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Radio-Electronics

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

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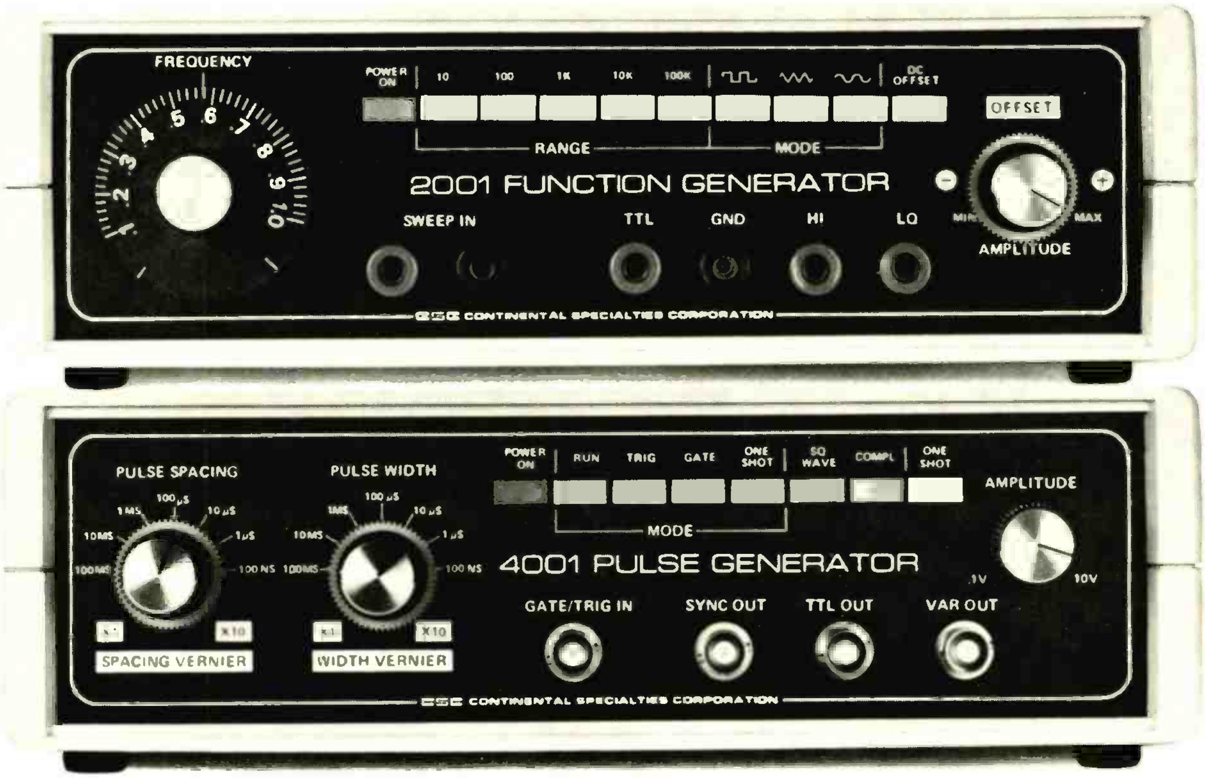

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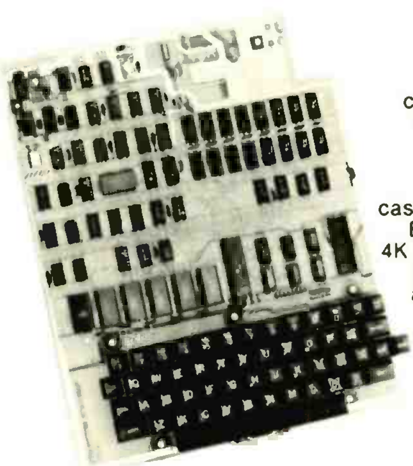

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SEPTEMBER 1979 Vol. 50 No. 9

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

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 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 sampled 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 it's 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 that 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 saphire 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 compatable, nor is either one compatable with the Philips system.

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

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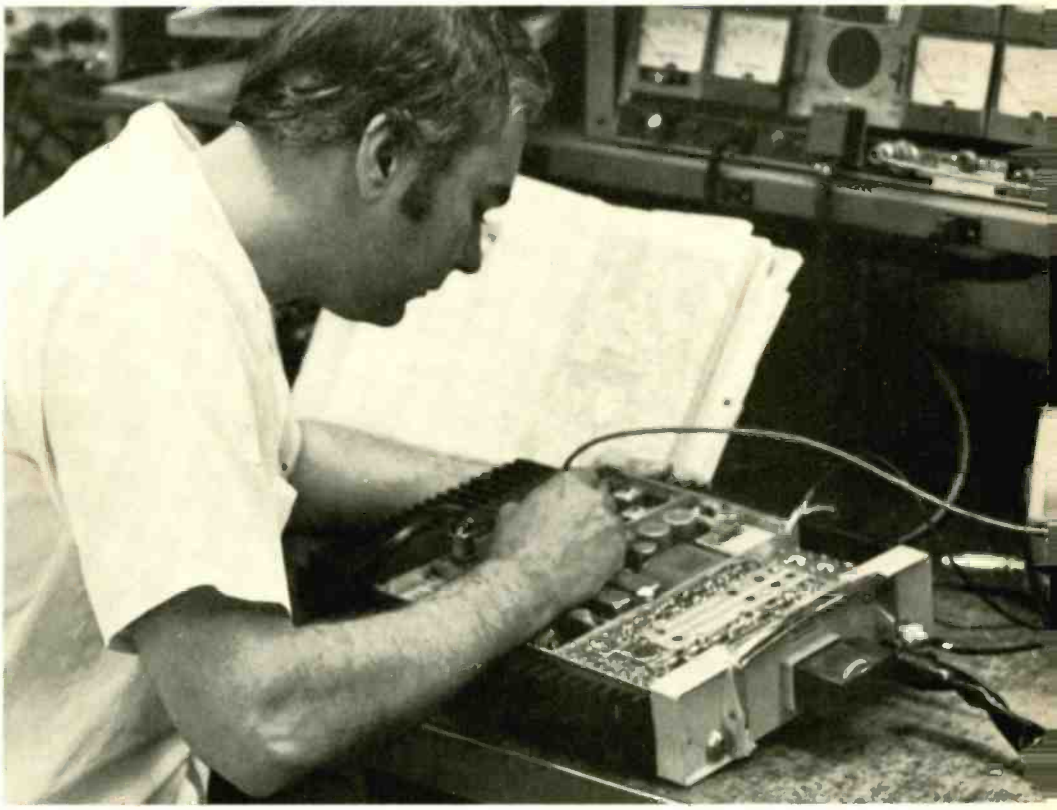

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what's news

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 softwear. 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.

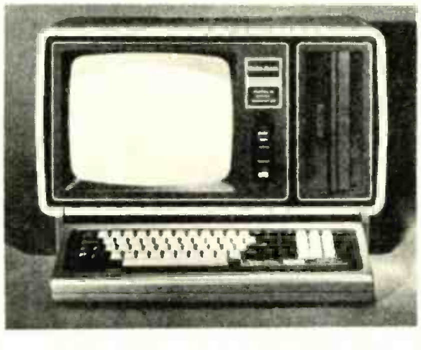
Texas Instruments New Computer

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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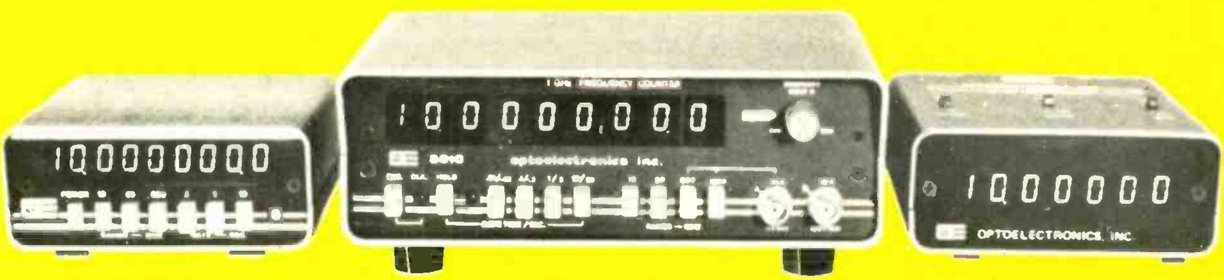

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K-7000 kit	79.95	550 MHz	7	5-20 mV	10-30 mV	20-50 mV to 550 MHz	1-10 mV	(2) 1, 1 SEC	10 Hz	10 Hz	100 Hz 550 MHz	1.6 PPM	5.24288 MHz	NO	YES OPTION $15
7010 *7010.1	145.00 225.00	600 MHz	9	5-20 mV	10-30 mV	20-40 mV to 600 MHz	1-10 mV	(3) 1, 1, 10 SEC	.1Hz	1 Hz	10 Hz 600 MHz	1 PPM 0.1 PPM	10 MHz	YES OPTION $25	YES OPTION $15
8010 *8010.1	325.00 405.00	1 GHz	9	1-10 mV	5- 20mV	10-35 mV	1-10 mV	(8) .01-20 SEC	1 Hz	1 Hz	10 Hz 1 GHz	1 PPM 0.1 PPM	10 MHz	YES STD	YES OPTION $39.

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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

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 traffice 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 (*C*ontinuous *W*ave) 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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John E Cunningham

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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

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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

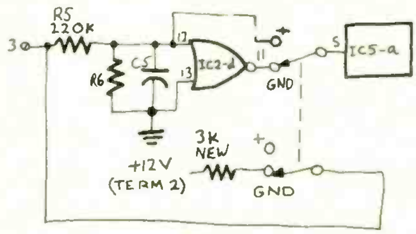

FIG. 1

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

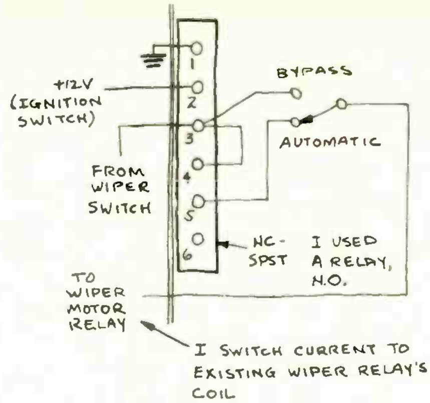

FIG. 2

(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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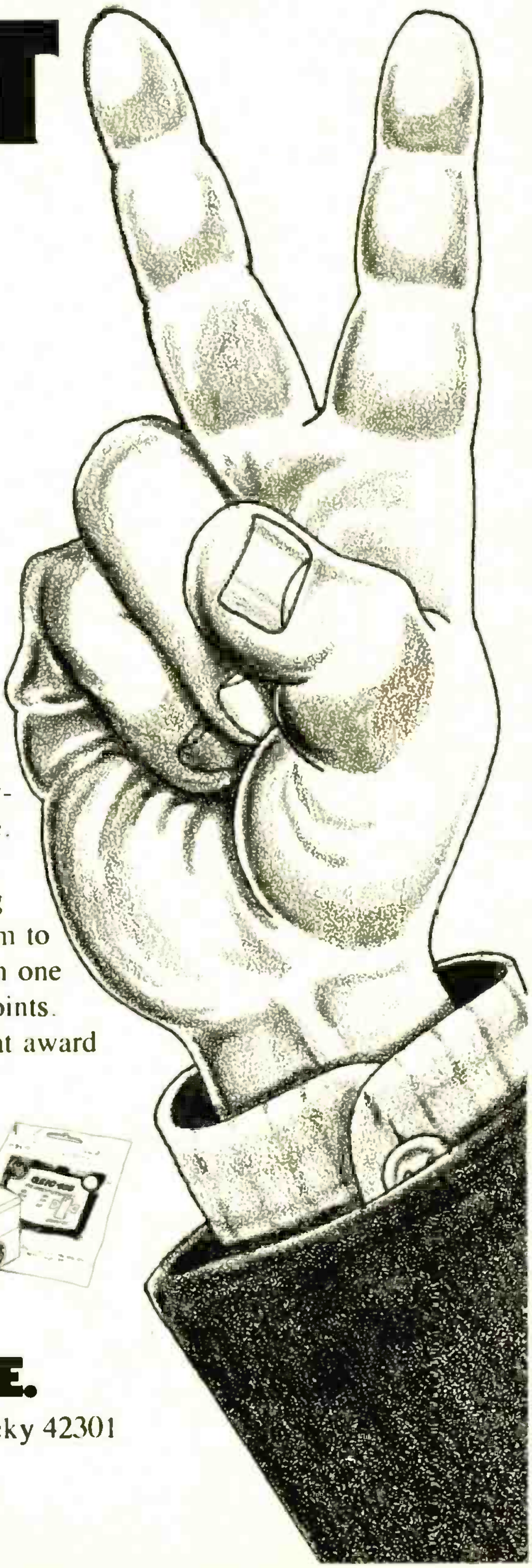

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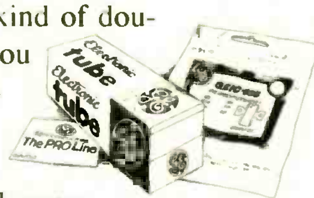

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GENERAL ELECTRIC

LETTERS
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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 police 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**

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

CIRCLE 60 ON FREE INFORMATION CARD

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EQUIPMENT REPORTS
continued from page 26

IF section have only about a 4.5-mHz bandpass. 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.
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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 4¾" X 3½" X 3½".

LAMP MODULE

Each module will control any incandescent lamp rated up to 300 watts from control signals received from the Command 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 - ⅓ 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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continued from page 32

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

CIRCLE 103 ON FREE INFORMATION CARD

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 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: 0.4μV 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 $\pm$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-generation, but it does work. Sensitivity should not be a problem for listeners near airports or aircraft flight patterns.

The greater improvement of this unit over all previous scanners is the virtual eradication of spurious signals. Reception is exceptionally clean of these phantom signals with no sacrifice in receiver sensitivity.

Scanning and search rates are slower than on previous *Bearcat* programmable scanners. A SPEED key selects between two speeds, which seems unnecessary since listeners would undoubtedly prefer to intercept communications as rapidly as possible.

A clever innovation in the *model BC220* is the inclusion of a preprogrammed aircraft and marine-band search/limit feature. Simply press AIRCRAFT or MARINE key, and the unit starts searching either of those bands for signals. Another desirable provision is the inclusion of a hold feature (not shown in the photo). This feature permits you to stop the search mode at any point and remain on the frequency displayed until the SEARCH key is pressed again. On some previous *Bearcat* models, the only way the unit could be stopped on a particular frequency when no signal was present was by advancing the squelch control. This was a noisy inconvenience, and the relief is welcome!

A PRIORITY mode is also featured for the channel one position. As with previous *Bearcat* programmable scanners, a brief interruption every 3 seconds samples channel one when the priority channel is in use; this may be irritating to some listeners.

A key is also provided for delay/no delay. When no delay is desired, scan or search functions resume immediately upon the loss of the carrier signal. Unfortunately, even with delay, scanning resumes almost as fast—within 1 second. All scanners should provide a delay time of no less than 2 or 3 seconds. If not there is scarcely enough time for the listener to be distracted, look at the display, and register the frequency or channel number before the unit resumes its search or scan function.

Audio passband is crisp, enhancing good voice fidelity. Any channel, from 1 through 20, can be selected at random without your having to step through the sequence. Search-limit programming is simplified. The keyboard action is very positive; no contact bounce was apparent as observed with some other scanners. And the display itself provides thicker and brighter characters.

All tests considered, we liked the *model BC220*. It performs well by itself or as a receiving mainframe with outboard converters, such as a 220–400-MHz converter for the UHF/AM military aircraft band. The *model BC220 Bearcat* has a suggested retail price of $379.95 and is available from Electra Company, Cumberland, IN 46229. **R-E**

Motorola Model CM540 Electroscan CB Transreceiver

MOTOROLA, LONG A LEADER IN RADIO COMMUNICATIONS equipment, has released an advanced CB radio. Called the *Electroscan*, the Model CM540 40-channel transceiver has no fewer than 28 (count 'em, 28!) front panel and mike-mounted pushbuttons, controls, and visual indicators.

In spite of the busy appearance of the rig, it does look more like a professionally-engineered piece of advanced communications 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 passband 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 automatic 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.

CIRCLE 104 ON FREE INFORMATION CARD

A memory feature permits up to ten channels 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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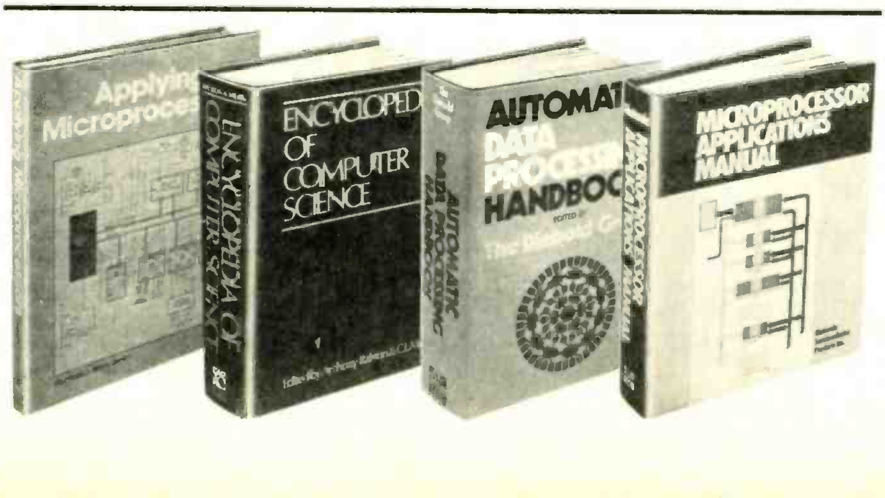

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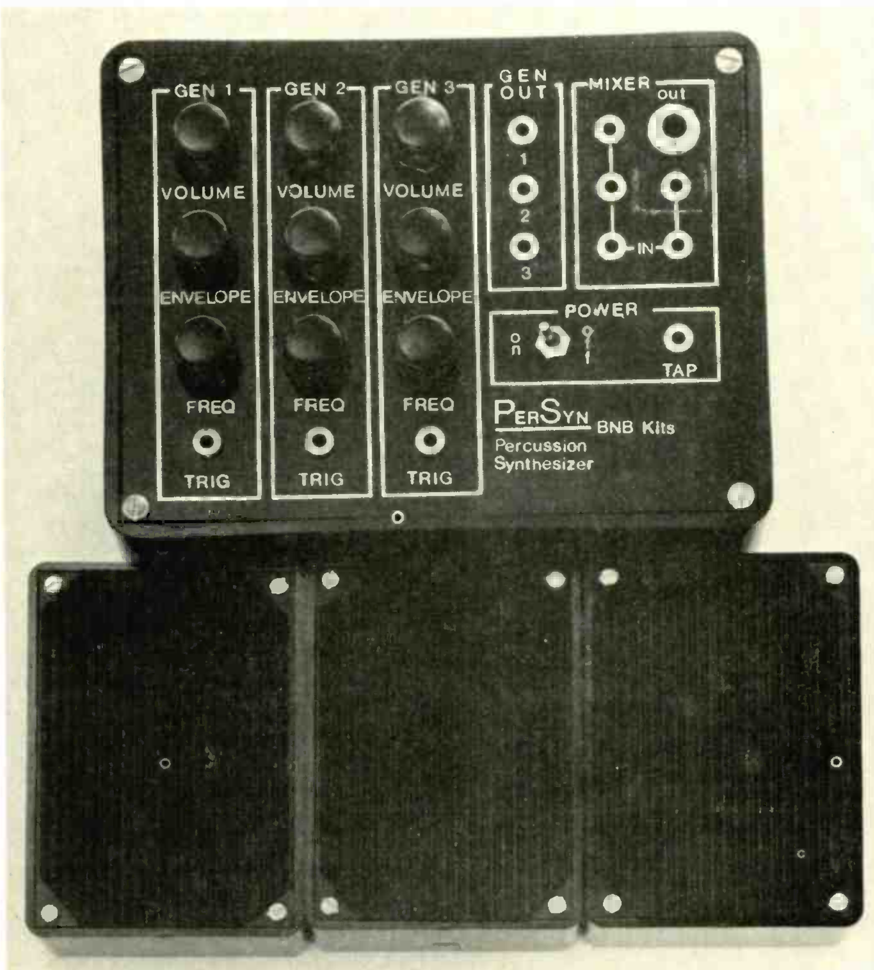
Even if you don't play a percussion instrument, you can have loads of fun simulating congas, bongos, wood blocks and timpani; either manually or with triggering from special circuits.

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).



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.

How it works

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

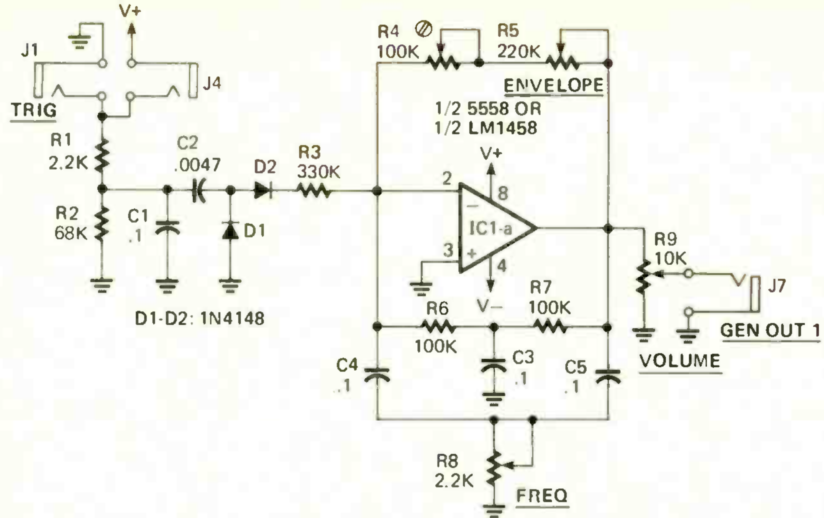
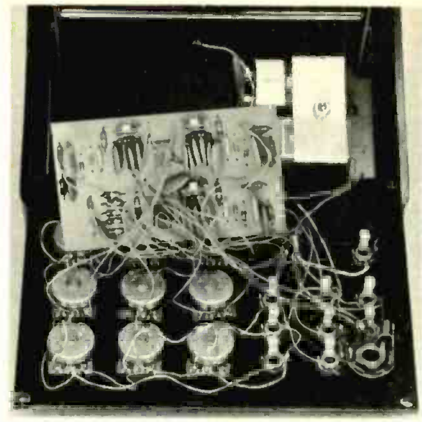


FIG. 1—SCHEMATIC of one of the three identical tone generators.



