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LBO-523: 35 MHz
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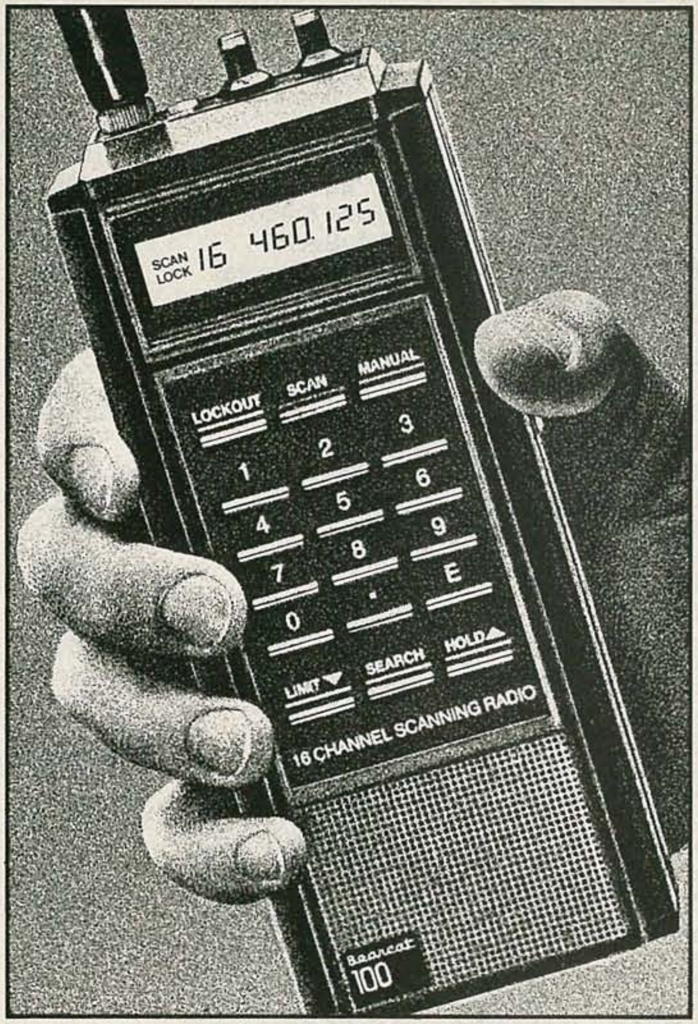

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Radio-Electronics

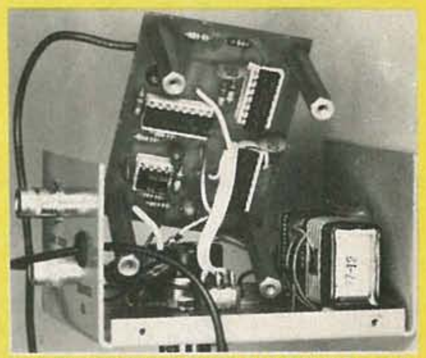
THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

Electronics publishers since 1908

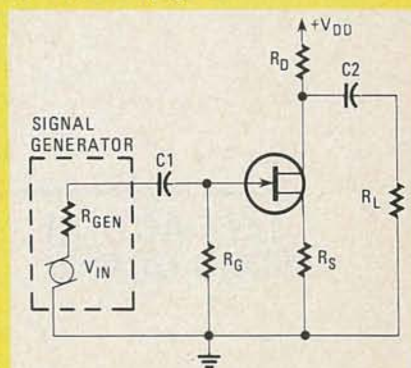
November 1982 Vol. 53 No. 11

ON THE COVER

Cordless telephones are more than just a convenience; they can also save you money. Rather than have multiple-extension phones, you can use just one cordless phone and answer the telephone from anywhere inside the house—or from up to 1000 feet away. For an in-depth look at what's available, including prices and features, turn to page 39.



BUILD THIS FREQUENCY MULTIPLIER and increase the low-frequency range and accuracy of your frequency counter. Complete construction details start on page 43.



HOW TRANSISTOR AMPLIFIERS WORK, and how to design them, are covered in this month's installment of our back-to-school series. For the full details, turn to page 67.

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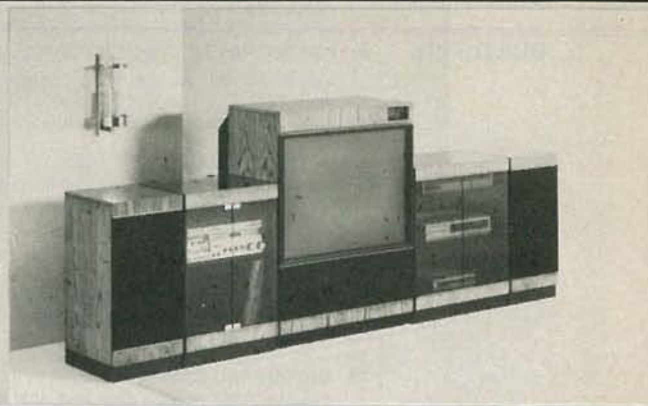
VIDEO ELECTRONICS

DAVID LACHENBRUCH
CONTRIBUTING EDITOR



MORE SEMI-COMPOS

Input and output jacks are featured on some models of almost all 1983 TV lines to accommodate various video-program sources and external audio systems. Like RCA, Magnavox didn't strictly go the video-component route in its 1983 models, but instead provided what it calls "user-friendly" video and audio systems—featuring complete color sets with 10 audio and video input and output jacks, as well as three switched 75-ohm RF inputs.

Console furniture has traditionally been a strong point with Magnavox, and for 1983 it will offer nine high-end audio, video, and storage modules in matching furniture cabinets. The modules can be assembled in 17 different combinations for use with VCR's, videodisc players, and so forth. The systems have a choice of three different screen sizes—an extremely compact 40-inch rear-projection (see photo) and 25- or 19-inch direct-view sets. There's also a choice of two audio systems, two sets of loudspeakers, and two equipment cabinets, all in the same console-rack styling. The TV's all have comb-filter circuits and random-access remote tuning systems; and the 25- and 40-inch models have stereo amplifiers.

LIVE-ACTION VIDEO GAMES

North American Philips is working on interfacing a home computer with the Laservision videodisc system to produce on-screen games with actual "live"-type video instead of computer-generated graphics. It's not known when the product actually will be introduced, but it may use the upcoming Odyssey 3 (which probably will more closely resemble a computer than a video game) and Magnavox's new-model videodisc player, which has a computer input jack.

VCR/CAMERA COMBOS

Sony has quietly been developing a single-unit combination camera and VCR which weighs only about five pounds, including battery, and records on a full-size standard Beta cassette. At press time, reports in Tokyo indicated it could be introduced some time in 1983. Sony conceded that such a product had been developed but was mum on details. It's understood that the miniaturization was made possible by using a smaller head drum which nonetheless is compatible with standard recording at the Beta II speed.

Sony's proposed camera and recorder is the size and shape of a slightly elongated cigar box and is only about 5% larger than JVC's VHS-C recorder without camera. JVC's unit, which weighs slightly more than the Sony combination, records for 20 minutes on a small cassette which can be played back on the VHS-C recorder itself, or on any standard VHS recorder by inserting it in an adaptor. The Sony mini is understood to record for three hours, but is a record-only unit, whereas the VHS-C recorder also will play back.

JVC has developed a miniaturized camera weighing 2¾ pounds, using a new ½-inch Saticon pickup tube as a companion to its VHS-C recorder. It can be combined with the recorder into a single unit without cable connections by use of a special shoulder-frame accessory, giving the combination camera-recorder a total weight of less than eight pounds. Sony's one-piece unit is said to be aimed at an under $1,000 price on the Japanese market. **R-E**

WHAT'S NEWS

National radio paging is now on the way

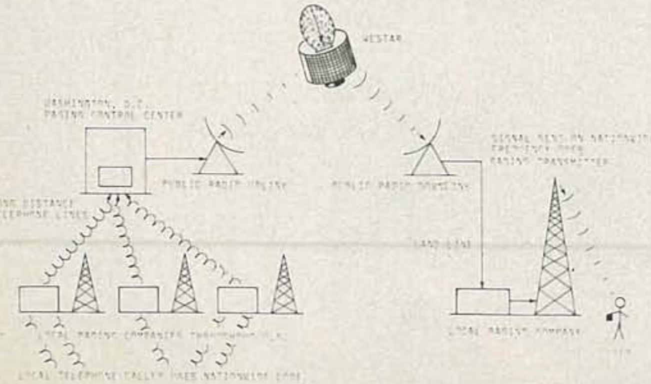
A preliminary agreement to form National Satellite Paging Inc.—a new company that will offer the first comprehensive satellite-interconnect paging system across the country—has been announced jointly by National Public Radio (NPR) and Mobile Communications Corp. of America (MCCA).

Users of the system will phone paging calls to the local paging services, which will transmit them by line telephone to NSP's control center in Washington, DC. They will then be uplinked to the Western Union satellite, Westar IV, on which NPR leases space. From the satellite, the calls will be transmitted through NPR's more than 200 downlinks to participating ground stations nationwide.

The stations will transmit all calls designed for their areas by telephone to the appropriate local paging company, which will then put them on the air in the usual manner. Users of the national service will pay a minimum additional fee above the current monthly rates for local paging.

National Public Radio is a nonprofit corporation based in Washington, DC. It supplies programs through more than 200 downlinks to 267 public radio stations in 48 states, the District of Columbia, and Puerto Rico. NPR expects to use revenues from the new service "to help alleviate the current budget crisis in public radio."

NATIONWIDE SATELLITE PAGING SYSTEM



THE NATIONAL SATELLITE PAGING SYSTEM, showing how paging calls can be routed to recipients all over the nation.

Amorphous solar cells reach 10% efficiency

Amorphous silicon cells that operate at 10 percent efficiency are reported by the RCA Laboratories at Princeton, NJ. That, according to RCA executives, marks an important step toward large-scale solar power production at costs comparable to those of oil-fired electric generating plants.

While the efficiency of amorphous silicon is still lower than the 17 percent or so of the crystalline type now used widely for solar cells, its cost is much lower. Scientists believe that at 10 percent efficiency, mass production becomes feasible.

RCA received a basic patent on its invention of amorphous silicon devices in 1977.

EFFICIENCY OF AMORPHOUS SILICON SOLAR CELLS is measured by Anthony W. Catalano, of the RCA Labs technical staff. The new higher-efficiency cells may open the way to large-scale production of solar power at costs competitive with the present oil-fired generating plants.

Progress reported in graphics standards

Digital Equipment Corp, Intel Corp and Textronix report that 12 companies are joining their move to adopt two proposed new graphics standards. Those would cover methods for creating and transmitting computer-graphics images. Lack of standards for those activities at lower interface levels results in inefficiency, especially in graphics software development and portability.

The new companies are Digital Research, Graphics Software Systems, Hazeltine Corp, ICL, ISSCO Graphics, Manneman Tally Corp, Microsoft, AEL Microtel Ltd, Norpak, Westinghouse, Xerox Corp and Precision Visuals.

The two proposed standards are the North American Presentation Level Protocol Syntax (NAPLPS) and Virtual Device Interface (VDI). NAPLPS is used in transmitting graphics information. VDI will result in improved software portability among computer systems and graphic devices.

Both of the new standards are being considered for adoption by the American National Standards Institute.

Computer translation offered in Europe

A new service to provide two-way translation between English and three other languages is being offered by the ITT Europe Engineering Support Center in Harlow, England. By coupling the new service with its present translation facilities, ITT can offer a faster and more reliable service—especially for lengthy technical documentation—than conventional manual translation between English and French, German, and Spanish.

The service uses six software programs, one for each language pair. Original text can be input from a keyboard, or from a disk, tape, or optical character readers, or via telex or data links.

The translated texts are produced at five to ten times the speed of manual translation, and with the help of ITT's own data bank as an integral part of the service, the computer-assisted system assures high accuracy, idiomatic usage, and orderly syntax. Final editing is done on-line by expert technical translators, native speakers of the language into which they translate. The customer receives the finished translation in hard copy, tape, or disk, or over data links worldwide.

The new service that is now being offered commercially was originally developed for use by ITT companies. **R-E**

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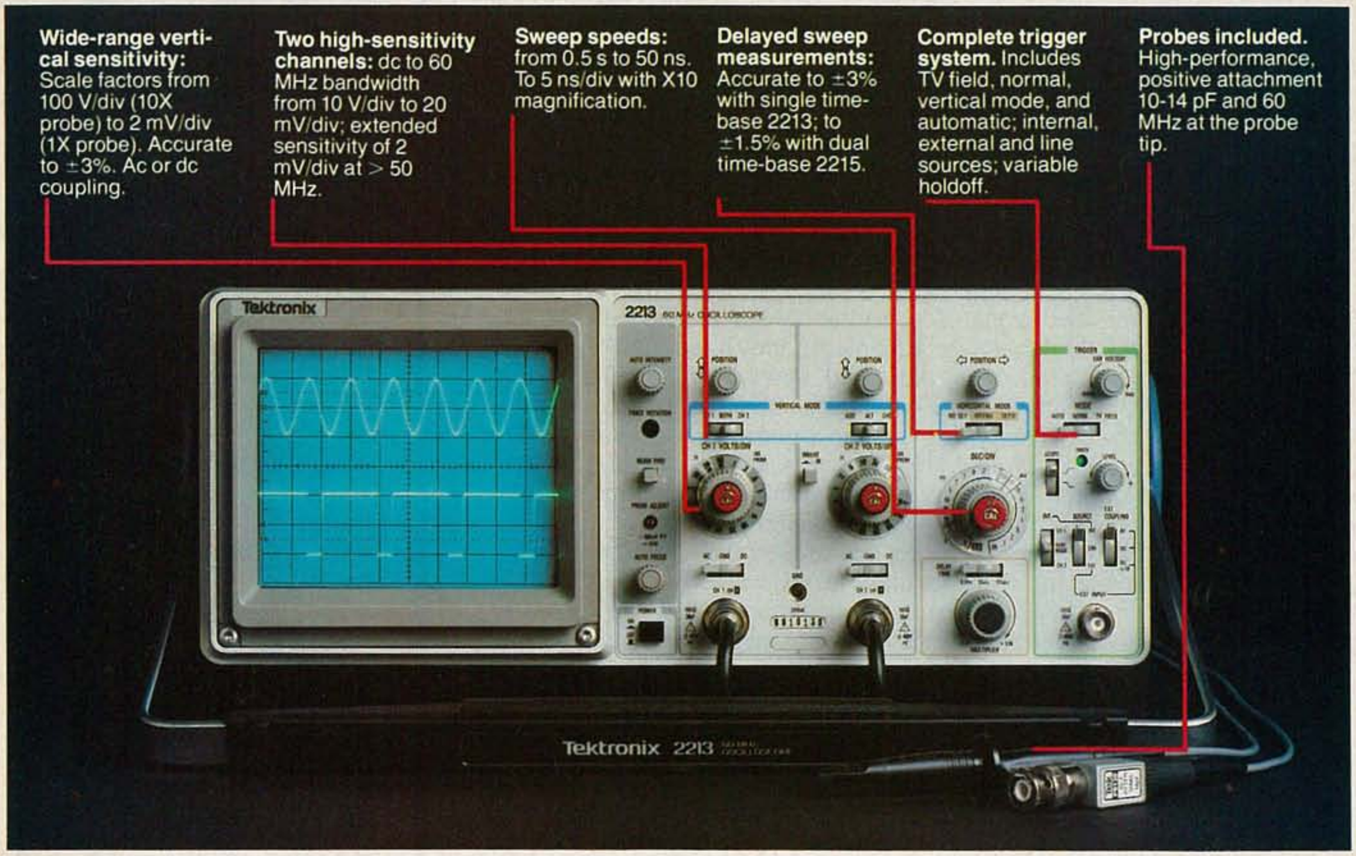

In 30 years of Tektronix oscilloscope leadership, no other scopes have recorded the immediate popular appeal of the Tek 2200 Series. The Tek 2213 and 2215 are unapproached for the performance and reliability they offer at a surprisingly affordable price.

There's no compromise with Tektronix quality: The low cost is the result of a new design concept that cut mechanical parts by 65%. Cut cabling by 90%. Virtually eliminated board electrical connectors. And obviated the usual cooling fan.

Yet performance is written all over the front panels. There's the bandwidth for digital and analog circuits. The sensitivity for low signal measurements. The sweep speeds for fast logic families. And delayed sweep for fast, accurate timing measurements.

The cost: $1100 for the 2213*. $1400 for the dual time base 2215. You can order, or obtain more information, through the Tektronix National Marketing Center, where technical personnel can answer your questions and expedite delivery. Your direct order includes probes, operating manuals, 15-day return policy and full Tektronix warranty.

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EDITORIAL

Behind closed doors

Do you ever wonder what's going on behind the closed doors of the research labs? As you know, the major consumer-electronics manufacturers (primarily located in, but not limited to, Japan) are pouring lots and lots of money into research and development with the hope of developing products that you will want to buy. Although very few people actually know what's going on behind those closed doors, we have seen some of the recent developments that have come out of the labs.

From ITT comes a set of 6 IC's for implementing a digital color TV—*all* signal processing will be performed digitally. Many TV manufacturers are currently evaluating those IC's for use in their own sets or developing their own digital IC's. To the consumer, the new digital TV sets will offer little immediate advantage; they'll reduce the manufacturers' cost both in terms of parts and assembling. For the future, that breakthrough could lead to new features such as automatic ghost cancellation, noise reduction for the video signal, TV receivers capable of receiving PAL, SECAM, and NTSC signals with the flip of a switch, and more. (Next month, we will present a feature article on digital TV as part of a special section on video entertainment.)

While the digital IC's are receiving lots of attention, Mitsubishi has succeeded in developing two IC's that make up a complete color TV chassis, minus the tuner, power-driver transistors and, of course, the CRT. The performance of those IC's is remarkable! For example, the video bandwidth is no less than 7 MHz.

TV isn't the only place where things are happening. Sony has put a complete AM/FM radio receiver on just one IC. The only external components are a few capacitors, coils and a speaker. The IC even includes a power amplifier. To demonstrate the new IC, Sony produced a prototype self-contained wristwatch/radio. Although impressive, Seiko's recent development of a wristwatch/TV is even more impressive. That device uses an LCD display, but unfortunately the majority of the electronics is housed separately and strapped around the user's waist.

Turning to a different area, Nippon Electric has developed a software technique that will permit online handwritten character recognition for personal computers. Using that new system with a digitizing tablet, a personal computer will be able to "read" handwritten (script as well as printed) words with a 99.5% recognition accuracy. Can you imagine writing a letter on that system while a word-processing program is loaded in the computer? Just by pressing a button you could have the spelling checked, the text justified, and then have it printed out.

Those are just a few of the many developments that have recently come out of the research labs. They will all have a major impact on future electronics products. Many more will be forthcoming. As the new ones are announced, you can be sure that **Radio-Electronics** will be there and we will report the details. And you can also be sure that we will cover the major developments in all other areas of electronics and not limit our coverage to just a few specific ones.

Art Kleiman

ART KLEIMAN
EDITOR

For $99.95 you can have a full powered personal computer.

Most people know by now that the ZX81 from Sinclair Research is the lowest priced personal computer in the world.

But serious programmers are looking for more than a low price. They're looking for true computer power. And that's where the ZX81 surprises a lot of people.

Just look at the keyboard and you'll get some idea of the ZX81's power. It has more than 60 BASIC commands, 20 graphic symbols, and complete mathematical functions. And there's even more power that you can't see.

Sinclair programs are available

A breakthrough in personal computers. The ZX81 offers features found only on computers costing two or three times as much.

Just look at what you get:

- Continuous display, including moving graphics
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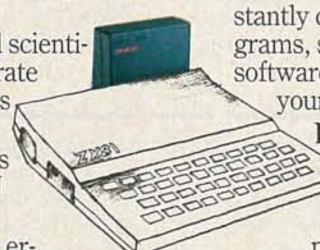
- Mathematical and scientific functions accurate to 8 decimal places
- Unique one-touch entry of key words like PRINT, RUN and LIST
- Automatic syntax error detection and easy editing
- Randomize function useful for both games and serious applications
- Built-in interface for ZX Printer
- 1K of memory expandable to 16K
- A comprehensive programming guide and operating manual



16K Memory Module

The ZX81 is also very convenient to use. It hooks up to any television set to produce a clear 32-column by 24-line display. And you can use a regular cassette recorder to store and recall programs by name.

What you get. When you order your ZX81, you get everything you need to start programming.

It comes with connectors for your TV and cassette recorder, an AC adaptor, and a free programming guide and operating manual that completely documents the capabilities of the ZX81.

Options and add-ons. Like any full-powered computer, the ZX81 can be expanded and upgraded.

Its 1K memory can be expanded to over 16K just by plugging the Sinclair Memory Module onto the back of the unit. The cost is only $49.95.

Sinclair has also published pre-recorded programs on cassettes for your ZX81. We're constantly coming out with new programs, so we'll send you our latest software catalog when you order your computer.

How did we do it? The question most often asked about the ZX81 is, "How can so much computer power cost so little money?"

The answer is that Sinclair Research simply took a different approach. Our only goal was to make programming power as affordable as possible. So we developed a radical new design that cuts costs dramatically without cutting computer power. For example, our unique Master Chip replaces as many as 18 chips used in other personal computers.

The success of the ZX81 speaks for itself. It is now the fastest-selling personal computer in the world. And we stand behind our product. If anything goes wrong in the first 90 days, we'll repair or replace your unit free of charge. Even after that, you can take advantage of our national service-by-mail facilities for a minimum fee.

Order now and try it out for 10 days. Simply send the coupon along with a check or money order. For faster delivery, call our toll-free number and use your MasterCard or VISA.

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SATELLITE/TELETEXT NEWS

GARY ARLEN
CONTRIBUTING EDITOR

INNOVATIVE PROGRAMMING

The latest batch of video program services aboard U.S. satellites includes a number of innovative approaches. For example, The Entertainment Channel (Satcom IV, Transponder 8) is concentrating on original and British-produced programming, including exclusive Broadway plays and musicals. And the Channel is also offering "Limited Editions," a series of shows that were once broadcast on commercial TV, but just for two or three episodes, only to be cancelled and forgotten.

Cable Health Network (Satcom III-R, Transponder 17), which started this past June, offers round-the-clock programming featuring ideas and advice about health, packaged into more than 20 specific series. It will carry "how-to" programs about fitness, nutrition, diet, and lifestyles, plus reports on what's new in health care.

An interesting pair of services shares Westar IV Transponder 10D: From 7 to 11 p.m., the Eternal Word Television Network carries its lineup of religious and inspirational messages. Then from 11 p.m. to 2 a.m., on the same transponder, the new "Eros" takes over (Thursday through Saturday nights only) with a roster of adult movies; Eros plans to expand to a nightly six-hour feed in September.

ABC'S PAY TELEVISION

ABC is cooking up a plan that would deliver movies and other special programming for a fee to home videocassette recorders via the nationwide broadcast network in early morning hours. ABC's "Home View Network," due to start up early next year, was tested during the past few months on TV stations which ABC owns in major markets. The plan calls for new movies, cultural programs, and other shows to be transmitted between approximately 2 A.M. and 6 A.M. when the network is now dormant. Homes equipped with a videocassette recorder and a special decoder box designed by Sony could pick up the programming, and viewers could then playback the overnight shows at their convenience. The service, including use of the decoder, will cost about $20 per month; homes that don't yet have a VCR can lease a Sony recorder for another $30 monthly. ABC assures that any VCR, whether it's made by Sony or another manufacturer, will work on the Home View Network.

