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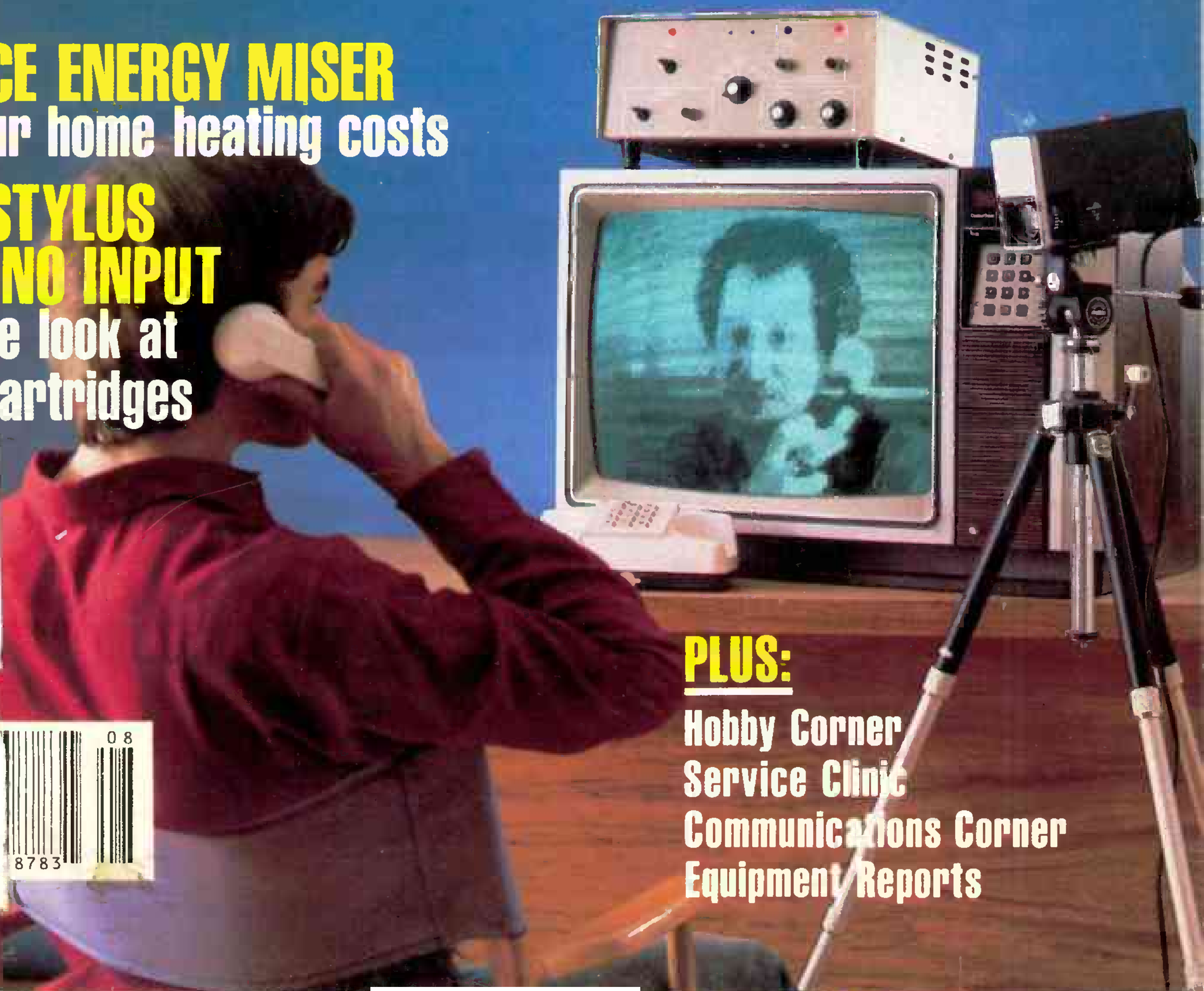

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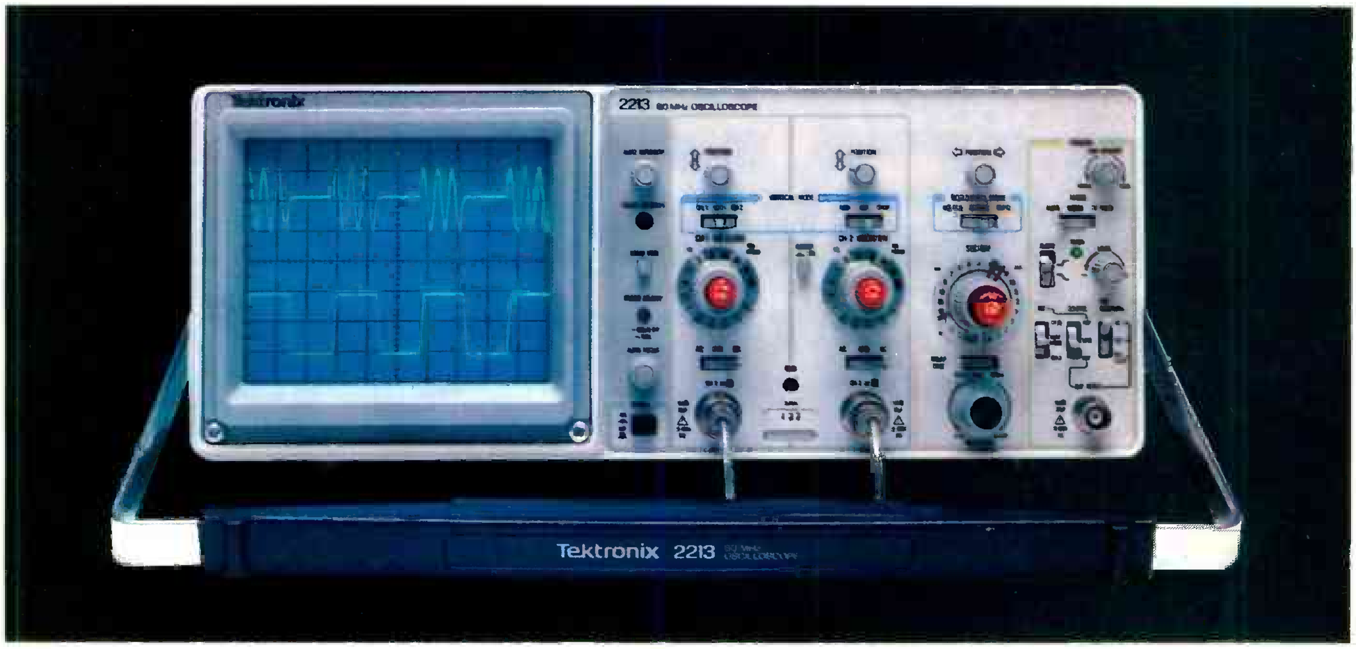

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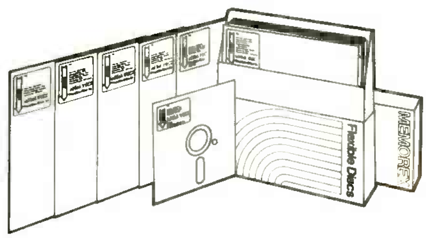

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Radio-Electronics

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

Electronics publishers since 1908

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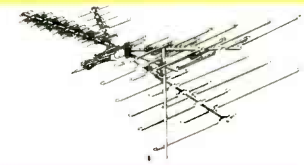
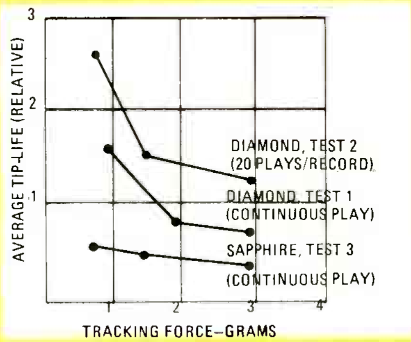
ON THE COVER

Up to now, about the only way you could add video to your telephone conversation was to go to one of a very few specially equipped Bell System centers. Even then, you could only talk with someone in another similarly equipped center—not a particularly convenient setup. Build a Picture Phone, and you can exchange pictures with anyone, anytime, anywhere, as long as both of you have one, and a telephone. The story starts on page 43.



GOOD VHF and UHF TELEVISION RECEPTION depends on many factors. Choosing the best system or configuration for your particular situation can be difficult, but for information that will make the task easier, turn to page 49.



THE SOUND QUALITY of even the best stereo systems can only be as good as the signal that is input from the phone cartridge. Find out more about phono cartridges, and whether you are getting the most out of yours. The story begins on page 61.

For those of our readers who have been awaiting the second part of our article on the stereo image expander, we promise that it will run in next month's issue.

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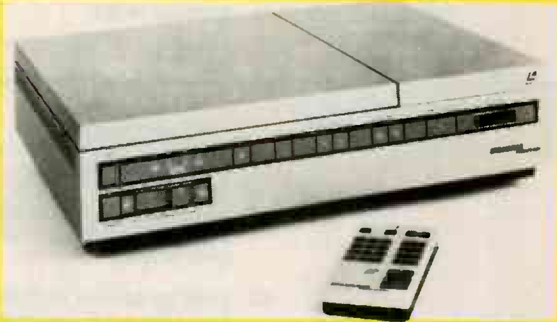
VIDEO ELECTRONICS

DAVID LACHENBRUCH
CONTRIBUTING EDITOR



ZENITH GOES COMPO

The first American TV manufacturer to offer a true video-component system is Zenith, and its entry into the field is significant in several ways. First, as one of the top two TV brands in the United States, Zenith carries more influence with middle America than any other brand except perhaps RCA. Its entry into the field takes component TV out of the "esoteric" category and brings it to the mainstream. Second, Zenith is bringing video components out of the stratospheric price area pioneered by Sony's Profeel.

The third significant aspect of Zenith's entry is that it is the first component brand, as of presstime, which doesn't require the TV tuner to do double duty as a switcher. The heart of Zenith's system is the "source selector," a versatile switching and routing system. It allows connection of up to six different audio/video program sources to the color monitor or VCR. Each of six sets of input jacks may be switched either to RF or baseband video. To ease the tangle of wires around the AC outlet, the back of the selector contains two switched and six unswitched AC sockets. The other components are a 19-inch video monitor with audio amplifier and speaker built in, and with video/audio and RGB (*R*ed-*G*reen-*B*lue) inputs, a remote-control digital TV tuner, plus a stereo amplifier and speaker system. (See left-hand photo.) Zenith has priced all the components separately—the monitor at $470, the source selector $170, TV tuner $280. Each piece has its own uses—for example, the monitor, added to a videocassette recorder (using its tuner) yields a high-quality TV set. The source selector is expected to have broad appeal as a building block with other video equipment.

NEW LV PLAYERS

LaserVision videodisc players got their first model change at midyear. Magnavox introduced a sleek new player, which will also be sold under the Sylvania brand name. (See right-hand photo.) The new model is built for North American Philips by Pioneer of Japan, which will field two redesigned models here under the Pioneer brand name. Functionally, the new players are similar to the earlier Pioneer model and have wireless remote-control units which can access discs by frame number (or time) and by chapter. Added to the system is the CBS-developed CX audio-noise-reduction feature—which also is on the new CED players.

STEREO WITH VIDEO

In addition to component systems, another trend in the new TV lines is the increasing number of high-end TV sets with stereo audio amplifiers, with the promise that they can be converted to stereo TV broadcasting when standards are adopted. In the meantime, they can be used with FM tuners for simulcasts, or with stereo VCR's and videodisc players.

This is the year that the home VCR will go stereo. Although Akai has had a stereo-sound video recorder for a year, almost every other brand will add stereo to its top-end unit this year. In the VHS format, Hitachi, JVC, GE, Quasar, RCA, and other VHS proponents had already announced stereo models at presstime, and the Beta group (Sony, Sanyo, Toshiba, Zenith) was expected to make a collective announcement about stereo standards.

Stereo finally came to the RCA-developed CED videodisc system. RCA now has introduced a total of three new player models—a "leader" mono unit designed to be sold for just below $300, a "step-up" mono player which has a list price of $349.95 and a stereo player at $399.95. Hitachi followed suit with a stereo model also carrying a list pice of $399.95, as well as a stereo converter for its earlier model at $59.95. Toshiba's stereo model carries an official $595 price tag, but is also expected to sell for less than $400. R-E

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WHAT'S NEWS

Magnetic monopole surfaces again

A Stanford University scientist, Blas Cabrera, believes he may have discovered a particle that is a magnet with only one pole, either S or N, but not both. The announcement has aroused great interest, because there is a gap in electromagnetic theory that would be filled neatly by magnetic monopoles (and magnetic current) and scientists have long searched for the elusive particle.

In 1931, physicist P. A. M. Dirac suggested that such a particle should exist, and that it would have a basic charge of 68.5 or a multiple of that number.

In 1944, the refugee Austrian scientist Felix Ehrenhaft, the former head of the Physics Institute of the University of Vienna, announced that he had discovered magnetic monopoles and tried to show evidence for a "magnetic current," **R-E**'s predecessor *Radio-Craft* printed two articles and an editorial on the subject, and there was much discussion. Experiments proved to be inconclusive, however, and the monopole dropped out of sight for some decades.

It reappeared briefly in 1970, with a report of a particle that reacted strongly in a magnetic field; and in 1975, scientists of the University of California reported the discovery of a particle that fitted the characteristics of a monopole as laid down by Dirac. Later, they decided the fit was not exact.

Cabrera's apparatus is a superconducting coil enclosed in a thin lead shield. The magnetic charge entering the coil caused the current through it to fluctuate. Only one such incident was reported in 185 days. (Physicists estimate that about one monopole a year would fall on each 100 square yards of the Earth's surface.) Cabrera is therefore building an apparatus 50 times larger, in the hope of attracting more monopoles.

Shielded room kills electronic pollution

A major car company has introduced a new kink in "shielded-room" testing. An ordinary shielded room protects the apparatus being tested from external radiation. But waves bounce around inside the chamber—from the car radio being tested, from the test equipment, or from other electronic systems in the car.

THE ABSORBING WEDGES, CONES, OR PYRAMIDS in this room make it look exactly like an acoustic anechoic chamber. Actually the cones are made of material designed to be especially absorptive to radio waves in the range of 14 kHz to 1 GHz. The chamber was installed by the Ray-Proof Division of Keene Corp. of Norwalk, CT.

To absorb those internal waves, huge cones of a material that makes them absorbent at radio frequencies line the chamber walls. To shield against outside interference, a continuous conductive metal skin surrounds the chamber. The two types of shields produce an electronic "clean room," a near-ideal test environment.

Macrocells will supply next-generation needs

Honeywell has designed and completed computer simulation of 43 macrocells, key to its VHSIC (*V*ery *H*igh *S*peed *I*ntegrated *C*ircuit) contract with the Department of Defense. The macrocells vary in size and complexity, containing units down to 1.25 microns (a little over one-hundredth of the thickness of a human hair).

The macrocells will be interconnected on two integrated-circuit chips. Each chip will measure 360 mils (thousandths of an inch) on a side and will contain 125,000 devices. The two controller integrated circuits drive 32 programmable parallel processor chips to achieve a throughput of several billion operations a second. The chips will be used in a electro-optical processor being developed for the Air Force.

The controller and programmable parallel processor chips are expected to be the most powerful high-speed bi-polar chips ever produced, packing over 100 times more computing power than current-generation chips. They are designed to meet the signal-processing needs of many next-generation military systems.

Sony gets support for home-recording stand

Tremendous support has been received by Sony Corp. of America and its co-defendants in their efforts to bring before the Supreme Court the decision of a California judge that home video-recording is illegal. Seventeen *amici curiae* (friends of the court) briefs objecting to that ruling have been filed.

That record number of briefs includes 12 state attorneys general; several consumer groups, a number of videocassette manufacturers, an ad hoc committee on copyright law, the American Library Association, blank tape manufacturers, advertising agencies, and a publishing group.

The attorneys general of Missouri and 11 other states declared that it is legally unjustifiable to ban all home recording because a very few copyright owners object. The Association of Massachusetts Consumers, and consumer councils of seven other states, told the Supreme Court that the decision violates the First Amendment and other constitutional rights of Americans, without giving any member of the public a chance to defend his rights in court.

The National Retail Merchants' Association, five national advertising agencies, five tape-manufacturing companies and eleven manufacturers or suppliers of home recorders pointed out the economic effects of the decision, stating that it threatens the whole recording industry, and could deprive the American public of home video recorders and other technological advantages enjoyed by the rest of the world.

Oak Industries starts direct broadcast plans

As a start of a project to put satellite-TV signals direct into American homes before the competition, Oak Industries has leased four transponders on the Canadian satellite Anik C, to deliver scrambled TV programming direct to viewers in the Pacific Northwest and the Northeastern United States in 1983.

One of Anik's channels will be used to carry a program similar to Oak's present mix of movies, sports, and entertainment specials. The second will offer cultural material, news, and special events. Four transponders were leased, to allow east and west feeds of the two sets of signals. The programs will be received well in portions of 14 Eastern states, from Maine to Virginia. They will also be received in Washington, Oregon, as well as several other parts of the country's Northwestern states.

Plans are to have the system in operation by mid-1983. **R-E**

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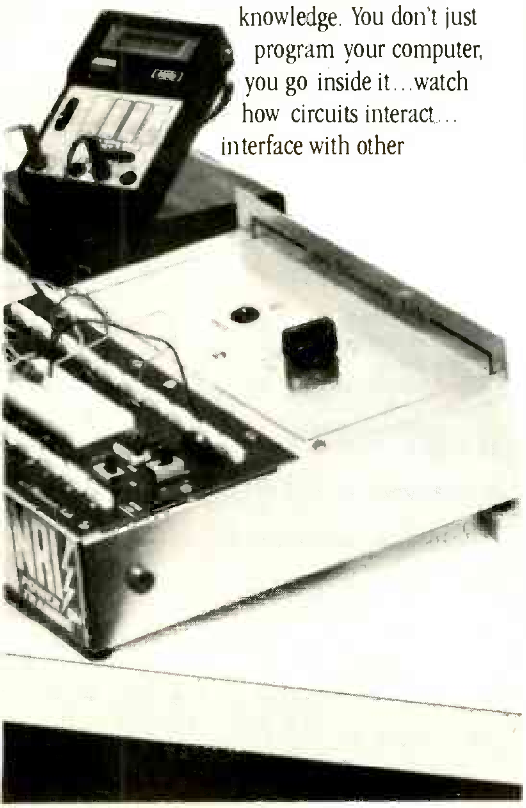

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EDITORIAL

Magnetic Digital Storage - technology extends the frontier

Since the introduction of the first recorder in 1898, magnetic recording has gone through many changes. That first recorder stored analog signals on piano wire. Over the years, that technology evolved into today's high-fidelity tape recorder. But recording analog signals is only a part of today's magnetic-recording technolgy. Some 25 years ago, born out of a need created by the computer revolution, magnetic-recording technology progressed to the point where digitized data could be recorded. Today, the magnetic media for storing digitized data includes tape, floppy disks, and hard disks.

The biggest limitation in magnetic digital-storage technology is recording density. To be more practical and economical, and to find applications in areas other than computers (i.e.: audio and video), today's digital-storage devices must store more information in less space. Over the 25 years of its life, digital-storage technology has progressed to the point where, today, we can store 10,000 bits-per-inch on a magnetic surface.

Why is recording density limited? Basic magnetism tells us that a magnet should be several times longer than it is wide. Today's digital recorders place the magnets on the magnetic surface longitudinally—end-to-end—so the width of the magnet is determined by the track width, and the thickness of the magnet is determined by the thickness of the magnetic material. The number of magnets-per-inch (bits-per-inch), therefore, is related to the track width and the thickness of the magnetic material.

In research labs, much effort has been devoted to overcoming that limitation. Now it appears that the research has paid off. Instead of placing the magnets end-to-end, they are placed perpendicular to the magnetic surface. The length of the magnet is determined by the thickness of the magnetic material. The width of the magnet is along the magnetic surface, so that more magnets-per-inch can be recorded than previously possible. With that new technology, recording densities of 100,000 bits-per-inch should be attained easily. Experiments suggest that recording densities of 440,000 bits-per-inch should be feasible. Achieving a recording density of 30,000 bits-per-inch, Vertimag Corp. (Minneapolis, MN) has already demonstrated a 5-megabyte floppy-disk system that is expected to sell for $750; it will be in production in mid-1983.

The new technology will have immense impact on consumer electronics as well as computers. For example, digital television is on the horizon and storage devices using the new technology will find application here. Breakthroughs such as those bring today's dreams of future technology one step closer to reality.

Art Kleiman

ART KLEIMAN
Editor

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Q "" W OR E STEP R <= T <> Y >= U $ I (O) P "
SIN COS TAN INT RND STR$ CHR$ CODE PEEK TAB
NEW SAVE DIM FOR GOTO GOSUB LOAD LIST LET
A STOP S LPRINT D SLOW F FAST G LLIST H ** J - K + L = FUNCTION ENTER
ARCSIN ARCCOS ARCTAN SGN ABS SQR VAL LEN USR
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SHIFT Z : X ; C ? V / B * N < M > . , £ SPACE
LN EXP AT IN KEY$ NOT π

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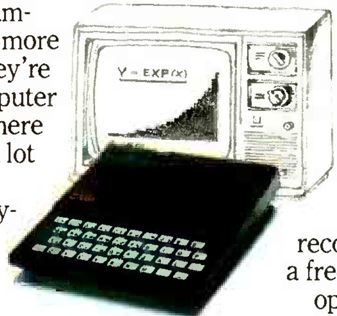

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SATELLITE/TELETEXT NEWS

GARY ARLEN
CONTRIBUTING EDITOR

TELETEXT VIA SATELLITE

A national teletext service, delivered via the vertical blanking-interval of Atlanta's superstation, WTBS-TV, is due to get under way by the end of this year. To pick up the teletext signal, viewers receiving WTBS will have to install a special decoder that uses British teletext technology. Field Electronic Publishing, which produces the Keyfax teletext service for WFLD-TV, Chicago, will expand Keyfax into a national teletext programming service. Satellite Syndicated Systems, the common carrier company that transmits the WTBS-TV signal out of Atlanta to cable-TV systems nationwide, will pick up the Keyfax service and insert it into the vertical blanking-interval of its signal on Satcom III, Transponder 6.

Zenith, which has been working closely with Field and with SSS, is already developing a text-decoder, based on the Z-TAC system, which it offers as a cable-TV converter. The Keyfax system will be offered to cable-TV customers who are already receiving WTBS. Initially, the teletext decoders may cost as much as $300, although that price could be cut to the $100 range rather quickly, if the plan catches on.

Details about the national teletext project are still being hammered out, although all the companies involved hope to begin offering the service during the next few months. Like the Chicago version of Keyfax, the national teletext service will include news reports, sports and business stories, videogames, and household and travel information, plus a variety of feature stories. Viewers can call up any page they'd like to see by pushing a few buttons on the teletext decoder.

The Keyfax announcement came as a big surprise to the cable-TV and broadcasting industry. It gives proponents of the British teletext technology a significant boost in their efforts to establish a foothold in the U.S. market, where they are competing with a rival format (combining French and Canadian technology); the latter system is endorsed by CBS, which itself plans to begin transmitting teletext nationwide this fall.

NEW SATELLITE PROGRAMMING

During the coming months, a new batch of satellite-TV programming will be introduced. For example, five transponders aboard the new Westar IV bird (at 99° west longitude) will be used by Satellite News Channels, the new all-news service jointly operated by Group W Satellite Communications and ABC Video Enterprises. Transponders 4X, 6D, 7X, 8X, and 9X will be used for the national and regional feeds.

Among the new program packages on Satellite Program Network (Satcom III, Transponder 9) is a "nostalgia" series, featuring classic TV shows of the '50s and '60s such as "Mr. Peepers," "Wyatt Earp" and the original "Life of Riley." It airs at 6 p.m. weeknights (eastern time) and noon saturdays. Another new SPN show is the "Shopping Game," which allows home viewers a chance to win prizes along with the studio audience.

DBS SERVICE PLANNED

United Satellite TV, a new direct-broadcast satellite service that will include two pay-TV channels and two commercially supported channels, is scheduled to go into operation in 1983. The project is a joint venture of General Instruments Corp. and two new programming companies, Pop Satellite, Inc. and Allstar Satellite Network Inc. Initially, the new DBS channels will be transmitted via Canada's Anik-C satellite, scheduled for launch in November 1982, a Ku-band satellite at 190° west longitude. In 1984, the programming will be moved to a new GT&E satellite due to be launched in 1983. United Satellite expects that its DBS reception equipment will cost about $1000 per site.

KU-BAND DOWNLINK

Scientific-Atlanta has introduced two small Ku-band satellite receivers—with a hint that a low-priced Ku-band uplink will soon be available—operating in the 14/12-GHz range. The small-dish equipment is primarily intended for data and video transmission users of the Satellite Business System, Anik, and OTS birds. Each of S-A's new configurations includes a manually steerable antenna, a series 361 Ku-band low-noise converter, and a series-6650 video receiver. The series-361 Ku-band converter is a combination LNA and block downconverter that generates an IF signal over the same band as S-A's C-band low-noise converter. Because the input of the low-noise converter is the same for both the C-band and Ku-band models, the identical video receiver is used for earth stations at both frequencies. The Ku-band downlink comes in a 1.8-meter ($5,000) and a 2.8-meter ($8,000) size. **R-E**

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Simulated TV Reception

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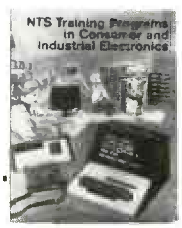

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THE PROM PROGRAMMER

I read Robert N. Beaber's article on how to build a 2716 Prom Programmer in the February 1982 **Radio-Electronics,** and found his design very simple and straightforward. I'm planning to build an EPROM programmer, using his designs with three small changes.

By using an SPDT switch, a 74LS244 buffer, and a 24-pin ZIF socket, I will have the capability of copying another 2716 EPROM in whole or in part.

The advantage of that is clear: Many times, an EPROM has one or two errors that could be fixed just by changing the byte at the location of the error(s). Instead of recopying the whole EPROM by hand, the majority is recopied by single-stepping then hitting the program button. The necessity of having another 2716 available is not a disadvantage, as they cost less than five dollars.

The disadvantage is that you can't copy a program to a different address. That would require the addition of three more 74LS193's, three more address-display LED's, one more 4071, and one more reset switch. The same clock from pin 4 of IC12 is used on each address counter. That circuit is more complex than I need, but someone else might like the added option.

The power supply should not be a concern with either one of the design additions. The design-change I plan to use is shown in Fig. 1.

JEFF McDONALD
Tucson, AZ

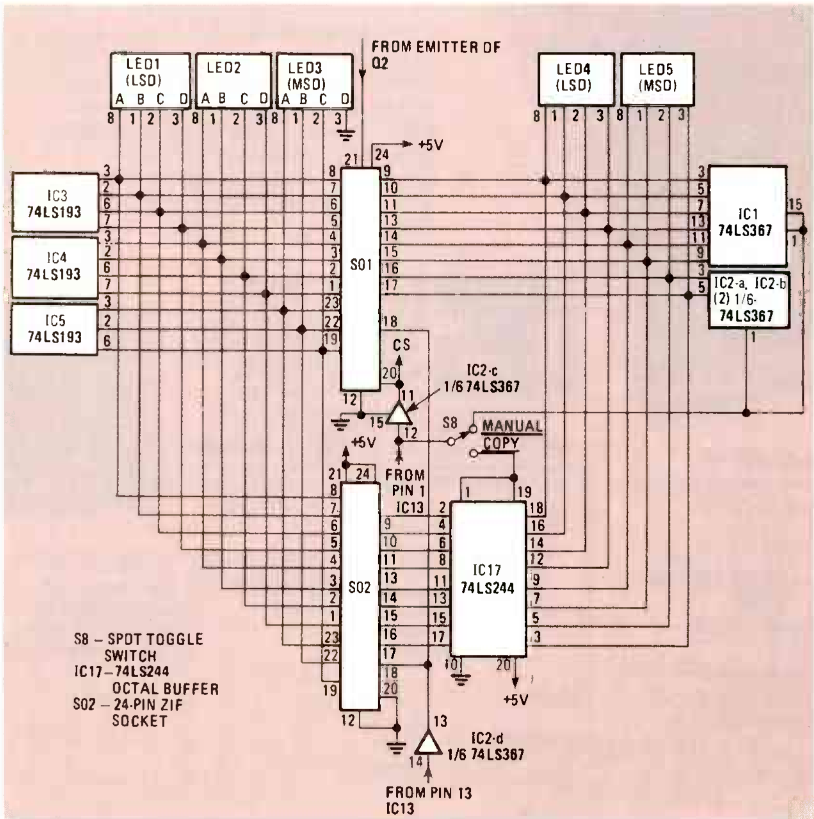

FIG. 1

RADAR DETECTORS

Mr. M. J. Rybicki's letter in the February 1982 issue of **Radio-Electronics** strikes me as being particularly illogical. He says: "I don't believe for one moment that the policeman operating the radar unit is primarily interested in saving my life ..." If it were only the lives of the drivers involved that were at stake, there would be some logic in letting them drive just as fast as they wanted to. Then, if they killed themselves, one could say, "Good riddance!" Unfortunately, all too often they kill someone else and not always themselves as well.

He also says: "To say that every radar-detector owner has it solely for the purpose of speeding without getting caught is like saying that anyone who owns a gun is planning a bank job or an assasination." Guns can be used for hunting, target-shooting, or self-defense—but I have yet to hear of a radar-detector in a car being used for *any* other purpose except to avoid getting caught when speeding. Perhaps Mr. Rybicki can tell us what he uses his for.

RICHARD KOLASINSKI
Richmond, MI

OOOOOPS

On page 59 of the March 1982 **Radio-Electronics,** there is a formula:

$Nf\ (g) = 10 \log_{10} N$

Where:

g = gain in dB
N = noise factor
Nf = noise figure.

The next formula:

$N = \log^{-1} \dfrac{Nf\ (g)}{10}$ is incorrect!

Solving equation (1) for (N) gives:

$N = \log^{-1} \left(\dfrac{Nf\ (g)}{10}\right)$ which is the correct formula for the noise factor.

In the same way, power gain (G) should be:

$G = \log^{-1} \left(\dfrac{g}{10}\right)$ *not* $G = \dfrac{\log^{-1} (g)}{10}$

These are the correct relationships.

BILL HOSTMANN

INSUFFICIENCY ALERT

Before building the ambient illumination insufficiency alert ("Six Unique Projects for Your Car," April 1982 **Radio-Electronics**), interested readers should consider the spectral response of PC1 in Figure 10, page 48. That is so that the alert is not activated falsely by a failure to sense the illumination from the various types of lamps that may be present. The "colors" of the light from conventional tungsten-filament lamps, those of the halogen type (quartz-iodine), and those of the filtered amber fog lamp should be compared with the spectral response curve of the photocell.

A fringe benefit of your circuit became apparent to me, and I would like to mention it here so as to give the readers an additional

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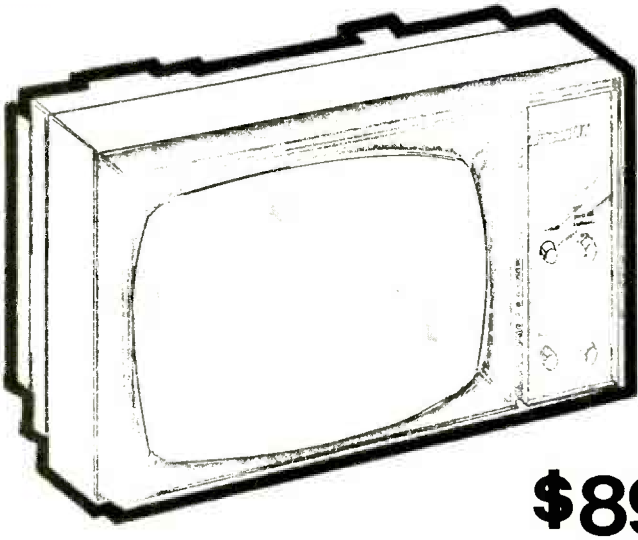

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Input Impedance	75 ohms
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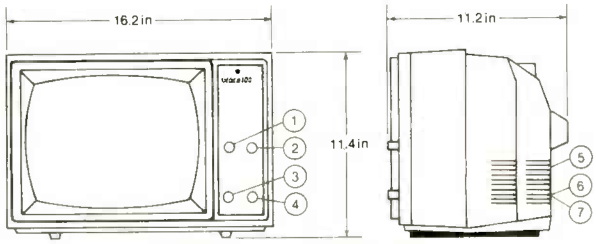
Display Size	210 (W) x 158 (H) mm
Deflection Linerity	Horizontal: 10% Max. (refer to EIA ball Chart and dot Pattern.) Vertical 8%
Video Response	12MHz (± 6dB)
Resolution	Center: 650 Corners: 550
Power Source	120V Ac, 50/60 Hz
Dimensions	11.375" (H) x 16.25" (W) x 11.25 (D)
Weight	6.5Kg (14.3 Lbs.) net



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Perhaps a reader with more expertise in circuit design will submit a circuit modification to make possible the detection of turn-indicator blinking under high ambient-light conditions.

RAYMOND E. VERNBICK
Detroit, MI

UHF-TV RECEPTION

I appreciate your article on UHF-TV reception (March 1982 issue, and last summer). Please continue with material on antenna-system improvements for VHF and FM. We're rural, where no cable will ever exist—and we need help!

ARNOLD B. HAWK
East Thetford, VT

SPEAKER-OVERLOAD PROTECTOR

In the December 1981 issue of **Radio-Electronics,** a circuit for a speaker-overload protector, by Mr. Willie Ward appeared in the "New Ideas" section. The design is simple and efficient, except that there has been a misinterpretation between the text and the circuit schematic. In the text, the right-channel signal is referred to as capacitor one (C1), contrary to the schematic which refers C1 to the left-channel input. The same error occurs when it is mentioned in that last paragraph that the right input is calibrated by resistor number three, which is opposite to what appears in the schematic.

JOSE A. EIJER
Detroit, MI

AUTOMOBILE LOCATER

I found a minor error on the "New Ideas" page (April, 1982 issue) which deals with the automobile locater. People, such as radio hams, who take direction-finding seriously, know that pointing the end of the whip at the transmitter exposes the least amount of antenna to the signal. That creates a null, not a peak. While it is usually sharper and more useful, unless you know how to interpret the lights, it can get confusing. Aside from that, the basic idea is a good one.

As for improvements, I would start by leaving out the switch. That would let me connect the plus lead directly to the plus battery terminal, and the negative lead to the hot side of the radio fuse. That assumes that the power for the radio goes through the key. When the radio is on, or the key is on, 12 volts on the negative connection would eliminate the voltage drop across the transmitter. When the key is off, the transmitter would have a ground connection through the radio or other accessory connected to that fuse.

Next, I would put in a Y connector in the radio-antenna lead. That would give me an outside antenna that is as good as any other that I could get.

Next, I would use a ferrite antenna for the receiver. That would make a more compact unit, while not hindering the reception very much. Retuning an AM radio to cover that frequency would probably be just as easy.

HARWOOD PILLAR
Dowling, MI

CELLULAR MOBILE TELEPHONES

I read the article on cellular mobile telephone, by Danny Goodman, in your February issue, and found it very interesting because the company I work for manufactures mobile telephones and is presently developing cellular equipment.

Mr. Goodman made only one comment about which I think there is a misunderstanding. The present system configuration does not require two mobile antennas, one each for transmit and receive. The original concept called for two mobile antennas using diversity reception techniques. Only the base station will have separate receive and transmit antennas.

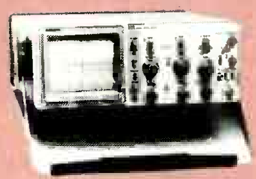
Also, I don't know who gave the installation figure of 4.5 to 5 hours per vehicle, but I think that the person is slow. My partner and I can knock one out in 1.5 to 2 hours, including testing. The cellular units aren't going to be much different, so far as installation goes, from presently existing ones.

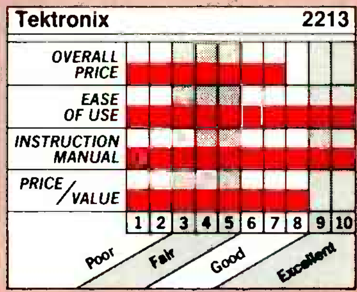
TOM PORPGLIA
Rochester, NY

R-E

EQUIPMENT REPORTS

Tektronix Model 2213 Oscilloscope



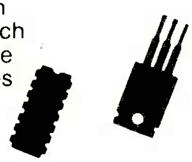


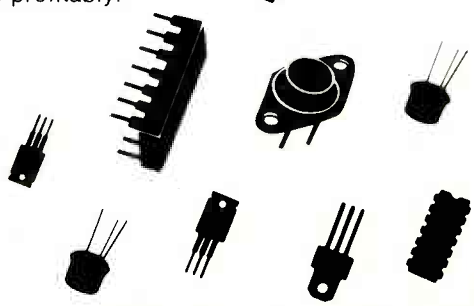
CIRCLE 106 ON FREE INFORMATION CARD

THE NEW *model 2213* oscilloscope from Tektronix (P.O. Box 500, Beaverton, OR 97077) is a low-cost dual-trace instrument with a 60-MHz response and an 80 × 100 mm CRT. The CRT has a bright trace and an internal graticule to eliminate any chance of parallax. Automatic focus and intensity circuits are included. Set up the brightness and focus, and the automatic circuits will hold them, no matter what the sweep-speed is. If you can't locate the trace, push the BEAM FINDER button; the trace will be compressed and returned to the viewing area. Center it and release the BEAM FINDER button; there you are.

The two vertical-input channels are identical. The VOLTS/DIV selector switch can be set for any sensitivity from 2 mV-per-division up to 10 volts-per-division in the familiar 1-2-5 sequence. There's a very useful feature on the switch; there are two panel labels around the outside of the selector switch about 45° apart. One label is 1X and the other is 10X PROBE. If you use a direct probe, set the selector switch using the 1X label. If you use a X10 probe, the 10X PROBE label. There's also a variable control in the center of the selector switch; that can be used for minor adjustments, or left in the calibrated position. The probes furnished are the 10:1 low-capacitance type.

Above the left-hand VOLTS/DIV switch is the channel-selector switch that lets you dis-





play either Channel 1 only, both at once, or Channel 2 only. Above the right-hand VOLTS/DIV switch is the vertical-mode selector switch. Setting that switch to the ADD position will let you see the algebraic sum of the Channel 1 and Channel 2 signals. The next position of the switch is the ALT position that displays alternate sweeps of each signal. The final CHOP position chops the signals at a 250-kHz rate. The CHOP mode is useful for viewing lower frequency signals that require sweep speeds from 0.5 milliseconds-per-division to 0.5 seconds-per-division. Vertical-positioning controls for each channel are located near the top of the front panel.

Located between the two VOLTS/DIV switches is a push-push switch that inverts and displays the Channel 2 signal when pushed in. That is handy for various tests.

The horizontal SEC/DIV switch sets the sweep speed, from 0.5 seconds-per-division to 0.05 microseconds-per-division. A variable control, in the center of the SEC/DIV switch can be used for minor adjustments to the sweep speeds. When that knob is pulled out, the sweep-speed is increased by 10 times, so that the highest sweep speed becomes only 5 nanoseconds-per-division. When the variable control is turned full counter clockwise, the SEC/DIV switch is calibrated. Finally, by setting the SEC/DIV to the X-Y position, both channels are displayed at once. The Channel-1 signal is displayed on the X-axis (horizontal) and the Channel-2 signal is displayed on the Y-axis (vertical). That is for sweep-alignment, vectorscope analysis, and the like.

The *model 2213* has a delayed-sweep feature that can control the starting position of the trace. The selector switch for that is located just above the horizontal SEC/DIV switch, and it has three positions. The left-hand position is labelled NO D'LY and it disables the delay feature. The center position is labelled INTEN and it causes an intensified zone (brighter) to appear on the waveform. The left-hand side of the intensified zone indicates the starting point of the sweep when the switch is moved to the right-hand D'LY position. Just below the SEC/DIV are two controls for the delay; a three-position switch that selects delays of 0.5 microseconds, 10 microseconds, and 10 milliseconds. Below that selector switch is a control that varies the sweep-delay from less than 1 to more than 20 times the setting of the selector switch.

At the far right-hand side of the front panel are the trigger controls. At the top is the MODE switch. That is a three-position paddle type. The AUTO position triggers the sweep on all waveforms with repetition rates faster than 20 Hz, and free-runs with no input so that the trace is visible at all times. The NORM position triggers the sweep only when a signal is applied. The LEVEL control sets the point at which the sweep triggers. The last position is TV FIELD. That displays TV field signals; for viewing individual lines of a TV signal, use the NORM position.

Beside the LEVEL control is a two-position paddle switch that selects the slope of the signal waveform on which the sweep is triggered, either positive going or negative going. Between that and the LEVEL control is an LED indicator that lights when the sweep is triggered.

Below the LEVEL control is a row of three-position paddle switches. Those select the source of the triggering signal. One paddle switch selects either the signal from Channel 1, whichever signal is selected by vertical MODE switch (Channel 1-Both-Channel 2), or the Channel 2 signal. The center paddle switch selects either internal triggering, or triggering from a sample of the power line frequency, or from an external signal. At the bottom of the panel is a BNC jack for feeding in external trigger signals. The last paddle switch is labelled EXT COUPLING and it selects the type of coupling for the external trigger. The AC position selects capacitive coupling to the trigger circuit, the DC position selects direct coupling of trigger signals, and the DC 10 position attenuates the external signal by a factor of 10 times. At the very top of the front panel is the VAR HOLDOFF control. That varies the holdoff time between sweeps by at least a factor of four, making it much easier to trigger on aperiodic waveforms such as complex digital waveforms.

A rear-panel BNC jack is for inputting Z-axis (brightness modulation) signals.

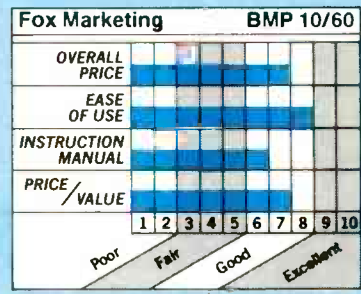
Despite the multiplicity of controls, the *model 2213* is a very easy instrument to use. All controls are grouped by function, and very plainly marked. The Operator's Manual is really complete. It gives full setup and check-out procedures, using only an external signal generator that will deliver a 1-kHz square wave signal. Set the output of the generator to read four divisions with the VOLTS/DIV switch set to 50 mV-per-division. Tests that check the operation of every control on the instrument are fully explained in great detail. That covers four and a half pages! Nothing is left out, not even the Z-axis function. Setup and check-out of the 10:1 probes provided with the *model 2213* is accomplished by using the PROBE ADJUST jack on the front panel, located between the BEAM FIND and AUTO FOCUS controls. That jack provides a 0.5-volt positive-going square wave at about 1 kHz. With that, the compensation of the probes can be checked, and if necessary set, for minimum overshoot or undershoot.

The rest of the manual is devoted to basic applications of the *model 2213*. It covers all kinds of tests, including non-delayed and delayed measurements. All of the tests and suggested uses are well illustrated.

The *model 2213* is a very versatile instrument. It's backed by the Tektronix name, which is a good recommendation. For any kind of electronic testing, lab or bench, it should be just what you need. The retail price of the *model 2213* is $1100. **R-E**

Fox Marketing BMP 10/60 Scanning Receiver

CIRCLE 107 ON FREE INFORMATION CARD



PEOPLE HAVE LONG BEEN INTERESTED IN listening to the public-service (police, fire, etc.) bands. That hobby has many attractions, including the thrill of hearing the news as it is being made. Interest in those bands, however, has grown even more with the introduction of frequency-synthesized, programmable scanners. Recently we've seen one of the newest of those, the *BMP 10/60* from Fox Marketing, Inc., a division of Comgeneral Corporation (4518 Taylorsville Road, Dayton, OH 45424); we would like to tell you about it.

First, and perhaps most important, is that the unit has all the features one would expect of a base-station scanner, but is still small enough to function well as either a mobile or portable unit. It measures just 6½ × 1½ × 9 inches and weighs 1½ pounds.

There is quite a bit packed into that small, black thermoplastic case. For one thing, the scanner offers 7-band, 70-channel capacity. Sixty of those channels (6 bands) are pre-programmed to include some of the most popular police, fire, marine, National Wea-

continued on page 32

HEATH/ZENITH & YOU... ONE STRONG PARTNERSHIP.

Buying a computer is only the beginning of a long-term partnership between you and the people from whom you buy. Your ongoing need for software, peripherals and accessories requires a partner who will stand by you. With a growing line of products to meet your needs with professional service and support, Heath/Zenith is that strong partner. Look at what we have to offer:

THE ALL-IN-ONE COMPUTER – The heart of the Heath/Zenith line is the stand-alone *89 Computer.* It's a complete system with built-in 5.25-inch floppy disk drive, professional keyboard and keypad, smart video terminal, two Z-80 microprocessors and three RS-232C Serial I/O Ports. It comes with 48K bytes of RAM, expandable to 64K.

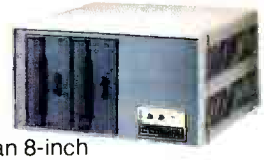
PERIPHERALS AND ACCESSORIES – These include the popular *Heath/Zenith 19 Smart Video* Terminal, loaded with professional features. We also offer color and black and white monitors, modems, computer language courses, and high-speed typewriter-quality printers.

SOFTWARE – Our complete library of software includes the SuperCalc Spreadsheet and Condor Data Base Management System. *Word processing,* includes three different programs. *Small Business Programs* feature Peachtree's P5 Series, General Ledger and Inventory Control. *HUG, Heath Users' Group,* offers members a library of over 500 low-cost programs for home, work or play.

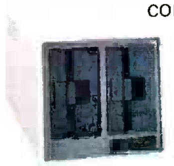
PROGRAMMING LANGUAGES – To write your own programs, Microsoft BASIC (compiler and interpreter), FORTRAN and COBOL Languages are available.

APPLICATIONS SOFTWARE – Expand the performance range of your computer with a broad selection of software, including the best of *Digital Research and Micropro* – as well as the complete line of *Softstuff*™ products.

OPERATING SYSTEMS – Three versatile systems give you the capability to perform your specific tasks. *CP/M by Digital Research* makes your system compatible with thousands of popular CP/M programs. *UCSD P-System with Pascal* is a complete program development and execution environment. And *HDOS, Heath Disk Operating System* gives you a sophisticated flexible environment for program construction, storage and editing.



DISK SYSTEMS – *The new Heath/Zenith 67 Winchester Disk System,* for commercial use, adds nearly 11 megabytes of storage to your 89 computer. It includes an 8-inch floppy disk drive for data portability. *The new 5.25-inch 37 disk system,* available with 1 or 2 drives, adds up to 1.28 megabytes of storage. Both plug-in systems have write protection.



SERVICE AND SUPPORT – Prompt and professional service and assistance is available nationally through Heathkit Electronic Centers, Zenith Data Systems for commercial users or through Heath factory servicing and phone-in technical assistance.

Complete, integrated computer hardware and software, designed to serve and grow with you – that's what to look for in a strong partner. And with Heath/Zenith, you get it all.

Heath/Zenith computer products are sold nationwide through Heathkit Electronic Centers* (check your white pages for locations). For a FREE colorful full-line catalog write: Heath Co., Dept. 320-924 Benton Harbor, MI 49022.

HEATH/ZENITH

Your strong partner

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*Heathkit Electronic Centers are operated by Veritechnology Electronics Corporation

CP-210R1

EQUIPMENT REPORTS

continued from page 28

ther Service, and mobile-telephone frequencies. The remaining 10 channels can be programmed by the user for any frequency in the scanner's range (30-50 MHz, 144-174 MHz, and 420-511.9875 MHz).

