
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2SA 509	30	35	40	2SB 440	40	53	59	2SC 732	20	27	30	2SC 1318	35	40	45	2SD 381	85	1.00	1.10
2SA 525	50	64	70	2SB 449	1.30	1.45	1.60	2SC 733	20	27	30	2SC 1325A	6.50	6.90	7.60	2SD 424	3.80	4.00	4.40
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2SA 537A	1.50	1.70	1.90	2SB 463	90	1.10	1.20	2SC 735	20	27	30	2SC 1330	50	55	60	2SD 426	3.10	3.30	3.60
2SA 539	40	45	50	2SB 471	1.10	1.25	1.40	2SC 738	20	27	30	2SC 1335	50	55	60	2SD 427	1.80	2.00	2.25
2SA 545	45	53	59	2SB 472	2.10	2.50	2.80	2SC 756	1.50	1.80	2.00	2SC 1342	45	53	59	2SD 525	90	1.10	1.20
2SA 561	30	35	40	2SB 473	80	90	1.00	2SC 756A	1.50	1.80	2.00	2SC 1344	45	53	59	2SD 526	60	70	80
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2SA 564A	20	27	30	2SB 481	90	1.10	1.20	2SC 772	30	35	40	2SC 1359	30	35	40	3SK 22V	1.40	1.60	1.80
2SA 565	70	80	90	2SB 492	60	70	80	2SC 773	35	40	45	2SC 1360	50	55	60	3SK 39	90	1.10	1.20
2SA 566	2.50	2.70	3.00	2SB 507	80	90	1.00	2SC 774	1.00	1.20	1.30	2SC 1362	35	40	45	3SK 40	90	1.10	1.20
2SA 606	1.00	1.20	1.30	2SB 509	1.10	1.20	1.30	2SC 775	1.40	1.60	1.80	2SC 1364	35	40	45	3SK 41	1.30	1.45	1.60
2SA 607	1.10	1.25	1.40	2SB 511	70	80	90	2SC 776	2.00	2.20	2.50	2SC 1377	3.20	3.40	3.70	3SK 45	1.30	1.45	1.60
2SA 624	70	80	90	2SB 514	70	80	90	2SC 777	3.00	3.25	3.50	2SC 1383	30	35	40	AN 203	1.40	1.60	1.80
2SA 627	3.10	3.30	3.60	2SB 523	70	80	90	2SC 778	2.90	3.20	3.40	2SC 1384	35	40	45	AN 214Q	1.50	1.70	1.90
2SA 628	30	35	40	2SB 526C	70	80	90	2SC 781	1.90	2.10	2.40	2SC 1396	45	53	59	AN 239	4.20	4.40	4.90
2SA 634	40	45	50	2SB 527	70	80	90	2SC 783	2.10	2.50	2.80	2SC 1398	70	80	90	AN 247	2.50	2.70	3.00
2SA 640	30	35	40	2SB 528D	70	80	90	2SC 784	30	35	40	2SC 1400	35	40	45	AN 274	1.50	1.75	1.95
2SA 642	30	35	40	2SB 529	70	80	90	2SC 785	35	40	45	2SC 1402	3.00	3.20	3.40	AN 313	3.00	3.20	3.40
2SA 643	30	40	45	2SB 530	3.20	3.40	3.70	2SC 789	80	90	1.00	2SC 1403	3.20	3.40	3.70	AN 315	1.80	2.00	2.25
2SA 653	1.90	2.10	2.40	2SB 531	1.80	2.00	2.25	2SC 790	80	90	1.00	2SC 1407	50	55	60	BA 511A	1.80	2.00	2.25
2SA 659	35	40	45	2SB 536	1.00	1.20	1.30	2SC 793	2.00	2.20	2.50	2SC 1419	60	70	80	BA 521	1.90	2.10	2.40
2SA 661	50	64	70	2SB 537	1.00	1.20	1.30	2SC 799	2.00	2.20	2.50	2SC 1444	1.60	1.80	2.00	HA 1151	1.50	1.75	1.95
2SA 663	3.65	3.80	4.20	2SB 538	3.20	3.40	3.70	2SC 828	20	27	30	2SC 1445	2.50	2.70	2.90	HA 1156W	1.60	1.80	2.00
2SA 666	35	40	45	2SC 840	3.20	3.40	3.70	2SC 829	20	27	30	2SC 1447	60	70	80	HA 1306W	2.00	2.20	2.50
2SA 671	80	90	1.00	2SB 554	5.00	6.00	6.60	2SC 830H	2.50	2.70	3.00	2SC 1448	70	80	90	HA 1339	2.50	2.70	3.00
2SA 672	30	35	40	2SB 556	3.20	3.40	3.70	2SC 838	35	40	45	2SC 1449	60	70	80	HA 1339A	2.50	2.70	3.00
2SA 673	35	40	45	2SB 557	2.10	2.50	2.80	2SC 839	30	35	40	2SC 1451	1.00	1.10	1.20	HA 1342A	2.50	2.70	3.00
2SA 678	35	40	45	2SB 561B	35	40	45	2SC 853	70	80	90	2SC 1454	3.20	3.40	3.70	HA 1366W	2.50	2.70	3.00
2SA 679	4.20	4.40	4.90	2SB 564	40	53	59	2SC 867	3.20	3.40	3.70	2SC 1475	80	90	1.00	HA 1366WR	2.50	2.70	3.00
2SA 680	4.20	4.40	4.90	2SB 565	1.10	1.40	1.50	2SC 867A	3.20	3.40	3.70	2SC 1478	50	55	60	LA 4031P	1.80	2.00	2.25
2SA 682	80	90	1.00	2SB 596	1.10	1.40	1.50	2SC 870	35	40	45	2SC 1509	50	55	60	LA 4032P	1.80	2.00	2.25
2SA 683	30	35	40	2SB 600	5.00	6.00	6.60	2SC 871	35	40	45	2SC 1567	60	70	80	LA 4051P	1.80	2.00	2.25
2SA 684	35	40	45	2SC 183	40	53	59	2SC 895	4.20	4.40	4.90	2SC 1567A	60	70	80	LA 4400	1.90	2.10	2.40
2SA 695	40	53	59	2SC 184	40	53	59	2SC 897	2.00	2.20	2.50	2SC 1584	6.00	6.30	7.00	LA 4400Y	2.00	2.20	2.50
2SA 697	40	53	59	2SC 281	30	35	40	2SC 898	2.50	2.70	3.00	2SC 1586	6.50	6.90	7.60	LA 4420	2.00	2.20	2.50
2SA 699A	50	64	70	2SC 282	40	53	59	2SC 901	20	27	30	2SC 1594	60	70	80	LD 3001	2.00	2.20	2.50
2SA 705	40	53	59	2SC 284	80	90	1.00	2SC 923	20	27	30	2SC 1626	60	70	80	MS 1513L	2.00	2.20	2.50
2SA 706	85	1.00	1.10	2SC 317	40	53	59	2SC 929	20	27	30	2SC 1628	60	70	80	STK 011	3.80	4.00	4.40
2SA 715	60	70	80	2SC 352A	2.00	2.20	2.50	2SC 930	20	27	30	2SC 1647	70	80	90	STK 013	7.60	8.00	8.80
2SA 719	30	35	40	2SC 353A	1.40	1.60	1.80	2SC 941	20	27	30	2SC 1667	3.00	3.20	3.40	STK 015	4.20	4.40	4.90
2SA 720	30	35	40	2SC 367	60	70	80	2SC 943	35	40	45	2SC 1669	90	1.00	1.10	STK 435	4.50	5.00	5.60
2SA 721	30	35	40	2SC 369	30	35	40	2SC 945	20	27	30	2SC 1674	30	35	40	STK 437	7.90	8.00	8.80
2SA 725	30	35	40	2SC 372	20	27	30	2SC 959	1.00	1.20	1.30	2SC 1675	20	27	30	TA 7045M	2.00	2.20	2.50
2SA 726	30	35	40	2SC 371	30	35	40	2SC 971	70	80	90	2SC 1678	1.10	1.25	1.40	TA 7055P	2.00	2.20	2.50
2SA 733	20	27	30	2SC 372	20	27	30	2SC 982	70	80	90	2SC 1679	3.00	3.20	3.40	TA 7061AP	90	1.10	1.20
2SA 738	40	53	59	2SC 373	20	27	30	2SC 983	50	64	70	2SC 1681	30	35	40	TA 7062P	1.10	1.25	1.40
2SA 740	1.50	1.70	1.90	2SC 374	30	35	40	2SC 1000	35	40	45	2SC 1682	30	35	40	TA 7203P	2.50	2.70	2.90
2SA 743A	85	1.00	1.10	2SC 375	30	35	40	2SC 1012	1.20	1.40	1.50	2SC 1684	30	35	40	TA 7204P	2.00	2.20	2.50
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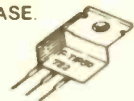
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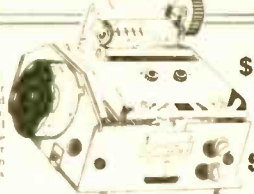
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30-WIRE NUTS, twist-on's, for 20-24 gauge wire. (#3724)	1.29	60 for 1.30
2-ALUM. HEAT SINKS, 2 3/4" x 3", for power tabs. Innumerable uses. (#5338)	1.29	4 for 1.30
1-MICRO MINI" METER, 1 1/2" dia., 0-1 scale movement. (#5858)	1.29	4 for 1.30
2-DOUBLE-SIDED PC BOARDS, 3 1/2" x 12", high quality G-10 glass. (#5694)	1.29	4 for 1.30
60-TUBULAR CAPACITORS, ass'd 100mfd to 1mf to 600 WVDC. (#35A219)	1.29	120 for 1.30
6-MICRO MINI REED SWITCHES, 1 1/2" long, for alarms, relays, etc. (#1258)	1.29	12 for 1.30
10-TANTALUM ELECTRODS, ass'd mini, axial, hermetically sealed. (#5048)	1.29	20 for 1.30
60-DISC TYPE CAPS, incl. NPO, hi-Q, mylar, ceramics, ass'd values. (#437)	1.29	120 for 1.30
60-COILS & CHOKES, ass'd RF, OSC, IF, parasitic types. (#35A297)	1.29	120 for 1.30
10-SWITCHCRAFT PHONO JACKS, hi-Q, chassis mount, teflon base. (#5119)	1.29	20 for 1.30
1-TO-3 HEAT SINK, heavy duty aluminum, pre-punched for TO-3. (#4083)	1.29	2 for 1.30
75-MOLEX SOCKETS, "one-a-strip", for multiple pin dips. (#1609)	1.29	150 for 1.30
6-PAIRS 9V BATTERY CLIPS, wired & black color-coded leads. (#2852)	1.29	12 for 1.30
1-UHF TUNER, 3 gang, uhl TV unit, 300 ohm, pos. direct drive. (#2927)	1.29	2 for 1.30
15-HUMBUCKER CONTROLS, assorted values, manufacturers dump. (#3807)	1.29	30 for 1.30
50-SUBMINI IF TRANSFORMERS, slug-tuned, shielded. (#35A9)	1.29	100 for 1.30
15-"POP" OPTICAL LENSES, plano-convex, 1" dia., plastic. (#5043)	1.29	30 for 1.30
40-ADJUSTABLE FERRITE CORES, center cut for hex adjust. (#5701)	1.29	80 for 1.30