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

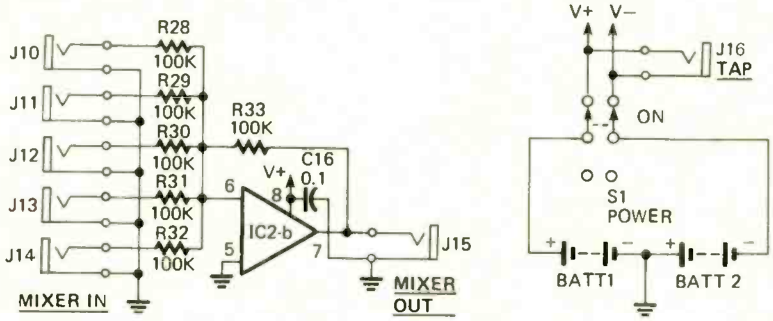
generator circuits built around two 5558 or 1458 dual op-amps (IC1 and IC2). (Table 1 compares the codes and IC pin connections of Generators 2 and 3 to Generator 2 in Fig. 1.) Using the IC1-a circuit as an example, we see that shorting J4 (or providing a positive voltage level to trigger jack J1) quickly 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 circuit 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 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

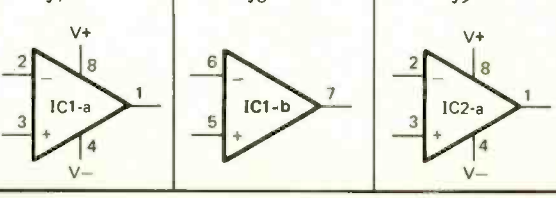


a) b)

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	



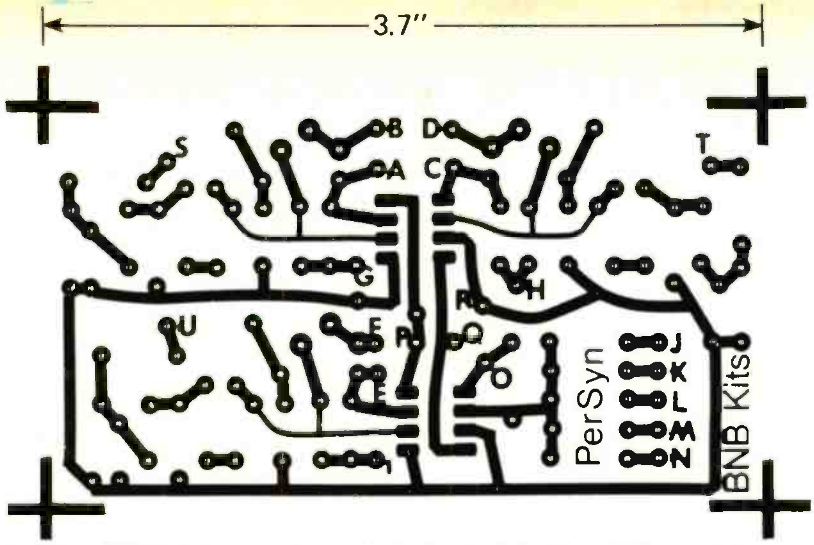


FIG. 3—FOIL PATTERN of the percussion synthesizer printed-circuit board. You can etch your own or get them in the complete kit of parts that is available.

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 6/32 × 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 ¼ 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—0.1 µF
C2, C7, C12—.0047 µF
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

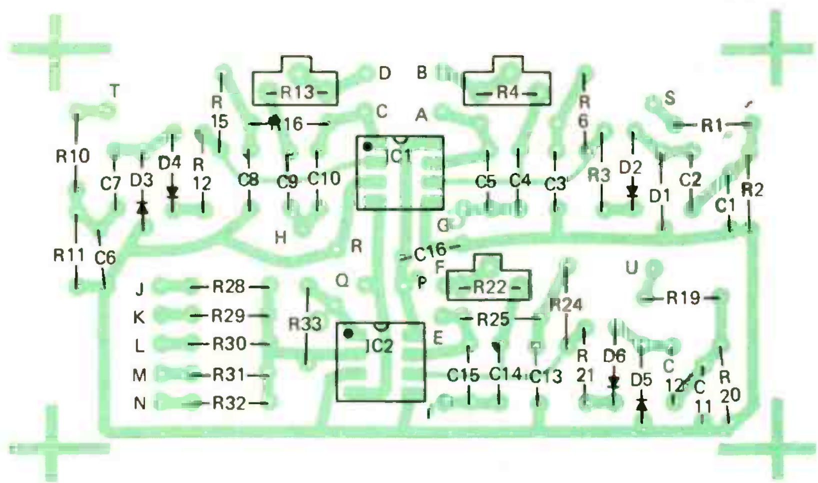


FIG. 4—COMPONENT LAYOUT for the percussion generator. Pads marked by letters A-U are for connections to the switch, pots and jacks on the panel.

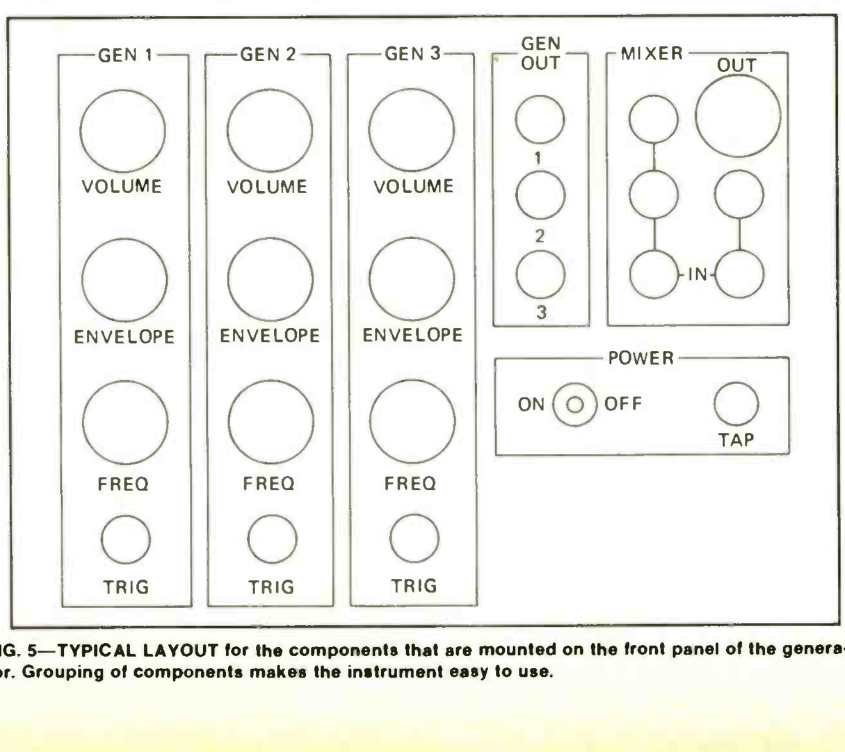


FIG. 5—TYPICAL LAYOUT for the components that are mounted on the front panel of the generator. Grouping of components makes the instrument easy to use.

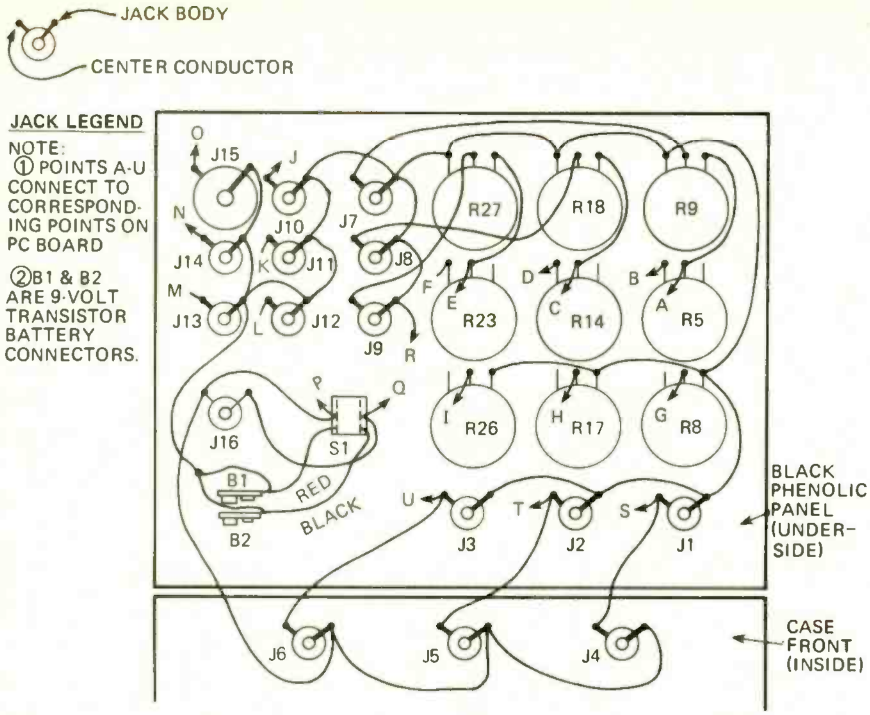
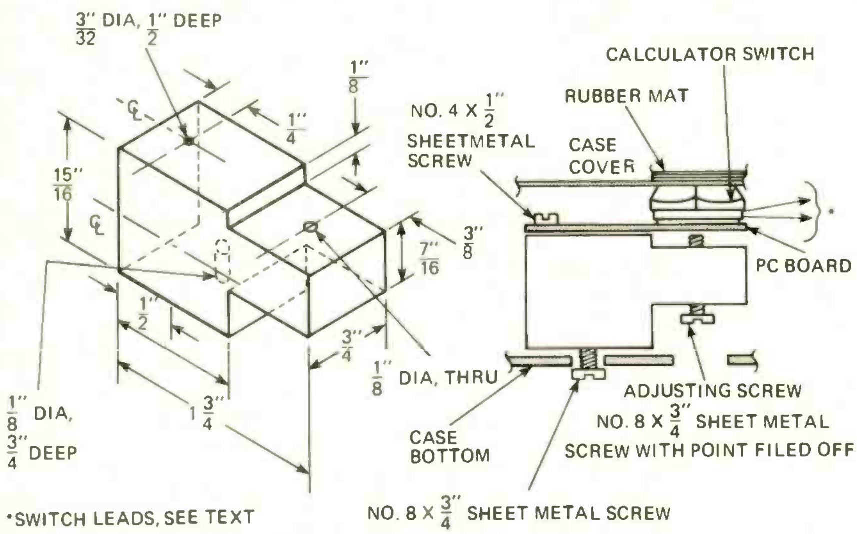
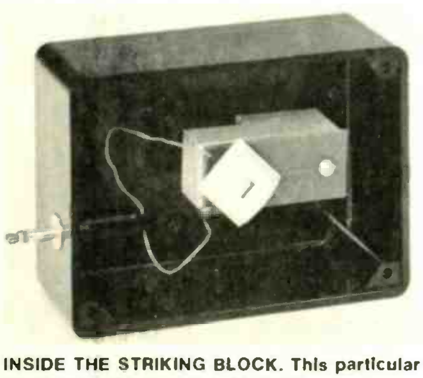


FIG. 6—INTERWIRING of the components on the control panel of the instrument. The points marked "A" through "U" are for making connections to the PC board.



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.

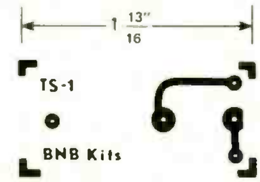


INSIDE THE STRIKING BLOCK. This particular block is on the right in lead photo.

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

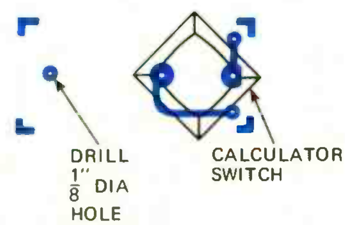


FIG. 9—CALCULATOR SWITCH positioned on the PC board. See photo on this page.

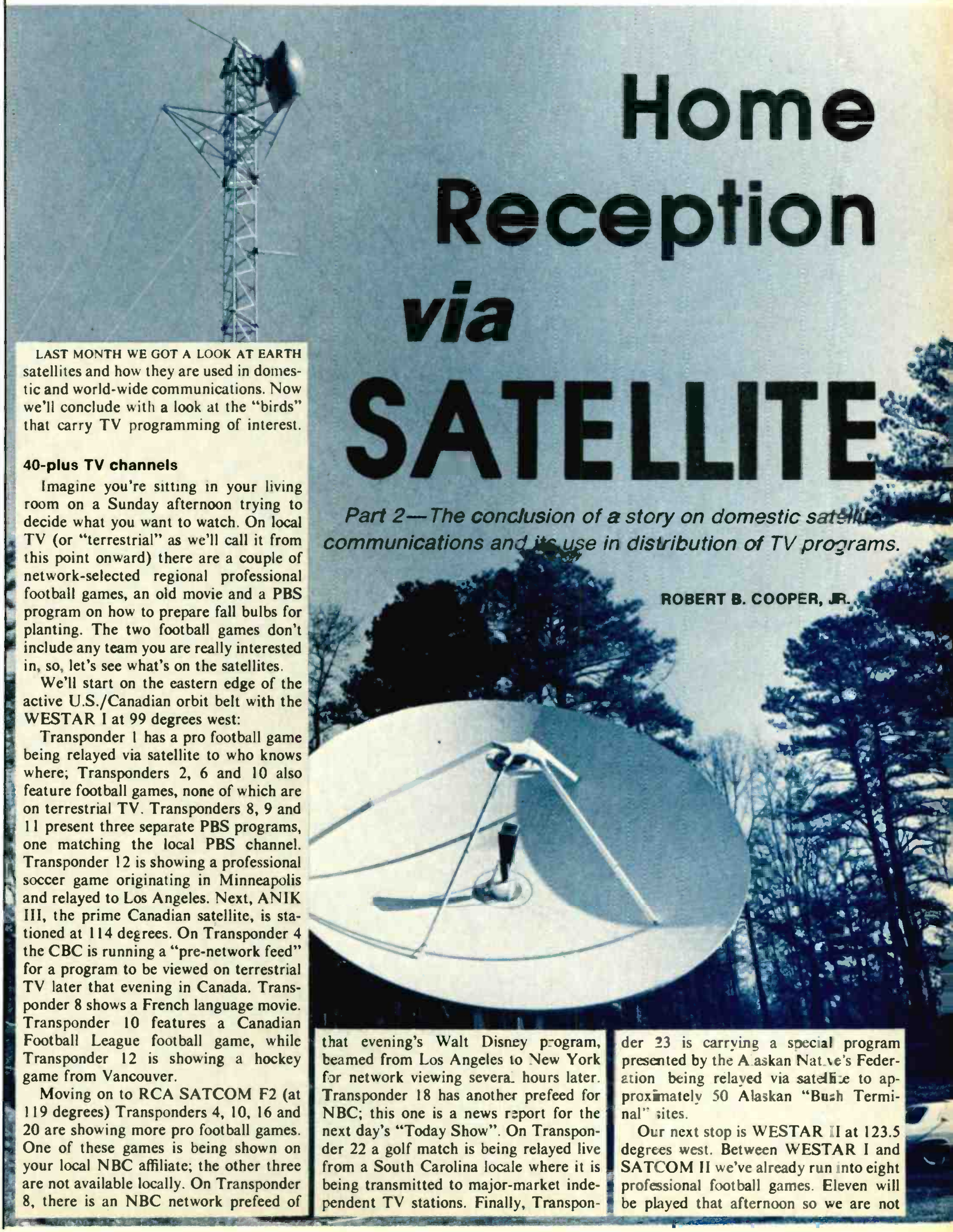
Back off the screw a few turns and begin again. After a sound is generated, back off the adjusting screw about a quarter turn. Tap the cover plate and note the presence of an output. Adjust the screw to obtain the sensitivity desired. Repeat this adjustment for the remaining two striking surface boxes.

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**



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.

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, Transponder 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 I, 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 (*C*hristian *B*roadcasting *N*etwork) 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 (*H*ome *B*ox *O*ffice), and as you tune in they are previewing the day's movie and 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.

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. 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.

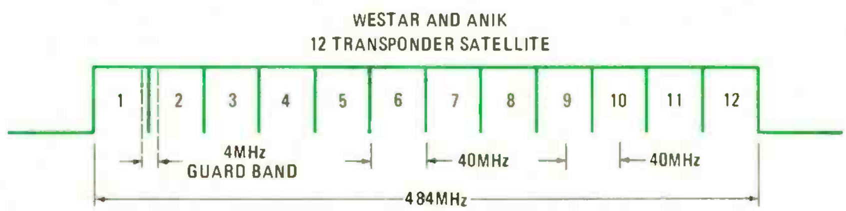


FIG 4—THE DOWNLINK BAND is 500 MHz wide from 3.7 to 4.2 GHz and is divided into 12 channels. Each channel is 40 MHz wide.

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

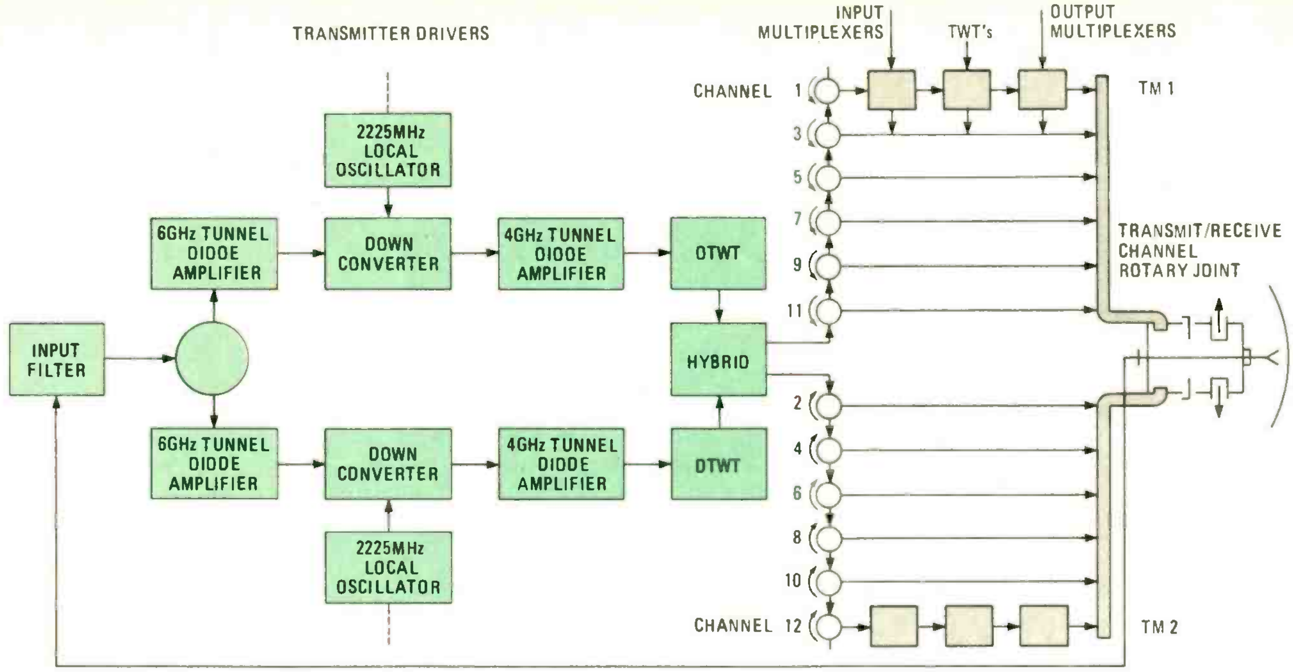


FIG. 5—12 CHANNEL SATELLITE designed by Hughes Aircraft.

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 (*T*raveling *W*ave *T*ube) 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:

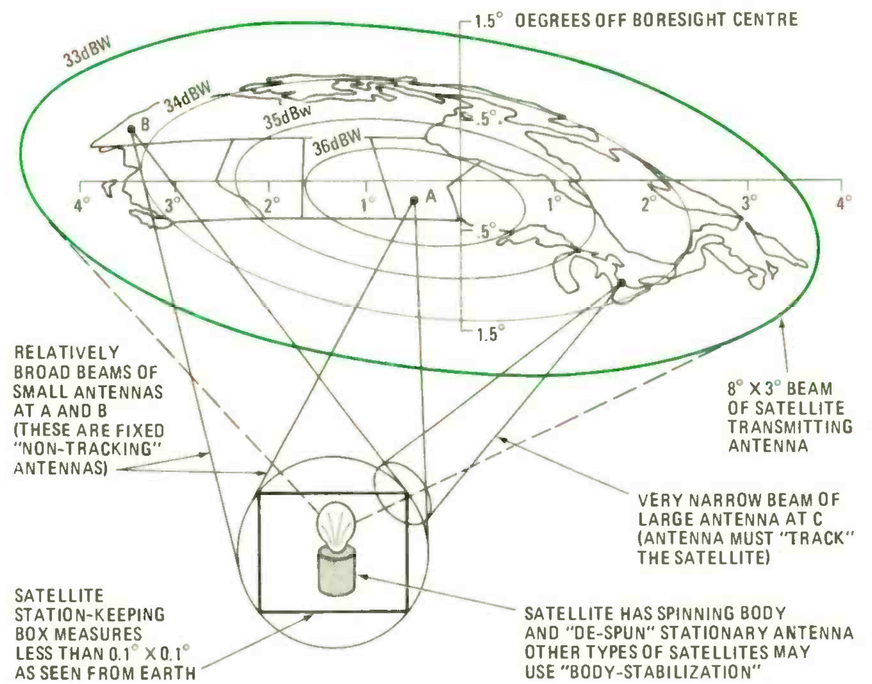


FIG. 6—TYPICAL COVERAGE of the earth's surface by a satellite. Two different approaches to receiving antennas are shown. Small antennas with a broad beam can be non-tracking while large antennas with a narrow beam must track the satellite.

TVRO terminals

TVRO (*Tele*V*ision* *R*eceive-*O*nly) 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.