However, it takes more than a wide frequency-range and ample channel capacity to make a full-featured scanner. This unit offers quite a bit more.

As with any other scanner, this unit will scan all of the channels in any band, stopping at any that are active. However, it is the extra functions—PAUSE, SKIP, STEP, and ACTION—that give the *BMP 10/60* its versatility. Any or all of those functions can be selected for any channel or band.

Normally, the unit begins scanning the instant that the channel you are monitoring becomes inactive. However, the PAUSE feature, when selected, keeps the unit on frequency for two seconds after the end of a transmission.

The SKIP function lets you lockout unwanted channels, without erasing them from the unit's memory. The STEP function lets you "step" through any band, one channel at a time. ACTION samples channel 1 every two seconds, and switches to that channel any time that it is active.

While the pre-programmed channels include some of the most popular frequencies around, those may not necessarily be the most popular in your area. That is where the user-programmed frequencies come in handy—up to 10 frequencies can be programmed into the scanner by the user. Entering user-programmed frequencies into the unit is simple and straightforward; the procedure is completely described in the instruction manual that accompanies the scanner (more on that later). Those frequencies are retained in the unit's memory even after it is turned off, as long as it is connected to its power supply. If it is disconnected from its supply, a 9-volt battery back-up (supplied) will let the unit retain the frequencies for about a week.

If you are not sure what frequencies are active in your area, or just want to scan a wide range of frequencies, the scanner's SEEK function will come in handy. That function will let you scan up or down from any frequency you choose, in 5-kHz steps (12.5-kHz steps for frequencies from 420 to 511.9875 MHz).

The scanner is designed to be easy to use, even by someone who has never used such a device before. A color-coded, touch-sensitive keypad is used to control most of the scanner's functions. The only other controls are two knobs. One is used to turn the unit on and set the volume; the other is used to set the squelch. Ten channel-indicator LED's are used to tell you which channel in the band is being monitored. A small, but easily readable, LED readout is used to display such things as the frequency being monitored, whether the unit is in the pre-programmed or normal (allowing the user to program his own frequencies) mode, and which scanner functions are active. Rear-apron connectors are provided for an external antenna, external speaker, and the 12.5-volt DC power input. The unit also has a built-in speaker and telescoping antenna, and comes with a wall-plug-type power supply for base-station operation.

The instruction manual is just that, as it has little technical data and no schematic diagram, block diagram, theory of operation, etc.; in addition, only limited troubleshooting hints are provided. What it does provide, however, are complete, easy-to-follow instructions for use. Setting up the unit for the first time; how to use the pre-programmed frequencies; keypad functions, and programming the unit are among the topics covered in detail. Warranty information and the addresses of authorized service centers are also included.

All-in-all we were rather impressed with this small scanner. Its features and performance compare favorably with others in its class, and its ability to serve as a base, mobile, or portable unit gives it all the flexibility that anyone may need. Among the accessories available are a mobile mounting bracket and a *Porta-Pac* battery pack for portable use; those list for $9.95 and $39.95, respectively. The *BMP 10/60* has a suggested retail price of $349.95. **R-E**

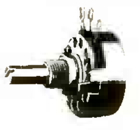
Jim-pak
electronic components
Belmont, California 94002

One-Stop Component Center(TM)
This is a partial listing of over 600 items available from 600 authorized Jim-pak Distributors:

TTL

7400	2/.85	7490	.85
7402	2/.85	7493	.85
7404	2/.85	74100	2.25
7406	2/1.19	74109	2/1.19
7407	2/1.19	74121	.69
7408	2/.89	74123	.99
7410	2/.85	74150	1.95
7414	.99	74154	1.95
7417	2/1.10	74157	.99
7420	2/.85	74161	1.19
7447	1.19	74164	1.59
7474	.69	74174	1.59
7475	.79	74175	1.49
7476	.69	74192	1.19
7485	1.19	74193	1.19
7486	2/1.19	74367	.99
7489	2.99	74393	1.95

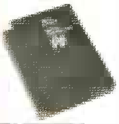
POTENTIOMETERS



2 Watt @ 70°C
7/8" Slotted Shaft
Linear Taper
1K, 5K, 10K, 25K, 50K, 100K, 1 Meg
CMU $2.95

3/4 Watt @ 70°C
15 Turn Pot.
Linear Taper
100 Ohm, 500 Ohm, 1K, 5K, 10K, 50K, 100K, 500K, 1Meg
830P $1.79

DATA BOOKS



JPTTL	Jim-Pak7400/74LS TTL	$3.95
JPCML	Jim-Pak CMOS/Linear	4.49
JPMPD	Jim-Pak Micro./Display	3.95
30001	National CMOS	6.95
30003	National Linear	9.95
30005	National TTL Logic	9.95
30009	Intersil	7.95
10400	Intel Component	10.95

CMOS

4000	.55	4030	.75
4001	.55	4040	1.79
4002	.59	4044	1.39
4006	1.49	4046	1.95
4009	.79	4047	2.75
4010	.79	4049	.79
4011	.55	4050	.89
4013	.79	4051	1.59
4016	.79	4066	.95
4017	1.39	4069	.69
4018	1.39	4070	.75
4020	1.39	4071	.69
4023	.49	4081	.59
4024	1.19	4093	1.19
4027	.79	4511	1.95

CONNECTORS

DB25P	D-Subminiature Plug	3.95
DB25S	D-Subminiature Socket	4.95
DB51226	Cover for DB25P/S	2.25
22/44SE	P.C. Edge	2.95
UG88/U	BNC Plug	2.19
UG89/U	BNC Jack	3.95
UG175/U	UHF Adapter	.59
SO239	UHF Panel Recp.	1.49
PL258	UHF Adapter	1.95
PL259	UHF Plug	1.95
UG260/U	BNC Plug	2.39
UG1094/U	BNC Bulkhead Recp.	1.49

LINEAR

LM301N	.59	LM7805T	1.75
LM305H	1.39	LM7812T	1.75
LM307N	.75	LM7815T	1.75
LM308N	1.19	LM380N	1.49
LM309K	2.25	LM384N	2.49
LM310N	2.69	LM555N	.69
LM311N	1.49	LM556N	1.49
LM317T	2.29	LM565N	1.95
LM318N	2.95	LM566N	1.95
LM319N	2.95	LM567N	1.79
LM320K-5	2.25	LM723N	.79
LM7905T	1.75	LM741N	.65
LM7912T	1.75	LM1310N	2.95
LM7915T	1.75	LM1458N	.99
LM323K	5.95	LM1488N	1.59
LM324N	1.29	LM1489N	1.59
LM337T	2.29	LM1800N	4.49
LM339N	1.29	76477N	3.95

DIP JUMPERS AND CABLE ASSEMBLIES

DJ-14-1	14-Pin 1-Foot Single-End (Dip Jumper)	$2.95
DJ-16-1	16-Pin 1-Foot Single-End (Dip Jumper)	3.25
DJ-24-1	24-Pin 1-Foot Single-End (Dip Jumper)	3.95
DJ-40-1	40-Pin 1-Foot Single-End (Dip Jumper)	7.95
DJ-14-1-14	14-Pin 1-Foot Double-End (Dip Jumper)	4.25
DJ-16-1-16	16-Pin 1-Foot Double-End (Dip Jumper)	4.95
DJ-24-1-24	24-Pin 1-Foot Double-End (Dip Jumper)	5.95
DJ-40-1-40	40-Pin 1-Foot Double-End (Dip Jumper)	11.95
DJ-14-3-14	14-Pin 3-Foot Double-End (Dip Jumper)	5.49
DJ-16-3-16	16-Pin 3-Foot Double-End (Dip Jumper)	5.95
DB25P-4-P	DB25P - 4 Foot - DB25P (Cable Assembly)	16.95
DB25P-4-S	DB25P - 4 Foot - DB25S (Cable Assembly)	17.95
DB25S-4-S	DB25S - 4 Foot - DB25S (Cable Assembly)	18.95

NEW!

JE215 Adjustable Dual Power Supply

General Description: The JE215 is a Dual Power Supply with independent adjustable positive and negative output voltages. A separate adjustment for each of the supplies provides the user unlimited applications for IC current voltage requirements. The supply can also be used as a general all-purpose variable power supply.

FEATURES:
- Adjustable regulated power supplies, pos. and neg. 1.2VDC to 15VDC.
- Power Output (each supply): 5VDC @ 500mA, 10VDC @ 750mA, 12VDC @ 500mA, and 15VDC @ 175mA.
- Two, 3-terminal adj. IC regulators with thermal overload protection.
- Heat sink regulator cooling
- LED "on" indicator
- Printed Board Construction
- 120VAC input
- Size: 3-1/2"w x 5-1/16"L x 2"H

JE215 Adj. Dual Power Supply Kit (as shown) . . $24.95

JIM-PAK KITS

JE730

JE701

JE200	5V 1 Amp Regulated Power Supply Kit	$14.95
JE205	Multi-Voltage Board Kit (Adapts to JE200)	12.95
JE210	5-15V / .5-1.5 Amp Regulated Power Supply Kit	19.95
JE212	Neg. 12VDC Adapter Board Kit (for JE610)	9.95
JE215	Adjustable Power Supply Kit (Pictured above center)	24.95
JE300	Digital Thermometer Kit	39.95
JE305	Solar Cell Panel Kit	39.95
JE600	Hexadecimal Encoder Kit	59.95
JE610	ASCII Encoded Keyboard Kit	79.95
JE701	6-Digit (.300") Clock Kit (Pictured above right)	19.95
JE730	4-Digit (.357") Clock Kit (Pictured above left)	14.95
JE747	6-Digit (.630") Clock Kit	29.95
JE2206B	Function Generator Kit (Pictured below right)	19.95

GRAB BAGS

GB100	Ceramic Disc. Capacitors	(100)	$2.95
GB101	Mylar Capacitors	(60)	4.95
GB102	Electrolytic Capacitors	(60)	4.95
GB103	Tantalum Capacitors	(40)	4.95
GB107	Silicon Diodes (1N914/1N4148)	(100)	2.95
GB108	TTL Series Integrated Circuits	(50)	4.95
GB109	Linear Integrated Circuits	(30)	4.95
GB110	Assorted LEDs	(100)	5.95
GB113	Miniature Trimmer Pots.	(30)	4.95
GB116	1/4 Watt Resistor Assortment	(200)	2.95
GB117	1/2 Watt Resistor Assortment	(200)	2.95
GB120	Miniature Slide Switches	(25)	3.95
GB123	Heat Sinks Assortment	(30)	3.95
GB127	Transistors Plastic/Power	(100)	3.95
GB137	Chokes, Coils and Inductors	(50)	3.95
GB139	3-8 Terminal Solder/Screw Type	(40)	3.95
GB140	Spacers, Standoffs, Insulators	(150)	2.95
GB141	Washers and Spacers	(200)	2.95
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GB147	Hardware Mix — Nuts, Screws, etc.	(500)	5.95
GB154	1 & 2 Watt Resistor Assortment	(100)	2.95
GB162	7-Segment Displays	(50)	5.95
GB165	Toggle, Rocker, Push Button Switches	(40)	10.95
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74LS00	.55	74LS109	.75
74LS02	.55	74LS123	1.49
74LS04	.69	74LS138	1.29
74LS08	.55	74LS139	1.29
74LS10	.55	74LS154	1.95
74LS14	1.09	74LS157	1.19
74LS30	.55	74LS161	1.29
74LS32	.69	74LS174	1.19
74LS38	.69	74LS175	1.19
74LS42	1.29	74LS192	1.49
74LS47	1.29	74LS193	1.49
74LS48	1.79	74LS221	1.49
74LS73	.75	74LS244	1.89
74LS74	.69	74LS245	3.49
74LS75	.75	74LS367	.89
74LS85	1.49	74LS374	1.95
74LS90	.89	81LS97	2.29

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Low Profile		Wire Wrap	
8 pin LP	2/.59	14 pin WW tin	.75
14 pin LP	2/.69	14 pin WW gold	1.09
16 pin LP	2/.79	16 pin WW tin	.79
18 pin LP	2/.89	16 pin WW gold	1.19
20 pin LP	2/.99	24 pin WW gold	1.69
22 pin LP	2/1.09	40 pin WW gold	2.75
24 pin LP	.79	14 p. plug/cover	1.29
28 pin LP	.82	16 p. plug/cover	1.39
36 pin LP	.99	24 p. plug/cover	1.95
40 pin LP	1.19	Also, The Molex Line	

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IN757	2/.59	2N2222A	2/.89
IN1188	2.69	2N2907A	2/.89
IN3600	5/.99	2N3055	.99
IN4001	4/.59	2N3772	2.25
IN4004	4/.69	2N3904	2/.69
IN4007	4/.79	2N3906	2/.69
IN4148	10/.99	2N4401	2/.79
IN4733	2/.69	2N4403	2/.79
IN4734	2/.69	2N5129	2/.69
IN4735	2/.69	2N5139	2/.69
IN5401	3/1.19	TIP29A	.89
IN5408	3/1.99	TIP31A	.99

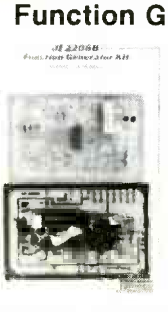
CAPACITORS

Dipped Tantalum		ELECTROLYTIC	
.1mfd@35V	2/.89	1mfd@50V	3/.69
.47mfd@35V	2/.89	4.7mfd@50V	2/.59
1mfd@35V	2/.89	10mfd@50V	2/.69
2.2mfd@25V	2/1.09	22mfd@50V	2/.79
3.3mfd@25V	2/1.19	47mfd@50V	2/.89
4.7mfd@25V	2/1.39	100mfd@50V	.59
10mfd@25V	1.19	220mfd@50V	.69
33mfd@25V	3.95	1000mfd@25V	1.19
100V MYLAR		2200mfd@16V	1.39
.001-.01mfd	4/.79	**50V CERAMIC**	
.022mfd	4/.89	10pf-.022mfd	4/.59
.047mfd	4/.99	.047mfd	4/.69
.1mfd	4/1.19	.1mfd	4/.79
.22mfd	4/1.29		

MICROPROCESSORS

Z80A	CPU (4MHz)	13.95
1173AN-1	30 Tune Musical MPU Chip	8.95
8080A	CPU	6.95
8212	8 Bit I/O Port	3.95
8216	Bi-Directional Bus Driver	4.49
2513/2140	Character Generator	12.95
8T97	Tri-State Hex Buffer	2.25
AY-5-1013	30K Baud UART	6.95
AY-5-2376	88-Key Keyboard Encoder	11.95
2114-2	4K Static RAM (200ns)	3.95
MK4116	16K Dynamic RAM (250ns)	3.95
2708	8K EPROM	5.95
2716	16K EPROM (+5V)	9.95

Function Generator Kit



Provides 3 basic waveforms: sine, triangle and square wave. Freq. range from 1 Hz to 100K Hz. Output amplitude from 0 volts to over 6 volts (peak to peak). Uses a 12V supply or a ±6V split supply. Includes chip, P.C. Board, components & instructions.

JE2206B . . . $19.95

CIRCLE 7 ON FREE INFORMATION CARD

HEATH/ZENITH
A GIANT STEP AHEAD IN

Computer power, printer speed, hard disk storage – all in one system.

The three elements you need for smooth, rapid data handling are together now in one Heath/Zenith system. For word processing, business and financial applications, or custom programming – this is the performance standard evolving in computer technology. It's what you expect from a *strong partner.*

All-In-One Computer

The heart of the system is the Heath/Zenith 89 Computer, a complete, stand-alone unit with professional keyboard, smart video terminal and 5¼-inch disk drive. It's easy to use for people having little or no experience – yet it can also run extended languages like BASIC, COBOL, FORTRAN and Pascal.

The 89 comes with 48K bytes RAM, expandable to 64K. It has two Z80 microprocessors, one for computer functions, one for terminal functions. And three serial I/O ports for interface with printers and modem.

The video display features a 12-inch diagonal, high-resolution CRT that's easy on the eyes. It displays up to 2,000 characters at a time, 24 lines (plus 25th status line) by 80 characters, with full cursor control. Also 33 block graphic characters for charts and graphs.

The heavy-duty keyboard follows standard typewriter format for easy operator training. All terminal functions are programmable from keyboard or I/O ports.

The 5¼-inch floppy diskette stores 100K bytes of information and interfaces on line with the Heath/Zenith 67 Hard Disk System.

Winchester Disk System

The 67 Disk System features one hard disk and one 8-inch, soft-sectored floppy for total on-line storage of 10.782 megabytes (formatted). That's a huge data base.

The floppy is double-sided, double-density and can also operate in single-sided or single-density modes, compatible with standard IBM 3740 format.

The 67 features write-protect switches for both drives to prevent accidental erasure of information. The average access time of the hard disk drive is 70 milliseconds.

High-speed printer

The Heath/Zenith 25 Printer is a heavy-duty, high-speed, dot matrix printer that gives you sharp, clear printouts. It prints over 150 characters per second with whisper-quiet smoothness.

The entire 95-character ASCII set prints in upper case and lower case with descenders, in a 9 x 9 matrix. Also, 33 block graphic characters let you create graphs and charts. All functions and timing are microprocessor-controlled.

It uses standard edge-punched papers and features a convenient cartridge ribbon for easy, no-mess replacement.

MICROCOMPUTERS– SYSTEM PERFORMANCE

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NEW IDEAS

Model rocket launcher

MODEL ROCKETRY IS A FASCINATING HOBBY that is enjoyed by millions, young and old alike. It teaches the principles of aerodynamics and gravity, among other subjects, in a way that can't be duplicated by using a textbook or slide rule.

Model rockets are generally ignited by heating a nickel-chromium wire that is inserted into the engine so that it touches the propellent. The wire is heated by passing a current through it, and the usual power source is a standard lantern battery. The circuit described here adds some class to the launch procedure. It allows the user to move up to 300 feet away from the rocket (normally, you're limited to a distance of 10-15 feet). Among the advantages is that it aids tracking and recovery, not to mention safety. With a few modifications, the launcher could be used for such things as a timer, sequencer, or reflex tester.

The circuit, shown in Fig. 1, consists of two parts—the launch timer itself and an automatic-off timer. The heart of the launch timer is IC1, an LM3914 (National) bargraph display driver. When power is applied to that IC, the countdown LED's sequence on until they are all lit. When the last one, LED1, is fully lit, transistor Q1 saturates, energizing RY2. When that happens, a circuit between the lantern battery at the launch pad and the nickel-chromium wire is completed; the wire heats up as before, and the rocket is launched. Resistor R4 and capacitor C3 determine the countdown timing; with the values shown it should be approximately 10 seconds. Resistors R3 and R5 set the LED brightness.

In a project of this type, safety is of the utmost importance. That's the purpose of the second half of the circuit. When RY2 opens, the current flow to Q2 is disrupted. But, because of the presence of R2 and C4 in the circuit, the transistor remains saturated for about 3 seconds. After that, however, the transistor stops conducting and RY1 is de-energized. That cuts off the power to the rest of the circuit, and RY2 de-energizes again, breaking the circuit to the launch pad. Speaking of safety, that's the purpose of S2—it is there so that the launch circuit can be disconnected from the timer; disconnecting that circuit eliminates the possibility of an accidental launch.

Operating the launcher is very simple. Switch S3 is used to reset the countdown. Once that is done, pressing S1 starts the launch sequence; the rest is automatic. Switch S4 is used to latch RY1 manually if needed. That's all there is to it.

The circuit can be built on perforated construction board using point-to-point wiring. Assembly is very easy (incidently, I'm only 13 and had very little trouble with it). As I said, with the values shown, the timing period is about 10 seconds; however, nothing in the circuit is very critical. Lead lengths should be kept as short as possible, however; if they get too long, oscillation may occur. To prevent that, C2 can be installed in the circuit as shown.

You can use any PNP transistor for Q1 and Q2, although the 2N404 seems to be a good choice. Switches S1 and S3 are normally open momentary pushbuttons. Switch S2 is DPDT, and S4 is SPST. The relays, RY1 and RY2, are SPDT, Radio Shack 275-004 or equivalent. The power source, B1, is 6 "C" cells wired in series—*John Miles*

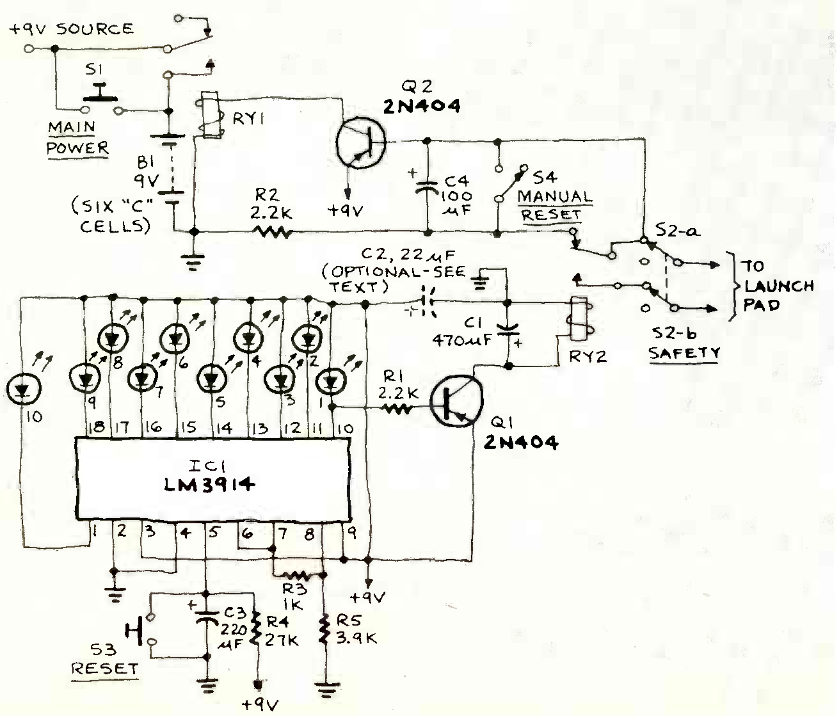

FIG. 1

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3. Each entry must be accompanied by a complete, signed, official entry form. Entries that do not have official forms attached or have forms that are not completed or signed, will be disqualified. Entry forms can be found in every copy of the July 1982 and August 1982 issues of Radio-Electronics. No copies or facsimiles will be accepted. In the event that you cannot locate an issue locally, these issues are available directly from Radio-Electronics. The cost is $1.25 plus $1.00 for first class postage. Payment must include your order, and must be payable in US funds.

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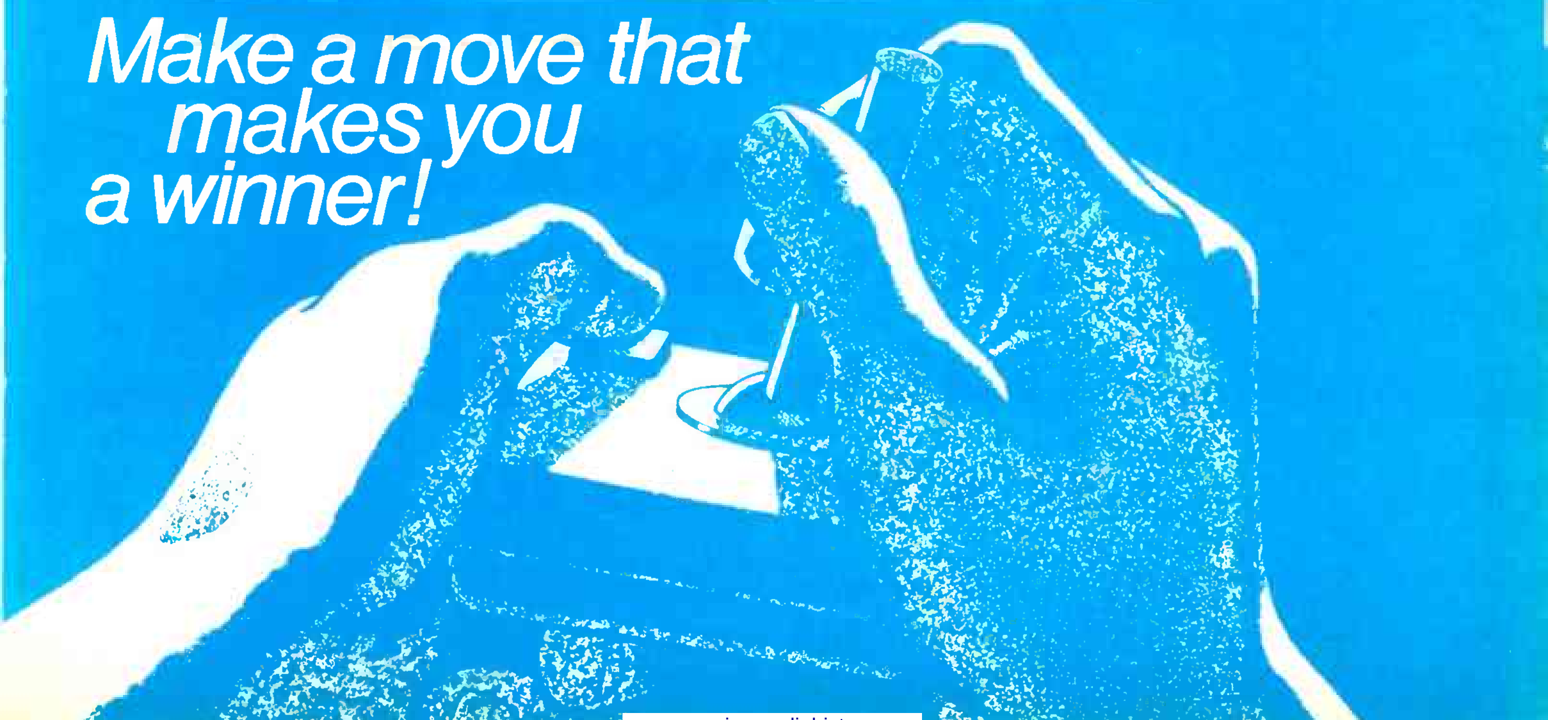

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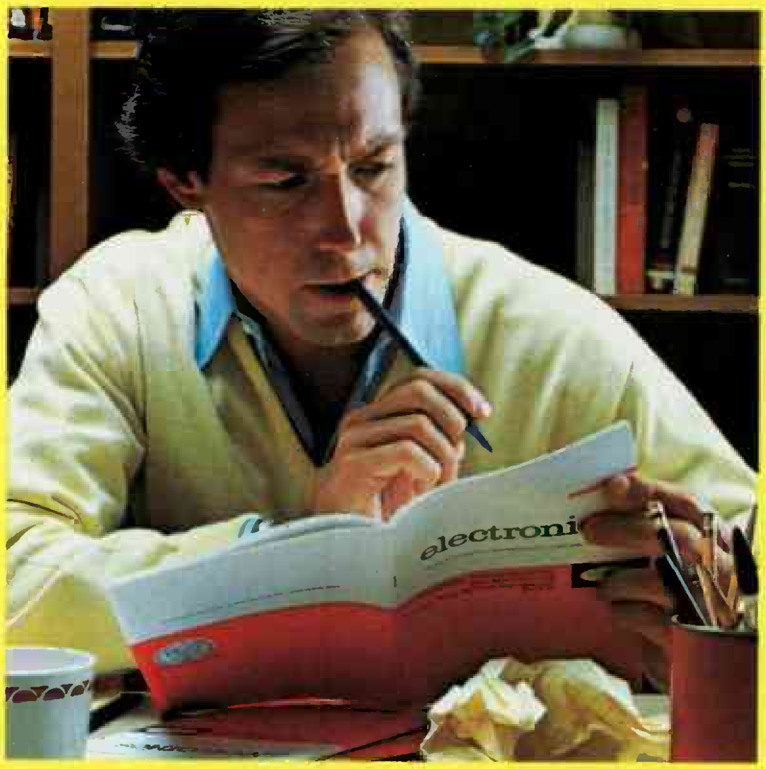

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JOSEF BERNARD,
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PICTURE PHONE

Build the Picture Phone and you can use your telephone to send and receive live television pictures to and from almost anywhere. The first part of this series explains how the system works.

Part 1

THE TELEPHONE COMPANY has recently been urging us to "reach out and touch someone." The Picture Phone described here will allow you to do more than that—it permits still video-pictures to be sent over ordinary phone lines so you can not only hear and "touch" someone, but also *see* him (or her).

What do you need to send and receive pictures using the telephone? The most important piece of equipment, of course, is the Picture Phone. It turns an ordinary video signal into a series of audio tones that the telephone equipment can handle and convey to a Picture Phone at the other end of the line. It also converts incoming video—in the form of tones—into a fast-scan video signal that can be viewed on a monitor or TV receiver. Fast-scan and slow-scan standards are compared in Table 1.

A video camera is necessary (there's an exception to that, which we'll get to in a moment), but it need not be elaborate or expensive. A camera of the type used in closed-circuit applications will do the job and can be purchased for about $150. Of course, if you already own a color or black-and-white video camera, you can use that.

The picture can be viewed on a video

TABLE 1

	FSTV	SSTV
Line rate—lines/second	15,750	15
Frame rate—frames/second	30	1/8
Aspect ratio	4:3	1:1
Lines transmitted	525	128
Lines displayed	525	256

monitor or on a TV receiver fitted with an inexpensive RF-modulator that will convert the composite-video signal into one that can be received on an unused VHF or UHF TV-channel.

You'll also probably need a device from your local phone company to couple the Picture Phone to their lines.

The exception to the video-camera rule is due to the fact that, since what is being transmitted is a series of audio tones, none higher in frequency than 2300 Hz, pictures can be recorded on a standard audio-cassette. If you know what you want to send, and can borrow a camera, the pictures can be put on tape ahead of time and the tape played when you're ready. Pictures received via the Picture Phone can also be saved on cassette for future reference.

Oh yes, you'll need a telephone, too.

How it's used

How do you carry on a video conversation using the Picture Phone? You start out just as you would any telephone conversation, speaking with the party at the other end of the line.

When the time comes, though, to illustrate a point (or, perhaps, to show off a brand new addition to the family) you turn the MODE switch to TRANSMIT, push the VIDEO button, and a picture will be transmitted to the Picture Phone at the other end of the line. The picture can be "set up" ahead of time and stored in the Picture Phone's memory or can be transmitted "live." The same frame can be repeated over and over or a new one can be "snatched" and sent every eight seconds. As you become more familiar with them, the capabilities of the Picture Phone will prove it to be an extremely versatile instrument.

At the other end, when video is ready to be received, the MODE switch is put into the RECEIVE position, the VIDEO button depressed, and, over a period of eight seconds, a still picture will appear from top to bottom on the screen of the monitor or TV set. The picture can be stored in the Picture Phone's memory and viewed even after the transmission is over and you are back in the VOICE mode. As was mentioned earlier, the pictures can be stored on audio cassettes for replay later.

The system used by the Picture Phone is described elsewhere in this article but, before we present instructions for building the device, we'll describe in some detail how it works. Not only will that help you to understand what's going on, but you will also receive something of an education in how digital circuitry works.

In must be mentioned that the construction of this project is *not* for beginners—the circuit uses nearly 100 IC's on a tightly packed double-sided PC board—but for those with previous construction experience, it should not prove difficult. Assembly is straightforward, and troubleshooting hints will be presented. Before we get to that, though, let's see what's needed to make the Picture Phone system function, and look at the circuit section by section.

Signal conditioning

Refer to Figs. 1 and 2 as we discuss how the Picture Phone operates. Signals from a fast-scan source such as a video camera or VCR are applied to J8, CAMERA IN. The signals are attenuated by R305 and AC-coupled to the video-input amplifier. DC bias is added to the signal by R307.

The video-input amplifier consists of transistors Q4 and Q5. Its first stage has a gain of 10 and its second stage is an emitter follower whose low output-impedance drives the A/D converter.

Slow-scan signals (see box copy) are input through either the TAPE IN jack, J6, or from the telephone line. The incoming signal drives a limiter made from op-amp IC90-b. Following that limiter are two active bandpass filters with full-wave rectifiers at their outputs. The output of the rectifier is combined by IC91-b. That filter/rectifier/combiner network forms a tuned FM-discriminator having an "S"-shaped transfer function. Modulation ripple is removed from the demodulated FM by a 4-pole Butterworth low-pass filter made from sections of IC92 and IC93.

The recovered slow-scan video is then attenuated by R313 and DC-biased by R323. From there it is fed to the same amplifier used for fast scan. A section of switch

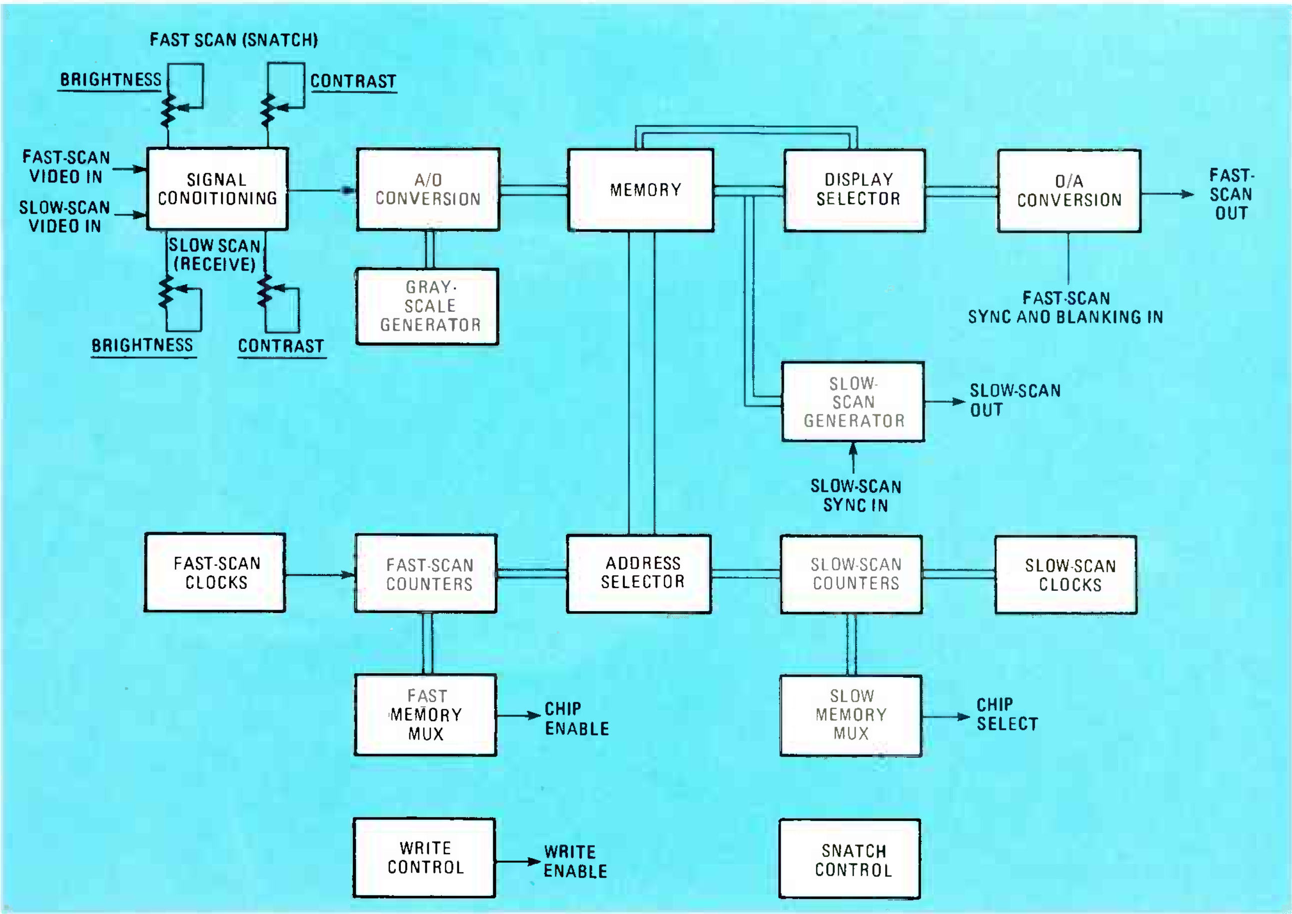


FIG. 1—LOGIC AND TIMING portions of Picture Phone circuit are shown at bottom of block diagram; video-processing blocks are at top.

HISTORY OF SSTV

Slow-scan television (SSTV) was developed during the 1960's by amateur radio operators to allow them to send pictures within the narrow (3-kHz) bandwidth permitted them by the FCC for transmissions on frequencies below 440 MHz.

Fast-scan television—the kind you're accustomed to watching in your living room—uses a bandwidth of about four *MHz*, so SSTV required a completely different technique to meet its restrictions.

SSTV uses a frame consisting of 128 lines, instead of the 525 used commercially. The horizontal-line rate is 1/15 of a second (as opposed to 1/15,734-second for fast scan), which means that it takes eight seconds to send—or receive—one slow-scan picture.

Audio tones are used to send the video and sync information—SSTV is frequency-modulated, unlike fast-scan TV, which is amplitude modulated. A frequency of 2300 Hz represents white, 1500-Hz represents black, and 1200-Hz is used for sync.

In the early days of SSTV, the output of a fast-scan camera was sampled over a period of eight seconds and converted into the tones required to transmit the video over the air. That means that, if a live subject was used, he had to sit still for that length of time.

At the receiving end, the image was viewed on a P7 (long-persistence) phosphor CRT of the sort used in radar displays. The picture started at the top and, eight seconds later, finished at the bottom. The top portion of the CRT was still glowing faintly at that point, and picture could be made out. There was no easy way, though to keep the image on the screen after it had been sent, so a lot of imagination was required.

The first scan converters were analog.

FIG. 1

They used surplus (blemished) video storage-tubes that, if new and perfect, would have cost about $50,000. With them, fast-scan video could be written onto the tube quickly and read out slowly, meaning that you could "snatch" a fast-scan picture in a 60th of a second and then read it out slowly for slow-scan conversion. Similarly, a slow-scan picture could be received and written onto the surface inside the storage tube and then read out quickly—and repeatedly. That allowed the image to be reproduced on a black-and-white monitor or TV set and viewed until all the details had been absorbed.

In the second half of the 1970's another technique for scan conversion was developed using digital IC's to store the video information. One of the earliest used 64 shift registers going around and around to store the data. Current scan converters, like the one described in this article, use RAM (*R*andom-*A*ccess *M*emory) IC's—the same sort used in computers—to hold the data representing the picture.

One of the most impressive uses of SSTV has been made by the Jet Propulsion Laboratories Radio Club, W6VIO, in Pasadena, CA. During the Viking missions to Mars, and the Voyager space probe encounters with the outer planets, the club station has retransmitted pictures from space on SSTV to amateur radio operators all over the world. (Figure 1 shows a view of Saturn's rings. The "spokes'" can be clearly seen.) Many of those pictures were seen before they were reproduced on television or in the papers, and some of the material that was sent never even made it to the media.

Your use for SSTV will probably be more mundane (pun intended). The audio frequencies used for slow scan fit nicely into the bandwidth that can be carried on an ordinary telephone line, which means that you do not need radio equipment to send or receive pictures—you can do it by telephone.

For a number of years the Bell System has offered a very limited *Picturephone* service, which requires that you go to a special center—one of a very few, and only in large cities—to see and talk with someone at another similarly equipped center. That service is not cheap, and, as you can imagine, it has not been too convenient, either.

Now, using SSTV, you can exchange video with anyone, anywhere, as long as you both have a telephone. You can transmit and receive pictures for business—of the people involved in long-distance negotiations, for example, or of portions of schematics, charts, or photographs that might take days to get from coast to coast by conventional means.

On a more personal note, you can chat with—and see—far-away friends and family whenever you like. All you need is a telephone, TV camera, and the Picture Phone. What's more, slow-scan video, because it's transmitted as a series of tones, can be stored on an ordinary audio cassette and replayed whenever you like. Top that, Ma Bell! **R-E**

S2 selects either fast- or slow-scan video for input to the memory.

Slow-scan sync signals are derived from the composite slow-scan signal by a low-pass filter made from IC93-b. An automatic-threshold sync separator, Q1, strips the sync from the video. Horizontal and vertical sync signals are separately filtered by non-linear filters Q3 and Q2. The filtered sync signals are converted to fast-rise-time logic signals by Schmitt trigger IC63. (The legend "ESH" stands for *E*xternal *S*low-scan *H*orizontal sync, and "ESV" for *E*xternal *S*low-scan *V*ertical sync. A bar above the legend indicates that the signal goes to a logic-low state when sync is present.)

Fast-scan sync is derived from the input video by automatic-threshold sync separator Q7. The horizontal and vertical sync signals are separated by the differentiator/integrator formed by Q8 and Q9. The sync signals are inverted and buffered by IC61-c and IC61-d. (The legend "EFV" stands for *E*xternal *F*ast-scan *V*ertical sync and "EFH" for *E*xternal *F*ast-scan *H*orizontal sync.)

A/D conversion

The analog video signal is continuously digitized into a series of 4-bit nybbles (half-bytes). A 4-bit nybble can represent 16 shades of gray, which has been found to be sufficient to display an intelligible black-and-white image without either using excessive memory, as would be the case if a larger word-size were used, or inducing excessive contouring (abrupt transitions from one gray-shade to the next), as would be the case if a smaller word-size were used.

A voltage divider (R60-R75) with equally-spaced taps establishes the 16 amplitude levels representing the gray shades. Each tap is connected to a comparator (IC73-IC80), that outputs a signal indicating whether the amplitude (gray shade) of the video at its position is greater or less than that established by the voltage-divider chain.

The comparator outputs are combined by logic gates IC88 and IC57-a and IC57-b to form a 4-bit nybble representing the instantaneous luminance value of the video signal. The whole forms what's known as a *flash converter*.

This type of A/D conversion has certain disadvantages, namely that the transition from one gray shade to another may involve changing the state of more than one bit of the 4-bit nybble. If several bits change at once, voltage spikes may occur, and be read as part of the video data. To avoid that, before the data is entered into memory it is converted from a straight binary number into one expressed in Gray code. In the Gray code, it is possible to go from any 4-bit value to the next one without changing more than a single bit, which tends to eliminate the glitches we want to avoid. Binary-to-Gray code conversion is shown in Table 2.

Memory

The heart of the digital scan-converter is its memory. It consists of 16 μPD411D (MM5280) 4K × 1 dynamic RAM's. (See Fig. 3) The memory is organized so the LSB (*L*east *S*ignificant *B*it) of each nybble is stored in IC1-IC4. Higher-order bits are stored in succeeding rows in the same order as they occur in the nybble. The memory is

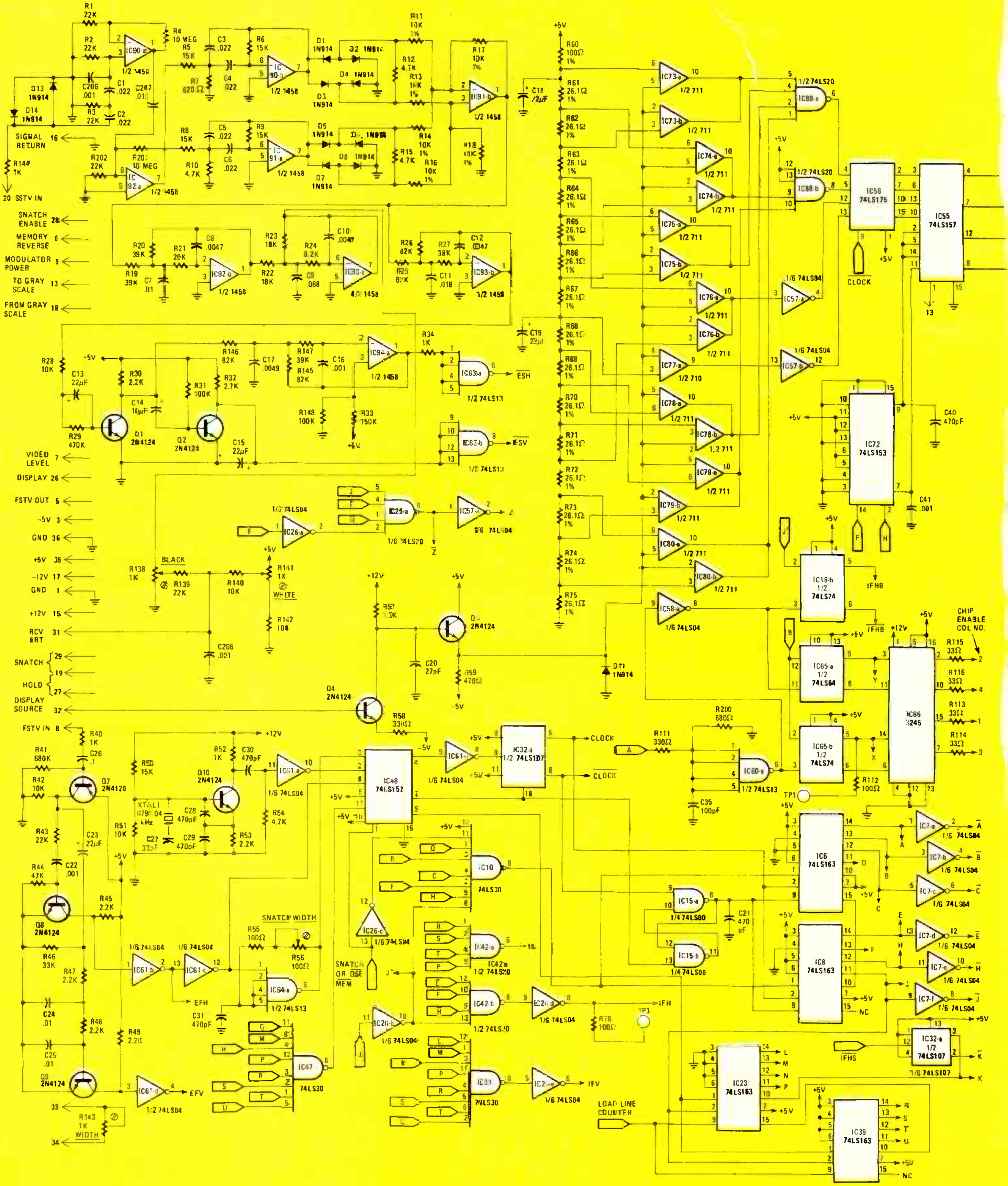
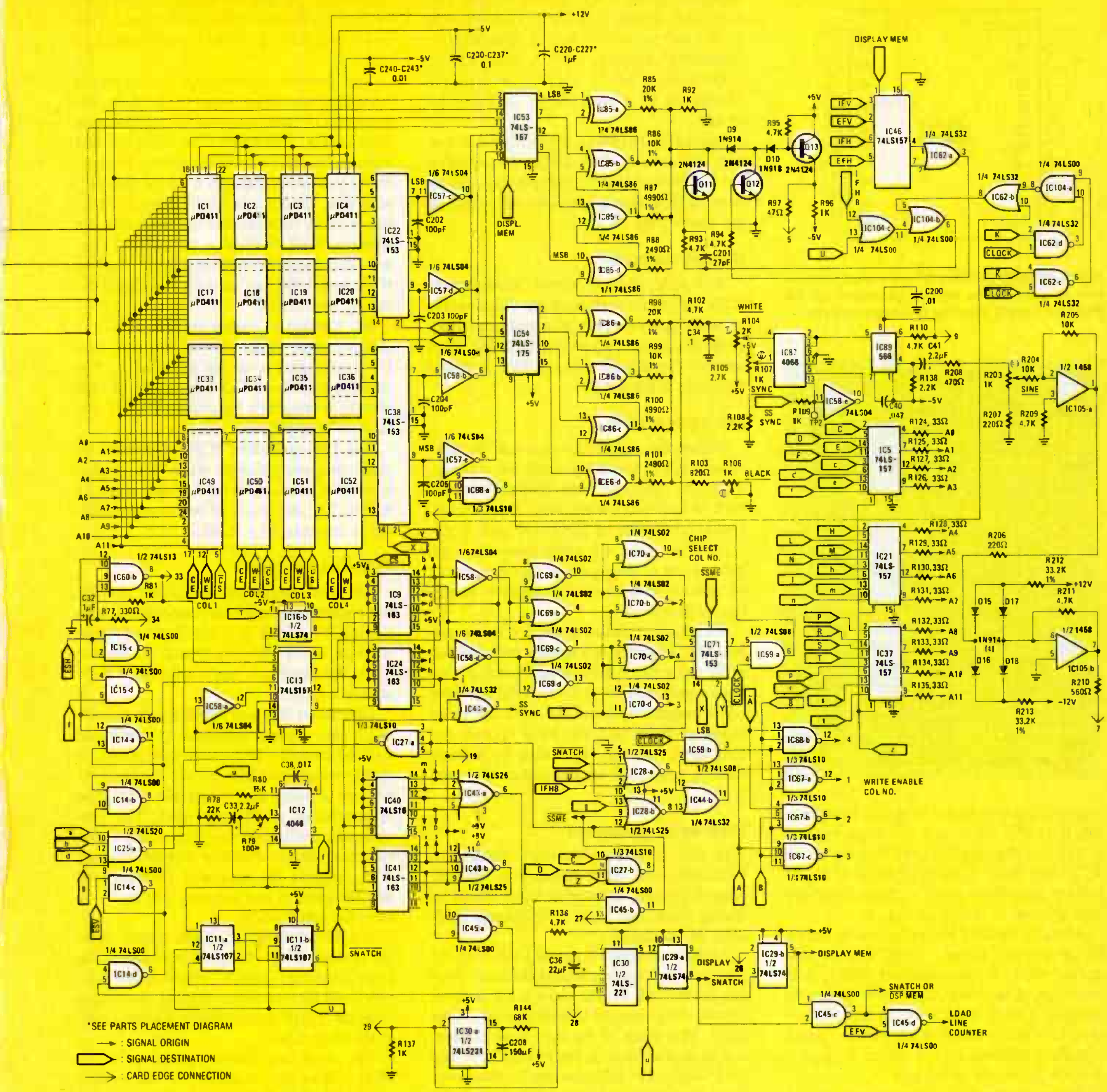


FIG. 2—HEART OF THE PICTUREPHONE is its memory, sixteen 4K-bit IC's that store video information prior to scan conversion.