3-1.5V MINI LAMPS, only 3/32" dia., draws 15 mA, w/1" wire leads. (#5693)	1.29	6 for 1.30
30-FT. WIRE-WRAP WIRE, 30 gauge, insulated, continuous length. (#3603)	1.29	60 for 1.30
5-DUAL DIGIT "BUBBLE" READOUTS, HP5082 style, red, dip type. (#5748)	1.29	8 for 1.30
50-METAL & PLASTIC TRANSISTORS, ass'd sizes. (#1965)	1.29	100 for 1.30
2-HI PWR. TRANSISTORS, Motorola type, MJ3201, NPN, 15W, TO-66. (#2797)	1.29	4 for 1.30
100-GERM. GLASS DIODES, similar to 1N34, axial leads, untested. (#642)	1.29	200 for 1.30
30-1N914 SWITCHING DIODES, silicon, 4N5, glass, untested. (#143)	1.29	60 for 1.30
4-AM/FM VARIABLE COND., 2 bands, "poly-con", 3/4" square. (#2924)	1.29	8 for 1.30
4-MICRO SWITCHES, SPST, NO contacts, plunger style, solder tabs. (#5785)	1.29	8 for 1.30
10-CRYSTAL SCHEMES, 3 1/8" x 1 1/8" x 1/8" holes for 1/16" PC leads. (#5527)	1.29	20 for 1.30
10-MULTI-GANG POTS, audio, 2 gangs and up, ass'd types and values. (#5326)	1.29	20 for 1.30
10-MAN-3's, 7 segment, w/bubble magnifier, 100% material. (#3842)	1.29	20 for 1.30
3-PL-259 COAX PLUG, mates to SO-239, Amphenol. (#5221)	1.29	6 for 1.30
1-LITE SENSITIVE UNIJUNCTION TRANSISTOR, programmable. (#5719)	1.29	2 for 1.30
1-LASER OPTO COUPLER, type H11C3, mini dip. (#5700)	1.29	2 for 1.30
4-MINI BLOCK READOUTS, .122", red, type FND-10. (#5913)	1.29	8 for 1.30
3-LINE CORDS, 6 ft., 18 gauge, 2 cond., white w/plug. (#3787)	1.29	6 for 1.30
15-SINGLE PIN MICRO RED LEADS, 100% material, 3 volts @ 10 mA. (#5896)	1.29	100 for 1.30
50-RECTOR CAPACITORS, used for hams, RF, UHF circuitry. (#5847)	1.29	100 for 1.30
40-PLASTIC TRANSISTORS, ass'd untested and hobby. (#2604A)	1.29	80 for 1.30
5-6V INDICATORS, w/leads, test lamp manufacturers excess. (#5893)	1.29	10 for 1.30
40-METAL CAN TRANSISTORS, ass'd types, hobby, untested. (#2603A)	1.29	80 for 1.30
15-UPRIGHT ELECTRODS, 100% ass'd values and voltages. (#5900)	1.29	30 for 1.30
40-SEMI-CON SUPRISE, zeners, rectifiers, transistors, etc. U-test. (#2226)	1.29	80 for 1.30
100-STABISTORS, axial, for regulators & computers, U-test. (#3140)	1.29	200 for 1.30
40-SQUARE PC COILS, uprights, assorted values, for PC applications. (#3188)	1.29	80 for 1.30
50-1 WATT ZENERS, 3.3, 6.8, 10, 12, 15V, etc., double plug, untested. (#1964)	1.29	100 for 1.30
4-ROCKER SWITCHES, DPDT, solder eyelet terminals. (#3302)	1.29	8 for 1.30
60-LONG LEAD DISCS, 100% prime, marked capacitors. (#5899)	1.29	120 for 1.30
6-MINI TRANSFORMERS, ass'd outputs, Interstate & audio. 1" sq. (#3295)	1.29	12 for 1.30
1-TV AUDIO SHIELDED CABLE, 2 cond., 15 ft. w/RCA phone plugs. (#5812)	1.29	2 for 1.30
25-DATA ENTRY KEYCAPS, 3/4" sq., n's & functions, ass't. colors. (#4013)	1.29	50 for 1.30
2-GE 3W AUDIO AMP, type PA-263 IC chip, mono. (#1522)	1.29	4 for 1.30
1-MERCURY TILT SWITCH, N.C. rated 24VDC @ .05A, w/leads. (#5686)	1.29	2 for 1.30
6-POWER TAB TRIACS, 100% prime, 100V, TO-220, black style. (#5904)	1.29	12 for 1.30
3-WATCH LEDS, 3-1/2 digit, ass't. types, size: 1" x 1-1/2" (approx.). (#5066)	1.29	6 for 1.30
10-TV INTERLOCK JACKS, for TV/power mtr. ctr. solder tab terms. (#5519)	1.29	20 for 1.30
4-MOS FETS, 1218, by Fairchild & RCA, TO-18, some duals. (#1686)	1.29	8 for 1.30
4-PHOTO ELECTRIC DARLINGTON TRANSISTORS, 2N5777. (#3276)	1.29	8 for 1.30
6-AC "UTILITY" OUTLETS, for 1 1/4" mtr. ctr. solder lugs. (#3582)	1.29	12 for 1.30
15-NE-2 LAMPS, neon red, for 110VAC, less resistor. (#1435)	1.29	30 for 1.30
20-1N4148 SWITCHING DIODES, 4N5, 100V @ 10mA, axial. (#3000)	1.29	40 for 1.30
2-4 AMP SILICON BRIDGE RECTIFIER, 200V, black style. (#5928)	1.29	4 for 1.30
4-VARACTOR DIODES, var. tuner capacitance, 20-50 pf. (#5887)	1.29	8 for 1.30
50-PRECISION RESISTORS, 1/2, 1, & 2 watts, 1%, assorted types. (#363)	1.29	100 for 1.30
60-CERAMIC CAPS, ass'd val. & styles, incl. tubulars, NPO's, etc. (#590)	1.29	120 for 1.30
25-PLASTIC SCR's, incl. 200V, untested, high yield, TO-92. (#3192)	1.29	50 for 1.30
35-MOLDED CAPACITORS, tubular, ass'd volt. to 1mf, axial leads. (#34842)	1.29	70 for 1.30
100-MICRO ZENER & RECT. KIT, ass'd voltages, only 1/8" sq. U-test. (#1251)	1.29	200 for 1.30
1-LINE COIL, 8 ft., 2 cond., 16 gauge, vinyl molded plug & grommet. (#3661)	1.29	2 for 1.30
6-SPDT MICRO SLIDE SWITCH, only 3/7" cube, for PC mount. (#3429)	1.29	12 for 1.30
10-PR. RCA PLUGS & JACKS, for audio, speakers, etc. (#402)	1.29	20 for 1.30
7-2N3055 HOBBY TRANSISTORS, 100%, TO-3. (#3771)	1.29	14 for 1.30
20-ZENERS, 1 watt 9.1 volts axial leads 100% (#5370A)	1.29	40 for 1.30
40-1N4148, 4 NANO. SWITCHING DIODE, axial leads untested. (#5923)	1.29	80 for 1.30
2-RELAYS, BARCOCK 6VDC, SPST, plastic case. (#5807)	1.29	4 for 1.30
1-25 AMP BRIDGE RECTIFIER, 50 volts, 100% (#5948)	1.29	2 for 1.30
2-QUADRACS, 10 amp 200 PRV, TO-220 100% (#5915)	1.29	4 for 1.30
15-PNP SWITCHING TRANSISTORS, 2N404, 1305 etc. TO-5. (#5911)	1.29	30 for 1.30
15-PNP RESISTORS, 30-1/2W, 30-1/4 watt, axial, color coded. (#5922)	1.29	120 for 1.30
12-SCRS-TRIAC-QUADRACS, ass't. volts, TO-220 case. (#2087)	1.29	24 for 1.30