ABC has other plans for interactive national programming. It recently set up a joint venture with Cox Communications, one of the nation's largest cable TV companies, to develop programming and two-way services, presumably for use on Cox's new two-way cable systems.

SCRAMBLED DBS SERVICE

Oak Satellite Corp. will begin broadcasting scrambled pay TV programming via satellite by mid-1983 to U.S. subscribers, using Telesat Canada's Anik-C satellite. The plan calls for Oak to lease four 14/12-GHz transponders on Anik C, which will be launched later this year. The bird will provide spot beam coverage of two channels for each of two areas: one reaching 14 eastern states from Ohio to Maine to Virginia, the other blanketing the Pacific Northwest.

Programming will be transmitted in a scrambled mode from a central uplink, and then retransmitted to homes equipped with receiving antennas and Oak's Orion satellite signal unscramblers. The program package will include movies, sports, variety shows, musicals, and other entertainment specials plus news, cultural events, and special-interest shows. The systems will also permit addressable pay-per-view events to be transmitted.

AROUND THE SATELLITE CIRCUIT

Field Electronic Publishing, which plans to launch a national teletext service using the vertical interval of superstation WTBS-TV, now has expanded its plans. Field has joined forces with Honeywell Computers and Centel to create Keycom Electronic Publishing, which will offer teletext and videotex services to cable TV and other customers in the Chicago area, starting later this year.

European telecommunications experts are stepping up their efforts to develop satellites using 30/20-GHz. France and Germany are already involved in plans for the Ka-band spectrum for satellites expected to be launched in the 1990's, primarily for wideband data transmission. England and Italy have similar plans. Some 30/20-GHz birds are on the drawing boards for trial launches in 1986-87. U.S. satellite companies are also looking at possible future uses of 30/20-GHz band, but recent analyses indicate that U.S. researchers are spending barely one-tenth of the $540 million budget in Europe. R-E

LETTERS

Address your comments to: Letters, **Radio-Electronics**, 200 Park Avenue South, New York, NY 10003

ON NIKOLA TESLA

Being yet another admirer of Nikola Tesla, I take your editor's comment in the June 1982 issue of **Radio-Electronics** as an open invitation to provide factual information missing in Mr. Vince Marasco's letter.

A native of Yugoslavia, Nikola Tesla (1856-1943) came to the United States of America in 1884, where his many inventions, covered by more than 700 patents, came to fruition in such diverse fields as electrical-energy processing, thermodynamics, telegraphy, radio, radio astronomy, aviation, physics, optics, mathematics, and chemistry. Here only a few will be highlighted, which are indeed in everyday use at home or at work.

Tesla invented the modern system of polyphase AC currents. Today, that system is still unsurpassed in its efficient and economic generation, transmission, and usage of virtually all available electrical power, and is the single most important factor is the widespread use of electrical energy as we know it now. To make the transmitted polyphase currents perform mechanical work, he invented a revolutionary polyphase AC motor, which is by far superior to the conventional DC commutator motor. The mechanical commutators, and the brushes that wear out and require continuous maintenance, are eliminated. The rotating action is obtained through his polyphase stator windings, which generate a rotating magnetic field, inducing currents in shorted turn rotor windings, hence producing torque and rotation.

In the days of the wars of currents, with Tesla being the proponent of his new AC polyphase power system and AC motor, and Edison backing DC power generation and transmission, and DC motors, the "Tesla motor", as it was known, was blamed by his opponents for "100 evils." Later, after it became the workhorse of industry, with today's estimates putting 90% of all industrial power in factories being created by using his motor, its name was changed to the mundane AC induction squirrel cage motor. It is also relatively little known that the Westinghouse Electric Company was born and built just on that small subset of Tesla's patents and inventions. That company had followed Edison and the DC approach, at first; later, it turned to follow Tesla's AC direction.

It is ironic that readers of **Radio-Electronics** magazine may be unfamiliar with another major contribution of Tesla's—the present-day radio. In 1893, in a lecture on high-frequency, high-voltage phenomena (given at St. Louis), Tesla demonstrated the first system for radio transmission, complete with 5 kVA transmitter and a receiver with electronic tube detection. Tesla's patents and priority over Marconi in wireless transmission were finally and belatedly established in the early 1960's by the United States Supreme

CIRCLE 9 ON FREE INFORMATION CARD

Court. Tesla even went one step further in experimenting not only with transmission of signals, but of high power as well. His high-frequency, high-power experiments at Colorado Springs in 1893 still fascinate present-day scientists.

Despite all of that, and other pioneering work, Tesla obtained very little recognition in the USA with (ironically) the Edison Medal being his highest honor. Nevertheless, the International Electrotechnical Commission in Munich, on July 7, 1956 (100 years after Tesla's birth), bestowed upon him one of the highest forms of recognition that a scientist can achieve. A unit of magnetic induction in the international system of units bears the name *tesla*, joining such historical electrical units as the farad, volt, ampere, and ohm.

Let me quote one of his contemporaries, Mr. Behrend, who spoke these words when asking Tesla to accept the Edison medal: "Were we to seize and eliminate from our industrial world the results of Mr. Tesla's work, the wheels of industry would cease to turn, our electric cars and trains would stop, our towns would be dark, our mills would be dead and idle...His name marks an epoch in the advance of electrical science. From that work has sprung a revolution."

For those of your readers who want to learn more about the accomplishments of Tesla, I recommend two books: the classical work, *Prodigal Genius—The Life of Nikola Tesla—Inventor Extraordinary,* by John O'Neill, and the recent work, *Tesla—Man Out Of Time,* by Margaret Cheney. (See page 158, **Radio-Electronics,** October 1982.)

SLOBODAN ĆUK, Ph.D.
Assistant Professor of Electrical Engineering, California Institute of Technology

POCKET CALIBRATOR

The Pocket Calibrator described by Mr. Gary McClellan in the June **Radio-Electronics** ("Pocket Calibrator for Volts and Ohms") holds some traps for the unwary.

First, the DC sources are "relatively" high resistance. For example, the one-volt source has an equivalent internal resistance of 1111 ohms. Thus, when calibrating a 20,000 ohms-per-volt meter (analog) on the three-volt scale, the output voltage will drop two percent; at 10,000 ohms-per-volt four percent, and at 1000 ohms-per-volt, it will drop 25 percent. A few percent accuracy, indeed!

Second, he implies a dependence of measurement accuracy of AC voltages on frequency—not so. The heating ability of an AC wave (that which we are usually trying to measure) is a function of periodicity, amplitude (usually specified as peak or peak-to-peak) and a shape factor (specifically, the root-mean-square of the voltage taken over a period); it depends upon frequency only to the extent of bandpass considerations of the measuring device. Thus crystal frequency stability in his calibrator is wholly unnecessary. The same result could have been obtained much more economically by using, say, a micropower equivalent of the 555 timer circuit in the free-running mode.

It is perhaps of no moment that the vertical scan rate of color TV is not 60 Hz but 59.94 Hz. McClellen can't get 60 Hz out of his circuit, anyway, without pushing (or pulling) the Xtal.

Let me say, however, that **Radio-Electronics** is the only electronics magazine

continued on page 22

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CO-104

CIRCLE 12 ON FREE INFORMATION CARD

continued from page 14

to which I subscribe, and I enjoy it. I'm pleased to say that I rarely find deficiencies in the material such as the ones mentioned above.

L.D. SMITHEY
Pacific Palisades, CA 90272

Reader Smithey makes some interesting points, and ones that are easily cleared up. But, first, I think it would help if I pointed out just what the intended use of the Pocket Calibrator is. It is intended for use in the field (e.g. transmitter site) to spot-check electronic instruments. The project is designed to be built at low cost by people who may not have access to laboratory instrumentation. As a result, the Pocket Calibrator will not provide absolute long-term accuracy, nor was it intended to. That job is reserved for standards located in a temperature:-controlled laboratory. By way of contrast, our low-cost Pocket Calibrator's nearest laboratory equivalent is the Datel-Intersil DVC-5000. *That low-cost instrument provides DC voltage calibration traceable to NBS, and sells for only $595.00! There's about a tenfold difference in price; Keep that in mind.*

Regarding Smithey's remarks about "relatively" high DC resistance, he is referring to the output resistance on the 10-volt, 1-volt, and 0.1-volt ranges. The 10-volt range is no problem, due to the low impedance of the LM-723 regulator. The other ranges can cause trouble with low-impedance analog multimeters. But both the text on page 53, **Radio-Electronics,** *June 1982 issue, and the assembly manual that comes with the project clear that up. As a reminder, the text points out that if you are using one of those meters, the output will be reduced. It is then suggested that you measure the 1-volt and the 0.1-volt outputs, and write down the readings. Then refer to them later, as necessary. So, as you see, there is no problem here* if *you follow the instructions under the subhead* "Use." *Of course, it is easy to calculate the correct output, if you prefer.*

Regarding Mr. Smithey's remarks on the frequency dependence of the AC calibration: In that case there is a relation, due to the characteristics of the sine shaper that follows the MM5369. Change the frequency and the sinewave loses its shape, distortion rises, and the meter shows error. Average reading DMM's are especially prone to waveshape error, so the frequency is crystal-controlled. The output, which is 16.67 ms (60.0 Hz), is also handy for scope timebase accuracy-checks. In short, the AC calibration circuitry is no place for an R-C oscillator.

To sum up: The project will give the reader no problems if he uses it for the purpose for which it was intended, and reads and follows the instructions on its use.

By the way: I designed a calibrator with no *adjustments, and with a low-resistance DC output. But the cost turned out to be $190.00!*—GARY McCLELLAN **R-E**

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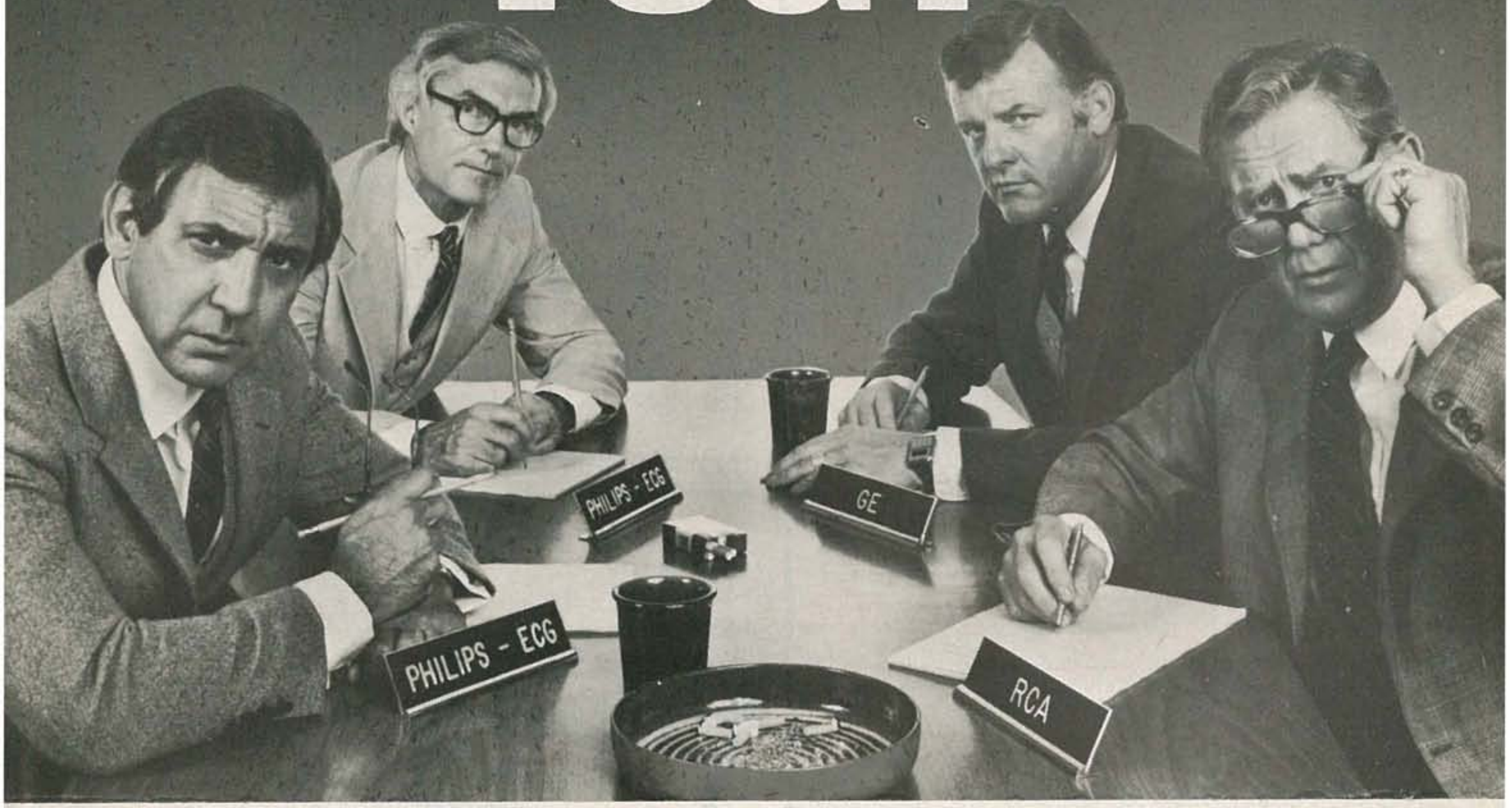

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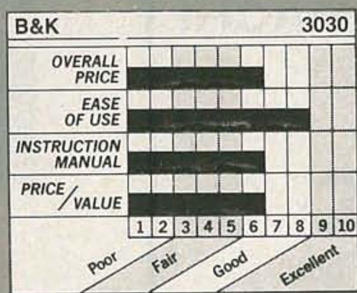

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continued on page 30

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RF-6300

RF-4900

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CIRCLE 19 ON FREE INFORMATION CARD

Introducing incredible tuning accuracy at an incredibly affordable price: The Command Series RF-3100 31-band AM/FM/SW receiver.* No other shortwave receiver brings in PLL quartz synthesized tuning and all-band digital readout for as low a price.† The tuner tracks and "locks" onto your signal, and the 5-digit display shows exactly what frequency you're on.

There are other ways the RF-3100 commands the airways: It can travel the full length of the shortwave band (that's 1.6 to 30 MHz). It eliminates interference when stations overlap by narrowing the broadcast band. It improves reception in strong signal areas with RF Gain Control. And the RF-3100 catches Morse communications accurately with BFO Pitch Control.

RF-6300 8-band AM/FM/SW

Want to bring in your favorite programs without lifting a finger? Then consider the Panasonic RF-6300 8-band AM/FM/SW receiver (1.6 to 30 MHz) has microcomputerized preset pushbutton tuning, for programming 12 different broadcasts, or the same broadcast 12 days in a row. Automatically. It even has a quartz alarm clock that turns the radio on and off to play your favorite broadcasts.

The Command Series RF-3100 and RF-6300. Two more ways to roam the globe at the speed of sound. Only from Panasonic.

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

†Based on a comparison of suggested retail prices.

This Panasonic Command Series™ shortwave receiver brings the state of the art closer to the state of your pocketbook.

With PLL Quartz Synthesized Tuning and Digital Frequency Readout.

Panasonic.
just slightly ahead of our time.

CIRCLE 15 ON FREE INFORMATION CARD

EQUIPMENT REPORTS

continued from page 26

range is 4 decades (10,000:1) allowing testing through the audio range and beyond with one sweep. Using that feature, the frequency response, from 1 Hz to 5 MHz, of any active or passive device can easily be determined. Pushbutton switches select linear or log operation. In addition, pushbuttons are also used to start and stop the sweep. Two dual rotary switches and an eight-position RANGE switch, all on the front panel, are used to select the start and stop frequencies.

In the triggered mode of operation, the unit's output can be gated either by a front-panel pushbutton or by an external control signal. The starting phase of gated sine and triangle waveforms is adjustable over the range of −90- to +90-degrees, with the output always consisting of full cycles. Depending upon the trigger, the output will be either bursts or single cycles.

Using variable symmetry of the output waveforms, the generator is able to produce rectangular waves or pulses, ramp or sawtooth waveforms, and sine waves of variable duty cycle. In addition, a front-panel-mounted BNC connector allows the user to control the frequency of operation from an external source. That feature will be particularly useful in FM applications. Also, according to the manual, many functions can be generated simultaneously making complex outputs possible.

Sweep times of 10 ms, 100 ms, 1 second, or 10 seconds and 10 dB, 20 dB, or 30 dB of attenuation can be selected using front-panel pushbuttons. Attenuation can also be controlled using a continuously variable OUTPUT control on the front panel.

One of the main uses of the sweep generator will be checking the response characteristics of amplifiers, tone controls, filters, and other frequency sensitive devices. Using the linear sweep will allow the observation of such response directly on an oscilloscope in the X-Y mode. For production line testing where several specific frequencies are required for various tests, an external DC voltage can be used to control frequency. Instructions for such operation are provided in the manual.

The instruction manual is quite good, with most of it devoted to the operating instructions. The theory of operation is covered briefly, but with enough depth to allow a good understanding of the circuit's operation. The maintenance and calibration section also covers selection of line voltages but is mostly devoted to calibration procedures, as is appropriate. Line drawings and photographs are used

Jim-pak electronic components

Belmont, California 94002

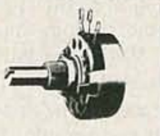
One-Stop Component Center™

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
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UG260/U	BNC Plug	2.39
UG1094/U	BNC Bulkhead Recp.	1.49

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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
GB145	Lugs, Crimp On	(100)	2.95
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
GB173	U Test & Sort 3/8'' Potentiometers	(100)	5.95
GB175	1 & 3 Amp Silicon Rectifiers (Diodes)	(100)	3.95
GB177	Shrink Tubing — Assorted 1'' pieces	(200)	3.95

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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

SOCKETS

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	

DIODES & TRANSISTORS

IN751	2/.59	2N2219A	2/1.19
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

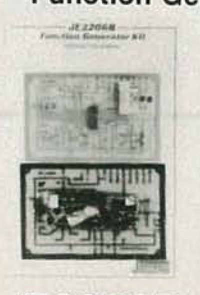
CAPACITORS

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 21 ON FREE INFORMATION CARD

where necessary to make a point more clear to the user. A large-sized schematic diagram is supplied separately and is broken up into several smaller schematics by function: those are generator loop and lockout, signal shaping and output circuitry, frequency multipliers, and power supplies and VCF control. The schematic also contains the parts list, which identifies the parts and provides the B&K part number for each item. A list that describes the function of all the IC's is also provided.

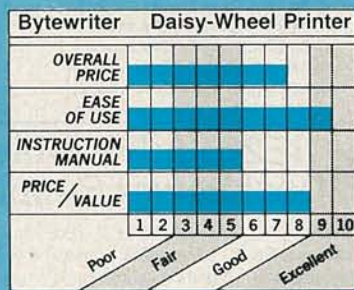
There is a list of authorized service centers provided that indicates where both in and out of warranty service is available: the unit comes with a one year limited warranty.

The generator measures 5 × 12.5 × 11 inches and weighs 10 pounds. Power requirements are 100/120/220/240 volts-AC, 50/60 Hz, 30 watts. An interesting bail-type handle that firmly locks into several positions is provided for carrying the unit, as well as for elevating it when it is used on the bench.

If you have been considering, but putting off the purchase of a sweep/function generator, why not investigate the features to be found on the B&K-Precision *model 3030* sweep/function generator? It may be exactly the unit you have been looking for. The *model 3030* sweep/function generator carries a suggested list price of $645.00. **R-E**

Bytewriter Daisy Wheel Printer

CIRCLE 102 ON FREE INFORMATION CARD



COMBINING THE LATEST TECHNOLOGY IN electronic typewriters with that of the microcomputer, the *Bytewriter* daisy-wheel printer from Bytewriter (125 Northview Rd., Ithaca, N.Y. 14850) is a rock-bottom priced printer capable of producing "letter quality" hard copy.

The unit, which is priced at $795 plus $35 for the connecting cable, functions as both a daisy-wheel printer at 8 to 12 characters-per-second, and as an electronic self-correcting typewriter. As we'll show, the flexibility of that arrangement far exceeds the convenience of the typical printer and/or terminal used with personal computers.

Many modern typewriters now use daisy-wheel printer mechanisms. Early typewriters used individual typebars that moved upwards to strike a ribbon, printing a character. The more modern *Selectric*-style mechanisms use a round typing element about the size of a golf ball. The ball is covered with raised characters. When a typewriter key is struck the ball is positioned so the appropriate character faces the ribbon; that is done almost instantly. When the ball is positioned properly, the ball strikes a ribbon, printing the character. The mechanism works well, but it's so complex that someone once claimed that "The *Selectric* is a triumph of marketing over engineering."

The daisy wheel, which was developed originally for computer-controlled printing, is a circular device with the characters located on flexible "petals"—the whole arrangement somewhat resembles a daisy flower, and hence the name. When a key is struck, that information is sent to a microprocessor that is part of the daisy-wheel mechanism. The microprocessor determines which character was selected and positions the daisy wheel properly. A hammer then strikes the appropriate petal, which in turn strikes a ribbon causing a character to be printed.

The daisy wheel's mechanical mechanism is rudimentary compared to that of the typebar and *Selectric* printers; most of the work is done by the microprocessor, which controls character selection, spacing, and even multiple keyboards.

Because a daisy-wheel typewriter is electronic, it is easily adapted for use as a computer printer. That is precisely what's done in the *Bytewriter*. That printer is based on the Olivetti *Praxis 30* self-correcting portable electronic typewriter. That unit types at 10-, 12-, or 15-characters-per-inch (switch selectable) and is supplied with a 10 pitch daisy-type printwheel, a linecord, and a carrying case. Printwheels are available in many different type styles.

In addition to the usual electronic-typewriter functions, the unit also features a "two-level" keyboard. The first level is a standard typewriter, the second level provides many of the special symbols used in languages other than English. Those include, for example, the accent marks of French, the inverted question mark and the tilde-accented "n" and "N" of Spanish. Those special symbols are substituted for some of the less-often used typewriter symbols and characters such as +, =, ½, ¼, etc. The levels are switch selectable and the user can switch from one to the other at will.

As the printwheel is already microprocessor controlled, all that's needed to make the *Praxis 30* function as a computer printer is an appropriate interface. What Bytewriter has done is to install a Centronics-compatable parallel interface directly into the typewriter, creating a daisy-wheel combination typewriter/printer. The interface is installed inside the typewriter, and the only obvious sign that it's there is a small connector added to the right side of the machine for the computer's connecting cable. Also inside the typewriter is a DIP switch package consisting of four SPST switches. Three of those switches are used to set the correct spacing for 10-, 12-, or 15- character-per-inch printwheels, the fourth can be used to defeat the automatic linefeed after the carriage return, if desired. That fourth switch thus allows the printer to be used either with computers that output a linefeed after a carriage return, or those that output only a carriage return, requiring the printer to provide the linefeed.

The interface also provides a self-test mode. If you send a CONTROL-T from the computer (use an LPRINT from BASIC, or its equivalent) the device will print a small display of its underline and tab capabilities, as well as the copyright notice. Alternately, the self-test can be generated by jumper-wiring a connector plug, but since the plug is difficult to obtain from many local electronics-parts stores, and since wiring that tiny connector isn't all that easy, one wonders why the jumper instructions are included at all.