+12V
+5V
−5V
C240-C243*
0.01
C230-C237*
0.1
C220-C227*
1µF
DISPLAY MEM
DISPL. MEM
WHITE
BLACK
SS SYNC
SYNC
SINE
CHIP SELECT COL NO.
WRITE ENABLE COL NO.
SNATCH OR DSP MEM
LOAD LINE COUNTER
SNATCH
COL1
COL2
COL3
COL4
*SEE PARTS PLACEMENT DIAGRAM
: SIGNAL ORIGIN
: SIGNAL DESTINATION
: CARD EDGE CONNECTION

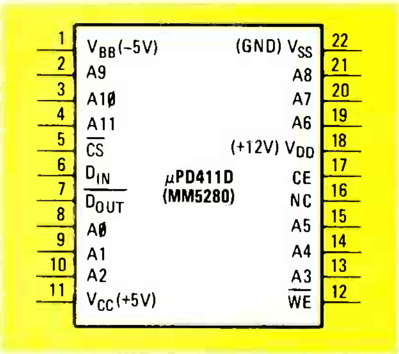


FIG. 3—PINOUT OF MEMORY IC shows destination of some of the signals generated by the Picture Phone's clocking and logic circuits.

TABLE 2

Shade	Binary code	Gray code
White	0000*	0000*
	0001	0001
	0010	0011
	0011	0010
	0100	0110
	0101*	0111*
	0110	0101
	0111	0100
	1000	1100
	1001	1101
	1010*	1111*
	1011	1110
	1100	1010
	1101	1011
	1110	1001
Black	1111*	1000*

* Values used for gray scale

multiplexed to increase its speed by operating IC1, IC2, IC3, and IC4 (and back to IC1) in overlapping fashion. Thus the active IC's shift from column to column as the picture goes from pixel to pixel. Memory organization is shown in Fig. 4.

Memory shifting is determined by the CE (*C*hip *E*nable) signal, which will be discussed later. As the memory shifts, it is necessary to shift the output from column to column. That is done by IC22 and IC38—double-pole, 4-throw multiplexers. Input signals to memory are connected in parallel to each IC in any given row.

The memory-control signals are CE, WE (*W*rite *E*nable) and CS (*C*hip *S*elect). The CE signal carries the clocking information. The WE signal controls whether information will be fed into a memory IC, or read from it, depending on whether it is a logic-high or logic-low. The CS signal determines whether an IC is available for data transfer or not.

In the Picture Phone, the CE signal acts as both the memory clock and as the source of the fast-scan memory multiplexing. Slow-scan multiplexing takes place according to the state of the CS signal.

Display selector

A 4-pole, double-throw multiplexer, IC55, determines whether the video monitor will display the picture stored in memory or the live (digitized) picture from the video source. The selection of the live or stored picture is made by S2.

D/A conversion

Before the digitized video can be converted back to an analog signal for viewing, it must be converted from gray-scale values back to standard binary ones. That conversion is performed by IC85, a 4-section EXCLUSIVE OR gate. By controlling the logic state of one of the inputs of that EXLCUSIVE OR gate, inverted video (a negative image) can be produced.

Weighting resistors connected to the outputs of IC85 generate a voltage proportional to the value of the 4-bit binary word applied to its inputs. Emitter follower Q13 provides a low output-impedance to drive the video monitor. Sync and blanking signals are combined with the raw video by voltage shifting produced by transistors Q11 and Q12.

Slow-scan generator

In this section, slow-scan picture information read from memory is latched, code-converted, converted from digital to analog form, and used to frequency modulate an oscillator.

At the end of each fast-scan line (every 63 microseconds) the memory-address lines are connected to the slow-scan address counter long enought to read one slow-scan pixel. That piece of the slow-scan picture, still in digital form, is latched by IC54 and held until new information is available. Slow-scan pixels occur at a rate such that a new one is available every 500 microseconds. At the 63-microsecond rate, each pixel is read about nine times. That re-reading does not affect performance in any way.

The latched information is converted from Gray to binary code by IC86 by the same process that was used for the fast-scan information. The same control signal that was used for black-to-white picture reversal in the fast-scan section is used for that purpose here. Because of the difference in picture polarity between fast and slow scan, an inverter, IC68, is used in the polarity control-line. Resistors R98-R101, as well as R103 and R106, are used for the digital-to-analog conversion.

An electronic analog-switch, IC87, is used to select either slow-scan video or a DC sync-signal level for input to the FM oscillator, IC89. The operation of that switch is triggered by the horizontal and vertical sync-pulses.

The FM oscillator, IC89, generates an audio-frequency triangle wave. That triangle wave is later converted to a sine wave by IC104. The amplitude of the slow-scan audio is controlled by R203.

Fast-scan clocks

All scan-conversion operations that do not require the fast-scan camera are controlled by clock signals derived from XTAL1, a 6791.04-kHz crystal. Transistor Q6 is the oscillator, and a section of IC61 acts as a buffer.

Operations that use the fast-scan camera use a free-running oscillator synchronized with the camera's horizontal-sync pulses. A synchronized oscillator avoids the horizontal jitter of pixels that would take place if an asynchronous clock were used. The synchronous oscillator is a section of IC64. The SNATCH WIDTH trimmer potentiometer, R56, controls the oscillator frequency so that the camera and memory displays will have the same width.

A 4PDT multiplexer, IC48, selects either the crystal- or synchronous-oscillator. The latter is used to "snatch" a field of fast-scan video and for the camera display; the output from the crystal-controlled oscillator is used at all other times.

The clock oscillators operate at 6.791 MHz—twice the frequency of the system clock. Flip-flop IC32 divides the output of the oscillator by two to obtain the actual clock pulse-string, which assures perfect symmetry of the waveform.

When we continue this article, we'll conclude our discussion of how the Picture Phone works. We'll also look at the power supply for the unit, the telephone interface circuit, and, space permitting, begin our discussion of how to build and align the device. **R-E**

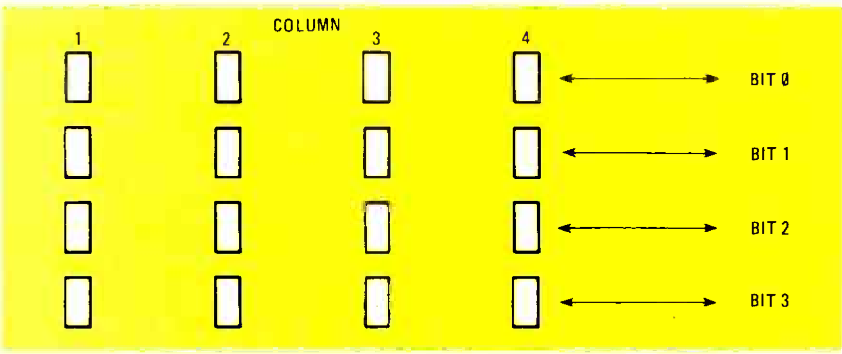
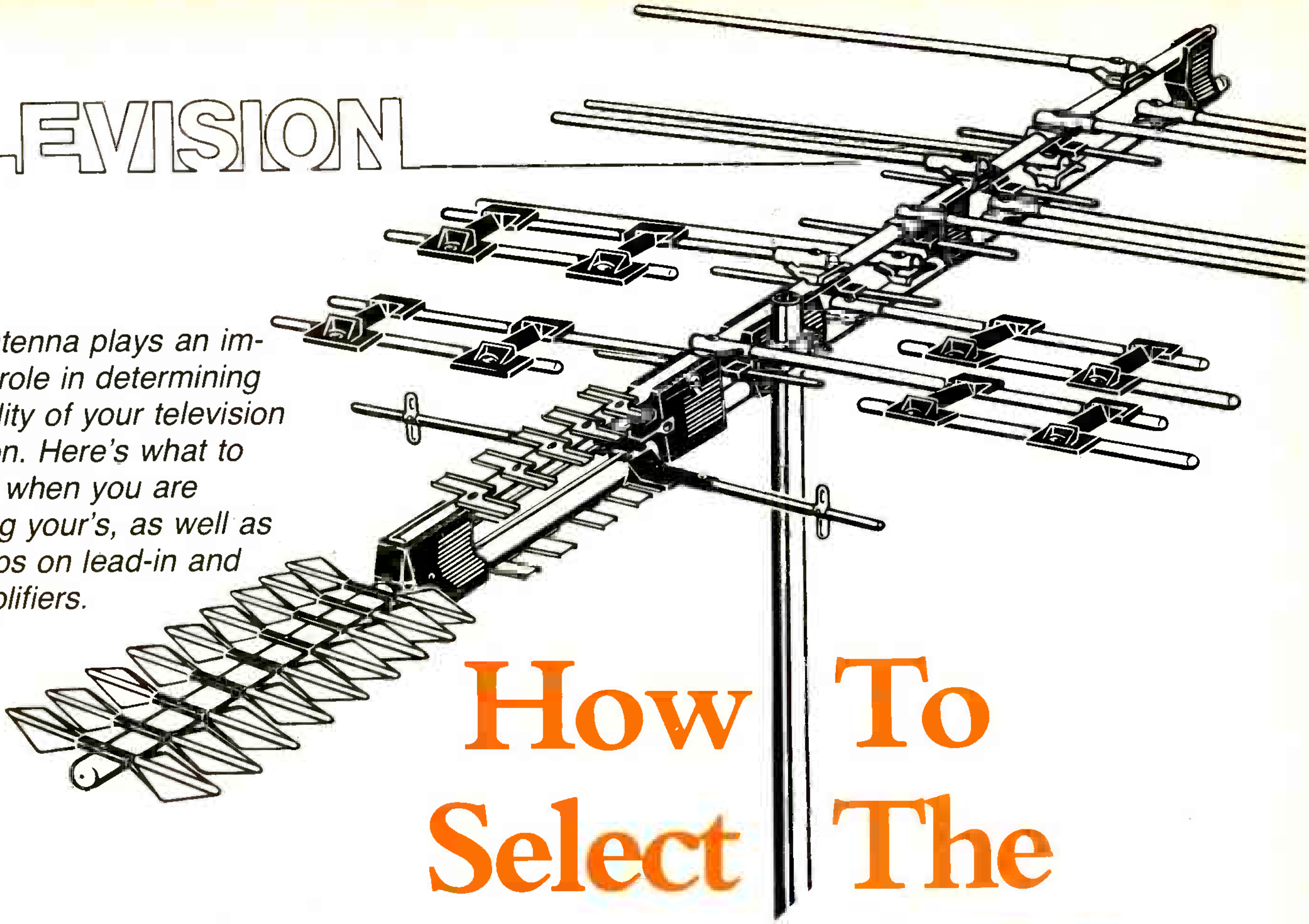


FIG. 4—MEMORY IC columns are multiplexed to provide speed needed for fast-scan applications.

Due to space restrictions, and the necessity for a lengthy technical discussion of the Picturephone circuitry, the parts list and foil patterns for the device will be presented in a future part of this article. The wait will be worth it.



Your antenna plays an important role in determining the quality of your television reception. Here's what to look for when you are choosing your's, as well as some tips on lead-in and pre-amplifiers.

How To Select The BEST TV ANTENNA

GARY J. ARNOLD

MANY FACTORS COMBINE TO DETERMINE UP the kind of television reception you have. A transmitted signal must be present; an antenna must pick it up; it must be transmitted to the television receiver, and the electronics inside the TV set then must convert that signal into picture and sound. In difficult reception areas, every one of those factors are critical. In this article we will concentrate on the antenna system.

In strong signal areas where interference is not a problem, just about any antenna will perform satisfactorily. When interference, weak signals, or congested, overlapping signals exist, reception problems become serious.

Our first step is to analyze our reception needs and problems. If signals are very weak, we need a high-gain antenna and perhaps a booster amplifier. If there are strong adjacent channels coming from different directions, a co-channel problem, or interference from power lines, power equipment, auto ignitions, strong FM signals, etc., a highly directional antenna is needed.

Remember: A strong signal is worthless if it is accompanied by strong interference. But an extremely weak signal, free of interference, can produce a watchable picture.

A highly-directional antenna can receive signals from the front of the antenna while rejecting signals coming from the sides and rear of the antenna. Think of the antenna as having "tunnel vision," or a *narrow beam width*. It *sees* only what it is aimed at. To understand what makes an antenna work, let's "build" one, starting with one element.

A simple dipole antenna (Fig. 1) consists of two rods, or one "element." The element is cut to a length that best matches the desired frequency. Since the antenna must send electronic impulses to the receiver, the stronger those impulses, the better the reception. The element will deliver the strongest possible signal if it is cut to the exact length for the frequency desired. The lower the frequency, the longer the wavelength; thus, the longer the element. The directional characteristic of a simple dipole antenna is shaped like a figure 8 (see Fig. 2).

FIG. 1—A SIMPLE DIPOLE ANTENNA. It is cut to the exact length for the frequency desired.

Now let's add two more elements to our simple dipole antenna, making it a three-element *array* (Fig. 3). The shorter element is the front of the antenna, and that element is called a *director*. The middle element is our dipole. The longest element is a *reflector*. Both the director and reflector are *parasitic* elements. They are not connected

FIG. 2—THE DIRECTIONAL CHARACTERISTIC of a simple dipole is shaped like a figure eight.

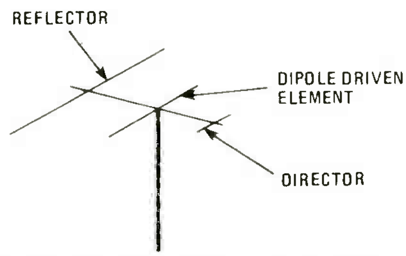


FIG. 3—THIS THREE-ELEMENT ARRAY consists of a dipole and two parasitic elements—the director and reflector.

directly to the antenna lead, but transfer received power to the *driven*, or *hot* element (the dipole in our example). The driven element is connected directly to the antenna lead in.

A director "pulls in" a signal. The director resonates when a signal hits it, and transfers that signal to the next element in line with it. In our three-element array, the director receives a signal, resonates, and transfers a part of the signal to the dipole. That increases the signal that the dipole receives, increasing the intensity of the signal. As a result, the dipole produces stronger impulses that are sent to the receiver. A director is slightly shorter than the driven element.

The reflector serves two purposes. First, it reflects signals hitting it from the front onto the driven element in front of it. That increases the signal that the driven element receives, increasing the intensity of the signal. Second, it reflects signals hitting it from the back *away from the antenna*, producing a more forward directional pick-up pattern. A reflector is slightly longer than the driven element.

The length, spacing, and number of elements determines the antenna's gain and directional characteristics. Unfortunately, ideal spacing and element length for gain is *not the same* as ideal spacing and element length for directivity. However, a good highly-directional antenna is only slightly lower in overall gain than an antenna made for highest gain. Generally speaking, the more elements in similarly designed antennas, the more directional the antenna, and the higher the gain.

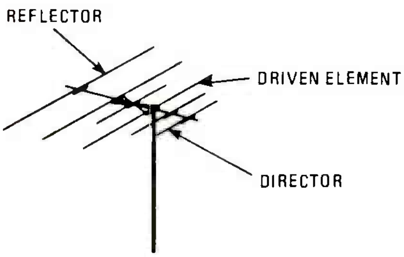


FIG. 4—A SIX-ELEMENT VHF antenna such as this is good for local TV reception.

With those basic principles in mind, let's examine a few antennas. Figure 4 shows a simple 6-element VHF antenna. The longest element is the reflector, the three short elements are directors, and the other two long elements are the driven elements. This is a low gain, slightly directional antenna, good for local VHF reception where interference is not a problem.

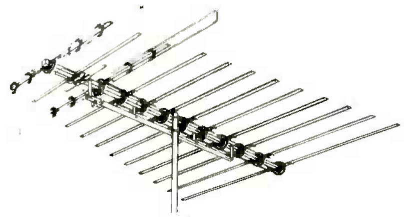


FIG. 5—FOR WEAK SIGNAL AREAS, a more sophisticated antenna, such as the one shown here, is required.

Figure 5 is a more sophisticated VHF antenna. The front element is a U-Wire parasitic director that has dual resonance on both the low and high VHF bands. The second element is an FM-control element that reduces FM signals; it can be broken off at score marks to permit it to receive FM signals at full gain, if desired. The third element is a VHF high-band parasitic director. The fourth element is a driven element with a U-Wire parasitic director attached that has dual resonance on both the low and high VHF bands. The remaining elements are all driven. Notice how they taper toward the front. Each longer element also acts as a reflector to the element in front of it. This antenna is a highly directional model that is good in weak signal areas.

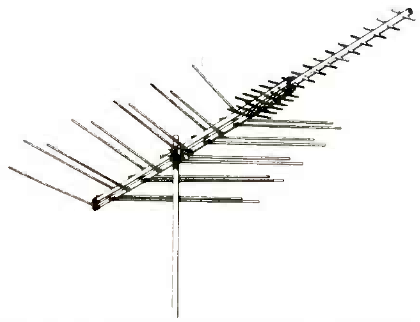


FIG. 6—THIS HIGHLY DIRECTIONAL ANTENNA is designed for both VHF and UHF reception.

Figure 6 shows a combination VHF-UHF antenna. The front of the antenna has 10 parasitic UHF directors. The next section of short elements has 11 UHF driven elements. The back section has 10 driven VHF elements. There are no VHF parasitic directors or reflectors. However, the longer VHF elements act as reflectors for the elements in front of them. The forward sweep angle of the VHF elements contributes to its directional characteristics. This antenna works well in medium-signal areas with strong interference since the antenna is extremely directional.

Figure 7 is a totally different approach to UHF antennas. This antenna has four driven elements and a reflector screen. This type of UHF antenna is widely used because of its high gain and low cost. It has a wide beam width from the front, so it picks up signals from various directions from the front of the antenna.

Figure 8 is a variation of Fig. 7. This antenna has 12 driven elements and a large reflector screen. It is extremely powerful, and very directional. It is a good choice in hilly or extremely weak UHF areas.

Figure 9 is a highly directional UHF antenna. It consists of a driven element, several parasitic directors, and a "corner reflector." That combination delivers good results in weak UHF areas where interference must be rejected from the sides and rear of the antenna.

Figure 10 is an extremely powerful combination VHF-UHF antenna with medium

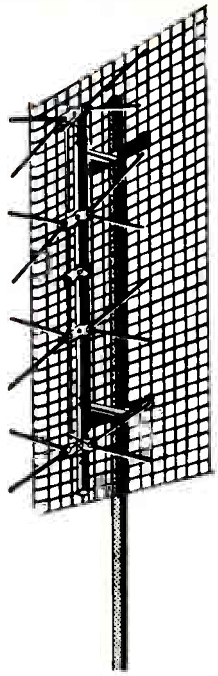


FIG. 7—HIGH GAIN AND LOW COST are among the reasons for this UHF antenna's popularity.

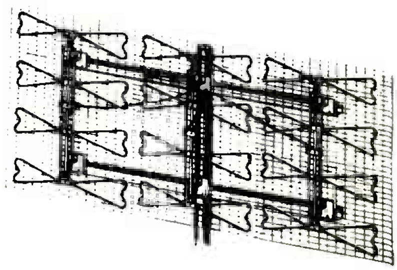


FIG. 8—WITH 12 DRIVEN ELEMENTS, this UHF antenna is a good choice for receiving weak signals.

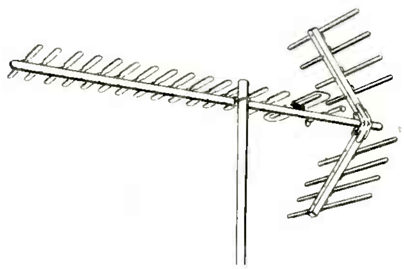


FIG. 9—THIS HIGHLY DIRECTIONAL UHF antenna is especially good when interference is persistent.

to good directional characteristics. The front of the antenna consists of a high-gain UHF section with multiple directors, one driven element, and a corner reflector. Some of the directors are made in three parts (Fig. 11). Each of the parts resonates on the high UHF frequencies while all three together act as a longer element and resonate on the low UHF frequencies.

The VHF section is on a split boom and is angled for more than one reason. First, it structurally strengthens the antenna. Second, it increases the "capture area" vertically. Third, it helps reduce VHF interference coming from above or below the antenna. This antenna is a good choice in very weak VHF-UHF areas with medium interference.

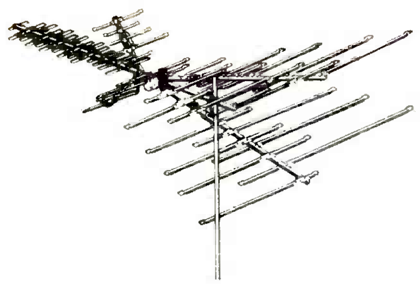


FIG. 10—SOME OF THE UHF DIRECTORS is this powerful antenna are made in three parts (see Fig. 11).

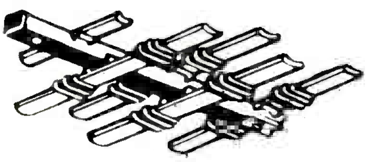


FIG. 11—EACH OF THE PARTS of this three-part UHF director resonates on the higher UHF frequencies. The three together act as a longer element and resonate on the lower frequencies.

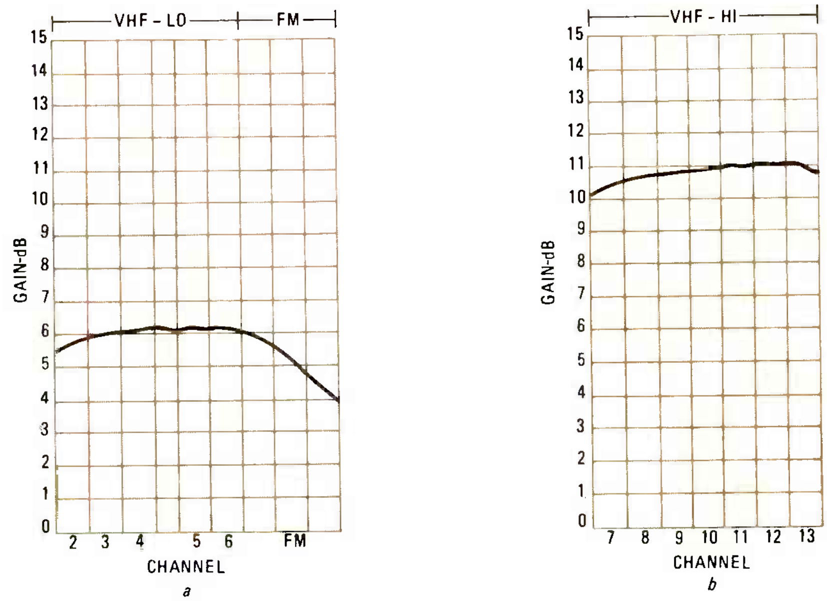


FIG. 12—THE GAIN OF THE ANTENNA SHOWN IN FIG. 5. The gain for the low band (channels 2-6) is shown in *a*; the gain for the high band (channels 7-13) is shown in *b*.

Antenna specifications

There is no consistency among manufacturers as to what specifications they list, if any. However, let's examine the most common specifications used.

1. The number of elements an antenna has is listed by some manufacturers. That specification, however, has little value when comparing one line of antennas to another. Notice we say that the antenna in Fig. 4 has 6 elements. That is a conservative method of counting elements. Some manufacturers would count these same elements as 12. Some manufacturers count an element that is driven, but also used as a reflector, as two elements.

The "number" of elements is not important. The length, spacing, and arrangement of the elements is what really matters.

2. Antenna gain is a common specification. It is stated in decibels (dB). To compare gain figures, you must know what reference the manufacturer used to determine the gain figure. The most common reference is a half-wave dipole. However, some manufacturers use a theoretical isotropic antenna as a reference. To compare the two methods, it is necessary to add 2.1 dB to the dipole-referenced figure, or you can substract 2.1 dB from the isotropic antenna reference figure.

When referring to antenna gain in this article, we are using the more common dipole reference method.

The gain figures given for the antenna shown in Fig. 5 is shown in Fig. 12. Notice how the gain is much higher at the VHF high band (channels 7–13). We mentioned earlier the higher the frequency, the shorter the wavelength. It's now time to mention that the shorter the wavelength, the weaker the signal will be.

In other words, given two transmitters, one on channel 2 and the other on channel 13, both at the same location and transmitting with the same amount of power, at any given distance from the transmitting antenna, the channel 2 signal will be much stronger than the channel 13 signal. The main cause is the fact that the lower frequencies tend to "bend" more with the earth's curvature than do higher frequencies, and that the higher frequencies lose more power in the air as they travel. Thus, the higher the frequency, the weaker the signal received, and the higher gain needed at the antenna. The average gain figures for several antennas are given in Table 1.

3. The antenna's front-to-back ratio, is another common specification. It is also expressed in dB's. Front-to-back ratio is defined as the ratio, expressed in decibels, of the gain of the peak of the main forward lobe to the gain of the peak of the largest lobe in the rear. In other words, it's the ratio of the forward gain to the rear gain. That specification is important in determining the antenna's directional pattern. The higher the F/B (front-to-back ratio), the more directional the antenna. A 22–dB figure is considered very good, and a 27 dB figure is quite impressive, to say the least. The average F/B ratio figures for several antennas are listed in Table 2.

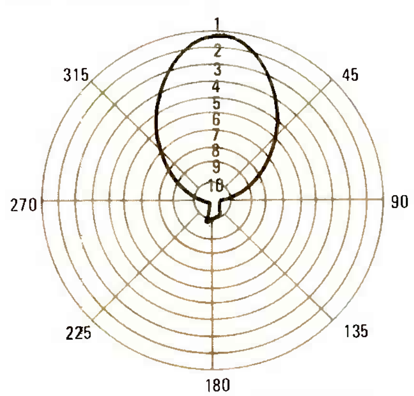


FIG. 13—GRAPH OF THE BEAM WIDTH of an antenna. This graph is of an antenna with a beam width specification of 53°.

4. The antenna's beam width is the maximum angle at which a signal can hit the antenna and still be at least half as strong, or no more than 3 dB down. Figure 13 is a graph of an antenna with a 53° beam width. The beam of the antenna shown in Fig. 6 averages 67° on channels 2–6, 29° on channels 7–13, and 31° on UHF channels 14–83. See Table 3 for beam width specifications on several antennas.

Generally speaking, the higher the antenna's front-to-back ratio, the narrower the beam width. Either specification is a good indication of the antenna's directivity.

Specialty antennas

Before continuing on to the rest of the "antenna system," it's important to note that many manufacturers custom-make antennas for particular reception needs. Single-channel antennas are available where additional gain and directivity is needed beyond that of the best all-channel antennas. Where extreme reception problems exist, check with your local antenna distributor, or the manufacturers themselves, to see if a special antenna has been designed for your particular problem.

For most extreme problem areas, separate VHF and UHF antennas will work wonders. Although the installation will not be as neat as a single antenna would be, the additional gain and directivity possible may be worth it.

When measuring the antenna's gain and front-to-back ratio we have used decibels. To compare one antenna to another, we must understand what a decibel is. A decibel merely expresses the relationship, or ratio, between two signals. It is important to know that 3 dB down, or 3 dB less means that the signal strength is cut in half.

When comparing gain specifications, if one antenna has a gain of 11 dB, an antenna with a gain of 8 dB (11 dB minus 3 dB) has only *half the gain* of the 11-dB antenna.

When comparing front-to-back ratio specifications, an antenna with a F/B ratio of 20 dB rejects only half the signal (or interference) hitting it from the rear when compared with an antenna with a F/B ratio of 23 dB.

It is important to choose the proper antenna to meet your particular needs. Between various high-priced models, directivity can vary greatly.

Antenna lead-in

Once you've decided on an antenna, the next item to consider is the lead-in. It's foolish to buy an expensive antenna and then use cheap lead-in.

Probably the most common type of lead-in is 300-ohm twin lead. It's available in a multitute of qualities. The conventional flat lead can be used on VHF antennas. The better-quality foam-filled is used for VHF or UHF antennas. Good quality foam 300-ohm twin lead has very low loss characteristics when new and dry. Losses increase, however, with moisture, and it is certainly degraded after sunlight destroys the dielectric. Twin lead has the distinct disadvantage of picking up any interference in the immediate area and carrying it with the desired signal to the receiver.

That type lead-in is good in strong-signal areas virtually free of interference. In weak signal areas it is recommended only if the lead-in is replaced every year or two.

Twin lead must never touch metal. It must be kept away from the antenna mast with stand-off insulators, and must be kept away from electrical wiring. Cut off any excess lead length; never coil it up. It is very important to install that type of lead properly.

Another common type of lead-in is 75-ohm coaxial cable, also known as "coax". There are fewer grades of "coax" than 300-ohm lead, but the differences are important.

If weak signals are to be received, then losses must be minimized. Foam coax losses are less than those of regular coax. The main advantages of coax over twin lead is that coax is immune (for the most part) to interference and moisture. If interference is a problem, then 100%-shielded coax is preferred. That can be done by purchasing a coax with a foil shielding covering 100% of the cable. A copper braid over the foil adds more durability and additional shielding properties (Fig. 14). The main disadvantage of coax is its higher losses.

The main objective of the total antenna system is to deliver a clean picture to your television set. If there is interference around—electrical; from a nearby highway; from strong signals overpowering weak signals on adjacent channels, or from co-channel interference—a highly directional antenna with 100% shielded foam coax might be the best solution.

Other considerations

To receive a clean picture at the receiver, we need a high *signal-to-noise ratio*. The highest signal to noise is at the antenna itself. From there it is degraded as the signal goes down the lead-in to the receiver. The lead-in can also contribute some noise. If the signal is too weak when it reaches the receiver, an antenna pre-amplifier may be needed. A pre-amplifier increases the level of the signal at the antenna and is powered through the antenna lead-in from a remote power supply at the receiver. The pre-amplifier maintains the signal-to-noise ratio from the antenna to the receiver. It cannot improve the ratio at the antenna, because it will amplify any noise picked up by the antenna along with the desired signal.

There are many models of pre-amplifiers on the market. The main consideration to watch for is a low noise figure. The lower the better.

Another consideration is antenna height. Your immediate terrain affects reception. Any tall buildings or hills between your antenna and the transmitting antenna will have a direct bearing on your reception. Generally speaking, the higher the antenna the stronger the signal. Unfortunately,

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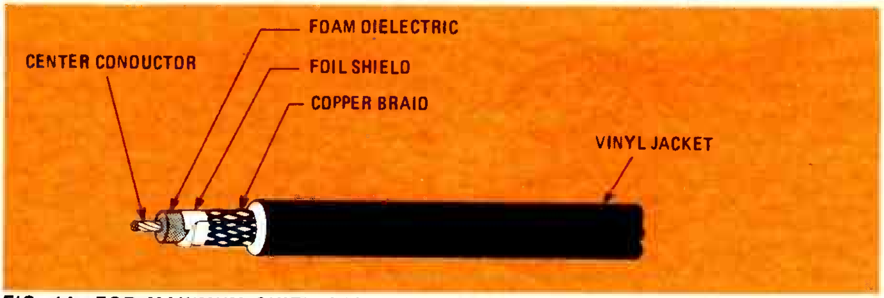

FIG. 14—FOR MAXIMUM SHIELDING AND DURABILITY, this type of coaxial cable should be used.

TABLE 1

ANTENNA MANUFACTURER/MODEL	Approx. Average dB Gain VHF-low	VHF-high	UHF
Winegard/CH-8100	6.8	10.6	11.8
Winegard/CH-8098	6.4	10.2	10.4
Finco/F-89-C	6.0	10.0	11.0
Channel Master/1160A	5.8	10.5	11.0
Jerrold/VU-937S	5.5	10.4	10.5
Channel Master/1162A	4.5	10.5	11.0
Jerrold/VU-935S	4.2	9.5	9.5
Blonder-Tongue/0719	4.3	7.3	8.0

NOTE: All the above are considered high-gain, top-quality TV antennas.

TABLE 2

ANTENNA MANUFACTURER/MODEL	Approx. Average F/B Ratio VHF-low	VHF-high	UHF
Channel Master/1160A	27	29	*
Channel Master/1162A	27	28	*
Blonder-Tongue/0719	25	24	21
Jerrold/VU-937S	23	23	24
Finco/F-89-C	20	26	18
Jerrold/VU-934S	20	20	22
Winegard/CH-8100	20	20	20
Winegard/CH-8098	20	20	20

*Not available
NOTE: All the above are considered top-quality TV antennas.

TABLE 3

ANTENNA MANUFACTURER/MODEL	Approx. Average Beam Width in Degrees VHF-low	VHF-high	UHF
Blonder-Tongue/0719	67	29	31
Jerrold/VU-937S	68	33	30
Jerrold/VU-935S	68	35	30
Finco/F-89-C	60	48	30
Winegard/CH-8100	69	48	33
Winegard/CH-8098	71	51	36

NOTE: All the above are considered top-quality TV antennas.

HOW TO DESIGN ANALOG CIRCUITS

TRANSISTORS— BIPOLAR JFET MOSFET

This month, we turn our attention to a slightly more complex solid-state component—the transistor. We'll begin by looking at the structure and operation of both bipolar and FET devices.

MANNY HOROWITZ

THIS MONTH, LET'S TURN OUR ATTENTION TO a slightly more complex device—the *transistor*. In modern circuits that use discrete components, two types of transistors are found. One type is called a *bipolar* transistor; the other a *F*ield *E*ffect *T*ransistor, or FET. A bipolar transistor is essentially an n-type or p-type slab of semiconductor material sandwiched between two slabs made of the opposite semiconductor material. Thus if the center slab, or *base* consists of p-type material, n-type material would be placed on either side of it. One of the slabs is called the *emitter* and the other is called the *collector*. Two junctions are formed by that type of construction. The amount of current flowing through one junction determines how much current will flow through the two slabs made of the same material.

FET's can be divided into two categories. In one, the Junction FET (or JFET), either p-type or n-type semiconductor material is used to form a channel that connects two terminals. One of those terminals is called the *source;* the other is called the *drain*. A junction is formed by placing an opposite type of material around the channel. The amount of voltage applied between that opposite type of material, called the *gate*, and the source determines the resistance of the channel. The direction of the current flow is determined by what type (p-type or n-type) of semiconductor material is used for the channel.

The second type of FET's are the *MOSFET's* (*M*etal *O*xide *S*emiconductor FET's). They also have a source, drain, and gate, but in their case, the gate is insulated from the source and the drain. Because of that construction, those devices are sometimes referred to as *I*nsulated *G*ate FET's, or IGFET's. We will take a closer look at FET's later in this article.

Bipolar transistors

A bipolar transistor can be one of two types. If a slab of p-type material is sandwiched between two n-type slabs, the transistor is an NPN device. The schematic symbol for that type of structure is shown in Fig. 1-a; a transistor with the reverse structure is called a PNP device and is shown in Fig. 1-b.

Before we go any farther, let's adopt a few conventions that will simplify the rest of our discussion. Those conventions will be used throughout the remainder of this series.

1. We will use conventional current-flow, rather than electron current-flow, in our discussion. In electron current-flow, we assume that electrons flow from the negative terminal of a battery through the circuit to the positive terminal of that battery. Conventional current flows in the opposite direction. That is an especially convenient approach when dealing with transistors because the arrow in the symbol indicates the direction of current flow when using the conventional current-flow standard.
2. Although both NPN and PNP transistors are common, we will be repeating ourselves if we detail both types of devices. We will describe

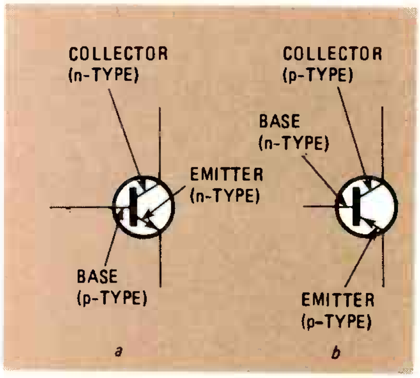

FIG.1—THESE SYMBOLS are used to identify bipolar transistors in schematic diagrams. The symbol for an NPN transistor is shown in *a*; the one for a PNP transistor is shown in *b*.

both types whenever necessary, but we will concentrate on the NPN transistor. Everything said here about that device, including the applied voltage, also applies to the PNP transistor. The exceptions are that the polarity of the applied voltage and direction of the current flow must both be reversed. Thus if current flows from the base to the emitter in an NPN device, it flows from the emitter to the base in a PNP device. Similarly, voltage applied to the base of an NPN device must be positive with respect to that at the emitter, if that transistor is to be turned on. It is negative with respect to the emitter voltage for the PNP device.

3. While Germanium transistors were popular in the past, currently silicon devices dominate the field. When describing circuits, we will be writing about silicon devices unless noted otherwise.

Except in switching and push-pull circuit applications, transistors are usually kept turned on at all times. That means that current will flow through the device as long as power is applied to the circuit. The proper voltage polarities for an NPN transistor, and the currents that are produced, are shown in Fig. 2. In that transistor, the base is positive with respect to the emitter and negative with respect to the collector. Because the base is made of p-type material and the emitter of n-type material, current flows from the base to the emitter. Little leakage current flows from the collector to the base; that is because of the polarity of the voltage applied to the n-type collector, with respect to the p-type base. However, current will flow from the collector to the emitter if the base-emitter junction is turned on and conducting.

One of the basic relationships in the performance of a bipolar transistor is how the collector current depends upon the base-to-emitter current in the circuit.

First, let us note that more emitter current, I_E, flows than does base current I_B, or collector current, I_C. Emitter current is essentially equal to the sum of base and collector currents. The ratio of collector current to emitter current has been given the special symbol α (alpha) so that:

$$\alpha = \frac{I_C}{I_E} \qquad (1)$$

Because almost all collector current flows into the emitter and very little into the base, and also because very little base-to-emitter current actually flows as compared to the collector current, I_E is just about equal to I_C and α is very close to 1.

A more useful ratio in most applications is the relationship between I_C and I_B. That ratio is called β (beta).

$$\beta = \frac{I_C}{I_B} \approx \frac{I_E}{I_B} \qquad (2)$$

β can usually be any value between 10 and 1000. It is related to α as follows:

$$\alpha = \frac{\beta}{\beta + 1} \qquad (3\text{-a})$$

$$\beta = \frac{\alpha}{\alpha - 1} \qquad (3\text{-b})$$

Transistors can be used in circuits in any one of three arrangements. Those are called common-emitter, common-collector, and common-base.

Common-emitter circuit

A transistor supplies the maximum power gain when used in a common-emitter configuration; it will also supply a voltage and current gain. A typical common-emitter circuit is shown in Fig. 3. Here, the size of the base current depends upon the base-supply voltage E_{BB}; the base resistor R_B; the voltage drop V_{BE} across the base-emitter junctions (usually 0.2 to 0.3 volt for germanium transistor and 0.7 volt for silicon devices), and the emitter resistor R_E. Base resistor R_B is usually connected to $+E_{CC}$ rather than using the separate power supply shown here. Considering that base current I_B flows through base resistor R_B and that emitter current I_E flows through emitter resistor R_E, we can conclude that the entire base-supply voltage, E_{BB}, is equal to:

$$I_B \times R_B + V_{BE} + I_E \times R_E \qquad (4\text{-a})$$

From equation 2, $I_B \approx I_E/\beta$. Substituting this into equation 4-a:

$$E_{BB} - V_{BE} \approx \frac{I_E R_B}{\beta} + I_E R_E \qquad (4\text{-b})$$

Solving for I_E:

$$I_E \approx \frac{E_{BB} - V_{BE}}{R_E + R_B/\beta} \approx I_C \qquad (4\text{-c})$$

Equation 4-c is used to determine the DC collector current. That current is equal to the net voltage in the circuit divided by the resistance through which the emitter (and collector) current flows.

It is obvious that emitter current flows through R_E; but what part does R_B/β play in equation 4-c? That term tells us that part of any resistance in the base circuit also appears in the emitter circuit—not the entire resistance, but that resistance divided by beta. Taking that discussion another step, any resistance in the emitter circuit appears in the base circuit as that resistance multiplied by beta. From that we can conclude that the base current is:

$$I_B = \frac{E_{BB} - V_{BE}}{\beta \times R_E + R_B} \qquad (5)$$

That agrees with equation 2, for if we divide I_C in equation 4-c by I_B in equation 5, we end up with β as defined in equation 2.

In the common-emitter configuration, the base-collector junction is reverse biased but there is a slight leakage current flowing through that junction from the collector to the base. That leakage current is called I_{CBO}, and defined as the collector-to-base leakage current when the emitter circuit is open. That is the current that flows though the base-emitter circuit when that circuit is complete. Because the emitter current is equal to the base current multiplied by beta, the current in the emitter (and collector) circuit due only to the leakage is βI_{CBO}. A special symbol, I_{CEO}, is used for that term, and it is defined as the collector-to-emitter leakage current when the base circuit is open. The total collector current, including the leakage, is therefore:

$$I_C = \beta \times I_B + \beta \times I_{CBO} = \beta \times I_B + I_{CEO}$$

Because leakage is usually very small, it is rarely considered when doing designs.

The characteristics of a transistor are frequently shown as a graph; Fig. 4-a shows

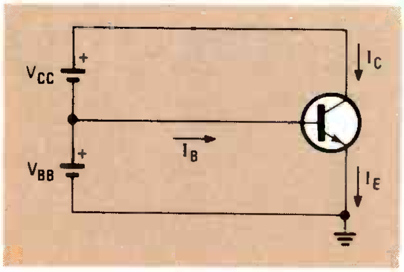

FIG. 2—THE VOLTAGE POLARITIES required to turn a bipolar NPN transistor on, as well as the currents that are produced. This circuit is used as an illustration only; do not attempt to build it, as it would most likely destroy the transistor.

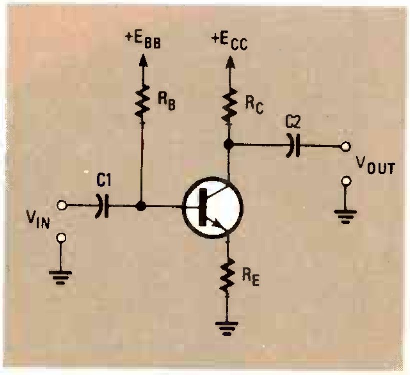

FIG. 3—A BIPOLAR NPN TRANSISTOR is shown here in a typical common-emitter circuit.

what that looks like for a common-emitter circuit. That graph shows how the collector current varies with different collector-to-emitter voltages for various levels of base current. If, for instance, you want to know the collector current when there are 6 volts between the collector and emitter of the transistor, with the base current adjusted to 300 μA, just extend a vertical line from the V_{CE} axis at 6 volts to the I_B = 300-μA characteristic. Next draw a horizontal line to the I_C axis. The line crosses that axis at about 32 mA as shown. That is the collector current flowing under those conditions. Obviously, at this point of operation, DC beta for the device is equal to I_C/I_B = 32 ma/300 μA = 107.

The curves shown in Fig. 4 are plots of a complex equation relating the V_{CE} and I_C of the transistor. Because there are two unknowns, we must plot a second equation on the graph to determine the quiescent operating point of the transistor. That can be done by first writing an equation for the collector-emitter circuit of Fig. 3:

$$E_{CC} = I_C \times R_C + V_{CE} + I_E \times R_E$$

and, since $I_C = I_E$:

$$E_{CC} = I_C(R_C + R_E) + V_{CE} \qquad (6)$$

Now we can plot that equation over the curves in the graph, as shown in Fig. 4-b. That plot is known as the *load line*. Two points are all that are required to plot it. Take one point to be where I_C = 0; then, substitute that into equation 6, $E_{CC} = V_{CE}$. That is a point on the horizontal axis. Take the second point to be where V_{CE} = 0; then, again substituting into equation 6, $I_C = E_{CC}/(R_C + R_E)$. That is a point on the vertical axis; connect those points and you have the load line.

Collector current and the collector-emitter voltage can be determined from where that load line crosses the base-current curve. Assume the base current has been adjusted to 200 μA. Put a dot where the load line and that base-current curve intersect. Draw a vertical line from that point to the V_{CE} axis. The point at which that line crosses the axis is the V_{CE} across the transistor. Now draw a horizontal line from the intersection point to the I_C axis. Where that line crosses that axis determines the collector current.

Note that the characteristic curves in Fig. 4 end somewhat before the I_C and V_{CE} axis. In the first case, the minimum voltage possible across the transistor is limited by a factor known as the transistor's *saturation voltage*. Useful minimum collector current is limited by the leakage current.

In Class A operation, it is desirable that a sine wave at the input of the circuit shown in Fig. 3 be reproduced with relatively little distortion at the output. To do that, the bias should be arranged so that the idling, or quiescent, voltage at the collector is about one-half of the supply voltage. Under those conditions, the collector voltage can swing to near zero when the voltage at the input is at its peak in the cycle and swing to near $+E_{CC}$ when that input voltage is at the low point of its cycle. We'll look into that in more detail in a future article.