"SKINNY-TRIMS" POTENTIOMETERS

1/4" square single turn 50k 500k 100k 20k 5k 1k 500 250 100 50 20 10 5 2 1 1/2 1/4 1/8 1/16 1/32 1/64 1/128 1/256 1/512 1/1024 1/2048 1/4096 1/8192 1/16384 1/32768 1/65536 1/131072 1/262144 1/524288 1/1048576 1/2097152 1/4194304 1/8388608 1/16777216 1/33554432 1/67108864 1/134217728 1/268435456 1/536870912 1/1073741824 1/2147483648 1/4294967296 1/8589934592 1/17179869184 1/34359738368 1/68719476736 1/137438953472 1/274877906944 1/549755813888 1/1099511627776 1/2199023255552 1/4398046511104 1/8796093022208 1/17592186044416 1/35184372088832 1/70368744177664 1/140737488355328 1/281474976710656 1/562949953421312 1/1125899906842624 1/2251799813685248 1/4503599627370496 1/9007199254740992 1/18014398509481984 1/36028797018963968 1/72057594037927936 1/144115188075855872 1/288230376151711744 1/576460752303423488 1/1152921504606846976 1/2305843009213693952 1/4611686018427387904 1/9223372036854775808 1/18446744073709551616 1/36893488147419103232 1/73786976294838206464 1/1475739525896764128 1/2951479051793528256 1/5902958103587056512 1/11805916207174113024 1/23611832414348226048 1/47223664828696452096 1/94447329657392904192 1/188894659314785808384 1/377789318629571616768 1/755578637259143233536 1/1511157274518286467072 1/3022314549036572934144 1/6044629098073145868288 1/12089258196146291736576 1/24178516392292583473152 1/48357032784585166946304 1/96714065569170333892608 1/193428131138340667785216 1/386856262276681335570432 1/773712524553362671140864 1/1547425049106725342281728 1/3094850098213450684563456 1/6189700196426901369126912 1/12379400392853802738253824 1/24758800785707605476507648 1/49517601571415210953015296 1/99035203142830421906030592 1/198070406285660843812061184 1/396140812571321687624122368 1/792281625142643375248244736 1/1584563250285286750496489472 1/3169126500570573500992978944 1/6338253001141147001985957888 1/12676506002282294003971915776 1/25353012004564588007943831552 1/50706024009129176015887663104 1/101412048018258352031775326208 1/202824096036516704063550652416 1/405648192073033408127101304832 1/811296384146066816254202609664 1/1622592768292133632508405219328 1/3245185536584267265016810438656 1/6490371073168534530033620877312 1/12980742146337069060067241754624 1/25961484292674138120134483509248 1/51922968585348276240268967018496 1/103845937170696552480537934036992 1/207691874341393104961075868073984 1/415383748682786209922151736147968 1/830767497365572419844303472295936 1/1661534994731144839688606945791872 1/332306998946228967937

7400 TTL

SN7400N	16	SN7472N	29	SN74160N	59
SN7401N	18	SN7473N	35	SN74161N	59
SN7402N	18	SN7474N	49	SN74162N	1.95
SN7403N	18	SN7475N	49	SN74163N	89
SN7404N	18	SN7476N	5.00	SN74164N	89
SN7405N	20	SN7477N	5.00	SN74165N	89
SN7406N	29	SN7478N	99	SN74166N	1.25
SN7407N	29	SN7479N	99	SN74167N	1.95
SN7408N	29	SN7480N	99	SN74168N	1.50
SN7409N	20	SN7481N	1.75	SN74169N	1.25
SN7410N	18	SN7482N	2.5	SN74170N	89
SN7411N	25	SN7483N	59	SN74171N	79
SN7412N	25	SN7484N	59	SN74172N	79
SN7413N	40	SN7485N	63	SN74173N	79
SN7414N	20	SN7486N	63	SN74174N	79
SN7415N	25	SN7487N	63	SN74175N	79
SN7416N	25	SN7488N	63	SN74176N	79
SN7417N	25	SN7489N	63	SN74177N	79
SN7418N	25	SN7490N	63	SN74178N	79
SN7419N	25	SN7491N	63	SN74179N	79
SN7420N	20	SN7492N	63	SN74180N	79
SN7421N	29	SN7493N	63	SN74181N	79
SN7422N	29	SN7494N	63	SN74182N	79
SN7423N	25	SN7495N	63	SN74183N	79
SN7424N	29	SN7496N	63	SN74184N	79
SN7425N	29	SN7497N	63	SN74185N	79
SN7426N	29	SN7498N	63	SN74186N	79
SN7427N	29	SN7499N	63	SN74187N	79
SN7428N	29	SN7500N	63	SN74188N	79
SN7429N	29	SN7501N	63	SN74189N	79
SN7430N	29	SN7502N	63	SN74190N	79
SN7431N	29	SN7503N	63	SN74191N	79
SN7432N	29	SN7504N	63	SN74192N	79
SN7433N	29	SN7505N	63	SN74193N	79
SN7434N	29	SN7506N	63	SN74194N	79
SN7435N	29	SN7507N	63	SN74195N	79
SN7436N	29	SN7508N	63	SN74196N	79
SN7437N	29	SN7509N	63	SN74197N	79
SN7438N	29	SN7510N	63	SN74198N	79
SN7439N	29	SN7511N	63	SN74199N	79
SN7440N	29	SN7512N	63	SN74200N	79
SN7441N	29	SN7513N	63	SN74201N	79
SN7442N	29	SN7514N	63	SN74202N	79
SN7443N	29	SN7515N	63	SN74203N	79
SN7444N	29	SN7516N	63	SN74204N	79
SN7445N	29	SN7517N	63	SN74205N	79
SN7446N	29	SN7518N	63	SN74206N	79
SN7447N	29	SN7519N	63	SN74207N	79
SN7448N	29	SN7520N	63	SN74208N	79
SN7449N	29	SN7521N	63	SN74209N	79
SN7450N	29	SN7522N	63	SN74210N	79
SN7451N	29	SN7523N	63	SN74211N	79
SN7452N	29	SN7524N	63	SN74212N	79
SN7453N	29	SN7525N	63	SN74213N	79
SN7454N	29	SN7526N	63	SN74214N	79
SN7455N	29	SN7527N	63	SN74215N	79
SN7456N	29	SN7528N	63	SN74216N	79
SN7457N	29	SN7529N	63	SN74217N	79
SN7458N	29	SN7530N	63	SN74218N	79
SN7459N	29	SN7531N	63	SN74219N	79
SN7460N	29	SN7532N	63	SN74220N	79