The nice part about the unit is that its use as a computer printer does not interfere with its use as a typewriter, and vice versa. That allows for great flexibility in word processing. For example, assume you are printing a form letter, but each person and their address is listed only on a printout, not stored in the computer where it can be automatically merged by a mailing-list program. There's no need to first enter the names and addresses in the computer before printing the letters. You simply position the paper, type the names and addresses manually, and then key the computer, which types the body of the letter.

Here's another example: Assume you have written a report on your word processor, and have just printed it out. Reading it over, you discover you've misspelled a word. With this unit there's no need to correct the computer-stored version and reprint the entire document. Instead, simply position the printhead over the incorrect characters and remove them

continued on page 82

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

"Don't settle for less. Especially when it comes to career training...because everything else in your life may depend on it. That's why you ought to pick CIE!"

Buyer's Guide

CORDLESS TELEPHONES

With all the cordless phones on the market, making a choice can be quite difficult. To make things easier, here's a rundown of what's currently available.

GORDON McCOMB

IF ALEXANDER GRAHAM BELL SAW THE modern versions of his invention, the telephone, he most likely would not recognize them. Not because they would look that much different from his original 1876 model, but because the new breed of telephones can do so much more. One particularly exciting and useful telephone innovation is the wireless or cordless phone.

What's so special about a cordless telephone? It means no more tangled wires, expensive extension wiring, or missed calls. With a cordless phone, you can be up to 700 feet from your phone, and still be able to answer it. With many models, you can even originate a call from anywhere within the unit's range. You can use a cordless phone both indoors and out—you can be working in the shop, washing the car, or over at the neighbor's house, and still catch every call.

Cordless phones have indeed become a popular household tool—so much in fact, that there are literally dozens of models now on the market. With so many models to choose from, there's bound to be something for everyone, but finding a perfect match between your needs and an available unit can be no easy task. So we've put together this survey of the major cordless phones now on the market, including what they can't do, what they can do, and how to make them work even better.

The basics

A typical cordless phone consists of two primary parts—a base unit (or transponder) and a handset (or remote). The base unit plugs into a 117-volt AC line and uses your home wiring as a carrier current antenna to transmit a 1.7-MHz FM signal to the handset; the base uses a separate telescopic-antenna to receive the incoming 49-MHz signal from the handset.

Often, the base also includes a battery-recharging circuit for the handset's nickle-cadmium batteries. To recharge the batteries, the handset is usually placed into a cradle on the base when the device is not otherwise in use.

The base connects easily to your phone line using a standard RJ11W modular jack. All units (unless specially ordered otherwise) use pulse dialing, even though the handset invariably is equipped with a *Touch-Tone*-type pushbutton keypad. The reason behind that is simple: All phone lines, whether they be designed for rotary pulse or *Touch-Tone*, will accept pulse dialing. However, the reverse is not true; few pulse-only lines can use *Touch-Tone*. (There is an exception to that rule—some specialized phone systems, especially those used within a large building, may only be able to accept *Touch-Tone* dialing. When in doubt, consult your phone company.) A few cordless phones are also capable of either pulse or tone dialing.

Several models allow a user at the base to "call" the remote handset, or vice versa. To use that feature, a call switch is pressed, which transmits a loud "beep" to the handset. Of course, the handset must be turned on to receive any signal, although its telescopic antenna need not be extended since it is used for transmitting only; an internal loopstick antenna is used for reception.

A few of the phones also include an intercom capability, allowing direct communications between a phone connected to the base, and the remote. In addition, quite a few of the systems can be used as a "limited" intercom by simply lifting the receiver of the telephone connected to the base and dialing a single digit. That cancels the dial tone and allows communications between the base unit and the remote. Most phone systems incorporate a time-out feature, however, limiting that type of intercom operation to only a minute or so.

The handset is composed of a speaker and mouthpiece, as in a regular telephone, but often includes other features such as a loudness control or switch, an on/off/standby switch, etc. More complicated models include other features such as an "intercom call" and "security". The security feature is used to prevent unauthorized use of your phone line. Manufacturers routinely offer their phones in a variety of operating frequencies, but it is possible that an individual near you could use another cordless phone or other type of communications equipment, and "tap" into your line. If your cordless phone does not have a security feature, it is recommended that you disconnect the unit from your phone line whenever you will be away from home for any length of time.

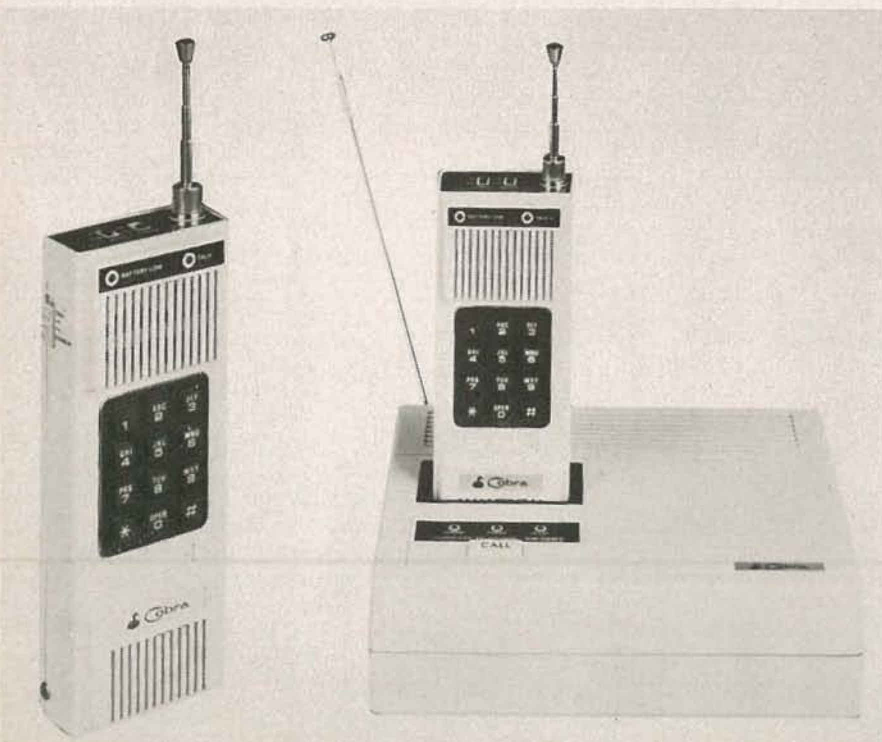
As mentioned earlier, a pushbutton keypad is provided for dialing on those units that offer dial-out capability. Quite often, the # or * key is used for an automatic redial function; pressing the appropriate key will cause the phone to redial that last number called—handy whenever the line is busy.

Nearly all of the cordless phones on the market use standard duplex transmission, allowing either party to speak at any time; a few less expensive models operate in the simplex mode, like a walkie-talkie or CB radio, and only one person can talk at a time. Also, with very few exceptions, today's cordless phones use FM. That allows the unit to operate with much less static and interference, although a completely static-free cordless phone, at this time at least, does not exist.

Because the base transponder usually uses the AC wiring in your home to transmit its signal, the structure of your house, as well as how it's wired, can have a significant effect on your reception. If your AC lines are enclosed in metal conduit, you'll have quite a bit of trouble getting a worthwhile signal to the handset. Aluminum-backed insulation in walls and attics will also impede the signal somewhat, as will concrete and brick structures. Many phone manufacturers recommend using a 25 foot AC extension-cord on the base if you have trouble with reception caused by those factors. Lay out the extension cord along a wall or, better yet, along two walls that are at right angles to each other.

Locating the base as high up as possible will help improve reception. According to many manufacturers, the higher the base unit, the better the reception. Avoid placing the base unit in basements or other parts of your house that are below ground level.

Obviously, since cordless phones use RF signals for communication, some interference problems may result when two or more units are used in close proximity to one another. Several manufacturers offer as many as five different channel selections to help avoid that problem. The frequency set is not user adjustable, however, and, at least so far, avoiding such interference is mostly a hit and miss affair. If, when you bring the unit home, you notice your neighbor's cordless phone is also operating at or near your frequency, the only recourse you have is to bring the unit back to the store and try another one. As cordless phones become more popular, the seriousness of that problem will increase rapidly. Already, some manufacturers are petitioning the FCC to open more frequencies for cordless-phone use.



THE MODEL *CP100S* from Cobra-Dynascan features a range of 600 feet, auto-redial, and answer and originate capability.

It's difficult to request specific frequency sets from the manufacturer, and even more difficult to order the base unit and handset separately. There may be an occasion when you may wish to have more than one base unit or handset on any one line. Keep in mind, however, that you cannot operate more than one handset with the base station at any one time. As the majority of models use FM, the handset with the stronger signal would simply capture the base station, effectively cutting out the other remote completely.

What does the phone company have to say about cordless phones? After all, by using a cordless, you are bypassing the need for installing and wiring extension phones, which is one of their primary sources of income. Simply stated, the telephone company cannot do a thing.

Over the past few years, Congress and the FCC have passed new laws and regulations governing the use of privately made equipment on common-carrier local and long distance phone-lines. Since 1977, it has been legal to own and connect your own commercially manufactured and FCC-approved phone or phone accessory. As of this writing, the FCC has ruled that all phone companies must "unbundle" their rates, that is, they must itemize your phone bill into service, rental, wiring, and other important catagories. Thus, you may be able to reduce your monthly charge for phone rental by as much as 50% by using your own phone—cordless or not—meaning a yearly savings of about $25 to $100.

The phone company does require (legally) that you notify them whenever you place a new phone or phone accessory onto their line. All you need to do is call up the customer service office (or other number so designated in your phone book), tell them you have installed a cordless phone per the instructions packed with the unit, and read off the make, model, FCC registration number, and Ringer equivalent number. All of that information should be stamped on the base unit, or clearly marked on the box or instruction booklet.

Keep in mind that no additional charge or fee is required when you own a cordless phone, and, since there is little or no extra wiring involved, you save yourself a service call and any monthly extension-wiring fee as well.

What's available

The following is a rundown of all the major cordless-phone manufacturers, and their models that are currently on the market. Remember that models come and go, so consult with your local dealer to see what's currently available. The price given for each model is the manufacturer's list price; the price you pay may vary from dealer to dealer.

TABLE 1—CORDLESS-PHONE FEATURES

Manufacturer	Model	Price	Frequencies (MHz)	Range (Feet)	Auto Redial	Security	Dial Type	Simplex Duplex	Modulation Type	Operating Modes	Intercom
Cobra/ Dynascan	CP15S	$ 89.95	1.7/49	600	—	No	—	Duplex	FM	Answer Only	No
Cobra/ Dynascan	CP100S	$189.95	1.7/49	600	Yes	No	Pulse	Duplex	FM	Answer/ Orig	No
Cobra/ Dynascan	CP200S	$189.95	1.7/49	600	Yes	No	Pulse	Duplex	FM	Answer/ Orig	No
Cobra/ Dynascan	CP210S	$219.95	1.7/49	600	Yes	No	Pulse	Duplex	FM	Answer/ Orig	Yes
Electra	FF-200	$149.95	1.7/49	300	—	Yes	—	Duplex	FM	Answer Only	No
Electra	FF-550	$219.95	1.7/49	600	Yes	Yes	Pulse	Duplex	FM	Answer/ Orig	No
Electra	FF-1550	$279.95	1.7/49	600	Yes	Yes	Pulse	Duplex	FM	Answer/ Orig	Yes
Electra	FF-3050	$239.95	1.7/49	600	Yes	Yes	Pulse	Duplex	FM	Answer/ Orig	No
Electra	FF-3500	$329.95	1.7/49	600	Yes	Yes	Pulse	Duplex	FM	Answer/ Orig	No
Electra	FF-4000	$349.95	49/49	600	Yes	Yes	Pulse and Tone	Duplex	FM	Answer/ Orig	No
Fracom/ Rovaphone	Rovette	$250	1.7/49	300	Yes	No	Pulse	Duplex	FM	Answer/ Orig	No
Fracom/ Rovaphone	Rovette 2	$189.95	1.7/49	600	Yes	No	Pulse	Duplex	FM	Answer/ Orig	Yes
Midland	80-200	$119.95	1.7/49	60	Yes	No	Pulse	Duplex	FM	Answer/ Orig	No
Midland	80-250	$169.96	1.7/49	600	Yes	No	Pulse	Duplex	FM	Answer/ Orig	No
Midland	80-300	$219.95	1.7/49	600	Yes (Nine-Number-Memory)	Yes	Pulse	Duplex	FM	Answer/ Orig	Yes
Mura	MP600/ 601	$200	1.7/49	600	Yes	Yes	Pulse	Duplex	FM	Answer/ Orig	No
Mura	MP510 511	$150	1.7/49	150	Yes	No	Pulse	Duplex	FM	Answer/ Orig	No
Pathcom	Pacer 7800	$219.95	1.7/49	1000	Yes	Yes	Pulse	Duplex	FM	Answer/ Orig	No
Pathcom	Pacer 7800T	$229.95	1.7/49	1000	Yes	Yes	Tone	Duplex	FM	Answer/ Orig	No
Pathcom	Pacer 7800D	$239.95	1.7/49	1000	Yes (Nine-Number-Memory)	Yes	Pulse	Duplex	FM	Answer/ Orig	No
Pathcom	Pacer 9800	$299.95	1.7/49	1000	Yes	Yes	Pulse and Tone	Duplex	FM	Answer/ Orig	Yes
Pathcom	Pacer 9800D	$329.95	1.7/49	1000	Yes (Nine-Number-Memory)	Yes	Pulse and Tone	Duplex	FM	Answer/ Orig	Yes
Radio Shack	ET-300	$199.95	1.7/49	500	Yes	No	Pulse	Duplex	FM	Answer/ Orig	No
Radio Shack	ET-310	$119.95	1.7/49	600	—	No	—	Duplex	FM	Answer Only	No
Radio Shack	ET-350	$ 99.95	1.7/49	50	Yes	No	Pulse	Duplex	FM	Answer/ Orig	No
Universal	Tote & Talk (TEL-3000)	$249.95	1.7/49	700	Yes	No	Pulse	Duplex	FM	Answer/ Orig	No
Universal	Talk-A Bout	$129.95	1.7/49	100	Yes	No	Pulse	Duplex	FM	Answer/ Orig	No
Webcor	575	$239.95	1.7/49	700	Yes	Yes	Pulse	Duplex	FM	Answer/ Orig	Yes
Webcor	555	$229.95	1.7/49	400	Yes	No	Pulse	Duplex	FM	Answer/ Orig	No
Webcor	525	$129.95	1.7/49	500	—	No	—	Duplex	FM	Answer Only	No
Webcor	777	$129.95	1.7/49	100	Yes	No	Pulse	Duplex	FM	Answer/ Orig	No

Cobra-Dynascan

Cobra, well known for its citizens' band radios, has come out with four cordless-phone models. The least expensive is their *CP15S*, an answer-only phone. That model has neither security nor intercom features.

The other models, the *CP100S*, *CP200S*, and *CP210S*, are all essentially identical. They all feature auto-redial circuitry, are capable of receiving as well as making calls from the handset, and use pulse dialing. All of them have claimed maximum ranges of up to 600 feet, although the manufacturer stresses that reception in enclosed areas, such as a warehouse, is usually limited to about 300 feet.

The only difference between the *CP100S* and the *CP200S* is cosmetic—the *CP100S* has a two-way-radio-styled handset. The *CP210S* has all the features of those two models, but also includes an intercom feature. That feature allows the user to disconnect the base unit phone from the line and use the handset and base unit as a wireless intercom system.

Electra-Bearcat

Electra has six "Freedom Phone" models to choose from, perhaps the most extensive line on the market. Available are units that range all the way from the pocket-sized *FF-3500* to the fully multiplexed, multi-featured model *FF-4000*.

Electra's most basic model is its *FF-200*, an answer only unit. The estimated reception range of that phone is about 300 feet. It includes several features that are found in all of this company's units. Those are a call button mounted on the base unit, a volume switch, and a security feature that automatically engages when the handset is placed in the base's recharging cradle.

Up the ladder we find two nearly identical models, the *FF-550* and the *FF-1550*; both use *Princess-Phone*-type styling. The biggest difference is that the *FF-1550* comes with a separate handset recharger in addition to the charger built into the base. Both models have a range of up to 600 feet and feature auto-redial circuitry. The *FF-1550* also includes a fully automatic two-way intercom that allows you to carry on a conversation between the handset and base without using the phone lines. Similar to those models is the *FF-3050*, which uses "military" styling and does not have an intercom.

The *FF-3500* is a refreshingly different cordless phone—both the base and the handset have been down-sized considerably. The handset has a few extra goodies built into it as well, including a three-position volume switch, a pulsing light for dialing confirmation, and pushbutton dialing with tone confirmation. The *FF-3500* is claimed to have a maximum range of about 600 feet.

Electra's best is their new *FF-4000*, a fully multiplexed 49-MHz/49-MHz unit that has a claimed range of 600 feet. In addition, that model boasts a three-phone-number-capacity automatic redial system and a three-position switch for 10 pulse-per-second (normal), 20 pulse-per-second, or *Touch-Tone* dialing. A coded security system helps ensure that only your handset will be able to access your base.

TABLE 2—
CORDLESS PHONE MANUFACTURERS

Cobra Communications
A Division of Dynascan Corp.
6460 W. Cortland
Chicago, IL 60635

Electra Co.
300 E. County Line Road
Cumberland, IN 46229

Fracom/Rovafone International
2130 W. Clybourn St.
Milwaukee, WI 53233

Midland International Corp.
1690 N. Topping
Kansas City, MO 64120

Mura Corporation
177 Cantiague Rock Rd
Westbury, NY 11590

Pathcom Inc. (Pace)
24105 S. Frampton Ave.
Harbor City, CA 90710

Radio Shack
One Tandy Center
Ft. Worth, Tx 76102

Universal Security Instruments, Inc.
10324 S. Dolfield Rd.
Owings Mills, MD 21117

Webcor Electronics
28 S. Terminal Drive
Plainview, NY 11803

Fracom/Rovaphone

This company's *Rovette* features *Trim-Line*-like styling and allows you to either store the base unit and handset on any flat surface like most other cordless models, or hang it up on a wall.

The unit uses pulse dialing and has an estimated maximum range of 300 feet. In addition, the unit includes auto-redial circuitry and pager-call buttons on both the base unit and remote. An intercom switch allows a phone connected to the base to communicate freely with the remote, bypassing the phone lines.

A unique feature of that cordless is that its base has no visible reception antenna. Instead, the antenna is encased in the coiled cord that attaches the base unit to the modular phone jack on the wall.

The company also offers the *Rovette 2*, which is similar to the *Rovette* but offers a 600-foot range.

Midland

Midland offers three cordless-phone models. All feature pushbutton pulse dialing, auto-redialing, a call button to page handset users, and slim styling. In addition, all are answer/originate models.

The model *80-200* has a range of up to 60 feet. The model *80-250* has a range of up to 600 feet. The top-of-the-line model *80-300* also has the 600-foot range of the *80-250* but adds intercom capability and a security feature; it can also store up to nine pre-programmed numbers for automatic dialing.

Mura

Mura Corporation has trimmed down its cordless-phone line and offers two moderately priced full-duplex versions—the *MP600/601* and the *MP510/511*. Previously, Mura had been offering several AM simplex-type units, but those have recently been discontinued.

The *MP510/511* has a maximum effective range of about 150 feet. It offers auto-redial and pulse dialing, but has no intercom or security feature. The *MP600/601* has a maximum range of 600 feet, auto-redial, and a security feature. Unlike most other cordless units, that one does not have a recharging unit built into the base. Instead, a coiled-cord battery charger plugs into the handset; that recharger will recharge the handset even when it is in use. The base unit can then be hidden away in a closet, behind a bookself, or even in an attic.

Pathcom (Pace)

Pathcom offers two of the more advanced lines of cordless phones currently on the market. Their *7800* series consists of three models. The base model *Pacer 7800* offers pulse dialing, paging from base to handset, automatic redial, and a security feature. The *Pacer 7800T* adds true *Touch-Tone* dialing. Their *Pacer 7800D* offers pulse dialing, but features a nine-phone-number memory for automatic dialing.

Unlike most other manufacturers, Pathcom allows you to order base units and handsets separately, allowing you to have more than one remote for each base, or vice versa. (Remember, you cannot operate more than one handset with a base at a time.)

Pathcom's top-of-the-line model, the *Pacer 9800*, has everything the *Pacer 7800* has, as well as a personal wireless intercom, call forwarding (where available from the phone company), and has switch-selectable pulse or *Touch-Tone* operation. The wireless intercom feature allows one user to screen calls at the base, call the other user with the handset, and speak to him or her over the intercom system before passing the incoming call to the handset. Also, while most cordless phones have a provision that allows the

continued on page 104

BUILD THIS

FREQUENCY MULTIPLIER FOR YOUR COUNTER

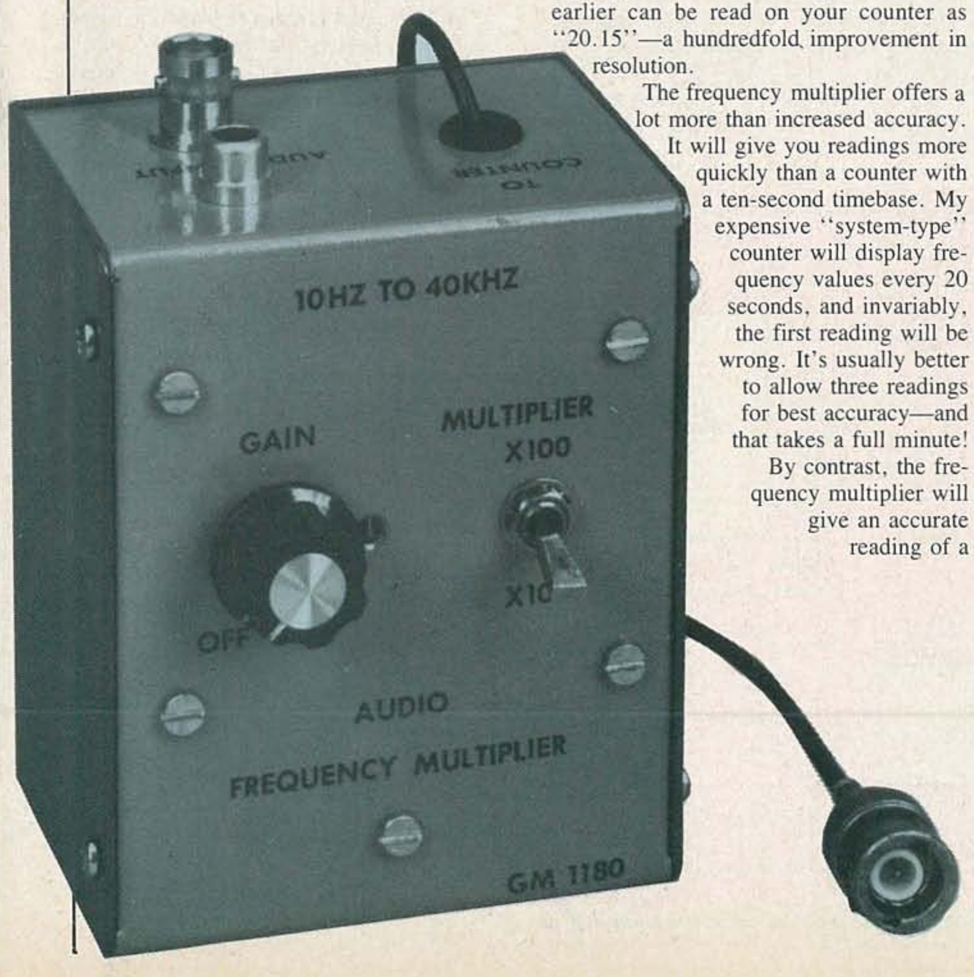
Here's an easy way to add low-frequency accuracy—and speed—to your counter. No modifications are required.