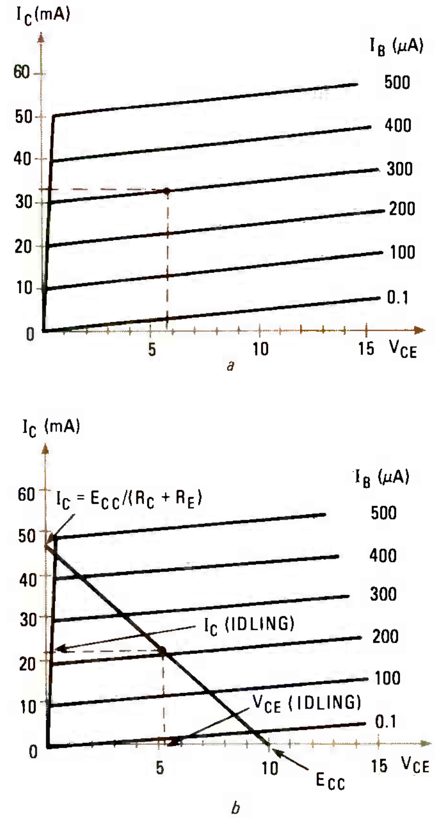

FIG. 4—COLLECTOR CHARACTERISTIC CURVES for a bipolar NPN transistor are shown in *a*; the load line is plotted over those curves in *b*.

Before a transistor is used in any circuit, it is important to be sure that it is not being used where its maximum ratings are exceeded. Manufacturers establish those ratings, and usually they can be found on the data sheet for that device. If those ratings are exceeded, the most likely result is the destruction of the device, as well as potential damage to the remainder of the circuit. Among the important ratings to look for are the emitter-base, collector-base, and collector-emitter breakdown voltages—BV_{EBO}, BV_{CBO}, and BV_{CEO} respectively. Those voltages are the maximum that can be applied between the two terminals mentioned. If it is exceeded, reverse breakdown, similar to what happens in a junction diode (see the June 1982 issue of **Radio-Electronics** for a discussion of that phenomenon), occurs. $I_{C(MAX)}$ refers to the maximum collector current that the device can safely handle. $P_{D(MAX)}$ is the *total* power dissipation across both junctions of the device. That power dissipation is determined by the device's maximum junction temperature, $T_{J(MAX)}$, as well as the device's thermal resistance, θ_{JA}. In many cases, the transistor's maximum power dissipation can be approximated by $V_{CE} \times I_C$.

Phototransistors

Transistors not enclosed in opaque containers, are useful as phototransistors. They are usually connected in a circuit similar to that shown in Fig. 3, but with the base left floating and the collector directly coupled to a following circuit. When light hits the device, the I_{CBO} increases with the intensity of the light striking the transistor. Since I_{CEO} flows due to the presence of I_{CBO}, and since I_{CEO} is a collector current, both I_{CEO} and collector current also increase with the intensity of light striking the phototransistor.

Common-collector circuit

The basic common-collector circuit is the same as the one drawn in Fig. 3, except that R_C is equal to 0 ohms. Now, however, the output is taken from the emitter rather than from the collector. R_E is much larger in this circuit than it was in the common-emitter circuit so that it can handle about one-half of the supply voltage when the desired amount of emitter current flows.

Emitter current is equal to the sum of the collector and base current, as before; if there is considerable leakage current, you must add I_{CEO} and I_{CBO} to the I_E determined under ideal conditions. Although here the current amplification is still equal to β, the voltage gain is just a trifle under 1.

Two very important characteristics of the circuit are high input resistance and low output resistance. Input resistance here is approximately equal to βR_E, in parallel with R_B. But now R_E is quite large so βR_E is of considerable size. The output resistance is equal to about R_B/β in parallel with R_E. That is usually much less than the R_C output resistance of the common-emitter circuit.

Common-base circuit

A common-base circuit is similar to the one in Fig. 3 except that the input capacitor, C1, is connected to the emitter rather than to the base. With the input fed to the emitter, the input impedance is just about equal to the emitter resistance of the device. In addition, the output impedance is approximately equal to R_C, the voltage gain is approximately equal to the ratio of R_C to R_E, and the current gain is equal to α, or about 1.

Field effect transistors

While bipolar transistors can be considered primarily as current amplifiers that provide voltage and power gain as well, when used in specific types of circuits, the FET is basically a voltage amplifier. The schematic symbols for the different types of FET's are shown in Fig. 5. Similar to what we did with bipolar transistors, we will concentrate here on the n-channel device and refer to the p-channel device only as required. Everything we say about n-channel devices will hold for p-channel devices, except that the applied voltage polarities and current directions are reversed.

JFET's

Power-supply voltage is applied between

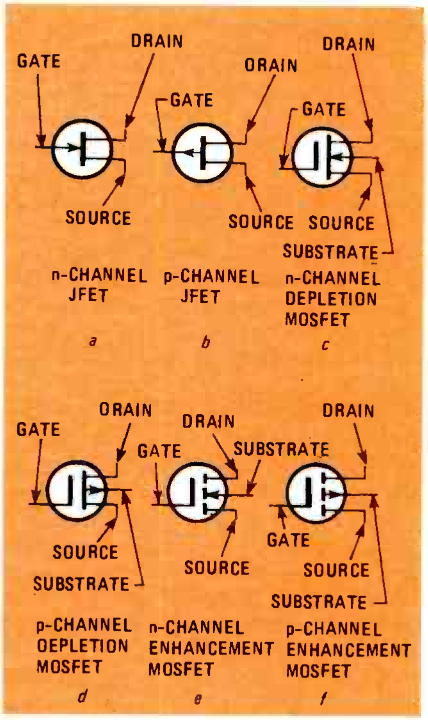

FIG. 5—THE DIFFERENT KINDS of FET's are identified in schematic diagrams by these standard symbols. Note that the depletion devices shown in *c* and *d* are also known as enhancement/depletion MOSFET's (see text).

the drain and source of the n-channel JFET. Polarity of the applied voltage is such as to make the drain positive with respect to the source. As with the bipolar transistor, the characteristics of an FET can be shown graphically; that is done in Fig. 6. Figure 6-a shows how the current flowing through the channel depends on V_{GS}, the voltage between the gate and source. The drain current, I_D, as shown on the graph, is at a maximum when V_{GS} is equal to zero. (Actually, V_{GS} can be made slightly positive—up to about 0.5 volt, and more drain current will flow.) When $V_{GS} = 0$, the drain current is called I_{DSS}. That is the drain current when the gate is shorted to the source. Drain current is reduced as the voltage at the gate is made more negative with respect to the voltage at the source. It reaches a low at V_p, the gate-to-source voltage when only an infinitesmal amount of drain current still flows. V_p, known as the pinch-off voltage, can also be determined from the $V_{GS} = 0$ curve. It is identical to the minimum drain-to-source voltage, V_{DS}, that must be applied for the curve to become horizontal. Because drain current is reduced as the voltage between the gate and source becomes more negative, the JFET is known as a depletion-type device.

Note that two regions on the graph are separated by a bold dashed line. To the left of that line, in the area marked *ohmic region,* the drain current varies directly with the drain-to-source voltage, and the DC resistance in this region is simply V_{DS}/I_D, much as it would be in a resistor, hence the name. The AC- or output drain-source resistance, R_{DS}, along any of the curves can be calculated in either the ohmic or *pinch-off* region by noting the difference between the voltages at two appropriate points on one curve and dividing that by the corresponding difference between the drain currents at those points. Some data sheets will not give the value of R_{DS} directly, but rather give the device's output conductance, G_{OS}, or admittance, Y_{OS}. You can calculate R_{DS} simply by noting that at normal frequencies:

$$G_{OS} = Y_{OS} = 1\backslash R_{DS}$$

The ohmic region is primarily of interest when the JFET is used in switching or digital circuits. Of special importance for those applications is the value of R_{DS} when V_{GS} is 0. That value is called $R_{DS(ON)}$, and is typically a few hundred ohms.

If the JFET is to be used as an amplifier, only the linear, or pinch off region is of interest. One of the important device parameters here is the JFET's *transconductance*, g_m, a measure of how much change there is in drain current for every change in gate-to-source voltage. It is defined by:

$$g_m = \frac{\Delta I_D}{\Delta V_{GS}} \qquad (7)$$

Transconductance varies with the amount of drain current that is present. To determine g_m at a particular drain current, choose two points around that current and note the corresponding gate-to-source voltage needed to achieve those currents. The difference of current at the two points is ΔI_D and the difference of voltage is ΔV_{GS}. Substituting those numbers into equation 7 will give you the transconductance.

Transconductance at the $V_{GS} = 0$ curve is denoted by g_{mo}. It may be specified in data supplied by the manufacturer of the transistor, or may be determined by using the method just described, or by using the following equation:

$$g_{mo} = \frac{2 \times I_{DSS}}{|V_p|} \qquad (8)$$

Where $|V_p|$ is the absolute value of the pinch-off voltage.

Using the next equation, we can determine the g_m for any V_{GS}, without doing any approximate measurements on the curves.

$$g_m = g_{mo}\left(1 - \frac{|V_{GS}|}{|V_p|}\right) \qquad (9)$$

Where $|V_{GS}|$ is the absolute value of V_{GS}.

Taking that one step farther, rather than using the curves, we can determine the drain current quite accurately from the following equation:

$$I_D = I_{DSS}\left(1 - \frac{|V_{GS}|}{V_p}\right)^2 = T_{DSS}\left(\frac{g_m}{g_{mo}}\right)^2 \qquad (10)$$

Staying in the pinch-off region, if V_{DS} were increased enough, beyond what is shown in Fig. 6-a, the JFET's operation would enter the *reverse breakdown* region. What happens here is similar to what happens in the junction diode. If the value of V_{DS} exceeds a certain critical point, BV_{GSS}, the gate-to-source breakdown voltage with drain shorted to source, the flow of I_D will increase drastically. As the source and drain are normally interchangeable, BV_{GSS} is also used to specify the gate-to-drain breakdown voltage. Just as with the junction diode, operation in the breakdown region can easily damage a JFET and should be avoided.

JFET's, like bipolar devices, are usually put into opaque packages. If, however, the gate-channel junction is exposed to light, current will flow from the channel through the gate. Gate current increases with the intensity of the light. A gate-source voltage is developed due to the presence of the current. Because that gate-source voltage is due to the presence of gate current, that voltage also increases with the light intensity. Its polarity is such as to cause the drain current to increase as the voltage grows. Devices using that effect are known as *Fotofets*.

When in an opaque container, current can still flow from the channel to the gate. Rather than being desirable, as it was in the case of the fotofet, here the current is due to leakage. That leakage current, I_{GSS}, is defined as the current flowing in the reverse-biased gate-channel junction, when the drain is connected to the source.

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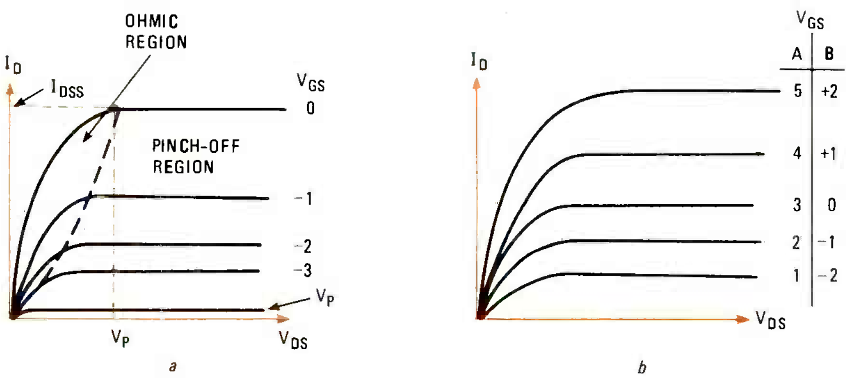


FIG. 6—DRAIN CHARACTERISTIC CURVES for the various types of FET's are shown here. The curves for a JFET are shown in *a*; the curves for enhancement and enhancement/depletion MOSFET's are shown in *b*.

ALL ABOUT

SOFT TOOLS

CHEMICALS FOR YOUR WORKBENCH

Often as useful as a screwdriver or pliers, these chemical "tools" can make repair jobs faster, easier, and less expensive.

KIRK VISTAIN

IMAGINE THIS: YOUR STEREO RECEIVER HAS developed a "scratchy noise" when you adjust the volume control; your tape recorder has some slipping belts, and when you jiggle the tuning knob on your TV set, the picture comes and goes. It certainly looks as if you're going to be spending quite a bit of time in your workshop putting everything back in order. You've got to replace that volume control and the belts, and your best bet for that tuner is to have it rebuilt professionally.

Of course, there is another answer, something that most service technicians use to make all of the above jobs a lot easier. All of those repairs could have been made using the proper chemical, or "soft" tool.

Tools mean money. A professional service technician's livelihood depends on repairing a unit as rapidly as possible. There is little room in any service department's budget for inefficiency. That's why the right tools are so important. The same holds true for a hobbyist; while his livelihood does not depend on it, a lot of time and aggravation can be saved if the right tools are used. Most of us are familiar with the traditional or "hard" tools, such as screwdrivers, wrenches, soldering irons, and the like, but how many of us are making the best use of the chemical, or "soft" tools that are available? Those chemicals are every bit as important as a No. 2 Phillips screwdriver or a ¼-inch nutdriver.

Chemical tools include solvents, adhesives, lubricants, etc. They are "soft" because they are all consumable. That is, part of the tool is used up when it performs its function. That is not true of hard tools such as a wrench, which has an indefinite life (unless you drop it across the AC line or use it as a hammer).

Spray solvents

Virtually all the aerosol, or spray solvents used in consumer servicing today contain either fluorocarbons or chlorinated hydrocarbons. Chlorinated hydrocarbons are compounds of hydrogen, carbon, and chlorine; the best known chlorinated hydrocarbon is carbon tetrachloride. Fluorocarbons are compounds of hydrogen, carbon, and fluorine; the most popular of these is Freon. One form of Freon, Freon TF, is often found in spray solvents. Because of its characteristics, it can be compounded with a variety of hydrocarbons or other solvents (even water), to make many specialized cleaners.

Spray cleaners can be broken up into two basic groups; those are the lubricating cleaners, and the non-lubricating, or "no-residue" types. Each has its place. The no-residue type should be used when lubrication is not needed, or when it could even do some harm. For example, one common use for such a solvent is to remove grit and dust from an open, ganged tuning-capacitor, such as the ones used in radio receivers. You would not want a lubricating cleaner as the lubricant is likely to cause more dust to accumulate quickly. No-residue cleaners are also preferred when cleaning tape heads, mechanical assemblies, or circuit boards.

On the other hand, lubricating cleaners are preferred for such things as potentiometers and switches. That's because those cleaners leave behind a coating of silicone that provides protection from oxidation and the resulting contact degradation. That type of solvent is also useful for cleaning the switch contacts in mechanical TV-tuners. Just remember that it's best to keep any type of residue off any of the frequency determining components, regardless of what the product label might claim.

One special caution concerning all spray cleaners: Even if the label says "safe for all plastics," it is a good idea to keep it off any of the exterior parts, such as cabinets, dial scales, clear plastic windows, or the like. The chlorinated-hydrocarbon cleaners are likely to cause you the most problems in that respect, but since you can't always be sure of what a cleaner is made (most manufacturers don't list the contents on their chemical products), it is better to be safe than sorry.

Most fluorocarbon solvents are safe inside a unit, but even here, caution is recommended. I once used a product that was claimed to be safe for plastics, only to have it destroy a record/play switch by damaging the switch insert. That is the kind of thing that you can only learn the hard way. Generally, plastics such as nylon, delrin, and similar substances will not be harmed by most solvents. The types of plastic used in switch inserts are seldom harmed by fluorocarbon cleaners, but keep chlorinated-hydrocarbon sprays away from them. Under no conditions should chlorinated-hydrocarbon compounds be used on styrene plastic!

For TV-tuner cleaning, several specially formulated viscous spray-cleaners are available. Unlike most cleaners, those foam-type cleaners come out of the can thick. They are mainly proprietary compounds and contain mild abrasives, such as jeweler's rouge, in a viscous base. What those products do is to adhere to the metal contacts and continually clean and burnish the switch parts. When used correctly, they can extend tuner life, but again, care should be taken so that the cleaner is kept off the frequency-determining components. Any that is accidentally applied to such parts should be removed with a no-residue cleaner.

Foam cleaners also can be used to restore most wiping contacts, including those on wafer and slide switches. Just be sure to remove the abrasive completely, using a no-residue solvent, once the cleaning and burnishing is done. If that is not done, switch action will suffer. It doesn't hurt to finish up with a good lubricating cleaner (remember, do not use the chlorinated-hydrocarbon type) to reduce further oxidation.

Some of the spray cleaners that are currently available are listed in Table 1.

TABLE 1
SPRAY CLEANERS

Type	Trade Name	Supplier	Recommended Usage
No-Residue	Tuner Bath	GC	Specially designed to clean TV tuners, also good general-purpose cleaner
	Big Bath	GC	General-purpose degreaser and cleaner
	Dry Kleen	GC	Heavy-duty chlorinated solvent; keep away from all plastics
	Blue Shower	Tech-Spray	Cleaner and degreaser for all parts of TV set
	Instant VTR/ VCR Cleaner	Tech-Spray	Specially designed to remove dirt, nicotine film, and oxides from tape heads
	Instant FD	Tech-Spray	Designed for precision cleaning of electronic equipment
	Kleen-All	Tech-Spray	Heavy-duty chlorinated cleaner; keep away from all plastics
	Electro-Wash	Chemtronics	General-purpose degreaser/ solvent
	Video-Renu	Chemtronics	Designed to remove deposits and particulate matter from tape heads
	Electro Contact Cleaner	Holt-Lloyd (LPS)	Multi-purpose cleaner designed for use on delicate mechanisms and switches
Lubricated	LPS 1	Holt-Lloyd	Penetrant, lubricant, water displacer for use on small mechanisms and switches
	Spra-Lube	GC	Designed to clean and lightly lubricate TV tuner contacts
	Spra-Kleen	GC	Heavy-duty version of Spra-Lube for general-purpose contact cleaning and lubrication. Keep away from plastic.
	Jif-Action	GC	General-purpose cleaner with silicone lubricants designed for use in adverse environments.
	Spray Pack Mark II	Quietrole	General-purpose tuner, switch, and control cleaner
	R_x First-Aid for Tuners	Tech-Spray	Specially designed to clean and lube TV tuners
	EZ-Kleen	Tech-Spray	Heavy-duty cleaner for switches, controls, and contacts. Keep away from plastics, such as polystyrene and polypropylene.
	Kontact Restorer	Chemtronics	For cleaning all types of contacts and controls
	Tuner Renu	Chemtronics	Specially designed to clean and lube TV tuner contacts
Foam	Blue-Stuff	Tech-Spray	Thick substance designed to clean, polish, and lubricate TV-tuner contacts. Don't get it on frequency-determining components
	Lube-A-Trol	Tech-Spray	Thick cleaner and lube for carbon and wirewound controls
	Magic Vista	GC	Thick substance designed to clean, polish, and lubricate TV-tuner contacts.

Other solvents

It is often necessary to clean the rubber drive surfaces in tape recorders, turntables, and the like. Bottled, rather than aerosol products are generally used for that job. Alcohol-type cleaners are not recommended, because they tend to leach out the stabilizers in the rubber, causing it to become soft and sticky. The ketones, such as acetone or MEK (*M*ethyl*E*thyl *K*etone) are better, provided a few precautions are taken. First, remember that acetone and MEK are flammable and should not be used near sparks or open flame. Second, those

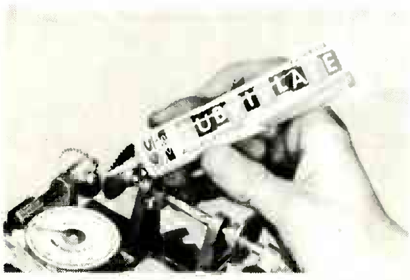


FIG. 1—SUITABLE FOR USE on wiping contacts. GC Electronics' *Lubriplate* reduces friction and wear.

are potent solvents that will destroy the rubber if too much is used. The way to use those chemicals is to apply them sparingly to the rubber's surface with a cotton swab; that will let you take off the top layer of rubber and residue, without harming the good rubber beneath.

The chief advantage of the ketones, since both they and the alcohols affect the stabilizers in rubber, is that they evaporate very quickly and thus have little time in which to damage the good rubber. The ketones, however, are notorious for dissolving almost anything made of plastic (except nylon, which seems relatively immune), so be careful when you use them. One drop on the transparent door of a cassette recorder, and it will be permanently blemished.

Adhesives

The adhesives that are currently available represent a wide variety of chemical types that can fasten two pieces of almost anything together reliably, and quickly; a list of some of those is given in Table 2.

TABLE 2
ADHESIVE USE AND COMPOSITION

Generic Name	Composition	Use	Trade Names
Cyanoacrylate	Alpha or ethyl cyanoacrylate	1,2,3,4* quick-set, light-duty	Permabond, Instant-Stick, Super-Glue, Krazy Glue
Thread lock	Dimethylacrylate	Metal or plastic threads	Permalok
Epoxy	Modified epoxy resin polymercaptan	1,2,4,5* quick-set, thin, medium-duty	Quik-Stik
Epoxy	Epoxide resins	1,2,4,5* non-running, 2-4 hour set, filler or heavy-duty bond	Epoxy Glue
Wood glue	Polyvinyl acetate copolymer resin	Wood, paper	Super Wood-Lok
	Synthetic thermoplastic	Most surfaces, 1 hour set, pliable, light-duty	Pliobond, GC Bond
Silicone adhesive	Vulcanized silicone rubber	Most surfaces, 24 hour cure, sealant, pliable medium-duty	Various
Solvent-release	Many different types for different materials, refer to manufacturer's data		

*1. Plastic 2. Metal 3. Glass 4. Non-porous 5. Porous

One of the most widely used adhesives is epoxy. Epoxies are universal adhesives that have a variety of setting times and viscosities; the viscosity and the setting time depends on the particular formulation used. They are solventless, two-component adhesives that must be mixed before application; the components should be mixed on a non-porous surface for best results. At room temperature, heat or pressure is not required for setting.

Epoxy will bond most materials, including metals, glass, ceramics, most plastics (except nylon and similar compounds), cardboard, wood, rubber, and fiber, with bond strength of up to 4000 pounds-per-square-inch; that is generally greater than the strength of the bonded materials themselves.

Viscosity tends to be related to setting time, with the quick setting glues being thinner than the slower setting ones. What type of epoxy you use will depend on both what is to be joined, as well as how many items are involved. If only one item is to be fastened, and the surfaces closely match, use one of the thin, quick-setting types. If you need more working time, or if there are gaps when the two surfaces are joined, use the slower-setting epoxies.

Epoxies can be especially useful if parts are either totally unavailable, or will take an extremely long time to arrive if ordered. That often happens with such things as cabinet assemblies, decorative parts, and other plastic pieces, especially if the unit being repaired is over five years old. Although it is usually best to replace a broken part with a new one, there are times when that is not possible or practical. I've also seen many cases where the original part, as well as the replacements, were not strong enough for their intended use, and reinforcing them with epoxy was the only way to insure reliability.

Cyanoacrylate adhesives (such as *Krazy Glue*) are relatively new, having been developed for use as a needleless suture during the Vietnam war. They are single component, solvent-free glues that set very rapidly. They will bond almost any substance, providing good surface contact can be maintained. The key to using any of those adhesives is to apply them sparingly, to clean, dry, well-mating surfaces—one drop will hold an elephant, but two drops won't hold a feather! While advertisements claim setting times of only a few seconds, a few mintues is closer to the truth. To be safe, don't stress the joint for at least 10 or 15 minuts. Remember too that the cyanoacrylates *bond skin instantaneously*, so be very careful when using them.

Those adhesives are most useful for light-duty bonds such as trim and similar applications. While they have excellent tensile strength, and thus are ideal for the emergency repair of broken drive belts, their shear strength is not very good; using them to secure the base of a cantilevered assembly, for example, is not recommended. Also, in general, cyanoacrylates tend to be much less tolerant of careless application than are the epoxies.

The biggest advantage those adhesives have over epoxy is that they can be used to join such hard-to-glue materials as polyethylene, Teflon, vinyl, and silicone rubber, although the surfaces must be pretreated with a surface activator and cleaner. If irregular, non-mating surfaces, or porous materials are to be bonded, epoxy or a rubber-base glue is a better bet. It's also a good idea to have a bottle of special cyanoacrylate solvent around for cleanup, and to release misaligned parts.

Solvent-release adhesives are another type that is often useful in a workshop. That type of adhesive includes a wide variety of resins and polymers that harden when the solvent either evaporates, or is absorbed. Some of the most useful of those are the thermoplastic adhesives. Those tan-colored compounds will provide a flexible, waterproof bond between virtually any two materials. They are often used to secure large electrolytic capacitors or the like to circuit boards. They also work well on decorative trim. Drying time ranges from 15 to 30 minutes. Those adhesives can also be used as a contact cement by coating each piece to be joined with a thin layer, waiting for the thermoplastic to become tacky, and then pressing the pieces together.

Another member of this group is silicone-rubber adhesive. Also called a *sealant*, it dries when it is exposed to the moisture in the air. It is best used to seal against air or moisture, or when a flexible bond is needed. It will adhere to almost any clean surface and can be easily removed with a scraper, if necessary. Its tensile strength is lower than either epoxy or cyanoacrylate, but its non-running consistency, one-component convenience, resilient bonding, and removability give it advantages over the other adhesives in situations where the tensile strength is not important. Since that substance also has dielectric properties, it can come in handy for potting components and subassemblies; it can also be used to damp the mechanical oscillations of components in a TV's horizontal circuits.

Lubricants

Many types of lubricants, other than the spray-solvent type mentioned earlier, are available. One word of caution: There is a tendency for inexperienced hobbyists, or

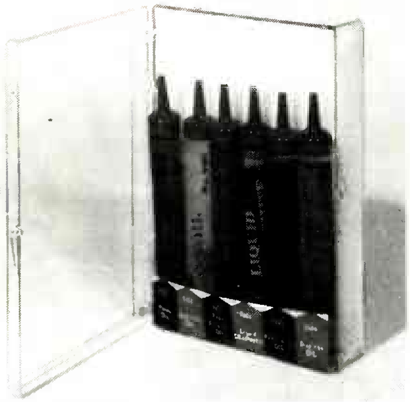


FIG. 2—THE RIGHT OIL FOR ANY NEED can be found in this selection of oils from GC Electronics.

even service technicians, to *overlubricate* the various small assemblies found in such things as phonographs and tape recorders. The widespread use of permanently lubricated bronze in most motors, idler wheels, and bearing assemblies makes oiling unnecessary under normal conditions. If oiling should ever be needed, either because of unusual use or perhaps after performing a motor overhaul, a light-grade machine oil is recommended.

Parts that slide against each other, such as head plate assemblies in cassette decks, do require occasional lubrication. In those cases, use a good molybdenum di-sulfide or lithium-based grease, such as *Luberex* (GC Electronics). When lubricating those small mechanisms, always remember that less is better.

For gear trains, turntable main bearings, and the like, a good grade of light-bodied grease made of polymerized oil (such as GC Electronics' *Phonolube*) provides long lasting lubrication that will not oxidize or become gummy for many years under normal conditions.

It's handy to have a can of silicone spray, such as *Silkon 35* from Chemtronics, for lubricating such things as hinges and sliding plastic parts. Those sprays are especially useful if you are trying to restore proper operation to a slide potentiometer. Most manufacturers warn against cleaning them, because that would likely remove the lubrication needed for smooth movement. Unfortunately, that type of control is much more susceptible to contamination than rotary potentiometer because it has a slot along its length (for the slide handle) that can allow dust to enter the device. Another consideration here is that this type of potentiometer is also rather expensive, which makes cleaning the unit rather than replacement, an attractive alternative.

To do that, just clean out the pot with a very small amount of tuner cleaner or Freon TF, and carefully work the control until the crackling noise disappears. Remember, the solvent tends to remove all lubrication, and if you're too rough with the control, something inside will probably break. The next step is to apply an ample amount of pure silicone lubricant and work the control until the slider moves smoothly. Using that procedure usually restores the pot to like-new condition.

Specialty items

There are a number of products whose composition or use does not fall into one of the broad categories we have been discussing. Some of those specialty items were not specifically designed for use in the electronics servicing industry, but are very useful nonetheless. While there are a great many of such products, here are just few examples of what is available.

Most service technicians are familiar with freeze spray. It is used regularly to cool suspected noisy or intermittent components. Several types are available; all are either fluorocarbons or chlorinated hydrocarbons. The major difference between the sprays is the speed at which they evaporate.

In general, the quicker evaporation occurs, the colder the spray becomes. Fast evaporating sprays, such as GC Electronics' *Super Freeze Mist*, are best for components with good thermal conductivity, such as metal-cased transistors, small electrolytic capacitors, and thinly insulated devices such as metal film resistors. A longer evaporating time, in the range of 20-30 seconds, is best for plastic or epoxy-encased semiconductors, Mylar or cardboard insulated capacitors, or other parts with a heavy insulation; one such freeze spray is *Component Cooler* from Chemtronics. In addition to finding thermally sensitive components, freeze sprays can also be used to assemble or disassemble tight fitting metal parts; cooling the inside piece will reduce its size temporarily. The types of plastic found on circuit boards are not harmed by freeze sprays, but, regardless of what the label says, don't trust them around decorative clear-plastic or cabinet-plastic, or any painted finish. Special anti-static freezes, such as *Instant Anti-Static Freeze Spray* from Tech Spray, are available for use with MOS, FET, and the various other static-sensitive components

Muriatic acid is a form of diluted hydrochloric acid. The substance is commonly used for etching concrete, so it is readily available at most hardware stores. That product, which must be used very carefully since it is quite corrosive, does an excellent job of restoring worn 8-track capstans to like-new condition.

Seized bearings can often be freed by a good penetrating lubricant under pressure; those are sold under many trade names including *LPS 1* and *WD-40*. A good light-weight belt dressing, such as *Permatex* (not the gasket compound) can extend the life of rubber parts, without making them sticky or gummy. Finally, sometimes the specially formulated chlorinated solvents in *Rubber Magic* will do the job when the generic rubber cleaners fail. Be especially careful around plastics when you are using that product, however, as it will likely damage most of them.

Soft tools can be among the most useful items in your workshop. While this article has given a broad view of the uses of those chemicals, it is up to you to find the ones that best suit your needs. You will have to do some experimenting, and may at first make some mistakes, but the long-term goal—faster, easier, and less expensive repairs—is well worth it. **R-E**

FIG. 3—HEAVY DUTY cleaner and lubricant from Quietrole is intended for switches, controls and contacts.

CHEMICAL SUPPLIERS

For more information, circle the corresponding number on the Free Information card inside the back cover.

Chemtronics
681 Old Willets Path
PO Box 1800
Hauppauge, NY 11787
CIRCLE NO. 101

GC Electronics
400 S. Wyman St.
Rockford, IL 61101
CIRCLE NO. 102

Holt Lloyd Corporation
LPS Products
4647 Hugh Howell Rd.
Box 3050
Tucker, GA 30084
CIRCLE NO. 103

Quietrole Co.
455 Montgomery Bldg.
Spartanburg, SC 29301
CIRCLE NO. 104

Tech-Spray
Box 949
Amarillo, TX 79105
CIRCLE NO. 105

From STYLUS to PHONO INPUT

What you need to know about modern phono cartridges, plus how you can measure the frequency response of your cartridge, determine the proper load impedance and then alter the load impedance for maximum performance.

LEN FELDMAN

MOST OF US STILL RELY UPON THE PHONOgraph record for much of our music listening, and while futuristic promises of optical (laser) and digital discs seem close to realization, it will be many years before the vinyl analog LP record will be replaced to any significant degree. That means that we will be using phonograph cartridges as the first element in our home music systems for the foreseeable future. While volumes could be written about the design criteria for a "good" phono cartridge, we have chosen to concentrate on the input and output ends of this remarkable little device—the stylus assembly and the required load impedance of modern magnetic pickups. Much of the information for this discussion was derived from a series of technical papers assembled by the engineers at Shure Bros., and distributed during informative seminars. Shure held these seminars primarily for the purpose of informing audio enthusiasts as to what is involved in the design of high quality cartridges and secondarily, to educate the audio consumer regarding the importance of using only original manufacturer stylus replacements when it becomes necessary to replace a worn stylus in a high-fidelity cartridge.

Stylus tip design

The stylus tip provides the physical interface between the record groove and the rest of the phono cartridge. It must accurately translate the signal stored in the record grooves into an electrical signal that can be transmitted through the rest of the playback system. If the stylus assembly, excluding the tip, cannot cope with a given signal, the stylus will mistrack. Another important requirement is that a stylus must not cause additional noise while doing its job. Also, record and tip wear must be kept to a minimum.

As shown in Fig. 1, the dimensions of a standard record groove impose certain constraints upon stylus tip design. The groove is not a constant shape (unless it is unmodulated) but can become as narrow as 0.001 inch at the record surface. The tip, therefore, must be designed to accommodate this minimum groove width. And, since the bottom of the record groove is rounded (and not pointed) precautions must be taken to prevent the tip from contacting the bottom of the groove. Unwanted noise and mistracking will result if adequate clearance between the tip and the bottom of the record groove is not maintained.

For other than spherical tips, the entire contact area of the tip must not be tilted forward or backward with respect to the groove modulation. Such tilting would cause distortion and tips with longer contact areas are more sensitive to such misalignment than are tips with shorter contact areas. Other design constraints include the need for the stylus tip to accommodate a moderate amount of dust and lint, the ability of the tip to slide along the record material without modifying, damaging, or destroying the record groove, and finally, the tip must be capable of being manufactured precisely and consistently.

Possible tip shapes

Offhand, one might suppose that the ideal shape of the stylus tip would be the same as the shape of the cutting stylus that made the record groove in the first place. As we see from Fig. 2, however, that is not the case, since stylus tilt of

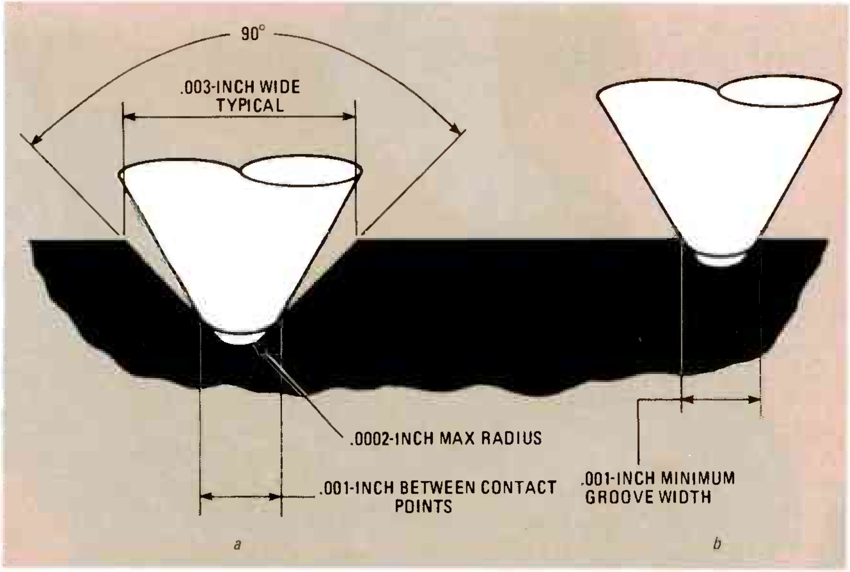


FIG. 1—GROOVE DIMENSIONS of standard lp record. The groove dimensions are constantly varying as a result of the modulation. The typical groove dimensions are shown in *a* while the minimum dimensions are shown in *b*.

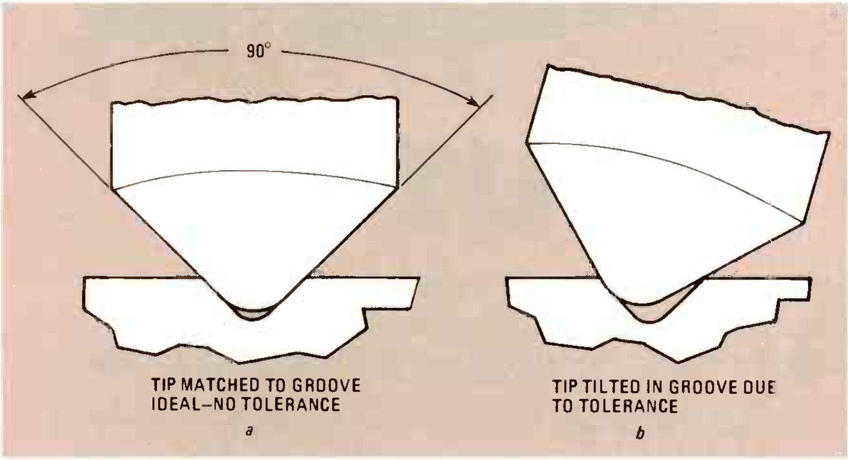


FIG. 2—THE STYLUS TIP must not be tilted left or right with respect to the record groove as shown in *a*. When stylus tip is tilted, proper contact with the record groove does not occur, as shown in *b*. This tilt angle is sometimes referred to as angular tolerance.

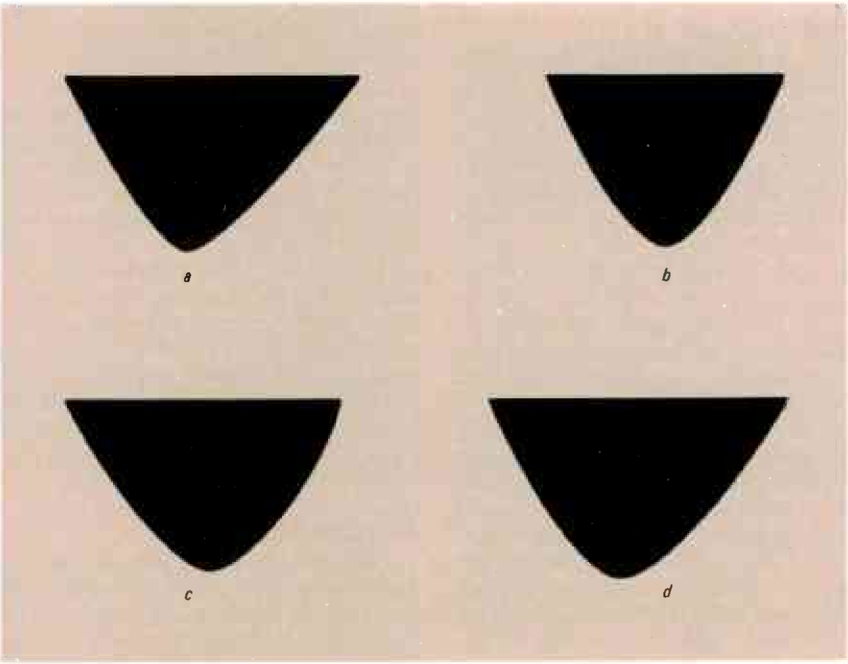


FIG. 4—BIRADIAL TIPS include several different shapes. The Shibata tip is shown in *a*, the Pramanik is shown in *b*, the quandrahedral is shown in *c*, and the hyperbolic is shown in *d*.

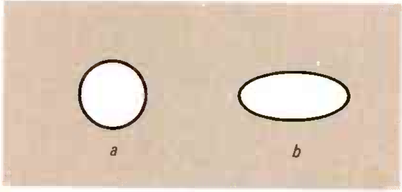


FIG. 3—SPHERICAL STYLUS TIPS produce a circular contact area with the record groove, as shown in a. Biradial tips produce an oval contact area as shown in *b*.

even a few degrees would lead to almost complete mistracking. Other possible tip design shapes include spherical tips, having circular cross sections and biradial tips having oval cross sections. These cross sections are shown in Fig. 3.

While the front profiles of a spherical tip and a biradial tip of equal major radius are the same, the advantage of the biradial tip is its smaller tracing radius that yields significantly lower tracing distortion. A class of tips having an elongated contact region evolved during the early and mid-1970's, when CD-4 quadraphonic records were being issued. As shown in Fig. 4, this classification now includes such tip shapes as Shibata, Pramanik, quadrahedral, hyperbolic, etc. The chief difference between these and the biradial tip is the front profile, but we cannot tell from these views about the contact radius. In fact, all of the tips just named in this category have approximately the same average tracing radii as the typical biradial tip—0.0003 to 0.0035-inch.

Carefully controlled tests are necessary to evaluate tip performance. Such tests must not be limited to one kind of measurement, but must include distortion, noise, and wear tests. The results of the tests have shown that biradial and long contact tips with the same tracing radius yield about the same average distortion as expected from theory. All of these geometries will reproduce roughly the same amount of surface noise provided that they have adequate clearance to the bottom of the groove.

Record and stylus tip wear tests conducted over the years by Shure Bros. have yielded some results worth noting. For example, their data shows that diamond tips have a significantly longer life than sapphire, as shown in the plotted curves of Fig. 5. Another test revealed the increased abrasive action of playing a stylus continuously on the same record as opposed to a limited number of plays (20) on several different records. Downward tracking force is also a major factor of tip life, regardless of stylus tip shape, as shown in Fig. 6. These tests show a trend toward a faster rate of wear as tracking force increases.

The record wear tests demonstrate the importance of proper tracking and low stylus mass in preventing groove damage. In other record wear tests, re-

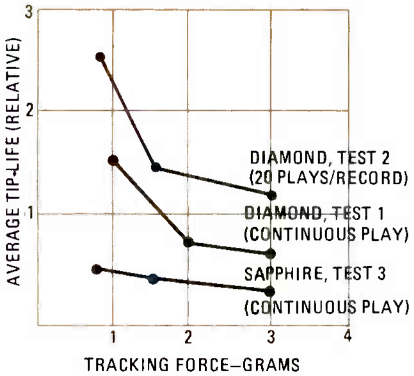


FIG. 5—TIP WEAR depends on the tip material and the tracking force.

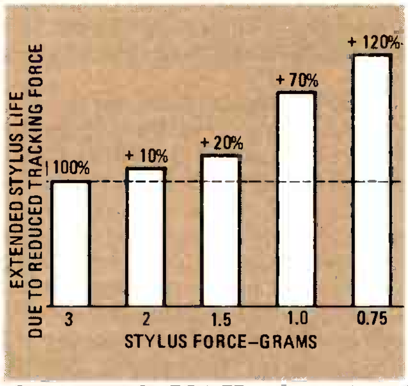


FIG. 6—AVERAGE TIP LIFE increases dramatically as the tracking force is reduced.

sults indicate some advantage to long contact tips, but the advantage is dependent on the groove modulation level and the tracking force. Low stylus mass (i.e. high trackability) and low tracking force are far more beneficial in achieving long record and tip life.

Proper cartridge loading

It is unfortunate that after dedicated engineering departments go to all the trouble that they do to create pickups that are capable of uniform frequency response, high trackability, and long life, so many users pay little or no attention to the proper mounting and impedance requirements of the cartridge. The subject of proper cartridge mounting is, in itself, a complicated one and requires a complete discussion on its own which would be too lengthy to include here. However, a few notes concerning proper cartridge loading are in order. The subject is not inordinately complex, but it is nevertheless often ignored.

Read any cartridge specification sheet or owner's manual supplied with a modern cartridge and you will find a specification called "load impedance". That specification consists of two parts, one resistance and the other capacitance. More often than not, the resistance component of that load impedance is specified as 47 kilohms, and you need do nothing about it since just about every phono preamp input presents that resistance. Some preamplifiers even have a choice of resistance values, from around 22 kilohms to 100 kilohms (the latter value was often recommended for CD-4 quadraphonic cartridges when those were common a few years ago, but but is hardly ever called for in a modern cartridge). What may or may not be listed under the general heading of impedance, however, is the required value of load capacitance, given in pF when it is listed.

Both the load resistance and the load capacitance are extremely important if "flat" frequency response is desired. If the load impedance presented to the cartridge is far removed from the recommended values, the high-frequency portion of the response will be altered. To show how the response is altered, Shure Bros. provided us with a response curve of their *V15 Type IV* cartridge when it was loaded with 47 kilohms of resistance and 250 pF of capacitance per channel. This response curve is shown in Fig. 7. Note that there is no resonant peak within the frequency range from 40 Hz to 20 kHz.

To show the effects of proper and improper cartridge loading, we mounted a lower cost magnetic cartridge into our turntable; one known to have a resonant peak within the audio spectrum. The

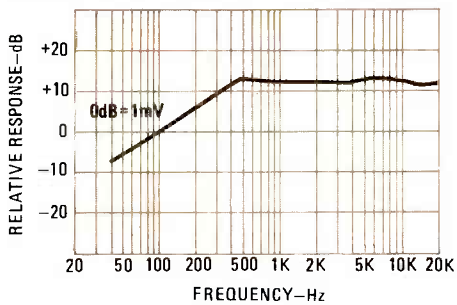


FIG. 7—FREQUENCY RESPONSE of the Shure V15 Type IV cartridge with a 47-kilohm 250-pF load impedance. The sloping response below 500 Hz is a result of the test record (see text.)

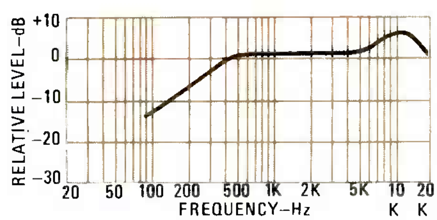


FIG. 8—FREQUENCY RESPONSE of a low-cost magnetic cartridge with a 100-kilohm 100-pF load impedance. Note the large resonant peak at 12 kHz.

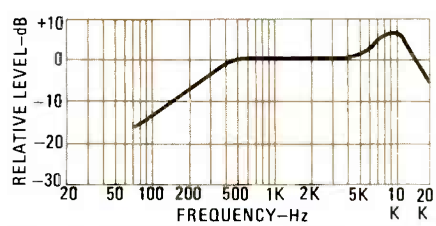


FIG. 9—INCREASING THE LOAD CAPACITANCE to 300 pF lowered the frequency of the resonant peak to 10.5 kHz. The load resistance is 100 kilohms.

make and model number are not important, but suffice it to say that it was not a cartridge from one of the better known, high-quality cartridge manufacturers. Two response curves were made each with a different load impedance. Results are shown in Figs. 8 and 9. Incidentally, in Figs. 7 through 9, the sloping response up to 500 Hz is a function of the test record (CBS STR-100), which is recorded with a constant amplitude below 500 Hz and with a constant velocity above that frequency. Since we were concerned only with the high-frequency end of the response as a function of load impedance, we did not pass the output of the cartridge through any equalization process to yield a horizontal line below 500 Hz.

In Fig. 8, we loaded the cartridge with 100 kilohms instead of 47 kilohms and added no loading capacitance other than that supplied by the connecting audio cables (about 100 pF for each channel). The resonant peak occurred at 12.0 kHz with a 6.3 dB rise in amplitude.

Next we added an additional 300 pF of capacitance across the cartridge output terminals, but left the higher-than-normal resistance of 100K ohms in the circuit. Results are shown in Fig. 9. Here, the resonant peak is shifted down in frequency to 10.5 kHz, but its amplitude has increased to +7.5-dB relative to our 0-dB point at 1 kHz.

From these response curves it should be clear that proper (or improper) cartridge loading can have a much greater effect upon the way a cartridge sounds when reproducing music than some of the more subtle, and often insignificant design elements promoted by some cartridge manufacturers. After you have selected a cartridge that can track your records properly, has low distortion, and will not wear out your records or its own stylus tip after a short time, it's still up to you to install it into a pickup arm that can work well with it and to load it with the recommended values of resistance and capacitance. Let's take a look at some tests you can perform in your home for determining whether your cartridge is loaded properly and what you can do if it isn't.