EXCITING NEW KITS

JE600 HEXADECIMAL ENCODER KIT

FEATURES:

- Full 8 bit latched output for microprocessor use
- 3 User Define keys with one being bi-directional
- Debounce circuit provided for all 19 keys
- LED readout to verify entries
- Easy interfacing with standard 16 pin IC connector

Only +5VDC required for operation

Full 8 BIT LATCHED OUTPUT—19 KEYBOARD

The JE600 Encoder-Keyboard provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8 bit microprocessors or 8 bit memory circuits. Three 131 additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with LED readouts. Also included is a key entry switch.

JE600
Hexadecimal Keypad only \$59.95
..... \$10.95

Digital Thermometer Kit

FEATURES:

- Dual sensors—switching control for indoor/outdoor or dual monitoring
- Continuous LED 8" h.t. display
- Range: -40°F to 199°F / -40°C to 100°C
- Accuracy: ±1° nominal
- Sim. Fahrenheit or Celsius reading
- Sim. Fahrenheit or Celsius wall display
- Size: 3-1/4" H x 6-5/8" W x 1-3/8" D

JE300 \$39.95

DISCRETE LEDs

TYPE	POLARITY	MT	PRICE	TYPE	POLARITY	MT	PRICE
MAN 1	Common Anode-red	270	2.95	MAN 6730	Common Anode-red ± 1	560	99
MAN 2	5 x 7.2 D (Narrow)	300	4.95	MAN 6742	Common Cathode-red ± 1	560	99
MAN 3	Common Anode-red	125	2.95	MAN 6750	Common Cathode-red ± 1	560	99
MAN 4	Common Cathode-red	167	1.95	MAN 6760	Common Cathode-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 7Z	Common Anode-yellow	300	99	DL704	Common Anode-red	300	99
MAN 7A	Common Cathode-red	300	1.25	DL707	Common Anode-red	300	99
MAN 82	Common Anode-yellow	300	99	DL728	Common Cathode-red	500	1.49
MAN 84	Common Anode-yellow	300	99	DL741	Common Anode-red ± 1	500	1.25
MAN 3520	Common Cathode-orange	300	99	DL745	Common Anode-red ± 1	500	1.49
MAN 3630	Common Anode-orange ± 1	300	99	DL749	Common Anode-red	600	1.49
MAN 3640	Common Cathode-orange	300	99	DL750	Common Cathode-red	600	1.49
MAN 4610	Common Anode-orange	400	99	DL753	Common Cathode-red	110	35
MAN 4640	Common Cathode-orange	400	99	DL754	Common Cathode-red	110	35
MAN 4710	Common Anode-red	400	99	DL757	Common Cathode-red	600	1.49
MAN 4730	Common Anode-red ± 1	400	99	DL759	Common Cathode-red	600	1.49
MAN 4740	Common Cathode-red	400	99	DL760	Common Cathode-red	600	1.49
MAN 4810	Common Anode-yellow	400	99	DL763	Common Cathode-red	600	1.49
MAN 4840	Common Cathode-yellow	400	99	DL764	Common Cathode-red	600	1.49
MAN 6610	Common Anode-orange-D	560	99	DL765	Common Cathode-red	600	1.49
MAN 6630	Common Cathode-orange-D	560	99	DL766	Common Cathode-red	600	1.49
MAN 6640	Common Cathode-orange ± 1	560	99	DL767	Common Cathode-red	600	1.49
MAN 6650	Common Cathode-orange	560	99	DL768	Common Cathode-red	600	1.49
MAN 6660	Common Cathode-orange	560	99	DL769	Common Cathode-red	600	1.49
MAN 6710	Common Cathode-orange-D	560	99	DL770	Common Cathode-red	600	1.49

DISPLAY LEDs

TYPE	POLARITY	MT	PRICE	TYPE	POLARITY	MT	PRICE
MAN 1	Common Anode-red	270	2.95	MAN 6730	Common Anode-red ± 1	560	99
MAN 2	5 x 7.2 D (Narrow)	300	4.95	MAN 6742	Common Cathode-red ± 1	560	99
MAN 3	Common Anode-red	125	2.95	MAN 6750	Common Cathode-red ± 1	560	99
MAN 4	Common Cathode-red	167	1.95	MAN 6760	Common Cathode-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 7Z	Common Anode-yellow	300	99	DL704	Common Anode-red	300	99
MAN 7A	Common Cathode-red	300	1.25	DL707	Common Anode-red	300	99
MAN 82	Common Anode-yellow	300	99	DL728	Common Cathode-red	500	1.49
MAN 84	Common Anode-yellow	300	99	DL741	Common Anode-red ± 1	500	1.25
MAN 3520	Common Cathode-orange	300	99	DL745	Common Anode-red ± 1	500	1.49
MAN 3630	Common Anode-orange ± 1	300	99	DL749	Common Anode-red	600	1.49
MAN 3640	Common Cathode-orange	300	99	DL750	Common Cathode-red	600	1.49
MAN 4610	Common Anode-orange	400	99	DL753	Common Cathode-red	110	35
MAN 4640	Common Cathode-orange	400	99	DL754	Common Cathode-red	110	35
MAN 4710	Common Anode-red	400	99	DL757	Common Cathode-red	600	1.49
MAN 4730	Common Anode-red ± 1	400	99	DL759	Common Cathode-red	600	1.49
MAN 4740	Common Cathode-red	400	99	DL760	Common Cathode-red	600	1.49
MAN 4810	Common Anode-yellow	400	99	DL763	Common Cathode-red	600	1.49
MAN 4840	Common Cathode-yellow	400	99	DL764	Common Cathode-red	600	1.49
MAN 6610	Common Anode-orange-D	560	99	DL765	Common Cathode-red	600	1.49
MAN 6630	Common Cathode-orange-D	560	99	DL766	Common Cathode-red	600	1.49
MAN 6640	Common Cathode-orange ± 1	560	99	DL767	Common Cathode-red	600	1.49
MAN 6650	Common Cathode-orange	560	99	DL768	Common Cathode-red	600	1.49
MAN 6660	Common Cathode-orange	560	99	DL769	Common Cathode-red	600	1.49
MAN 6710	Common Cathode-orange-D	560	99	DL770	Common Cathode-red	600	1.49

RCA LINEAR

A3013T	2.15	CA3082N	2.00	CHIPS/DRIVE
A2023T	2.56	CA3083N	1.60	MM5725
A3035T	2.56	CA3086N	85	MM5738
A3039T	1.35	CA3089N	3.75	DM8864
A3046N	1.30	CA3130T	1.39	DM8865
A3059N	3.25	CA3140T	1.25	DM8887
A3060N	3.25	CA3160T	1.25	DM8889
A1180T	85	CA3170N	49	9317A 7 seq
A3081N	2.00	CA3190N	3.10	CA-100

Transistor Checker



— Completely Assembled —
— Battery Operated —

The ASI Transistor Checker is capable of checking a wide range of transistor types, either "in circuit" or out of circuit. To operate, simply plug the transistor to be checked into the front panel socket, or connect it with the alligator clip test leads provided. The unit safely and automatically identifies low, medium and high-power PNP and NPN transistors. Size: 3 1/4" x 5 1/2" x 2 1/4". "C" cell battery not included.