GARY McCLELLAN

FOR YEARS THERE HAVE BEEN PLENTY OF devices like prescalers available to extend the high-frequency range of the average counter. But for those of us who work with audio frequencies, the selection of add-on's hasn't been so great and that can cause a problem when you try to measure something like a 20-Hz signal accurately.

Most of the time the counter reads "20," but it frequently jumps to "19" or "21." That's a total of 10% error (5% above, and 5% below), and not very good if you're trying to get a precise reading. The usual solution is either to use a counter that has a ten-second timebase, or that has period-measurement capability. Such counters are usually fairly expensive, though. But wait—there's a far-lower-cost solution to the problem, and it requires no modifications to your counter!

The audio-frequency multiplier described here allows you to measure signals from 10 Hz to 40 kHz accurately and quickly using your existing counter. The multiplier is a little box that goes between your test cable and counter. With it you can multiply the frequency of the incoming signal by a factor of ten or a hundred for easier reading. Now, the 20-Hz signal mentioned earlier can be read on your counter as "20.15"—a hundredfold improvement in resolution.



The frequency multiplier offers a lot more than increased accuracy. It will give you readings more quickly than a counter with a ten-second timebase. My expensive "system-type" counter will display frequency values every 20 seconds, and invariably, the first reading will be wrong. It's usually better to allow three readings for best accuracy—and that takes a full minute! By contrast, the frequency multiplier will give an accurate reading of a 20-Hz signal within just six seconds—and that includes the two-second update time of the typical inexpensive counter. Furthermore, the circuit responds to small changes faster than my expensive counter, and the speed increases as the frequency being measured does. If you hate to stand around and wait for the display on an expensive counter to be updated, you're bound to like this device.

Many expensive counters have period-measurement capabilities, which means fast, accurate, display of *time*, but some calculation is needed to convert that figure to frequency. The frequency multiplier gives a direct readout of frequency without time-consuming calculations. (To be fair, though, if the signal frequency is not stable—if it jitters a bit—the figure derived from the period measurement will be more accurate.)

It's tough to estimate project costs these days, but you should be able to build the frequency multiplier for under $15; quite possibly for under $10 if you have a well-stocked junk box. Costs are kept down by using common, low-cost IC's and parts. There's one board to "stuff," with four IC's on it, and little else. The board is installed in a cabinet along with a few more parts, and that is about all there is to it. The prototype was built in one afternoon, and there is no reason why you can't build the frequency multiplier about as quickly.

How it works

The frequency multiplier is basically a PLL (*P*hase *L*ocked *L*oop) circuit, and is similar to the Programma 1 synthesized pulse-generator featured in the October 1980 issue of **Radio-Electronics** . Many of the same IC's are used, and the circuit design is similar, but the thumbwheel switches are replaced by a single switch for $\times 10$ or $\times 100$ output. Also, the input signal replaces the 100-Hz reference used in the Programma 1. Refer to Fig. 1 as we look at how the frequency multiplier works.

Low-frequency signals appearing at the input pass through the GAIN potentiometer, R101, which permits the frequency multiplier to handle a very wide range of signal levels. Then, the attenuated signal drives IC1, which shapes it into a square wave. That signal drives phase detector IC2.

Another part of the same IC also serves as a VCO (*V*oltage *C*ontrolled *O*scillator). It accepts a DC voltage from the phase detector and generates a square-wave signal. The VCO can generate signals ranging from under 100 Hz to over 400 kHz without any switching. From the VCO, the signal-path branches out.

One branch takes the signal to IC3, a NAND gate. That gate acts as a switch, and allows signals to pass to the frequency counter *only* when the PLL is locked onto a good signal. That suppresses the stray readings you would normally get without an input signal, or with signals the device can't handle. The output from the VCO also drives two divide-by-ten counters, both of which are contained in IC4. The outputs from the dividers are selected by S101, the MULTIPLIER switch. The output selected drives the phase detector, which generates the DC control-voltage for the VCO. Thus, a simple PLL circuit, that can generate frequencies ten times or a hundred times the input frequency, is formed.

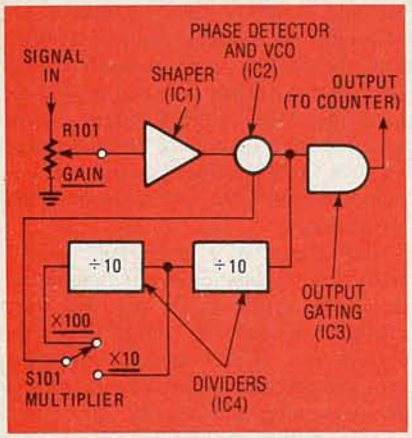


FIG. 1—MULTIPLICATION FACTOR is determined by number of divide-by-ten counters used.

Let's look at some of the finer points of the circuitry. Refer to the schematic diagram in Fig. 2 for details. The shaper amp consists of a fast CMOS CA3130 op-amp, IC1. Its high-frequency response is reduced by C3 so the circuit won't oscillate, yet will have flat gain over its 10-Hz to 40-kHz input range. The inputs of the op-amp are biased to half the supply voltage by R1 and R3, eliminating the need for a split (positive and negative voltages) power supply.

Resistors R4 and R5 set the hysteresis or "trip" point for the circuit, which is about 350 mV. The output signal is a nine-volt square wave that drives the phase-detector portion of IC2. The phase detector compares the signal with that from the MULTIPLIER switch, and outputs a DC voltage at pin 13 of the IC. That drives a network known as a *loop filter*, which smooths out the pulses from the phase detector, giving a clean DC-signal.

The VCO input is at pin 9 of IC2, and the timing capacitor that sets the frequency range is C5. The VCO output appears at pin 4, and drives both IC3 and IC4. Resistor R9 and capacitor C7 form another filter to "debounce" the signal from pin 1 of IC2 (which indicates that the PLL is locked onto the signal) so that it can enable IC3-a's NAND gate whenever a good signal is present at pin 4 of IC2. Resistor R10 is included so that the charge on C7 won't blow IC3 when the power is turned off. The output of IC3 is reduced by R11/R12 to about 900 mV peak-to-peak, which is a comfortable level for most counters. The remaining circuitry consists of a standard CMOS dual divide-by-ten counter, IC4.

Components

Because most people will want to raid their junk boxes for parts for the multiplier, let's discuss substitutions. Since most of the component values aren't critical, some substitutions can be made. The exceptions to that are resistors R1 and R3, which bias the op-amp. If you have to substitute for them, you must make sure that the values of both substitutes are identical. Another area you should watch is the loop filter. Try to use the values indicated for C6, R7, and R8 if you can. (If you have trouble finding a 1.8K resistor for R8, you can either combine two resistors in series or parallel to get the correct value, or use a 1.5K or 2K one.)

Also, be sure to use a tantalum-type capacitor for C6. If you use an electrolytic, with its higher leakage, the performance of the multiplier will suffer. Finally, C5 must be 220 pF—it sets the VCO range, which is critical.

Aside from observing those precautions, you are free to make reasonable substitutions from your junk box. Remember to test the parts before installing them; that can save troubleshooting later.

Construction

A PC board will make construction a lot easier and will help to insure that the device will work the first time it is tried. You can also use perforated construction-board, but be careful with the parts layout—you are

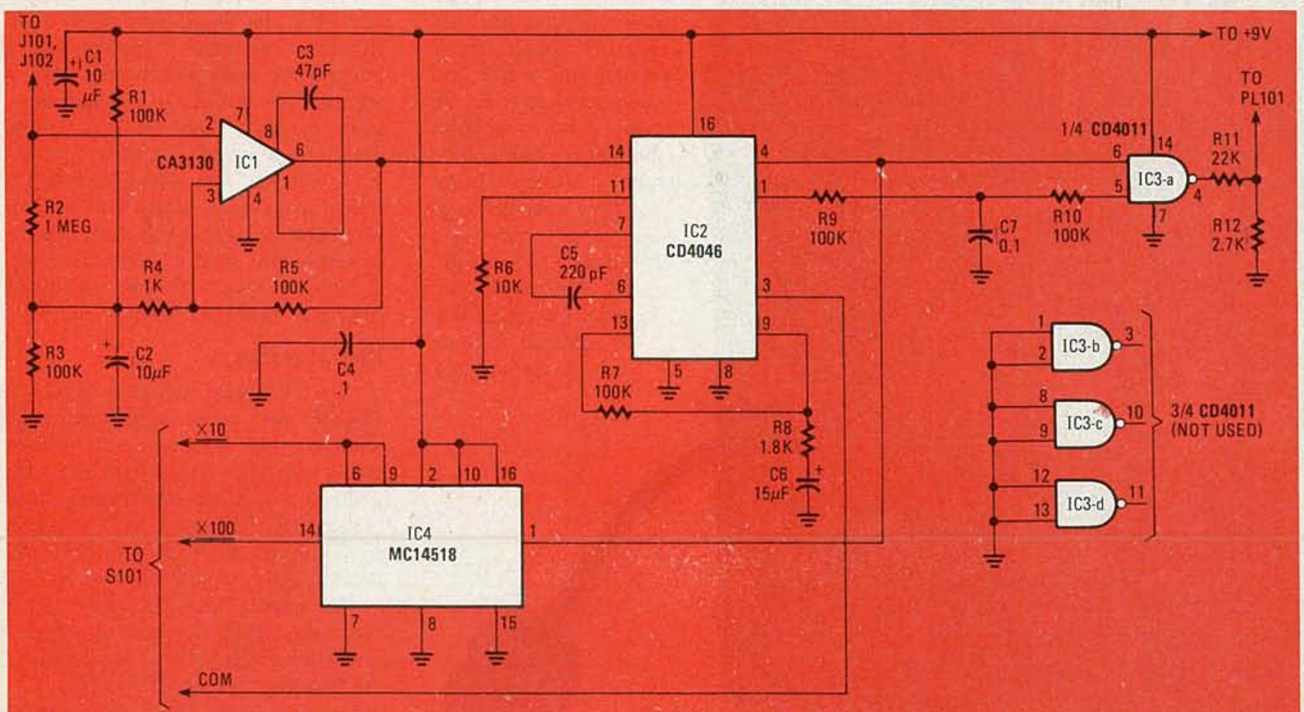


FIG. 2—A LOGIC-HIGH OUTPUT from pin 1 of IC2 indicates that the PLL is locked and allows IC3, a NAND gate to pass the pulse string from IC2's pin 4.

working with high-gain analog circuitry and noisy digital-circuitry. The PC-board layout shown in Fig. 3 is ideal for the circuit, and you may want to copy it even if you use point-to-point wiring.

Start construction by installing the board-mounted components. Refer to Figs. 4 and 5 as you proceed. Position the board as shown in Fig. 4 and leave the board in that position until you are finished with it.

Install an 8-pin IC socket at the IC1 location. Be sure to orient any pin-1 identification (notch or dot) on that socket so that it points up. Then install a 16-pin socket with its pin-1 identification pointing down at IC2, and another, pointing right, at IC4. Finally, install a 14-pin socket at IC3 so it faces to the right.

With the four IC sockets in place, next come the resistors. Start at the IC1 socket. Install a 1-megohm resistor at R2, and then a 1K resistor next to it at R4. Move down and install a 100K resistor at R3. After that, install two 100K resistors at R1 and R5, at the "tail" end of IC1.

The second batch of resistors is located around IC2. Install a 10K unit at R6 first,

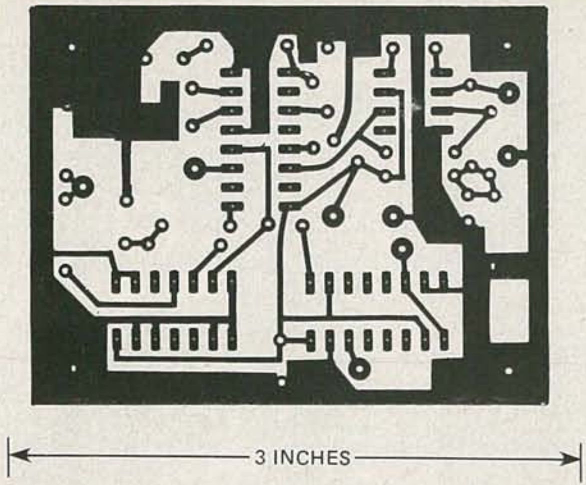


FIG. 3—FULL-SIZE foil pattern for frequency multiplier can be used for making your own PC board.

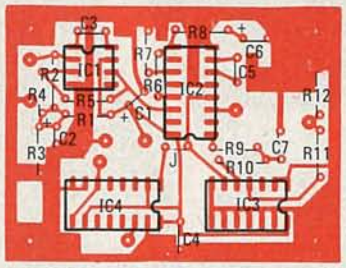


FIG. 4—MAKE CERTAIN that IC's and polarized capacitors are oriented properly. Failure to do so can cause sensitive parts to be destroyed.

then a 100K resistor between it and IC2 at R7. Move up and install a 1.8K resistor at R8. Then, on the other side of IC2, install two 100K units at R9 and R10. At the right edge of the board install a 2.7K resistor at R12, and a 22K one at R11. Stop at that point and check your work. Correct any mistakes you may find before going farther.

Next come the capacitors. Start near IC1 as you did with the resistors and install a 10-μF electrolytic or tantalum capacitor at C2. Note that the positive side faces R2. Install a 47-pF ceramic disc at C3. Install a 10-μF electrolytic or tantalum at C1, making sure that the positive side points toward IC4. On the other side of IC2 install a 15-μF tantalum capacitor at C6 with its "plus" sign pointing toward the 1.8K resistor, R8. Then below it install a 220-pF disc at C5. Finish up by installing 0.1-μF ceramic discs at C7 and C4. Be sure to check your work after all the capacitors are installed.

Install a wire jumper near pin 1 of IC2 and then cut five pieces of hookup wire, each about three inches long. Strip both ends of the wires, and solder one to each of the five pads marked with asterisks in Fig. 6. The remaining connections to the board will be made when it is installed in the box.

Connect S101 as shown in Fig. 6 and then finish up the board by installing the IC's. Install the CA3130 at IC1, a CD4046 at IC2, a CD4011 at IC3, and a MC14518 (or CD4518) at IC4. Double check to be sure the IC's are installed correctly; if they're in backwards, they'll probably be damaged when power is applied to the board. Set the board aside temporarily.

The enclosure comes next. Figure 5 shows how the case-mounted components can be laid out. One thing we did that needs comment concerns the input jacks. In our laboratory, all the connectors are of the BNC type, so that's what was used for J101. For some applications, though, an RCA-type jack is preferable, so J102, connected in parallel with J101, is of that sort. Use whatever best suits your needs.

You can install the PC board in the box using long (about 1½ inches) threaded spacers behind S101 and R101. If you can't locate the spacers, use "L" brackets to fasten the board to the top of the box. Don't mount the board in place, yet, though; there's still a bit of wiring left to be done. Refer again to Fig. 5 for details.

Start by mounting and wiring the GAIN pot (R101). Attach one end of a 0.1 μF Mylar capacitor (C101) to the wiper of the potentiometer. As indicated in Fig. 6, the ground lug of the pot should be connected both to the ground wire coming from the board *and* to the case. The "hot" end of the control should be connected to the center connectors of J101 and J102. The other end of C101 should be connected to the board as shown in Fig. 6.

Connect the left-hand (as seen in Fig. 6) battery wire (−) to the switch mounted on the pot (S102), and wire a transistor-battery snap between that switch and the other battery-pad on the board. Mount S101 on the case and install the board. Finish up by attaching PL101 to one end of a three-foot length of thin coaxial cable (like RG-174/AU) and the other end of the cable to the points indicated in the parts-placement diagram *on the foil side of the board*. Tack-solder the shield of the cable to the ground plane of the board. Position C101 so it doesn't short against anything.

Check over your work for shorts and other potential problem-causers, and correct anything that's amiss. Install a 9-volt battery and you're ready to go.

Applications

Using the frequency multiplier is easy.

PARTS LIST

All resistors ¼-watt, 5%
R1, R3, R5, R7, R9, R10—100,000 ohms
R2—1 megohm
R4—1000 ohms
R6—10,000 ohms
R8—1800 ohms
R11—22,000 ohms
R12—2700 ohms
R101—1 megohm, potentiometer, linear taper with SPST switch (S102)

Capacitors
C1, C2—10 μF, 16 volts, electrolytic or tantalum
C3—47 pF, ceramic disc
C4, C7—0.1 μF, 16 volts, ceramic disc
C5—220 pF, ceramic disc
C6—15 μF, 16 volts, tantalum
C101—0.1 μF, 100 volts, Mylar

Semiconductors
IC1—CA3130AE CMOS op-amp
IC2—CD4046 CMOS PLL
IC3—CD4011 CMOS quad 2-input NAND gate
IC4—MC14518 or CD4518 CMOS dual synchronous ÷10 counter
J101—female BNC connector, chassis-mount
J102—RCA phono jack, chassis mount
PL101—male BNC connector
S101—SPDT toggle switch
S102—SPST switch (part of R101)
B1—9-volt transistor battery

Miscellaneous: PC board, cabinet (LMB type CR-332 or similar), 1½-inch spacers, 9-volt battery snap, battery clip, IC sockets, wire, solder, etc.

The following is available from Technico Services, PO Box 20HC, Orangehurst, Fullerton, CA 92633: Etched and drilled PC board (MULT), $6.00. Kit of all parts *excluding PC board* (MULT-P) is available for $35.00 from: ABC Electronics, 2033 La Habra Blvd., La Habra, CA 90631. CA residents please add 6% sales tax; foreign orders please add $1.00 for shipping.

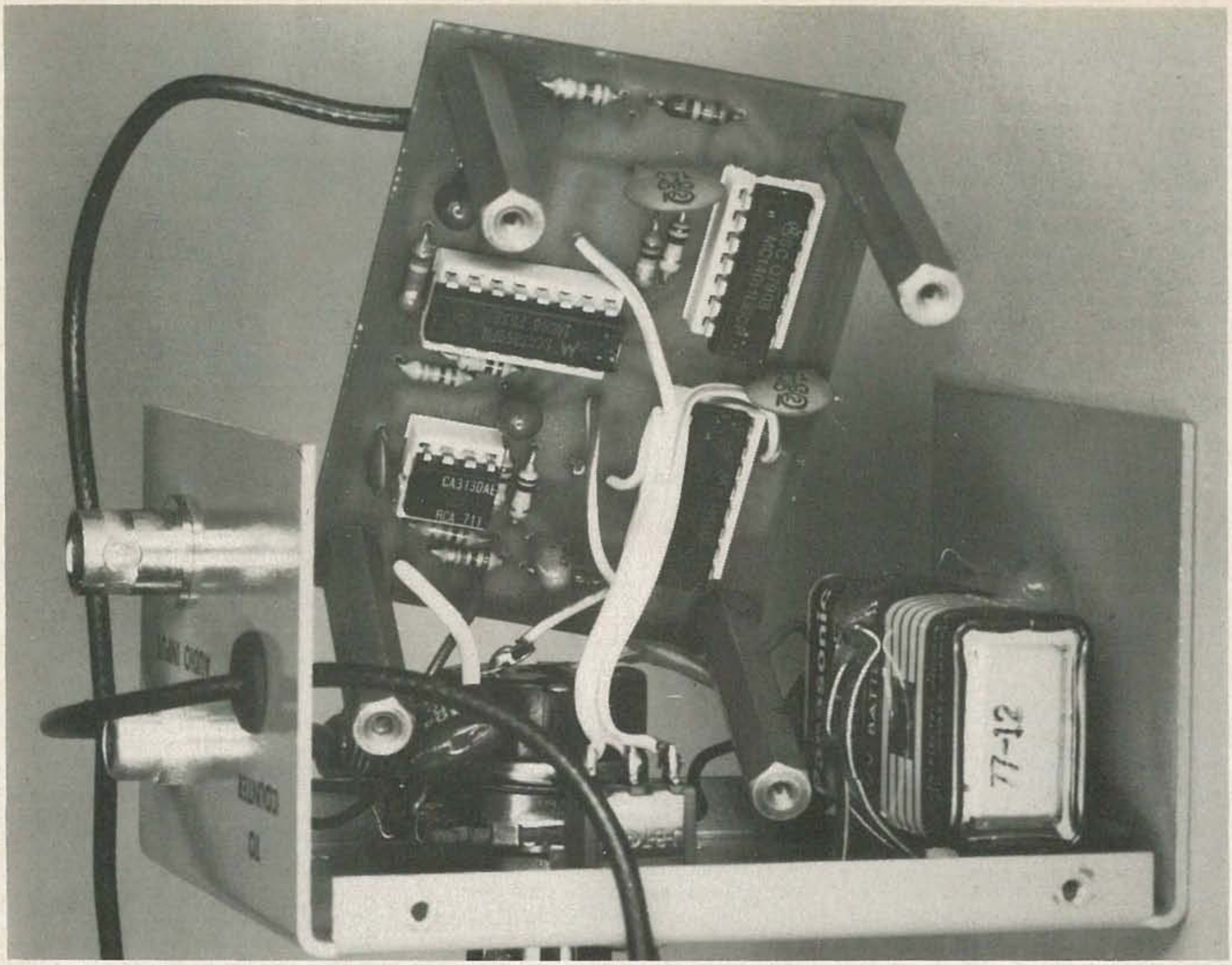


FIG. 5—1½-INCH threaded spacers are used to attach PC board to top of case.

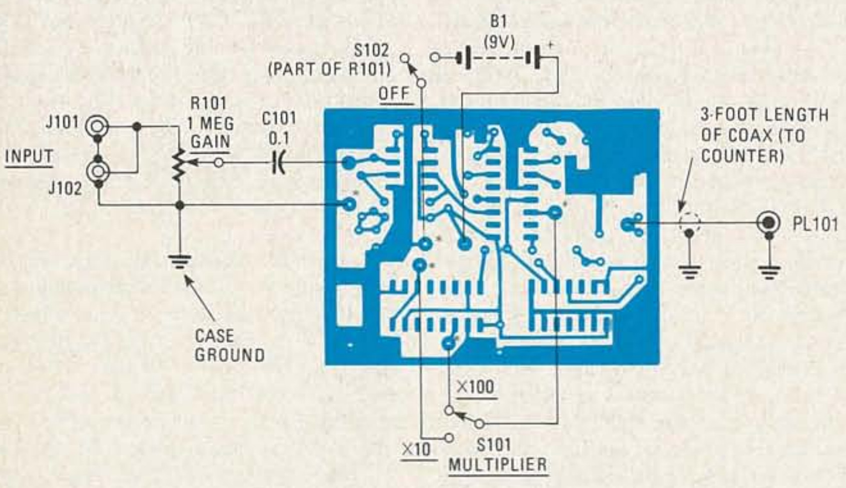


FIG. 6—CONNECTIONS TO CASE-MOUNTED parts. Shield of coax used for output is tack-soldered to ground foil on bottom of board.

Simply connect the audio signal to be measured to J101 or J102 and connect PL101 to your counter. Set the MULTIPLIER switch to ×10 and advance the GAIN control until the counter gives a stable reading. Note that advancing the control beyond that point will have little or no effect. If you need better resolution, and the frequency you're measuring is 4-kHz or lower, switch the MULTIPLIER to ×100.