User tests

Often, a phono cartridge is installed by the manufacturer of the turntable system or by the dealer from whom the turntable and cartridge were purchased. Under those circumstances it is difficult to know whether or not the matter of proper cartridge loading has been properly taken care of. Furthermore, the instruction pamphlet supplied with most phono pickups is usually discarded when the cartridge is installed, so that you have no easy way of determining what the proper loading capacitance is for the cartridge in question.

In such case, proper loading of a cart-

TABLE 1-TEST RECORDS

Record catalog number	Source
STR-130	CBS Technology Center 227 High Ridge Road Stamford, CT 06905
STR-100	CBS Technology Center 227 High Ridge Road Stamford, CT 06905
AT-6606	Audio-Technica U.S., Inc. 1221 Commerce Drive Stow, OH 48224
QR-2011	B&K Instruments, Inc. 5111 W. 164th Street Cleveland, OH 44142
XG-7001	Denon America, Inc. P.O. Box 1139 West Caldwell, NJ 07006

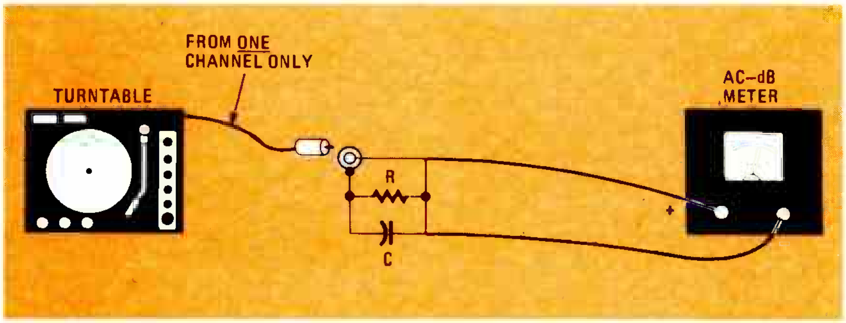


FIG. 10—TEST SETUP for measuring the frequency response of a phono cartridge at the output of the cartridge. The R-C load impedance network is connected across the output terminals of the cartridge.

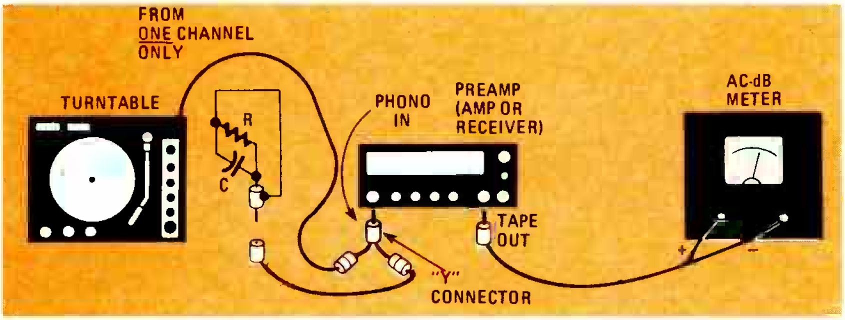


FIG. 11—TEST SETUP for measuring the frequency response of a cartridge with the cartridge connected to a preamplifier. In this case, the load impedance is the impedance of the phono input of the preamplifier. A "Y" connector is used to connect an R-C circuit across the output terminals of the cartridge if the load impedance needs to be altered.

ridge can be verified by direct measurement of frequency response, using any of a number of available test records, all of which contain tones on a one-at-a-time basis rather than on a continuous sweep basis that requires the use of a synchronized X-Y response plotter. A partial list of such test records will be found in Table 1, along with the names and addresses of the organizations from whom the record can be obtained.

The STR-100, ST-130, and AT-6606 test records contain single-tone frequencies, while the remaining two contain third-octave pink-noise bands rather than single frequencies. Either type may be used to obtain a frequency response plot of your phono pickup, and the only other piece of test equipment required is an AC voltmeter that has a flat response (preferably to within +1 dB or better) over the range from 20 Hz to 20 kHz. As for meter sensitivity, if you plan to measure the response of the cartridge with no intermediary electronics (such as a preamplifier) and you are dealing with typical moving-magnet cartridges, the meter's most sensitive full-scale reading should be around 5 millivolts or lower. If you do not have access to such a sensitive AC voltmeter, you may prefer to measure cartridge response including the amplification and equalization characteristics of your associated preamp. In that case, sensitivity need be no lower than 0.5 volts full-scale for the AC voltmeter you intend to use.

TABLE 2

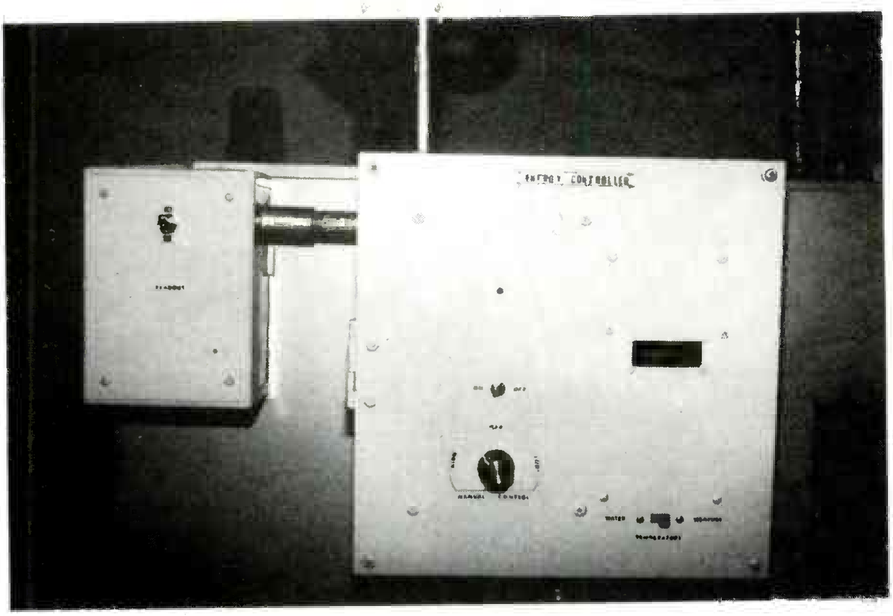
Frequency Hz	Meter Reading-dB
1000	0.0
20,000 to 500	0.0
400	-2.0
300	-4.4
200	-8.0
100	-14.0
80	-16.0
60	-18.4
50	-20.0
40	-22.0
30	-24.4
25	-26.0
20	-28.0

To obtain the response curves, the cartridge output (via the connecting audio cables) would be connected directly to the voltmeter as shown in Fig. 10. Of course, for a stereo cartridge, the response of each channel would be measured separately. A terminal strip could be used for convenience, so that various values of capacitance and resistance could be used to terminate the cartridge output. Because the STR-100 record is recorded at constant amplitude below 500 Hz and at constant velocity above that frequency, the ideal response from a perfectly loaded and perfectly designed phono cartridge at the spot frequencies would have the output levels listed in Table 2 if we assume an arbitrary 0 dB at 1000 Hz.

Using the direct-hookup method shown in Fig. 10, the readings are likely to be very low in voltage and unless cable lengths are kept quite short, readings might be influenced by stray hum fields that could lead to erroneous results. Still, this method is worthwhile because only the cartridge performance is involved. There are no intermediate electronic circuits, with their possible frequency response errors, to detract from the accuracy of the measurements being made.

If this same test record (STR-100) is used to test cartridges that are already connected to the preamplifier, then the setup shown in Fig. 11 would be used. The "Y" connector, readily available from electronics parts stores, permits parallel connection of various load resistors and capacitors, each wired to a blank phono-tip plug. With this setup, the phono pickup itself remains connected to the preamplifier of the system. The voltmeter should then be connected to the TAPE OUT (sometimes identified as REC OUT) jack on the rear of the preamplifier (or integrated amp, or receiver) being used. Since RIAA equalization is being provided by the preamp-equalizer of the system, a perfectly loaded ideal cartridge would yield the readings listed in Table 3 (again, re-

continued on page 86



ENERGY MISER FOR YOUR FURNACE

Cut fuel costs and increase the efficiency of your home heating system with this easy-to-build energy controller.

ROLAND GIBSON

EVEN IN THESE TIMES OF UNCERTAIN FUEL costs, there is one fact that you can be sure of—if less fuel is consumed, the cost of energy will be lowered. That is the purpose of this project—it is an energy "controller" designed to minimize the amount of oil used by a hot-water heating system.

Oil hot-water heating systems use an aquastat to control the system's water temperature. That aquastat has adjustable settings for hot-water temperature and circulator control. Before installing this controller, our fuel-oil supplier had recommended that the hot-water temperature be set at 180°F during the winter, and 160°F for the summer; the corresponding recommended circulator settings were 160°F and 140°F respectively. However, I did some tests and found that, except during periods of very cold weather, those settings were excessive and it should therefore be possible to reduce fuel-oil consumption if the circulator were set at 120°F and the water temperature were varied inversely with the outside temperature. From that idea grew the controller.

An energy controller

In the AUTOMATIC mode, the controller monitors the atmospheric temperature and compares that with the temperature of the water in the heating system's boiler. Based on that comparison, the circuit either turns on or turns off the boiler's burner, maintaining the water temperature at a level that is no higher than needed for heating.

In addition, in the MANUAL mode, provision has been made so that the water temperature can be set by hand and then maintained at any level between 100°F. That is intended for use during periods when heat is not required.

The circuit design is relatively simple, supplementing but not eliminating any of the oil-burner's control circuit. When the controller is switched OFF, oil-burner operation returns to normal.

The controller has a "fail-safe" design. But that we mean that if it fails during an "on" cycle, the oil burner will operate using the preset oil-burner controls. If a failure occurs during the "off" cycle, the burner will shut off and stay off until the controller switch is placed in the OFF position, returning the burner operation to the preset burner controls.

The components used in this project are readily available. Construction is straightforward and any technique can be used. A PC board can be used if desired, and will certainly make things a bit neater, but it is not *required*—none was used in building the prototype described here.

How it works

The controller's schematic is shown in Fig. 1. The power supply for the circuit is shown in Fig. 2-a; the power supply for the temperature readout is shown in Fig. 2-b. The two temperature sensors, IC5 and IC6, are AD590's from Analog Devices. They have an output of 1 microamp-per-degree Kelvin. Accuracy is 0.5°.

As most oil-burner controls in the U.S. are calibrated in degrees Fahrenheit, for convenience it would be desirable to scale the sensor output to those units; 10 millivolts-per-degree Fahrenheit was the output we chose. Let's see how that scaling is done. To keep things simple, we'll only discuss the scaling for the water-temperature sensor, IC6; the procedure, and values used, are identical for the air-temperature sensor, IC5. To convert from Kelvin to Fahrenheit, the following equation is used:

$$\text{Temp (in °F)} = \text{Temp (in °K)} - 459.67$$

Remembering that we are scaling the output to 10 millivolts-per-degree Fahrenheit, the total resistance of R1 and R2 becomes:

$$1.8 \times \frac{10^{-2}}{10^{-6}} = 18000 \text{ ohms}$$

To create that resistance, a 16K resistor and a 5K pot are connected in series; the pot is used to trim the total resistance until it is the precise value needed. When that is done, the voltage drop across R1 and R2 will be equal to 10-millivolts-per-degree-Fahrenheit, plus 4.5967 volts. To complete

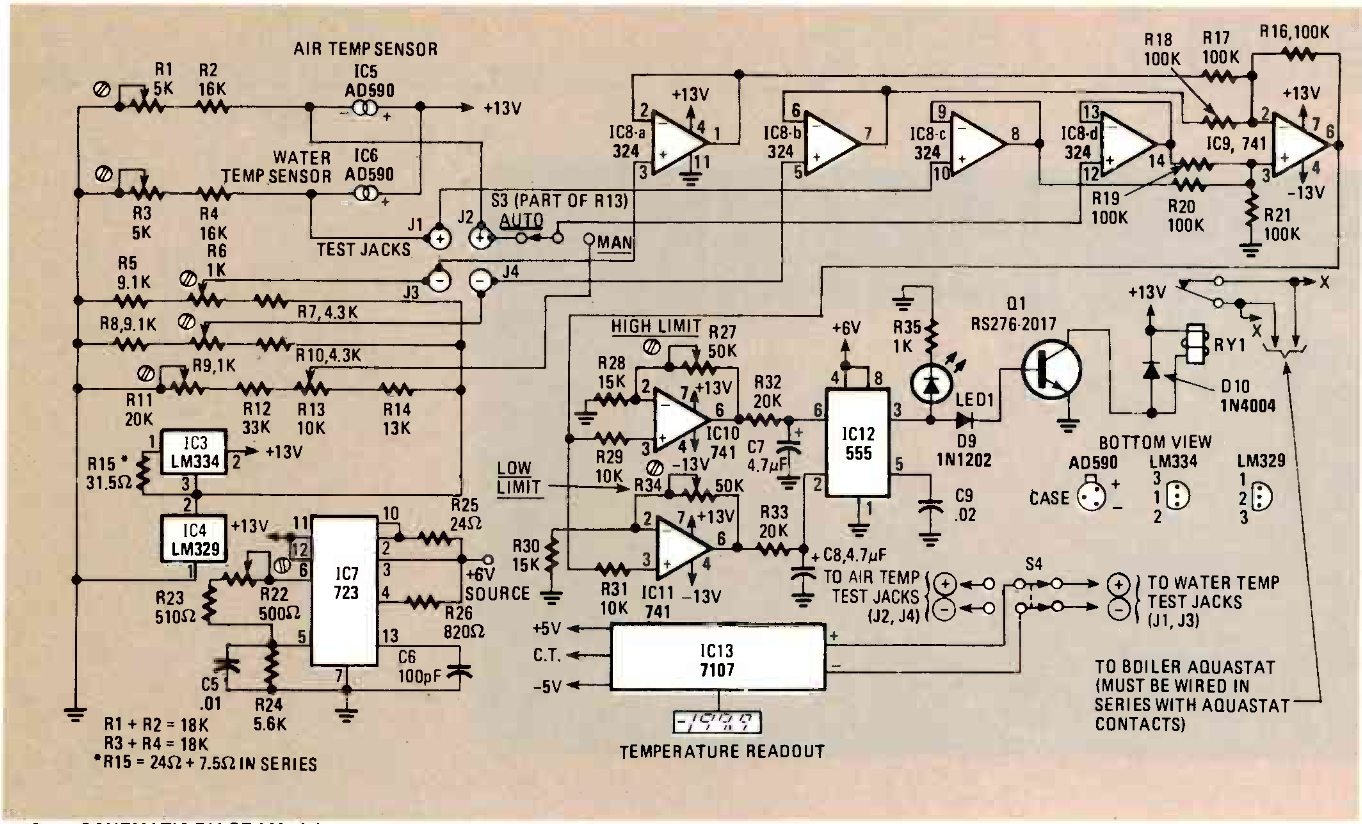


FIG. 1—SCHEMATIC DIAGRAM of the energy controller. Relay RY1's contacts must be wired in series with the oil burner aquastat's contacts.

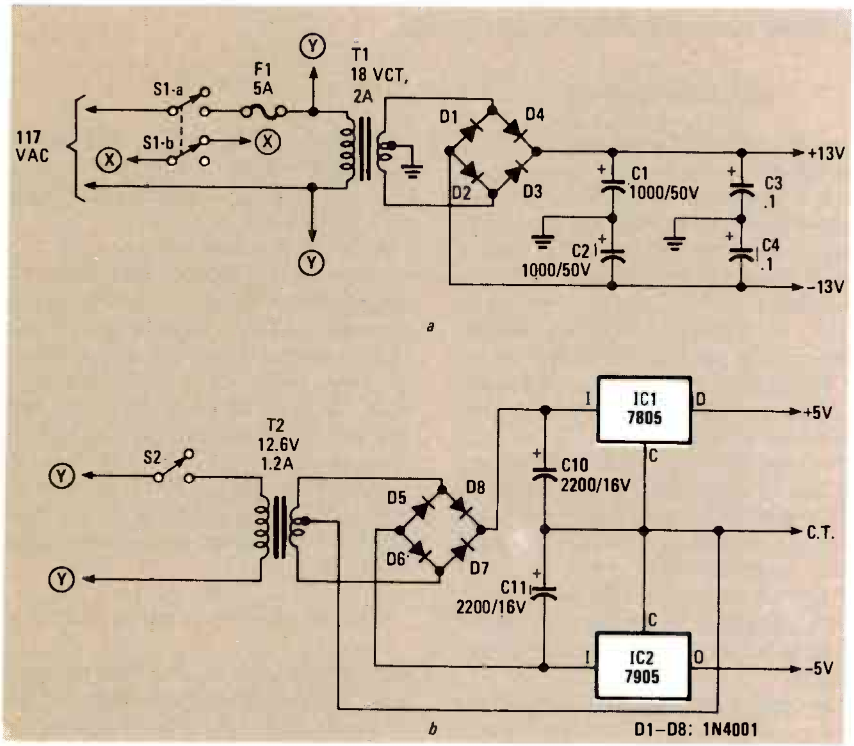


FIG. 2—POWER SUPPLY for the energy controller is shown in *a*; the power supply for the readout is shown in *b*.

that conversion, a 4.6-volt reference voltage is needed. That is done by generating a precise 6.9 volts using the combination of IC3, an LM334 constant-current source; IC4, an LM329 6.9-volt voltage reference, and R15. That voltage is then placed across a voltage divider network consisting of R8, R9, and R10. Trimpot R9 is used to balance the divider, and the 4.6 volts is taken from its wiper.

In the manual mode, a resistor network, R11-R14, is used in place of the air-temperature sensor. With the values shown, R11 is adjusted so that the voltage at the junction of R12 and R13 is 4.6 volts. The output, taken from the wiper of R13, can be adjusted so that is simulates an air-temperature of between 0°F and 100°F.

The outputs from the temperature sensors and reference voltages are buffered by IC8-a–IC8-d, a 324 quad op-amp. The op-amp outputs are connected to IC9, a 741 op-amp. That IC adds the two 4.60-volt reference voltages and subtracts them from the sum of the two temperature-sensor output voltages. The output of IC9 equals the sum of 10 millivolts-per-°F of outside temperature plus 10 millivolts-per-°F of water temperature.

The controller's operation is a function of the sum of the air temperature and the water temperature. Take a look at Fig. 3. You'll note that irrespective of whether water-temperature scale A or B is used, the sum of the air and water temperatures is the same. That is, using scale A, at an air temperature of 0°F, the water temperature is 180°F, for a total of 180°F; at an air temperature of 30°F, the water temperature is 150°F, for a total of 180°F, and so on. That works the same way for scale B, and would for any other scale, as long as that relationship was maintained.

To conserve fuel, we want to turn off the boiler's oil burner when the combined sensor readings equal that critical value. When that is done, the higher the air temperature, the lower the water temperature maintained by the boiler. For the rest of this discussion, let's assume that we've chosen 180°F for that value. Remembering our scaling factor of 10 millivolts per degree Fahrenheit, we are going to want to open the relay when IC9's output reaches 1.8 volts. That output is connected to IC10 and IC11, two additional 741 op-amps; those IC's are used here

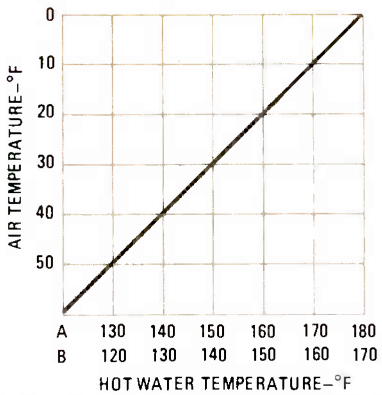


FIG. 3—WATER TEMPERATURE versus air temperature. At every point along this line, the sum of the air and water temperatures is the same.

PARTS LIST

All resistors ¼-watt, 5%
R1, R3—5000-ohm potentiometer, lienar taper
R2, R4—16,000 ohms
R5, R8—9100 ohms
R6, R9—1000-ohm potentiometer, linear taper
R7, R10—4300 ohms
R11—20,000-ohm potentiometer, linear taper
R12—33,000 ohms
R13—10,000-ohm potentiometer, linear taper
R14—13,000 ohms
R15—31.5 ohms (see text)
R16-R21—100,000 ohms
R22—500-ohm potentiometer, linear taper
R23—510 ohms
R24—5600 ohms
R25—24 ohms
R26—820 ohms
R27, R34—50,000-ohm potentiometer, linear taper
R28, R30—15,000 ohms
R29, R31—10,000 ohms
R32, R33—20,000 ohms
R35—1000 ohms

Capacitors
C1-C4—1000 µF, 50 volts or better, electrolytic
C5—.014 µF, ceramic disc
C6—100 pF, ceramic disc
C7, C8—4.7 µF, 25 volts or better, electrolytic
C9—.01 µF, ceramic disc
C10, C11—2200 µF, 1600 volts or better, electrolytic

Semiconductors
IC1—LM7805 5-volt positive voltage regulator (National)
IC2—LM7905 5-volt negative voltage regulator (National)
IC3—LM334 constant-current source (National)
IC4—LM329 6.9-volt reference voltage, temperature stabilized (National)
IC5, IC6—AD590 temperature sensor (Analog Devices)
IC7—723 linear voltage-regulator (Intersil)
IC8—324 quad op-amp (National)
IC9-IC11—741 op-amp (National)
IC12—555 timer (National)
IC13—7107 evaluation kit (Intersil)
Q1—RS276-2017 NPN transistor (Radio Shack), or equivalent
D1-D8—1N4001
D9—1N1202
D10—1N4004
LED1—jumbo red LED
J1-J4—banana jacks
RY1—DPDT relay, 12 VDC, 160 ohm coil, Radio Shack 275-218 or equivalent (see text)
S1—DPDT switch
S2—SPST switch
S3—SPDT switch (part of R13)
S4—DPDT switch
Miscellaneous: Perforated construction board, enclosures (see text), copper piping (see text), wire solder etc.

to control the operation of IC12, a 555 timer configured as a Schmitt trigger. A 723 precision voltage regulator, IC7, is used to provide V_{CC}, a regulated +6 volts, for IC12. The output of IC12 (pin 3) depends on the voltages at its pins 6 and 12. If the voltage at pin 6 is ⅔ V_{CC}, or 4 volts, IC12's output will go high. If the voltage at pin 2 is ⅓ V_{CC}, or 2 volts, IC12's output will go low.

The output from IC12 drives Q1, which is used to control the operation of RY1, a normally closed relay. Ideally, RY1's contacts should be rated at 20 amps, but if such a relay is unavailable, a DPDT relay whose contacts are rated at 10 amps may be used; the contacts are tied together to double the rating. That's what was done here.

Relay RY1's contacts are wired in series with the aquastat water-temperature control contacts. Note that the aquastat's contact circuit will have to be broken for that to be done.

The 3½-digit temperature readout is an Intersil 7107 evaluation kit. That kit comes complete with all necessary components and a PC board, but not a power supply; an appropriate supply is shown in Fig. 2-b. As supplied, however, the meter's full-scale reading is 200 millivolts; it must be modified for this application so that the full-scale reading is 2.00 volts. That can be done by changing the value of three of the components in the evaluation kit. Those changes are C2 from 0.47 µF to .047 µF, R1 from 24K to 1.5K, and R2 from 47K to 470K.

Construction

Construction is straightforward and can be done using any technique. The prototype was built on perforated construction board, using point-to-point wiring with good results. Once the unit is built, but before it is housed or installed, it must be aligned.

To align the temperature sensors you'll need an accurate thermometer as well as a voltmeter. Making sure that the area that you are working in is not subject to sudden changes in temeprature (caused by drafts, etc.), place the thermometer and the sensors next to each other. Turn the controller on and place it in the AUTOMATIC mode. With the meter's positive lead connected to J1 and the negative lead to ground, adjust R6 until the meter reads exactly 4.6 volts. Next, connect the meter's positive lead to J4 and adjust R9 for 4.6 volts.

Once those adjustments have been made, connect the meter's positive lead to J1 and the negative lead to J3, and adjust R3 until the meter's reading agrees with the measured temperature. Remember—the voltage across those jacks has been scaled so that 10 millivolts equals 1°F. For example, an 80°F temperature would be read on the meter as 0.8 volts. After that has been done, connect the meter's positive lead to J2 and the negative one to J4, and adjust R1 until the meter reading agrees with the measured temperature. Finally, verify that the output of IC9 is twice the measured temperature. That is, if the measured temperature is 65°F, there should be 1.3 volts on pin 6 of IC9.

Next, we need to adjust the output of IC10 so that it is 4 volts when IC9's output is 1.8 volts. To do that, place the controller in the manual mode, and adjust R11 so that the voltage at the junction of R12 and R13 is 4.6 volts. Then adjust R13 so that you get a 1.8-volt output from IC9. Finally, adjust R27 for 4 volts at pin 6 of IC12.

The last adjustment to be made is to adjust the lower temperature-limit. Here we were interested in a temperature differential and selected a combined air- and water-temperature drop of 15°F. That differential is one that was convenient for our situation; any that works well for you can be used. In any event, the adjustment is made in the same manner. Adjust R13 until the IC9's output measures 1.65 volts (1.8 − .15). When that is done, simply adjust R34 until 2 volts is measured at pin 2 of IC12.

Final assembly and installation

With the exception of the readout's power supply, the unit was housed in a 12 × 12 × 4-inch recessed light-fixture box lined with asbestos. The readout's power supply was housed in a separate 5 × 7 × 3-inch metal case. Both units were mounted on the boiler using ⅝-inch standoffs. All external wiring, other than the sensor wires, must be enclosed in BX or conduit.

The outside air-temperature sensor was enclosed in a 3 × 2 × 1-inch case, such as the one shown in Fig. 4. A 5/32-inch hole was drilled in the bottom so that air could reach the sensor. A small hole was also drilled in the top for the cable. The sensor's cable should fit snugly through the hole, and any spaces sealed against leaks. Connections inside the case, of course, were soldered and insulated. The unit was fastened under a windowsill on the north side of the house.

Placement of the water-temperature sensor was not that simple. It would have been ideal if the sensor could have been placed in the same well as the aquastat, or if the temperature could be measured at the boiler's case. However, neither approach was feasible: the first due to insufficient space and the second due to temperature lag.

Figure 5 shows an acceptable solution.
continued on page 83

HOBBY CORNER

It's easier to keep up than catch up

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

HOW THINGS DO CHANGE. WHY, I RECALL visiting Bell Laboratories in New Jersey in what seems just a few years ago. There, I saw for the first time, a "real live" transistor. A while later, I actually got my hands on one and, following instructions very carefully, built a simple audio amplifier. What a marvel it was—amplification without a glowing tube heater to be seen. It was a year or more before I had any idea how the little thing worked.

Now, of course, it is the tubes that are rare and the transistors that are common—in fact, you might say that transistors have come and started to fade away, largely replaced by integrated circuits.

Yes, there have been a multitude of changes in a short period of time—enough to boggle the mind. And who knows what we will have and what we will be doing a few years from now.

Those of us with snow on the roof will have to continue our struggle just to keep up. If you are just getting into electronics, you have an advantage on us oldsters! You are starting out where technology is *NOW!*. You don't have to "unlearn" the old before you can understand the new.

Make no mistake, however. Technology of NOW will be outdated soon. It will advance to something we do not know about yet. In a short time you, too, will be having to relearn and we'll both be doing it together. The process can get ahead of you if you are not very careful.

Now and then I receive a letter from a reader who says, in effect, "Where did all the tubes go? To me, transistors are foreign and IC's are alien. What is the best way to get caught up?" I am hard pressed to come up with any advice better than to forget all that you "know" and start back at the very beginning.

The same thing will happen to you unless you keep up with the changes as they occur. The only way to do that is to keep reading, studying, building, and experimenting. Dont' let things get so far ahead of you that you have to start over all at once.

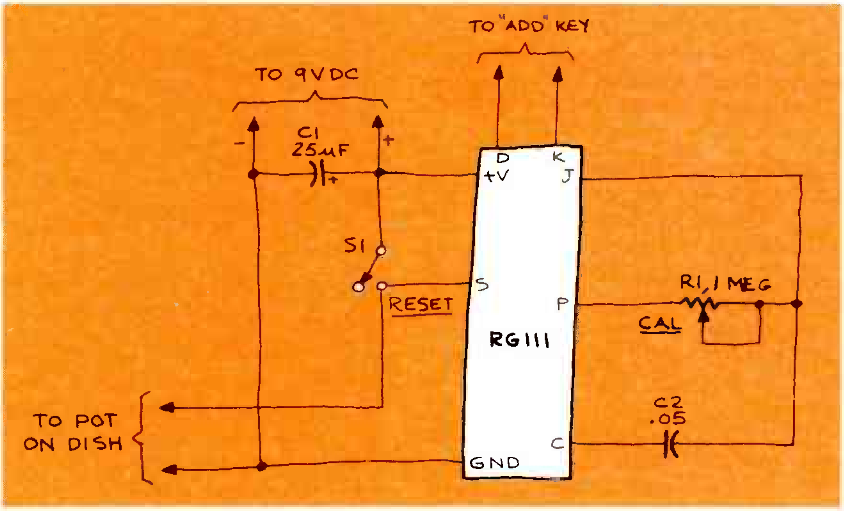


FIG. 1

Good idea

Daniel Fitspatrick of Ashville, NC has come up with a good idea for the use of the RC-111 module—the module we discussed here in the March 1982 issue. He works with satellite-TV systems and plans to use the RC-111 to give a remote reading to the area of the sky at which a dish is pointing. According to Daniel, very basic commercial remote-reading accessories cost $150 and up.

The simple dish tracker consists of two parts. The first is mounted on the dish and is nothing more than a pot that is turned by the rotating arm that aims the dish. A small drive belt is used to turn the shaft of the pot. To avoid the effects of weather, the pot and belt system are housed in a waterproof case.

The readout portion of the tracker is located inside the house. It consists of a calculator and an RC-111. The module circuit is shown in Fig. 1. The pot labeled R1 is a 1-megohm CALIBRATION control. (You may wish to refer back to the March 1982 issue to see exactly what is taking place here.)

Daniel reports that calibration (R1) is adjusted by rotating the dish between satellites. Knowing the location of each satellite permits you to adjust R1 by trial and error until the calculator reads out directly in degrees.

Thanks for letting us know about this application, Daniel.

Five-year survey

Five years ago, the "Hobby Corner" first appeared in **Radio-Electronics;** that initial column was in the August, 1977 issue. Since then, we have covered a lot of territory together, but even more striking is the quantity and quality of the changes that have

1) NAME______________________________
2) MAIL ADDRESS______________________________
______________________________ ZIP __________
3) OCCUPATION______________________________
4) HOW LONG HAVE YOU BEEN AN ELECTRONICS HOBBYISTS?__________ (YEARS)
5) HOW LONG HAVE YOU BEEN READING "HOBBY CORNER?"__________ (YEARS)
6) WHAT ARE YOUR SPECIAL INTERESTS?

______ GENERAL	______ TUBES (?)
______ DIGITAL	______ TRANSISTORS
______ ANALOG	______ INTEGRATED CIRCUITS
______ OTHER:__________	

7) WHAT ARE YOUR ELECTRONIC-RELATED HOBBIES?

______ SWL RADIO	______ COMPUTER
______ CB RADIO	______ AUDIO
______ HAM RADIO	______ SATELLITE TV
______ OTHER:__________	

8) WHAT AREA(S) OF ELECTRONICS WOULD YOU LIKE TO KNOW MORE ABOUT?______
____

taken place in our hobby in that short time. We have available to us many things that were only on the drawing boards then, and some that we didn't forsee!

Very complex integrated circuits at low prices are just a phone call or a quick trip to the parts store away. There are microprocessors, one-chip 64K random access memories, complex sound generators, and a host of others. "Computer boards" are controlling more and more of the conveniences and necessities of life.

Home reception of TV direct from satellites is a practical reality. "Microwave" ovens are common appliances in kitchens around the country. The ownership of videotape recorders has grown to the point that video stores have sprung up everywhere just to sell and rent taped programs. Videodisc players are making a big splash in the market and I won't be surprised to discover that recorders will follow quickly.

There is no way that all the "wonders" could be listed, but there's one that cannot be omitted. That, of course, is the microcomputer, itself. The hundreds of thousands of microcomputers in homes, offices, and schools today have already had a great impact on our lives. The significant changes it has caused in education, business, and home entertainment are only the beginning of a revolution that will effect all of us.

This five-year point is a good place to pause to see where we are and where we want to go. After all, "Hobby Corner" is *your* column and you should have a say in its content. Of course, I have a bit of an idea from the letters which you send me, but there are those of you who do not write.

This time, I would like to hear from *ALL* of you. To mke it as easy as possible, I have made up a short survey. The questions have been pared down to a minimum and it should not take long to answer them. Of course, you may add any additional information that you would like—just attach a sheet to your survey form.

You may use the form printed here or, if you don't want to tear up the magazine, you can make a copy on the nearest copying machine. If that is inconvenient, just put the question numbers and your answers on a postcard. Send your answers any old way so that they can be added to the answers of other readers.

To sweeten the pot a bit, I'll have an independent party draw one survey from those received. If yours is selected, you will receive a small box of electronic "goodies" for your trouble.

Your real reward, however, will be to see "Hobby Corner" emphasize more of the things you like and want to know more about. Dont' let the other readers decide that without your vote. Send me your survey now, before you forget. Address your response to

Hobby Corner
Radio-Electronics
200 Park Avenue South
New York, NY 10003

I'll be looking for your answers.

Mailbag

Stuart Engelke (Hackensack, NJ) would like a circuit for a 4-digit one hour "clock" that automatically resets when the time reaches 59 minutes and 59 seconds.

Vic Richter of Corpus Christi, TX is trying to find out how to address a 1024 × 8 memory IC using thumbwheel switches or a keyboard. **R-E**

"I agree, Harold, the reception up here would be great, but where would the children go to school?"

COMMUNICATIONS CORNER

Deciphering antenna specifications

HERB FRIEDMAN, COMMUNCIATIONS EDITOR

BACK IN THE FIRST DEPRESSION (1930-1939), I worked after school for an uncle who re-packaged vinegar. Actually, he didn't re-package by filling small bottles from a multi-gallon "jobber's drum"; rather, he sold small bottles on which he slapped a cover label over the original. The new label read "Super-Sour Vinegar." When I asked why he didn't just call the stuff vinegar—which it was—he replied that no one would pay the few pennies extra he charged if people believed they were buying ordinary vinegar. But the public would splurge—even in the depression—for a super something. Essentially, Uncle Joe was saying that few would buy his product if he told the truth.

About thirty years later, antenna manufacturers were to fall under the spell of Uncle Joe's philosophy, and technicians and experimenters would be hard-pressed to unravel the mysteries of consumer-service antennas: those intended for SWL, CB, TV, amateur, and VHF-UHF monitoring.

From the time Jonah invented maritime-mobile by transmitting his S.O.S. from the belly of a whale (spark-gap, of course), the dipole antenna has been the standard of reference. The dipole is a ½-wavelength center-fed antenna. The energy radiated by that antenna in the horizontal direction is assumed to be in the shape of a figure eight—maximum at right angles to the wire; minimum off the ends.

The amount of radiation at right angles to the center of the dipole antenna, at the same height as the antenna, was the forward-power reference to which all other antennas for the same frequency were compared. If you built an antenna, which when substituted for the dipole resulted in an increase of twice the forward-radiated RF energy, you had built an antenna with a 3-dB gain compared to a dipole. (There is nothing like rational standards: it allows everyone to know what everyone else is talking about.)

The problem was, in a field where variations of 2-3 dB are the *minimal* practical value, the boys who wrote the advertising copy started to deal in tenths of a decibel. One way that was accomplished was to change the standard of reference. Soon, instead of seeing antenna gain referenced to the dipole, it became fashionable in some ads to use an "isotropic source" as the reference radiator. An isotropic source is an imaginary, theoretical antenna, that radiates equally in all directions; its output in any direction is slightly less than that of a dipole. Therefore, if you compare the foward gain (output) of an antenna to an isotropic source instead of a dipole it is possible to claim an additional 2.1-dB gain because an isotropic source has 2.1-dB less forward output than a dipole.

With such terms as isotropic source and negative tilt; and specifications that included front-to-back ratios translated to antenna gain, the ads became so bad that finally one manufacturer—tongue in cheek, of course—used a wet noodle in space as the radiating reference. As you might expect, that claim caused no end of amateur-radio club discussions concerning the practicality of boiling the noodle in salt water for a better impedance match to a 72-ohm transmission line.

Notwithstanding the wet noodle or isotropic source radiator, gain and front-to-back ratios, using a dipole as the reference will tell you a lot about the way an antenna will perform for you.

First off, an antenna cannot create radiation. It can only take the energy put in by the transmitter and re-arrange the way that it is radiated. For example, we mentioned that the radiation pattern of a dipole in the horizontal direction is shaped like a figure eight: that means that there is equal energy going out towards the front and rear. If we place an element near the dipole (at a calculated distance), and if it is a specific ratio longer than the dipole, it will reflect some of the energy. That will increase the amount of energy radiated forward while reducing the energy radiated to the rear. Within reasonable limits, adding additional elements (called parasitic elements) behind and in front of the radiator squeezes even more energy forward—the energy being taken from the rear of the basic dipole-radiation pattern. It is often easy to achieve between a 10-dB to 13-dB forward gain in a moderately priced antenna; though lesser gain is common at the lower HF frequencies because the antenna size becomes an important consideration.

When the antenna sensitivity has been squeezed forward, we come up with the "front-to-back ratio". That figure rarely indicates true reception conditions unless the user interpolates the values. For example: Assume that we have a "super" antenna that has a 10-dB forward gain. Since an antenna has the same "gain" for receiving as for transmitting, our "super" antenna provides a 10-dB gain to received signals arriving into the front of the antenna. Next, assume that the "super" antenna has a 25-dB front-to-back ratio (a not uncommon value). That does not mean that undesired signals arriving into the rear of our "super" antenna will be attenuated 25-dB below what it would be if we were using a dipole antenna. It means that signals arriving at the rear of our "super" antenna will be attenuated 25 dB compared to signals arriving at the front of our "super" antenna. Since our "super" antenna has a 10-dB forward gain, we must subtract 10 dB from 25 dB, and the unwanted signal will be attenuated 15-dB more than if received by a dipole.

The height of the antenna above ground also affects how the signals are received and radiated. Depending on the height above the ground, the signals might radiate either horizontally—actually a slight rise—called low angle, or high angle, or almost straight up where the best reception of the radiated signal would be by a receiver mounted in an airplane flying over the antenna. (See the *ARRL Handbook* for a complete discussion of directional antennas.)

As for vertical antennas, such as those used for CB and VHF: again, the reference antenna should be the "theoretically perfect" vertical dipole (shown in Fig. 1-a), or its cousin, the *coaxial antenna*—which has the same gain/radiation characteristics. One

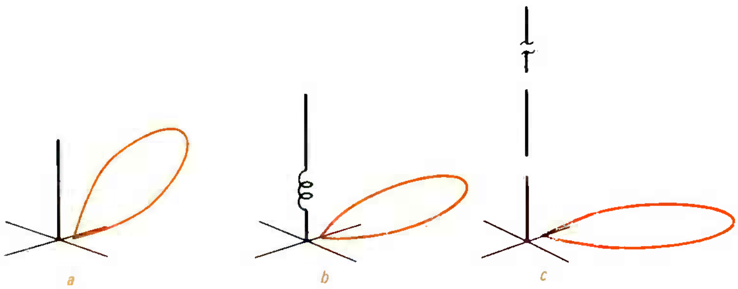
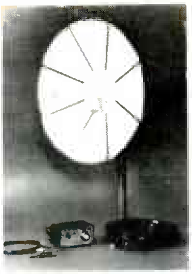


FIG 1

Radio-Electronics mini-ADS



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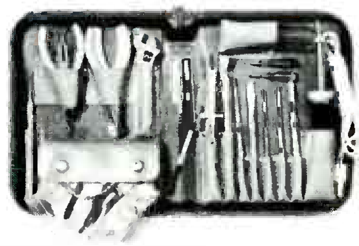

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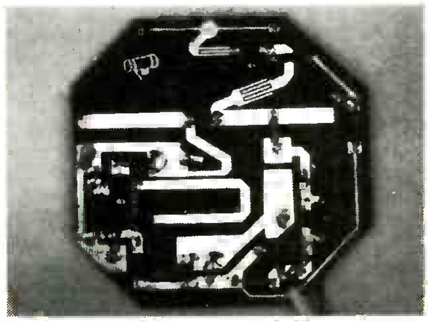

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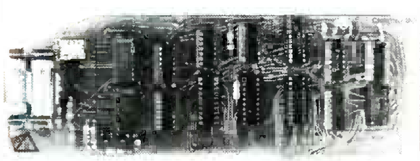

CHRONO-MODULE FOR APPLE II FEATURING: Y/M/D, H:M:S, day of week. SW. select int. H,M,S with software disable 1 K fast CMOS RAM, write disable SW. & battery backup makes RAM act like a fast eprom. 4 software selectable 256 byte pages. 3 drivers supplied to put time date on: video display, into a string, and time stamp disk files. **Price $149.00. Microcomputer Division of US Module, Inc., 2801A Broadbent Parkway N.E., Albuquerque, New Mexico 87107, 1-800-545-6294**

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ANTI STATIC DESOLDERING TOOL. The new Anti-static desoldering tool, PA 1704, was designed with quality, versatility and performance in mind. The unit is entirely conductive, discharging static build-up once touched by a grounded operator. This desoldering pump will allow a grounding strap to be attached to the tool, thus alleviating the need to ground the operator or work surface. **Paladin Corporation,** 31332 Via Colinas Suite 106, Westlake Village, CA 91362, 213-991-4970, TWX 910-494-2799

CIRCLE 35 ON FREE INFORMATION CARD

way to achieve omnidirectional radiation is to take a horizontal dipole and flip it 90°, running the transmission line away at right angles for ¼-wavelength to prevent induced RF currents in the line. Alternatively, the radiator dipole could be replaced with a coaxial radiator that allows the transmission line to be run inside a coax sleeve directly to the radiator.

For high forward gain we would simply use a vertical version of the directional beam antenna.

Most vertical antenna systems are designed for omnidirectional radiation with "gain." Gain is achieved by compressing some of the energy that is normally radiated skyward towards the ground. It is that "extra" energy at ground level that provides us with "gain." (At least it is gain at ground level.)

At the relatively lower frequencies, such as 27 MHz, where the antenna is somewhat large to begin with, we obtain the compression by using a radiator larger than 0.5 wavelength and a ground-plane, as shown in Fig. 1-b. The ground-plane can be a vehicle or elements arranged to form a ground-skirt. When using a ground-plane, the radiation pattern is formed by a "mirror image" from the ground; and it is even possible to tilt the signal towards true ground, providing a smidgen extra signal where it is most needed.

At the VHF/UHF frequencies where antennas are relatively small, gain is attained by simply stacking several antennas one above the other, each fed through a matching section of transmission line. Alternately, several radiators using collinear feed (see Fig. 1-c) can be concealed within a plastic or fiberglass sleeve: those are the long-pole antennas that can often be seen sticking up over the tops of taxi and petroleum-dealer headquarters, just to name a few user examples.

Though there are many ways to achieve "antenna gain," the common thread between them must be comparison to the dipole if we are to have a reasonably accurate idea of how the antenna will function in actual practice. Any other reference is really make-believe. **R-E**

TO MAGAZINE RETAILERS:

Radio-Electronics Magazine is pleased to announce its "Retail Display Allowance Plan" available to retailers interested in earning a display allowance on **Radio-Electronics** Magazine. To obtain details and a copy of the formal contract, please write to the Marketing Department, Kable News Company, Inc., 777 Third Avenue, New York, New York 10017, our national distributor, who will act as administrator of our plan. Under our Retail Display Allowance Plan, in consideration for fulfilling conditions of the agreement, you will be entitled to receive a display allowance. This plan will become effective for all issues you receive subsequent to written acceptance on our behalf of your application.

SERVICE CLINIC

Troubleshooting antenna rotators

JACK DARR, SERVICE EDITOR

A VERY COMMON TV ACCESSORY FOUND IN rural and fringe areas is the antenna rotator (or "rotor" for short). It's really a pretty simple device. Basically, a rotator is a reversible motor, running on 24-volts AC derived from a step-down transformer. The motor, and the gears it turns, are in a two-piece housing. The bottom half has clamps for mounting to a mast or tower and the top half, which is the part that turns, is designed to accept a short section of mast to which the antenna is fastened.

Indoors, at the other end of a multi-wire cable, there's a control unit containing the power transformer, control switches, and, usually, some kind of direction indicator.

That indicator can be one of several types. It can run from a pair of simple lights all the way up to a circuit with five lights, one for each major compass-point (N-E-S-W) with another to indicate "end of travel." Another type has a dial marked with compass points and a pointer-knob; you turn the pointer to the direction you want, and the rotator turns the antenna until it's headed that way and then stops.

The heart of the system is a reversible motor. As shown in Fig. 1, it has two field-coils, with one end of each tied together and brought down to the control box as the "common." The other end of each field coil is also brought down to the control box. The "common" lead goes to one end of the secondary of a 24-volt transformer. The other end of the secondary goes to a selector switch, to which the other two leads from the field windings are connected. Those three wires are all that we need to operate the motor; other wires are used for the direction indicators, etc.

The heart of the control box is a big (125-150 μF) non-polarized electrolytic capacitor that's connected across the leads from the open ends of the coils. When the switch is closed in one direction, one of the coils is connected directly to the transformer winding, and the capacitor is in series with the other coil. That creates a phase-shift in the AC, causing a rotating magnetic field to be generated in the motor and making it turn.

If the switch is closed the other way, the capacitor is switched to the other coil and the motor turns in the opposite direction. That's all there is to it. The switch is always ganged with the on-off switch, and they always have a spring-return "center-off" position. The two are electrically isolated, of course.

The key cause of control-box problems is the capacitor. If it opens, or drops in value, the motor won't start—the pilot light will go on, and the transformer will usually hum a bit, but the antenna won't turn. The capacitor is always mounted inside the control box (thank goodness!) so replacing it is simple and keeps you from having to climb around on the roof.

Many of the control boxes that used a knob with a pointer to set the direction in which the antenna is to be aimed use a "stepper" switch. That is a complex wafer switch mounted on the back of the stepper relay. The "direction" knob turns another wafer switch. Turning the "direction" knob closes the on-off switch (in series with the switch feeding power to the stepper-relay coil). The stepper relay then starts to "step," a pawl and ratchet making the wiper on the switch move a small distance each time.

The phasing-capacitor switch is also a part of that mechanism. Let's say the antenna is aimed south and you want it headed west. When the "direction" dial is moved, the capacitor switch is closed in the position that will make the antenna turn clockwise. (All directions are referred to from the top of the rotator looking down on it! From south to west would be clockwise.) When the antenna gets to the desired position, a gap in the stepper-switch wafer causes the power switch to open, and the unit turns itself off.

Some of the problems with that kind of system are due to the antenna getting "out of sync" with the dial and winding up pointing north when the dial says west! To remedy that, a shunt switch across the stepper relay is included just for that purpose! To use it, turn the dial to "north" and wait until the antenna stops turning. Then use the shunt switch to turn the antenna step-by-step until the direction indicator lines up with the "direction" dial. (The problem is caused by the stepper relay occasionally "skipping" a step, while the motor keeps on running.)

Other problems can be due to dirty or corroded contacts on any of the switches. Give them a good cleaning every time the control box is serviced. The phasing capacitor can also cause problems in this type of rotator.

In recent years, we have begun to see "electronically-controlled" rotators. Their motors and basic circuitry are identical to those of the other types. Control is managed by a bridge circuit using two heavy-duty, wirewound variable resistors, identical in value. One is in the rotor unit itself, driven by the moving part so that its resistance is always directly proportional to antenna position. The other is on the panel of the control box. A fixed resistor and one transistor complete the bridge circuit.