Trans-Check \$19.95 ea.

Custom Cables & Jumpers

NEW



NEW

DB 25 Series Cables

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

Dip Jumpers

Part No.	Cable Length	Connectors	Price
DJ14-1	1 ft.	1-14 Pin	\$1.59 ea.
DJ16-1	1 ft.	1-16 Pin	1.79 ea.
DJ24-1	1 ft.	1-24 Pin	2.79 ea.
DJ14-1-14	1 ft.	2-14 Pin	2.79 ea.
DJ16-1-16	1 ft.	2-16 Pin	3.19 ea.
DJ24-1-24	1 ft.	2-24 Pin	4.95 ea.

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

CONNECTORS

25 Pin-D Subminiature

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

PRINTED CIRCUIT EDGE-CARD

156 Spacing-Tin Double Rear Gull - Brimmed Contacts - Fits .054 to .070 P.C. Cards		
15/30	PINS (Solder Eyelet)	\$1.95
18/36	PINS (Solder Eyelet)	\$2.49
22/44	PINS (Solder Eyelet)	\$2.95
50/100 (.100 Spacing)	PINS (Wire Wrap)	\$6.95
50/100 (.125 Spacing)	PINS (Wire Wrap)	R681-1 \$6.95

4-Digit Clock Kit

- Bright .35" ht. red display
- Sequential flashing colon
- 12 or 24 hour operation
- Extended aluminum case (black)
- Pressure switches for hours, minutes & hold functions
- Includes all components, case and wall transformer
- Size: 3 1/4 x 1 1/4

JE730 \$14.95

Jumbo 6-Digit Clock Kit

- Four .35" ht. and two .300" ht. common anode displays
- Uses MMS314 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: 6 1/4 x 3 1/4 x 1 1/4

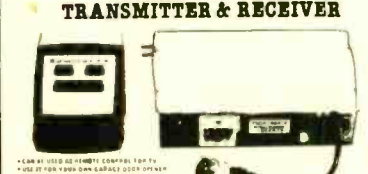
JE747 \$29.95

JE701

- Bright .300 ht. comm. cathode display
- Uses MMS314 clock chip
- Switches for hours, minutes and hold modes
- Mrs. easily viewable to 20 ft.
- Simulated walnut case
- 115VAC operation
- 12 or 24 hr. operation
- Incl. all components, case & wall transformer
- Size: 6 1/4" x 3 1/8" x 1 1/4"

6-Digit Clock Kit \$19.95

REMOTE CONTROL TRANSMITTER & RECEIVER



\$19.98

Digital Stopwatch Kit

- Use Intersil 7205 Chip
- Plated thru double-sided P.C. Board
- LED display (red)
- Times to 99 min. 59.99 sec. with auto reset
- Quartz crystal controlled
- Three stopwatches in one: single event, split (cumulative) & Taylor (sequential timing)
- Uses 3 penlite batteries
- Size: 4.5" x 2.15" x .90"

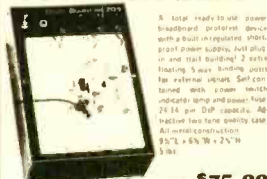
JE900 \$39.95

MICROPROCESSOR COMPONENTS

8080A/8080A SUPPORT DEVICES		MICROPROCESSOR MANUALS	
8080A	CPU	\$ 9.95	
8212	8-Bit Input/Output	3.25	M-280 User Manual \$7.50
8214	Priority Interrupt Controller	5.95	M-CDP1802 User Manual 7.50
8216	8-Directional Bus Driver	3.49	M-2850 User Manual 5.00
8274	Clock Generator/Driver	3.49	
8278	Bus Driver	3.49	
8228	System Controller/Bus Driver	5.95	
8238	System Controller	5.95	
8251	Prog. Comm. I/O (USART)	7.95	
8253	Prog. Interval Timer	14.95	
8255	Prog. Periph. I/O (PPI)	9.95	
8257	Prog. DMA Controller	19.95	
8259	Prog. Interrupt Controller	19.95	
8080/8080 SUPPORT DEVICES		ROM'S	
MC6800	MPU	\$14.95	
MC6802CP	MPU with Clock and Ram	24.95	25132140 Character Generator (lower case) \$9.95
MC6810AP	128KB Static Ram	5.95	25133021 Character Generator (lower case) 9.95
MC6821	Periph. Inter. Adapt (MC6820)	7.49	2516 Character Generator 10.95
MC6828	Priority Interrupt Controller	12.95	MMS230N 2048-Bit Read Only Memory 1.95
MC6830L8	1024x8 Bit ROM (MC6830-8)	14.95	
MC6850	Asynchronous Comm. Adapter	7.95	
MC6852	Synchronous Serial Data Adapt	9.95	
MC6860	0-500 kps Digital MODEM	12.95	
MC6862	2400 cps Modulator	14.95	
MC6880A	Quad 3-State Bus, Trans. (MC6826)	2.25	
MICROPROCESSOR CHIPS—MISCELLANEOUS		RAM'S	
2801780C	CPU	\$19.95	1101 256K1 Static \$1.49
280A1780-1	CPU	24.95	1103 1024K1 Dynamic .99
CDP1802	CPU	19.95	2101(8101) 256K1 Static 3.95
2650	MPU	19.95	2102 1024K1 Static 1.75
6502	CPU	11.95	2111(8111) 256K1 Static 3.95
8035	8-Bit MPU w/clock, RAM, I/O lines	19.95	2112 256K1 Static MOS 4.95
P8085	CPU	19.95	2114 1024K1 Static 450ns low power 10.95
TMS9900UL	16-Bit MPU w/hardware, multiply & divide	49.95	2114-3 1024K1 Static 300ns low power 11.95
SHIFT REGISTERS		TMS4048-16K	
MMS500H	Dual 25 Bit Dynamic	\$ 50	7489 16K1 Static 14.95
MMS503H	Dual 50 Bit Dynamic	50	7489 16K1 Static 14.95
MMS504H	Dual 16 Bit Static	50	7489 16K1 Static 14.95
MMS506H	Dual 100 Bit Static	50	7489 16K1 Static 14.95
MMS510H	Dual 64 Bit Accumulator	89	7489 16K1 Static 14.95
MMS516H	500/512 Bit Dynamic	89	7489 16K1 Static 14.95
25041	1024 Dynamic	3.95	7489 16K1 Static 14.95
2516	Hex 32 Bit Static	4.95	7489 16K1 Static 14.95
2522	Dual 132 Bit Static	2.95	7489 16K1 Static 14.95
2524	512 Static	99	7489 16K1 Static 14.95
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2532	Quad 80 Bit Static	2.95	7489 16K1 Static 14.95
2533	1024 Static	2.95	7489 16K1 Static 14.95
3341	Pin	6.95	7489 16K1 Static 14.95
74LS670	4K4 Register File (TriState)	2.49	7489 16K1 Static 14.95
UART'S		74LS287	
A-Y-5-1013	30K BAUD	5.95	74LS287 1024 Static 2.95

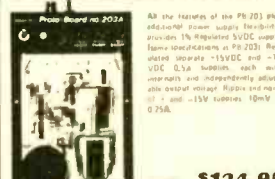
CSC CONTINENTAL SPECIALTIES

Proto Board 203



Model	L x W x H (inches)	Price
PB-6	6.0 x 4.5 x 1.4	\$15.95
PB-100	6.0 x 4.5 x 1.4	\$19.95
PB-101	6.0 x 4.5 x 1.4	\$22.95

Proto Board 203A



Model	L x W x H (inches)	Price
PB-102	7.0 x 4.5 x 1.4	\$26.95
PB-103	9.0 x 6.0 x 1.4	\$44.95
PB-104	9.8 x 6.0 x 1.4	\$54.95

62-Key ASCII Encoder Keyboard Kit



The JE610 62-Key ASCII Encoder Keyboard Kit can be interfaced into most any computer system. The JE610 Kit comes complete with an industrial grade keyboard switch assembly (62 keys), IC's, sockets, connector, electronic components, a double-sided printed wiring board. The keyboard assembly requires +5V @ 150mA and -12V @ 10mA for operation.