Here are a few tips that you may find helpful. When you look at the display on your counter, remember to mentally shift the decimal point one place to the left when you're using the ×10 range, and two places to the left when you're using the ×100 range. A reading of "200" on the ×10 range will represent "20.0" and a reading of "2000" on the ×100 range will represent "20.00." That will soon become automatic.

The frequency multiplier does have some limitations. For example, the VCO range of the unit is 100 Hz to 400 kHz. That means that with the MULTIPLIER switch set to the ×10 position, the input frequency must be between 10 Hz and 40 kHz, since 40 kHz × 10 is 400 kHz—the upper limit of the VCO. Similarly, on the ×100 range you are restricted to a range of 10 Hz to 4 kHz. If you are not within those limits, there will be no reading on the counter.

Because the current drain (500-750 μA) on the battery is so light, you may wonder how you'll know when to change it. Replace it when the upper frequency-limit starts to drop, and you can no longer get outputs in the 300-kHz to 400-kHz range. The maximum range will drop with the battery voltage. Another clue that it's time for battery replacement is the multiplier's suddenly refusing to multiply. That's a sure sign that it's time to change the battery.

Finally, for those of you who would like (or need) more gain, it can be increased simply by making the value of R4 (1K) smaller. Nothing else need be changed. **R-E**

PICTURE PHONE

Your Picture Phone should now be nearly complete. Here's how to finish it, calibrate it, set it up, and use it.

JOSEF BERNARD
TECHNICAL EDITOR

Part 4 BEFORE YOU CAN PUT your Picture Phone into service, you'll need to buy and install a telephone coupler. This month we'll look at those, and show you how to align and use your Picture Phone. But first, let's finish up the construction.

When running lines for the AC voltages, twist wires carrying similar voltages together; that will help reduce 60-Hz hum in the system. Also try to keep the wires as close to the chassis as possible, again to reduce hum.

Next, install the telephone adaptor board, again using standoffs. You can now proceed with the chassis wiring, shown in Fig. 16. It's a good idea to color-code your wires—red for +5 volts, blue for +12 volts, orange for control signals, etc. That will make wire-routing easier and also help you in troubleshooting, should that be required.

Aside from keeping things neat, perhaps the most difficult part of the chassis wiring is the MODE switch, S1. Make sure that all the diodes on the switch are oriented correctly, and be liberal with the "spaghetti" to prevent shorts. Thinning the braid of the shielded cables before twisting and tinning it may make it easier for it to fit through the switch lugs.

Note that the use of the DB25-S connector (see Fig. 17) is optional, but it's a good idea to install it in case you decide to use it later. Also, R710 (10K) is intended for use with tape recorders having a LINE or AUX input. If your recorder has only a MIC input, use a much higher value—at least several hundred kilohms.

Your last step should be to mount the edge connector for the PC board, again using standoffs. It should be at a level where the board can plug into it without touching the components below it. You will also have to provide a frame and bracket to support the sides and rear of the board. Figure 15 (see last month's issue) shows you how that can be done (note the nylon standoffs into which the board snaps).

Before plugging the PC board into the edge connector, turn the unit on and check to make sure that the right voltages appear at the right pins. If everything checks out, turn the power off, allow a couple of seconds for the capacitors to discharge (you can tell by watching the front-panel LED's), and then carefully insert the board into its connector.

Again, turn the power on and, this time, check for the proper voltages at the IC-sockets. An ordinary straight pin makes an ideal probe for the purpose—it will slip right into the socket hole you're checking. If everything looks OK, turn the power off and insert the IC's into their sockets.

Certain pins on IC23, IC31, and IC47 have to be disabled for timing purposes. That is done as shown in Fig. 18, by bending the unused pins up until they stick out at right angles to the others and cannot fit into the sockets.

An inexpensive coupler

Telephone couplers, sometimes known as wiring protectors, are required to prevent the possibility of damage to telephone-company equipment by devices (such as the Picture Phone you built) that have not been approved by, and registered with, the FCC. Unfortunately, homebrew equipment—even if built from a kit—cannot, at least, not easily—obtain FCC approval, and an approved coupler must be used.

There are a number of couplers that

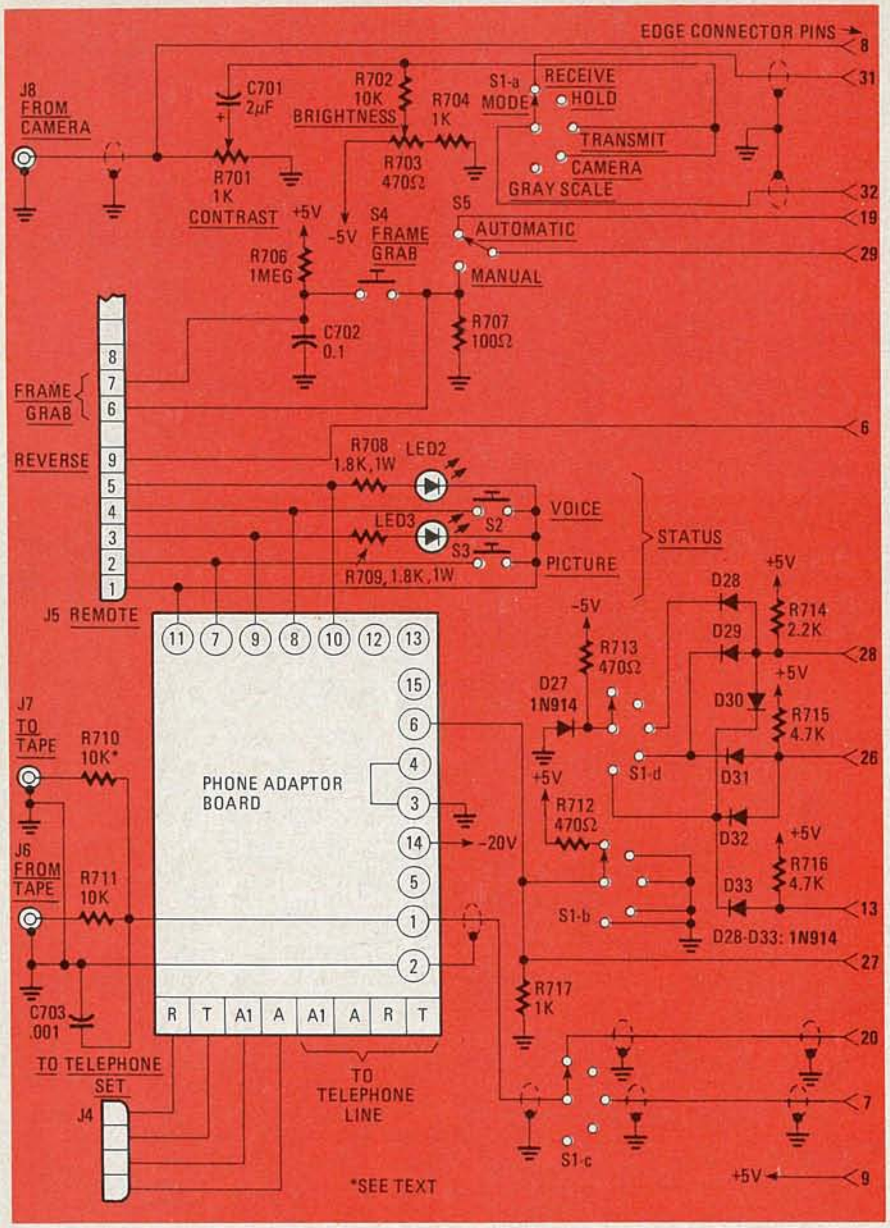


FIG. 16—WIRING DIAGRAM for chassis-mounted components and for connections to edge connector. Be especially careful in wiring diodes to S1-d.

FIG. 17—REAR PANEL of Picture Phone. Circuit-breaker reset is located above line cord at left.

will do the job for us available from various manufacturers; the one we'll use as an example is the Elgin Electronics model *EWP130A Voice Coupler*, which costs about $85 (see the Parts List for ordering information).

Figure 19 shows the terminals on the *EWP130A* board, and the connections that have to be made to the Picture Phone and the telephone company's modular telephone jack. Note that only the *tip* (green) and *ring* (red) leads are used.

The coupler is designed to pass audio signals and to translate the ring signal and on-hook/off-hook voltages into relay closures that will supply the appropriate voltages to the telephone equipment on your side of it. (You can do almost anything on *your* side of the coupler; that's why it's used—to protect the equipment on the telephone-company side from damage.)

The coupler requires two operating voltages and, if the telephone is going to be permanently connected to the Picture Phone, those voltages must *always* be available. Only a few hundred milliamps are required, and a suitable supply is shown in Fig. 20. It provides −24-volts DC to operate the coupler's relays, and 117-volts AC at 30 Hz (derived by placing diode D801 in the AC line) to ring the telephone's bell.

The coupler comes with a cord and modular plug, which is inserted in the wall jack that your phone would normally connect to (refer back to Fig. 19.) The telephone itself is connected to the modular jack on the rear of the Picture Phone and the user-side (your side) of the coupler to the "T" and "R" *output* terminals on the Picture Phone's telephone adapter board.

While the power supply for the coupler can be mounted inside the Picture Phone (and the 117-volts AC taken from its line cord *before* the power switch), the coupler should be mounted as close as possible to the wall jack it will be plugged into.

Be sure to notify your telephone company of the following:

1. The particular line to which you will be making your connection.
2. The type of jack used (type RJ11W in the case of modular wall jacks).
3. The FCC registration number of the coupler.
4. The ringer-equivalence number of the coupler.

Checkout and adjustment

Now that you know how to connect the Picture Phone to the phone line in a perfectly legal fashion, it's time to make sure that it works properly and to calibrate it. (If you run into problems, skip to the section on troubleshooting.) Perform the

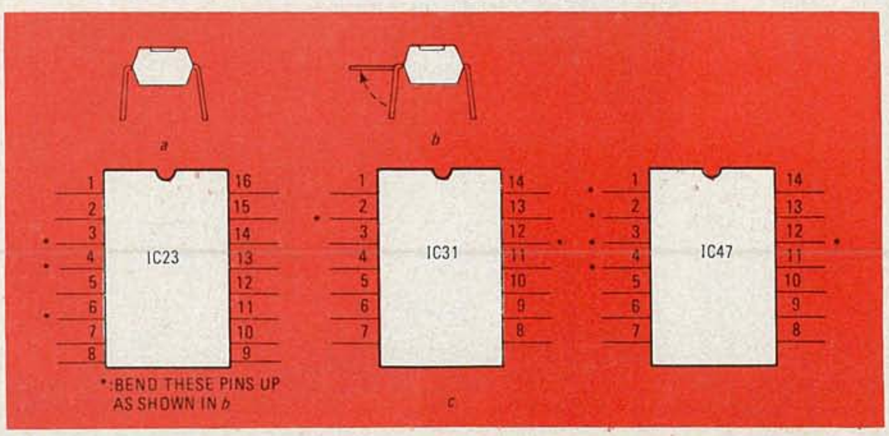


FIG. 18—SECTIONS OF IC23, IC31, and IC47 are disabled by bending IC pins up (*b*). Pins to be bent are indicated by asterisks in *c*.

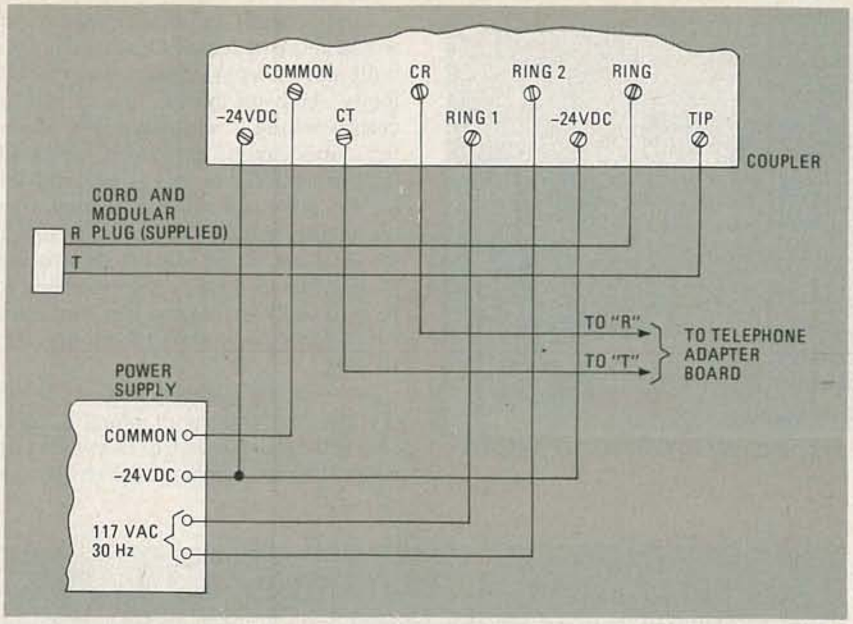


FIG. 19—CONNECTIONS TO AND FROM THE EWP130A coupler. Details of the power supply will be found in Fig. 21.

ORDERING INFORMATION

The following are available from Robot Research Inc., 7591 Convoy Court, San Diego, CA 92111, (714) 279-9430: Assembled & tested Model 535 Picture Phone, FCC registered for direct connection to telephone line (KIT-1) (14 lbs.), $1195.00; assembled and tested No. 400929C main PC board (KIT-2) (4 lbs.), $495.00; assembled and tested Picture Phone chassis, including telephone adaptor board, but *less main board,* (KIT-3) (12 lbs.), $695.00; kit of No. 400929C main PC board with all main-board parts (KIT-4) (5 lbs.), $295.00; kit including chassis and chassis parts, and telephone adaptor board and parts, but *less main board,* (KIT-5) (12 lbs.), $445.00; telephone adaptor board kit including board and parts (KIT-6) (3 lbs.), $79.50; etched, drilled, and plated-through main board (KIT-7) (3 lbs.), $59.00; etched, drilled, and plated-through telephone adaptor board (KIT-8) (2 lbs.), $19.95; T1 (KIT-9) (4 lbs.), $29.50; T601 (KIT-10) (2 lbs.), $24.50; DT1 (KIT-11) (1 lb.), $8.50; kit of 32 1% resistors for main board (KIT-12) (1 lb.), $12.00; individual 1% resistor (KIT-13) (1 lb.), $0.35; Model 535 Picture Phone enclosure kit with mounting rails for main board and back plate for controls (KIT-14) (6 lbs.), $99.50; kit of *front panel parts only,* (KIT-15) (2 lbs.), $59.50; assembled & tested RF modulator, less power supply and enclosure (KIT-16) (1 lb.), $29.00; RF-modulator kit, less power supply and enclosure (KIT-17) (1 lb.), $19.50. For information on other parts, write to Robot Research.

CA residents please add 6% sales tax. All prices F.O.B. San Diego—check with UPS for shipping charges; please add $0.50 per $100.00 of value above first $100.00 for insurance. MC and Visa accepted.

For information on where to obtain the coupler described in the text write to: Elgin Electronics, 802 Walnut Street, Waterford, PA 16441. The price of the EWP130A coupler is $87.00, ppd.

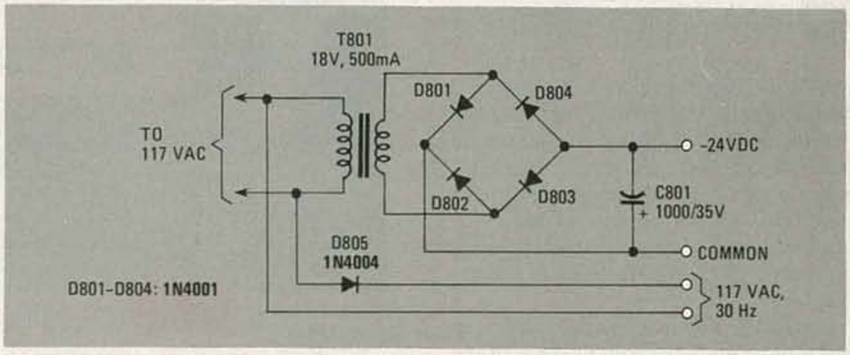


FIG. 20—POWER SUPPLY for use with the EWP130A telephone coupler. It can easily be built on perforated construction board and mounted inside the Picture Phone enclosure.

calibration *without* connecting the device to the phone line—if you leave it connected while you are working on it, anyone who tries to call you will get a busy signal. Instead, temporarily use a small piece of wire to jumper the contacts on the PICTURE switch so you are constantly in the VIDEO mode.

To perform the alignment you'll need a frequency counter, cassette recorder, and a video monitor or a TV set with an RF modulator (which you're going to need anyway when you put the Picture Phone to use). A TV camera, which, of course, you'll eventually require, is not needed for most of the alignment procedure.

The first step is to set the proper frequencies for slow-scan sync, white level, and black level. Connect a frequency counter to the TO TAPE jack and then temporarily connect TP2 (see Fig. 2 in the August issue) to +5 volts. Adjust the SYNC trimmer, R107 until you get a reading of 1200 Hz, the slow-scan sync frequency.

Next, ground TP2 and turn the front-panel CONTRAST control fully counterclockwise and the BRIGHTNESS control fully clockwise (Fig. 21 shows the front-panel controls). With the FRAME GRAB switch in the MANUAL position push the FRAME GRAB *button* to load a frame of white into memory. Adjust the WHITE trimmer potentiometer, R104, until you get a reading of 2300 Hz on your counter.

Finally, with TP2 still grounded, turn the CONTRAST control fully *clockwise*, and the BRIGHTNESS control fully *counterclockwise*. Adjust the BLACK trimmer, R106, until your counter reads 1500 Hz, the frequency used in slow scan to represent black. That completes the frequency adjustments for slow-scan output and you can remove the lead from TP2.

The next step is to adjust the brightness and contrast levels for slow-scan reception. That will be done by referring to the four-level (black, two shades of gray, and white) gray scale generated by the Picture Phone.

First, set the MODE switch to the GRAY SCALE position and snatch a gray scale using the FRAME GRAB button. **Do not be alarmed if, with no TV camera connected, you see a crazy jumble of lines on the screen in the GRAY SCALE or CAMERA mode. That is normal, and is due to the fact that the Picture Phone is receiving no fast-scan sync signal. The gray scale can be viewed by putting the MODE switch into the TRANSMIT or HOLD position.** You may notice some slight glitches where one gray shade meets the next. That, too, is normal, and will not be obvious when you are viewing slow-scan pictures.

With a gray scale being displayed from memory (MODE switch in the HOLD position) adjust the CONTRAST control of the monitor or receiver until the white bar at the right just begins to "bloom"—blend with the next shade of gray. Then adjust the monitor or TV set's BRIGHTNESS control until the black bar on the left matches the blanked area of the screen. Do not reduce the brightness below the point where the raster lines just disappear from the screen. Your display device should now be correctly adjusted for slow-scan viewing.

Now you can adjust the Picture Phone

FIG. 21—PICTURE PHONE'S front-panel controls. The FRAME GRAB button is below and to the left of the five-position MODE switch.

PICTURE PHONE DIRECTORY

Should you build—or purchase—your own Picture Phone, **Radio-Electronics** would like to know about it. We hope to publish a directory of Picture Phone users so, if you're interested in talking to (and seeing) others, be sure to include your telephone number.

for slow-scan reception. Connect a shielded audio cable from the TO TAPE jack of the Picture Phone to the line or mike input of the cassette recorder and, with a gray scale being displayed in the TRANSMIT mode, record about five-minutes worth. You may have to adjust the SINE trimmer, R204, to get an acceptable recording level.

Connect a second shielded cable between the output or earphone jack of the recorder and the FROM TAPE jack on the Picture Phone. Rewind the tape you just made and set the Picture Phone's MODE SWITCH TO THE RECEIVE position. Play back the gray-scale tape and adjust trimmers R138 (BLACK) and R141 (WHITE) until the recorded gray scale matches a frame-grabbed one (viewed in the TRANSMIT position).

If you are not able to make the recorded center two gray shades match the ones viewed directly from the Picture Phone, R138 is probably not set correctly. Change its setting slightly, and then try to match the two gray scales using R141. In the end, you should be able to make four distinctly different brightness levels.

The last two adjustments require a TV camera. A digitized, *real-time* image can be viewed with the MODE control in the CAMERA position. Focus on a round object—a dinner plate or fisbee, perhaps—and grab a frame of it. Use the SNATCH WIDTH trimmer, R56, to adjust the width of the picture stored in memory (viewed in the TRANSMIT or HOLD position of the MODE switch) until it is the same as that of the one obtained directly from the camera.

Finally, record several minutes worth of your test picture and then play it back with the MODE control in the RECEIVE position. Adjust the WIDTH trimmer, R143, until the picture just fills the square display area. It should have the same height and width as the picture viewed in the CAMERA mode.

Remove the jumper from the PICTURE switch and you've completed the Picture Phone calibration, and are ready to put your unit to use.

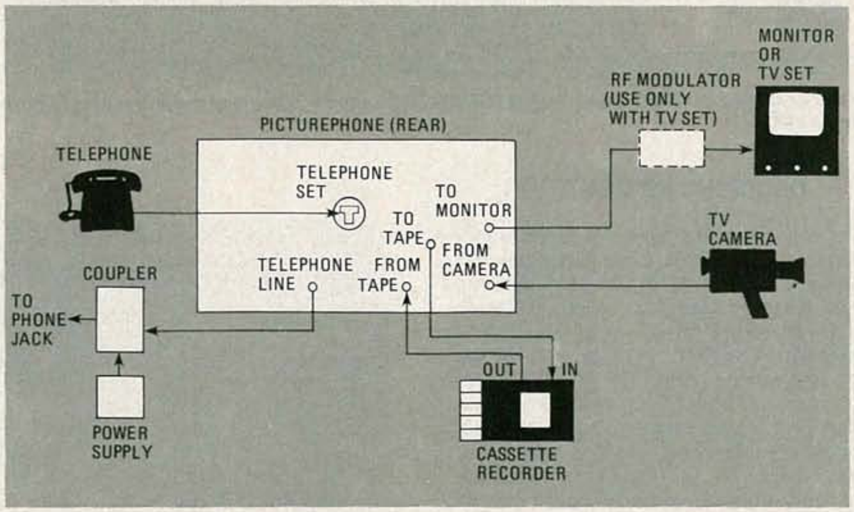


FIG. 22—CONNECTIONS TO AND FROM the Picture Phone. Be sure to use shielded cable to keep signals clean.

OOOOOOPS

In the schematic of the main board of the Picture Phone (Fig. 2, August 1982), capacitor C208 appeared twice. The C208 with a value of .001μF (near R139) should be omitted, as should its ground. In the Parts List (page 50, September 1982), resistor R81 *is* used—its value is 1000 ohms. Resistors R82—R84 are not used.

Troubleshooting

The preceding assumed that your Picture Phone operated properly the first time you turned it on. It is quite possible—due to the complexity of the device—that it did not and the following may help you to set things right.