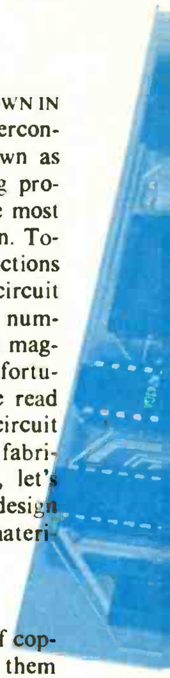
This indicates that *if* the frequency-modulated satellite video signal could be maintained just above the noise threshold and if the satellite signal was very stable, you could get by with a "low-margin" (for fading) receive system that would to all normal eyeball testing give the same apparent picture 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 baseband 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

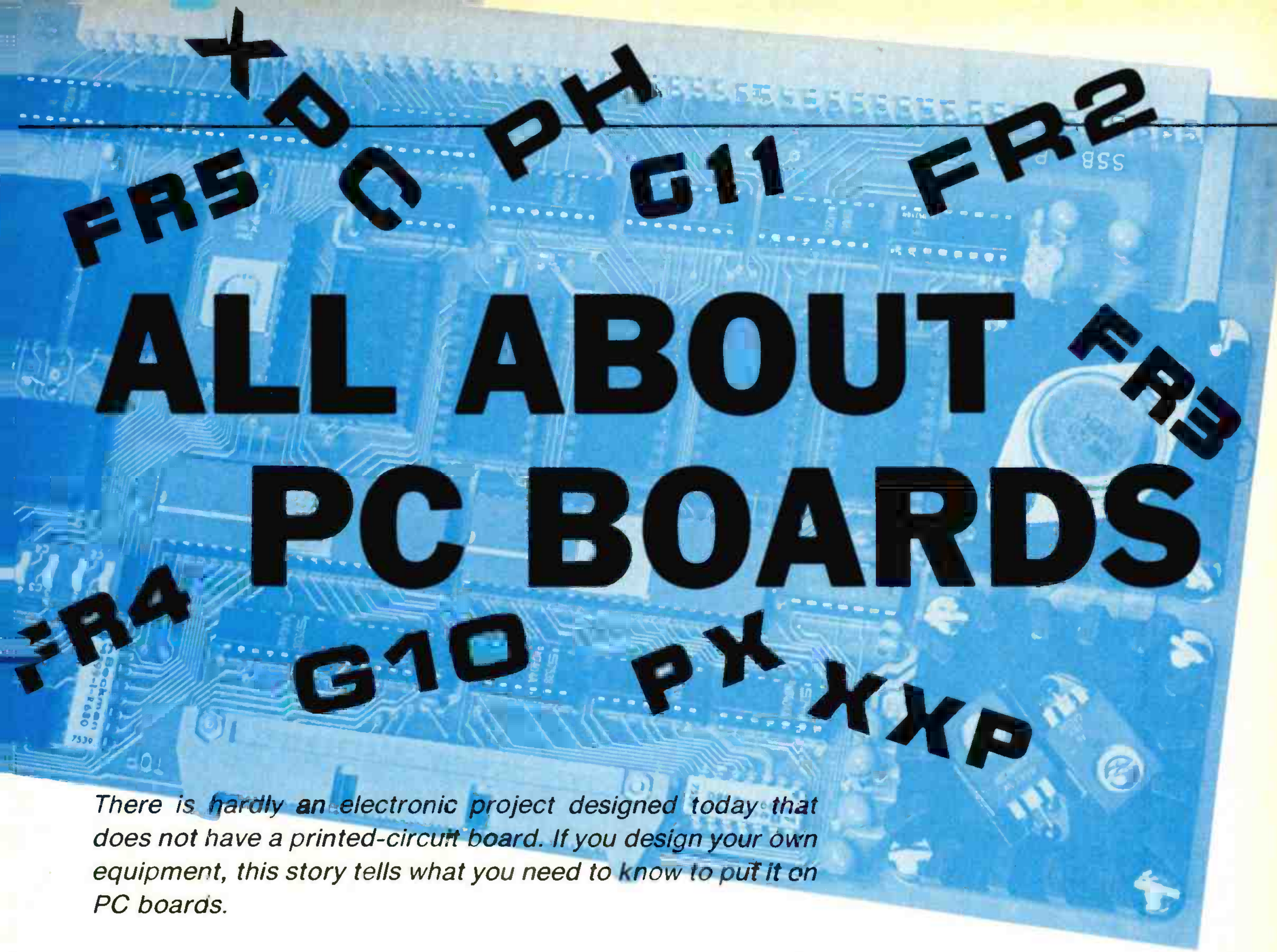
There are seven general classes of copper-clad stock used today; three of them are a phenolic paper base and four are a type of glass epoxy. The first phenolic paper material has two subclasses—designated XXXP and XXXPC—where the only difference in their characteristics is that the XXXPC material must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

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 (*N*ational *E*lectrical *M*anufacturers *A*ssociation) 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 featurTof 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

$$C = (0.00235)\,\frac{W\,d}{s}$$

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:

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

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. Therefore, 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—

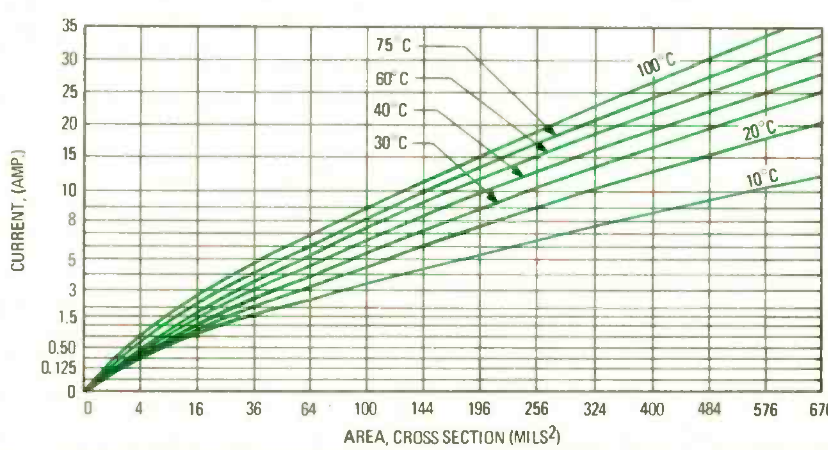


FIG. 1—CONDUCTOR CROSS-SECTIONAL AREA vs. current flow for safe temperature rise above ambient.

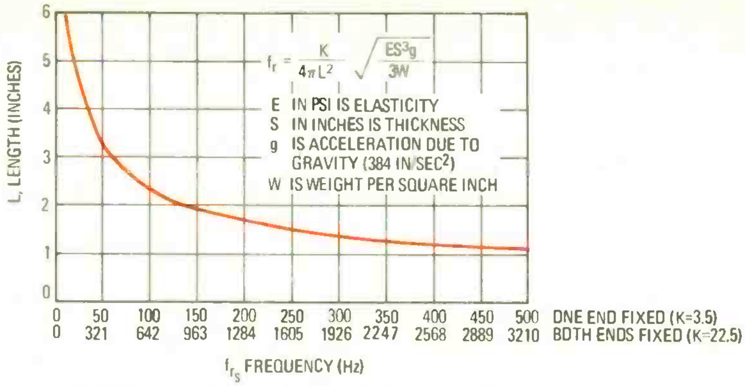


FIG. 2—RESONANT FREQUENCY as a function of board length.

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 5¼ times greater then 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 ¼-watt resistors and fourteen bypass capacitors, the following equation would result:

$$A_C = 10\,A_{IC_{14}} + 3\,A_{IC_{16}} + 15\,A_R + 14\,A_C$$

Since, $A_{IC_{14}} = 0.257$ sq. in.; $A_{IC_{16}} = 0.264$ 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 24½ 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 *Puppet* 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 ½ 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 ½-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 withstand 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 ¼-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

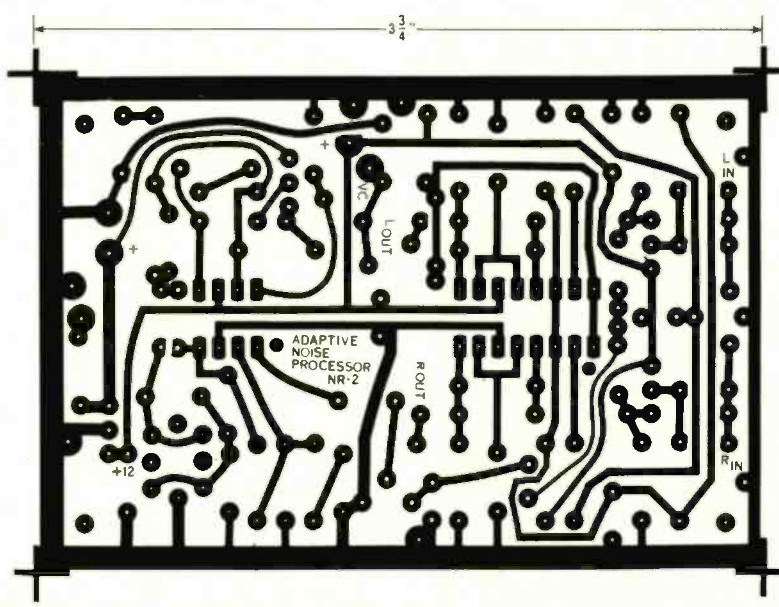


FIG. 7—FULL-SIZE FOIL pattern for the main board in the noise filter. The circuit on top half of board is for left channel; right channel is on lower half.

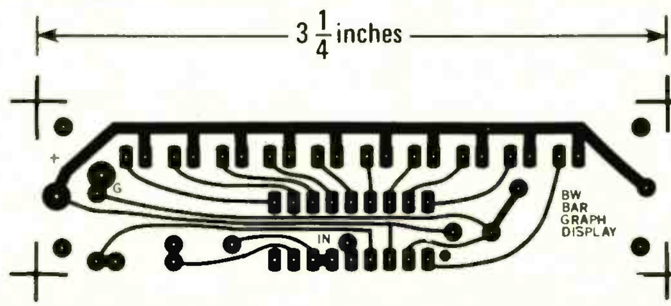


FIG. 8—THE BAR-GRAPH is made by mounting rectangular LED's in this PC board along with the IC that drives the individual elements.

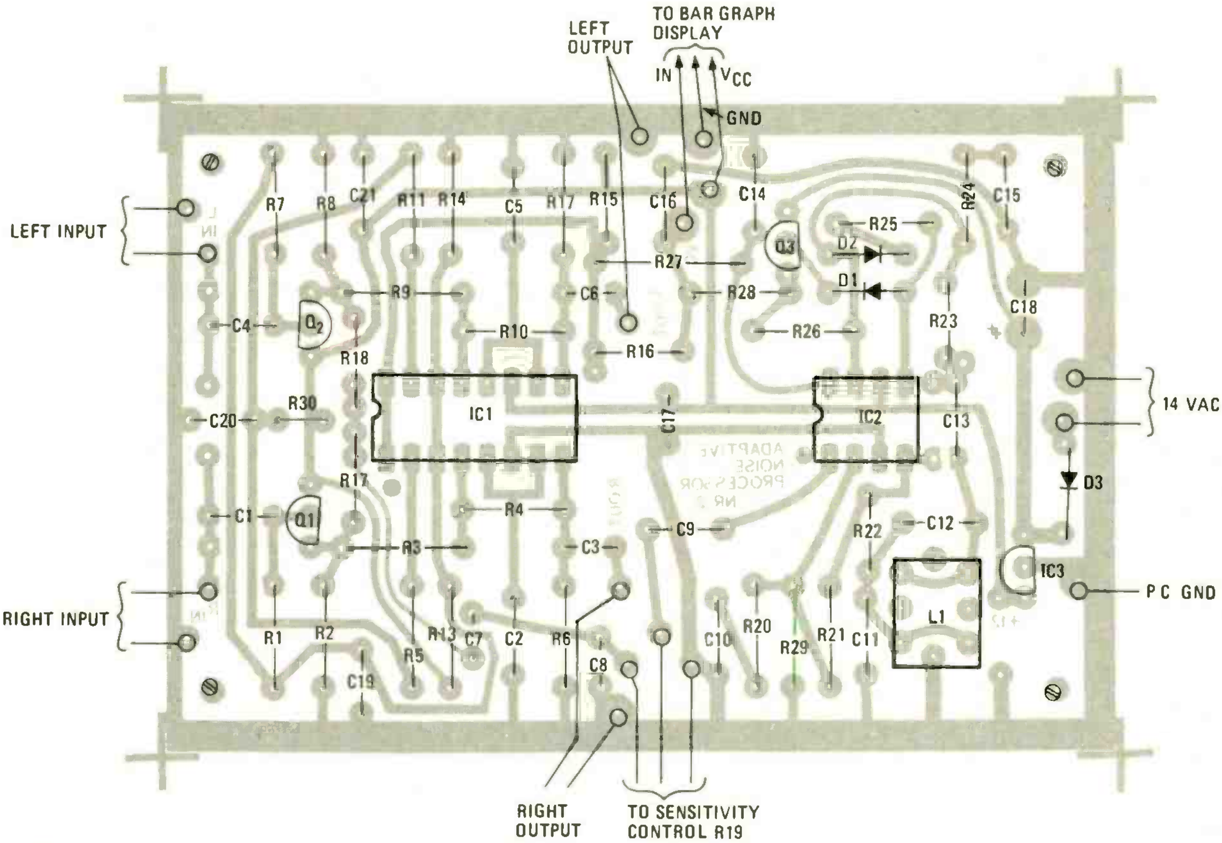


FIG. 9—HOW PARTS ARE POSITIONED on the filter's main circuit board. Patterns on the left side of board are almost mirror images because they are for right- and left-channel inputs.

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.

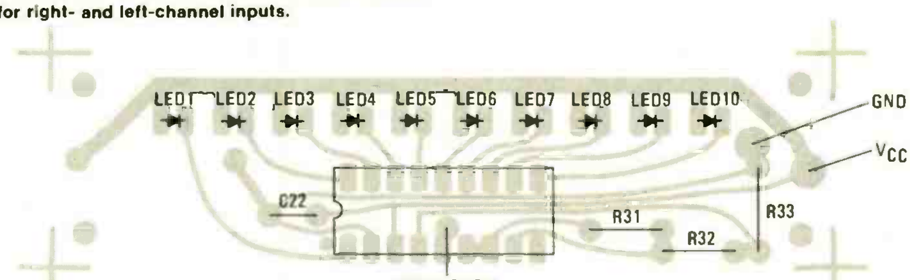


FIG. 10—COMPONENT LAYOUT for the display board. The rectangular LED's in the bar-graph protrude through a narrow slot that is cut in the front panel.

Using the filter

The Adaptive Noise Filter can now be connected in the tape monitor loop of a 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 present 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 pretuned 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%, ¼ 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 μF, 16 volts electrolytic, radial leads
C2, C5—.0047 μF, 50 volts, Mylar, 10%
C3, C6—5 μF, 10 volts, electrolytic, radial leads
C7, C8—.001 μF, 50 volts, ceramic disc
C9, C10—.01 μF, 50 volts, ceramic disc
C11, C14, C15, C17, C21, 022—0.1 μF, 50 volts, Mylar
C12—.015 μF, 50 volts, Mylar, 5%
C13—.033 μF, 50 volts, Mylar
C16—6.8 μF, 25 volts, tantalum, 10%, radial leads
C18—470 μF, 25 volts, electrolytic, radial leads
C19—10 μF, 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)

Miscellanepus

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—¼-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.

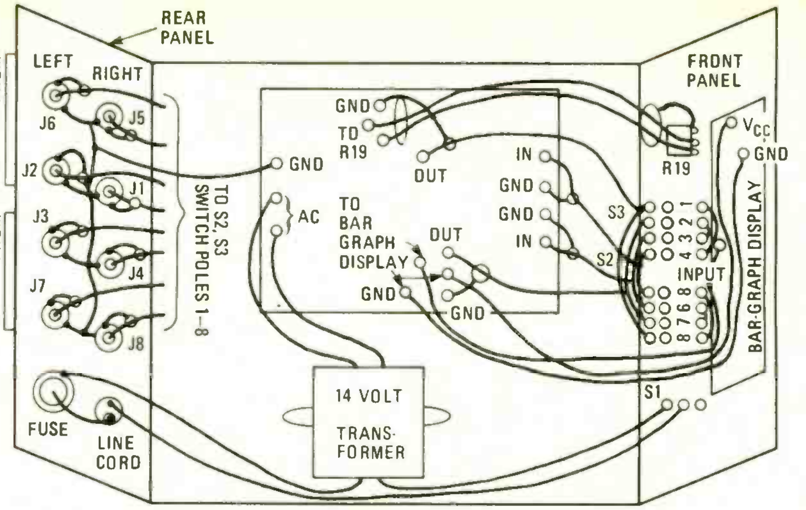
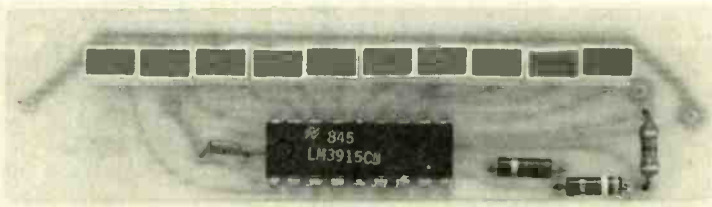
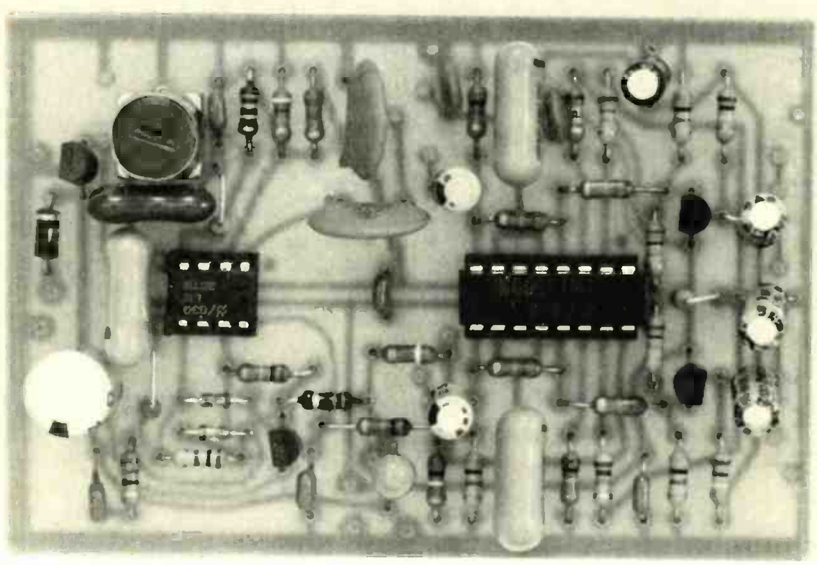


FIG. 11—WIRING LAYOUT shows connections between the main circuit board, the components on the back panel and the switches, pot and display board on the front panel.





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 ×1, ×10 and ×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 protective 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.

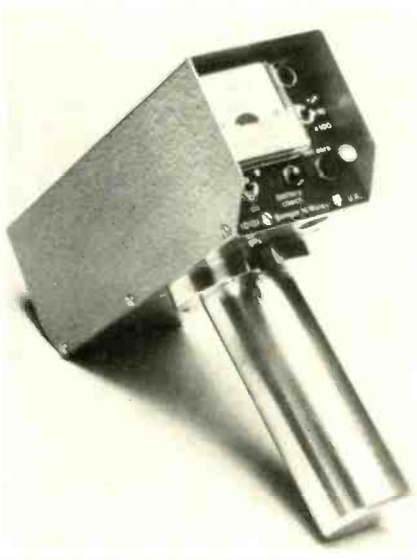


FIG. 1—FIELD MILL DEVICE measures electrostatic surface charge. Reading is in volts-per-centimeter.

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 ⅜ 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; 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. 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-

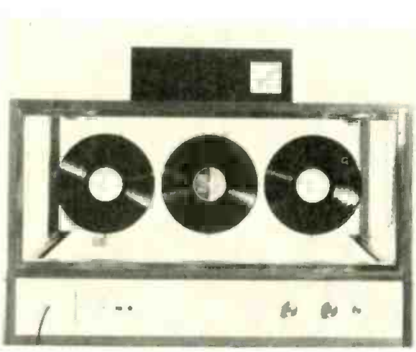


FIG. 2—DUST CHAMBER produces a dust storm that is used to demonstrate anti-static effectiveness.

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.

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

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

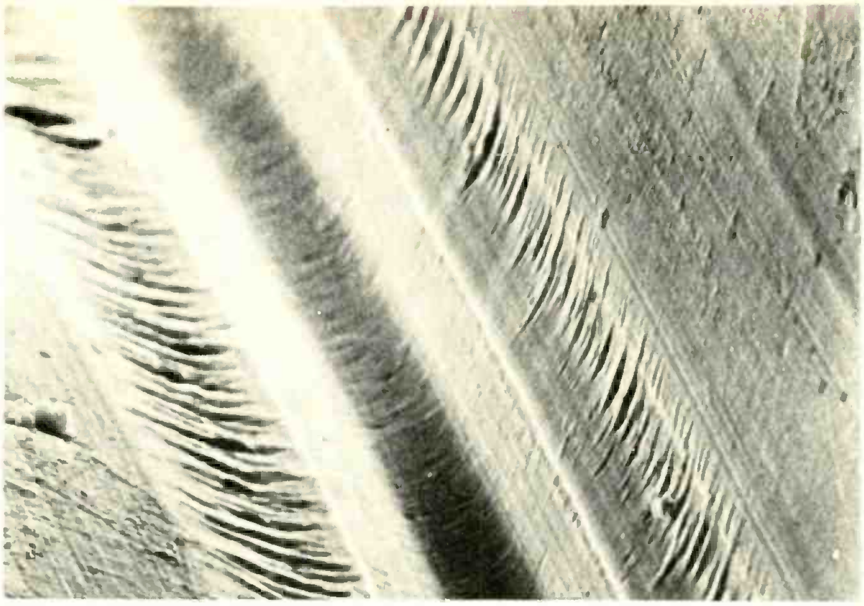


FIG. 7—SINGLE RECORD GROOVE of untreated record after 100 plays as viewed through electron microscope.

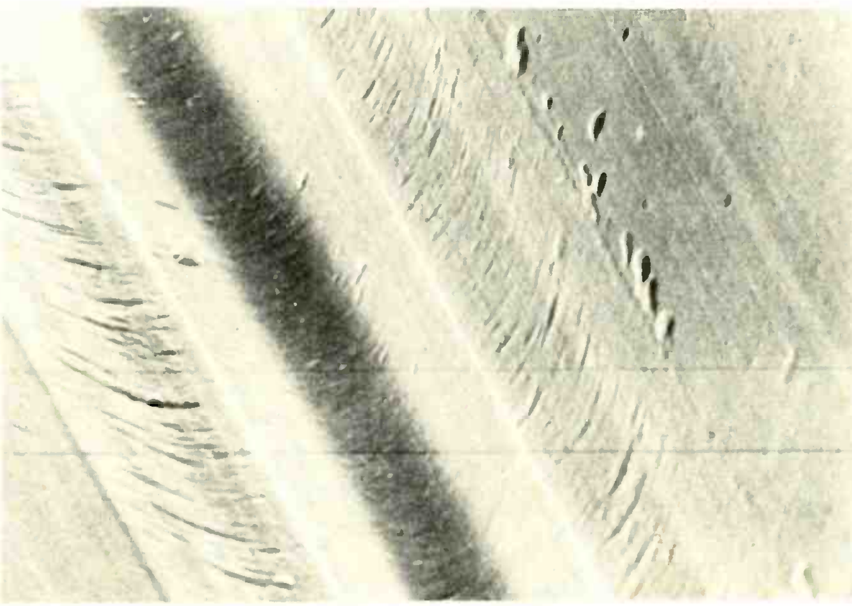


FIG. 8—PERMOSTAT-TREATED record groove after 100 plays.

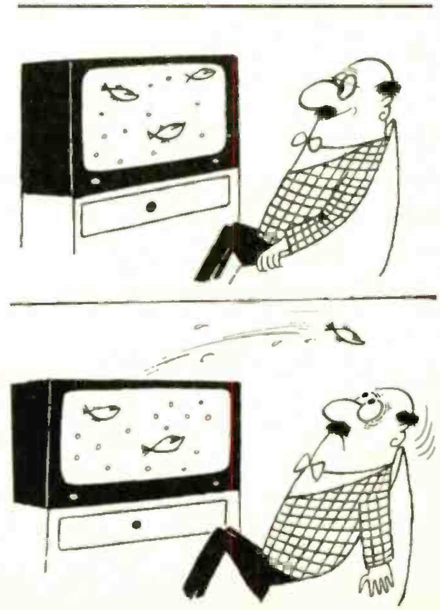
ronment results in an appreciable collection of dust and debris on the disc surface. If such phonograph records are highly charged, it becomes extremely difficult to dislodge the dust. In the case of a record whose charge has been neutralized to zero volts, whatever dust does accumulate can be easily 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.