NEW! JE610

FEATURES:

- 60 Keys generate the full 128 characters, upper and lower case ASCII set
- Fully buffered
- 2 user-definable 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 \$79.95

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JE200	5V - 1 AMP POWER SUPPLY	JE205	ADAPTER BOARD - Adapts to JE200 - ±5V, ±9V and ±12V
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The Incredible "Pennywhistle 103"



\$139.95 Kit Only

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

Data Transmission Method: Frequency Shift Keying, full duplex (half-duplex selectable)
Maximum Data Rate: 300 Baud
Data Format: Asynchronous Serial (return to mark level required between each character)
Receive Channel Frequencies: 2025 Hz for space, 2275 Hz for mark
Transmit Channel Frequencies: 1270 mark, High = 825 space, 2225 mark
Receive Sensitivity: -46 dbm acoustically coupled
Transmit Level: -15 dbm nominal, Adjustable from -5 dbm to -20 dbm
Relative Frequency Tolerance: Frequency reference automatically adjusts to allow for operation between 1800 Hz and 2400 Hz
Digital Data Interface: 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 8" printed circuit board. All components included
Requires a VOM, Audio Oscillator, Frequency Counter and/or Oscilloscope to align

TRS-80 16K Conversion Kit

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

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

TRS-16K \$75.00

COMPUTER CASSETTES

- * 6 EACH 15 MINUTE HIGH QUALITY C-15 CASSETTES
- * PLASTIC CASE INCLUDED
- * 12 CASSETTE CAPACITY
- * ADDITIONAL CASSETTES AVAILABLE @ C-15-\$2.95 ea

CAS-6

\$14.95 (Case and 6 Cassettes)

SUP 'R' MOD II

UHF Channel 33 TV Interface Unit Kit

- Wide Band B/W or Color System
- Converts TV to Video Display for home computers, CCTV camera, Apple II, works with Cromeco Dazzler, SOL-20, IRS-80, Challenger, etc.
- MOD II is returned to Channel 33 (UHF).
- * Includes coaxial cable and antenna transformer.

MOD II \$29.95 Kit

Function Generator Kit

- Provides 3 basic waveforms: sine, triangle & square wave
- Frequency 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
- Incl. chip, P.C. board, components and instructions.

JE2206B \$19.95

IDEAL FOR TRS 80 CASSETTE CONTROLLER

- * Plug/Jack interface to any computer system requiring remote control of cassette functions
- The CC100 controls cassette motor functions, monitors tape location with its internal speaker and requires no power. Eliminates the plugging and unplugging of cables during computer loading operation from cassette.

#CC-100 \$29.50



Micro-Miniature Joystick

- * 2 each 100K pots (Linear Taper)
- * Printed Circuit Board Mount
- * Size: 1" x 1-3/16" x 1-3/16"

Micro-Miniature Joystick \$4.95

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74LS08	276-1908	.49
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74LS13	276-1911	.99
74LS20	276-1912	.59
74LS27	276-1913	.69
74LS30	276-1914	.59
74LS32	276-1915	.69
74LS47	276-1916	1.29
74LS51	276-1917	.59
74LS73	276-1918	.69
74LS74	276-1919	.69
74LS75	276-1920	.99
74LS76	276-1921	.79
74LS85	276-1922	1.29
74LS90	276-1923	.99
74LS92	276-1924	.99
74LS93	276-1925	.99
74LS123	276-1926	1.19
74LS132	276-1927	.99
74LS151	276-1929	.99
74LS157	276-1930	1.19
74LS161	276-1931	1.49
74LS164	276-1932	1.49
74LS175	276-1934	1.19
74LS192	276-1935	1.49
74LS193	276-1936	1.49
74LS194	276-1937	1.49
74LS196	276-1938	1.59
74LS367	276-1835	1.19
74LS368	276-1836	1.19
74LS373	276-1943	2.39
74LS374	276-1944	2.39

4000-Series CMOS ICs

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4001	276-2401	.69
4011	276-2411	.69
4012	276-2412	.79
4013	276-2413	.99
4017	276-2417	1.69
4020	276-2420	1.69
4021	276-2421	1.69
4023	276-2423	.69
4027	276-2427	.99
4028	276-2428	1.29
4046	276-2446	1.69
4511	276-2447	1.69
4049	276-2449	.79
4050	276-2450	.79
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4070	276-2470	.79
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All from Major Semiconductor Mfrs., and Prime. Specs and Pin Out Diagram Included with Each Device.

28-Range Multitester with 10-Megohm Input

Save **33%**

Reg. 59.95 **39⁹⁵**

- Dual FET Input
- 5" Mirrored Scale
- Overload Protected
- Polarity Reverse Switch



High-accuracy 25 μ A meter with single-knob range selector measures DC Volts: 0-3-1-3-10-30-100-300-1000 at 10 Megohms. AC Volts: 0-3-30-100-300-1000 at 10 k Ω per volt. DC Current: 0-100 μ A, 3-30-300 mA, 10A. Resistance: Rx1, Rx10, Rx1000, Rx10k, Rx1M (10 ohms center scale). dB: -20 to +62 in 5 ranges. Accuracy: $\pm$ 3% DC, $\pm$ 4% AC. 7x5 1/2x3 1/8" overall. With leads, test probes, batteries. 22-208 Sale 39.95

6-Digit Frequency Counter

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Overload protected. 1-megohm input. Sensitivity, 30 mV up to 30 MHz. Accuracy is 3 ppm at 25° or less than 30 Hz at 10 MHz. With antenna, leads, case, instructions. 22-351 Sale 49.95

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Only 3 1/2x2 1/2x1 1/4" yet measures AC, DC volts to 1000; DC current 0-150 mA; resistance, 1000 ohms/volt. With leads. Requires "AA" battery (not incl.). 22-027 Sale 7.88

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Ideal DC source for solid-state projects and servicing. Load regulation better than 2%. Ripple 25 mV at full load. Large switchable meter reads voltage or current. 3-way binding posts. U.L. listed AC operation. 22-123 Sale 29.95

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10⁹⁵



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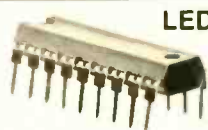
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Full 0-9 binary-coded outputs for logic circuits. Gold contacts are sealed for long life. Positive detents. Fits 8-pin DIP socket or mounts on PC board. Data included. 275-1310 2.99

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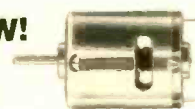
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HY5

Preamplifier

The HY5 is a mono hybrid amplifier ideally suited for all applications. All common input functions (mag. Cartridge, tuner, etc.) are catered for. The desired function is achieved either by a multi-way switch or direct connection to the appropriate pins. The internal volume and tone controls require converting to external potentiometers (not included). The HY5 is compatible with all I.C.P. power amplifiers and power supplies. To ease construction and mounting, a P.C. connector is supplied with each pre-amplifier.
FEATURES: Complete pre-amplifier in single package—Multifunction equalization—Low noise—Low distortion—High overload—Two strongly combined for stereo.
APPLICATIONS: Hi-Fi—Monitor—Disc—Guitar and Organ—Public address
SPECIFICATIONS:
INPUTS: Magnetic Pick-up 3mV; Ceramic Pick-up 30mV; Tuner 100mV; Microphone 10mV; Auxiliaries 100mV; Input impedance 4.7kΩ at 1kHz.
OUTPUTS: Tape 100mV; Main output 300mV R.M.S.
ACTIVE TONE CONTROLS: Treble & 12dB at 10kHz; Bass & 12dB at 100Hz.
DISTORTION: 0.1% at 1kHz; Signal/Noise Ratio 80dB.
OVERLOAD: 10dB on Magnetic Pick-up SUPPLY VOLTAGE ± 16-50V. \$18.95

HY200

120 Watts into 8Ω

The HY200 has been improved to give an output of 120 Watts has been designed to stand the most rugged conditions such as disco or group while still retaining true HIFI performance.
FEATURES: Thermal shutdown—Very low distortion—Load line protection—Integral heatsink—No external components.
APPLICATIONS: Hi-Fi—Disc—Monitor—Power slave—Industrial—Public address
SPECIFICATIONS:
INPUT SENSITIVITY 300mV
OUTPUT POWER 120W RMS into 8Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0.05% at 100W at 1kHz
SIGNAL/NOISE RATIO 80dB FREQUENCY RESPONSE 10Hz-45kHz—3dB SUPPLY VOLTAGE ± 16-50V
SIZE 114x50x55mm \$79.95