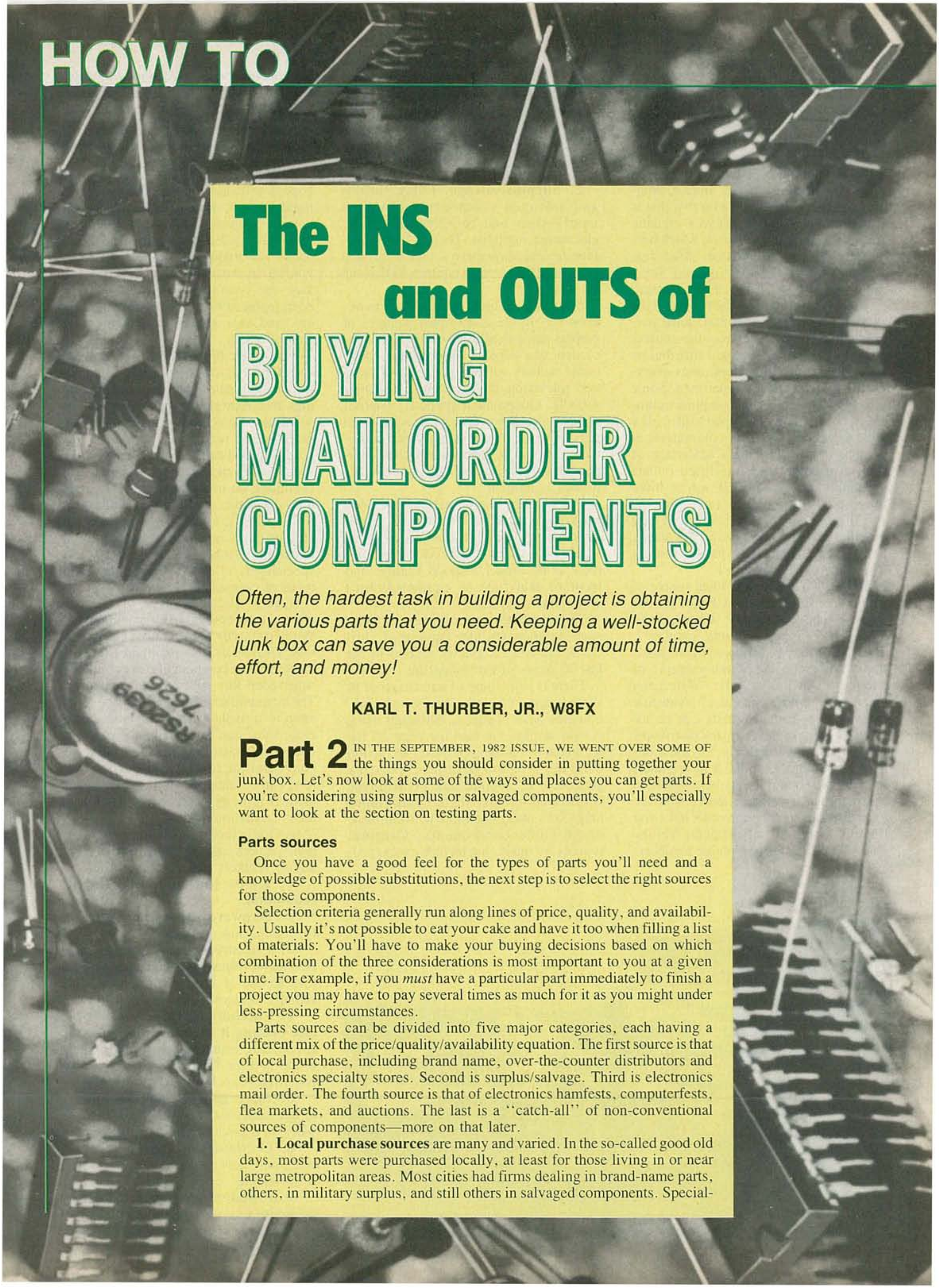
First, check for all the things you would normally look for if something you built didn't work. Check your solder joints—both on the PC boards and the chassis wiring— and make sure that all the wires run to and from the points they're supposed to. Also make sure that all the IC's and other polarized components are installed properly and that all the IC's are in the sockets they're supposed to be in. Don't forget to check for IC pins that may have gotten bent under when you were inserting them into their sockets.

You can tell whether your unit is outputting slow scan by grabbing a frame, setting the MODE switch to TRANSMIT, and connecting an earphone to the TO TAPE jack. You should hear a sort of burbling sound that's very difficult to describe in writing but which you'll soon become familiar with. If you hear a steady tone, something's wrong; start checking back from the slow-scan audio-output stage.

If everything you've built looks all right, but you're still not getting results, it's time to get an oscilloscope and start signal tracing. It's not enough to verify that all the clocking and control signals are present—they must also be at the proper logic-levels. In the unit I built, I found that an off-value resistor had caused the biasing of one of the 1458 op-amps to be off, and the logic-level signals it was passing were shifted to the extent that the following TTL IC's could not recognize them. Use a logic probe, if necessary, to verify that you are getting true logic-highs and logic-lows.

While IC's are normally the last things you should blame for your problems, brand-new ones do tend to have an "infant mortality" rate of about one percent and, in a device with as many IC's as the Picture Phone has, there is a chance that one of them is bad. So, if a signal goes into an IC but doesn't come out, try

continued on page 112



The INS and OUTS of BUYING MAILORDER COMPONENTS

Often, the hardest task in building a project is obtaining the various parts that you need. Keeping a well-stocked junk box can save you a considerable amount of time, effort, and money!

KARL T. THURBER, JR., W8FX

Part 2 IN THE SEPTEMBER, 1982 ISSUE, WE WENT OVER SOME OF the things you should consider in putting together your junk box. Let's now look at some of the ways and places you can get parts. If you're considering using surplus or salvaged components, you'll especially want to look at the section on testing parts.

Parts sources

Once you have a good feel for the types of parts you'll need and a knowledge of possible substitutions, the next step is to select the right sources for those components.

Selection criteria generally run along lines of price, quality, and availability. Usually it's not possible to eat your cake and have it too when filling a list of materials: You'll have to make your buying decisions based on which combination of the three considerations is most important to you at a given time. For example, if you *must* have a particular part immediately to finish a project you may have to pay several times as much for it as you might under less-pressing circumstances.

Parts sources can be divided into five major categories, each having a different mix of the price/quality/availability equation. The first source is that of local purchase, including brand name, over-the-counter distributors and electronics specialty stores. Second is surplus/salvage. Third is electronics mail order. The fourth source is that of electronics hamfests, computerfests, flea markets, and auctions. The last is a "catch-all" of non-conventional sources of components—more on that later.

1. Local purchase sources are many and varied. In the so-called good old days, most parts were purchased locally, at least for those living in or near large metropolitan areas. Most cities had firms dealing in brand-name parts, others, in military surplus, and still others in salvaged components. Specialized emporiums sold, at bargain prices, the most-needed components—resistors, capacitors, tubes, inductors, transformers, sockets, gears, dials, cabinets, test equipment, and chassis, *ad infinitum*. Today, very few cities have more than a few walk-in electronics distributors' outlets, other than franchised ones. In fact, probably the only "classic" radio row that is still thriving today is Tokyo's gigantic Akihibara electronics district, which may be described as an updated, solid-state version of New York's Cortland Street radio row of 1940's and 1950's vintage.

There is little hope for the revival of the radio row. For the most part, local purchase means the lone over-the-counter electronics distributor. Such distributors specialize in selling electronics parts, mostly to radio and TV repairmen. Some also sell CB, audio, and computer equipment, but are rarely equipped to provide a wide selection of project components at popular prices. The main advantage of such distributors and franchised outlets is, simply, *availability*. If you're more interested in price than fast delivery, you'll probably want to save money by ordering parts by mail. But if you need a part fast, all you have to do is to make a trip to the store to obtain it.

To locate a convenient local source of supply, consult the Yellow Pages of your local telephone directory. Check under "*Electronics Equipment and Supplies*". That listing may be followed by the notation "Wholesale and Manufacturers" or "Retail". Also look under "*Television and Radio Supplies and Parts*". Note that many hard-to-come-by parts can be located by going to the company distributor in your area—particularly for semiconductors. Motorola and RCA have outlets in many cities, and it may be possible to obtain the particular item needed from the local distributor, or he can order it for you if out of stock. Again, check the Yellow Pages for addresses and phone numbers.

Several larger radio distributors (especially those also doing a substantial mail-order business) issue periodic catalogs, usually free. Many of these run to several hundred pages, and can be thought of as encyclopedias of highly useful information.

2. Surplus/salvage. Using surplus and salvaged components can be a money-saver and convenience for the electronics hobbyist. There's little doubt that the least expensive source of needed parts is old electronics equipment that can be salvaged.

Surplus isn't quite what it used to be, however. In the distant past, sources of surplus equipment were many. Those included war-surplus emporiums, mail-order military salvage firms, local radio and television dealers, and electronics schools. Government property disposal and surplus-sales programs have been good sources of classic salvage, equipment that can be stripped of useful components and/or converted into useful electronics equipment.

Much of the classic market has dried up: What is available is not terribly useful for contemporary construction projects. World War II and 1950's-vintage equipment is no longer in good supply, and most of that type of equipment isn't appropriate, anyway.

Still, there are opportunities to obtain such components and equipment. Just check the Market Center section in the last 30 pages of this magazine.

There is something of a renaissance of surplus today, but the times and technologies have changed. Although using classic surplus can take the edge off the high cost of building projects, the action today lies in *industrial* surplus. There is a great deal of commercial, civilian-type surplus advertised in the electronics magazines alongside more conventional, brand-name components. Original sources are many, but include excess production quantities, overstocks, obsolete product lines, bankruptcy liquidations, CB components closeouts, etc., all available at bargain-basement prices that represent but a fraction of original prices or replacement costs.

3. Mail-order. While there's little hope for revival of the radio row, the rapid growth of mail-order electronics houses, coupled with the convenience of the toll-free telephone number and instant bank-card credit, have largely filled the void left by the demise of in-city stores. In fact, the central radio row has largely been replaced by stacks of catalogs, flyers, and sale sheets announcing merchants' wares.

Mail-order firms tend to specialize in specific kinds of components, assemblies, or equipment. Each firm and the catalogs that represent it have distinct personalities. Some companies handle only brand-new, factory component lines, sold individually. Some companies specialize in specific types of parts, concentrating on transistors and IC's, resistors, capacitors, or inductors. Others sell only manufacturers' overruns and surplus-parts inventories by the lot or package. Others are genuinely non-specialized, selling a smattering of all types of components.

A very specialized type of supplier, often overlooked, is the kit manufacturer. While primarily packagers of electronics kits, kit makers also maintain extensive inventories of components for current and superseded kits sold by the companies. The kit manufacturer can usually be relied upon to furnish an exact replacement or close substitute for an ailing component in any of his kits. In some cases, one-of-a-kind parts for non-kit construction projects can be obtained from the kit manufacturer if the part can be found in one of the construction manuals.

Buying electronics components by mail requires care. Keeping in mind a few buying pointers will save later grief:

1. Know the company and its reputation.

2. Be aware of the firm's warranty, return, and restocking policies.

3. Use current catalogs and magazine advertisements, and check with the firm to see if critical components are actually in stock.

4. Carefully check your order before mailing it or calling it in, and take special care with telephone orders to help insure that the firm knows exactly what you want. Check arithmetic carefully!

5. Place general correspondence or questions not directly pertaining to the order on a separate sheet of paper.

6. Use the dealer's part numbers in addition to generic part numbers, if those are available.

7. Include a remittance that will be adequate to cover the order, plus postage, handling charges, and tax, but don't use a blank check. Use a money order,

ELECTRONICS FLEA MARKET and hamfest dealers, such as this one, are among the best sources for low-cost parts.

TABLE 2—SELECTED LISTING OF MAIL ORDER ELECTRONIC PARTS DEALERS

Advertisers in Radio-Electronics Magazine are listed in bold type

Active Electronics Sales Corp.
PO Box 1035
Framingham, MA 01701
617-366-0500

ADVA Electronics
Box 4181
Woodside, CA 94062

Advanced Computer Products
PO Box 17329
Irvine, CA 92713
714-558-8813

Alaska Microwave Labs
4335 E. 5th Street
Anchorage, AK 99504

All Electronics
PO Box 20406
905 S. Vermont
Los Angeles, CA 90006
213-380-8000

Aldelco
27890 Milburn Avenue
Baldwin, NY 11510
516-378-4555

Altex Electronics
618 W. Sunset
San Antonio, TX 78216
512-828-0503

Arizona Electronic-Surplus
6835 N. 16th St.
Phoenix, AZ 85016
602-266-9758

Babylon Electronics
4811 Myrtle Ave.
Sacramento, CA 95841
916-334-2161

B&F Enterprises
119 Foster Street
Peabody, MA 01960

Barry Electronics Corp.*
512 Broadway
New York, NY 10012
212-WA5-7000

B.G. Micro
PO Box 280298
Dallas, TX 75228
214-271-5546

Bullet Electronics
PO Box 401244
Garland, TX 75040
214-278-3553

Chaney Electronics, Inc.
PO Box 27038
Denver, CO 80227
303-781-5750

Components Express
1380 E. Edinger
Santa Ana, CA 92705
714-558-3972

Concord Computer Products
1971 So. State College
Anaheim, CA 92806
714-937-0637

Dealin Electronics
735 Loma Verde
Palo, Alto, CA 94303
413-493-5930

Diamondback Electronics
2083 12th St.
Sarasota, FL 33577
813-953-2829

Digi-Key Corp.
Highway 32 South
Thief River Falls, MN 56701
218-681-6674

Dokay Computer Products
3250 Keller St., No. 9
Santa Clara, CA 95050
408-988-0697

Edlie Electronics, Inc.
2700-DP Hempstead Turnpike
Levittown, NY 11756
516-735-3330

EICO
108 New South Road
Hicksville, NY 11801

Electronic Distributors, Inc.
4900 Elston Avenue
Chicago, IL 60630
312-283-4800

Electronic Mart
90 E. Water Street
Chillicothe, OH 45601
614-773-1313

Electronic Surplus, Inc.
1224 Prospect Ave.
Cleveland, OH 44115
216-621-1052

ETCO Electronics
North Country
Shopping Center
Plattsburgh, NY 12901
518-561-8700

Etronix
14803 N.E. 40th
Redmond, WA 98052
206-881-0857

Fair Radio Sales Co., Inc.*
1016 E. Eureka
Box 1105
Lima, OH 45802
419-227-6573

Fordham
855 Conklin Street
Farmingdale, NY 11735
516-752-0050

Formula International, Inc.
12603 Crenshaw Blvd.
Hawthorne, CA 90250
213-973-1921

Gladstone Electronics
901 Fuhrmann Blvd.
Buffalo, NY 14203
716-849-0735

Gemeni Electronics
473 W. State Rd.
Altemonte Sp., FL 32701
305-819-9292

Godbout Electronics
Box 2355
Oakland Airport, CA 94614
415-562-0636

Hal-Tronix
PO Box 1101
Southgate, MI 48195
313-285-1782

Heath Co.
Benton Harbor, MI 49022
616-982-3200

Hitech Electronics
4425 W. Sepulveda Blvd.
Torrance, CA 90505
213-371-2160

Integrated Circuits, Unlimited
7889 Clairmont Mesa Blvd.
San Diego, CA 92111

International Electronics
435 First Street
Solvang, CA 93463

Jameco Electronics
1355 Shoreway Road
Belmont, CA 94002
415-592-8097

JDR Microdevices, Inc.
1224 Bascom Avenue
Campbell, CA 95008
408-995-5430

JAVANCO
150 Second Avenue
South Nashville, TN 37201
615-224-4444

H.J. Knapp of Florida, Inc.
4750 96th Street
St. Petersburg, FL 33708
813-392-0406

MCM Electronic Parts
858 Congress Park Drive
Centerville, OH 45459
614-434-0031

McGee Radio
1901 McGee Street
Kansas City, MO 64108
816-842-5092

Meshna, Inc.
PO Box 62
E. Lynn, MA 01904
617-595-2275

MHZ Electronics
2111 W. Camelback
Phoenix, AZ 85015

Mikos
PO Box 955
El Granda, CA 94018
415-728-9121

M-M Electronic Sales
2300 1st Avenue
Seattle, WA 98121

Mouser Electronics
11433 Woodside Ave.
Santee, CA 92071
714-449-2229

New-Tone Electronics
PO Box 1738
Bloomfield, NJ 07003
201-748-5089

Olson Electronics
2850 Gilchrist Road
Akron, OH 44305
216-798-1000

Omnitron
768 Amsterdam Ave.
New York, NY 10025
212-865-5580

Ora Electronics
18215 Parthenia St.
Northridge, CA 91325
213-201-5848

Page Digital
1858 Evergreen
Duarte, CA 91010
213-357-5005

Poly Paks, Inc.
PO Box 942
S. Lynnfield, MA 01940
617-245-3828

PPG Electronics
791 Red Rock Rd.
St. George, UT 84770
801-628-3627

Priority One
9161 Deering Avenue
Chatsworth, CA 91311

Quest Electronics
PO Box 4430C
Santa Clara, CA 95054
408-988-1640

R.F. Gain, Ltd.
100 Merrick Road
Rockville, Centre, NY 11570

Radio Shack
One Tandy Center
Ft. Worth, TX 76102
(Consult your local directory for the store nearest you)

Ramsey Electronics, Inc.
2575 Baird Road
Penfield, NY 14526
716-586-3950

SCR Electronics
5303 Lincoln Ave.
Cypress, CA 90630
714-527-2554

Table 2 continues on the following page

TABLE 2 (continued)

Semiconductors Surplus 2822 N. 32nd Street, Unit 1 Phoenix, AZ 85008 602-956-9423	Sparton Electronics 6094 Jericho Tpk. Commack, NY 11725 516-499-9500	**Surplus Electronics 7294 N.W. 54th Street Miami, FL 33166 305-887-8228**
Simple Simon Electronic Kits 3871 S. Valley View, Suite 12 Las Vegas, NV 89103 702-322-5273	Space Electronics Co.* 35 Ruta Court S. Hackensack, NJ 07606	**Tri-Tek 7808 N. 27th Ave. Phoenix, AZ 85021 602-995-9352**
Slep Electronics Co.* Highway 441 PO Box 100 Otto, NC 28763	**Stavis Electronics 912 Touhy Ave. Park Ridge, IL 60068 212-692-5223**	Vermont Electronics 312 W. Vermont Anaheim, CA 92805
Solid State Sales PO Box 74 Somerville, MA 02143 617-547-4005	**Suntronics Co. Inc. 12621 Crenshaw Blvd. Hawthorne, CA 90250 213-644-1149**	**Westland Electronics 37387 Ford Road Westland, MI 48185 313-728-0650**

*Specializes in "classic" military surplus

cashier's check, or charge-card number to speed delivery.

8. Observe minimum-order requirements to prevent being embarrassed later.

9. Ask that very small parts be sent first class mail, larger ones by UPS.

10. Keep a copy of your order, charge-account slips, and cancelled checks.

11. Tell the firm what you will take in the way of substitutions and if you will accept credit slips for items that are out-of-stock.

12. Consolidate small orders for savings in the cost of the parts themselves as well as postage and handling charges.

13. Be specific on how urgent the order is. Say something like, "Ship everything in stock within 10 days and cancel balance of order," or "Ship partial immediately and ship balance when available."

Mail-order houses generally offer good service, but there are built-in delays in the "system" that often mean that receipt of your parts may be several weeks away. The pointers above should help you get your order in the least possible time, however.

The biggest mail order complaints focus on substitutions and back-orders. Notwithstanding what may be advertised in a direct-mail flyer or catalog (which may have been composed many months ago), suppliers frequently don't have all of the advertised components in stock. That is especially true of solid-state components such as transistors, diodes, and IC's, and closeout, one-of-a-kind or especially bargain-priced components. Specific "kill" instructions should make your time sensitivity and amenability to backordering clear to the order filler. But what do you do about the problem of substitutions?

The best advice is to state clearly what you will accept in the way of substitutions—not very easy in the case of most transistors and IC's, that may not be readily substitutable. It's probably better to state on your order that you won't accept *any* substitutes, rather than to say that you will—unless you're willing to go to the trouble of specifying the acceptable substitutions for every single part on your order.

At the risk of confusing the order-filler with your range of substitutes, it may be wise to list one or two equivalents you will accept should a *critical* part requested be out of stock. Most dealers will comply with your request if your instructions aren't too complicated. Obviously, for unique items, or for pieces of *equipment,* you would not normally want to consider substitutes at all, or would require that you be contacted before authorizing the firm to ship a substitute of its choice.

To minimize the impact of minimum-order levels, stock-outs, and substitutions, consider judicious buying in advance of needs with respect to widely-used components and investigate the possibility of combining parts orders with those of friends or associates.

Table 2 lists representative mail-order electronics suppliers, including those firms which specialize in surplus.

4. Flea markets and auctions. Taking a somewhat less-conventional approach to parts acquisition, the flea-market circuit probably represents a very inexpensive source of electronics parts and supplies. Since one can rarely predict in advance what is likely to be encountered at a flea market, this source is generally best suited to junk-box building—for accumulating an inventory of parts for future projects.

Many amateur radio clubs and computer groups sponsor hamfests and conventions that include well-developed flea-markets. Regular distributors and direct-mail firms sell their wares at these functions, so that the hobbyist is presented with a selection of both new and surplus components, assemblies and equipment from which to choose. Some of the larger events include the *Dayton Hamvention, Birminghamfest, Atlanta HamFestival, Ak-Sar-Ben auction (Omaha, NE), SAROC (NV),* and *Hamfest Chattanooga (TN).* Dozens of lesser-known events occur regularly around the country, most being held in the good-weather season from April through October. Many amateur and some computer publications list them.

Auctions, usually conducted in conjunction with flea-markets and frequently as part of ameteur radio and computer club meetings, also represent another source of parts. Usually, however, the focus is on surplus *assemblies* rather than individual components; whatever components are included are usually grouped together and sold in lots. Those factors make auctions somewhat less attractive for small-scale buying for construction projects.

Another point: Flea markets and auctions also provide good outlets for your own junk box, which may ultimately become too bloated and may need some weeding out to make room for future purchases.

5. Other sources of supply. Sometimes, items required for a particular construction project will not be electronics components at all. One should always be alert for non-electronics sources of supply, particularly in the local area; there are a number of unique or unusual items that can be purchased locally for use in electronics construction projects.