The transistor controls two other transistors, each of which controls a relay, and the two relays do the directional switching. Moving the panel resistor unbalances the bridge; the control transistor turns on the relay that makes the rotator move in the desired direction. The motor runs until the two resistances are equal and the bridge is balanced once more, at which point everything turns off.

That type of rotator can also have a fully automatic mode. The direction can be selected by push-buttons. The FUNCTION switch has a center-off position, to one side is DIAL; to the other PUSHBUTTON. Each pushbutton switches in a variable resistor whose value can be set by pulling off the escutcheon plate covering the buttons. Push one of the buttons, tune in a TV station (aiming the antenna is easier if you can see the quality of the reception as you turn it), and then move FUNCTION switch to PUSHBUTTON. Turn the adjustment screw of the potentiometer until the antenna is aimed at

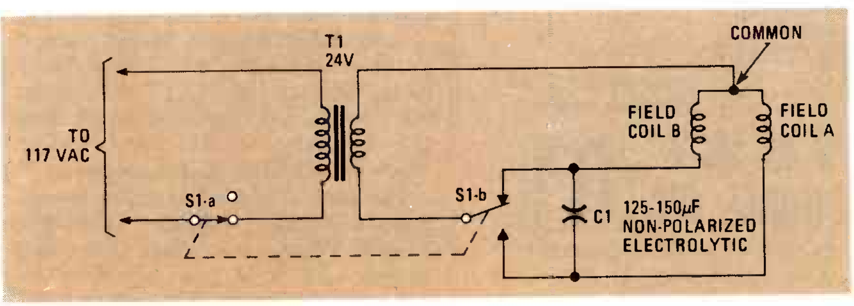


FIG. 1

the station, as indicated by the quality of the picture on the set. Repeat the procedure for the remaining buttons, put the plate back on, and you're ready to go.

That type of control box develops troubles just like the others; if the antenna won't turn but you have power, check the phasing capacitor. If the antenna will turn one way but not the other, check the control transistors and relays. If the antenna keeps turning in the same direction and won't stop, there could be a shorted relay-control transistor holding the relay closed.

If you suspect lightning damage, check all the transistors for shorts or opens, as well making sure that no other part of the circuit was damaged. If the antenna took even a small direct hit, check the control cables up the mast, and—if you have to—the inside of the rotator itself. **R-E**

SERVICE QUESTIONS

TUNER PROBLEM

Had an odd problem with this Zenith 19JC55Z. The transformer had been replaced in another shop before I got it. Customer was told that he needed a tuner. I found that I could receive one channel (Channel 9) very well, but nothing else. Sent the tuner, an electronic type, off for repair, but it turned out to be good.

Checking around, I found that all of the voltages on the tuner were OK, except the 6.24 volts AC—it was missing. Tracing that out, I found that the wire from the transformer had been cut. I fixed that, and everything now works fine. What I can't understand is why the set would only get one channel?—J.K., Ormond Beach, FL

That makes two of us—I don't know why either!

A BATCH OF HINTS

A.W. Jernberg, of Richmond, MI sent these tips along:

Zenith 19EC45: Poor horizontal sync may be due to problems on AGC/sync module 9-87. Also, when this set is used on cable, the picture may overload on midband channels, but not on any of the others. Touch up the RF AGC Delay control on the 9-87 module and that'll cure it. This works with similar chassis, too.

Sony KV-1910, etc: If you have a problem in finding the correct Photofacts, look up the "SCC" number on the chassis, and watch out for the three last digits after the SCC! They change when production changes are made.

Panasonic CT-935: The picture flashes, and the B+ may "bounce" as much as 35-40V. This set uses a dual-SCR power supply: one SCR is triggered by the other to "phase-control" the B+ and regulate it. Off the bridge-rectifier output there is a 1.0μF, 160-volt electrolytic, C-808. Its "+" terminal is connected to +135-volts DC; the "−" terminal to 9-volts DC. If the capacitor develops any leakage it upsets things, and in some cases can self-destruct! Replace it with an exact duplicate—ECEA-160VIE or a similar part number. Watch the polarity when you install it!

Sylvania D-16: There may be color problems—ringing, etc. On a very high-frequency RF signal, the color may be better. There's a 48K, 2-watt resistor that feeds almost all of the B+ to the color stages. With age, that resistor changes in value, usually going lower (one dropped to 1.8K). The PC board may be scorched. Install a new resistor and recheck.

MULTIPLE IMAGES

After replacing the flyback in this Admiral 19P647C, I got a raster, but now I have three pictures overlapping on the screen! I checked the capacitors and resistors in the horizontal frequency-determining circuits, but without luck. Would you take a peak into the crystal ball?—E.A., Bronx, NY

Well, you're in the right area—the cause must be some part in the frequency-determining circuitry. It's sort of an oddball Colpitts oscillator, and the two capacitors across the coil, C421 and C422, are critical. Use exact duplicates for substitutes. Also, run the core all the way out of the horizontal-hold control (oscillator coil) and check to see whether a part of it has been broken off! That upsets the inductance and makes the oscillator run faster!

One more unlikely, but possible, cause. Check the polarity of the comparison pulse fed into the AFC: the new flyback may have it reversed! That can *really* mess things up!

LOW B+, SANYO 91C48N

Thanks for prompt reply to my question about low B+ on a Sanyo 91C48N. I found it: I had replaced Q901, the voltage regulator, and the replacement turned out to be the wrong type! (My parts supplier didn't have the original, and substituted another part for it.) After I got the proper part, the set worked fine!—N.G., Cardiff, NJ

When you replace a part, and find the same symptoms, readings, etc. that you got with the other, you should suspect that the replacement used wasn't right! It's a good idea to try a different one when that happens. R-E

BURNING RESISTOR

I get raster but no video in a Sharp 2K-39. Resistor R207, 470 ohms, in the plate feed to the last IF tube burns up. I tried a bigger resistor, but get no voltage on the

output end! I've changed the tube, and also the first-IF tube. I need ideas!—B.M., Coopers Mills, ME

It looks as if you've got some kind of a dead short in the plate or screen circuitry of the last IF. If it doesn't show up on an ohmmeter, something may be breaking down under load—the screen bypass-capacitor or some other part. Try this: Leave the resistor out of the circuit; then turn the set on and read the grid voltage on the last IF tube. If the interstage transformer is shorted, it would put a tremendous positive voltage on the grid of the 4JC6. Those tubes can carry very high currents—enough to burn the resistor.

The only other thing left to do would be to change T202, the IF output-transformer; something in the primary winding may be breaking down to ground. *Something* in here is breaking down... it's just a matter of finding it.

BREAKDOWN UNDER LOAD

I tried a new yoke and the capacitor you suggested on the Admiral T-1KB chassis that I was having problems with. I finally replaced the flyback, and that fixed it. The old one was breaking down under load, even though it checked OK.

Thanks to James Jiranek of Farmington, IA for that one.

DARK VERTICAL LINE

I wrote you about a dark vertical line on the right side of the screen of a GE 19YA and you suggested several possible causes. The problem turned out to be C702, a special capacitor (part no. EP 25X60). I hope this will help someone in the future.

It will. Thanks to L.P. of Lincoln, NE for this one.

FOCUS PROBLEMS

The size of the raster shrank on this Zenith 4B25C19. I found a bad voltage regulator on the +25-volts-DC source and replaced it. Now I've got a good picture and color, but the focus is poor. Any ideas?—C.B., Jamaica, NY

I've got a couple. If the focus voltage is OK, there are two things that could be causing your difficulty. Let's take the easy one first.

Take the socket off the CRT and examine the focus pin. If it's covered with a light-greenish powdery stuff, clean it very well and tigthen the socket contacts. The oxidation may be keeping the voltage from even getting to the pin. To check your results, remove the CRT socket just far enough so you can get at the focus pin to measure the voltage on it. If it's there, and the focus is still poor, you've got a more serious problem—something's almost certainly wrong with the CRT. (It's probably gone "soft".)

In most cases, though, the cause turns out to be a bad socket-contact. Try the chassis on a test jig to make sure before you pull the picture tube.

STARTUP PROBLEM SOLVED

Thanks for the helpful hint on the GE AB/AC chassis in the May 1982 **Radio-Electronics.** I solved an intermittent starting problem in one of those chassis by running jumpers between eyelets W41A-B and W42A-B, but there was still some doubt in my mind until I read the article. Now I feel better.

Thanks to C.H. in Alplaus, NY. I've had several other letters about the same problem and it has been fixed using the same method—just run short insulated jumpers between the points that you suspect. One case needed three different ones. Always look out for that when you run into intermittents in those sets.

ION BURN

We've got a ten-year-old, 19-inch, black-and-white Zenith in the shop. It's got a fuzzy dark spot in the center of the CRT, but you can see some picture behind it. The tube checks out a bit weak, but OK. Got any ideas?—D.S., Newton, IA

What you seem to be describing is an ion burn but, if the set is only 10 years old, it should have an aluminized screen and be immune to that problem. You say you can't see the spot with the set off, so it doesn't sound like the old ones—there the spot was visible all the time.

It looks like you've got me! The only thing I can suggest is trying another similar tube, using the set you've got as a kind of test jig, to see if there's any change. If there's anyone out there who's run into a similar situation, let me know.

MORE ON DYNACO PREAMP

I'd like to add a bit to your ideas on the Dynaco preamp problem presented by J.F. in the April 1981 **Radio-Electronics.** I've seen it quite often, and the cause turns out to be intermittent transistors. I'd recommend replacing Q1 and Q2.

That sounds like good advice. Thanks to E.S., Arrow Electronics of Corydon, IN.

MORE ON CRACKED 6LF6's

In the April 1982 issue of **Radio-Electronics** you replied to a technician who had a cracked 6LF6 tube in a Quasar. (That was a replacement—the original had also cracked.) I've run into similar things in some of those sets, and the damper tube is responsible for a lot of them. Always change the damper tube if the 6LF6 self-destructs in that manner.

Also, while the 6LX6 is a better tube than the 6LF6, don't use it in Quasar portables or the 0.6-amp fuse will blow. That fuse is not used in the console models, though.

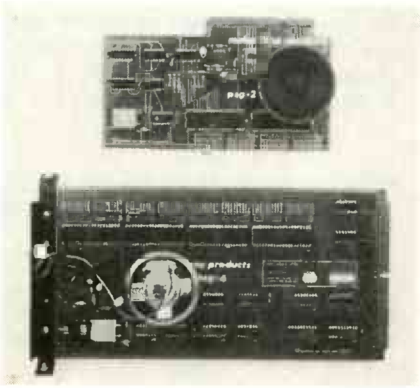
Finally, the 6BL8 oscillator tube can cause the 6LF6 tube to fail, but won't crack the glass. Check pin 15 of the FA panel and make sure that you get at least −45-volts of drive. Some 6BL8's are "hotter" and will get up to −60 to −70 volts, but you need at least −45 volts.

Thanks very much to V.E. of Janesville, WI for those hints. **R-E**

NEW PRODUCTS

For more details use the free information card inside the back cover.

SOUND AND MUSIC BOARDS, *model PSGx2* and *model PSGx4*, are multiple programmable sound-generators for Heath/Zenith computers. They use the General Instruments AY3-8910 PSG IC that can produce a wide variety of complex sounds under software control. Each board comes with a speaker, and featurers a built-in audio monitor amplifier and crystal timebase.



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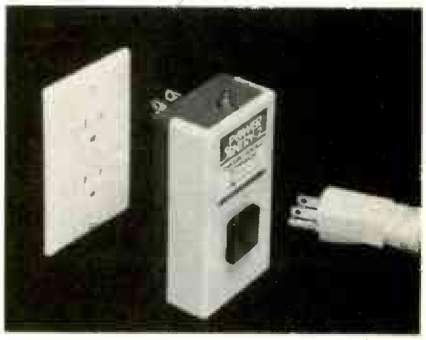
Multiple IC's give multiple complex sounds, and each IC has two 8-bit parallel I/O ports, which are brought out to connectors on the board. The boards create sound effects for games and enable you to play music from your keyboard. They are easy to program in any language that allows you to output data to a port. They come assembled, fully tested, and include demo software and documentation.

The *model PSGx2* for the *Z/H89* has two PSG IC's, plugs into P504 or P505 of the *H89* bus and uses any decoded port address. It is priced at $125.00, plus $5 for shipping and handling.

The model PSGx4 contains four sound-generator IC's and plugs directly into the *H8* bus. It is priced at $225.00, plus $5 for shipping and handling.—**Mako Data Products,** 1441-B N. Red Gum, Anaheim, CA 92806.

SURGE SUPPRESSOR, The *Power Sentry-2*, has been developed to "filter" electricity to insure against potentially disastrous voltage surges (transients). The *Power Sentry-2* simply plugs into an electrical outlet, and your equipment plugs into the *Power Sentry-2*. Upon the occurrence of a transient spike 10% above line voltage, the *Power Sentry-2* reacts in trillionths of a second to suppress the transient voltage to a safe, non-destructive level. It can suppress surges up to 6500 amperes for two milliseconds. It also reduces power-line noise with its built-in



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radio-frequency filter. (Line noise is usually caused by electrical equipment such as motors, fluorescent lighting, etc., and results in annoying static sounds on radios and TV's.)

The *Power Sentry-2* is priced at $49.95.—**Surgeonics, Ltd.,** 155 Kisco Avenue, Mount Kisco, NY 10549.

MULTITESTER, *model M75,* has seventeen ranges, chosen to place most measurement near midscale. For example: Midscale on the low ohm range, 12 ohms, facilitates testing motor windings, relays, and contactor coils. Accuracy specifications are DC ±3% full scale; AC ±4% full scale, and resistance ±3% full scale.

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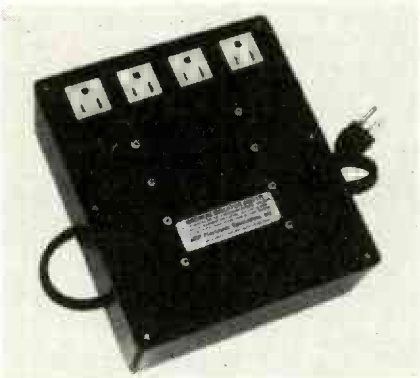
Features of the *model M75* include a fuse-protected ohm circuit, easy-to-read three-color coded plate and front panel, diode-protected movement, sensitivity of 20,000 ohm/VDC and 10,000 ohm/VAC, and a one-year warranty.

The *model M75* comes with carrying case, test leads, batteries, and instructions. It is priced at $34.95.—**Universal Enterprises,** 14270 NW Science Park Drive, Suite 101, Portland, OR 97229.

MICROCOMPUTER ELECTRICAL FILTER, The Magnum Isolater, *model ISO-17,* incorporates heavy-duty spike/surge suppression and features four individually quad-Pi filtered AC sockets. Equipment interactions



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are thereby eliminated, and disruptive/damaging power-line "pollution" (transients, power-line noise, etc.) is controlled. The *model ISO-17* is rated for an 1875-watt load, and each socket can handle a 1000-watt load.

The Magnum Isolator, *model ISO-17* is priced at $181.95.—**ELECTRONIC SPECIALISTS, INC.,** 171 So. Main Street, PO Box 389, Natick, MA 01760.

CORDLESS SPEAKERPHONE, *model EX-5000,* enables the user to enjoy a hands-free conversation up to 700 feet from the base unit. It also provides two-way paging and clear, reliable intercom capability. A volume control permits the user to adjust

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the audio to the most desirable level for individual comfort. Other features include a MUTE switch to put the other party on hold momentarily, automatic redial of the last number dialed, and automatic re-charging.

The *model EX-5000* can be mounted on the wall or used on a desk or counter top. The suggested list price is $299.95. Other models in the Extend-A-Phone line offer varying ranges and features, and their price starts at $99.95.—**Uniden,** Extend-A-Phone, 15161 Triton Lane, Huntington Beach, CA 92649.

POWER SUPPLY with dual auto-tracking outputs, the *model 1652,* provides two variable A and B 0-to-25-volt outputs at 0-to-1.5 amperes each. A general-purpose bench supply, the unit is designed for test and engineering applications involving both analog and MOS digital circuits.

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Both outputs can be operated independently or in a tracking mode. In the tracking mode, the B output can be preset to any percentage of the A supply voltage from 0 to 100%. When the A output is varied, the B output will track the variations. (For example: If the tracking percentage is preset to 50%, and the A supply is set to 20 volts, the B supply will operate at 10 volts. If the A supply is then changed to 15 volts, the B supply will change to 7.5 volts. Complete electrical isolation is always maintained.)

The *model 1652* is priced at $465.00.—**B&K PRECISION,** Dynascan Corporation, 6460 West Cortland Avenue, Chicago, IL 60635.

EARTH STATION RECEIVER, *model ESR24,* is designed for satellite-TV reception, covers 3.7-4.2 GHz, and features digital channel display, preset and variable audio subcarrier selector, AFC for stability, and full

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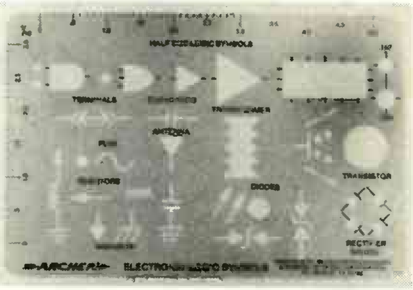
metering. For installation versatility, the downconverter module (supplied) may be mounted internally or at the antenna. Accessories for the *model ESR24* include a remote control, a remote tuning meter, and splash-proof housing.

The styling of this receiver makes it suitable for either commercial or private installations; the *model ESR24* is priced under $1000.00.—**R.L. Drake Company,** 540 Richard Street, Miamisburg, OH 45342.

CIRCUIT-DESIGNERS' AIDS, the *Archer Circuit Symbols Template* (276-180—shown), and the *Archer PC Board Layout Template* (276-179) are tools for students and amateur or professional circuit designers and builders.



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The *Circuit Symbols Template* offers a large selection of component and logic symbols, including symbols for fuses, antennas, transformers, transistors, rectifier bridges, terminals, capacitors, resistors, LED's, diodes, photodiodes, grounds, logic devices, and more. It also offers two ruled edges with 1/10th-inch graduations.

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ENERGY MISER

continued from page 67

An offset connector was made by soldering together a ½-inch elbow, a short length of ½-inch pipe, and a ½-inch T-connector. Then a ½-inch copper end cap was drilled to accommodate a length of ⅜-inch (O.D.) copper pipe. The pipe was passed through the hole as shown, and soldered. Finally, a copper plug was soldered at the bottom of the ⅜-inch pipe. To place the sensor, the water supply to the boiler was shut off and the expansion tank drained. With the expansion tank drained and the boiler indicating zero pressure, the boiler was also drained to about one half of its capacity. The expansion tank's ½-inch copper feed-pipe was cut at about four inches above the boiler's outside metal enclosure. The ⅜-inch pipe was then inserted into the boiler through the bottom half of the expansion tank's pipe, and the top half of the expansion pipe was fitted

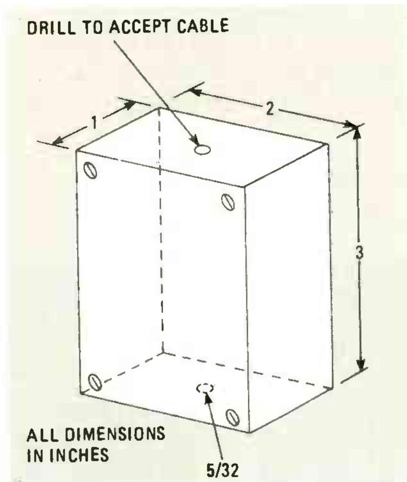

FIG. 4—THE AIR TEMPERATURE sensor is mounted in a box with these dimensions and mounted outdoors.

into the open end of the elbow. After soldering the top half of the expansion tank's pipe to the elbow, and the bottom half to the open end of the "T", the drain valves were closed and the boiler's water supply valve reopened. The boiler was then started and the radiators bled to release air pockets.

The water-temperature sensor was connected to the controller, using No. 22 gauge high-temperature insulated wire. Connections to the sensors were soldered and insulated. The sensor was inserted into the ⅜-inch pipe and the correct depth of insertion was determined by setting the aquastat's upper temperature limit at 150°F and moving the sensor up and down inside the pipe until the temperature readout agreed with the aquastat setting at the instant of boiler shut off.

For most installations, the aquastat circulator control should be set at 120°F; where you set the aquastat's high temperature limit depends on location and other factors. In our house, we found that a water temperature of 150°F was sufficient for heating even in zero-degree weather. With that arrangement, the controller automatically controls the water temperature at outside temperatures of 20°F and higher. When the outside temperature drops below 20°F, the boiler maintains the water temperature at 150°F. That setup allowed for an 18-percent reduction in fuel use over the last year. In that time, there have been no problems or malfunctions with the system other than a defective toggle switch. **R-E**

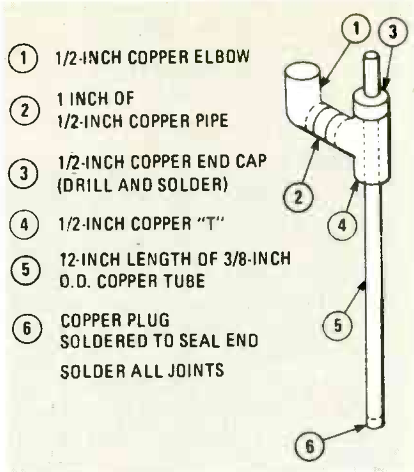

FIG. 5—USE THIS SETUP to place the water-temperature sensor. With it, temperature readings will be accurate, and normal boiler operation will be maintained.

ANALOG CIRCUITS

continued from page 56

MOSFET's

In the MOSFET the gate is physically insulated from the rest of the device, usually by a thin layer of silicon dioxide. Here, as for the JFET, the amount of current flowing between the source and drain is influenced by the voltage between the gate and source.

The MOSFET's can be further divided into two groups—*enhancement MOSFET's*, which only operate in the enhancement mode, and *enhancement/depletion MOSFET's*, which operate in either the enhancement or depletion mode depending on the polarity of the gate voltage. Enhancement/depletion MOSFET's are often simply referred to as depletion MOSFET's. Let's start by examining the enhancement MOSFET. Its characteristics are shown in Fig. 6-b; the applicable V_{GS} voltages are in column A of that figure.

In the enhancement n-type device, shown in Fig. 7, two n-slabs are imbedded in a foundation or *substrate* made of highly resistive p-type material. Of the two n-type slabs, one is considered the source and the second the drain. In circuits, the substrate is usually connected to the source. As you can see, there is no channel between the source and the drain, but one can be induced electrically if a positive voltage is applied to the gate with respect to the source. For current to flow, that voltage must exceed a certain *threshold* voltage, V_{GST}, defined as the gate-to-source voltage required for the device to conduct 10 μA of drain current, I_D. At voltages less than V_{GST}, the device is considered to be not operating, or in *cutoff*.

Enhancement/depletion n-type devices have basically the same structure as the enhancement-type MOSFET, but an n-type semiconductor joining the source and drain is added. The characteristics shown in Fig. 6-b still apply, but now the V_{GS} shown in column B should be used. Here the $V_{GS} = 0$ curve is at the center of the diagram. More drain current will flow when V_{GS} is positive; less will flow when it is negative. For extremely low drain currents, the gate-to-source voltage is $V_{GS(off)}$ rather than V_p, the pinch-off voltage.

Transconductance and drain-current characteristics for MOSFET's can best be determined from the curves and data supplied by the manufacturers.

Common-source circuit

Just as was the case with the bipolar devices, FET's are commonly used in three different circuit arrangements. Although the circuits we'll discuss are for n-channel JFET's, the information supplied here applies as well to p-channel JFETs. In all instances, just change the polarity of the applied voltages and the directions of the resulting currents. MOSFET's can also be used in those arrangements. The substrate lead, if available, is connected to the source or to ground.

A typical common-source circuit using an n-channel JFET is shown in Fig. 8. The DC load line is established using the equation of the drain-source circuit:

$$E_{DD} = I_D \times R_D + V_{DS} + I_D \times R_S$$
$$= I_D (R_D + R_S) + V_{DS} \qquad (11)$$

The concept used here is identical to what we did when we used equation 6 to establish the load line for a bipolar transistor in a common-collector circuit. The load line for the JFET is plotted over the JFET characteristic curves in the same fashion.

Voltage is developed across R_S due to the source current, I_S; that voltage is equal to I_SR_S. The voltage at the source is positive with respect to ground. Resistor R_G, which should be much larger than R_S, completes the circuit from the bottom of R_S (ground) to the gate. Due to that path, and because of the relative values of R_S and R_G, the voltage across R_S is essentially the voltage between the gate and source. That is the gate-to-source bias voltage; as a result, the gate is negative with respect to the source. Leakage current, I_{GSS} can upset that bias voltage, however. If I_{GSS} is large, a substantial volt-

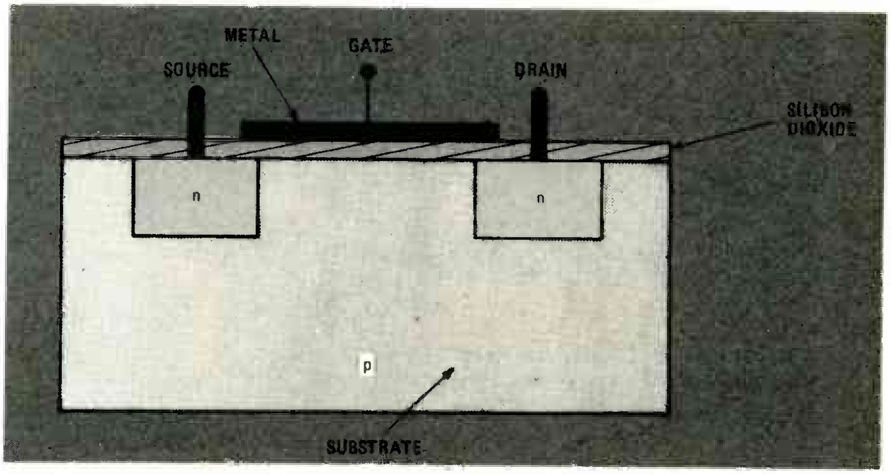

FIG. 7—THE STRUCTURE of an n-type enhancement MOSFET. In MOSFET's, the gate is insulated from the rest of the semiconductor by a thin layer of silicon dioxide.

age will be developed across R_G. That voltage is in series with the voltage across R_S, and when added to it, it wil reduce the bias. To compensate for that, R_S must be increased. Despite the possible effects of I_{GSS}, we will ignore it here because it is usually negligible. The bias should be large enough to bring the drain voltage to about one half of E_{DD}.

In the common-source configuration, the signal is applied to the gate, amplified, and output from the drain. In the circuit shown in Fig. 8, voltage gain is about $g_m \times R_D$, where g_m is the transconductance of the JFET, if R_S is equal to zero ohms. Otherwise, gain as just noted must be divided by $(1 + g_m \times R_S)$. The input resistance seen by the signal looking into the gate circuit, is R_G, shunted by very little else in the gate circuit. When looking back into the drain circuit, the output impedance is about R_D.

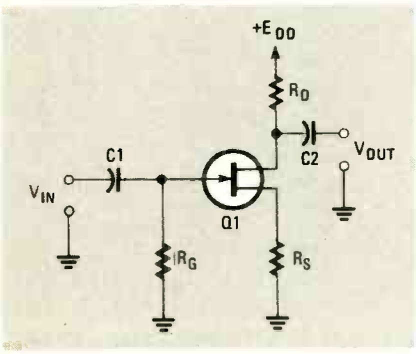

FIG. 8—AN N-CHANNEL JFET is used here in a common-source circuit.

Common-drain circuit

Should R_D be shorted and C2 connected to the source rather than to the drain, we would have a common-drain configuration. While its input impedance is not unlike that when the JFET is connected in the common-source configuration, its voltage gain is just under 1, as was the case for the bipolar transistor common-collector circuit. The output resistance is equal to R_S divided by $(1 + g_m \times R_S)$. That low-output impedance is the major feature of the arrangement.

Common-gate circuit

Here too, the basic circuit does not differ much from the one shown in Fig. 8. Now, however, the input is applied to the source rather than to the gate. The voltage gain and output impedance is equal to $R_S + 1/g_m$. The common-gate arrangement is most useful in RF applications, as is the bipolar transistor common-base circuit.

Next time

When we continue this series, we will take a look at biasing circuits. When those circuits are designed properly, and in an organized manner, they optimize the performance of a transistor. Among the topics we'll cover will be the different types of bias circuits, and how—as well as when—to use them most effectively. R-E

TV ANTENNA

continued from page 52

theory and reality do not always coincide. It's best to experiment with height. Especially on UHF, a few feet up or down, or from left to right, can have a drastic effect on the signal received.

Generally, every 10 feet of height, starting from 40 feet from ground level will actually double the signal strength of weak, distant signals. When weak signals are overcome by strong adjacent channels, an extra 10 feet or so of antenna height will sometimes increase the strength of the weak signal significantly without increasing the already strong signal. In other cases a height of 10 feet above roof level will deliver excellent reception of all desired signals.

An antenna rotor is often needed when using an extremely directional antenna, or when signals are coming from various directions. Turning an antenna just a few degrees can make a big difference in reception.

Unfortunately, no one can guarantee what type of reception you will get using any given antenna system. Atmospheric conditions, local terrain, the buildings near you, etc. all affect reception. But if weak signals are present, you'll have a better chance at good reception if you use a good-quality antenna and lead-in. You pretty much get what you pay for. R-E

STYLUS TO PHONO INPUT

continued from page 64

ferred to a 0-dB reference level at 1000 Hz).

After the spot frequency levels at the output of the preamp are noted in dB terms, they can be compared with the RIAA related readings listed in Table 2 and any differences between the two can be plotted on graph paper. Since cartridge loading primarily affects the high frequency response of a cartridge, it is not really necessary to plot frequencies below 1000 Hz. Omitting frequencies below 1000 Hz greatly reduces the time it takes to complete a single plot and, since several plots will probably be required until you have optimized the cartridge load for your system, you may want to simply concentrate on the upper part of the audio spectrum where changes in capacitance and resistive loads have their greatest effect.

The CBS test record, STR-130, is recorded using RIAA equalization in the first place. Therefore, when playing back the spot frequencies available from this record through a preamplifier, the perfectly-loaded ideal phono cartridge should deliver equal amplitude outputs at all of the available test frequencies. Any deviation from equal amplitude outputs indicates an inferior cartridge design or improper cartridge loading.

Modifying the load impedance

The results of the frequency-response tests will reveal much about the correct load impedance for the cartridge. High-end resonance peaks are usually tamed by increasing the capacitance across the cartridge terminals, by reducing the resistive load across the cartridge terminals, or by using a combination of both methods.

Generally speaking, the total load-resistance should be maintained at 47 kilohms and should only be changed if the overall response of a cartridge cannot be brought into line by changing the overall value of capacitance. Even then, the total load-resistance should not go below 27 kilohms or higher than 100 kilohms.

To increase the effective capacitance across the cartridge terminals and/or decrease the resistive load across the cartridge terminals it is necessary to use a parallel R-C circuit. Figures 10 and 11 show circuit examples. To increase the capacitance, a capacitor, C, may be connected in parallel with the cartridge output. I have found that it is best to experiment in steps of approximately 50 pF, increasing the capacitance until the desired results are obtained.

To decrease the resistive load, a resistor, R, may be connected in parallel with the output of the cartridge. If it is necessary to further decrease the resistive load, a smaller value resistor should be used.

A new frequency response test should be done each time the load impedance is altered to determine the best response and, therefore, the best load impedance for the cartridge. If the cartridge is a stereo cartridge, the response tests will have to be repeated to determine the best load impedance for the other stereo channel.

After the tests are completed, you will have two R-C networks, one for each stereo channel. There are two options for incorporating the two R-C networks into your stereo system. The first is to connect the resistor and capacitor to a male phono plug for use with a "Y" connector. The parallel R-C network is soldered between the "hot" (center) and "ground" (outer) terminal. When completed, the male phono plug with the R-C circuit is plugged into the "Y" connector. The cable from the turntable is plugged into the other jack on the "Y" connector and, finally, the "Y" connector is plugged into the input of the phono preamplifier, as shown in Fig. 15. Of course, two "Y" connectors and two R-C networks will be necessary for stereo systems.

The other alternative is to house the R-C circuit in a small metal box. In addition to the small metal box you'll need two jacks (one will be the input, the other the output) and a length of shielded cable (four jacks and two lengths of shielded cable for stereo. Connect the box in series with the audio cables from the turntable. R-E

TABLE 3

Frequency Hz	Meter Reading-dB
20000	−19.5
18000	−18.8
16000	−17.7
14000	−16.6
12000	−15.3
10000	−13.7
8000	−11.9
6000	−9.6
5000	−8.2
4000	−6.6
3000	−4.8
2000	−2.6
1500	−1.5
1000	0
800	+0.7
600	+1.8
500	+2.6
400	+1.9
300	+1.1
200	+0.2
150	−0.6
100	−0.9
80	−1.3
60	−2.3
50	−3.0
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20	−8.6

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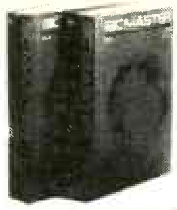

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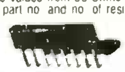

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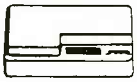

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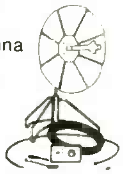

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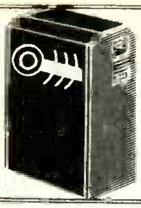

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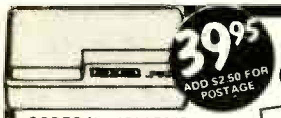

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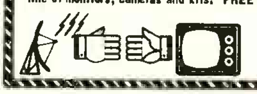

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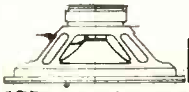

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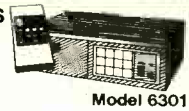

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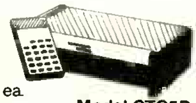

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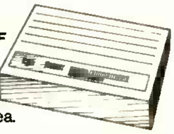

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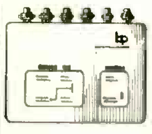

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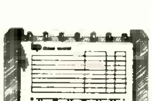

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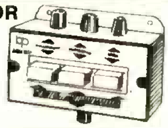

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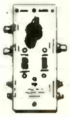

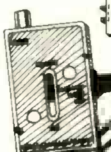

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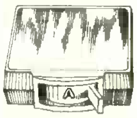

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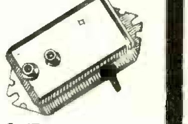

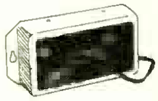

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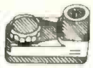

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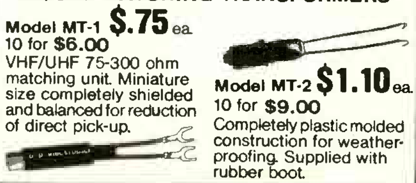

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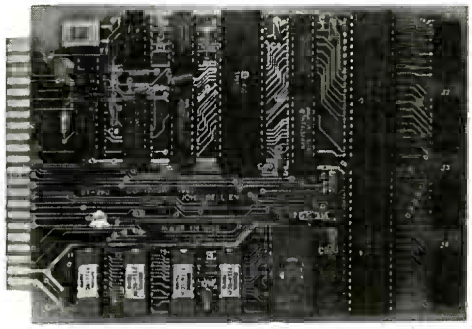

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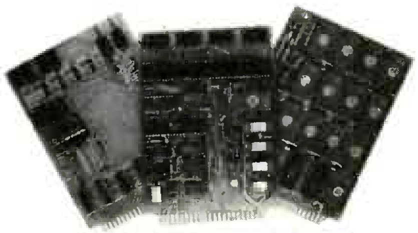

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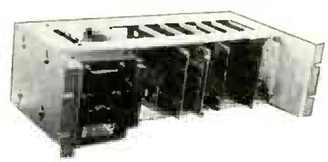

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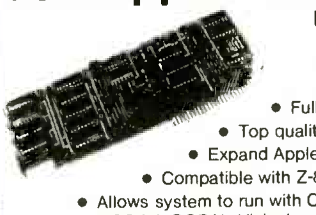

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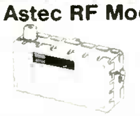
- Allows system to run with CP/M™, PASCAL, DOS 3.3, COBAL, Visicalc, etc.
- Supplied with extra 16K RAM & has (2) LED's

32K STATIC RAM

2 or 4 MHz
Expandable
Uses
2114L's

16K 4 MHz Kit	$159.95
16K 4 MHz A&T	217.95
32K 4 MHz Kit	$199.95 ~~289.95~~
• 32K 4 MHz A&T	• 339.00
BARE BOARD	39.95
Bare Bd w/all parts less mem.	99.95

Astec RF Modulator



for COLOR & B/W

P/N 1082 Channel 3 or 4	$6.95
P/N 4151 UHF Channel 33	8.95

MOSTEK 4K RAMS

29¢ ea.

200,000 pieces in stock — priced to move. Same as MK4027 except 1mS refresh MK4015 4Kx1 RAM

BARE BOARDS

S-100 Sound Board	$34.95
8080A CPU	34.95
32K Static RAM (2114)	34.95
8K EPROM (2708)	24.95
2708/2716 EPROM	34.95
ACP Proto Board	22.95
Vector 8800 Proto	22.20
Vector 8803 11 slot MB	29.95
ACP Extender with connector	18.95
13 Slot Mother Board (WMC)	32.95
9 Slot Mother Board (WMC)	29.95
8 Slot Mother Bd (Expandable)	34.95
Floppy PCB (8" SHUGART)	39.95
S100 (AY5-8910) Sound Board	34.95
Apple Sound Board	24.95

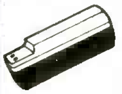
PMI "Super Beta" LOW POWER AMPLIFIER

INTERNALLY COMPENSATED
P/N OP12GJ

list $6.95
ACP $1.95

Voffset = 1.0 mV
Ibias = 5.0mA
Gain = 40V/mV
(quantity limited)

UV "EPROM" ERASER



Model UVs-11E
$79.95
Holds 4 EPROM's at a time.

Model S-52T $325.00

4K STATIC RAM SELL-OFF

10/$9.90

Same as TMS4044 but designed specifically for Z-80 based systems. This is a full-spec 4Kx1 RAM, 450nS. Order P/N Zilog 6104-4 while supply lasts.

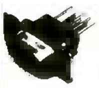
16K Memory Expansion Kits for Apple/TRS-80

8 pcs 4116 16K 200/250nS
Specify computer **$12.95**
CALL FOR VOLUME PRICING

Zilog Z8 CPU with TINY BASIC

Debug prog. **$49.95**
Plus 6132 companion quasi-static RAM 29.95

"D" SUB CONNECTORS



Unreal price. DB37 male, DB25 female. Gold PC mount with mounting holes. Mfg. AMP. Specify 25 or 37 pins.

DB37 $2.50 DB25 $1.95

"BLINKER"

LED's respond to sound. Complete, ready to wear. (2"x2"). Sold at Nieman Marcus for 69.95. ACP **$49.95** red, yellow, green LED's

Stepper Motor

NEW

USED IN DATA PRODUCTS PRINTER
$19.95 ea.

CONNECTORS

DB25P (RS232)	$3.25
DB25S Female	3.75
Hood	1.25
Set with Hood, Sale	7.50
22/44 S/T, KIM	2.95
43/86 S/T, MOT	6.50
50/100 S-100 Connector W/W	4.95
50/100 S-100 Connector S/T	3.95

12 VOLT BUZZER/HORN

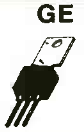
2" DIAMETER
ALL METAL
2/$1.99

Full ASCII Encoded Keyboards

RCA 128-Character, 58-Key Typewriter Format for Alphanumeric Entry

VP-606 Async serial output Reg $99.00
ACP SALE ... **$69.95**

GE D43C3



PNP power
HFE = 40-120
VCEO = 30
IC = 3A
6,000 pcs available
69¢ ea.

MICROPROCESSORS

Z8001	$99.00	8008-1	$14.95	6802P	14.95
Z8002	69.00	2901	9.90	8035	14.95
Z80	8.95	2901A	14.95	8039	12.95
Z80A	11.95	9900JL	49.95	8073N	34.95
F-8 (3850)	16.95	6502	9.95	8755	49.95
2650	16.95	6502A	16.95	8748	49.95
1802	8.75	IM6100	29.95	6809	30.00
8080A	4.75	6800	11.75	8086	49.95
8085	14.95	6800B	19.95	68000	129.95

RAMS

CALL FOR QTY PRICING

6116/2016	$7.95	2147	$5.99	5290	$1.99
8264-64K	8.50	411	5.99	5298	1.49
4116-2	1.99	414	4.69	6508	4.50
4116-2	8/12.95	1101	.99	6518	6.79
2101	3.99	1103	.99	6561	3.79
2102	.79	4027	4.69	6604	3.99
21L02-2	1.49	4044	3.99	6605	7.99
21L02-4	1.29	4050	4.69	9130	8.99
2111	3.49	4060	4.69	9140	8.99
2112	3.49	4096	3.99	93415	6.99
2114	1.49	4115	1.49	93425	6.99
2114L-2	3.25	4200	7.95		
2114L-4	2.29	4402	1.99		
2125	6.99	5280	4.60		

64K only $8.50

SUPPORT

8155	$9.95	8259	$8.95	68047	$22.95
8156	9.95	8275	19.95	68488	19.95
8202	29.95	8279	9.50	46505	22.95
8205	2.69	6810	4.75	6520	6.95
8212	2.75	6820	6.50	6522	9.95
8214	4.95	6821	6.50	6530-X	24.95
8216	2.75	6828	10.50	6532	17.95
8224	2.95	6834	16.95	6551	19.95
8226	2.95	6845	22.95	Z80-PIO	6.50
8228	3.95	6847	27.95	Z80A-PIO	9.50
8243	9.50	6850	5.25	Z80-CTC	6.50
8250	14.95	6852	5.25	Z80A-CTC	9.50
8251	6.50	6860	10.95	Z80-DMA	19.95
8253	11.95	6862	10.95	Z80A-DMA	27.95
8255	4.75	6875	5.95	Z80-SIO	24.95
8257	9.50	6880	2.49	Z80A-SIO	29.95

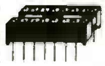
MOS PROMS

2764 (8Kx8) TS	$69.95	2708 (450nS)	$5.75
2732 (4Kx8) TS	12.95	2708 (650nS)	5.25
2716/2516; 5V		1702A	5.75
(2Kx8) TS	7.95	MM5203AQ	14.50
TMS2716, 5V, 12V	17.95	MM5204Q	9.95
2758, 5V, (450nS)	3.50		

HI-TECH

2513-001 (5V) Upper	$9.50	DAC08	$9.95
2513-005 (5V) Lower	10.95	DAC100	9.95
2513-ADM3 (5V) Lower	14.95	8038 Function Generator	4.50
MCM66710 ASCII Shifted	12.95	MC4024 VCO	2.95
MCM66740 Math Symbol	13.95	LM566 VCO	1.95
MCM66750 Alpha Control	13.45	XR2206 Function Generator	5.25
1771-01 8" & Minifloppy	24.95	TR1602B (5V, 12V)	3.95
1781 Dual Floppy	29.95	AY51013 (5V, 12V)	4.95
1791-01 Dual Floppy	36.95	AY51014A/1612 (5-14V)	6.95
1791-02 Dual Floppy	44.95	AY51015A/1863 (5V)	6.95
1793 DD, DS Floppy	44.95	IM6402	7.95
1797 DD, DS Floppy	54.95	IM6403	8.95
1691 Data Separator	18.95	2350 USRT	9.95
2143 Clock Generator	18.95	16718 Astros	24.95
8700 8 bit Binary	13.50	MC14411	11.95
8701 10 bit Binary	22.00	4702	14.95
8703 8 bit TS	13.50	WD1941	9.95
9400 Volt to Freq Conv.	7.25	COM5016	16.95
8750 3½ Digit BKD	13.95	INS8250	15.95
1408L6 6 bit	3.95	AY5-2376	13.75
1408L8 8 bit	5.95	AY5-3600	13.75
DAC01 0 to A	5.95	MM5740AAC	8.95

SOCKETS



LOW PROFILE SOCKETS (TIN)

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

3L WIREWRAP SOCKETS (GOLD)

	1-24	25-49	50-100
8 pin WW	.55	.54	.49
10 pin WW (Tin)	.65	.63	.58
14 pin WW	.75	.73	.67
16 pin WW	.80	.77	.70
18 pin WW	95	.90	.81
20 pin WW	1.15	1.08	.99
22 pin WW	1.45	1.35	1.23
24 pin WW	1.35	1.26	1.14
28 pin WW	1.60	1.53	1.38
40 pin WW	2.20	2.09	1.89

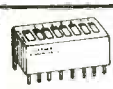
LINEAR

78H05K	$5.95	LM1414N	$1.90
78M06	1.49	LM1458CN/N	.49
78M.G.	1.49	MC1488N	.99
LM108AH	2.95	MC1489N	.99
LM300H	.99	LM1496N	.89
LM301CN	.35	LM1556N	1.50
LM304H	1.98	LM1820N	.95
LM305H	1.89	LM1850N	.95
LM306H	3.25	LM1889N	3.10
LM307CN	.29	LM2111N	1.75
LM308CN	.98	LM2900N	.99
LM309K	1.49	LM2901N	2.50
LM310CN	1.25	LM2917N	2.95
LM311D/CN	.89	CA3013T	2.19
LM312H	1.75	CA3018T	1.99
LM317T	1.70	CA3021T	3.49
LM318CN	1.49	CA3023T	2.99
LM319N/H	1.25	CA3035T	2.75
LM320K-XX*	1.35	CA3039T	1.29
LM320T-XX*	1.39	CA3046N	1.29
LM320H-XX*	1.25	CA3053N	1.49
LM323K	4.95	CA3059N	3.19
LM324N	.95	CA3060N	3.19
LM337K	5.95	CA3062N	4.95
LM338K	6.95	LM3065N	1.49
LM339N	.95	CA3080T	1.29
LM340K-XX*	1.75	CA3081N	1.69
LM340T-XX*	1.25	CA3082N	1.69
LM340H-XX*	1.25	CA3083N	1.55
LM344H	1.95	CA3086N	.80
LM348N	1.20	CA3089N	2.99
LM350K	5.60	CA3096N	3.49
LM358CN	.98	CA3097N	1.99
LM360N	1.49	CA3130T	1.30
LM372N	1.95	CA3140T	1.19
LM376N	3.75	CA3146N	2.49
LM377N	2.75	CA3160T	1.19
LM380CN/N	1.25	CA3190N	1.95
LM381N	1.79	CA3410N	.59
LM383T	1.95	MC3423N	1.49
LM386N	1.25	MC3460N	3.95
LM387N	1.40	SG3524N	3.95
LM390N	1.95	CA3600N	3.39
NE531V/T	3.75	LM3900N	.59
NE555V	.39	LM3905N	1.19
NE556N	98	LM3909N	.98
NE561T	19.95	LM3914N	3.75
NE565N/H	1.25	LM3915N	3.95
NE566H/V	1.75	LM3916N	3.75
NE567V/H	1.50	RC4131N	2.95
NE592N	2.75	RC4136N	1.10
LM702H	1.99	RC4151N	3.70
LM709N/H	.29	RC4194TK	4.95
LM710N/H	.75	RC4195TK	5.40
LM711N/H	.39	ULN2001	1.25
LM715N	1.95	ULN2003	1.50
LM723N/H	.65	SN75450N	.59
LM733N/H	.98	SN75451N	.35
LM739N	1.15	SN75452N	.49
LM741CN/H	.33	SN75453N	.49
LM741CN-14	.19	SN75454N	.49
LM747N/H	.75	SN75491N	.89
LM748N/H	.39	SN75492N	.89
LM760CN	2.95	SN75493N	.89
LM1310N	1.90	SN75494N	.89
MC1330	1.95	TL494CN	4.20
MC1350	1.95	TL496CP	1.65
MC1358	1.75		

74S00

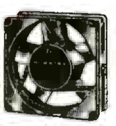
74S00	$ .39	74S124	3.69	74S244	$2.99
74S02	.43	74S133	.54	74S251	1.35
74S03	.45	74S134	.66	74S253	1.35
74S04	.52	74S135	1.15	74S257	1.29
74S05	.52	74S136	1.69	74S258	1.29
74S08	.49	74S138	1.29	74S260	.75
74S09	.49	74S139	1.29	74S280	2.79
74S10	.42	74S140	.73	74S287	2.99
74S11	.42	74S151	1.29	74S288	2.55
74S15	.42	74S153	1.29	74S373	3.10
74S20	.42	74S157	1.29	74S374	3.10
74S22	.42	74S158	1.29	74S387	2.75
74S30	.42	74S160	2.79	74S471	7.95
74S32	.49	74S174	1.49	74S472	7.95
74S38	1.19	74S175	1.49	74S473	7.95
74S40	.49	74S188	2.69	74S474	9.95
74S51	42	74S194	1.89	74S475	9.95
74S64	.46	74S195	1.89	74S570	5.75
74S65	.46	74S196	1.69	74S571	5.75
74S74	.69	74S240	2.75	74S572	8.95
74S86	.72	74S241	2.75	74S573	8.95
74S112	.72	74S242	2.99	74S940	2.90
74S113	.72	74S243	2.99	74S941	2.90
74S114	.72				

DIP SWITCHES



2 Position	$ .99	7 Position	$1.39
4 Position	1.19	8 Position	1.49
5 Position	1.29	9 Position	1.65
6 Position	1.35	10 Position	1.69

MUFFIN® FAN



The dependable, low cost, largest selling fan for commercial cooling applications.