HY400

240 Watts into 4Ω

The HY400 is I.C.P.'s "Big Daddy" of the range producing 240W into 4Ω! It has been designed for high power disco address applications. The amplifier is to be used at continuous high power levels a cooling fan is recommended. The amplifier includes all the qualities of the rest of the family to lead the market as a true high power hi-fi ready power module.
FEATURES: Thermal shutdown—Very low distortion—Load line protection—No external components.
APPLICATIONS: Public address—Disc—Power slave—Industrial—Public address
SPECIFICATIONS:
OUTPUT POWER 240W RMS into 4Ω LOAD IMPEDANCE 4-16Ω DISTORTION 0.1% at 240W at 1kHz
SIGNAL/NOISE RATIO 80dB FREQUENCY RESPONSE 10Hz-45kHz—3dB SUPPLY VOLTAGE ± 16-50V
INPUT SENSITIVITY 300mV SIZE 114x50x55mm \$99.95

HY30 - 15W/8ohm \$17.49

HY50 - 25W/8ohm: \$24.90

HY120 - 60W/8ohm: \$49.00

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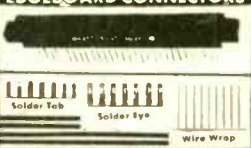
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14-54	18 Pin Solid Tap	10	1.80
14-55	20 Pin Solid Tap	10	2.00
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21-52	24 Pin Solid Tap	20	2.40
21-53	28 Pin Solid Tap	20	2.80
21-54	32 Pin Solid Tap	20	3.20
21-55	40 Pin Solid Tap	20	4.00
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40-52	14 Pin Wire Wrap	24	2.40
40-53	16 Pin Wire Wrap	20	2.00
40-54	18 Pin Wire Wrap	20	2.00
40-55	20 Pin Wire Wrap	20	2.00
40-56	24 Pin Wire Wrap	20	2.40
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40-58	32 Pin Wire Wrap	20	3.20
40-59	40 Pin Wire Wrap	20	4.00

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7403N	18 Pin Molex I.C. Socket	10	1.60
7404N	20 Pin Molex I.C. Socket	10	1.80
7405N	24 Pin Molex I.C. Socket	10	2.00
7406N	28 Pin Molex I.C. Socket	10	2.20
7407N	32 Pin Molex I.C. Socket	10	2.40
7408N	36 Pin Molex I.C. Socket	10	2.60
7409N	40 Pin Molex I.C. Socket	10	2.80
7410N	44 Pin Molex I.C. Socket	10	3.00
7411N	48 Pin Molex I.C. Socket	10	3.20
7412N	52 Pin Molex I.C. Socket	10	3.40
7413N	56 Pin Molex I.C. Socket	10	3.60
7414N	60 Pin Molex I.C. Socket	10	3.80
7415N	64 Pin Molex I.C. Socket	10	4.00
7416N	68 Pin Molex I.C. Socket	10	4.20
7417N	72 Pin Molex I.C. Socket	10	4.40
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7419N	80 Pin Molex I.C. Socket	10	4.80
7420N	84 Pin Molex I.C. Socket	10	5.00
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7424N	100 Pin Molex I.C. Socket	10	5.80
7425N	104 Pin Molex I.C. Socket	10	6.00
7426N	108 Pin Molex I.C. Socket	10	6.20
7427N	112 Pin Molex I.C. Socket	10	6.40
7428N	116 Pin Molex I.C. Socket	10	6.60
7429N	120 Pin Molex I.C. Socket	10	6.80
7430N	124 Pin Molex I.C. Socket	10	7.00
7431N	128 Pin Molex I.C. Socket	10	7.20
7432N	132 Pin Molex I.C. Socket	10	7.40
7433N	136 Pin Molex I.C. Socket	10	7.60
7434N	140 Pin Molex I.C. Socket	10	7.80
7435N	144 Pin Molex I.C. Socket	10	8.00
7436N	148 Pin Molex I.C. Socket	10	8.20
7437N	152 Pin Molex I.C. Socket	10	8.40
7438N	156 Pin Molex I.C. Socket	10	8.60
7439N	160 Pin Molex I.C. Socket	10	8.80
7440N	164 Pin Molex I.C. Socket	10	9.00
7441N	168 Pin Molex I.C. Socket	10	9.20
7442N	172 Pin Molex I.C. Socket	10	9.40
7443N	176 Pin Molex I.C. Socket	10	9.60
7444N	180 Pin Molex I.C. Socket	10	9.80
7445N	184 Pin Molex I.C. Socket	10	10.00
7446N	188 Pin Molex I.C. Socket	10	10.20
7447N	192 Pin Molex I.C. Socket	10	10.40
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7451N	208 Pin Molex I.C. Socket	10	11.20
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7460N	244 Pin Molex I.C. Socket	10	13.00
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7462N	252 Pin Molex I.C. Socket	10	13.40
7463N	256 Pin Molex I.C. Socket	10	13.60
7464N	260 Pin Molex I.C. Socket	10	13.80
7465N	264 Pin Molex I.C. Socket	10	14.00
7466N	268 Pin Molex I.C. Socket	10	14.20
7467N	272 Pin Molex I.C. Socket	10	14.40
7468N	276 Pin Molex I.C. Socket	10	14.60
7469N	280 Pin Molex I.C. Socket	10	14.80
7470N	284 Pin Molex I.C. Socket	10	15.00
7471N	288 Pin Molex I.C. Socket	10	15.20
7472N	292 Pin Molex I.C. Socket	10	15.40
7473N	296 Pin Molex I.C. Socket	10	15.60
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7475N	304 Pin Molex I.C. Socket	10	16.00
7476N	308 Pin Molex I.C. Socket	10	16.20
7477N	312 Pin Molex I.C. Socket	10	16.40
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7491N	368 Pin Molex I.C. Socket	10	19.20
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7494N	380 Pin Molex I.C. Socket	10	19.80
7495N	384 Pin Molex I.C. Socket	10	20.00
7496N	388 Pin Molex I.C. Socket	10	20.20
7497N	392 Pin Molex I.C. Socket	10	20.40
7498N	396 Pin Molex I.C. Socket	10	20.60
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7402N	120 Pin N41 Series	10	1.20
7403N	140 Pin N41 Series	10	1.40
7404N	160 Pin N41 Series	10	1.60
7405N	180 Pin N41 Series	10	1.80
7406N	200 Pin N41 Series	10	2.00

N42 SERIES, 125 to 250 Pin Edgeboard Connectors

Part No.	Description	QTY	Price
7407N	125 Pin N42 Series	10	1.25
7408N	150 Pin N42 Series	10	1.50
7409N	175 Pin N42 Series	10	1.75
7410N	200 Pin N42 Series	10	2.00
7411N	225 Pin N42 Series	10	2.25
7412N	250 Pin N42 Series	10	2.50

N43 SERIES, 150 to 300 Pin Edgeboard Connectors

Part No.	Description	QTY	Price
7413N	150 Pin N43 Series	10	1.50
7414N	175 Pin N43 Series	10	1.75
7415N	200 Pin N43 Series	10	2.00
7416N	225 Pin N43 Series	10	2.25
7417N	250 Pin N43 Series	10	2.50
7418N	275 Pin N43 Series	10	2.75
7419N	300 Pin N43 Series	10	3.00