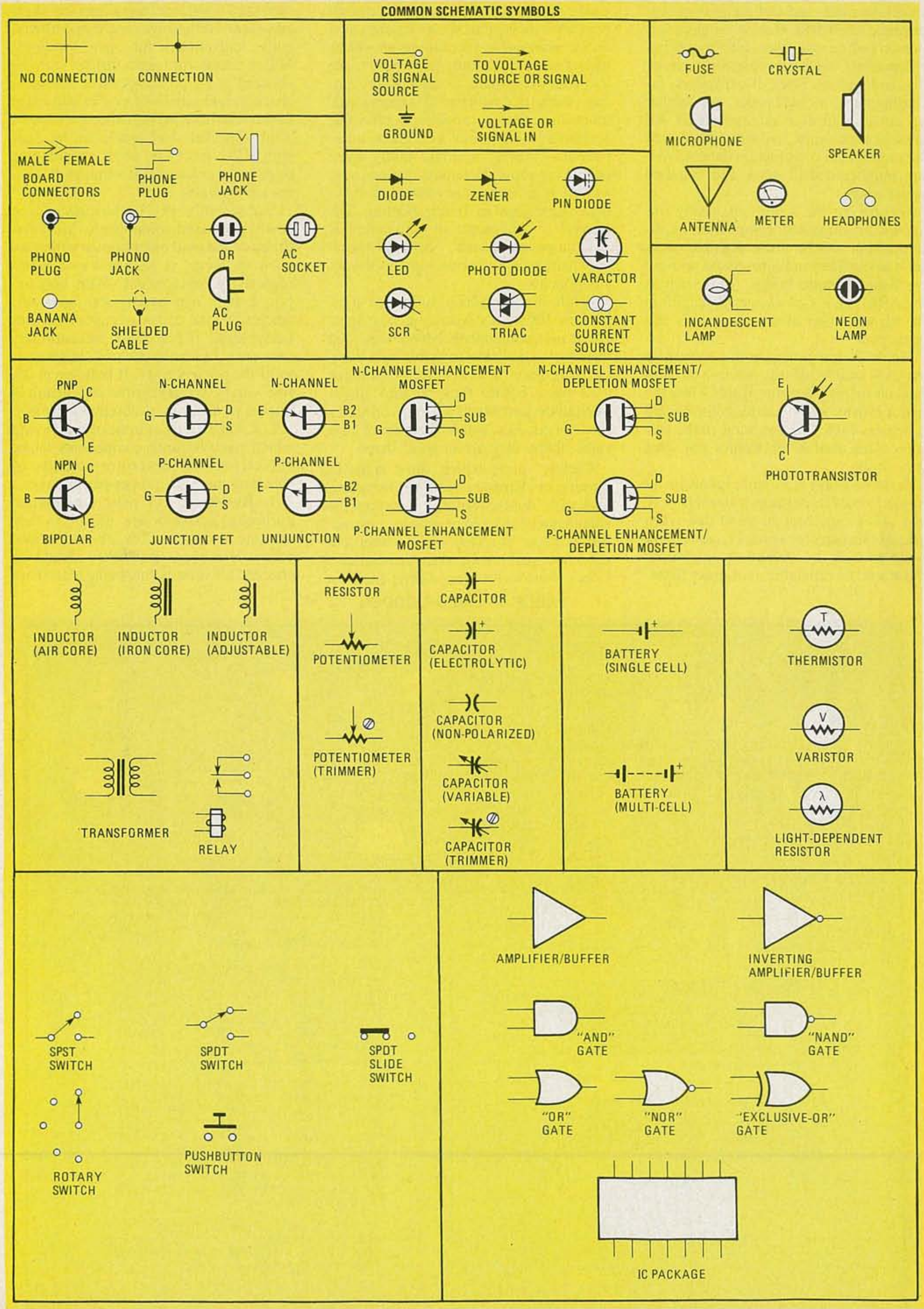
Some of these possible sources are: hardware stores (for aluminum stock); office-supply houses (boxes and enclosures); electric supply houses (wire and switches); discount stores (CB parts, batteries, and hardware); and plastics dealers (panels). A little ingenuity and creativity will surely turn up many more non-conventional parts sources.

Component identification and testing

For the most part, components purchased from local sources and from mail-order firms are labeled and packaged so that there is a minimum of difficulty in proper identification. Transistors usually have the identification stenciled-on, or they are mounted on cards; IC's are labeled; resistors and capacitors imprinted with a standardized color-code; transformer leads colored, and diodes coded. Notable exceptions include some grab-bag and bulk offerings, which may present such problems in identification that purchase is not advisable unless one is highly knowledgeable of the particular components involved and has the capability to measure a wide range of component values.

Identifying the values of unknown parts can be a risky proposition. It may be possible to do so with the help of specialized data tables and color-code keys appearing in reference texts, as well as

TABLE 3—SCHEMATIC SYMBOLS



calculating aids and test equipment. For example, the ARRL *Handbook* has a section on coding and values for a number of components, such as composition resistors and various types of capacitors, including mica, molded paper, and tubular ceramics; tubular encapsulated RF chokes; pilot lamps, and wire. Also listed are mechanical construction data, including numbered drill sizes and standard metal gauges.

Identifying the values of totally unknown or unmarked components is difficult, but can be made possible using such devices as a multimeter and grid-dip oscillator or noise bridge. Aids such as the ARRL *LCF Calculator* are helpful in the identification of unknown coils and capacitors.

Table 3 shows the various schematic symbols used to identify electronics components in this magazine. Table 4 lists the major resistor and capacitor color-coding schemes. Table 5 shows some of the prefixes often used in electronics and what they mean.

It doesn't take a lifetime involvement in electronics to develop a sizeable junk box. However, bear in mind that when assembling parts for a project, many components may be defective, including those sold by reputable mail-order firms. Using salvaged and bargain-priced components is a convenience and money saver, but reasonable precautions should be taken to insure that only good parts make it to your workbench. Completed projects can't work right with bad IC's and shorted transistors, leaky capacitors, off-value resistors, and other defective components. Worse, a single faulty component can cause the failure of good parts, as well as generate many hours of workbench time spent in troubleshooting. The proverb, "An ounce of prevention is worth a pound of cure," definitely applies when you are working with electronics components.

While it's impractical to test all components 100%, it's wise to at least spot-check *new* components before they find their way into your parts bin and completed projects, and to closely scrutinize *used* parts before they go into stock. Though the junk box is a wonderful storehouse of goodies, components are of little value unless they are in good shape.

Clearly, parts which show signs of burning or charring should be discarded, and old, dust-encrusted components should not be stocked or used in construction projects. It's also wise to weed out defective parts with your multimeter. Check resistors for gross discrepancies in measured resistance; capacitors for shorts and excessive leakage; and transformers, coils, and chokes for open windings. Many transistors and diodes can be checked using an inexpensive transistor checker, and tubes—if you're still using them—can have performance checked on a tube checker. Not much can be done with IC's, however, short of plugging them into a given circuit—though IC testers are available.

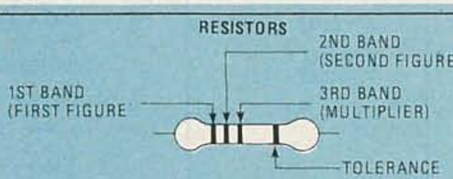
Occasionally, you'll find duds in even newly purchased components. Most distributors and mail order houses will make good on them, in response to a polite request for replacement. With bargain-priced IC's and transistors, however, where the risk of bad components runs fairly high, it's a good precautionary measure to order *two* of each semiconductor if the price is right. If both are good, fine—and you can keep the second unit as a spare or use it in a subsequent project.

Let's take a look at some of the ways in which many common components can be defective, and describe methods of checking them for proper performance.

1. Resistors. For most construction purposes, resistors are useful if they measure within ± 20% of color-coded value. However, used ones should be checked for value before being placed in a

TABLE 4—COLOR CODES

RESISTORS

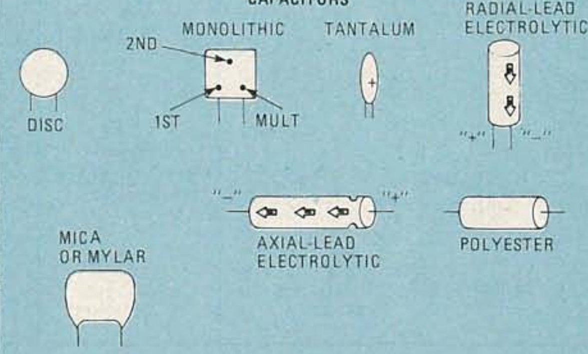


COLOR	FIRST BAND FIRST FIGURE	SECOND BAND SECOND FIGURE	THIRD BAND MULTIPLIER	FOURTH BAND TOLERANCE
BLACK	0	0	None	–
BROWN	1	1	0	–
RED	2	2	00	–
ORANGE	3	3	000	–
YELLOW	4	4	0 000	–
GREEN	5	5	00 000	–
BLUE	6	6	000 000	–
VIOLET	7	7	0 000 000	–
GRAY	8	8	00 000 000	–
WHITE	9	9	000 000 000	–
SILVER	–	–	–	10%
GOLD	–	–	–	5%

RESISTOR VALUES CAN BE DETERMINED FROM THE COLOR BANDS ON THEM. THE FIRST TWO BANDS INDICATE THE FIRST TWO DIGITS OF THE VALUE. THE THIRD BAND INDICATES THE NUMBER OF ZEROES THAT FOLLOW. THE FOURTH BAND, SEPARATED FROM THE OTHERS, INDICATES THE TOLERANCE.

SOME PRECISION RESISTORS MAY HAVE THE VALUE PRINTED ON THEM. IF THE LETTER "R" APPEARS, AS IN "2R7," IT REPRESENTS A DECIMAL POINT (THE VALUE WOULD BE 2.7 OHMS).

CAPACITORS



THE POLARITY OF TANTALUM AND ELECTROLYTIC CAPACITORS IS USUALLY CLEARLY INDICATED BY "+" AND/OR "–" SIGNS. THE POSITIVE END OF AXIAL-LEAD ELECTROLYTICS IS FREQUENTLY CRIMPED SLIGHTLY.

THE VALUES OF MOST CAPACITORS ARE CLEARLY MARKED. SOME MONOLOTHIC CAPACITORS USE A THREE-DOT COLOR CODE–THE COLORS REPRESENT THE SAME VALUES AS THOSE USED ON RESISTORS, AND ARE READ IN THE SAME WAY. THE VALUE IS GIVEN IN PICOFARADS; MULTIPLYING BY 1,000,000 WILL GIVE THE VALUE IN MICROFARADS.

MANY CERAMIC DISC CAPACITORS USE MORE CRYPTIC CODING. FREQUENTLY THE VALUE WILL BE INDICATED BY A THREE-DIGIT NUMBER SUCH AS "102." THE FIRST TWO DIGITS REPRESENT THE FIRST TWO DIGITS OF THE VALUE; THE THIRD IS THE MULTIPLIER. THE RESULT WILL BE IN PICOFARADS–MULTIPLY BY 1,000,000 TO OBTAIN THE VALUE IN MICROFARADS. IF A CAPACITOR IS MARKED "1K," ITS VALUE IS 1000 PICOFARADS (.001 μF).

LETTERS ON DISC CAPACITORS INDICATE TOLERANCES AS FOLLOWS:
"NPO" OR "Z": +80%, –20% (THIS IS THE MOST COMMON TOLERANCE.)
"J": ± 5%
"K": ±10%
"M": ±20%

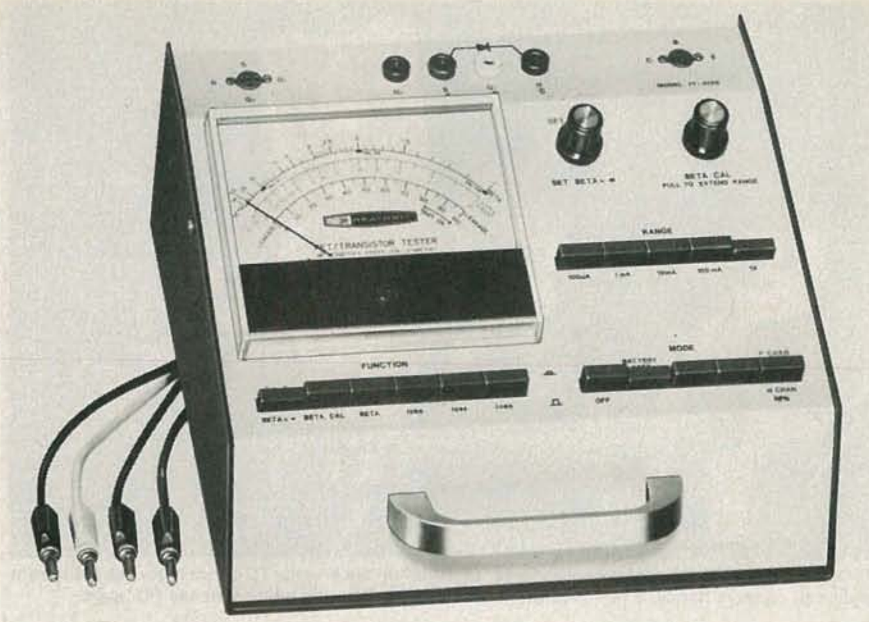
circuit.

Ordinary carbon-composition resistors change value over time, and they often suffer the effects of too much heat being applied in soldering. Precision resistors, such as 5% types, may eventually become 10% or 20% types, after long periods in damp storage. Cracked resistors should be discarded, since they tend to open up or become unstable when they heat up in normal operation.

Wirewound resistors are more stable than composition resistors, but they may suffer from cracking of the hard ceramic shell or breaking of the internal resistance wire. Usually when a wirewound type is defective, it's open and is easily checked. Wirewound slide resistors often develop shorts between turns, which reduces resistance, or develop an open circuit at the point where the tap connects.

Older deposited-film carbon resistors often suffer from aging, while newer metal-film types are considerably more stable. Still, those types can be ruined by a scratch on the outside of the shell which interferes with the spiral grooving that is cut into the resistance coating, and which determines the unit's resistance.

2. Potentiometers. The resistance element of pots should be checked using the ohms function of a multimeter by placing the leads across the outer terminals of the pot to insure that it's not open, and that it is of the proper resistance. Following that check, the leads can be connected between an outer and the adjustable-arm terminals to make certain that the movable contact isn't open or intermittent. The pot shaft should be rotated slowly while watching the meter. The meter should change its reading smoothly; if the needle jumps erratically, the pot is noisy or, in some cases, may have an open circuit over part of its rotation. At the same time you can easily determine the taper of the pot. While contact sprays may restore a unit, it's preferable to discard the unit and use another one. The on/off switch that is part of many control assemblies should also be checked for proper functioning.



A TRANSISTOR TESTER, such as the one from Heathkit shown here, should be used to check all surplus and salvaged transistors before use.

3. Capacitors. Most capacitors that fail do so because they have shorted internally. Capacitors that have experienced voltages at or near their breakdown voltages, and a lot of heat, are particularly vulnerable to shorting, and should be checked carefully.

Paper, Mylar, ceramic, and similar types of .001 µF or greater can be checked using the highest ohms range on a multimeter. Connect the probes across the leads of the capacitor in either direction. Since such capacitors are not polarized, it doesn't make any difference which way the leads are connected. If the capacitor is normal, the meter needle should suddenly deflect toward zero the moment the leads touch the capacitor, than rapidly drop back toward the high-resistance end of the scale as the capacitor charges. A shorted capacitor is indicated by the meter pointer remaining at the low-resistance end of the scale, while an open capacitor will not deflect toward zero.

The capacitor may also be checked for leakage by noting the value of resistance on the meter after about five seconds of charging. The leakage resistance should be 10 megohms or greater if the capacitor is usable. That check may be all that can be done for capacitors of less than .001 µF, as the meter "dips" are very small with low-value capacitors. Since those capacitors rarely change much in value because of storage conditions, the leakage test should suffice.

Caution is paramount when evaluating used aluminum electrolytics. They have a limited shelf life, and once they dry out, they can't be used. A defective electrolytic can easily destroy itself by drawing excessive current, heating up, and ultimately shorting out.

To check on an electrolytic's condition, apply DC voltage gradually, observing correct polarity, and beginning with a voltage equal to about 10% of the capacitor's rated voltage—working up to the full rated voltage while monitoring leakage current. A 1000-ohm resistor can be used to limit charging current and to provide a safe means of monitoring the leakage current without risking damage to the power supply or multimeter, should the capacitor short out under test. The leakage current can be found by first measuring the voltage drop across the resistor, then using Ohm's law to determine the leakage current in milliamperes. While allowable leakage current is a function of the capacitance and working voltage, 5 mA represents a good working figure. Capacitors with substantially greater leakage should be discarded. **Caution: Be sure to discharge the capacitor before handling it.**

Electrolytics of the "dry" tantalum type don't usually suffer from aging problems, though high-capacitance, high-voltage tantalums are expensive and rare. Salvaged units may be checked in a similar manner to the method described above.

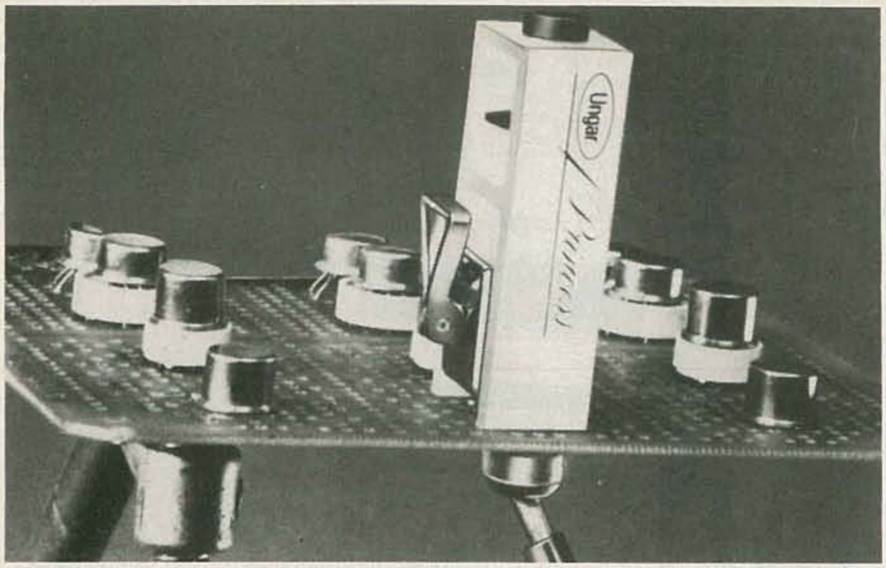
4. Diodes. Usually, a quick check using the ohms scale on a multimeter is enough to determine the usability of silicon and germanium diodes. The diode should be checked in both the forward and reverse directions; in the forward direction the R × 1 or R × 10 scale should be used. The negative terminal of the multimeter is connected to the cathode, and the

TABLE 5— MULTIPLIER PREFIXES

The table below lists the multiples and submultiples of fundamental electronic units, such as the henry, watt, farad, ampere, etc. The following prefixes, conversion multipliers and abbreviations will be particularly useful:

Prefix	Abbreviation	Multiplier
tera	T	10^{12}
giga	G	10^{9}
mega	M	10^{6}
kilo	k	10^{3}
hecto	h	10^{2}
deci	d	10^{-1}
centi	c	10^{-2}
milli	m	10^{-3}
micro	µ	10^{-6}
nano	n	10^{-9}
pico ("micro-micro")	p	10^{-12}

The above table will be used most when working with capacitor and inductor/coil values.



IF YOU ARE SALVAGING a lot of components, an extractor, such as the TO-5 transistor extractor from Ungar can come in handy. It removes the device without harming either it or the PC board.

positive terminal is connected to the anode. The reading in the forward direction should lie between 50 and 500 ohms. Reversing the meter leads should result in a reverse resistance greater than 1 megohm.

5. Transistors and IC's. Transistors can take long-time storage in the junk box without deterioration, but each salvaged transistor should be checked, as a minimum, for leaks or shorts before it is wired into equipment. If available, a transistor checker should be used for more comprehensive checking.

Check with caution, since careless checks with a multimeter can destroy a transistor. Usually it's safe to make careful measurements on a transistor with a meter whose voltage between probe leads is less than 4 volts. The R × 1 and R × 100 ranges should be safe to use.

For example, it is readily possible to check for a defective power transistor using only a multimeter. Emitter-to-collector resistance should be high with the probes applied in either direction. On the other hand, when the probes are placed on either the base-to-emitter or base-to-collector circuits, a low resistance would be obtained one way and a high resistance the other. Actual resistance values obtained aren't critical, since the spread between the high and low measurements is so great that you'll have no trouble spotting the difference. If readings differ from those described, there is probably something wrong with the transistor and it should be discarded. It's also possible to identify and sort unmarked bipolar PNP and NPN transistors, though we won't go into the details here.

Far better is a transistor tester. It is not terribly expensive, and allows more sophisticated measurements to be made with reduced risk of damage to the semiconductor.

Look for a unit that will evaluate conventional (bipolar) transistors, diodes, FET's, SCR's, triacs and UJT's. It should test them in-circuit with color-coded leads supplied, or out-of-circuit with built-in sockets. The unit displays gain (DC beta), transconductance (G^m), and leakage current. Shorted and open units can also be identified.

There is no simple way to test IC's. In-circuit substitution is often required. However, logic probes are available that can be used to detect and indicate high and low logic levels in TTL or CMOS circuitry.

6. Power transformers and filter chokes. Iron-core transformers and chokes are susceptible to insulation deterioration from humidity. The windings should be checked for continuity and coil-to-core shorts, using the ohms function on a multimeter. Insulation resistance, coil to frame, should be in excess of 50 megohms. A lower reading suggests that the insulation has deteriorated to the point where life expectancy of the unit may be shortened.

A power transformer should be checked under application of rated voltage and current. Rated input is applied to the primary winding and secondary voltages are read using the AC voltmeter function of the multimeter. The secondaries should be "loaded down" with a suitable resistance that causes the rated current to flow through the winding; this resistance can be calculated using Ohm's law. The transformer shouldn't be overloaded, even in testing—overheating as a result of overloading is the primary cause of insulation failure.

7. Vacuum tubes. Used or unknown-condition vacuum tubes should be checked before use. Using a standard vacuum-tube manual to determine pin connections, the tube can be checked for filament continuity using the ohms function of a multimeter. That will tell nothing about actual in-circuit performance, so a tube tester should be used to assess performance short of actual substitution in a working circuit. If you don't have a tube tester, the free testers still found in some drugstores, supermarkets, and franchised electronics outlets can be used for casual checking of emission and for shorted elements. Most ordinary tube testers will not test special-purpose or transmitting tube types, however.

8. Other components. Many used, surplus, and junk-box-type components can be judged from their physical condition, but many cannot. For example, switches can usually be checked using the ohmmeter function of a multimeter if the switching scheme is known or can be determined from inspection; intermittent, broken, or shorted contacts can often be determined from a combination of visual and electrical inspection. Meters can be checked for calibration by comparison with another known good meter, or a well-calibrated multimeter. Acceptability of the meter depends, however, not just on calibration but also on a reliable (non-sticking) display—often a problem with meters that have been abused or stored improperly. Note that it's usually worth the try to attempt to fix a malfunctioning meter, *if* extensive dis-assembling and reassembling can be avoided. Otherwise, it will usually cost more than the price of a new meter to have factory experts recondition or repair the defective unit.

Check RF coils and chokes for open circuits using a multimeter's ohms function. Those devices are wound with fine wire that may become broken in storage or shipment, and in the process of unsoldering those components, the ends of the winding often are unsoldered from the terminals.

Note that the DC resistance of RF chokes is frequently given in catalogs: If the measured resistance is less than 80% of the rated resistance, there may be shorted turns, which will result in degraded performance.

We have shown in this article that it *is possible* to buy the components you need, when you need them, at prices you're likely to be able to afford. Although the problems involved are great in this day of double-digit inflation, they're by no means insurmountable.

We've indicated that those challenges can be met with an organized approach to parts buying, a working knowledge of parts selection and substitution criteria, a good feel for parts sources, and a familiarity with component identification and testing procedures.

We've only scratched the surface. But this article should give you an introduction to the considerations involved when lining up parts for that next construction project.

Buying electronics parts? ... Why, if you follow the hints we've given you in this article, it's almost fun! **R-E**

Heart Rate Monitor

Keep track of your heart rate—and your health. This month we'll show you how to build your own Heart-a-Matic.

ROBERT GROSSBLATT

Part 2 THE HEART-RATE MONITOR WE DESCRIBED IN the September 1982 issue of **Radio-Electronics** is intended to give an audible and visible readout of your heart rate. In that previous part we described the theory behind the device, now its time to show you how to build your own.

Construction

The circuitry of the Heart-A-Matic is broken up to fit on six circuit boards (that has been indicated in the schematic in Fig. 3). Although wire-wrap techiques can be used, you're better off using the foil patterns in Figs. 4 through 10 to produce a set of PC boards (a set of boards is also available from the supplier indicated in the Parts List). That is particularly true of board 1, which is double-sided, has a high component density, and has a lot of interconnections. Also, unless you're the sort of person who does crossword puzzles in ink, the use of IC sockets is a must. Troubleshooting the boards is virtually impossible unless the IC's can be removed—and, more often than not, unsoldering an IC will ruin it, even if it was good to begin with. Note that if you are making your own boards, the dimensions provided for boards 1, 2, and 3, are solely for reproducing the foil patterns. Once those boards are etched and drilled, they should be cut to fit the case (more on that later).