- 105cfm free air delivery
- 4.68" sq. x 1.50" deep. Weight - 17 oz.

SPECIAL PURCHASE
NEW! **$9.50 ea.**

7400

7400	$ .19	7475	$ .38	74161	$ .88
7401	.22	7476	.34	74162	.89
7402	.22	7479	4.60	74163	.87
7403	.22	7480	.49	74164	.87
7404	.22	7482	.95	74165	.87
7405	.23	7483	.55	74166	1.20
7406	.35	7485	.65	74167	1.95
7407	.35	7486	.35	74170	1.69
7408	.26	7489	1.75	74172	4.75
7409	.23	7490	.39	74173	.79
7410	.22	7491	.57	74174	.89
7411	.29	7492	.45	74175	.85
7412	.29	7493	.45	74176	.75
7413	.39	7494	.69	74177	.75
7414	.59	7495	.65	74179	1.34
7416	.29	7496	69	74180	.75
7417	.29	7497	2.90	74181	1.75
7420	.22	74100	2.90	74182	.75
7421	.35	74107	.32	74184	2.25
7422	.29	74109	.37	74185	2.25
7423	.29	74116	1.95	74186	9.95
7425	.29	74121	.29	74188	3.90
7426	.29	74122	.39	74190	1.15
7427	.25	74123	.59	74191	1.15
7429	.45	74125	.39	74192	.85
7430	.23	74126	.44	74193	.85
7432	.29	74128	.59	74194	.85
7437	.25	74132	.69	74195	.68
7438	.29	74136	75	74196	.85
7439	.29	74139	.95	74197	.85
7440	.19	74141	.79	74198	1.39
7441	.79	74142	2.95	74199	1.39
7442	.57	74143	2.95	74221	1.19
7443	.95	74144	2.95	74251	.95
7444	.95	74145	.62	74273	1.05
7445	.79	74147	1.95	74276	1.89
7446	.79	74148	1.20	74279	.75
7447	.65	74150	1.09	74283	1.40
7448	.79	74151	.67	74284	3.90
7450	.19	74152	67	74285	3.90
7451	.19	74153	.67	74290	1.25
7453	.19	74154	1.19	74298	95
7454	.19	74155	.78	74365	.68
7459	25	74156	.78	74366	.68
7460	.23	74157	.69	74367	.68
7470	.29	74158	1.65	74368	.68
7472	.29	74159	2.49	74390	1.45
7473	.34	74160	.88	74393	1.90
7474	.34			74490	1.90

74LS00

74LS00	$ .26	74LS113	$ .43	74LS245	$2.20
74LS01	.28	74LS114	.43	74LS247	1.10
74LS02	28	74LS122	.55	74LS248	1.10
74LS03	.28	74LS123	1.19	74LS249	1.19
74LS04	.35	74LS124	1.35	74LS251	1.40
74LS05	28	74LS125	.89	74LS253	1.40
74LS08	28	74LS126	.52	74LS257	.85
74LS09	.35	74LS132	.79	74LS258	.98
74LS10	.28	74LS136	.49	74LS259	2.95
74LS11	.39	74LS138	.85	74LS260	.65
74LS12	.33	74LS139	.85	74LS261	2.49
74LS13	.47	74LS145	1.25	74LS266	.59
74LS14	.95	74LS148	1.49	74LS273	1.75
74LS15	.33	74LS151	.79	74LS275	4.40
74LS20	.26	74LS153	.79	74LS279	.59
74LS21	.33	74LS154	1.70	74LS283	.99
74LS22	.33	74LS155	1.19	74LS290	.99
74LS26	.33	74LS156	.99	74LS293	.99
74LS27	.33	74LS157	.85	74LS295	1.10
74LS28	.33	74LS158	.75	74LS298	1.19
74LS30	.26	74LS160	1.05	74LS324	1.75
74LS32	.33	74LS161	1.15	74LS347	1.95
74LS33	.55	74LS162	1.05	74LS348	1.95
74LS37	.45	74LS163	1.05	74LS352	1.19
74LS38	.39	74LS164	1.19	74LS353	1.19
74LS40	.26	74LS165	.89	74LS363	1.49
74LS42	.79	74LS166	2.48	74LS365	.69
74LS47	.79	74LS168	1.15	74LS366	.69
74LS48	.95	74LS169	1.15	74LS367	.69
74LS51	26	74LS170	1.99	74LS368	.69
74LS54	.29	74LS173	.89	74LS373	1.89
74LS55	.29	74LS174	.89	74LS374	1.89
74LS73	.45	74LS175	.89	74LS375	.69
74LS74	.42	74LS181	2.20	74LS377	1.95
74LS75	.59	74LS190	1.15	74LS385	1.95
74LS76	45	74LS191	1.15	74LS386	.65
74LS78	.45	74LS192	.98	74LS390	1.95
74LS83A	.79	74LS193	.98	74LS393	1.95
74LS85	1.19	74LS194	1.15	74LS395	1.70
74LS86	.45	74LS195	95	74LS399	2.35
74LS90	57	74LS196	.89	74LS424	2.95
74LS92	.75	74LS197	.89	74LS668	1.75
74LS93	.75	74LS221	1.15	74LS670	2.29
74LS95	.88	74LS240	1.69	81LS95	1.69
74LS96	.98	74LS242	1.69	81LS96	1.69
74LS107	.45	74LS243	1.69	81LS97	1.69
74LS109	.45	74LS244	1.49	81LS98	1.69
74LS112	.43				

VOLUME PRICING CALL TOLL FREE

CMOS

4000	$ .35	4037	$1.95	4089	$2.95
4001	.35	4040	1.29	4093	.99
4002	.35	4041	1.25	4094	2.95
4006	1.05	4042	95	4098	2.29
4007	.25	4043	85	4099	2.25
4008	1.39	4044	.85	14408	12.95
4009	.45	4046	1.75	14409	12.95
4010	.45	4047	1.25	14410	12.95
4011	.35	4048	.99	14412	12.95
4012	.25	4049	.45	14415	8.95
4013	.45	4050	.69	14419	4.95
4014	1.39	4051	1.10	4501	.39
4015	1.15	4052	1.10	4502	1.65
4016	.59	4053	1.10	4503	.69
4017	1.19	4055	3.95	4505	8.95
4018	89	4056	2.95	4506	.75
4019	.45	4059	9.25	4507	95
4020	1.10	4060	1.39	4508	3.75
4021	1.19	4066	.75	4510	1.19
4022	1.15	4069	.35	4511	1.19
4023	.29	4070	.49	4512	1.39
4024	.75	4071	.35	4515	2.75
4025	.25	4072	.35	4516	1.45
4027	.65	4073	.35	4518	1.39
4028	.85	4075	.35	4520	1.25
4029	1.29	4076	1.29	4555	4.95
4030	.45	4077	.35	4556	.99
4031	3.25	4078	.35	4566	2.25
4032	2.15	4081	.35	80C95	1.50
4034	3.25	4082	.35	80C97	1.25
4035	.95	4085	1.95		

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			Each	100 pcs
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5101	256 x 4	(cmos) (450ns)	4.95	3.95
2102-1	1024 x 1	(450ns)	.89	.85
2102L-2	1024 x 1	(LP) (250ns)	1.69	1.55
2102L-4	1024 x 1	(LP) (450ns)	1.29	1.15
2111	256 x 4	(450ns)	2.99	2.49
2112	256 x 4	(450ns)	2.99	2.79
2114	1024 x 4	(450ns)	8/16.95	1.95
2114L-2	1024 x 4	(LP) (200ns)	8/15.95	1.90
2114L-3	1024 x 4	(LP) (300ns)	8/18.95	2.25
2114L-4	1024 x 4	(LP) (450ns)	8/17.95	2.10
2147	4096 x 1	(55ns)	9.95	call
TMS4044-4	4096 x 1	(450ns)	3.49	3.25
TMS4044-3	4096 x 1	(300ns)	3.99	3.75
TMS4044-2	4096 x 1	(200ns)	4.49	4.25
MK4118	1024 x 8	(250ns)	9.95	call
TMM2016	2048 x 8	(150ns)	call	call
HM6116-4	2048 x 8	(cmos) (200ns)	call	call
HM6116-3	2048 x 8	(cmos) (150ns)	call	call
HM6116-2	2048 x 8	(cmos) (120ns)	call	call
HM6116LP-4	2048 x 8	(LP) (cmos) (200ns)	call	call
HM6116LP-3	2048 x 8	(LP) (cmos) (150ns)	call	call
HM6116LP-2	2048 x 8	(LP) (cmos) (120ns)	call	call
Z-6132	4096 x 8	(Qstat) (300ns)	34.95	call

LP = Low Power Qstat = Quasi-Static

DYNAMIC RAMS

			Each	100 pcs
TMS4027	4096 x 1	(250ns)	2.50	2.00
MK4108	8192 x 1	(200ns)	1.95	call
MM5298	8192 x 1	(250ns)	1.85	call
4116-120	16384 x 1	(120ns)	8/29.95	call
4116-150	16384 x 1	(150ns)	8/18.95	1.95
4116-200	16384 x 1	(200ns)	8/13.95	call
4116-250	16384 x 1	(250ns)	8/11.95	call
4116-300	16384 x 1	(300ns)	8/13.80	call
2118	16384 x 1	(5v) (150ns)	4.95	call
MK4816	2048 x 8	(5v) (300ns)	24.95	call
4164-200	65536 x 1	(5v) (200ns)	call	call
4164-150	65536 x 1	(5v) (150ns)	call	call

EPROMS

			Each	8 pcs
1702	256 x 8	(1us)	4.95	4.50
2708	1024 x 8	(450ns)	3.75	3.50
2758	1024 x 8	(5v) (450ns)	9.95	8.95
TMS2516	2048 x 8	(5v) (450ns)	6.95	5.95
2716	2048 x 8	(5v) (450ns)	4.95	3.95
2716-1	2048 x 8	(5v) (350ns)	9.00	8.50
TMS2716	2048 x 8	(450ns)	9.95	8.95
TMS2532	4096 x 8	(5v) (450ns)	9.95	7.95
2732	4096 x 8	(5v) (450ns)	9.95	7.95
2732A-2	4096 x 8	(5v) (200ns)	call	call
2764	8192 x 8	(5v) (450ns)	call	call
TMS2564	8192 x 8	(5v) (450ns)	call	call

5v = Single 5 Volt Supply

EPROM ERASERS

	Timer	Capacity Chip	Intensity (uW/V,²)	
PE-14		6	5,200	83.00
PE-14T	X	6	5,200	119.00
PE-24T	X	9	6,700	175.00
PL-265T	X	20	6,700	255.00
PR-125T	X	16	15,000	349.00
PR-320T	X	32	15,000	595.00

Z-80

2.5 Mhz	
Z80-CPU	6.00
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Z80-DART	15.25
Z80-DMA	17.50
Z80-PIO	6.00
Z80-SIO/0	18.50
Z80-SIO/1	18.50
Z80-SIO/2	18.50
Z80-SIO/9	16.95
4.0 Mhz	
Z80A-CPU	6.00
Z80A-CTC	8.65
Z80A-DART	18.75
Z80A-DMA	27.50
Z80A-PIO	6.00
Z80A-SIO/0	22.50
Z80A-SIO/1	22.50
Z80A-SIO/2	22.50
Z80A-SIO/9	19.95
6.0 Mhz	
Z80B-CPU	17.95
Z80B-CTC	15.50
Z80B-PIO	15.50
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Z6132	34.95
Z8671	39.95

8200

8202	34.95
8205	3.50
8212	1.85
8214	3.85
8216	1.80
8224	2.50
8226	1.80
8228	4.90
8237	19.95
8238	4.95
8243	4.45
8250	14.95
8251	4.75
8253	9.25
8253-5	9.85
8255	4.75
8255-5	5.25
8257	8.50
8257-5	8.95
8259	6.90
8259-5	7.50
8272	39.95
8275	29.95
8279	9.50
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6522	8.75
6532	11.25
6545	22.50
6551	11.85
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5.185	3.95
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6.0	3.95
6.144	3.95
6.5536	3.95
8.0	3.95
10.0	3.95
14.31818	3.95
15.0	3.95
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74LS01	.25	74LS86	.40	74LS169	1.75	74LS298	1.20
74LS02	.25	74LS90	.65	74LS170	1.75	74LS324	1.75
74LS03	.25	74LS91	.89	74LS173	.80	74LS352	1.55
74LS04	.25	74LS92	.70	74LS174	.95	74LS353	1.55
74LS05	.25	74LS93	.65	74LS175	.95	74LS363	1.35
74LS08	.35	74LS95	.85	74LS181	2.15	74LS364	1.95
74LS09	.35	74LS96	.95	74LS189	9.95	74LS365	.95
74LS10	.25	74LS107	.40	74LS190	1.00	74LS366	.95
74LS11	.35	74LS109	.40	74LS191	1.00	74LS367	.70
74LS12	.35	74LS112	.45	74LS192	.85	74LS368	.70
74LS13	.45	74LS113	.45	74LS193	.95	74LS373	1.75
74LS14	1.00	74LS114	.50	74LS194	1.00	74LS374	1.75
74LS15	.35	74LS122	.45	74LS195	.95	74LS377	1.45
74LS20	.25	74LS123	.95	74LS196	.85	74LS378	1.18
74LS21	.35	74LS124	2.99	74LS197	.85	74LS379	1.35
74LS22	.25	74LS125	.95	74LS221	1.20	74LS385	1.90
74LS26	.35	74LS126	.85	74LS240	1.29	74LS386	.65
74LS27	.35	74LS132	.75	74LS241	1.29	74LS390	1.90
74LS28	.35	74LS136	.55	74LS242	1.85	74LS393	1.90
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74LS47	.75	74LS153	.75	74LS253	.85	74LS669	1.89
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74LS54	.35	74LS157	.75	74LS260	.65	74LS683	2.30
74LS55	.35	74LS158	.75	74LS266	.55	74LS684	2.40
74LS63	1.25	74LS160	.90	74LS273	1.65	74LS685	2.40
74LS73	.40	74LS161	.95	74LS275	3.35	74LS688	2.40
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8 pin ST	.13	.11
14 pin ST	.15	.12
16 pin ST	.17	.13
18 pin ST	.20	.18
20 pin ST	.29	.27
22 pin ST	.30	.27
24 pin ST	.30	.27
28 pin ST	.40	.32
40 pin ST	.49	.39

ST = SOLDERTAIL

8 pin WW	.59	.49
14 pin WW	.69	.52
16 pin WW	.69	.58
18 pin WW	.99	.90
20 pin WW	1.09	.98
22 pin WW	1.39	1.28
24 pin WW	1.49	1.35
28 pin WW	1.69	1.49
40 pin WW	1.99	1.80

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4001	.35	4072	.30
4002	.25	4073	.30
4006	.95	4075	.30
4007	.29	4076	.95
4008	.95	4078	.30
4009	.45	4081	.30
4010	.45	4082	.30
4011	.35	4085	.95
4012	.25	4086	.95
4013	.45	4093	.95
4014	.95	4098	2.49
4015	.95	4099	1.95
4016	.45	14409	12.95
4017	1.15	14410	12.95
4018	.95	14411	11.95
4019	.45	14412	12.95
4020	.95	14419	4.95
4021	.95	4502	.95
4022	1.15	4503	.65
4023	.35	4508	1.95
4024	.75	4510	.95
4025	.35	4511	.95
4026	1.65	4512	.95
4027	.65	4514	1.25
4028	.80	4515	2.25
4029	.95	4516	1.55
4030	.45	4518	1.25
4034	2.95	4519	1.25
4035	.85	4520	1.25
4040	.95	4522	1.25
4041	1.25	4526	1.25
4042	.75	4527	1.95
4043	.85	4528	1.25
4044	.85	4531	.95
4046	.95	4532	1.95
4047	.95	4538	1.95
4049	.55	4539	1.95
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4051	.95	4555	.95
4053	.95	4556	.95
4060	1.45	4581	1.95
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78L05	.69	79L05	.79
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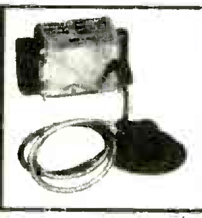

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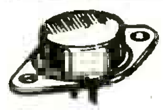

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9 DIGITS 600 MHz $129.95 WIRED

PRICES

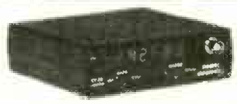
CT-90 wired, 1 year warranty	$129.95
CT-90 Kit, 90 day parts warranty	109.95
AC-1 AC adapter	3.95
BP-1 Nicad pack +AC Adapter/Charger	12.95
OV-1, Micro-power Oven time base	49.95
External time base input	14.95

The CT-90 is the most versatile, feature packed counter available for less than $300.00! Advanced design features include; three selectable gate times, nine digits, gate indicator and a unique display hold function which holds the displayed count after the input signal is removed! Also, a 10mHz TCXO time base is used which enables easy zero beat calibration checks against WWV. Optionally; an internal nicad battery pack, external time base input and Micro-power high stability crystal oven time base are available. The CT-90, performance you can count on!

SPECIFICATIONS:

Range:	20 Hz to 600 MHz
Sensitivity:	Less than 10 MV to 150 MHz Less than 50 MV to 500 MHz
Resolution:	0.1 Hz (10 MHz range) 1.0 Hz (60 MHz range) 10.0 Hz (600 MHz range)
Display:	9 digits 0.4" LED
Time base:	Standard-10.000 mHz, 1.0 ppm 20-40°C. Optional Micro-power oven-0.1 ppm 20-40°C
Power:	8-15 VAC @ 250 ma

7 DIGITS 525 MHz $99.95 WIRED



SPECIFICATIONS:

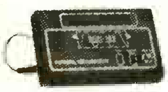
Range:	20 Hz to 525 MHz
Sensitivity:	Less than 50 MV to 150 MHz Less than 150 MV to 500 MHz
Resolution:	1.0 Hz (5 MHz range) 10.0 Hz (50 MHz range) 100.0 Hz (500 MHz range)
Display:	7 digits 0.4" LED
Time base:	1.0 ppm TCXO 20-40°C
Power:	12 VAC @ 250 ma

The CT-70 breaks the price barrier on lab quality frequency counters. Deluxe features such as; three frequency ranges - each with pre-amplification, dual selectable gate times, and gate activity indication make measurements a snap. The wide frequency range enables you to accurately measure signals from audio thru UHF with 1.0 ppm accuracy - that's .0001%! The CT-70 is the answer to all your measurement needs, in the field, lab or ham shack.

PRICES:

CT-70 wired, 1 year warranty	$99.95
CT-70 Kit, 90 day parts warranty	84.95
AC-1 AC adapter	3.95
BP-1 Nicad pack + AC adapter/charger	12.95

7 DIGITS 500 MHz $79.95 WIRED



PRICES:

MINI-100 wired, 1 year warranty	$79.95
AC-Z Ac adapter for MINI-100	3.95
BP-Z Nicad pack and AC adapter/charger	12.95

Here's a handy, general purpose counter that provides most counter functions at an unbelievable price. The MINI-100 doesn't have the full frequency range or input impedance qualities found in higher price units, but for basic RF signal measurements, it can't be beat! Accurate measurements can be made from 1 MHz all the way up to 500 MHz with excellent sensitivity throughout the range, and the two gate times let you select the resolution desired. Add the nicad pack option and the MINI-100 makes an ideal addition to your tool box for "in-the-field" frequency checks and repairs.

SPECIFICATIONS:

Range:	1 MHz to 500 MHz
Sensitivity:	Less than 25 MV
Resolution:	100 Hz (slow gate) 1.0 KHz (fast gate)
Display:	7 digits, 0.4" LED
Time base:	2.0 ppm 20-40°C
Power:	5 VDC @ 200 ma

8 DIGITS 600 MHz $159.95 WIRED

NEW READ RECEIVER FREQUENCY

SPECIFICATIONS:

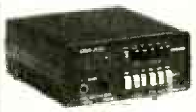
Range:	20 Hz to 600 MHz
Sensitivity:	Less than 25 mv to 150 MHz Less than 150 mv to 600 MHz
Resolution:	1.0 Hz (60 MHz range) 10.0 Hz (600 MHz range)
Display:	8 digits 0.4" LED
Time base:	2.0 ppm 20-40°C
Power:	110 VAC or 12 VDC

The CT-50 is a versatile lab bench counter that will measure up to 600 MHz with 8 digit precision. And, one of its best features is the Receive Frequency Adapter, which turns the CT-50 into a digital readout for any receiver. The adapter is easily programmed for any receiver and a simple connection to the receiver's VFO is all that is required for use. Adding the receiver adapter in no way limits the operation of the CT-50, the adapter can be conveniently switched on or off. The CT-50, a counter that can work double-duty!

PRICES:

CT-50 wired, 1 year warranty	$159.95
CT-50 Kit, 90 day parts warranty	119.95
RA-1, receiver adapter kit	14.95
RA-1 wired and pre-programmed (send copy of receiver schematic)	29.95

DIGITAL MULTIMETER $99.95 WIRED



PRICES:

DM-700 wired, 1 year warranty	$99.95
DM-700 Kit, 90 day parts warranty	79.95
AC-1, AC adaptor	3.95
BP-3, Nicad pack +AC adapter/charger	19.95
MP-1, Probe kit	2.95

The DM-700 offers professional quality performance at a hobbyist price. Features include; 26 different ranges and 5 functions, all arranged in a convenient, easy to use format. Measurements are displayed on a large 3½ digit, ½ inch LED readout with automatic decimal placement, automatic polarity, overrange indication and overload protection up to 1250 volts on all ranges, making it virtually goof-proof! The DM-700 looks great, a handsome, jet black, rugged ABS case with convenient retractable tilt bail makes it an ideal addition to any shop.

SPECIFICATIONS:

DC/AC volts:	100uV to 1 KV, 5 ranges
DC/AC current:	0.1 uA to 2.0 Amps, 5 ranges
Resistance:	0.1 ohms to 20 Megohms, 6 ranges
Input impedance:	10 Megohms, DC/AC volts
Accuracy:	0.1% basic DC volts
Power:	4 'C' cells

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- Great for PL tones
- Multiplies by 10 or 100
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$29.95 Kit $39.95 Wired

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Telescopic whip antenna - BNC plug	$ 7.95
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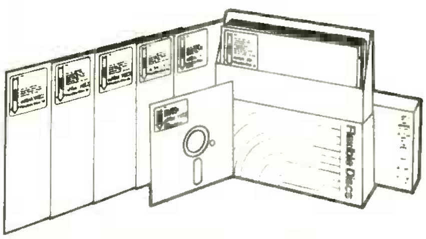

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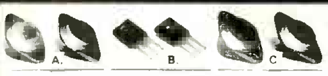

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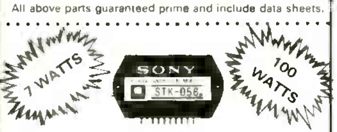

HYBRID AUDIO POWER AMPLIFIER IC's

From 7 WATTS to 100 WATTS

Typical ratings: Operating case temp. 85°C T.H.D.=0.5%f =20Hz-20KHz. Input resistance Po=0 1W30KΩ. Power band width 20Hz-20KHz. Freq. response 10-100KHz. Output resistance =8Ω. With built-in protection circuit. All units come with data sheet.

Part No.	Output	Vcc	Unit Price
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STK050	50W	±35V	$26.50
STK054	23W	±19V	$13.50
STK056	30W	±22V	$18.50
STK070	70W	±42V	$32.50
STK415	7W+7W	30V	$ 8.50
STK439	15W+15W	39V	$18.50
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SANYO ANTENNA SIGNAL BOOSTER

This Booster is specially designed for UHF Channels (14-83). After installing (between the antenna input cable and the UHF tuner), this unit will provide a minimum of 10dB gain, that is approximately 2 times better than you are seeing now. Ideal for those who live in apartments that can not put up an outdoor antenna. Small in size, only 2" x 1½" x 1". Supply voltage is 15 VDC. Back In Stock

★NEW ITEM★
MODEL 001-0076
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FOR UHF CHANNEL 14-83

Tuning voltage +1-+28VDC. Input impedance 75Ω. IF band width 7-16MHz. Noise figure 11.5dB Max. Size 2⅝" x 1¼" x ¾". Supply voltage 15VDC. Sound IF=58.0MHz.

Model 115-B-403A, Video IF 62.5MHz
Model 115-B-405A, Video IF 45.0MHz
$35.00 ea.

Tuner is the most important part of the circuit. Don't let those $19.00 tuners fool you.
All units are brand new from Sanyo. When ordering please specify model number.

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No FCC License Required.
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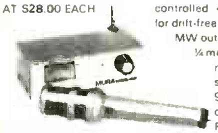
ADDITIONAL MICROPHONE (TRANSMITTER) AVAILABLE AT $28.00 EACH



Transmitter: FET mic for flat 30-18 KHz response. Xtal controlled 49 MHz AM Band for drift-free performance. 100 MW output (range approx. ¼ mile) for reliable long range transmission. Powered by a 9V radio battery (included).
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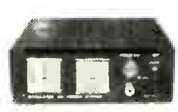
MURA WMS-49

WHISTLE ACTIVATED SWITCH BOARD

All boards are pre-assembled and tested. Your whistle to its FET condenser microphone from a distance, as far as 30 feet away (sensitivity can be easily adjusted), will turn the switch on and if you whistle again, it will turn off. Ideal for remote control toys, electrical appliance such as lights, coffee pots, TV, Hi-Fi, radio or other projects. Unit works on 9VDC.

MODEL 968 .... $4.50 ea.



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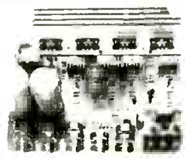
MODEL TR88A 0-15VDC @ 2A
MODEL TR88B 0-30VDC @ 1A

$59.50 Per Kit



TA-800
120W PURE DC POWER STEREO AMP KIT

Getting power hungry from your small amp? Have to watch your budget? Here's a good solution! The TA-800 is a pure DC amplifier with a built in pre-amp. All coupling capacitors are eliminated to give you a true reproduction of the music. On board tone and volume controls combined with built in power supply make the TA-800 the most compact stereo amp available. Specifications: 60W x 2 into 8Ω. Freq. range: 0-100KHz ±3dB. THD .01% or better. S/N ratio: 80dB. Sensitivity: 3mV into 47K. Power Requirement: ±24-40 Volts.

A GOOD BUY
at $65.00

SUPER FM WIRELESS MIC KIT — MARK III

This new designed circuit uses high FREQ FET transistors with 2 stage pre-amp. Transmits FM range (88-120MHz) up to 2 blocks away and with the ultra sensitive condenser microphone, that comes with the kit, allows you to pick up any sound within 15 ft. away. Kit includes all electronic parts, OSC coils, and PC Board. Power supply 9VDC.

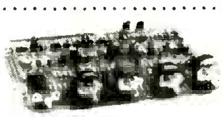
FMC-105
$11.50 Per Kit

ULTRASONIC SWITCH KIT

Kit includes the Ultra Sonic Transducers, 2 PC Boards for transmitter and receiver, all electronic parts and instructions. Easy to build and a lot of uses such as remote control for TV, garage door, alarm system or counter. Unit operates by 9-12VDC. $15.50 ea.

ELECTRONIC SWITCH KIT

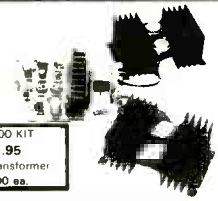
CONDENSER TYPE. Touch On—Touch Off. Uses 7473 IC and 12V relay $5.50



LOW TIM DC STEREO PRE-AMP KIT TA-1020

Incorporates brand-new DC design that gives a frequency response from 0-100Khz ±0.5dB. Added features like tone defeat and loudness control let you tailor your own frequency supplies to eliminate power fluctuation!
Specifications: • THD/TIM 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 controls Bass ±10dB @ 50Hz/Treble ±10dB @ 15Hz • Power supply ±24VDC @ 0.5A. Kit comes with regulated power supply, all you need is a 48VCT transformer @ 0.5A.

Only $44.50
X'former
$4.50 ea.



TA-1000 KIT
$51.95
Power Transformer
$18.00 ea.

100W 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 TIM stereo pre-amp.
Specifications: • Output power 100W RMS into 8Ω, 125W RMS into 4Ω • Frequency response 10Hz-100KHz • THD less than 0.008% • S/N ratio better than 80dB • Input sensitivity 1V max. • Power supply ±40V @ 5A.

1 WATT AUDIO AMP

All parts are pre-assembled on a mini PC Board. Supply Voltage 6-9VDC SPECIAL PRICE $1.95

5W AUDIO AMP KIT

2 LM380 with Volume Control. Power Supply 6-18VDC

Only $6.00 ea.

TA-323 6 WATTS TOTAL
30W + 30W STEREO AMP KIT

This is a solid state all transistor circuitry with on board stereo pre-amp for most microphone or phone input. Power output employs 2 pairs matching Darlington Transistors driven by the popular 2N3053 Driver Transistors. Four built on board controls for, volume, balance, treble and bass. Power supply requires 48VCT 2.5A transformer. THD of less than 0.1% between 100Hz-10Khz at full power. (30 Watts + 30 Watts loaded into 8Ω).

★SPECIAL★
EXCELLENT PRICE!
MODEL 001-0034
$29.50 Per Kit
Transformer (Optional)
$10.50 ea.

ELECTRONIC DUAL SPEAKER PROTECTOR

Cuts off when circuit is shorted or over loaded to protect your amplifier as well as your speakers. A must for OCL circuits.

KIT FORM $8.75 ea.

"FISHER" 30 WATT STEREO AMP

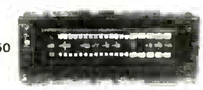
MAIN AMP (15W x 2). Kit includes 2 pcs. Fisher PA 301 Hybrid IC, all electronic parts with PC Board. Power supply ±16VDC (not included). Power band with (KF 1%±3dB). Voltage gain 33dB. 20Hz-20KHz.

Super Buy
Only $18.50

FLUORESCENT AUDIO LEVEL MONITOR

This is the kind of VU monitor that is being used by most amplifier manufacturers. IC's are used to simplify circuit layout. Easy to assemble and can be used with all power level amplifiers. Power requirement 12VDC.

TE-221 KIT
For Just $28.50
(Limited Stock)



MARK IV — 15 STEP
LED POWER LEVEL INDICATOR KIT

This new stereo level indicator kit consists of 36 4-color LED's (15 per channel) to indicate the sound level output of your amplifier from −36dB to +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 6-12VDC with THG on board input sensitivity controls. This unit can work with any amplifier from 1W to 200W! Kit includes 70 pcs driver transistors, 38 pcs matched 4-color LED's, all other electronic components, PC Board and front panel.

MARK IV KIT
$31.50

REGULATED DUAL VOLTAGE SUPPLY KIT

±10-30VDC @ 800ma adjustable, fully regulated by Fairchild 78MG and 79MG voltage regulator IC Kit. Includes all electronic parts, filter capacitors, IC's, heat sinks and PC Board.

$12.50 Per Kit

MICROPROCESSOR COMPONENTS

Z80	8.75	Z80A-DMA	28.50	2708	5.95
Z80A	9.25	2102	1.50	2716	9.60
8080A	5.50	21L02	1.50	2516	11.95
Z80-PIO	7.50	2114	2.95	2732	15.95
Z80A-PIO	8.50	2114L	2.95	2532	16.95
Z80A-SIO	29.50	4116	3.00	2764	49.95
Z80A-CTC	8.50	1702A	4.95		

SPECIAL OF THE MONTH

2532 EPROM	2732 EPROM	4116 (200nS)	
$9.95 ea.	$8.95 ea.	8/$13.50	32/$43.20

LIMITED QUANTITY

IC SOCKETS

	LP	WW 3 level		LP	WW 3 level
8-pin	5/ .75	5/1.91	22-pin	5/1.62	5/4.66
14-pin	5/1.00	5/2.40	24-pin	5/1.80	5/4.77
16-pin	5/1.20	5/2.65	28-pin	5/2.10	5/5.87
18-pin	5/1.35	5/2.98	40-pin	5/3.02	5/6.89
20-pin	5/1.52	5/4.55			

BRAND NEW IN BULK

MEMOREX 5¼" SINGLE SIDED DOUBLE DENSITY SOFT SECTOR DISKETTE
10 for $21.50 — 100 for $200.00

POWER SUPPLY KIT

0-30VDC REGULATED. Uses UA723 and 2N3055 power transistor. Output can be adjusted from 0-30V @ 2A. Complete with PC Board and all electronic parts.

TRANSFORMER $9.50 ea.
POWER SUPPLY KIT $10.50 ea.

WEM-36 FM WIRELESS MICROPHONE

TEET MODEL WEM-36 is a factory assembled FM wireless microphone powered by two AA size batteries. It transmits in the range of 88-108 MHz with 3 transistor circuits to meet with FCC part 15 regulations. Element is built in a plastic tube type case with an omni-directional electric condenser microphone unit. By using a standard FM radio, signal can be heard anywhere on a one-acre lot. Sound quality was judged "very good". MODEL WEM-36

$16.50 ea.

PRESS-A-LIGHT
SELF GENERATED FLASHLIGHT

Never worry about battery, because it has none! Easy to carry in pocket and handy to use. Ideal for emergency light. It generates its own electricity by squeezing grip lever. Put one in your car, boat, camper or home. You may need it some time!

EXCLUSIVE $3.95 ea.

FLUORESCENT LIGHT DRIVER KIT

12V DC POWERED ... Lights up 8-15 Watt Fluorescent Light Tubes. Ideal for camper, outdoor, auto or boat. Kit includes high voltage coil, power transistor, heat sink, all other electronic parts and PC Board. Light tube not included.

$6.50 Per Kit

SOLAR CELLS

0.5V 200MA. Ideal for all kinds of solar projects, cells can be put in series to double voltage or parallel to double current.

$1.99 ea.

FOR COMMERCIAL FREE TV BOX BUILDERS

MC1358	$3.00	LM7815	$1.20
MC1350	2.25	NE565	2.19
MC1330	3.00	Connectors Set	1.00
LM1458	1.00	IC Socket Set	2.00
LM380	2.00	Matching X'former	1.40
Sanyo UHF Tuner	35.00	Toroid Coils (Set 4)	3.00
Capacitors Set	12.50	Speaker Cabinet	12.95
Resitors Set	2.00	Power Transformer	
Trim Pots/Caps Set	13.50	18V @ 800ma	3.50
Pots and Knobs	2.00		

We sell all the above components in a package for $125.00 and you will receive a free pre-drilled PC Board and instructions at no charge.

DELUXE VERSION OF COMMERCIAL FREE TV

VCR COMPATIBLE!

MC4558	Sanyo UHF Tuner
MC1350	IC Sockets
MC1330	Transformer
MC1496	Matching Transformer
LM1889	Trimpots
NE564	Resistors
NE565	Capacitors
	RF Connectors
	Pots & Knobs & Switch
	Woodgrain Cabinet

We will sell you all the above components in a package for $175.00 and you will receive a pre-drilled PC Board and instructions at no extra charge!

Minimum Order $10.00/Calif. Residents add 6% Sales Tax.
Phone Orders Accepted on VISA or MC ONLY. NO C.O.D's

SHIPPING AND HANDLING CHARGES

	Under $50.00 Purchase	Over $50.00 Purchase
Inside California	10%	5%
Outside Calif. (Incl. Mexico & Canada)	15%	10%
Overseas	25%	20%

STORE HOURS
10-7 MON.-SAT.

8/82

CIRCLE 40 ON FREE INFORMATION CARD

7400

Part	Price	Part	Price	Part	Price
SN7400N	.20	SN7472N	.29	SN74156N	.79
SN7401N	.20	SN7473N	.35	SN74157N	.69
SN7402N	.25	SN7474N	.35	SN74160N	.89
SN7403N	.25	SN7475N	.49	SN74161N	.89
SN7404N	.25	SN7476N	.35	SN74162N	.89
SN7405N	.29	SN7479N	5.00	SN74163N	.89
SN7406N	.35	SN7480N	.50	SN74164N	.89
SN7407N	.35	SN7482N	.99	SN74165N	.89
SN7408N	.29	SN7483N	.69	SN74166N	1.25
SN7409N	.29	SN7485N	.89	SN74167N	2.79
SN7410N	.25	SN7486N	.35	SN74170N	1.95
SN7411N	.29	SN7489N	1.75	SN74172N	4.95
SN7412N	.35	SN7490N	.49	SN74173N	1.39
SN7413N	.40	SN7491N	.59	SN74174N	.99
SN7414N	.69	SN7492N	.45	SN74175N	.89
SN7416N	.29	SN7493N	.45	SN74176N	.79
SN7417N	.29	SN7494N	.69	SN74177N	.79
SN7420N	.25	SN7495N	.69	SN74179N	1.49
SN7421N	.29	SN7496N	.69	SN74180N	.79
SN7422N	.45	SN7497N	3.00	SN74181N	2.25
SN7423N	.29	SN74100N	1.49	SN74182N	.79
SN7425N	.29	SN74104N	.89	SN74184N	2.49
SN7426N	.29	SN74105N	.89	SN74185N	2.49
SN7427N	.25	SN74107N	.35	SN74190N	1.25
SN7428N	.49	SN74109N	.39	SN74191N	1.25
SN7430N	.25	SN74116N	1.95	SN74192N	.89
SN7432N	.29	SN74121N	.39	SN74193N	.89
SN7437N	.25	SN74122N	.55	SN74194N	.89
SN7438N	.40	SN74123N	.59	SN74195N	.69
SN7439N	.25	SN74125N	.49	SN74196N	.89
SN7440N	.20	SN74126N	.49	SN74197N	.89
SN7441N	.89	SN74132N	.75	SN74198N	1.49
SN7442N	.59	SN74136N	.75	SN74199N	1.49
SN7443N	1.10	SN74141N	.99	SN74221N	1.25
SN7444N	1.10	SN74142N	3.25	SN74251N	.99
SN7445N	.89	SN74143N	3.49	SN74276N	1.95
SN7446N	.79	SN74144N	3.49	SN74279N	.79
SN7447N	.69	SN74145N	.79	SN74283N	1.49
SN7448N	.79	SN74147N	1.95	SN74284N	3.95
SN7450N	.20	SN74148N	1.29	SN74285N	3.95
SN7451N	.20	SN74150N	1.25	SN74365N	.69
SN7453N	.20	SN74151N	.69	SN74366N	.69
SN7454N	.20	SN74152N	.69	SN74367N	.69
SN7459A	.25	SN74153N	.79	SN74368N	.69
SN7460N	.20	SN74154N	1.25	SN74390N	1.49
SN7470N	.29	SN74155N	.79	SN74393N	1.49

74LS

Part	Price	Part	Price	Part	Price
74LS00	.29	74LS92	.75	74LS192	1.15
74LS01	.29	74LS93	.75	74LS193	1.15
74LS02	.29	74LS95	.99	74LS194	1.15
74LS03	.29	74LS96	1.15	74LS195	1.15
74LS04	.35	74LS107	.45	74LS197	1.19
74LS05	.35	74LS109	.45	74LS221	1.19
74LS08	.35	74LS112	.45	74LS240	1.49
74LS09	.35	74LS113	.49	74LS241	1.49
74LS10	.35	74LS114	.49	74LS242	1.49
74LS11	.39	74LS122	.89	74LS243	1.49
74LS12	.35	74LS123	1.25	74LS244	1.49
74LS13	.59	74LS125	.59	74LS245	2.95
74LS14	.99	74LS126	.59	74LS247	1.19
74LS15	.35	74LS132	.99	74LS248	1.19
74LS20	.35	74LS133	.89	74LS249	1.19
74LS21	.35	74LS136	.59	74LS251	.99
74LS22	.35	74LS138	.89	74LS253	.99
74LS26	.35	74LS139	.89	74LS257	.89
74LS27	.35	74LS151	.89	74LS258	.69
74LS28	.35	74LS153	.89	74LS260	.69
74LS30	.35	74LS154	1.75	74LS266	.69
74LS32	.35	74LS155	.89	74LS273	1.95
74LS33	.59	74LS156	.89	74LS279	.89
74LS37	.45	74LS157	.89	74LS283	.89
74LS38	.39	74LS158	.89	74LS290	.99
74LS40	.35	74LS160	1.15	74LS293	.99
74LS42	.89	74LS161	1.15	74LS298	1.25
74LS47	.89	74LS162	1.15	74LS352	1.29
74LS48	1.15	74LS163	1.15	74LS353	1.29
74LS49	1.15	74LS164	1.15	74LS363	1.29
74LS51	.35	74LS165	1.15	74LS365	.69
74LS54	.35	74LS168	1.19	74LS366	.69
74LS55	.35	74LS169	1.19	74LS367	.69
74LS73	.45	74LS170	1.95	74LS368	.69
74LS74	.45	74LS173	.99	74LS373	1.95
74LS75	.59	74LS174	.99	74LS374	1.95
74LS76	.45	74LS175	.99	74LS375	.89
74LS78	.49	74LS181	2.95	74LS386	.69
74LS83	.89	74LS190	1.25	74LS393	2.49
74LS85	1.25	74LS191	1.25	74LS399	2.49
74LS86	.49			74LS670	2.49
74LS90	.69			81LS95	1.95
				81LS97	1.95

74S/PROMS*

Part	Price	Part	Price	Part	Price
74S00	.35	74S124	2.95	74S243	2.25
74S02	.35	74S133	.45	74S244	2.25
74S03	.35	74S134	.50	74S251	.99
74S04	.45	74S135	.89	74S253	.99
74S05	.45	74S136	1.39	74S257	.99
74S08	.40	74S138	.99	74S258	.99
74S09	.40	74S139	.99	74S260	.79
74S10	.35	74S140	.55	74S280	2.25
74S11	.35	74S151	.99	74S287*	1.95
74S15	.35	74S153	.99	74S288*	1.95
74S20	.35	74S157	.99	74S373	2.49
74S22	.35	74S158	.99	74S374	2.49
74S30	.35	74S160	2.49	74S387*	1.95
74S32	.45	74S174	1.25	74S471*	5.95
74S38	.89	74S175	1.25	74S472*	5.95
74S40	.40	74S188*	1.95	74S473*	5.95
74S51	.35	74S194	1.49	74S474*	7.95
74S64	.40	74S195	1.49	74S475*	7.95
74S65	.40	74S196	1.49	74S570*	4.49
74S74	.55	74S240	2.25	74S571*	4.49
74S86	.55	74S241	2.25	74S572*	5.95
74S112	.55	74S242	2.25	74S573*	5.95
74S113	.55			74S940	1.95
74S114	.55			74S941	1.95

CA—LINEAR

Part	Price	Part	Price	Part	Price
CA3010H	.99	CA3060N	3.25	CA3089N	3.75
CA3013H	2.15	CA3080H	1.25	CA3096N	3.95
CA3023H	3.25	CA3081N	2.00	CA3130H	1.39
CA3035H	2.49	CA3082N	2.00	CA3140H	1.25
CA3039H	1.35	CA3083N	1.60	CA3160H	1.25
CA3046N	1.30	CA3086N	.85	CA3401N	.59
CA3059N	3.25			CA3600N	3.50

CD—CMOS

Part	Price	Part	Price	Part	Price
CD4000	.39	CD4041	1.49	CD4098	2.49
CD4001	.39	CD4042	.99	CD4506	.75
CD4002	.39	CD4043	.89	CD4507	.99
CD4006	1.19	CD4044	.89	CD4508	3.95
CD4007	.29	CD4046	1.79	CD4510	1.39
CD4009	.49	CD4047	2.50	CD4511	1.29
CD4010	.49	CD4048	1.35	CD4512	1.49
CD4011	.39	CD4049	.49	CD4514	3.95
CD4012	.25	CD4050	.69	CD4515	2.95
CD4013	.49	CD4051	1.19	CD4516	1.49
CD4014	1.39	CD4052	1.19	CD4518	1.79
CD4015	1.19	CD4053	1.19	CD4519	.89
CD4016	.59	CD4056	2.95	CD4520	1.29
CD4017	1.19	CD4059	9.95	CD4526	1.79
CD4018	.99	CD4060	1.49	CD4528	1.79
CD4019	.49	CD4066	.79	CD4529	1.95
CD4020	1.19	CD4068	.39	CD4543	2.79
CD4021	1.39	CD4069	.45	CD4562	11.95
CD4022	1.19	CD4070	.55	CD4566	2.79
CD4023	.29	CD4071	.49	CD4583	2.49
CD4024	.79	CD4072	.49	CD4584	.75
CD4025	.23	CD4073	.39	CD4723	1.95
CD4026	2.95	CD4075	.39	CD4724	1.95
CD4027	.69	CD4076	1.39	MC14409	17.95
CD4028	.89	CD4078	.55	MC14410	18.95
CD4029	1.49	CD4081	.39	MC14411	15.95
CD4030	.49	CD4082	.39	MC14412	15.95
CD4034	3.49	CD4093	.99	MC14419	7.95
CD4035	.99			MC14433	15.95
CD4040	1.49			MC14538	2.49
				MC14541	1.95