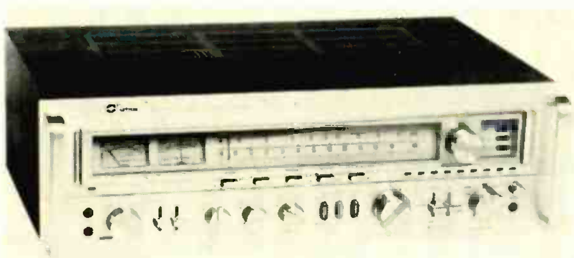
Figure 6 shows the *Permostat* treated disc, after *their emergence from* the dust-chamber test. In the course of the demonstration conducted by Stanton, several pertinent questions were asked regarding the use of *Permostat* with other preparations, such as *cleaning* liquids and preservatives. We learned 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 reduce overall friction between the pickup 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 serrations 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**





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 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-μs 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

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 μV. **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 × 6.7 H × 13.8 inches D. **Weight:** 37 lb. **Suggested Retail Price:** $879.95.

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 receptable 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 distorion 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.

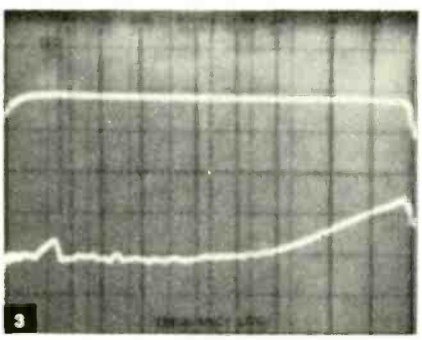
TABLE 1

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 (μV) (dBf)	2.0 (11.2)	Very good
Sensitivity, stereo (μV) (dBf)	4.2 (17.6)	Excellent
50-dB quieting signal, mono (μV) (dBf)	3.1 (15.0)	Very good
50-dB quieting signal, stereo (μV) (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 (±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 (μV) (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 (μV) (dBf)	2.5 (13.2)	Excellent
Dial calibration accuracy (±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



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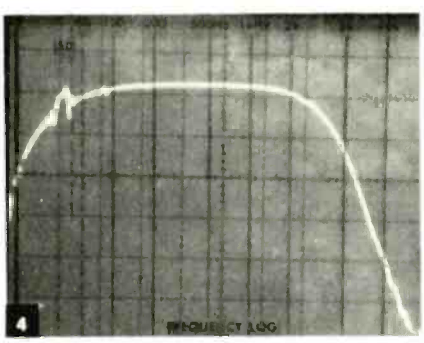

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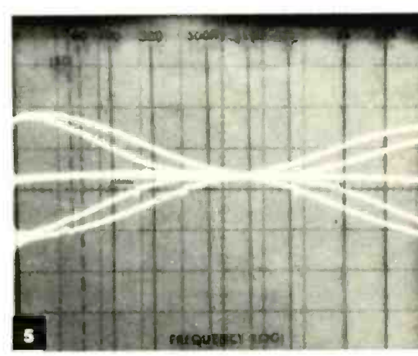
Setton is one of the few manufacturers of stereo receivers that is willing to disclose the AM frequency response of their products. As it turns out, although the stated response range is nothing to be proud of, it was somewhat exceeded in our test sample as is shown in the response trace of Fig. 4. The −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.

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



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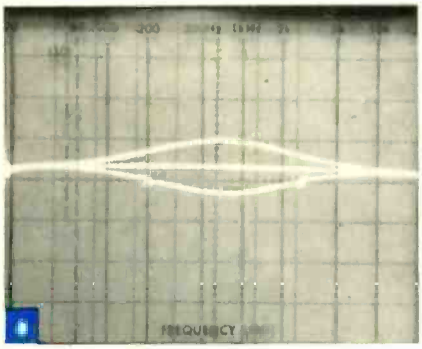
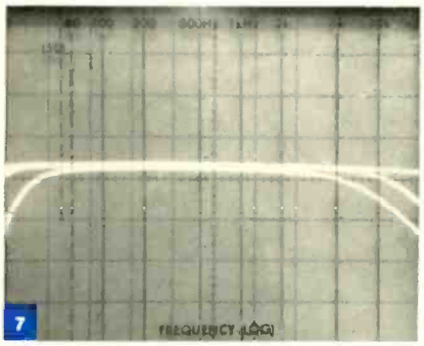
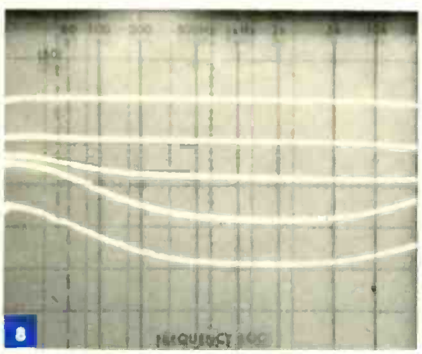
clearly provides increased tone control flexibility that is further augmented by the MID-range tone control whose maximum boost and cut range is shown in the scope photo of Fig. 6.

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 phisically 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**
PHONO PREAMPLIFIER MEASUREMENTS		
Frequency respons (RIAA ± 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, ± 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**

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.

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 frequency 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.)

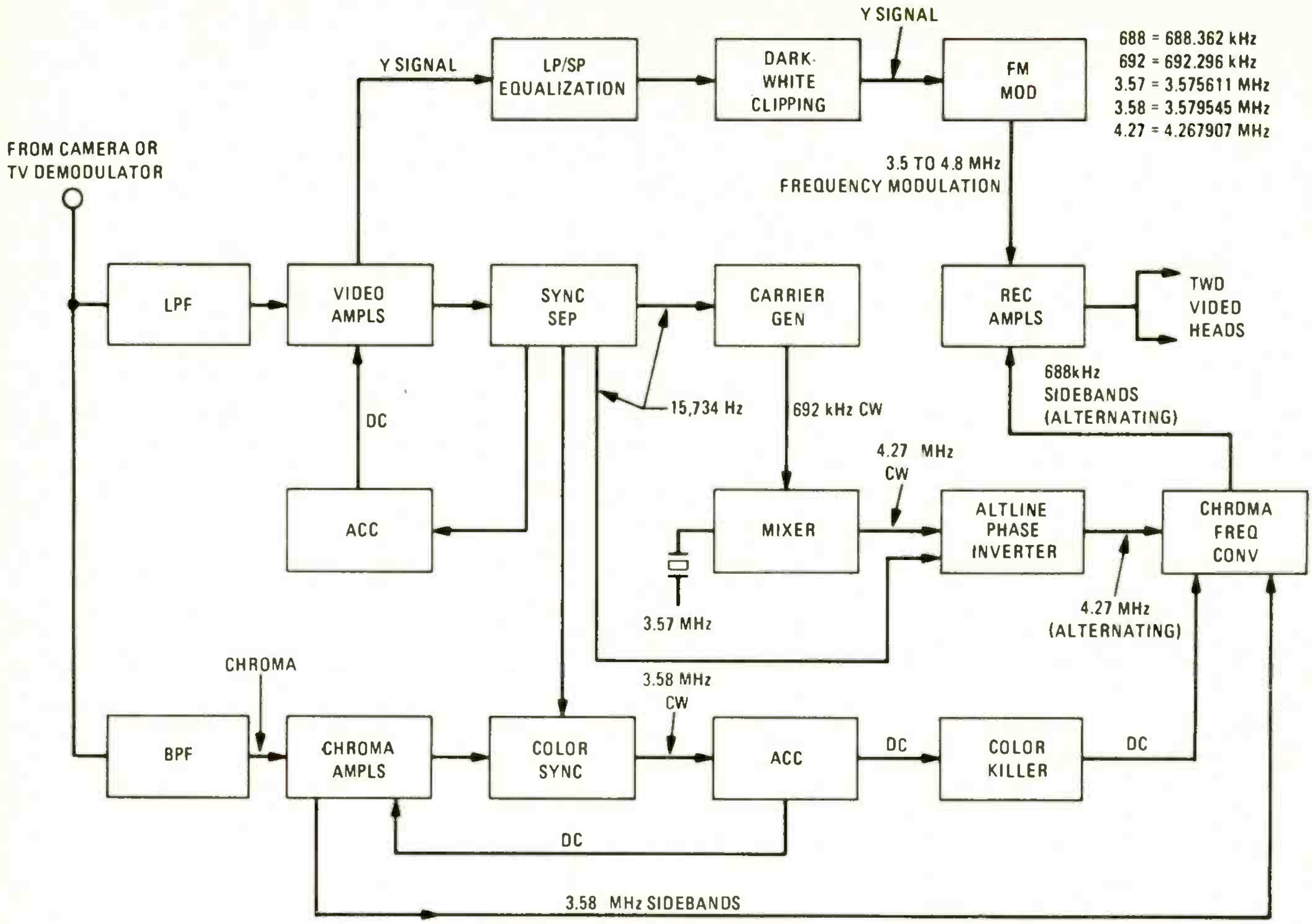


FIG. 1—BETA recording function

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 continous-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

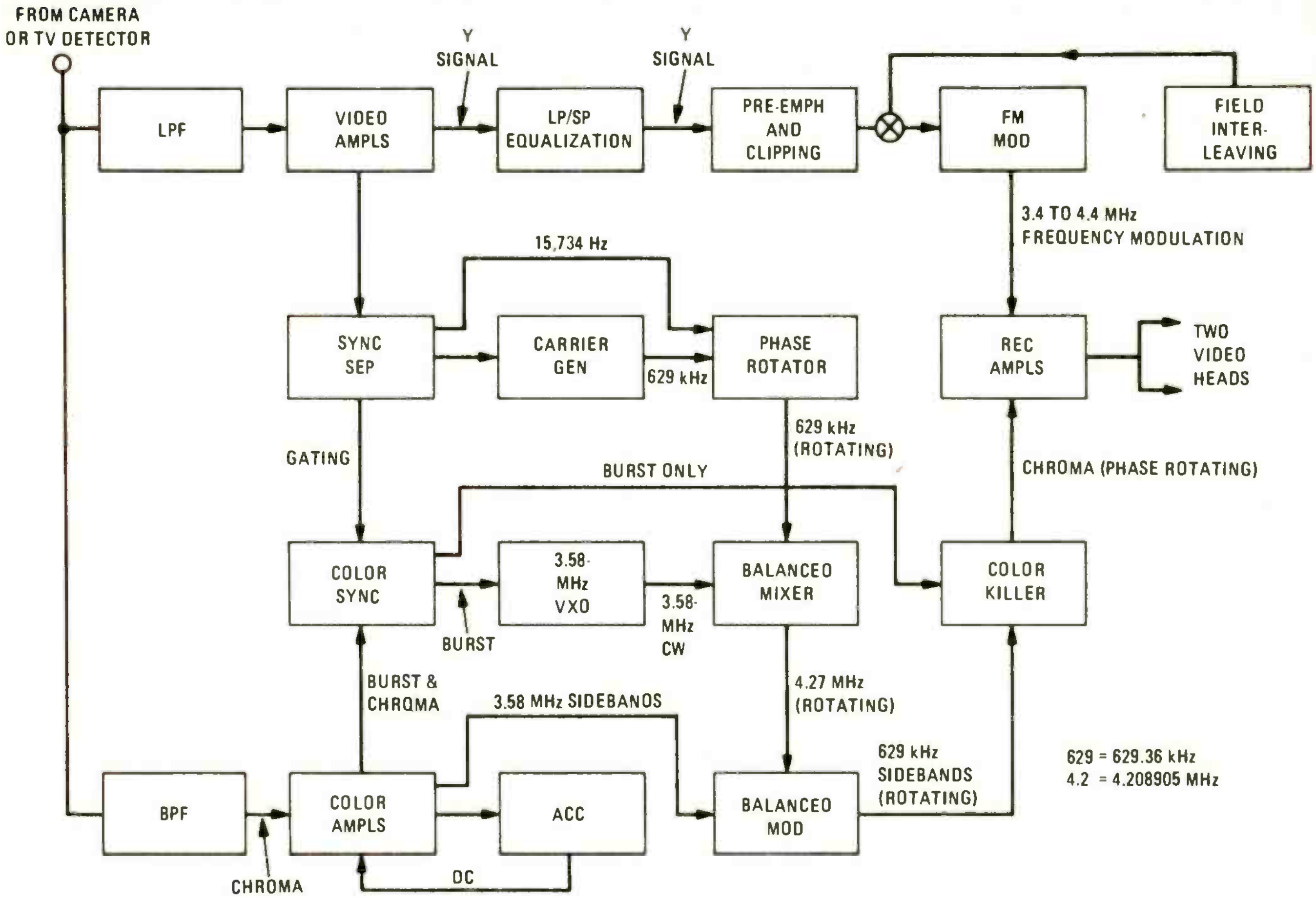


FIG. 2—VHS recording function

then goes to the recording amplifiers that matrix the FM signal and the 688-kHz sideband signal (this is linear mixing, with no heterodyning). The two recording heads lay both signals down on the tape.

This doesn't seem too complicated, does it? It really isn't, at this level of analysis. And this is the level at which you ordinarily begin your troubleshooting diagnosis.

VHS recording function

A VHS video cassette recorder uses similar electronics for recording. Figure 2 is the block diagram of the sections involved; you can just follow the analysis on this diagram.

A low-pass filter separates out the luminance or Y signal, and feeds it through a video amplifier section. Then, long-play/standard-play (2-hour/4-hour) equalization is added, some pre-emphasis and the usual black/white clipping.

The only real difference in the luminance processing comes with the *field interleaving* that occurs before the video goes to the FM modulator. This locks the start of video in each field to the head/servo system. The frequency-modulated luminance signal proceeds through the amplifiers to the two video recording heads. A sync separator right after the video amplifiers does essentially the same thing as in a Beta-format tape deck. That is, it supplies gating and control pulses for other sections.

Chroma, pulled out by a bandpass filter, goes to a color amplifier section, where an ACC section controls the gain.

A color sync section uses horizontal-rate gating from the sync separator to lift out the burst signal. Color sync controls a 3.58-MHz (actually, 3.579545-MHz) variable crystal oscillator (VXO). A color-burst-locked CW signal enters a balanced mixer.

Meanwhile, in a carrier generator section, a sync separator signal serves as reference to phase-lock a 2.51744-MHz VCO. A 4:1 down-counter divides the VCO signal. Output of the carrier generator therefore is 629.36 kHz, a CW signal that feeds a phase rotator.

Phase rotation accomplishes the same end as the alternate-line inverter does in the system described earlier—it reduces crosstalk. A unique phase-shifting system, slaved to the 15,734-Hz sync signal, rotates the vector (phase) of the 629-kHz CW signal. Coinciding with the start of each line, the CW signal phase rotates 90 degrees. At the next line-start time, the phase rotates again, and so forth.

At the start of each TV field, a phase shifter also inverts the phase of the 629-kHz signal. This phase-switched signal goes to the balanced mixer to heterodyne with the color-burst-synchronized signal from the VXO. These signals together create an alternate-line-rotated and alternate-field-reversed CW signal at 4.208905 MHz.

This 4.2-MHz signal takes on the same phase-switched characteristics as the 629-kHz signal. The 4.2-MHz signal now goes to a balanced modulator. There it is modulated by the 3.58-MHz chroma sidebands. The result is the difference heterodyne: 4.208905 MHz minus 3.479545 MHz equals 629.36-kHz *sidebands*. In other words, the chroma signal has become 629.36-kHz sidebands, *with the phase-rotating characteristics* carried from the phase rotator/switcher.

This signal goes to the recording amplifiers and from there to the video heads. The color signals are laid down on the tape, oriented according to the phase conditions instituted by the signals. Video goes onto the tape simultaneously, but remember it is an FM signal that is confined between 3.4 MHz and 4.4 MHz.

Beta playback functions

Keeping in mind what happens to the signal during recording helps you know 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

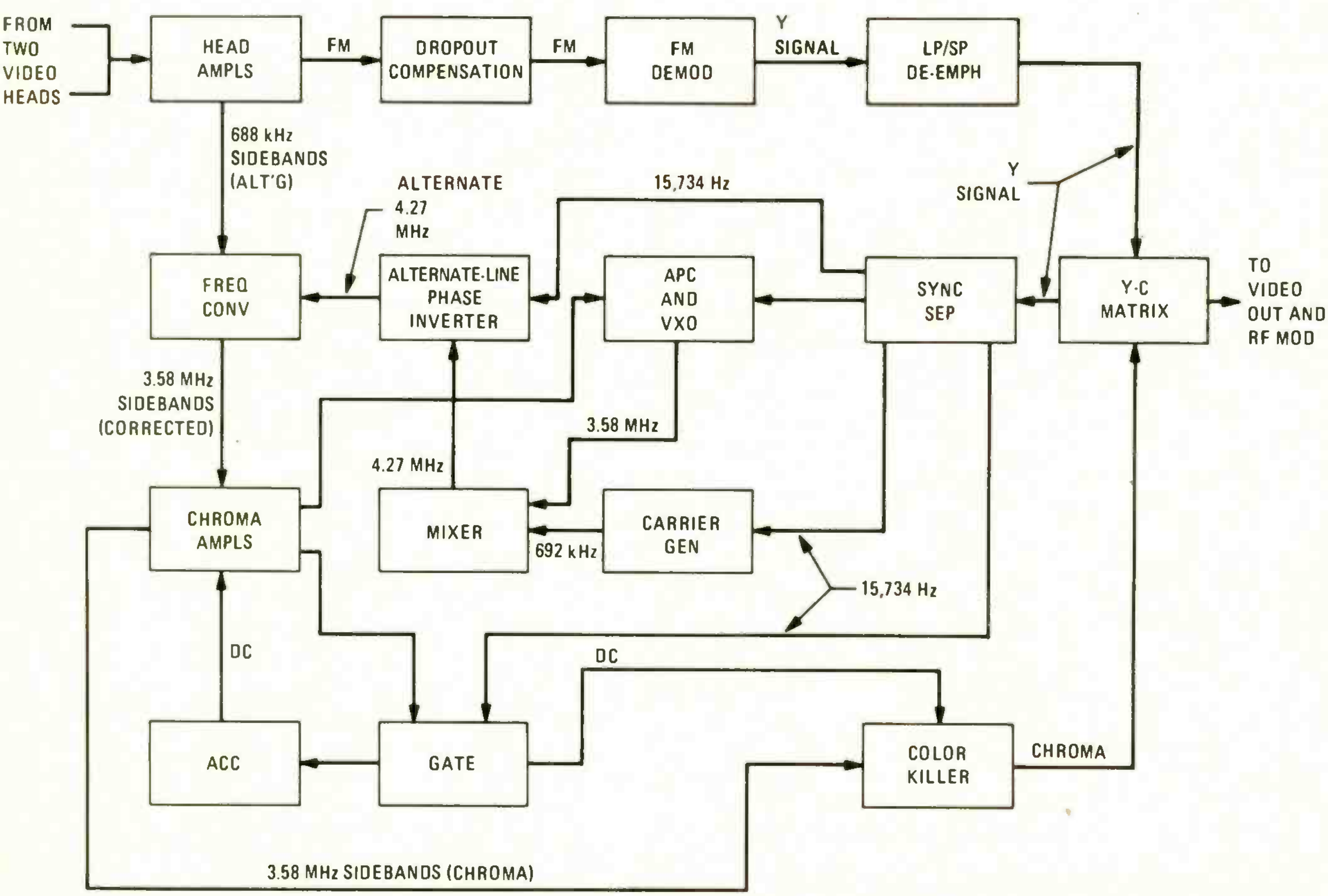


FIG. 3—BETA playback function

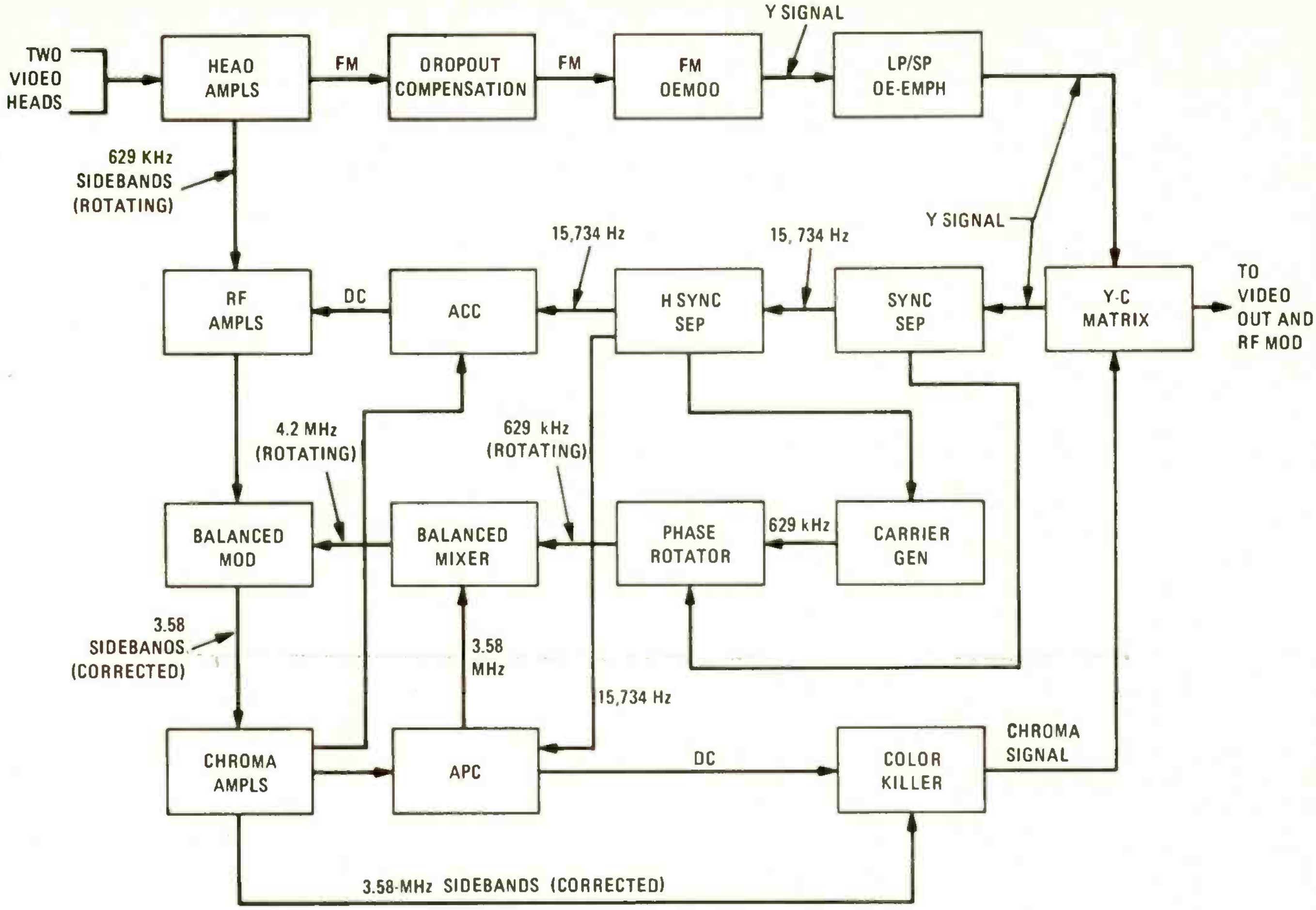


FIG. 4—VHS playback function

for the picture to jitter.

The sync separator also provides the gate signal to recover the burst from the chroma signal. One direction sends a burst signal to the automatic color control, just as in a TV receiver. Another direction opens the color-killer stage when color is present. This allows the chroma signal to reach the Y-C or luminance-chroma matrix. Of course, when no color burst is present, the killer blocks noise originating in the chroma amplifiers. The Y-C mixer feeds the video output jack and the RF modulator (for a TV set monitor).