SILICON TRANSISTORS

Part No.	Description	QTY	Price
2N2904	2N2904 PNP	10	1.00
2N2907	2N2907 PNP	10	1.00
2N3055	2N3055 NPN	10	1.00
2N3638	2N3638 PNP	10	1.00
2N3773	2N3773 PNP	10	1.00
2N4349	2N4349 PNP	10	1.00
2N4350	2N4350 PNP	10	1.00
2N4351	2N4351 PNP	10	1.00
2N4352	2N4352 PNP	10	1.00
2N4353	2N4353 PNP	10	1.00
2N4354	2N4354 PNP	10	1.00
2N4355	2N4355 PNP	10	1.00
2N4356	2N4356 PNP	10	1.00
2N4357	2N4357 PNP	10	1.00
2N4358	2N4358 PNP	10	1.00
2N4359	2N4359 PNP	10	1.00
2N4360	2N4360 PNP	10	1.00
2N4361	2N4361 PNP	10	1.00
2N4362	2N4362 PNP	10	1.00
2N4363	2N4363 PNP	10	1.00
2N4364	2N4364 PNP	10	1.00
2N4365	2N4365 PNP	10	1.00
2N4366	2N4366 PNP	10	1.00
2N4367	2N4367 PNP	10	1.00
2N4368	2N4368 PNP	10	1.00
2N4369	2N4369 PNP	10	1.00
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2N4379	2N4379 PNP	10	1.00
2N4380	2N4380 PNP	10	1.00
2N4381	2N4381 PNP	10	1.00
2N4382	2N4382 PNP	10	1.00
2N4383	2N4383 PNP	10	1.00
2N4384	2N4384 PNP	10	1.00
2N4385	2N4385 PNP	10	1.00
2N4386	2N4386 PNP	10	1.00
2N4387	2N4387 PNP	10	1.00
2N4388	2N4388 PNP	10	1.00
2N4389	2N4389 PNP	10	1.00
2N4390	2N4390 PNP	10	1.00
2N4391	2N4391 PNP	10	1.00
2N4392	2N4392 PNP	10	1.00
2N4393	2N4393 PNP	10	1.00
2N4394	2N4394 PNP	10	1.00
2N4395	2N4395 PNP	10	1.00
2N4396	2N4396 PNP	10	1.00
2N4397	2N4397 PNP	10	1.00
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2N4399	2N4399 PNP	10	1.00
2N4400	2N4400 PNP	10	1.00

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D400	Digi-Clock 400	10	4.00
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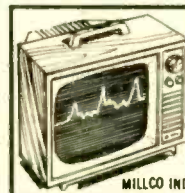
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Super Expansion Board with Cassette Interface \$89.95

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 IK 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. The Super Monitor is written with subroutines allowing users to take advantage of

monitor functions simply by calling them up. Improvements and revisions are easily done with the monitor. If you have the Super Expansion Board and Super Monitor the monitor is up and running at the push of a button.

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

The Power Supply Kit for the Super Expansion Board is a 5 amp supply with multiple positive and negative voltages \$29.95. Add \$4.00 for shipping. Prepacked frame \$7.50. Case \$10.00. Add \$1.50 for shipping.

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. Kit \$29.95. Kit with punched frame \$37.45. Woodgrain case \$10.00.

60 Hz Crystal Time Base Kit \$4.40

Converts digital clocks from AC line frequency to crystal time base. Outstanding accuracy. Kit includes: PC board, IC, crystal, resistors, capacitors and trimmer.

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7492N	LM340A	1.25	CD4044	63
7493N	LM340A	1.25	CD4046	167
7498N	LM340A	1.25	CD4049	36
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74107N	LM343H	1.15	CD4051	142
74123N	LM377	3.00	CD4056	100
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74157N	LM377	1.60	CD4067	28
74157N	LM377	1.60	CD4071	28
74162N	LM377	1.60	CD4072	28
74162N	LM377	1.60	CD4073	28
74162N	LM377	1.60	CD4074	28
74162N	LM377	1.60	CD4075	28
74162N	LM377	1.60	CD4076	28
74162N	LM377	1.60	CD4077	28
74162N	LM377	1.60	CD4078	28
74162N	LM377	1.60	CD4079	28
74162N	LM377	1.60	CD4080	28
74162N	LM377	1.60	CD4081	28
74162N	LM377	1.60	CD4082	28
74162N	LM377	1.60	CD4083	28
74162N	LM377	1.60	CD4084	28
74162N	LM377	1.60	CD4085	28
74162N	LM377	1.60	CD4086	28
74162N	LM377	1.60	CD4087	28
74162N	LM377	1.60	CD4088	28
74162N	LM377	1.60	CD4089	28
74162N	LM377	1.60	CD4090	28
74162N	LM377	1.60	CD4091	28
74162N	LM377	1.60	CD4092	28
74162N	LM377	1.60	CD4093	28
74162N	LM377	1.60	CD4094	28
74162N	LM377	1.60	CD4095	28
74162N	LM377	1.60	CD4096	28
74162N	LM377	1.60	CD4097	28
74162N	LM377	1.60	CD4098	28
74162N	LM377	1.60	CD4099	28
74162N	LM377	1.60	CD4100	28

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2102-1	95	
2102A-1	1.60	
2102A-2	1.18	
2102A-3	1.18	
2102A-4	1.18	
2102A-5	1.18	
2102A-6	1.18	
2102A-7	1.18	
2102A-8	1.18	
2102A-9	1.18	
2102A-10	1.18	
2102A-11	1.18	
2102A-12	1.18	
2102A-13	1.18	
2102A-14	1.18	
2102A-15	1.18	
2102A-16	1.18	
2102A-17	1.18	
2102A-18	1.18	
2102A-19	1.18	
2102A-20	1.18	
2102A-21	1.18	
2102A-22	1.18	
2102A-23	1.18	
2102A-24	1.18	
2102A-25	1.18	
2102A-26	1.18	
2102A-27	1.18	
2102A-28	1.18	
2102A-29	1.18	
2102A-30	1.18	
2102A-31	1.18	
2102A-32	1.18	
2102A-33	1.18	
2102A-34	1.18	
2102A-35	1.18	
2102A-36	1.18	
2102A-37	1.18	
2102A-38	1.18	
2102A-39	1.18	
2102A-40	1.18	
2102A-41	1.18	
2102A-42	1.18	
2102A-43	1.18	
2102A-44	1.18	
2102A-45	1.18	
2102A-46	1.18	
2102A-47	1.18	
2102A-48	1.18	
2102A-49	1.18	
2102A-50	1.18	
2102A-51	1.18	
2102A-52	1.18	
2102A-53	1.18	
2102A-54	1.18	
2102A-55	1.18	
2102A-56	1.18	
2102A-57	1.18	
2102A-58	1.18	
2102A-59	1.18	
2102A-60	1.18	
2102A-61	1.18	
2102A-62	1.18	
2102A-63	1.18	
2102A-64	1.18	
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2102A-67	1.18	
2102A-68	1.18	
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2102A-74	1.18	
2102A-75	1.18	
2102A-76	1.18	
2102A-77	1.18	
2102A-78	1.18	
2102A-79	1.18	
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2102A-82	1.18	
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2102A-84	1.18	
2102A-85	1.18	
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2102A-88	1.18	
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2102A-94	1.18	
2102A-95	1.18	
2102A-96	1.18	
2102A-97	1.18	
2102A-98	1.18	
2102A-99	1.18	
2102A-100	1.18	

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	MM5364	4.00
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	MM5380	4.00
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	MM5396	4.00
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3.3	13	56	290	390	18K	56K	330K		
3.6	15	62	330	430	20K	62K	360K		
3.9	16	68	360	470	22K	68K	390K		
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4.7	20	82	430	560	27K	82K	470K		
5.1	22	91	470	620	30K	91K	510K		
5.6	24	100	510	680	33K	100K	560K		
6.2	27	110	560	750	36K	110K	620K		
6.8	30	120	620	820	39K	120K	680K		
7.5	33	130	680	910	43K	130K	750K		
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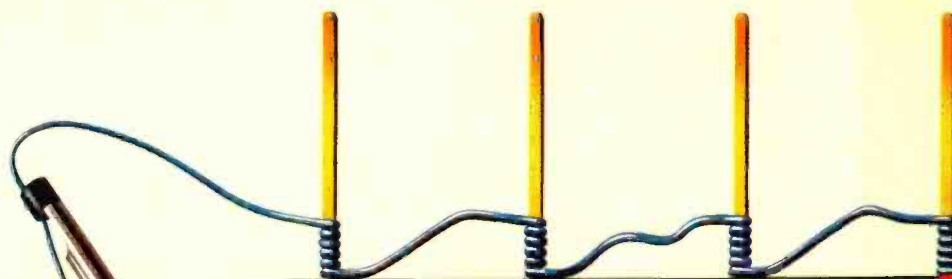
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