MICROPROCESSOR COMPONENTS

STATIC RAMS

1101	256x1	(650ns)	1.49
2101 (8101)	256x4	(450ns)	3.95
2102	1024x1	(350ns)	1.75
21L02	1024x1	(450ns) L.P.	1.95
2111 (8111)	256x4	(450ns)	3.95
2112	256x4	(450ns) MOS	4.95
2114	1024x4	(450ns)	2.25 — 8/14.95
2114L	1024x4	(450ns) L.P.	2.49 — 8/16.95
2114-2	1024x4	(200ns)	2.49 — 8/16.95
2114L-2	1024x4	(200ns) L.P.	2.95 — 8/19.95
2141-3	4096x1	(150ns)	7.95
2147	4096x1	(70ns)	4.95
2148	1024x4	(70ns)	8.95
TMS4044	4096x1	(450ns)	5.95
TMS4045	1024x4	(450ns)	5.95
5101	256x4	(450ns) CMOS	7.95
MM5257(4044)	4096x1	(450ns)	6.40
HM6116-4	2048x8	(200ns) CMOS	9.95
HM6116LP-4	2048x8	(200ns) L.P. CMOS	9.95
7489 (3101)	16x4	(50ns)	1.75
74C920 (6551)	256x4	(250ns) CMOS	6.49
74C921	256x4	(250ns) CMOS	5.95
74C929 (6501)	1024x1	(250ns) CMOS	5.95
74C930 (6518)	1024x1	(250ns) CMOS	5.49
74S189 (93405)	16x4	(35ns)	2.95
74S200 (93410)	256x1	(80ns)	4.95
74S206 (93411)	256x1	(60ns)	4.95
74S289 (3101)	16x4	(35ns)	2.49
82S10 (93415)	1024x1	(50ns) O.C.	4.95
82S25 (74S289)	16x4	(50ns) O.C.	3.49

EPROMS

1702A	256x8	(1µs)	4.95
2708	1024x8	(450ns)	4.95
TMS2516	2048x8	(450ns) 2716	6.95
TMS2532	4096x8	(450ns) NMC2532	9.95
TMS2564	8192x8	(450ns)	39.95
TMS2716	2048x8	(450ns) 3 voltage	9.95
2716	2048x8	(450ns)	5.95
2732	4096x8	(450ns)	9.95
2758Q	1024x8	(450ns) single +5V	7.49
MM2764	8192x8	(450ns)	29.95
MM52030	256x8	(1µs)	14.95

MICROPROCESSOR CHIPS

Z80 (780C)	CPU (MK3880N) (2MHz)	11.95
Z80A (780-1)	CPU (MK3880N-4) (4MHz)	13.95
CDP1802	CPU	19.95
2650	MPU	16.95
IDM2901ADC	CPU—4-bit slice (Com. Temp. Gr.)	19.95
MCS6502	MPU w/Clock (65K bytes mem.)	11.95
INS8035N-6	MPU—8-bit (6MHz)	7.95
INS8039N-6	CPU-Sgl chip 8-bit (128 bts. Ram)	9.95
INS8040N-6	CPU (256 bytes RAM)	24.95
INS8070N	CPU (64 bytes RAM)	24.95
INS8073N	CPU w/Basic Micro Interpreter	29.95
P8085	CPU	9.95
TMS9900JL	MPU — 16-bit	39.95

MICROPROCESSOR MANUALS

M-Z80	User Manual	7.50
M-CDP1802	User Manual	7.50
M-2650	User Manual	5.00

6800/6800 SUPPORT DEVICES

MC6800	MPU	7.95
MC6802CP	MPU with clock and RAM	14.95
MC6810API	128x8 Static RAM	4.05
MC6821	Peripheral Inter. Adapt (MC6820)	7.49
MC6828	Priority Interrupt Controller	17.95
MC6830L8	1024x8-bit ROM (MC68A30-8)	14.95
MC6850	Asynchronous Comm. Adapter	6.95
MC6852	Synchronous Serial Data Adapter	6.95
MC6860	0-600bps Digital MODEM	10.95
MC6862	2400bps Modulator	12.95
MC6880A	Quad 3-state bus. trans. (MC8T26)	2.25

8080/8080A SUPPORT DEVICES

INS8080A	CPU	4.95
DP8212	8-bit Input/Output	3.25
DP8214	Priority Interrupt Control	5.95
DP8216	Bi-Directional Bus Driver	3.49
DP8224	Clock Generator/Driver	3.95
DP8226	Bus Driver	3.49
DP8228	System Controller/Bus Driver	4.95
DP8238	System Controller	5.95
INS8243	I/O Expander for 48 Series	9.95
INS8250	Asynchronous Comm. Element	16.95
DP8251	Prog. Comm. I/O (USART)	6.95
DP8253	Prog. Interval Timer	8.95
DP8255	Prog. Peripheral I/O (PPI)	5.95
DP8257	Prog. DMA Control	9.95
DP8259	Prog. Interrupt Control	9.95
DP8275	Prog. CRT Controller	39.95
DP8279	Prog. Keyboard/Display Interface	9.95
DP8303	System Timing Element	6.95
DP8304	8-bit Bi-Directional Receiver	3.95
DP8307	8-bit Bi-Directional Receiver	3.95
DP8308	8-bit Bi-Directional Receiver	3.95
DP8310	Octal Latched Peripheral Driver	5.25
DP8311	Octal Latched Peripheral Driver	5.25

DYNAMIC RAMS

1103	1024x1	(300ns)	.99
4027	4096x1	(250ns)	2.49
4116N-2	16,384x1	(150ns)	2.95 — 8/19.95
4116N-3	16,384x1	(200ns)	2.49 — 8/16.95
4116N-4	16,384x1	(250ns)	1.95 — 8/14.95
4164N-2	65,536x1	(200ns)	9.95
MM5261	1024x1	(300ns)	.49 — 8/1.95
MM5262	2048x1	(365ns)	.49 — 8/1.95
MM5270(MK4096)	4096x1	(250ns)	4.95
MM5280 (2107)	4096x1	(200ns)	4.95
MM5290-2	16,384x1	(150ns)	2.95 — 8/19.95
MM5290-3	16,384x1	(200ns)	2.49 — 8/16.95
MM5290-4	16,384x1	(250ns)	1.95 — 8/14.95
MM5298-3	8192x1	(200ns)	1.95

PROMS

74S188	32x8	PROM O.C. (6330-1)	1.95
74S287	256x4	PROM T.S. (6301-1)	1.95
74S288	32x8	PROM T.S. (6331-1)	1.95
74S387	256x4	PROM O.C. (6300-1)	1.95
74S471	256x8	PROM T.S. (6309-1)	5.95
74S472	512x8	PROM T.S. (6349-1)	5.95
74S473	512x8	PROM O.C. (6348)	5.95
74S474	512x8	PROM O.C. (6340)	5.95
74S475	512x8	PROM T.S. (DM87S296N)	7.95
74S478	1024x8	PROM T.S. (TBP28S86)	12.95
74S570	512x4	PROM O.C. (6305)	4.49
74S571	512x4	PROM T.S. (6306)	4.49
74S572	1024x4	PROM O.C. (6352)	5.95
74S573	1024x4	PROM T.S. (82S137)	5.95
82S23	32x8	PROM O.C. (27S18)	3.95
82S115	512x8	PROM T.S. (27S15)	9.95
82S123	32x8	PROM T.S. (27S19)	3.95
82S126	256x4	PROM O.C. (27S20)	3.95
82S129	256x4	PROM T.S. (27S21)	3.95
82S130	512x4	PROM O.C. (27S12)	5.95
82S185	2048x4	PROM T.S. (TBP24S81)	9.95
DM87S180N	1024x8	PROM O.C. (82S180)	9.95
DM87S181N	1024x8	PROM T.S. (82S181)	9.95
DM87S184N	2048x4	PROM O.C. (82S184)	9.95
DM87S185N	2048x4	PROM T.S. (82S185)	9.95
DM87S190N	2048x8	PROM O.C. (82S190)	19.95
DM87S191N	2048x8	PROM T.S. (82S191)	19.95

ROM'S

2513 (2140)	Character Generator (Upper Case)	9.95
2513 (3021)	Character Generator (Lower Case)	9.95

NMOS READ ONLY MEMORIES

MCM66710P	128x9x7 ASCII Shifted w/Greek	13.50
MCM66740P	128x9x7 Math Symbol & Pictures	13.50
MCM66750P	128x9x7 Alpha. Control Char. Gen.	13.50

DATA ACQUISITION

DC10	Mostek DC/DC Convert. +5V to -9V	2.95
MC3470P	Floppy Disk Read AMP System	4.95
MC1408L7	7-bit D/A Converter (DAC0807LCN)	4.95
MC1408L8	8-bit D/A Converter (DAC0808LCN)	5.75
AF100-1CN	Universal Active Filter 2.5%	5.95
AF121-1CJ	Touch Tone Low Band Filter	19.95
AF122-1CJ	Touch Tone High Band Filter	19.95
LM308CH	Super Gain Op Amp	1.15
LM334Z	Constant Current Source	1.30
LM335Z	Temperature Transducer	1.40
LF356N	JFET Input Op Amp	1.10
LF398N	Sample & Hold Amplifiers	3.95
LM399H	Temp.Comp.Prec. Ref. (.5ppm/C°)	5.00
ADC0804LCN	8-bit A/D Converter (1 LSB)	4.95
DAC0806LCN	8-bit D/A Converter (0.78% Lin.)	2.25
ADC0809CCN	8-bit A/D Converter (8-Ch. Mult.)	5.25
ADC0817CCN	8-bit A/D Converter (16-Ch. Mult.)	10.95
DAC1000LCN	10-bit D/A Conv. Micro. Comp. (0.05%)	13.95
DAC1008LCN	10-bit D/A Conc. Micro. Comp. (0.20%)	8.95
DAC1020LCN	10-bit D/A Converter (0.05% Lin.)	8.49
DAC1022LCN	10-bit D/A Converter (0.20% Lin.)	5.95
DAC1222LCN	12-bit D/A Converter (0.20% Lin.)	9.95
CD4051N	8-Channel Multiplexer	1.19
AY-5-1013	30K BAUD UART	6.95

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DS0025CN	Dual MOS Clock Driver (5MZ)	3.50
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HD0165-5	Keyboard Encoder (16 keys)	7.95
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74C923	Keyboard Encoder (20 keys)	5.75
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14 pin LP	.20	.19	.18
16 pin LP	.22	.21	.20
18 pin LP	.29	.28	.27
20 pin LP	.34	.32	.30
22 pin LP	.37	.36	.35
24 pin LP	.38	.37	.36
28 pin LP	.45	.44	.43
36 pin LP	.60	.59	.58
40 pin LP	.63	.62	.61

SOLDERTAIL STANDARD (TIN)

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

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16 pin SG	.54	.49	.44
18 pin SG	.59	.53	.48
24 pin SG	.79	.75	.69
28 pin SG	1.10	1.00	.90
36 pin SG	1.65	1.40	1.26
40 pin SG	1.75	1.59	1.45

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8 pin WW	.59	.54	.49
10 pin WW	.69	.63	.58
14 pin WW	.79	.73	.67
16 pin WW	.85	.77	.70
18 pin WW	.99	.90	.81
20 pin WW	1.19	1.08	.99
22 pin WW	1.39	1.26	1.14
24 pin WW	1.49	1.35	1.23
28 pin WW	1.69	1.53	1.38
36 pin WW	2.19	1.99	1.79
40 pin WW	2.29	2.09	1.89

INTERSIL

*Evaluation Kits

Part No.	Function	Price
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7106CPL	3½ Digit A/D (LCD Drive)	16.95
7106EV/Kit*	IC, Circuit Board, Display	34.95
7107CPL	3½ Digit A/D (LED Drive)	15.95
7107EV/Kit*	IC, Circuit Board, Display	29.95
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7117CPL	3½ Digit A/D LED Dis. HLD.	17.95
7201IDR	Low Battery Volt Indicator	2.25
7205IPG	CMOS LED Stopwatch/Timer	12.95
7205EV/Kit*	Stopwatch Chip, XTL	19.95
7206CJPE	Tone Generator	5.15
7206CEV/Kit*	Tone Generator Chip, XTL	12.95
7207AIPD	Oscillator Controller	6.50
7207AEV/Kit*	Freq. Counter Chip, XTL	13.95
7208IPI	Seven Decade Counter	17.95
7209IPA	Clock Generator	3.95
7215IPG	4 Func. CMOS Stopwatch CKT	13.95
7215EV/Kit*	4 Func. Stopwatch Chip, XTL	19.95
7216AIJI	8-Digit Univ. Counter C.A.	32.00
7216CIJI	8-Digit Freq. Counter C.A.	26.95
7216DIPI	8-Digit Freq. Counter C.C.	21.95
7217IJI	4-Digit LED Up/Down Counter CA	12.95
7217AIPI	4-Digit LED Up/Down Counter CC	14.95
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7226AIJL	8-Digit Univ. Counter	31.95
7226AEV/Kit*	5 Function Counter Chip, XTL	74.95
7240IJE	CMOS Bin Prog. Timer/Counter	4.95
7242IJA	CMOS Divide-by-256 RC Timer	2.05
7250IJE	CMOS BCD Prog. Timer/Counter	6.00
7260IJE	CMOS BCD Prog. Timer/Counter	5.25
7555IPA	CMOS 555 Timer (8 pin)	1.45
7556IPD	CMOS 556 Timer (14 pin)	2.20
7611BCPA	CMOS Op Amp Comparator 5MV	2.25
7612BCPA	CMOS Op Amp Ext. Cmvr. 5MV	2.95
7621BCPA	CMOS Dual Op Amp Comp. 5MV	3.95
7631CCPE	CMOS Tri Op Amp Comp. 10MV	5.35
7641CCPD	CMOS Quad Op Amp Comp. 10MV	7.50
7642CCPD	CMOS Quad Op Amp Comp. 10MV	7.50
7660CPA	Voltage Converter	2.95
8038CCPD	Waveform Generator	4.95
8048CCPE	Monolithic Logarithmic Amp	21.60
8069CCQ	50ppm Band—GAP Volt Ref. Diode	2.50
8211CPA	Volt Ref/Indicator	2.95
8212CPA	Volt Ref/Indicator	2.95

74C

Part	Price	Part	Price	Part	Price
74C00	.39	74C95	1.59	74C221	1.95
74C02	.39	74C107	1.89	74C240	2.25
74C04	.39	74C151	2.95	74C244	2.25
74C08	.39	74C154	3.95	74C373	2.49
74C10	.39	74C157	2.25	74C374	2.59
74C14	.75	74C160	1.69	74C901	.69
74C20	.39	74C161	1.60	74C903	.69
74C30	.39	74C162	1.49	74C911	10.95
74C32	.39	74C163	1.69	74C912	10.95
74C42	1.39	74C164	1.59	74C915	1.69
74C48	1.95	74C173	1.39	74C917	10.95
74C73	.79	74C174	1.39	74C922	5.49
74C74	.79	74C175	1.19	74C923	5.75
74C85	1.99	74C192	1.69	74C925	7.50
74C86	.99	74C193	1.69	74C926	7.50
74C89	6.95	74C195	1.59	80C95	.79
74C90	1.29			80C97	.79
74C93	1.29				

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Part	Price	Part	Price	Part	Price
LH0002CN	6.85	LM340T-5	1.25	NE571N	3.95
LM10CLH	4.50	LM340T-12	1.25	LM703CN	.89
LM11CLH	4.75	LM340T-15	1.25	LM709N	.29
LH0070-0H	4.95	LM341P-5	.75	LM710N	.79
TL071CP	.79	LM341P-12	.75	LM711N	.79
TL072CP	1.39	LM341P-15	.75	LM723N	.69
TL074CN	2.49	LM342P-5	.69	LM733N	1.00
LH0082CD	35.80	LM342P-12	.69	LM739N	1.19
TL082CP	1.19	LM342P-15	.69	LM741CN	.35
TL084CN	2.19	LM348N	1.25	MC1741SCG	3.00
LH0094CD	36.80	LM350K	5.75	LM747N	.79
LM300H	.99	LF351N	.60	LM748N	.59
LM301CN	.35	LF353N	1.00	LM1014N	2.75
LM302H	1.95	LF355N	1.10	LM1310N	1.95
LM304H	1.95	LF356N	1.10	LM1458CN	.59
LM305H	.99	LM358N	1.00	LM1488N	1.25
LM307CN	.45	LM359N	1.79	LM1489N	1.25
LM308CN	1.00	LM370N	4.49	LM1496N	1.95
LM309H	1.95	LM373N	3.25	LM1556V	1.75
LM309K	1.25	LM377N	2.95	LM1800N	2.95
LM310CN	1.75	LM380N	1.25	LM1871N	5.49
LM311/CN	.90	LM381N	1.95	LM1872N	5.49
LM312H	2.49	LM382N	1.79	LM1877N-9	3.25
LM317MP	1.15	LM384N	1.95	LM1889N	3.20
LM317T	1.95	LM386N-3	1.29	LM1896N	1.75
LM317K	3.95	LM387N	1.45	LM2002T	1.49
LM318CN	1.95	LM389N	1.35	LM2877P	2.05
LM319N	1.95	LM392N	.69	LM2878P	2.25
LM320K-5	1.35	LF398N	4.00	LM2896P-1	2.25
LM320K-12	1.35	LM399H	5.00	LM3189N	2.95
LM320K-15	1.35	TL494CN	4.49	LM3900N	.69
LM320T-5	1.25	TL496CP	1.75	LM3905CN	1.25
LM320T-12	1.25	NE510A	6.00	LM3909N	1.15
LM320T-15	1.25	NE529A	4.95	LM3914N	3.95
LM323K	5.95	NE531H	3.95	LM3915N	3.95
LM324N	.99	NE536H	6.00	LM3916N	3.95
LM329DZ	.65	NE540H	6.00	RC4136N	1.25
LM331N	3.95	NE544N	4.95	RC4151NB	3.95
LM334Z	1.30	NE550A	1.30	RC4194TK	6.95
LM335Z	1.40	NE555V	.39	RC4195TK	5.49
LM336Z	1.75	NE556N	.99	LM4500A	3.25
LM337T	1.95	NE564N	3.95	ICL8038B	4.95
LM337MP	1.15	LM565N	.99	LM13080N	1.29
LM338K	6.95	LM566CN	1.95	LM13600N	1.49
LM339N	.99	LM567V	1.25	75138N	1.95
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47 pf	.08	.06	.05	.01µF	.08	.06	.05
100 pf	.08	.06	.05	.022µF	.09	.07	.06
220 pf	.08	.06	.05	.047µF	.09	.07	.06
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.001mf	.12	.10	.07	.022mf	.13	.11	.08
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.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22

+20% DIPPED TANTALUMS (Solid) CAPACITORS

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.22/35V	.39	.34	.29	3.3/25V	.53	.47	.37
.33/35V	.39	.34	.29	4.7/25V	.63	.56	.45
.47/35V	.39	.34	.29	6.8/25V	.79	.69	.55
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1.0/50V	.19	.16	.12	.47/50V	.16	.14	.13
3.3/50V	.17	.15	.11	1.0/16V	.15	.13	.12
4.7/25V	.18	.15	.11	1.0/25V	.16	.14	.13
10/25V	.18	.15	.11	1.0/50V	.17	.15	.14
10/50V	.19	.16	.12	4.7/16V	.15	.13	.12
22/25V	.19	.16	.12	4.7/25V	.16	.14	.13
22/50V	.24	.20	.18	4.7/50V	.17	.15	.14
47/25V	.25	.21	.19	10/16V	.15	.13	.12
47/50V	.29	.25	.23	10/25V	.16	.14	.13
100/25V	.28	.24	.22	10/50V	.17	.15	.14
100/50V	.41	.37	.34	47/50V	.25	.21	.19
220/25V	.39	.34	.33	100/16V	.21	.17	.14
220/50V	.49	.45	.41	100/25V	.25	.23	.21
470/25V	.54	.49	.45	100/50V	.37	.34	.31
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8/82

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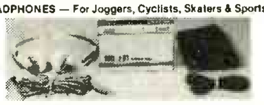

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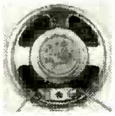

2¼" Round — 8 Ohm .25 Watt (4" Leads) Size: 2¼" x ¾"

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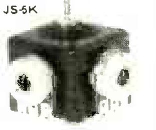
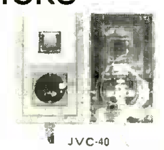
JS-5K





JVC-40

JS-5K	5K Linear Taper Pots	$5.25
JS-100K	100K Linear Taper Pots	$4.95
JS-150K	150K Linear Taper Pots	$4.75
JVC-40	40K (2) Video Controller in case	$4.95

5¼" Mini-Floppy Disc Drive
Partec Computer Corp.

FOR TRS-80 MODEL I, III (Industry Standard)

Features single or double density. Recording mode: FM single, MFM double density. Power: +12VDC (±0.6V) 1.6 amps max. 5VDC (±0.25V) 0.8 amps max. Unit as pictured at left (does not incl. case, power supply or cables). 30-page data book included. Weighs 3½ pounds. Size: 5¾"W x 8"D x 3¼"H

Limited Quantity!

Part No.	Price
FD200 — Single-sided, 40 tracks, 250K bytes capacity	$179.95
FD250 — Double-sided, 35 tracks, 438K bytes capacity	$199.95

JE215 Adjustable Dual Power Supply

General Description: The JE215 is a Dual Power Supply with independent adjustable positive and negative output voltages. A separate adjustment for each of the supplies provides the user unlimited applications for IC current voltage requirements. The supply can also be used as a general all-purpose variable power supply.

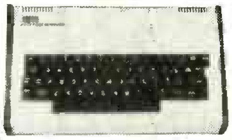
FEATURES
- Adjustable regulated power supplies, pos. and neg. 1.2VDC to 15VDC.
- Power Output (each supply): 5VDC @ 500mA, 10VDC @ 750mA, 12VDC @ 500mA, and 15VDC @ 175mA.
- Two, 3-terminal adj. IC regulators with thermal overload protection.
- Heat sink regulator cooling
- LED "on" indicator
- Printed Board Construction
- 120VAC input
- Size: 3-1/2"w x 5-1/16"L x 2"H

JE215 Adj. Dual Power Supply Kit (as shown) .. **$24.95**

(Picture not shown but similar in construction to above)

JE200 Reg. Power Supply Kit (5VDC, 1 amp)	$14.95
JE205 Adapter Brd. (to JE200) ±5, ±9 & ±12V.	$12.95
JE210 Var. Pwr. Sply. Kit, 5-15VDC, to 1.5amp.	$19.95

KEYBOARDS — POWER SUPPLIES



JE610 ASCII Encoded Keyboard Kit

The JE610 ASCII Keyboard Kit can be interfaced into most any computer system. The kit comes complete with 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 128 characters, upper and lower case ASCII set. Fully buffered. Two user-define keys provided for custom applications. Caps lock for upper-case-only alpha characters. Utilizes a 2376 (40-pin) encoder read-only memory chip. Outputs directly compatible with TTL/DTL or MOS logic arrays. Easy interfacing with a 16-pin dip or 18-pin edge connector. Size: 3½"H x 14½"W x 8¾"D.

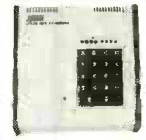
JE610/DTE-AK (After assembly as pictured above) **$124.95**

JE610 Kit 62-Key Keyboard, PC Board & Components (no case) ...... **$ 79.95**

K62 62-Key Keyboard (Keyboard only) .... **$ 34.95**

DTE-AK (case only — 3¼"H x 11"W x 8¾"D) .... **$ 49.95**

JE212 — Negative 12VDC Adapter Board Kit for JE610 ASCII KEYBOARD KIT
Provides −12VDC from incoming 5VDC $9.95



JE600 Hexadecimal Encoder Kit
FULL 8-BIT LATCHED OUTPUT 19-KEY KEYBOARD

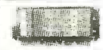
The JE600 Encoder Keyboard Kit provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8-bit microprocessor or 8-bit memory circuits. Three additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with 9 LED readouts. Also included is a key entry strobe. Features: Full 8-bit latched output for microprocessor use. Debounce circuit provided for all 19 keys. Nine LED readouts to verify entries. Easy interfacing with standard 16-pin IC connector. Only +5VDC required for operation. Size: 3½"H x 8¼"W x 8¾"D.

JE600/DTE-HK (After assembly as pictured above) **$99.95**

JE600 Kit 19-Key Hexadecimal Keyboard, PC Board & Components (no case) **$59.95**

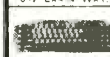
K19 19-Key Keyboarc (Keyboard only) **$14.95**

DTE-HK (case only — 3½"H x 8¼"W x 8¾"D) **$44.95**



9½"L x 4¼"W x 1"H

ALPS 26-KEY CALCULATOR KEYBOARD
Gray Key Caps with blue, green and white back drop. Mechanical SPST Switching: 22-pin Edge Card Connection.
Part No. KB26 .... $2.95 each or 2/$4.95



16⅛"L x 5¼"W x 1⅝"H

MICRO SWITCH 69-KEY KEYBOARD
Data Entry Keyboard, Encoded Output: 8-bit Parallel EBC DIC. Switching: Hall Effect, 24-pin Edge Card Connection. Complete with Pin Connection.
Part No. KB69SD12-2 .... $19.95 each

16¾"L x 5½"W x 1⅞"H

DATANETICS 74-KEY KEYBOARD
ASCII Encoded Keyboard, Output: Even Parity ASCII. Supply voltage +5, -12 volt. Switching: Mechanical SPST — 50-pin Connection. Complete with Pin Connection.
Part No. KB354 .... $29.95 each

23"L x 5¾"W x 1-3/8"H

MICRO SWITCH 85-KEY KEYBOARD
Data Entry Keyboard. Switching: Hall Effect, 13-pin Edge Card Connection. Metal frame, dark brown key caps.
Part No. 85SD18-1 .... $29.95 each

18⅛"L x 5⅝"W x 1⅝"H

MICRO SWITCH 88-KEY KEYBOARD
Data Entry Keyboard used in a Diablo 1640 Terminal. Supply Voltage: +5V, -12V. Switching: Hall Effect — 10-pin Edge Card Connection. Schematic Included.
Part No. 88SD22 .... $69.95 each

POWER SUPPLIES

POWER SUPPLY — 5VDC @ 1 AMP REGULATED — Transaction Tech
Output +5VDC @ 1 amp (also +30VDC) reg. Input 115VAC 60Hz. Two-tone (black/beige) self-enclosed case, 6 ft., 3 cond. black power cord. Size: 6½"W x 7"D x 2¼"H. Wt. 3 lbs.
Part No. PS51194 .... $19.95 each

POWER SUPPLY — 5VDC @ 1 AMP REGULATED — B Industries
Output +5VDC @ 1 amp, +36-42VDC adj. 400mA or less, 30VAC (isol.) @ 1.5 amp. Input 115VAC 60Hz. Circ. brkr. re-set button. Blk. self-encl. case w/4 rubber feet. 6 ft., 3 cond. blk. pow. cord. On/off switch. 6¾"W x 7¾"D x 3-7/8"H - wt. 7 lbs.
Part No. PS407D .... $24.95 each

POWER SUPPLY — 5VDC @ 7.5 AMP, 12VDC @ 1.5 AMP SWITCHING
Input: 115VAC, 50-60Hz @ 3 amp/230VAC, 50Hz @ 1.6 amp. Fan volt./power supply select switches (115/230VAC). Output: 5VDC @ 7.6 amp, 12VDC @ 1.6 amp. 8 ft. blk. pow. cord. 11½"W x 13¼"D x 3¾"H. Wt. 6 lbs.
Part No. PS94V0 .... $49.95 each

POWER PAC — Heavy Duty Multi-Voltage Power Supply — 5VDC, 12VDC, 24VDC
Output: +5VDC @ 30A, +12VDC @ 2A, -12VDC @ 4A & +24VDC @ 3A. Input: 115VAC, 7A, 220VAC, 3.5A. Reg.: ± .15% line & load comb. Ripple: 10MV peak to peak (3MV RMS). Overvolt. protect.: 5V, +12V, -12V. Overcur. protect. Incl. 15½"L x 6"H x 11-7/8"D. Wt. 40 lbs.
Part No. 285-016 .... $89.95 each

★ SHIPMENT IN 24 HOURS ★
6:00 AM to 6:00 PM (PST)
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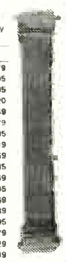
Custom Jumpers! **JUMPER AND CABLE ASSEMBLIES** *Custom Cables!*

STANDARD DIP JUMPERS

All jumpers use low profile dip plugs with heavy duty pins for repeated disconnect applications

JAMECO Part No.	AP Cross Reference	No. Pins	Description	Wire Length	Price
DJ14-1	924102 12	14	single end	12"	$1.79
DJ14-2	924102 24	14	single end	24"	2.05
DJ14-3	924102 36	14	single end	36"	2.35
DJ14-1 14	924106 12	14	double end	12"	3.20
DJ14-2 14	924106 24	14	double end	24"	3.49
DJ14-3 14	924106 36	14	double end	36"	3.79
DJ16-1	924112 12	16	single end	12"	1.85
DJ16-2	924112 24	16	single end	24"	2.19
DJ16-3	924112 36	16	single end	36"	2.59
DJ16-1 16	924116 12	16	double end	12"	3.35
DJ16-2 16	924116 24	16	double end	24"	3.69
DJ16-3 16	924116 36	16	double end	36"	4.05
DJ24-1	924122 12	24	single end	12"	2.69
DJ24-2	924122 24	24	single end	24"	3.39
DJ24-3	924122 36	24	single end	36"	3.95
DJ24-1 24	924126 12	24	double end	12"	4.79
DJ24-2 24	924126 24	24	double end	24"	5.29
DJ24-3 24	924126 36	24	double end	36"	5.89



JAMECO Part No.	AP Cross Reference	No. Pins	Description	Wire Length	Price
DJ40-1	924132 12	40	single end	12"	5.89
DJ40-2	924132 24	40	single end	24"	6.79
DJ40-3	924132 36	40	single end	36"	7.69
DJ40-1 40	924136 12	40	double end	12"	10.95
DJ40-2 40	924136 24	40	double end	24"	11.89
DJ40-3 40	924136 36	40	double end	36"	12.79

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Now you can order DB25 P or S connectors with the cable necessary to fit your application. Choose from our standard flat cable in 4-foot lengths. **Call today.**

STANDARD CABLES

Part No.	Cable Length	Connectors	Price
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DB25S-4	4 feet	1-DB25S	10.95 ea.
DB25P-4-P	4 feet	2-DB25P	16.95 ea.
DB25P-4-S	4 feet	1-DB25P/1-DB25S	17.95 ea.
DB25S-4-S	4 feet	2-DB25S	18.95 ea.

BOOKS
National Semiconductor — Intersil — Intel

30001	National CMOS Data Book (640 pages) 74C, CD4000, and A/D Converters	$5.95
30002	National Interface Data Book (704 pages) DP, DS8000, OS3600, DS75000, etc.	$6.95
30003	National Linear Data Book (1376 pages) LM, LF, ADC, DAC, LH Series	$11.95
30004	National Series 80 — Board Level Computer (224 pages)	$4.95
30005	National TTL Logic Data Book (624 pages) 7400, LS, L, H, S, and DM8000 Series	$8.95

30006 Above (3) 30001,3,5 as set $24.95/lot

010400	Intel Component Data Catalog — Full data sheets for Intel's products incl. memory devices, microproc., peripherals & indust./mil. products (1328 pages)	$14.95
205610	Intel Peripheral Design Handbook — Full data sheets, appl. notes for Intel peripheral device components (644 pages)	$9.95

AC and DC Wall Transformers

Part No. DC6912

With Universal Plug and 9V Battery Snap

Selective voltages: 6,9,12VDC. Polarity selection (+/-). six-foot line from adapter to plugs — six-inch line from adapter to battery snap. 120V/60Hz. 300mA.

Part No.	Input	Output	Price
AC 250	117V/60Hz	12VAC 250mA	$3.95
AC 500	117V/60Hz	12VAC 500mA	$4.95
AC1000	117V/60Hz	12VAC 1 amp	$5.95
AC9004	117V/60Hz	9.2VAC 2.5 amp	$2.95 or 2/$4.95
DC 800	120V/60Hz	8VDC 400mA	$1.95 or 2/$2.95
DC6912 (above)	120V/60Hz	6,9,12VDC 300mA	$9.95
DV5490	117V/60Hz	9.5VDC 275mA	$2.49 or 2/$3.95
DC900	120V/60Hz	9VDC 500mA	$3.95
DC1200	120V/60Hz	12VDC 300mA	$2.95 or 2/$4.95

CONNECTORS
DB25P/DB25S Meet RS232 — Computer Users!

DB25P	D-Subminiature Plug	$2.95
DB25S	D-Subminiature Socket	$3.50
D20418-2	Screw Lock Hdwr. (2) DB25S/P	2/$.99
DB51226	Cover for DB25P/S	$1.75
22/44SE	P.C. Edge (22/44 Pin)	$2.95
UG88/U	BNC Plug	$1.79
UG89/U	BNC Jack	$3.79
UG175/U	UHF Adapter	$ .49
SO239	UHF Panel Recp.	$1.29
PL258	UHF Adapter	$1.60
PL259	UHF Plug	$1.60
UG260/U	BNC Plug	$1.79
UG1094/U	BNC Bulkhead Recp.	$1.29

TRS-80 16K Conversion Kit
Expand your 4K TRS-80 System to 16K or 32K

Kit comes complete with:
- 8 ea. MM5290 (UPD416/4116) 16K Dyn. Ram (*ns)
- Documentation for conversion

TRS-16K2 *150ns	$19.95
TRS-16K3 *200ns	$16.95
TRS-16K4 *250ns	$14.95

Mostek DC/DC Converter
+5 VOLTS TO -9 VOLTS

Input: +5V. Output: -9V (regulated) @ 30mA. Printed circuit mounting.

DC10 .... $2.95 ea. or 2/$4.95

Sorensen Regulated Power Supplies

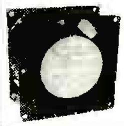
Sorensen's open construction (SOC) power supplies are series-regulated solid-state systems, designed to provide regulated DC voltages at six levels (2-28 volt range). Units are open-framed on sturdy black anodized aluminum for excellent mounting.

FEATURES: 115/208/230 VAC Input @ 50-63Hz. Low Ripple: 1.5mVrms, 5mV P-P max. Adjustable current limit. Voltage adjustment control. Temperature-compensated circuitry. Optional over-voltage protection. All schematics and specifications supplied with unit. Series A, B, C, E have 3 mounting surfaces (Series F, bottom mounting only).

SPECIFICATION CHART

Part No.	Series	Output Volt. Adjust. Range min.	max.	Output Current (Adc) 40°C	50°C	60°C	Size (inches)	Wt. lbs.	Price
SOC 2-8	B	1 9	2 1	6 0	4 9	3.8	5.62x4.88x2 50	4 3	19.95
SOC2-25	F	1 9	2 1	25.0	21 5	17 5	16.00x4.88x4 88	16 0	29.95
SOC5-3	A	4 75	5 25	3 0	2 4	1 8	4.00x4.88x1 62	2 0	24.95
SOC5-18	E	4 25	5 25	18 0	15 0	12 0	14.00x4.88x2.75	12 0	39.95
SOC5-25	F	4 25	5 25	25 0	21 5	17 5	16.00x4.88x4.88	16 0	49.95
SOC12-11	E	11 4	12 6	11 0	9 2	6 8	14.00x4.88x1.62	12 0	44.95
SOC12-15	F	11 4	12 6	15 0	12 75	9.5	16.00x4.88x4.88	15 0	49.95
SOC15-5	C	14 25	15 75	5 0	4 2	3 5	7.00x4.88x3.37	6 6	39.95
SOC15-9.5	E	14 25	15 75	9 5	7 6	5 6	14.00x4.88x1.62	12 0	44.95
SOC15-13	F	14 25	15 75	13 0	10 5	8 0	16.00x4.88x4.88	16 0	49.95
SOC28-0.8	A	26 6	29 4	0 8	64	45	4.00x4.88x1.62	2 0	24.95

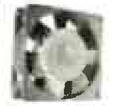
Pee Wee Boxer Fan



- 36cfm free air delivery
- 3.125" sq. x 1.665" depth
- 10 yrs. cont. duty at 20°C
- 115V 50/60Hz
- For Apple users

PWS2107U Cleaned & tested (used)	$ 9.95 ea.
PWS2107F New	$14.95 ea.

Muffin® Fan



- 105cfm free air delivery
- 4.68" sq. x 1.50" depth
- 10 yrs. cont. duty at 20°C
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MU2A1-N New	$14.95 ea.

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500	200	2.49	5,500	25	4.49	21,000	15	3.95	45,000	5	5.95
1,250	3	.99	6,100	40	2.49	22,000	15	4.95	52,000	20	5.95
1,500	25	1.95	7,000	60	4.95	23,000	7	1.95	55,000	15	5.95
1,500	50	2.95	10,000	15	2.95	23,000	10	2.95	58,000	20	5.95
2,000	10	2.95	10,000	16	3.95	23,000	20	3.95	65,000	10	7.95
2,100	200	2.95	11,000	19	4.95	24,000	20	2.95	73,000	5	7.95
2,250	100	3.95	13,000	16	2.95	27,000	10	2.95	80,000	15	9.95
2,300	33	2.95	14,000	13	2.95	32,500	25	4.95	90,000	10	8.95
2,500	15	2.95	14,000	35	3.95	40,000	25	5.95	120,000	15	10.95
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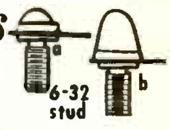
	ASSEMBLED & TESTED	39.95
MICROWAVE	RECEIVING SYSTEM - ALL THREE - ASSEMBLED AND TESTED	124.95

SUPER LED's



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MV4 RED (a)
$4.95 each
6-32 stud

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.25W 5% carbon film- all standard values from 2.7 to 4.7M ohms
$1.50 per 100 (one value)
$12 per 1000

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8085	NEC CERAMIC 40 PIN CPU CHIP	$6.95
MM5290J	NSC 16K/1 DYNAMIC RAM(4116)	2.95
B2758	INTEL EPROM 1K/8	8.95
TRIAC	8A-600V TO220 RCA	.75
VOX-	MICROPHONE,AMP,2A SCR,PC BD	.95
H11A2	G.E. OPTO ISOLATOR 6 PIN DIP	.25
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74LS

LS00	.20
LS02	.23
LS03	.23
LS04	.23
LS05	.23
LS08	.23
LS10	.23
LS11	.30
LS14	.40
LS20	.23
LS27	.23
LS30	.23
LS32	.28
LS37	.40
LS51	.23
LS54	.30
LS74	.32
LS85	.80
LS86	.32
LS93	.60
LS107	.36
LS109	.36
LS112	.40
LS123	.60
LS126	.50
LS145	11.05
LS138	.50
LS151	.38
LS153	.38
LS154	.75
LS155	.80
LS156	.80
LS157	.45
LS160	.95
LS161	.70
LS163	.80
LS164	.80
LS165	.80
LS166	.80
LS173	.85
LS174	.80
LS175	.38
LS191	.80
LS192	.65
LS193	.65
LS194	1.05
LS195	.90
LS221	.75
LS240	.90
LS241	.90
LS242	1.15
LS244	.80
LS257	.75
LS258	.75
LS279	.45
LS293	.95
LS299	2.10
LS365	.65
LS366	.65
LS367	.65
LS368	.95
LS373	1.45
LS374	1.45
LS377	1.35
LS378	1.10
LS399	1.65
LS673	2.10

74S

S00	.32
S02	.34
S03	.35
S04	.35
S08	.38
S10	.40
S11	.40
S20	.40
S30	.40
S32	.45
S51	.40
S64	.45
S74	.50
S85	1.95
S86	.70
S112	.70
S138	.90
S139	1.20
S140	1.40
S151	1.20
S153	1.20
S157	1.20
S163	2.75
S172	2.20
S174	.90
S175	.80
S181	3.75
S240	2.40
S244	2.90
S253	1.15
S257	1.20
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S373	2.95
S374	2.75
S381	3.50
S399	2.75
S412	2.40
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7400

7400	.17
7402	.17
7403	.17
7404	.17
7405	.22
7406	.21
7407	.28
7409	.17
7410	.17
7411	.21
7412	.26
7413	.32
7414	.40
7420	.17
7421	.28
7426	.28
7427	.24
7430	.17
7432	.24
7433	.42
7437	.24
7438	.24
7442	.42
7446	.58
7470	.28
7473	.28
7474	.28
7475	.35
7476	.28
7483	.50
7485	.60
7486	.32
7492	.42
7493	.42
7495	.45
7496	.65
74109	.35
74121	.28
74123	.50
74132	.40
74145	.45
74148	.95
74151	.60
74153	.65
74156	.75
74157	.40
74159	.75
74161	.80
74162	.80
74164	.80
74165	.80
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74181	1.60
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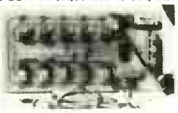

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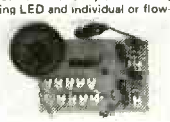

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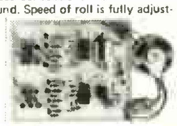

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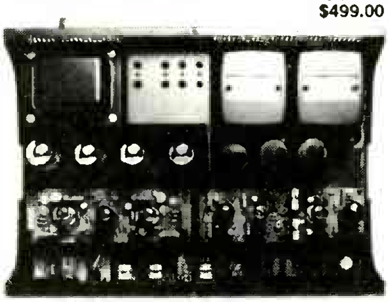

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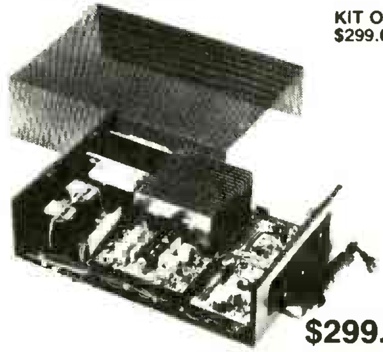

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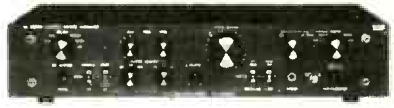

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LS05	.25	1.23	LS139	.75	3.56	LS243	1.75	8.31
LS08	.35	1.66	LS145	1.20	5.70	LS244	1.75	8.31
LS10	.25	1.23	LS147	2.49	-	LS245	2.15	-
LS13	.45	2.14	LS148	1.35	-	LS251	1.00	4.75
LS14	99	4.50	LS151	.75	3.56	LS257	.85	4.04
LS20	25	1.23	LS153	.75	3.56	LS258	.85	4.04
LS26	35	1.66	LS155	.90	4.28	LS260	.65	-
LS27	.35	1.66	LS156	.90	4.28	LS266	.46	2.19
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LS37	.55	2.50	LS160	.90	4.28	LS293	.80	3.80
LS38	.35	1.66	LS161	.95	4.51	LS295	1.05	4.99
LS42	.55	2.50	LS162	.95	4.51	LS367	.70	3.33
LS74	.45	2.14	LS163	.95	4.51	LS368	.70	3.33
LS75	50	2.38	LS164	.95	4.51	LS373	1.85	8.79
LS85	1.15	5.46	LS166	1.75	8.31	LS374	1.80	8.55
LS86	.40	1.90	LS173	.80	3.80	LS377	1.45	6.89
LS90	.60	2 85	LS174	.95	4.51	LS378	1.18	5 61
LS92	.60	2.85	LS175	.95	4.51	LS620	2.25	-
LS93	.60	2.85	LS190	1.00	4.75	LS626	2.25	-
LS122	.45	2.14	LS191	1.00	4.75	LS629	1.44	-
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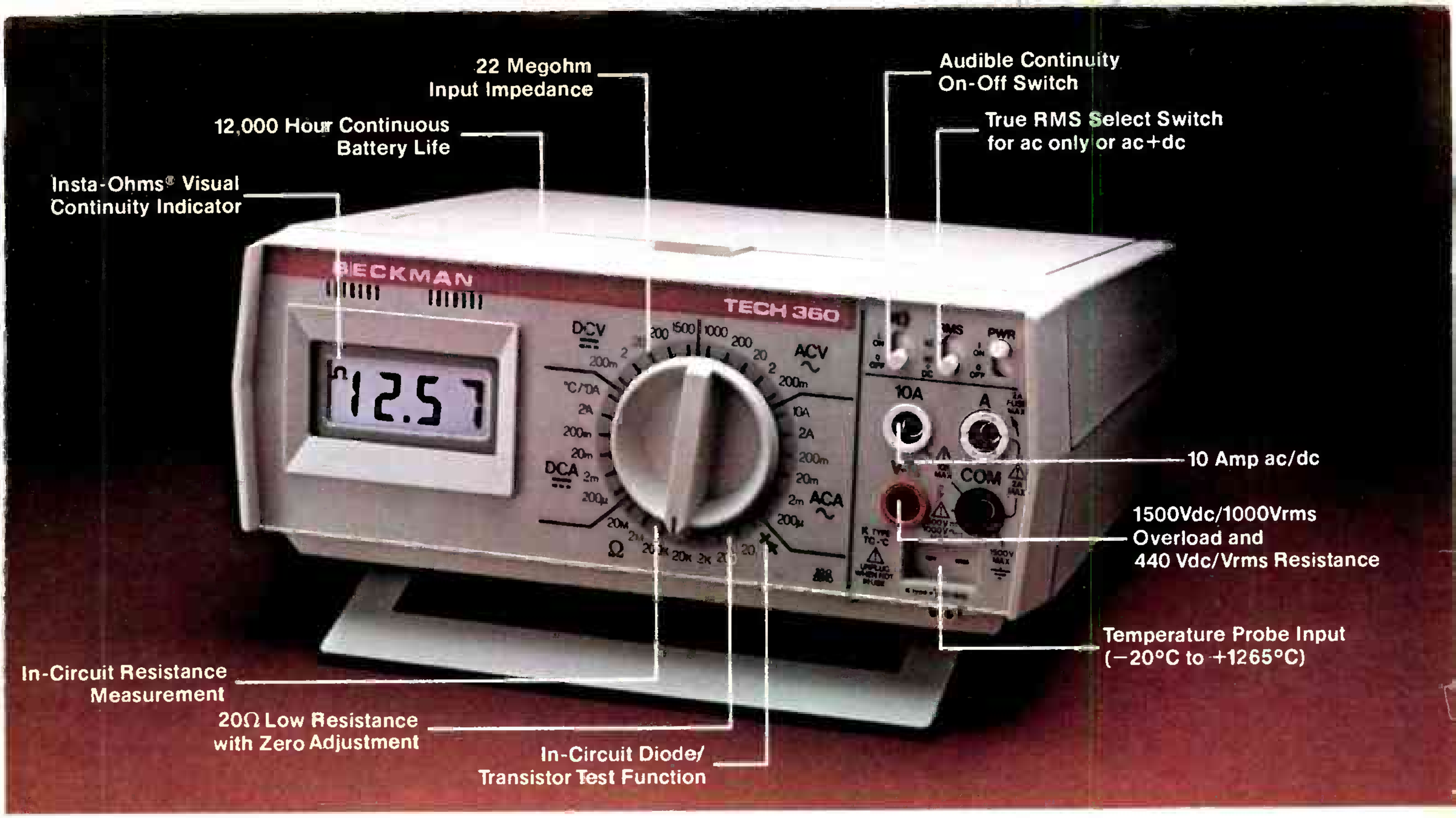

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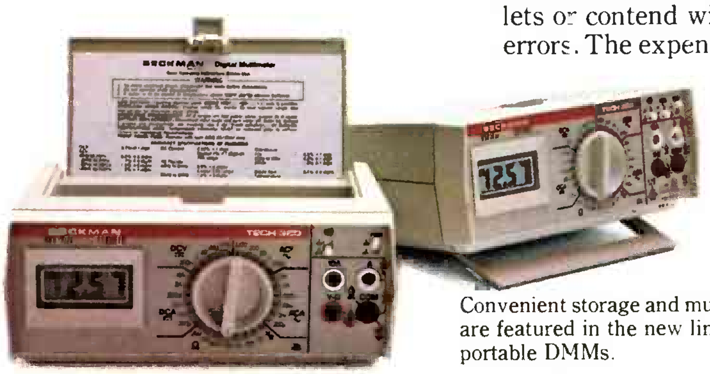

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