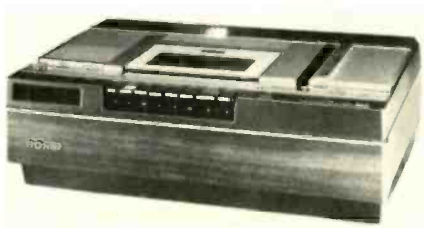
The important thing to recognize here is that Playback processes the color and video signals virtually in mirror to the way they were processed when recording the tape. As soon as you recognize this fact, you can commit the whole record/playback system to memory.

VHS playback sections

Figure 4 shows a virtual reversal of the signal processing that took place during the VHS Record function.

Signals from the two video heads drive the playback amplifiers. The frequency-modulated Y signal and sync pass through a dropout compensator and demodulator. Video then finds de-emphasis on its way to the Y- combiner. Video also goes to a sync separator.

Meanwhile, the chroma, in the form of 629-kHz sideband signals, arrives at a balanced modulator whose job is to "modulate" a heterodyne with these sidebands.



SONY MODEL SL-5400

Horizontal sync, taken from Y video, controls a phase-rotation section that reverses the rotation applied during Record. The phase-corrected 629-kHz signal goes to a balanced mixer, along with a 3.58-MHz signal that has been locked by color burst in the APC (Automatic Phase Control) section. The sum of these signals forms a phase-correcting 4.2-MHz signal. It is fed to the balanced modulator to mix with the phase-rotating 629-kHz chroma sideband signals coming from the tape through the head amplifiers.

Without the correcting rotation of the 4.2-MHz CW signal, color sidebands from the balanced modulator would contain the recorded phase rotation. But, as it's processed here, the output of the balanced modulator consists of the phase-corrected original 3.58-MHz color-sideband signals.

This goes through chroma amplifiers. Some signal from the chroma amplifiers is fed back to an ACC section that is keyed by the horizontal sync separator. A DC voltage proportional to the burst-signal amplitude controls the gain in the 629-kHz RF section.

The chroma signal from the chroma amplifiers goes through a color-killer stage to the Y-C matrix—if the color killer doesn't block it. The color-killer section, operated from the APC, is open when the color burst is present. When the color burst is not present, the killer blocks noise coming from any of the chroma amplifier circuitry.

And, of course, the Y-C matrix sends color and luminance plus sync to the video-output jack or to the RF modulator in the tape deck.

Learning to understand and troubleshoot record and playback electronics of a VCR probably is the least of your worries with video cassette recorders. There are other functions that are more difficult to understand. They will be the subject of future "What You Need to Know" sections in **Radio-Electronics.** Watch for them in future issues. **R-E**

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

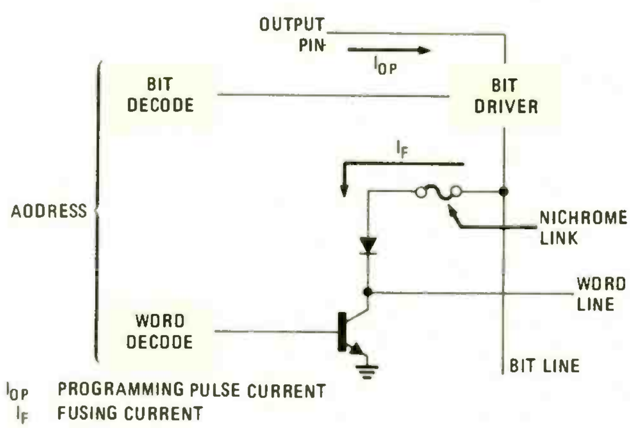


Fig. 1 Programming Current Path

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.

Reprinted from "Fairchild Journal of Semiconductor Progress, Vol. 6 No. 2

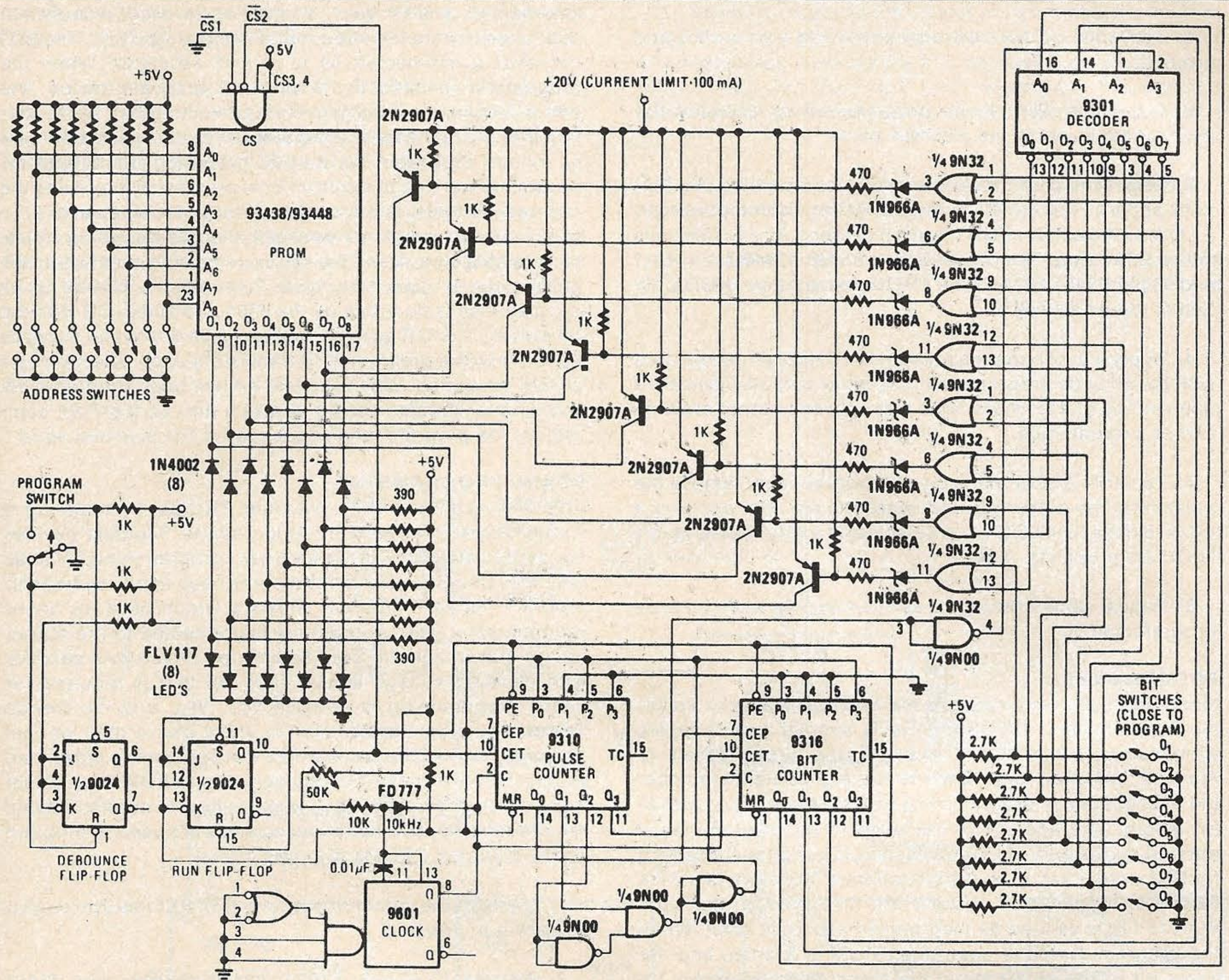


Fig. 2 PROM Programming Circuit

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 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 JK flip-flop is used as a switch debouncer, while the other half is the run flip-flop. The 9601 one-shot is connected as a 10 kHz oscillator. When the program is initiated by closing the program switch, the switch debouncer sets; this clocks the other half of the flip-flop into the run state and enables the pulse and bit counters to initiate programming pulses, preparing the PROM for programming. The pulse counter is preset to 5 to provide the requisite 20% duty factor, and the bit counter is preset to 8. To avoid overlap problems between the programming pulse, chip enable and scan, the bit counter advances when the pulse counter goes from state 3 to state 4. The bit to be programmed is decoded by the 9301 and wired-OR with the bit switch. The OR gate is a high-voltage driver that supplies the drive to the programming transistors upon selection by a 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 0 V. 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°C
Programming Pulse Rise Time	t_r	0.5	1.0	3.0	μs	
Number of Required Pulses		1		4		
Case Temperature			25	85	°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 CS_3 and CS_4 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**

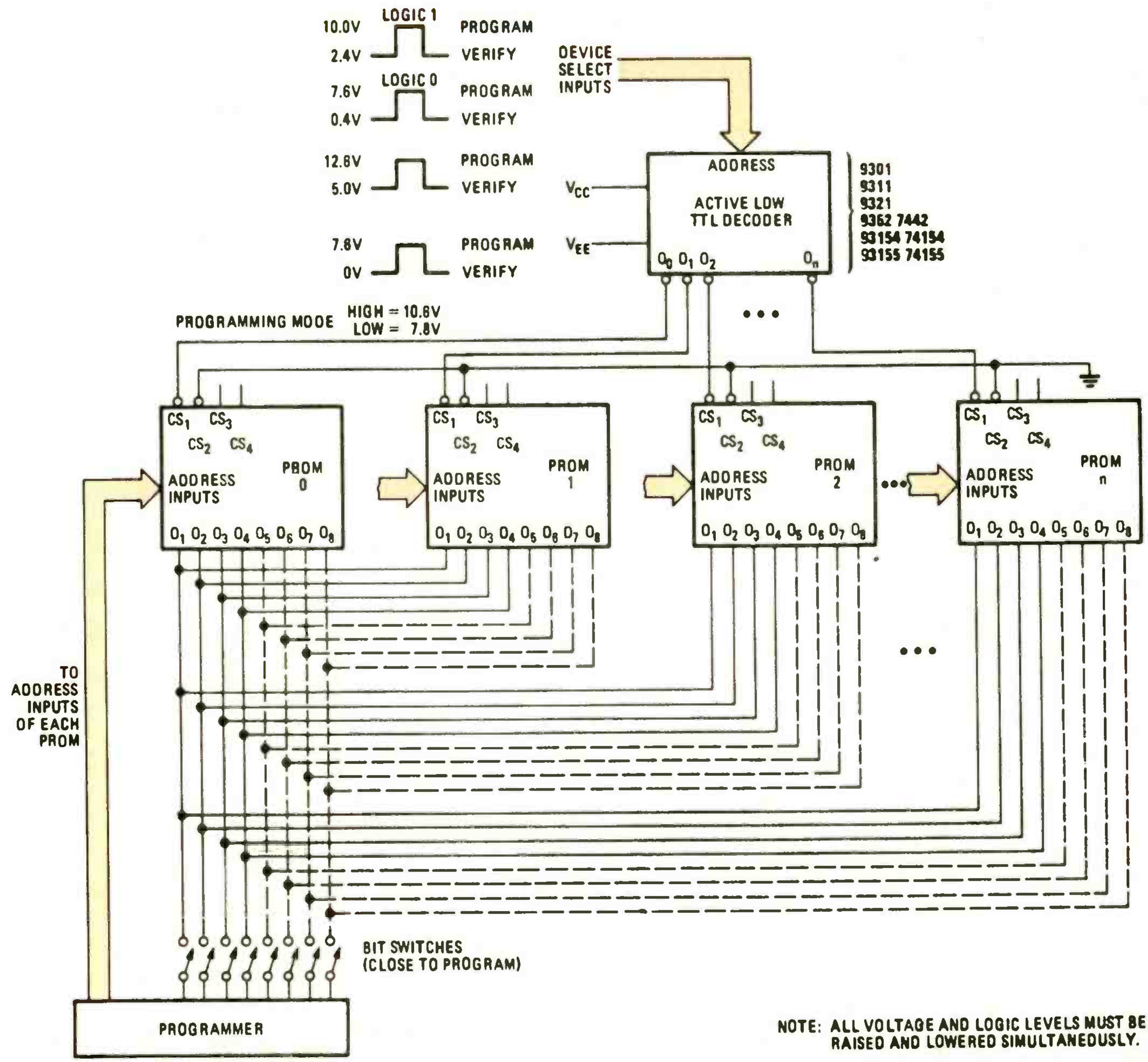


Fig. 3 Board Programming

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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 examples, 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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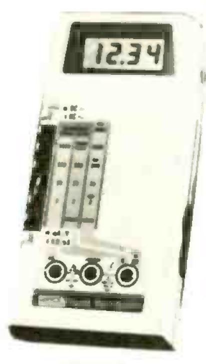

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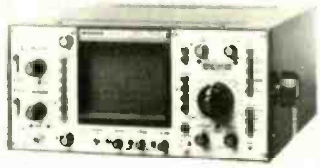


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HOBBY CORNER

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." **R-E**

CIRCLE 100 ON FREE INFORMATION CARD

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 × 100 feet or smaller, local ordinances against "transmitting" antennas, and crackpot neighbors who claim any visible wire radiates "eminations" 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 ±90°, 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 ±90° 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 adjustment 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.

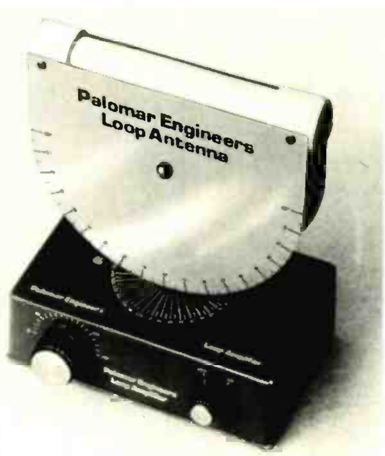

FIG. 1

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 *mistyque* concerning SWR (*S*tanding *W*ave *R*atio), 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 ÷ 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 ÷ 50, or 6:1. There is no such thing as an SWR less than 1:1; we cannot have 50 ÷ 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

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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

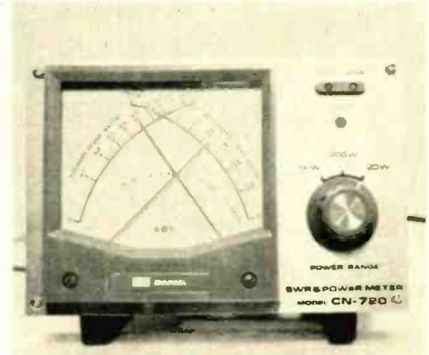

FIG. 1

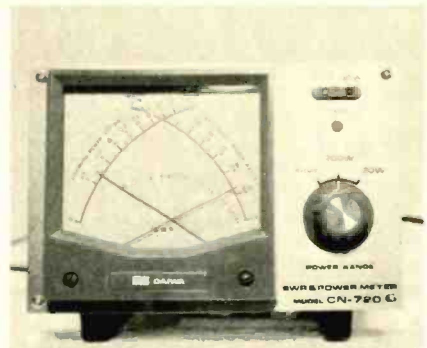

FIG. 2

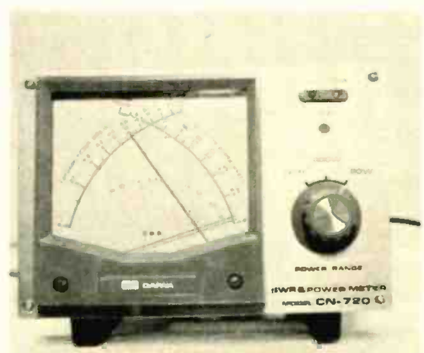

FIG. 3

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. **R-E**

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-μF or 100-μF 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 convergerce 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 troubleshoot *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. **R-E**

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CIRCLE 51 ON FREE INFORMATION CARD

new products

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

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, 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.

CIRCLE 151 ON FREE INFORMATION CARD

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 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.

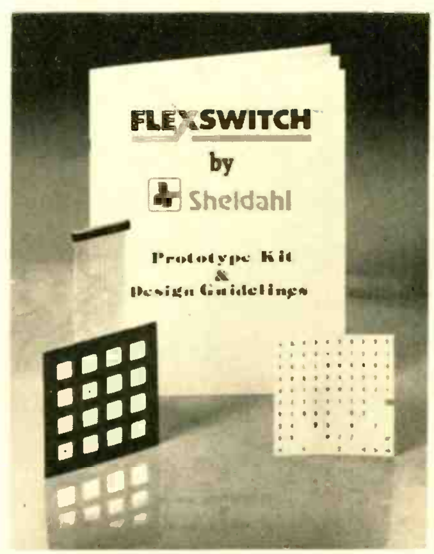
CIRCLE 152 ON FREE INFORMATION CARD

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 × 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; ×10 magnification; 36-ns risetime; ±3% accuracy; internal and external triggering. Both units measure 8 W × 7⅞ D × 3¼ inches H; weigh approximately 5 lbs., and operate on 10–16 VDC at less than 1A. Both models come with probes, ×10/×1 feature, 115 VAC adapter,

CIRCLE 153 ON FREE INFORMATION CARD

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 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. **R-E**



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communications products

More information on communications products is available from manufacturers of items identified by a Free Information number. Free Information Card is inside the back cover.

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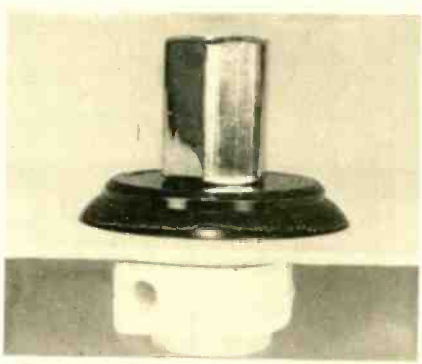
variable-speed scan-delay control; seek function to tune to and lock into next programmed channel; digital clock; volume and squelch controls; built-in speaker; and AC/DC operation. List price: $489.95.—**J.I.L.,** Dept. P, 737 West Artesia, Compton, CA 90220.

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 ⅜-inch



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base antenna and fits a ½-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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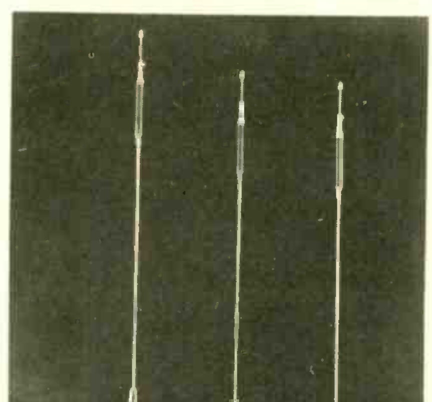
limiter, volume, squelch, RF gain, mike gain, SWR calibrate, and speaker and power switches. Built-in power supply provides 12 VDC or 117 VAC operation. Unit comes in simulated woodgrain vinyl-clad aluminum, and carries a list price of $529.95—**Robyn International, Inc.,** Northland Dr., P.O. Box 478, 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 hermetically sealed coils and RG-58/U coax cable (plugs attached). Retail prices: $19.95-$26.95.—**Channel Master,** Ellenville, NY 12428. **R-E**



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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 × 8¼ 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 × 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. 5¼ × 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. 8½ × 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

minal 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 design 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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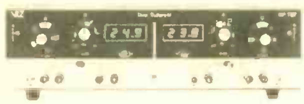

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SPEAKER SYSTEMS, 49-page catalog details characteristics of *Speakerlab* hi-fi speaker kits. Speakers are shown in full color and each system is described in detail, with technical specifications and prices. Some of the systems featured include *Speakerlab 30, Subwoofer Drive System 1000,* and *Speakerlab 1* (designed for inexpensive or low-powered receivers). Also included is a section on woofer design as well as lists of woofers, mid-range speakers, tweeters, enclosures, crossovers, accessories and publications. Two complete stereo systems are described with their specs and prices. A handy separate order form for your convenience comes with the catalog.—**Speakerlab Inc.,** 735 N. Northlake Way, Seattle, WA 98103. **R-E**

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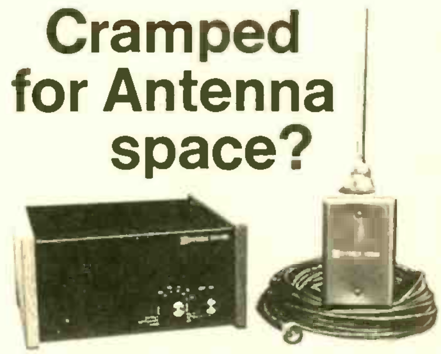

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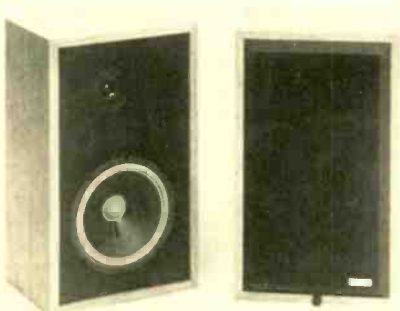
stereo products

More information on stereo products is available from manufacturers of items identified by a Free Information number. Free Information Card is inside the back cover.

SPEAKER SYSTEM, *model CL 2,* features acoustic suspension with a 10-inch woofer and 1-inch soft-dome tweeter. Its specifications include: frequency response, 52 Hz–22 kHz within 2 dB; crossover, 1200 Hz; nominal input impedance, 8 ohms; minimum input impedance, 6 ohms; 60-



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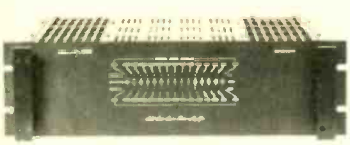
watt power-handling capacity; sensitivity, 91.5 dB at 1 meter with a 1-watt "pink noise" input. The *model CL 2* comes housed in either an oak or walnut-grain cabinet, with black or brown front-grille panel. It measures 23¼ H × 14 W × 10¾-inches D. Suggested retail price, $139.—**KLH Research & Development Corp.,** 145 University Ave., Westwood, MA 02090.

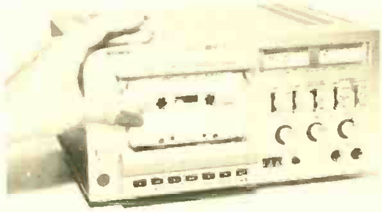
POWER AMPLIFIER, *model 2300,* has a rated output of 150 watts-per-channel minimum RMS, into 8 ohms, 20 Hz—20 kHz, 0.05% THD. Other features include toroidal transformer, thermal



CIRCLE 132 ON FREE INFORMATION CARD

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.

CASSETTE TAPE DECK, *model M-T01,* measures just 10⅝ × 5½ × 9⅝ inches and weighs 17 lbs., 10 oz. The unit features a closed-loop dual-capstan system and Dolby noise reduction. Controls include peak-level meters, a multiplex filter, three-way bias and equalization switches, time-controlled record/playback functions, memory play/stop capability, line/mike mixing capability, an output-level control, and a mike jack. Specifications: frequency response: (standard tape), 30 Hz–15 kHz; (ferrous and chrome tape), 30 Hz–17 kHz; S/N ratio, 64 dB (with Dolby); wow-and-flut-



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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.

DIRECT-DRIVE TURNTABLES, *Series 5000,* is a line of quartz-locked automatic, semiautomatic and manual turntables constructed of antiresonant material. The *model SL-5100* (shown) is a manual turntable with a high-torque servomotor, an LED strobe light speed indicator, a manual pitch control and a 12-gram tonearm (includes diecast aluminum headshell with gimbal suspen-

CIRCLE 134 ON FREE INFORMATION CARD

sion). The *model SL-5200* is a semiautomatic unit with automatic tonearm return, LED indicator and manual pitch control. The *model SL-5300* has a high-torque servo-controlled motor to minimize ripple, cueing switch, on-off switch, two speed controls and manual pitch control, 12-gram tonearm; plus automatic single disc operation with *Memo-Gram* control that automatically repeats records up to 6 times. Specifications for the *model SL-5300*: speed drift, ±0.002%; wow-and-flutter, 0.025%; rumble, 78 dB. The *model SL-5350* is fully automatic; plays up to 6 records; and features *Memo-Gram* repeat control, LED indicator light, manual pitch control and cueing switch (optional manual spindle available). Suggested retail prices: *model SL-5100*, $240; *model SL-5200*, $260; *model SL-5350*, $340; *model SL-5300*, $290.—**Technics,** One Panasonic Way, Secaucus, NJ 07094. **R-E**

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TELEPHONES unlimited, equipment, supplies. **All types, regular, keyed, modular. Free** catalog. Call now toll free (800) 824-7888 in California, (800) 852-7777—Alaska, Hawaii—(800) 824-7919 ask for Operator 738

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SENSITIVE converter 1.6-2.4 GHz $99.95 postpaid. Details for stamp. **GW ELECTRONICS,** POB 688, Greenwood, IN 46142

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COMPUTER INFORMATION

OSI 1P users. Solve some of the mysteries of your machine. Also some 1P orientated supplies. $1.00 + S.A.S.E. gets sample info sheet and list. **BILL'S MICRO SERVICES,** c/o William Dirks, 44th USAAD, APO New York, NY 09221

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Outstanding Performance

Incredible Price $89.95

CT-50

The CT-50 is a versatile and precision frequency counter which will measure frequencies to 60 mHz and up to 600 mHz with the CT-600 option. Large Scale Integration, CMOS circuitry and solid state display technology have enabled this counter to match performance found in units selling for over three times as much. Low power consumption (typically 300-400 ma) makes the CT-50 ideal for portable battery operation. Features of the CT-50 include: large 8 digit LED display, RF shielded all metal case, easy pushbutton operation, automatic decimal point, fully socketed IC chips and input protection to 50 volts to insure against accidental burnout or overload. And, the best feature of all is the easy assembly. Clear, step by step instructions guide you to a finished unit you can rely on. **Order your today!**

SPECIFICATIONS:
Frequency range: 6 Hz to 65 mHz, 600 mHz with CT-600
Resolution: 10 Hz @ 0.1 sec gate, 1 Hz @ 1 sec gate
Readout: 8 digit 0.4" high LED, direct readout in mHz
Accuracy: adjustable to 0.5 ppm
Stability: 2.0 ppm over 10° to 40° C, temperature compensated
Input: BNC, 1 megohm/20 pf direct, 50 ohm with CT-600
Overload: 50VAC maximum, all modes
Sensitivity: less than 25 mv to 65 mHz, 50-150 mv to 600 mHz
Power: 110 VAC 5 Watts or 12 VDC @ 400 ma
Size: 6" x 4" x 2", high quality aluminum case, 2 lbs
ICS: 13 units, all socketed

CT-50, 60 mHz counter kit	$89.95
CT-50WT, 60 mHz counter, wired and tested	159.95
CT-600, 600 mHz scaler option, add	29.95
CB-1, Color TV calibrator-stabilizer	$14.95
DP-1, DC probe, general purpose probe	12.95
HP-1, High impedance probe, non-loadir	15.95

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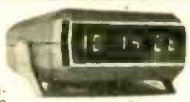
The UN-KIT, only 5 solder connections

Here's a super looking, rugged and accurate auto clock which is a snap to build and install. Clock movement is completely assembled—you only solder 3 wires and 2 switches, takes about 15 minutes! Display is bright green with automatic brightness control photocell—assures you of a highly readable display, day or night. Comes in a satin finish anodized aluminum case which can be attached 5 different ways using 2 sided tape. Choice of silver, black or gold case (specify).

DC-3 kit, 12 hour format	$22.95
DC-3 wired and tested	$29.95
110V AC adapter	$5.95

Under dash car clock



12/24 hour clock in a beautiful plastic case features 6 jumbo RED LEDS, high accuracy (1 min/mo.), easy 3 wire hookup, display blanks with ignition, and super instructions. Optional dimmer automatically adjusts display to ambient light level.

DC-11 clock with mtg. bracket	$27.95
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PRESCALER

Extend the range of your counter to 600 mHz. Works with any counter. Includes 2 transistor pre-amp to give super sens. typically 20 mv at 150 mHz. Specify ÷10 or ÷100 ratio.

PS-1B, 600 mHz prescaler	$59.95
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OP-AMP SPECIAL

741 mini dip	12/$2.00
B1-FET, mini dip, 741 type	10/$2.00

VIDEO TERMINAL

A completely self-contained, stand alone video terminal card. Requires only an ASCII keyboard and TV set to become a complete terminal unit. Two units available, common features are: single 5V supply, XTAL controlled sync and baud rates (to 9600), complete computer and keyboard control of cursor. Parity error control and display. Accepts and generates serial ASCII plus parallel keyboard input. The 3216 is 32 char. by 16 lines, 2 pages with memory dump feature. The 6416 is 64 char. by 16 lines, with scrolling, upper and lower case (optional) and has RS-232 and 20ma loop interfaces on board. Kits include sockets and complete documentation.

RE 3216, terminal card	$149.95
RE 6416, terminal card	189.95
Lower Case option, 6416 only	13.95
Power Supply Kit	14.95
Video/RF Modulator, VD-1	6.95
Assembled, tested units, add	60.00

CALENDAR ALARM CLOCK

The clock that's got it all. 6-.5" LEDs, 12/24 hour, snooze, 24 hour alarm, 4 year calendar, battery backup, and lots more. The super 7001 chip is used. Size 5x4x2 inches.
Complete kit, less case (not available)

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30 Watt 2 mtr PWR AMP

Simple Class C power amp features 8 times power gain. 1 W in for 8 out, 2 in for 15 out, 4 W in for 30 out. Max. output of 35 W, incredible value, complete with all parts, less case and T-R relay.

PA-1, 30 W pwr amp kit	$22.95
TR-1, RF sensed T-R relay kit	6.95

FM MINI MIKE KIT

A super high performance FM wireless mike kit! Transmits a stable signal up to 300 yards with exceptional audio quality by means of its built in electret mike. Kit includes case, mike, on-off switch, antenna, battery and super instructions. This is the finest unit available.

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Try your hand at building the finest looking clock on the market. Its satin finish anodized aluminum case looks great anywhere, while six .4" LED digits provide a highly readable display. This is a complete kit, no extras needed, and it only takes 1-2 hours to assemble. Your choice of case colors silver, gold, bronze, black, blue (specify).

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Alarm clock, 12 hour only, DC-8	24.95
12V DC car clock, DC-7	27.95

For wired and tested clocks add $10.00 to kit price.

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324	1.50
380	1.25
380-8	.75
555	.45
556	.85
566	1.15
567	1.25
1458	.50
3900	.50
CMOS ICs	
4011	.20
4013	.35
4046	1.85
4049	.40
4518	1.25
5369	1.75
TRANSISTORS	
2N3904 type	10/1.00
2N3906 type	10/1.00
NPN 30W Pwr	3/1.00
PNP 30W Pwr	3/1.00
2N3055	.60
UJT 2N2646 type	3/2.00
FET MPF102 type	3/2.00
UHF 2N5179 type	3/2.00
MRF-238 RF	11.95
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14 pin	10/2.00
16 pin	10/2.00
24 pin	4/2.00
28 pin	4/2.00
40 pin	3/2.00

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78MG	$1.25
723	.50
309K	.85
7805	.85
78L05	.25
7905	1.25
7812	.85
7912	1.25
7815	.85
TTL ICs	
74S00	.35
7447	.65
7475	.50
7490	.50
74196TI	1.35
SPECIAL ICs	
11C90	13.50
10116	1.25
4511	2.00
5314	2.95
5375AB	2.95
7001	6.50
4059 ÷ N	9.00
7208	17.95
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Jumbo green	6/1.00
Jumbo yellow	6/1.00
Mini red	8/1.00
Micro red	8/1.00
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FERRITE BEADS	
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Ramsey's famous MINI-KITS

FM WIRELESS MIKE KIT

Transmits up to 300' to any FM broadcast radio, uses any type of mike. Runs on 3 to 9V. Type FM-2 has added sensitive mike preamp stage.
FM-1 kit $2.95 FM-2 kit $4.95

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See music come alive! 3 different lights flicker with music. One light for lows, one for the mid-range and one for the highs. Each channel individually adjustable, and drives up to 300W. Great for parties, band music, nite clubs and more.
Complete kit, ML-1 $7.95

LED BLINKY KIT

A great attention getter which alternately flashes 2 jumbo LEDs. Use for name badges, buttons, warning panel lights, anything! Runs on 3 to 15 volts.
Complete kit, BL-1 $2.95

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Complete kit, VD-1 $6.95

TONE DECODER

A complete tone decoder on a single PC board. Features 400-5000 Hz adjustable range via 20 turn pot, voltage regulation, 567 IC. Useful for touch-tone decoding, tone burst detection, FSK, etc. Can also be used as a stable tone encoder. Runs on 5 to 12 volts.
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An interesting kit, small mike picks up sounds and converts them to light. The louder the sound, the brighter the light. Completely self-contained, includes mike, runs on 110VAC, controls up to 300 watts.
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SUPER SLEUTH

A super sensitive amplifier which will pick up a pin drop at 15 feet! Great for monitoring baby's room or as general purpose amplifier. Full 2 W rms output, runs on 6 to 15 volts, uses 8-45 ohm speaker.
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Complete triple regulated power supply provides variable 6 to 18 volts at 200 ma and +5V at 1 Amp. Excellent load regulation, good filtering and small size. Less transformers, requires 6.3V @ 1 A and 24 VCT.
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PRINTED circuit boards from your sketch or artwork. Affordable prices. Also fun kit projects. Free details. **DANOCINTHS INC.,** Box 261, Westland, MI 48185

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Active Electronic Sales Corp.

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2708 IK x 8 450 NS		$9.95

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2102-1PC 1K 450NS	~~$.99~~	0.94
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MICROCOMPUTER BOARDS

NEC MICROCOMPUTER TK-80A

The TK 80A is a complete microcomputer on a board based on the industry standard 8080A. The board has both 1K RAM and 1K Electrically Erasable PROM expandable to 4K × 8 and 8K × 8 respectively, on board. It also features 300 or 1200 baud cassette interface, the Kansas City type, and three 8-Bit Programmable I/O Ports (24 lines). Keypad with 25 keys (not a glorified calculator keypad) and 8 big, bright digits for display are also included.

TK-80A $299.00

MICROPROCESSOR CHIPS

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P = Printed Circuit Pins (flat mounting)
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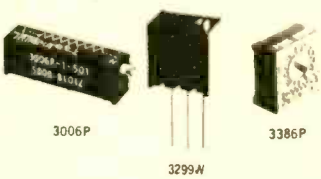

3006P 3299W 3386P

Special of the Month

Zilog

Z80-CPU	~~[illegible]~~	$9.95
Z80A-CPU	~~[illegible]~~	$11.95
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Z80A-PIO	~~[illegible]~~	$8.95
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Z80A-SIO/0	~~[illegible]~~	$45.00
Z80-SIO/1	~~[illegible]~~	$35.00
Z80A-SIO/1	~~[illegible]~~	$45.00
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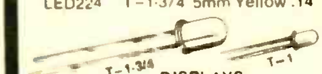
LED211	T-1	3mm Green	.14
LED212	T-1	3mm Yellow	.13
LED220	T-1-3/4	5mm Red	.11
LED222	T-1-3/4	5mm Green	.15
LED224	T-1-3/4	5mm Yellow	.14



DISPLAYS

MAN74A	.300"	Common Cathode		$0.99
FND357	.375"	Common Cathode	~~[illegible]~~	$1.09
FND500	.500"	Common Cathode	~~[illegible]~~	$1.09
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DL704	.300"	Common Cathode	~~[illegible]~~	$1.29
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IL1	Opto Coupler	1500V		.49
4N26	Opto Isolator	2500V		.59
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Finest Quality Socket available in the world. Nobody can match Texas Instruments quality — a unique combination of I.C. technology and multi-metal expertise.

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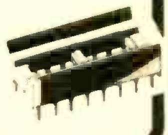
16 PIN	.14	28 PIN	.28
18 PIN	.18	40 PIN	.40
20 PIN	.20		



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

SPECIAL $19.95

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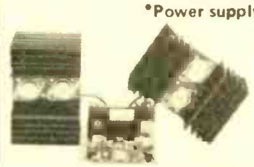
100 W CLASS A POWER AMP KIT

Dynamic Bias Class "A" circuit design makes this unit unique in its class. Crystal clear, 100 watts power output will satisfy the most picky fans. A perfect combination with the TA-1020 low T.I.M. stereo pre-amp.

Specifications:

- *Output power : 100W RMS into 8-ohm, 125W RMS into 4-ohm
- *Frequency response: 10Hz - 100 KHz
- *T.H.D.: less than 0.008%
- *S/N ratio: better than 80dB
- *Input sensitivity: IV max.
- *Power supply: ±40V @ 5amp



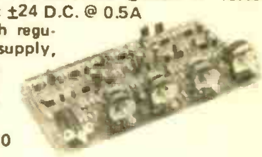
TA-1000 KIT $51.95

Power transformer $15.00 each

LOW TIM DC STEREO PRE-AMP KIT TA-10 20

Incorporates brand-new D.C. design that gives a frequency response from 0Hz – 100KHz ±0.5dB! Added features like tone defeat and loudness control let you tailor your own frequency response. Independent I.C. regulated power supplies to eliminate power fluctuation! Specifications: *T.H.D. less than .005% *T.I.M. less than .005% *Frequency response: DC to 100KHz ±0.5dB *RIAA deviation: ±0.2dB *S/N ratio: better than 70dB *Sensitivity: Phono 2MV 47K/Aux. 100MV 100K *Output level: 1.3V *Max output: 15V *Tone control: bass ±10dB @ 50Hz/treble ±10dB @ 15Hz *Power supply: ±24 D.C. @ 0.5A

Kit comes with regulated power supply, all you need is a 48V C.T. transformer @ 0.5A



ONLY $44.50

X'FORMER

THE MOST ADVANCED TIMEPIECE OF ITS KIND IN THE WORLD!

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

Features:

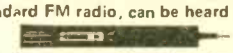
- 24 hour alarm
- Chronograph counts up to 12 hrs., 59 mins. 59.9 sec.
- Precision of chrono up to 1/10 sec indicated by 10 moving arrows!!
- Lap time (with chrono running uninterrupted)
- Time displays by LCD for hour, min, sec, day, date of the week and AM/PM.
- Calendar gives out date-day
- Dual time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

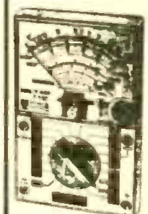
$55.50

ONE YEAR FULL WARRANTY!

PROFESSIONAL FM WIRELESS MICROPHONE

TECT model WEM-16 is a factory assembled FM wireless microphonep 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 6¼" 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 —
— ULTRA-SLIM —
BATTERY CHECKER
— LED TESTER —

T-55D (w/o temp probe) $44.50

T-55THD (temp probe) $66.50

SPECIFICATIONS:

Ranges

DC Voltage:	150mV, 500mV, 1.5V, 5V, 15V, 50V, 250V, 1kV (All 20kΩ/V) 25kV *Using HV probe)
DC Current:	50μA, 2.5mA, 25mA, 250mA (500mV drop)
AC Voltage:	15V, 150V, 500V (9kΩ/V)
AC Current:	6mA, 6A (2V and 55mV drop)
Resistance:	10kΩ 100kΩ 1MΩ 5MΩ (max calbtn) 100Ω 1kΩ 10kΩ 50kΩ (mid scale)
Load Current:	30mA 3mA 300mA
Load Voltage:	3V 3V 3V
Decibels	-10 to +55dB
Batt Check:	0.9 to 1.5V (10Ω load)
LED Check:	(Available)
Temperature:	50· to +100·C and 0· to +200·C (Probe not supplied with T-55D)

Accuracy

DC Voltage:	±2.5% f.s.d.
DC Current:	±2.5% f.s.d.
Batt Check:	±2.5% f.s.d.
AC Voltage/Power on 1.5V range:	±5% f.s.d.
AC Voltage/Power above 15V range:	±3.5% f.s.d.
AC Current:	±5% f.s.d.
Resistance/Temperature:	±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

Temperature Probe (T-55THD only)

HICKOK LX303 DIGITAL LCD MULTIMETER

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

CALL FOR OUR DISCOUNTED PRICE

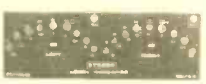
MARK IV 18 STEPS LED POWER LEVEL INDICATOR KIT

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

NEW MARK III 9 Steps 4 Colors LED VU



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

IN KIT FORM $18.50

60W + 60W STEREO AMPLIFIER

COMPLETED UNIT—NOT A KIT!

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

Assembled $49.50 ea.

Power transformer $ 8.50 ea.

ELECTRONIC DUAL SPEAKER PROTECTOR

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

KIT FORM $8.75 EA.

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

FM WIRELESS MIC KIT

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

KIT FORM $7.95

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

POWER TRANSFORMER $6.50 EACH

CIRCLE 11 ON FREE INFORMATION CARD

WE'RE BACK WITH OUR WORLD FAMOUS INFLATION FIGHTIN'

'ONE CENTERS"

4V RECHARGEABLE $12.50
GEL/SEL ENERGY PAK

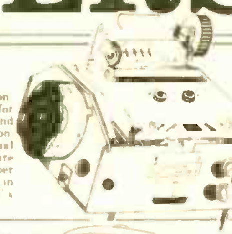
Portable Power at Poly Paks Prices. Brand New, 4V — 2.6 Amp Hr. Gel/Cell storage battery. Units consist of gelled electrolyte enclosed in hermetically sealed plastic for years of dependable service. Compact, (only 3-1/2" x 2 3/8" x 1 5/16" in size!) Stack 'em to produce 8V, 12V, 24V ... or increase the amperage up up and away. Use 'em for Burglar Alarms, Intrusion Detectors, Ham Mo... or Solar Storage Applications. **Cat. No. 92CU5788**

2 for $12.51

It's Stacked Energy!

PARALLEL ENTRY DIGITAL PRINTER

These unique printers feature precision Swiss construction. 18 key columns are divided into 16 for numerals, and 2 for alphabetical and trig figures, and mathematical functions. Each wheel is 12 position. Utilizes 2.75" wide adding machine tape, and dual color ribbon. Printing technique: parallel pressure printing, multiple copies. Print Rate: 3 lines per second. Operating voltage: 22 to 28 VDC. Comes in original packing w roll of tape. Size: 6 1/2" x 3 1/8" x 5 5/8". Wt. 7 lbs. **Cat. No. 92CU5545**



Only $19.99

2 for $20.00

40 CHANNEL CB BOARD

$12.50

2 FOR $12.51

Poly Paks buys up factory close-out from Hy-Gain so you gain! Boards have: Heatsinked 9 Watt Amp Chip, RF and Mod Transistors, and Motorola MC series PLL. May be used for 10 meter conversion. (see continuing series "CB to 10" in 73 magazine!) The parts alone make it an offer you can't refuse. Wt. 9 oz. **Cat. No. 92CU5554**

HY - GAIN ONE ARM BANDIT MIKES

Only $14.99

2 FOR $15

Take one hand command of your mobile or base rig with Hy-Gain's One Arm Bandit Mike. ON/OFF, VOLUME, SQUELCH, CHANNEL SELECTOR, SPEAKER, and DIGITAL DISPLAY are all conveniently located where your fingers do the talking. Comes with 6 ft. multi-conductor, color-coded, coiled cable. (separate) for easy integration into any type of rig. Size: 4½" x 2¾" x 1¼". Wt. 9 oz. **No. 92CU5886**

$12.50

2 for $12.51

DIAL DESK TELEPHONE

(Cat. No. 92CU5908)

"TIE-PIN" CONDENSER MIKE

2 for $3.96

It's a little giant in sound quality. Metal encased, and omnidirectional. Frequency response 20-20,000 Hz. Less tie pin or lapel clip. 600 ohm impedance. 1.5 VDC. **Cat. No. 5730**

$3.95

25 AMP BRIDGE RECTIFIERS

	PIV	SALE	2 FOR
☐	25	1.25	1.26
☐	50	1.95	1.96
☐	100	2.25	2.26
☐	200	2.95	2.96
☐	400	3.50	3.51
☐	600	4.25	4.26
☐	800	4.95	4.96

Order No. 2273 & voltage

1N4000 Epoxy Rectifiers

Cat. No.	Type	Volts	Sale		1¢ SALE!	
2377	1N4001	50	10 for	$ .75	20 for	$ .76
2378	1N4002	100	10 for	.85	20 for	.86
2379	1N4003	200	10 for	.95	20 for	.96
2380	1N4004	400	10 for	1.19	20 for	1.20
2381	1N4005	600	10 for	1.39	20 for	1.40
2382	1N4006	800	10 for	1.49	20 for	1.50
2383	1N4007	1000	10 for	1.59	20 for	1.60

ULTRASONIC TRANSDUCER

$3.98

2 for $3.99

Perfect for dozens of projects, including remote control devices, alarms, etc. Sends and Receives! 1" diameter, ¾" deep, with standard RCA type phono jack. Wt. 2 oz. **Cat. No. 92CU5375**

FANTASTIC? YOU BET IT IS! LOOK WHAT YOU GET FOR 1¢ MORE!

☐	10-HUMBUCKER CONTRDLS W/KNOB, for TV vertical, horiz., etc. (#5882)	1.29	20 for 1.30
☐	50-CAPACITOR SPECIAL, discs, mylars, and more. (#3775)	1.29	100 for 1.30
☐	6-HOBBY VOLTAGE REGULATORS, LM-309, 320, 340's, TO-3, (#3330A)	1.29	12 for 1.30
☐	12-PANEL SWITCHES, assorted slides, rotaries, modulars, etc. (#295)	1.29	24 for 1.30
☐	65-RESISTOR SPECIAL, 1/4 to 1 watt, carbons, carbo-films, etc. (#35896)	1.29	130 for 1.30
☐	65-HALF WATT RESISTORS, asstd. carbons, carbo-films, various values. (#454)	1.29	130 for 1.30
☐	6-LM340T VOLTAGE REGULATORS, 5 to 24 volts, TO-220. (#5897)	1.29	12 for 1.30
☐	60-POLYSTYRENE CAPACITORS, asst'd values and voltages, (#1052)	1.29	120 for 1.30
☐	15-THERMISTORS, resistors that change with the temperature, (#2048)	1.29	30 for 1.30
☐	65-1/4 WATT RESISTORS, asst'd values, metal film, marked, (#5797)	1.29	130 for 1.30
☐	1-12VDC SPDT RELAY, 180 ohm coil, 25 mA, 1x1x1½" (#5937)	1.29	2 for 1.30
☐	15-VOLUME CONTROLS, asst. values, audio, and switch too! (#592)	1.29	30 for 1.30
☐	75-PREFORMED DISC CAPS, handy assortment of values, marked, (#1181)	1.29	150 for 1.30
☐	15-AXIAL ELECTROS, assorted values and capacitance. (#5901)	1.29	30 for 1.30
☐	100-GLASS ZENERS, 400mW, untested, better than 50% yield, (#5889)	1.29	200 for 1.30
☐	10-PC TRIMPOTS, screwdriver adjust, assorted values, (#3346)	1.29	20 for 1.30
☐	5-SLIDE VOLUME CONTROLS, assortment of values, duals, singles, (#2318)	1.29	10 for 1.30
☐	30-4" CABLE TIES, plastic, like Ty-wrap style, (#5217)	1.29	60 for 1.30
☐	5-CRYSTALS, may include; CB, ham, various shapes and sizes, (#5716)	1.29	10 for 1.30
☐	30-POWER RESISTORS, assorted types, includes 2 to 10 watters, (#228)	1.29	60 for 1.30
☐	30-TWO WATT RESISTORS, carbo-films, carbons, some 5%ers, (#456)	1.29	60 for 1.30
☐	60-TERMINAL STRIPS, asst'd solder and screw types, 2 lugs & up, (#334)	1.29	120 for 1.30
☐	1-WATCH GUTS, LED, who knows how good, micro-digital bonanze, (#5115)	1.29	2 for 1.30
☐	10-1000V 1A RECTIFIERS, 1N4007, epoxy case, axial leads, (#5926)	1.29	20 for 1.30
☐	5-MULTI-DIGIT LED READOUTS, bubble magnifier, 2 to 6 digits, (#3624)	1.29	10 for 1.30
☐	15-POWER TAB TRANSISTORS, NPN, plastic, TO-220, (#5898)	1.29	30 for 1.30
☐	6-PRECISION TRIM POTS, asst'd singles and multi-turns, untested, (#3389)	1.29	12 for 1.30
☐	50-1N4000 RECTIFIERS, epoxy, axial leads, untested, (#2594)	1.29	100 for 1.30
☐	30pc.-HEAT SHRINK, Thermo-fit, useful asst. of sizes, shrinks 50%, (#5248)	1.29	60 for 1.30
☐	15-SLIDE SWITCHES, SPST, SPDT, etc. all shapes and sizes, (#5927)	1.29	30 for 1.30
☐	25-DTL's, 100% prime, asst'd flip flops, etc., marked, (#3709)	1.29	50 for 1.30
☐	25-TTL's, 100% prime, asst'd flip flops, etc., marked, (#5873)	1.29	50 for 1.30
☐	6-HOBBY OPTO COUPLERS, 1500 volt isolation, U-test, (#2629A)	1.29	12 for 1.30
☐	8-TAPE RECORDER EARPHONE, for radios, recorders, 8 ohms, (#2946)	1.29	16 for 1.30
☐	8-MICRO-MINI JACKS, in a block, for 2mm sub-mini plugs, (#1437)	1.29	16 for 1.30
☐	5-PL-55 PHONE JACKS, standard bushing, for hams, communications, (#5868)	1.29	10 for 1.30
☐	15-RED DEVIL CAPACITORS, handy assort. of pop. values, axial leads, (#3823)	1.29	30 for 1.30
☐	60-MICAS asst. sizes-n-shapes, incl. "silvers" too! (#373)	1.29	120 for 1.30
☐	12-TRANSISTOR SOCKETS, for npn and pnp types, (#5944)	1.29	24 for 1.30
☐	12-LED DRIVER IC's, similar to 75491, (#5890)	1.29	24 for 1.30
☐	10-MODULAR SWITCHES, Centralab "push-on" type, up to 8PDT, (#3150)	1.29	20 for 1.30
☐	6-"MOTORS MOTORS", small, high speed, asst'd sizes, 3-6VDC, (#2551)	1.29	12 for 1.30
☐	2-HEAVY DUTY LINE CORDS, 8 ft., 2 cond., 18 gauge, black insulation, (#5803)	1.29	4 for 1.30
☐	12-LED SOCKETS, "snap-in" minis, for LEDS, and transistors too! (#5745)	1.29	24 for 1.30
☐	15-MV-54 MICRO-MINI LEDS, flat top style, diffused red lens, (#1789)	1.29	30 for 1.30
☐	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"x3", for power tabs, innumerable uses, (#5338)	1.29	4 for 1.30
☐	1-"MICRO MINI" METER, 1/2" dia, 0-1 basic movement (#5858)	1.29	2 for 1.30
☐	2-DOUBLE-SIDED PC BOARDS, 3"x12" high quality G-10 glass, (#5694)	1.29	4 for 1.30
☐	60-TUBULAR CAPACITORS, asst'd 100mmf to .1mf to 600 WVDC, (#35A219)	1.29	120 for 1.30
☐	6-MICRO MINI REED SWITCHES, 1" long, for alarms, relays, etc., (#1258)	1.29	12 for 1.30
☐	10-TANTELUM ELECTROS, asst'd mini, axial, hermetically sealed, (#5848)	1.29	20 for 1.30
☐	60-DISC TYPE CAPS, incl; NPO, hi-Q, mylar, ceramics, asst'd values, (#437)	1.29	120 for 1.30
☐	60-COILS & CHOKES, asst'd RF, OSC, IF, parasitic types, (#35A297)	1.29	120 for 1.30
☐	10-SWITCHCRAFT PHONO JACKS, hi-Q, chasis mount, teflon base, (#5119)	1.29	20 for 1.30
☐	1-TO-3 HEAT SINK, heavy duty aluminum, prepunched for TO-3, (#4083)	1.29	2 for 1.30
☐	75-MOLEX SOCKETS, "on-a-strip", for multiple pin dips, (#1609)	1.29	150 for 1.30
☐	6-PAIRS 9V BATTERY CLIPS, w/red & black color-coded leads, (#2852)	1.29	12 for 1.30
☐	1-UHF TUNER, 3 gang, uhf 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 guage, insulated, continuous length, (#3803)	1.29	60 for 1.30
☐	4-MOND TAPE HEADS, may incl; cassette, 8-track, reel to reel too! (#5789)	1.29	8 for 1.30
☐	5-DUAL DIGIT "BUBBLE" READOUTS, HP5082 style, red, dip type (#5748)	1.29	10 for 1.30
☐	50-METAL & PLASTIC TRANSISTORS, asst'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, 4nS, 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 SOCKETS, 3/16" mt. holes for 1/16" PC leads, (#5527)	1.29	20 for 1.30
☐	10-MULTI-GANG POTS, audio 2 gangs and up, asst'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-LASCR 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 LEDS, 100% material, 3 volts @ 10 mils, (#5896)	1.29	30 for 1.30
☐	50-FEEDTHRU CAPACITORS, used for hams, RF, UHF circuitry, (#5847)	1.29	100 for 1.30
☐	40-PLASTIC TRANSISTORS, asst'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, asst'd types, hobby, untested, (#2603A)	1.29	80 for 1.30
☐	15-UPRIGHT ELECTROS, 100% asst'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, 3.3,8,10,12,15V, 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, asst'd outputs, interstage & 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. #'s & functions, asst. 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, (#5888)	1.29	12 for 1.30
☐	6-POWER TAB SCR's, 100% prime, 100V, TO-220, (#5904)	1.29	12 for 1.30
☐	3-WATCH LCD's, 3-1/2 digit, asst. types, size: 1" x 1-1/2" (approx.), (#5066)	1.29	6 for 1.30
☐	10-TV INTERLOCK JACKS, for TV/power mt. ctr, solder tab terms., (#5519)	1.29	20 for 1.30
☐	4-MOS FETS, 3N128, 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" mt. 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, 4nS, 100V @ 10mA, axial 100%, (#3000)	1.29	40 for 1.30
☐	2-4 AMP SILICON BRIDGE RECTIFIER, 200V, block 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, asst'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, asst'd volt. to 1 mf, axial leads (#348642)	1.29	70 for 1.30
☐	100-MICRO ZENER & RECT. KIT, asst'd voltages, only 1/8" sq. U-test, (#1251)	1.29	200 for 1.30
☐	1-LINE CORD, 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, BABCOCK 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
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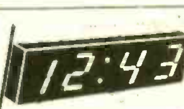
HY GAIN LED CLOCK KIT*



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• Panel or case design • 3 PC set

*Kit consists of a 3 pc set, transformer, function switches on a board, and a National MA1012 12A digital clock module with all parts and IC chip mounted on a 3" x 1 3/8" G-10 pc board. The RED filtered module measures 3" x 3/4" x 3/16". The PC board module is mounted in a bakelite frame 3 7/8" x 1 3/4" x 1/8" with 2 holes for easy panel mounting ... on centers.

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CD4010	.49	CD4042	.99	CD4093	.99
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CD4012	.25	CD4044	.89	MC14409	14.95
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CD4021	1.39	CD4059	9.95	CD4508	3.95
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CD4023	.23	CD4066	.79	CD4511	1.29
CD4024	.79	CD4068	.39	CD4515	2.95
CD4025	.23	CD4069	.45	CD4518	1.29
CD4026	2.25			CD4520	1.29
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74C00	.39	74C85	2.49	74C163	2.49
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74C08	.49	74C95	1.95	74C192	2.49
74C10	.39	74C107	1.25	74C193	2.49
74C14	1.95	74C151	2.90	74C195	2.49
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LM324N	1.80	NE566CN	1.75	75492CN	.89
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LM340K-6	1.35	LM703CN/H	.69	RC4136	1.25
LM340K-8	1.35	LM709N/H	.29	RC4151	2.85
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74LS00TTL

74LS00	.29	74LS47	.89	74LS138	.89
74LS01	.29	74LS51	.29	74LS139	.89
74LS02	.29	74LS54	.29	74LS151	.89
74LS03	.29	74LS55	.29	74LS155	.89
74LS04	.35	74LS73	.45	74LS157	.89
74LS05	.35	74LS74	.45	74LS160	1.15
74LS08	.29	74LS75	.59	74LS161	1.15
74LS09	.35	74LS76	.45	74LS162	1.15
74LS10	.29	74LS78	.49	74LS163	1.15
74LS11	.35	74LS83	.89	74LS164	1.15
74LS13	.59	74LS85	1.25	74LS175	.99
74LS14	1.25	74LS86	.45	74LS181	2.49
74LS15	.35	74LS90	.59	74LS190	1.15
74LS20	.29	74LS92	.75	74LS191	1.15
74LS21	.35	74LS93	.75	74LS192	1.15
74LS22	.35	74LS95	.99	74LS193	1.15
74LS26	.35	74LS96	1.15	74LS194	1.15
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74LS28	.35	74LS109	.45	74LS253	.99
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FEATURES:

- Full 8 bit latched output for microprocessor use
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- Debounce circuit provided for all 19 keys
- LED readout to verify entries
- Easy interfacing with standard 16 pin IC connector
- Only +5VDC required for operations

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 microprocessor or 8 bit memory circuits. Three (3) 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 strobe.

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Hexadecimal Keypad only $10.95

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NEW

- Dual sensors—switching control for indoor/outdoor or dual monitoring
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MAN 3	Common Cathode-red	.125	.25	MAN 6750	Common Cathode-red ±1	.560	.99
MAN 4	Common Cathode-red	.187	1.95	MAN 6760	Common Anode-red	.560	.99
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MAN 7Y	Common Anode-yellow	.300	.99	DL701	Common Anode-red ±1	.300	.99
MAN 72	Common Anode-red	.300	.99	DL704	Common Cathode-red	.300	.99
MAN 74	Common Cathode-red	.300	1.25	DL707	Common Anode-red	.300	.99
MAN 82	Common Anode-yellow	.300	.99	DL728	Common Cathode-red	.500	1.49
MAN 84	Common Cathode-yellow	.300	.99	DL741	Common Anode-red	.600	1.25
MAN 3620	Common Anode-orange	.300	.99	DL746	Common Anode-red ±1	.630	1.49
MAN 3630	Common Anode-orange ±1	.300	.99	DL747	Common Anode-red	.600	1.49
MAN 3640	Common Cathode-orange	.300	.99	DL749	Common Cathode-red ±1	.630	1.49
MAN 4610	Common Anode-orange	.400	.99	DL750	Common Cathode-red	.600	1.49
MAN 4640	Common Cathode-orange	.400	.99	DL338	Common Cathode-red	.110	.35
MAN 4710	Common Anode-red	.400	.99	FND70	Common Cathode	.250	.69
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MAN 6640	Common Cathode-orange-D.D.	.560	.99	HDSP-3403	Common Cathode-red	.800	2.10
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IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin LP	$.17	.16	.15	22 pin LP	$ .37	.36	.35
14 pin LP	.20	.19	.18	24 pin LP	.38	.37	.36
16 pin LP	.22	.21	.20	28 pin LP	.45	.44	.43
18 pin LP	.29	.28	.27	36 pin LP	.60	.59	.58
20 pin LP	.34	.32	.30	40 pin LP	.63	.62	.61

SOLDERTAIL STANDARD (TIN)

	1-24	25-49	50-100		1-24	25-49	50-100
14 pin ST	$.27	.25	.24	28 pin ST	$ .99	.90	.81
16 pin ST	.30	.27	.25	36 pin ST	1.39	1.26	1.15
18 pin ST	.35	.32	.30	40 pin ST	1.59	1.45	1.30
24 pin ST	.49	.45	.42				

SOLDERTAIL STANDARD (GOLD)

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin SG	$.30	.27	.24	24 pin SG	$ .70	.63	.57
14 pin SG	.35	.32	.29	28 pin SG	1.10	1.00	.90
16 pin SG	.38	.35	.32	36 pin SG	1.65	1.40	1.26
18 pin SG	.52	.47	.43	40 pin SG	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin WW	$.39	.38	.31	22 pin WW	$ .95	.85	.75
10 pin WW	.45	.41	.37	24 pin WW	1.05	.95	.85
14 pin WW	.39	.38	.37	28 pin WW	1.40	1.25	1.10
16 pin WW	.43	.42	.41	36 pin WW	1.59	1.45	1.30
18 pin WW	.75	.68	.62	40 pin WW	1.75	1.55	1.40

1/4 WATT RESISTOR ASSORTMENTS – 5%

ASST. 1	5 ea.	10 OHM / 27 OHM	12 OHM / 33 OHM	15 OHM / 39 OHM	18 OHM / 47 OHM	22 OHM / 56 OHM	50 PCS	$1.75
ASST. 2	5 ea.	68 OHM / 180 OHM	82 OHM / 220 OHM	100 OHM / 270 OHM	120 OHM / 330 OHM	150 OHM / 390 OHM	50 PCS	1.75
ASST. 3	5 ea.	470 OHM / 1.2K	560 OHM / 1.5K	680 OHM / 1.8K	820 OHM / 2.2K	1K / 2.7K	50 PCS	1.75
ASST. 4	5 ea.	3.3K / 8.2K	3.9K / 10K	4.7K / 12K	5.6K / 15K	6.8K / 18K	50 PCS	1.75
ASST. 5	5 ea.	22K / 56K	27K / 68K	33K / 82K	39K / 100K	47K / 120K	50 PCS	1.75
ASST. 6	5 ea.	150K / 390K	180K / 470K	220K / 560K	270K / 680K	330K / 820K	50 PCS	1.75
ASST. 7	5 ea.	1M / 2.7M	1.2M / 3.3M	1.5M / 3.9M	1.8M / 4.7M	2.2M / 5.6M	50 PCS	1.75

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

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Photo Transistor Opto-Isolator
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2/99¢

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SOUND GENERATOR
Generates Complex Sounds
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XR555	.39	XR1800	3.20	XR4136	1.25
XR556	.99	XR2206	4.40	XR4151	2.85
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XR567CT	1.25	XR2208	5.20	XR4202	3.60
XR1310P	1.30	XR2209	1.75	XR4212	2.05
XR1468CN	3.85	XR2211	5.25	XR4558	.75
XR1488	1.39	XR2212	4.35	XR4739	1.15
XR1489	1.39	XR2240	3.45	XR4741	1.47

DIODES

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

SCR AND FW BRIDGE RECTIFIERS

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

TRANSISTORS

C106B1	.50			2N3904	4/1.00
MPSA05	.30	2N3055	.89	2N3905	4/1.00
MPSA06	5/1.00	MJE3055	1.00	2N3906	4/1.00
TIS97	6/1.00	2N3392	5/1.00	2N4013	3/1.00
TIS98	6/1.00	2N3396	5/1.00	2N4123	6/1.00
40409	1.75	PN3567	3/1.00	PN4249	4/1.00
40410	1.75	PN3568	4/1.00	PN4250	4/1.00
40673	1.75	PN3569	4/1.00	2N4400	4/1.00
2N918	4/1.00	MPS3638A	5/1.00	2N4401	4/1.00
2N2219A	2/1.00	MPS3702	5/1.00	2N4402	4/1.00
2N2221A	4/1.00	2N3704	5/1.00	2N4403	4/1.00
2N2222A	5/1.00	MPS3704	5/1.00	2N4409	5/1.00
PN2222 Plastic	7/1.00	2N3705	5/1.00	2N5086	4/1.00
2N2369	5/1.00	MPS3705	5/1.00	2N5087	4/1.00
2N2369A	4/1.00	2N3706	5/1.00	2N5088	4/1.00
MPS2369	5/1.00	MPS3706	5/1.00	2N5089	5/1.00
2N2484	4/1.00	2N3707	5/1.00	2N5129	5/1.00
2N2906	4/1.00	2N3711	5/1.00	PN5134	5/1.00
2N2907	5/1.00	2N3724A	.65	PN5138	5/1.00
PN2907 Plastic	7/1.00	2N3725A	1.00	2N5139	5/1.00
2N2925	5/1.00	2N3772	2.25	2N5210	5/1.00
MJE2955	1.25	2N3823	1.00	2N5449	3/1.00
2N3053	2/1.00	2N3903	5/1.00	2N5951	3/1.00

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-99	100-		1-9	10-99	100-
10 pf	.05	.04	.03	.001µF	.05	.04	.035
22 pf	.05	.04	.03	.0047µF	.05	.04	.035
47 pf	.05	.04	.03	.01µF	.05	.04	.035
100 pf	.05	.04	.03	.022µF	.06	.05	.04
220 pf	.05	.04	.03	.047µF	.06	.05	.04
470 pf	.05	.04	.035	1µF	.12	.09	.075

100 VOLT MYLAR FILM CAPACITORS

.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22

+20% DIPPED TANTALUMS (SOLID) CAPACITORS

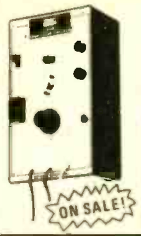
.1/35V	.28	.23	.17	1.5/35V	.30	.26	.21
.15/35V	.28	.23	.17	2.2/25V	.31	.27	.22
.22/35V	.28	.23	.17	3.3/25V	.31	.27	.22
.33/35V	.28	.23	.17	4.7/25V	.32	.28	.23
.47/35V	.28	.23	.17	6.8/25V	.36	.31	.25
.68/35V	.28	.23	.17	15/25V	.63	.50	.40
1.0/35V	.28	.23	.17				

MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS

Axial Lead				Radial Lead			
.47/50V	.15	.13	.10	.47/25V	.15	.13	.10
1.0/50V	.16	.14	.11	.47/50V	.16	.14	.11
3.3/50V	.14	.12	.09	1.0/16V	.15	.13	.10
4.7/25V	.15	.13	.10	1.0/25V	.16	.14	.11
10/25V	.15	.13	.10	1.0/50V	.16	.14	.11
10/50V	.16	.14	.12	4.7/16V	.15	.13	.10
22/25V	.17	.15	.12	4.7/25V	.15	.13	.10
22/50V	.24	.20	.18	4.7/50V	.16	.14	.11
47/25V	.19	.17	.15	10/16V	.14	.12	.09
47/50V	.25	.21	.19	10/25V	.15	.13	.10
100/25V	.24	.20	.18	10/50V	.16	.14	.12
100/50V	.35	.30	.28	47/50V	.24	.21	.19
220/25V	.32	.28	.25	100/16V	.19	.15	.14
220/50V	.45	.41	.38	100/25V	.24	.20	.18
470/25V	.33	.29	.27	100/50V	.35	.30	.28
1000/16V	.55	.50	.45	220/16V	.23	.17	.16
2200/16V	.70	.62	.55	470/25V	.31	.28	.26

CIRCLE 15 ON FREE INFORMATION CARD

Transistor Checker



— Completely Assembled —
— Battery Operated —

The ASI Transistor Checker is capable of checking a wide range of transistor types, either "in circuit" or out of circuit. To operate, simply plug the transistor to be checked into the front panel socket, or connect it with the alligator clip test leads provided. The unit safely and automatically identifies low, medium and high-power PNP and NPN transistors. Size: 3¾" x 6¼" x 2"
"C" cell battery not included.

ON SALE!

Trans-Check $19.95 ea.

Custom Cables & Jumpers

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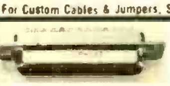
DB 25 Series Cables

Part No.	Cable Length	Connectors	Price
DB25P-4-P	4 Ft.	2-DP25P	$15.95 ea.
DB25P-4-S	4 Ft.	1-DP25P/1-25S	$16.95 ea.
DB25S-4-S	4 ft.	2-DP25S	$17.95 ea.
Dip Jumpers			
DJ14-1	1 ft.	1-14 Pin	$1.59 ea.
DJ16-1	1 ft.	1-16 Pin	1.79 ea.
DJ24-1	1 ft.	1-24 Pin	2.79 ea.
DJ14-1-14	1 ft.	2-14 Pin	2.79 ea.
DJ16-1-16	1 ft.	2-16 Pin	3.19 ea.
DJ24-1-24	1 ft.	2-24 Pin	4.95 ea.

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

CONNECTORS



25 Pin-D Subminiature

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

PRINTED CIRCUIT EDGE-CARD

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

15/30	PINS (Solder Eyelet)		$1.95
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50/100 (.100 Spacing)	PINS (Wire Wrap)		$6.95
50/100 (.125 Spacing)	PINS (Wire Wrap)	R681-1	$6.95

4-Digit Clock Kit

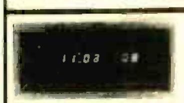
- Bright .357" ht. red display
- Sequential flashing colon
- 12 or 24 hour operation
- Extruded aluminum case (black)
- Pressure switches for hours, minutes & hold functions
- Includes all components, case and wall transformer
- Size: 3¼ x 1¾ x 1¼

JE730 .... $14.95

Jumbo 6-Digit Clock Kit

- Four .630"ht. and two .300"ht. common anode displays
- Uses MM5314 clock chip
- Switches for hours, minutes and hold functions
- Hours easily viewable to 30 feet
- Simulated walnut case
- 115VAC operation
- 12 or 24 hour operation
- Includes all components, case and wall transformer
- Size: 6¾ x 3¼ x 1¾

JE747 .... $29.95



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

JE701

6-Digit Clock Kit $19.95

REMOTE CONTROL TRANSMITTER & RECEIVER

$19.95

Digital Stopwatch Kit

- Use Intersil 7205 Chip
- Plated thru double-sided P.C. Board
- LED display (red)
- Times to 59 min. 59.59 sec. with auto reset
- Quartz crystal controlled
- Three stopwatches in one: single event, split (cummulative) & taylor (sequential timing)
- Uses 3 Penlite batteries
- Size: 4.5" x 2.15" x .90"

JE900 $39.95

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8080A	CPU	$ 9.95
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8224	Clock Generator/Driver	3.95
8226	Bus Driver	3.49
8228	System Controller/Bus Driver	5.95
8238	System Controller	5.95
8251	Prog. Comm. 1/0 (USART)	7.95
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8255	Prog. Periph. 1/0 (PPI)	9.95
8257	Prog. DMA Control	19.95
8259	Prog. Interrupt Control	19.95
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MC6802CP	MPU with Clock and Ram	24.95
MC6810API	128X8 Static Ram	5.95
MC6821	Periph. Inter. Adapt (MC6820)	7.49
MC6828	Priority Interrupt Controller	12.95
MC6830L8	1024X8 Bit ROM (MC68A30-8)	14.95
MC6850	Asynchronous Comm. Adapter	7.95
MC6852	Synchronous Serial Data Adapt	9.95
MC6860	0-600 bps Digital MODEM	12.95
MC6862	2400 bps Modulator	14.95
MC6880A	Quad 3-State Bus. Trans. (MC8T26)	2.25
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Z80A(780-1)	CPU	24.95
CDP1802	CPU	19.95
2650	MPU	19.95
6502	CPU	11.95
8035	8-Bit MPU w/clock, RAM, 1/0 lines	19.95
P8085	CPU	19.95
TMS9900JL	16-Bit MPU w/hardware, multiply & divide	49.95
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MM500H	Dual 25 Bit Dynamic	$ .50
MM503H	Dual 50 Bit Dynamic	.50
MM504H	Dual 16 Bit Static	.50
MM506H	Dual 100 Bit Static	.50
MM510H	Dual 64 Bit Accumulator	.50
MM5016H	500/512 Bit Dynamic	.89
2504T	1024 Dynamic	3.95
2518	Hex 32 Bit Static	4.95
2522	Dual 132 Bit Static	2.95
2524	512 Static	.99
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2533	1024 Static	2.95
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A-Y-5-1013	30k BAUD	5.95

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M-CDP1802	User Manual	7.50
M-2650	User Manual	5.00
ROM'S		
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2513(3021)	Character Generator(lower case)	9.95
2516	Character Generator	10.95
MM5230N	2048-Bit Read Only Memory	1.95

RAM'S			
1101	256X1	Static	$1.49
1103	1024X1	Dynamic	.99
2101(8101)	256X4	Static	3.95
2102	1024X1	Static	1.75
21L02	1024X1	Static	1.95
2111(8111)	256X4	Static	3.95
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2114L	1024X4	Static 450ns low power	10.95
2114-3	1024X4	Static 300ns	10.95
2114L-3	1024X4	Static 300ns low power	11.95
5101	256X4	Static	7.95
5280/2107	4096X1	Dynamic	4.95
7489	16X4	Static	1.75
74S200	256X1	Static Tristate	4.95
93421	256X1	Static	2.95
UPD414 (MK4027)	4K	Dynamic 16 pin	4.95
UPD416 (MK4116)	16K	Dynamic 16 pin	9.95
TMS4044-45NL	4K	Static	14.95
TMS4045	1024X4	Static	14.95
2117	16,384X1	Dynamic 350ns (house marked)	9.95
MM5262	2KX1	Dynamic	4/1.00
PROM'S			
1702A	2048	FAMOS	$5.95
2716INTEL	16K*	EPROM	59.95
TMS2516 (2716)	16K*	EPROM	49.95
	*Requires single +5V power supply		
TMS2532	4KX8	EPROM	89.95
2708	8K	EPROM	10.95
2716 T.I.	16K**	EPROM	29.95
	**Requires 3 voltages, −5V, +5V, +12V		
5203	2048	FAMOS	14.95
6301-1(7611)	1024	Tristate Bipolar	3.49
6330-1(7602)	256	Open C Bipolar	2.95
82S23	32X8	Open Collector	3.95
82S115	4096	Bipolar	19.95
82S123	32X8	Tristate	3.95
74186	512	TTL Open Collector	9.95
74188	256	TTL Open Collector	3.95
74S287	1024	Static	2.95

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Proto Board 203

A total ready-to-use power breadboard prototest device with a built in regulated short-proof power supply. Just plug in and start building! 2 extra floating 5-way binding posts for external signals. Self contained with power switch indicator lamp and power fuse. 24 14 pin DIP capacity. Attractive two tone quality case. All metal construction. 9½"L x 6½"W x 2¾"H 5 lbs.

PB 203 **$75.00**

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

Proto Board 203A

All the features of the PB 203 plus additional power supply flexibility. Provides 1% Regulated 5VDC supply (same specifications as PB 203). Regulated separate +15VDC and −15 VDC 0.5A supplies, each with internally and independently adjustable output voltage. Ripple and noise at + and −15V supplies 10mV at 0.75A.

PB 203A **$124.95**

Model Number	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 8.0 x 1.4	$54.95

62-Key ASCII Encoder Keyboard Kit

NEW! **JE610**

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 and a double-sided printed wiring board. The keyboard assembly requires +5V @ 150mA and −12V @ 10mA for operation.

FEATURES:
- 60 Keys generate the full 128 characters, upper and lower case ASCII set
- Fully buffered
- 2 user-define keys provided for custom applications
- Caps lock for upper case only alpha characters
- Utilizes a 2376 (40 pin) encoder read only memory chip
- Outputs directly compatible with TTL/DTL or MOS logic arrays
- Easy interfacing with a 16-pin dip or 18-pin edge connector

JE610 ..... $79.95

REGULATED POWER SUPPLY

NEW

JE200 5V-1 AMP POWER SUPPLY

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

JE200 $14.95

JE205 ADAPTER BOARD
— Adapts to JE200 —
±5V, ±9V and ±12V

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

JE205 $12.95

$10.00 Min. Order — U.S. Funds Only
Calif. Residents Add 6% Sales Tax
Postage — Add 5% plus $1 Insurance (if desired)

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

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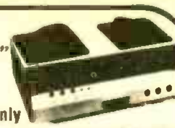
The Incredible
"Pennywhistle 103"



$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 another modem and terminal for telephone "hamming" and communications. In addition, it is free of critical adjustments and is built with non-precision, readily available parts.

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

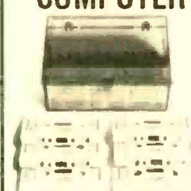
Requires a VOM, Audio Oscillator, Frequency Counter and/or Oscilloscope to align

TRS-80 16K Conversion Kit

Expand your 4K TRS-80 System to 16K. Kit comes complete with:
- 8 each UPD416-1 (16K Dynamic Rams) 250NS
- Documentation for conversion

TRS-16K $75.00

COMPUTER CASSETTES



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- ADDITIONAL CASSETTES AVAILABLE #C-15-$2.95 ea

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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, TRS-80, Challenger, etc.
MOD II is pretuned 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
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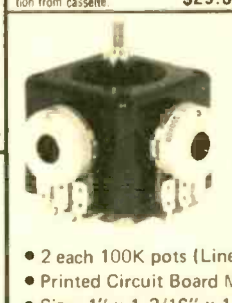
"Plug/Jack interface to any computer system requiring remote control of cassette functions"
The CC100 controls cassette motor functions, monitors tape location with its internal speaker and requires no power. Eliminates the plugging and unplugging of cables during computer loading operation from cassette.

#CC-100
$29.50



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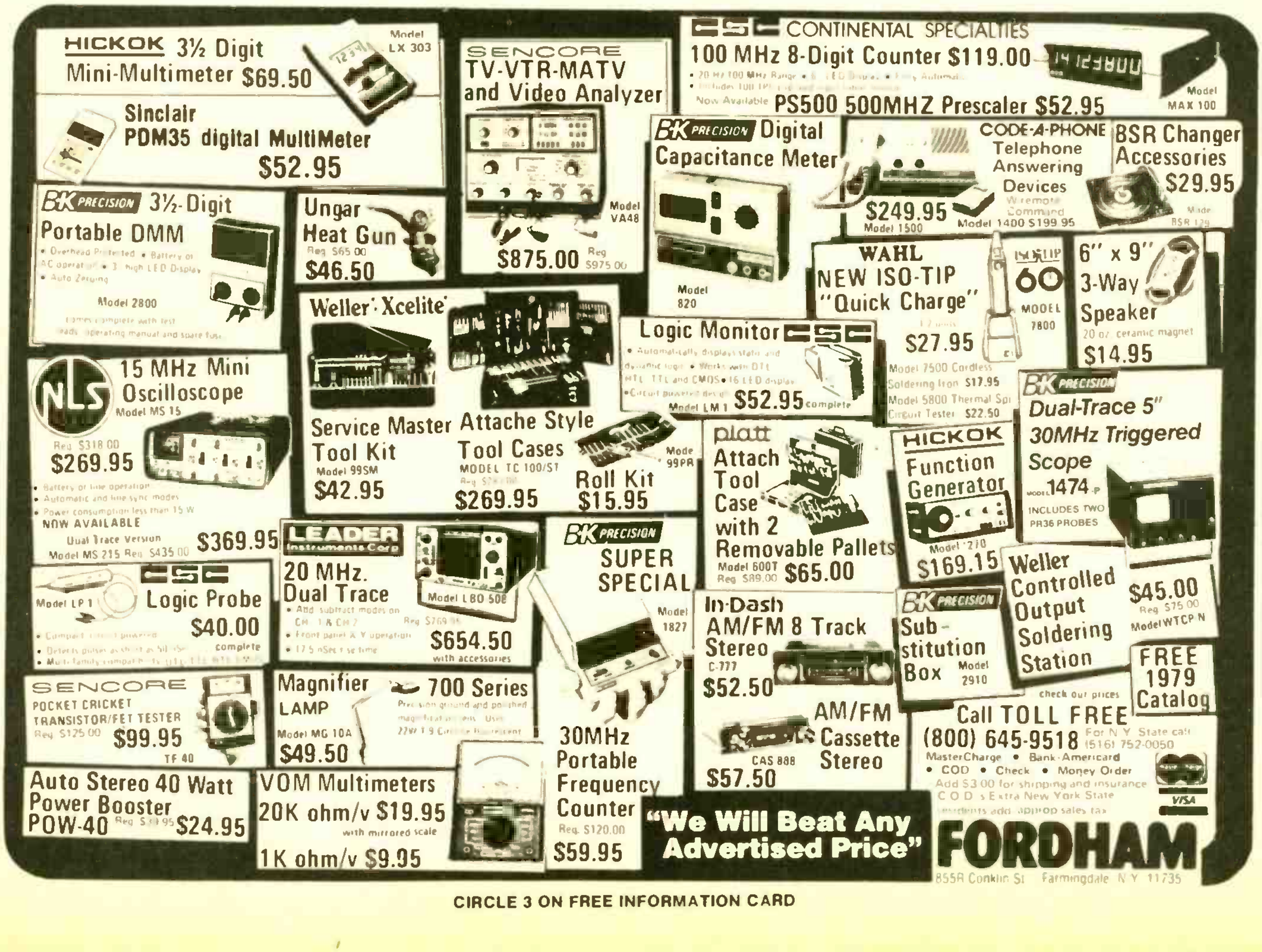
- 2 each 100K pots (Linear Taper)
- Printed Circuit Board Mount
- Size: 1" x 1-3/16" x 1-3/16"

Micro-Miniature Joystick $4.95



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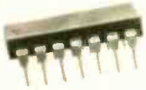

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74LS13	276-1911	.99
74LS20	276-1912	.59
74LS27	276-1913	.69
74LS30	276-1914	.59
74LS32	276-1915	.69
74LS47	276-1916	1.29
74LS51	276-1917	.59
74LS73	276-1918	.69
74LS74	276-1919	.69
74LS75	276-1920	.99
74LS76	276-1921	.79
74LS85	276-1922	1.29
74LS90	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
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4027	276-2427	.99
4028	276-2428	1.29
4046	276-2446	1.69
4511	276-2447	1.69
4049	276-2449	.79
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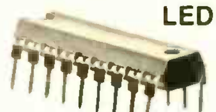

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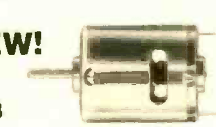

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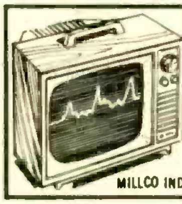

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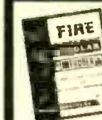

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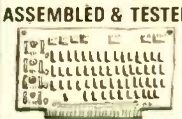

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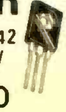

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Super Basic on Cassette **$40.00**

Tiny Basic Source now available **$19.00**

S-100 Slot Expansion. Add 3 more S-100 slots to your Super Expansion Board or use as a 4 slot S-100 Mother Board. Board without connectors **$9.95.**

Coming Soon: High resolution alpha/numerics with color graphics expandable up to 256 x 192 resolution for less than **$100**. Economical versions for other popular 1802 systems also.

16K Dynamic RAM board expandable to 32K for less than **$150.**

RCA Cosmac Super Elf Computer $106.95

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

Before you buy another small computer, see if it includes the following features: ROM monitor; State and Mode displays; Single step; Optional address displays; Power Supply; Audio Amplifier and Speaker; Fully socketed for all IC's; Real cost of in warranty repairs; Full documentation.

The **Super Elf** includes a **ROM** monitor for program loading, editing and execution with **SINGLE STEP for program debugging** which is not included in others at the same price. With **SINGLE STEP** you can see the microprocessor chip operating with the **unique Quest** address and data bus displays **before, during and after** executing instructions. Also, CPU mode and instruction cycle are decoded and displayed on 8 LED indicators.

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

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

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

Remember, other computers only offer Super Elf features at additional cost or not at all. **Compare before you buy. Super Elf Kit $106.95, High address option $8.95, Low address option $9.95. Custom Cabinet** with drilled and labelled plexiglass front panel **$24.95.** Expansion Cabinet with room for 4 S-100 boards **$41.00. NiCad Battery Memory Saver Kit $6.95.** All kits and options also come completely assembled and tested.

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

Tiny Basic Cassette **$10.00,** on ROM **$38.00,** original Elf kit board **$14.95.**

Super Expansion Board with Cassette Interface $89.95

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

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

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

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

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7400N	.17
7402N	17
7404N	.19
7409N	23
7410N	.17
7414N	63
7420N	.17
7422N	1.39
7430N	20
7442N	50
7445N	.69
7447N	60
7448N	69
7450N	17
7474N	29
7475N	49
7485N	88
7489N	2 00
7490N	43
7492N	43
7493N	43
7495N	69
74100N	90
74107N	29
74121N	34
74123N	59
74125N	39
74145N	69
74150N	95
74151N	69
74154N	1 00
74157N	69
74161N	87
74162N	87
74163N	87
74174N	96
74175N	90
74190N	1 15
74192N	87
74193N	85
74221N	1 55
74298N	1.65
74365N	66
74366N	66
74367N	66

74LS00 TTL	
74LS00N	25
74LS02N	25
74LS04N	25
74LS05N	.25
74LS08N	25
74LS10N	.25
74LS13N	40
74LS14N	.90
74LS20N	.25
74LS22N	25
74LS28N	41
74LS30N	25
74LS33N	39
74LS38N	30
74LS74N	70
74LS75N	47
74LS90N	51
74LS93N	51
74LS95N	1 89
74LS107N	35
74LS112N	35
74LS113N	35
74LS132N	72
74LS136N	35
74LS151N	.67
74LS155N	.67
74LS157N	.67
74LS162N	.91
74LS163N	91
74LS174N	95
74LS190N	1.06
74LS221N	1 95
74LS258N	67
74LS367N	1.35

LINEAR	
CA3045	90
CA3046	67
CA3081	1.80
CA3082	1 90
CA3089	2 95
LM301 AN/AH	35
LM305H	87
LM307N	.35
LM308N	.89
LM309H	1.15
LM309K	1 50
LM311H/N	90

LM317T/K	2 92
LM318	1.35
LM320K-5	1 20
LM323K-5	6 95
LM320K-12	1 35
LM320K-15	1 35
LM320T-5	1 60
LM320T-8	1 60
LM320T-12	1 50
LM320T-15	1 60
LM324N	1 15
LM339N	1 55
LM340K-5	1 35
LM340K-8	1 35
LM340K-12	1 35
LM340K-15	1 35
LM340K-24	1 35
LM340T-5	1 25
LM340T-8	1 25
LM340T-12	1 25
LM340T-15	1 25
LM340T-18	1 25
LM340T-24	1 25
LM343H	4 50
LM350	7 50
LM370	1 15
LM377	3 00
LM379	5 00
LM380N	1 00
LM381	1 60
LM382	1.60
LM703H	40
LM709H	28
LM723H/N	50
LM733N	67
LM741CH	.35
LM741N	25
LM747H/N	.62
LM748N	35
LM1303N	82
LM1304	1 10
LM1305	1.27
LM1307	2 00
LM1310	2 75
LM1458	47
LM1800	1.75
LM1812	7 50
LM1889	3 00
LM2111	1.75
LM2902	1 50
LM3900N	.60
LM3905	1 75
LM3909N	.61
MC1458V	.50
NE540L	2 89
NE550N	65
NE555V	43
NE556A	79
NE565A	1 00
NE566V	1 50
NE567V	1 20
NE570B	5 00
NE571B	5 00
78L05	60
78L08	60
78M05	85
75108	1 75
75491CN	50
75492CN	.55
75494CN	.89

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8701CN	22 00
8750CJ	13.95
LD130	9.95
9400CJV/F	7.40
ICL7103	9 50
ICL7107	14 25

CMOS	
CD34001 Fair	50
CD4000	16
CD4001	.28
CD4002	28
CD4006	1 10
CD4007	28
CD4008	28
CD4009	39
CD4010	39
CD4011	28
CD4012	.28
CD4013	38
CD4014	86

CD4015	86
CD4016	36
CD4017	94
CD4018	94
CD4019	28
CD4020	1 02
CD4021	1.02
CD4022	86
CD4023	28
CD4024	75
CD4025	28
CD4026	1 51
CD4027	36
CD4028	79
CD4029	1 02
CD4030	28
CD4035	1 02
CD4040	1 02
CD4042	.71
CD4043	63
CD4044	63
CD4046	1.67
CD4049	36
CD4050	36
CD4051	1 13
CD4060	1 42
CD4066	71
CD4068	40
CD4069	40
CD4070	40
CD4071	28
CD4072	28
CD4073	28
CD4075	28
CD4076	1 75
CD4078	40
CD4081	28
CD4082	28
CD4116	47
CD4490	5 50
CD4507	1.00
CD4508	4 25
CD4510	1 02
CD4511	94
CD4515	2 52
CD4516	1,10
CD4518	1.02
CD4520	1 02
CD4527	1.51
CD4528	.79
CD4553	3 50
CD4566	2.25
CD4583	4.50
CD4585	1 10
CD40192	3 00
74C00	28
74C04	.33
74C10	28
74C14	2 10
74C20	28
74C30	.28
74C48	1 95
74C74	75
74C76	1 40
74C90	1 15
74C93	1 40
74C154	3 00
74C160	1 44
74C175	1.35
74C192	1 65
74C221	2 00
74C905	3 00
74C906	.75
74C914	1 95
74C922	5 50
74C923	5 50
74C925	6 95
74C926	6 95
74C927	6.95

INTERFACE	
8095	65
8096	65
8097	65
8098	.65
8T09	1.25
8T10	4 50
8T13	3 00
8T20	5 50
8T23	3 10
8T24	3 50
8T25	3 20
8T26	1 69
8T28	2 75
8T97	1 69
8T98	1.69

MOS/MEMORY RAM	
2101-1	3 95
2102-1	.95
2102AL-4	1 60
21L02-1	1 18
21F02	1.25
2104A-4	4 95
2107B-4	3 75
2111-1	3.75
2112-2	3.95
2114L-3	7 90
4116	10 95
2513B	6 30
MM5262	40
MM5280	3 00
MM5320	9 95
MM5330	5 94
PD411D-3	4 00
PD411D-4	5 00
P5101L	13 95
4200A	9.95
82S25	2 90
91L02A	1.50
HD0165-5	6 95
MM57100	4 50
GIAY38500-1	9 95
MCM6571A	9 95
9368	3.50
4100	10 00
416	16 00

CLOCKS	
MM5314	3 90
MM5315	4 00
MM5369	2 10
MM5841	14 45
MM5865	7 95
CT7001	5 80
CT7010	8.95
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MM5375AG/N	4 90
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8212	2 90
8214	8 00
8216	2 90
8224	2.90
8228	5 35
8251	8 50
8253	10 00
8255	9 25
8257	19 50
8259	19.50
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1802DP plas.	17.95
1861P	11.50
CDP1802CD	19.95
CDP1802D	25 00
CDP1861	12 95
6820	9 95
6850	12.95
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6504	16 50
6522	13 60

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AY5-1014	7 50
3341	6 95

PROM	
1702A	3 95
N82S23	2.95
N82S123	3 50
N82S126	3.75
N82S129	3.75
N82S131	3.75

N82S136	8.75
N82S137	8 75
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DM8577	2 90
8223	2 90
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CONNECTORS	
44 pin edge	2.75
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IC SOCKETS
Solder Tin Low Profile

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

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

WIRE WRAP LEVEL 3

PIN		PIN	
14	.25	24	.86
16	.33	28	1 00
18	.57	40	1.23

CRYSTALS	
1 MHz	4 50
2 MHz	4.50
4 MHz	4 25
5 MHz	4 25
10 MHz	4 25
18 MHz	3 90
20 MHz	3 90
32 MHz	3 90
32768 MHz	4 00
1 8432 MHz	4 50
3.5795 MHz	1 20
2.0100 MHz	1.95
2.097152 MHz	4.50
2.4576 MHz	4 50
3 2768 MHz	4 50
5 0688 MHz	4 50
5 185 MHz	4 50
5 7143 MHz	4.50
6 5536 MHz	4.50
14.31818 MHz	4.25
18 432 MHz	4 50
22.1184 MHz	4.50

KEYBOARD ENCODERS	
AY5-2376	$12.50
AY5-3600	17.95
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74C923	5 50
HD0165-5	6.95

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DB25S	3.95
Cover	1.50
RS232 Complete Set	6 50
DE9S	1,95
DA15P	2.10
DA15S	3.10

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2N2222A	.18
2N2369	.30
2N2904A	.20
2N2907A	.25
2N3053	.40
2N3638	.25
2N3643	.25
2N3904	18
2N3906	18
2N3055	.69
2N4400	25
2N4401	75
2N4402	20
TIP31	.60
TIP33A	1.00

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Model 150 Bus Grabber Kit	$369 00
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12V CT 250 ma wall plug	3 50
24V CT 400 ma	3.95
10V 1.2 amp wall plug	4 85
12V 6 amp	12.95

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MAN1	CA	270	2 90
MAN3	CC	.125	.39
MAN72/74	CA/CA	.300	1 00
DL704	CC	300	1 25
DL707/DL707R	CA	300	1 00
DL727/728	CA/CC	500	1 90
DL747/750	CA/CC	600	1 95
DL750	CC	600	1 95
FND359	CC	357	.70
FND500/507	CC/CA	500	1 35
FND503/510	CC/CA	.500	.90
FND800/807	CC/CA	800	2.20
3 digit Bubble			.60
4 digit Bubble			.80
DG8 Fluorescent			1 75
DG10 Fluorescent			1 75
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NSN69 9 digit display			.60
7520 Clairex photocells			.39
TIL311 Hex			9 50

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