Assembly of the boards is straightforward. Refer to Figs. 11 through 16 for parts-placement diagrams. Be sure to observe the orientation of polarized components, such as electrolytic capacitors (and, of course, transistors, diodes, and IC's). Be especially careful in handling the CMOS IC's—they're sensitive to static electricity and can be "zapped," easily. If you made your own board 1 (the double-sided one) without plated-through holes, install all the feedthroughs—small pieces of wire such as resistor leads that connect one side of the board with the other—before doing anything else.

There are a few things that you should pay particular attention to. Diode D2 is tack-soldered to the component side of board 1, but holes should be drilled for its legs, anyway; it's not good practice to rely on the solder for strength. When the crystal is inserted in board 1, sufficient leg length should be left so it can be bent over at a 90-degree angle to lie parallel to the board, making its overall height the same as that of the IC's. The same goes for IC11, the voltage regulator on board 2. The speaker is mounted directly on board 2, and enough space has been left on the board to accommodate various-size speakers. Widen the hole just enough to allow the magnet of the speaker to fit snugly. Note also that there are two pins each for ground and +6-volts on the board's 12-pin edge connector.

Resistor R48 and switch S1 are a single unit and are soldered directly to board 4 (see Fig. 17). That is done because the mounting hardware is used to secure the board to the case. The foil pattern for board 4 (Fig. 8) shows where the cutouts for the edge connectors are located as well as the holes for the bolts to hold them. It may be necessary to file down the ears of the edge connectors to make them fit properly in the space provided. Put ⅛-inch spacers between the ears and the board to make sure that the connectors don't stick too far out on the rear side of the board. The spacers can be small pieces of plastic. When the edge connectors are attached, use insulated hook-up wire between the eyelets on the back of the connectors and the appropriate pads on the board.

Checkout and troubleshooting

Connect the boards together as shown in Fig. 18 and turn on the power. Verify that the regulator is putting out about 6 volts to the circuit. When power is first applied, some number will appear in the display. What that number will be depends—as mentioned earlier—on the "temperament" of the particular 4508 used for IC15. Press your finger lightly on IC24 on board

6. The Heart-a-Matic should start beeping in time with your pulse. After the ninth beat it will start displaying your heart rate. If the device fails to operate, there are several checks you can make.

It goes without saying that you should look for cold-solder joints, bad or unsoldered connections, broken traces, and other mechanical problems. Assuming that nothing is wrong there, each individual section of the unit can be checked separately.

The input section can be checked by connecting an LED from the output of IC2 through a 1K resistor to ground. If you have a logic probe, so much the better. Shine a small light on the top of IC24 on the sensor board. As you blink it on and off you should see corresponding pulses at the IC. If you don't, do the same thing and monitor the output of IC1. If the problem isn't there, connect a jumper from the regulated supply-voltage through a 10K resistor to the positive side of C2. Every time you touch C2 with the jumper you should see a corresponding pulse at the output of IC2. If you do, then the problem is with the sensor board. If you don't, check the output of IC1 again. That method should help you to find a defective IC and, if your IC's are in sockets, you should be able to replace it easily.

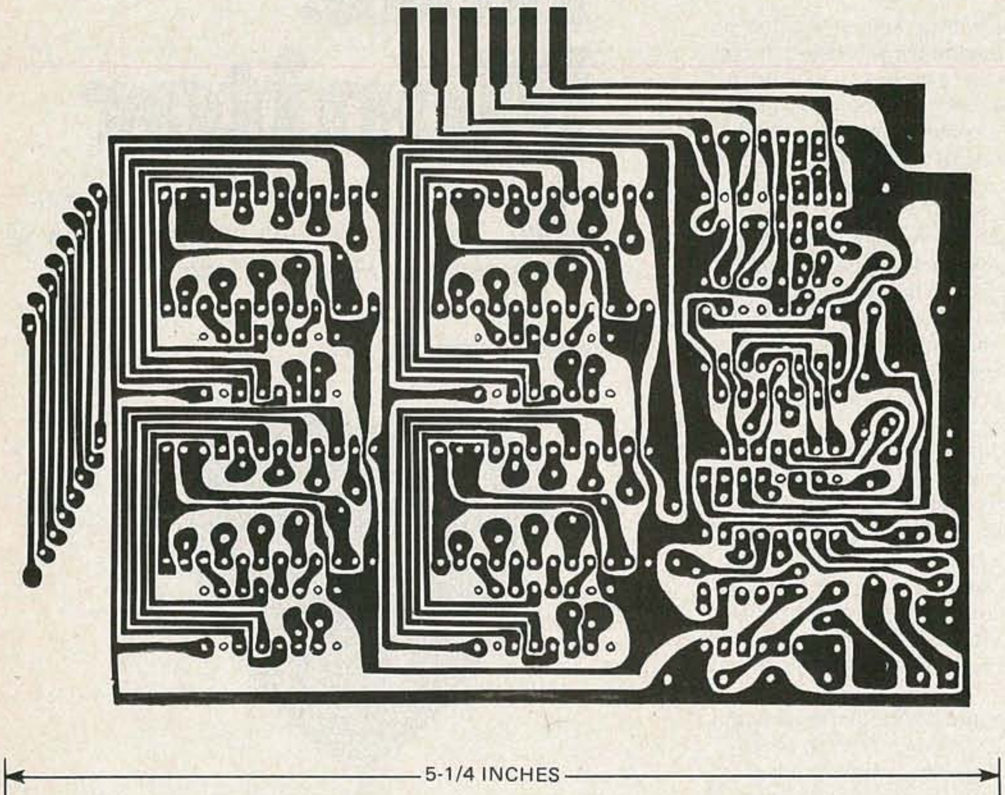


FIG. 4—FOIL PATTERN for the foil side of board 1. Note that this is a double-sided board. The component side as shown in Fig. 5.

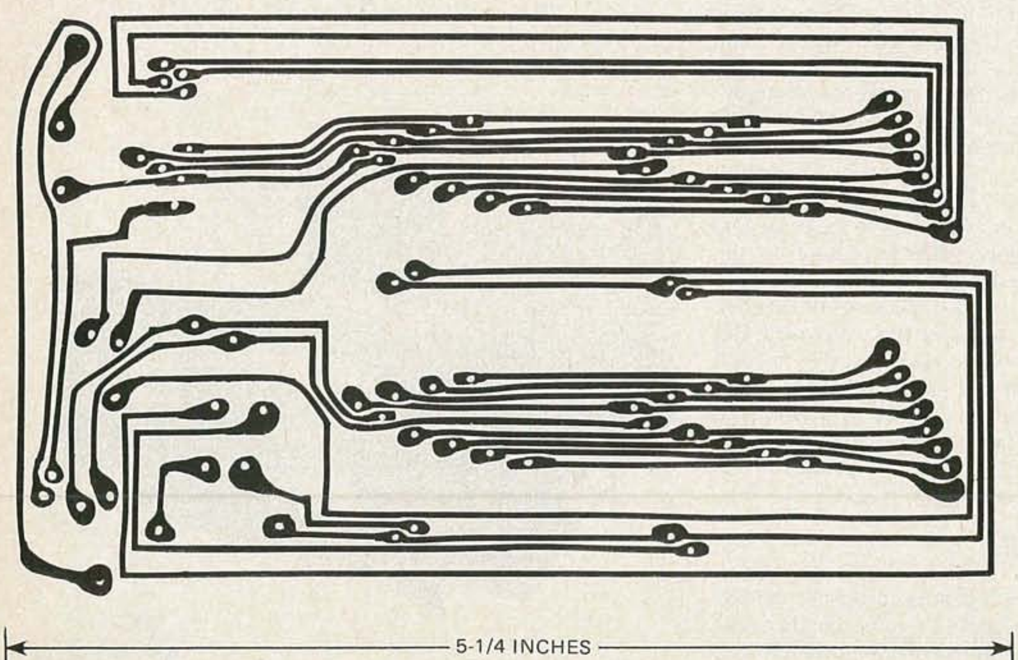


FIG. 5—COMPONENT SIDE of board 1. Note that if you etch your own boards plated-through holes or jumpers are needed (see text and Fig. 11 for more information).

Board 1 is the most complex part of the Heart-a-Matic but, fortunately, it's also the easiest to check. Remove the board from its edge connector and solder a piece of hook-up wire to pin 3 of any one of 4040's. Replace the board in the edge connector and remove IC1 on board 2. Insert the other end of the wire into pin 6 of IC1's socket and turn the monitor on. If the digital circuits of the Heart-a-Matic are operating properly, you will get a display of 120 that will be updated every half-second. If that doesn't happen, make the same sort of checks you would for any digital circuit: Is the clock clocking? Is IC21 advancing with each incoming pulse? Is IC23 putting out 60 Hz? And so on. Most of the problems on the board will be found to be due to "mechanical error." Bad IC's should be way down near the bottom of your list of suspects.

After building three Heart-a-Matics, the only problems I ever encountered were mechanical ones. In any event, none of the three worked the first time I applied power, and the problem always turned out to be in the construction of the boards, not the design or the condition of the components. As far as troubleshooting the boards goes, all that can be said is that careful work always pays off...and that you'll always find the source of the problem in the last place you look.

Bottom case

The Heart-a-Matic's case is made entirely of ⅛-inch acrylic plastic, which can be cut and shaped using ordinary woodworking tools. Solvent-type cement (available where you buy the plastic) is used throughout to hold it together. When you're assembling the case, be sure to keep your fingers off the areas of the plastic where you apply the cement. The cement softens the plastic and nothing ruins the appearance of a project more than a fingerprint etched into the case. There are more elegant, if not quite so personal, ways of signing your work.

Figure 19 shows an exploded view of the bottom case of the Heart-a-Matic. The easiest way to assemble it is to cut the base to the exact size indicated in Table 1. The sides and front can be cut larger and then attached to it. When the cement has dried they can be sanded down to fit exactly. The top of the case is one of the last parts to be attached, and it will be discussed shortly. Make sure that the slots for the circuit boards line up correctly with the edge connectors on board 4 and that the boards can slide easily in and out of the case.

The dimensions given for the base assume that slots will be routed in the sides as shown. If you decide to use card guides instead, you will have to make the base, rear door, and other pieces larger than indicated.

There are two doors in the unit; they should be installed last (their installation will be described below). One door is at the rear to allow access to the boards and the other is in front to close the storage compartment for the sensor assembly and the shielded cable that connects it to board 4. The pieces should fit snugly enough so that friction will hold the doors closed. Cut them slightly larger than needed and then carefully sand them to the correct fit.

The circuit-board assembly is held in the case by the nut on R48 and a nut-and-bolt assembly that goes in a hole drilled

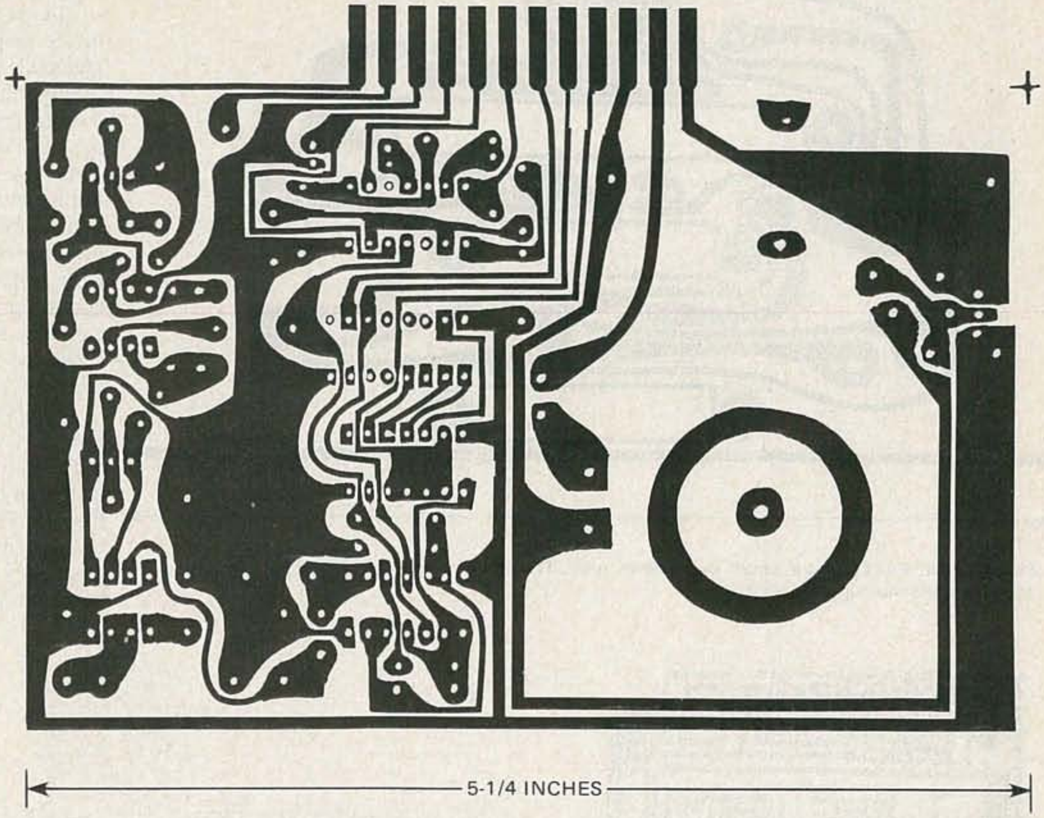


FIG. 6—FOIL PATTERN for board 2 of the Heart-a-Matic. Note that enough space has been left to accommodate a speaker (see text).

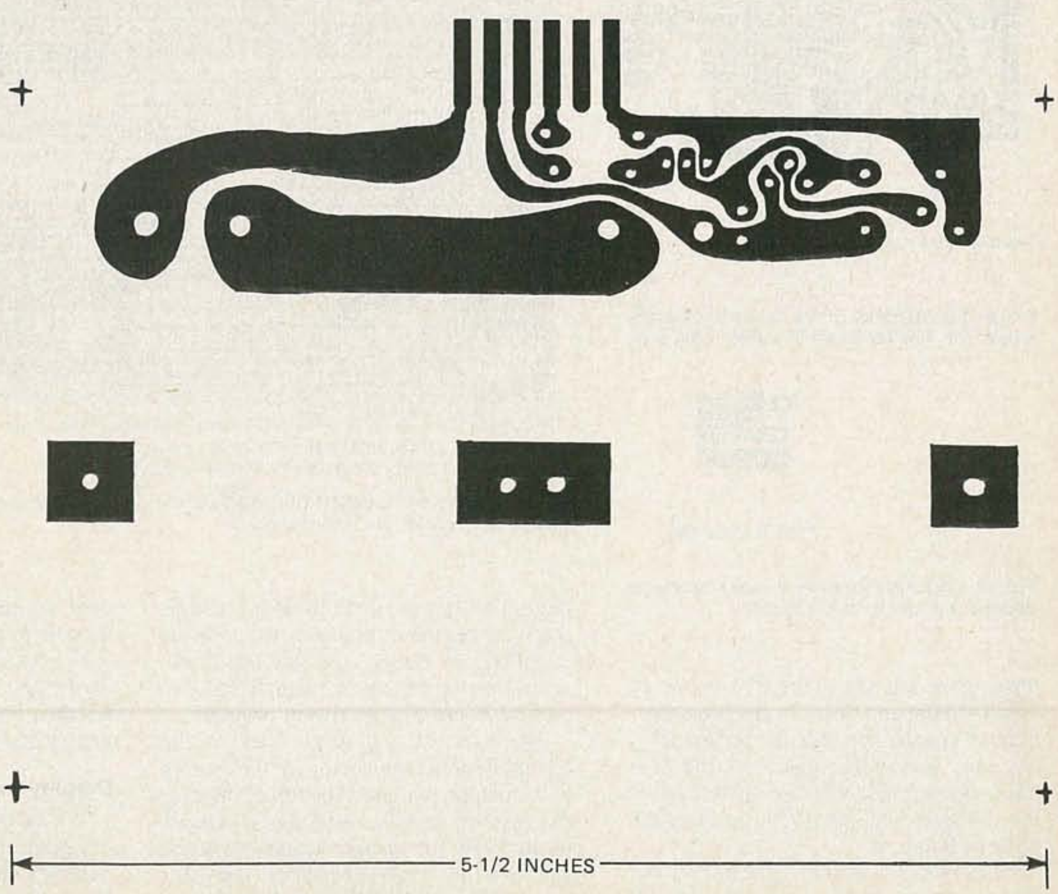
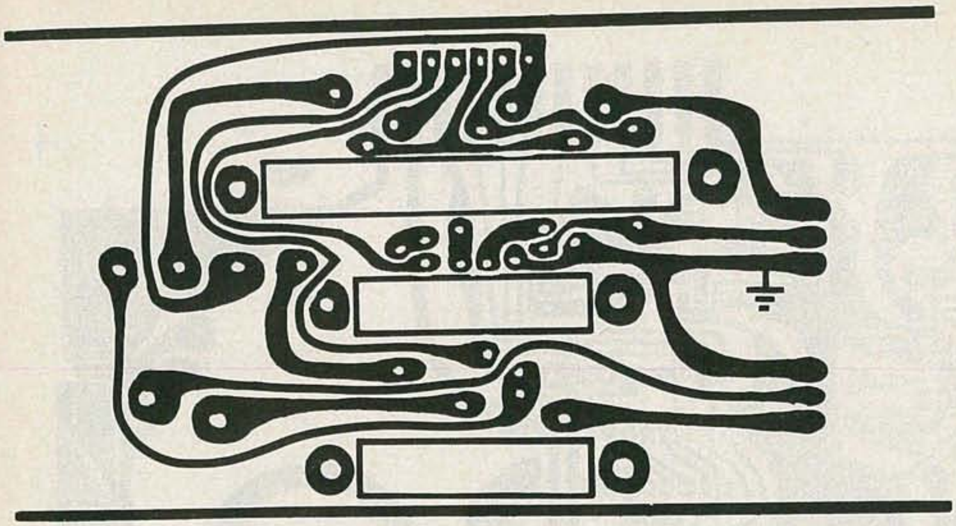
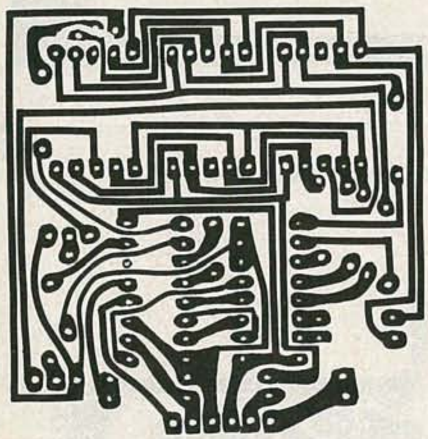


FIG. 7—MOST OF BOARD 3 is taken up by battery holders. The foil pattern for that board is shown here.



5 INCHES

FIG. 8—FOIL PATTERN for board 4 is shown here. The three rectangles should be cut out to accommodate the edge connectors.

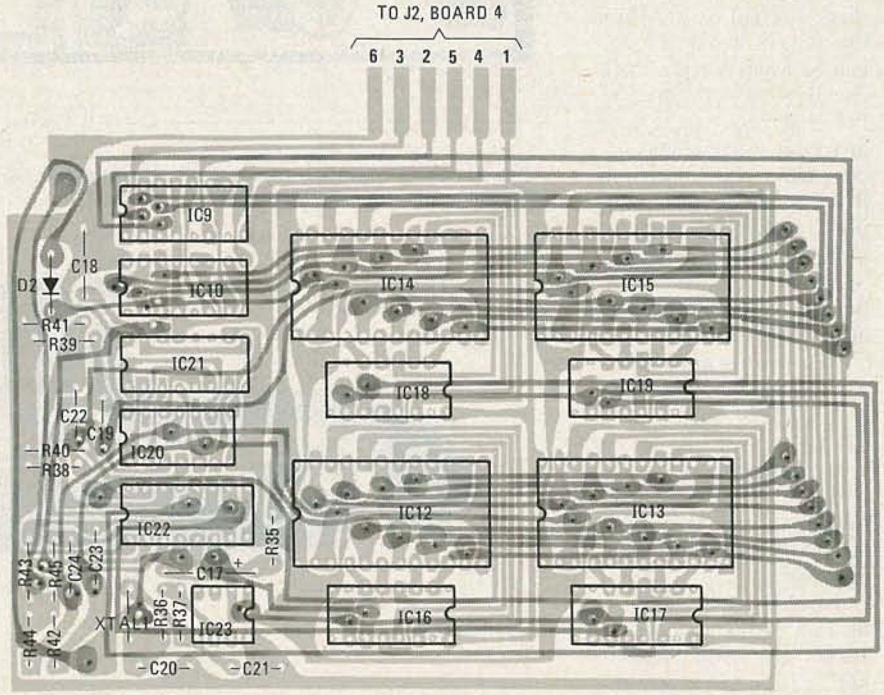


2-1/4 INCHES

FIG. 9—AS WITH ALL OF the foil patterns in this article, this one for board 5 is shown full size.

3/4 INCH

FIG. 10—THE TINY foil pattern shown here is for board 6, the small sensor board.



ASTERISKS (*) INDICATE PLATED-THROUGH HOLES OR JUMPERS SOLDERED ON BOTH SIDES OF BOARDS

FIG. 11—PARTS PLACEMENT DIAGRAM for the main board (board 1). To prevent problems later on, the use of IC sockets is recommended.

through the top rear of the sensor storage compartment and board 4. Its exact location will depend on how the boards fit in the case. Remember that a second hole has to be drilled in the case as well, to let the shielded cable get to the pads on the back of board 4.

The last piece of advice for this part of the case concerns the rubber feet. Small pieces of plastic should be glued to the bottom of the case and the feet should be screwed into them. If you try to screw the feet directly into the case, the tips of the screws may protrude far enough into it to prevent board 3 from fitting properly.

The trickiest part of the case is the assembly of the connector for the bottom of the display section. The top of the case has two sets of holes drilled in it. One is located over the speaker located on board 2 to allow the beeps to be heard. The other is a set of six holes drilled in the center of the top for the connections that have to be made between the main case and the one that contains the display.

The six leads from the top of board 4 go to the display and are routed along the underside of the case top and inserted through the holes. The holes themselves are drilled in a pattern to accommodate the six solder tails of a piece of edge connector. The details for that are shown in Fig. 19. The wires should be soldered to the tails of the edge connector and then the edge connector should be glued to the case top using epoxy. The six edge-connector pins that protrude into the case can then be bent over flat. Once that is done, the top can be glued to the rest of the case with the solvent cement.

The doors can now be fit into place and the hinges installed. The hinges are small wire brads that are pushed into holes drilled in the doors and case as shown in Fig. 19. Don't force the brads in too far because it is easy to crack the plastic. Once they are in securely, grind the ends down so they are flush with the case. If they are too loose in the holes, secure them with a small drop of epoxy, making sure you don't inadvertantly glue the doors shut in the process. When you're finished, you can put the assembly aside and let the epoxy harden.

Display case

We've given you a choice of two types of display case—plain or fancy. The plain case is a simple box, assembled more or less in the same way as the bottom case. The fancy version, shown in Fig. 20, is

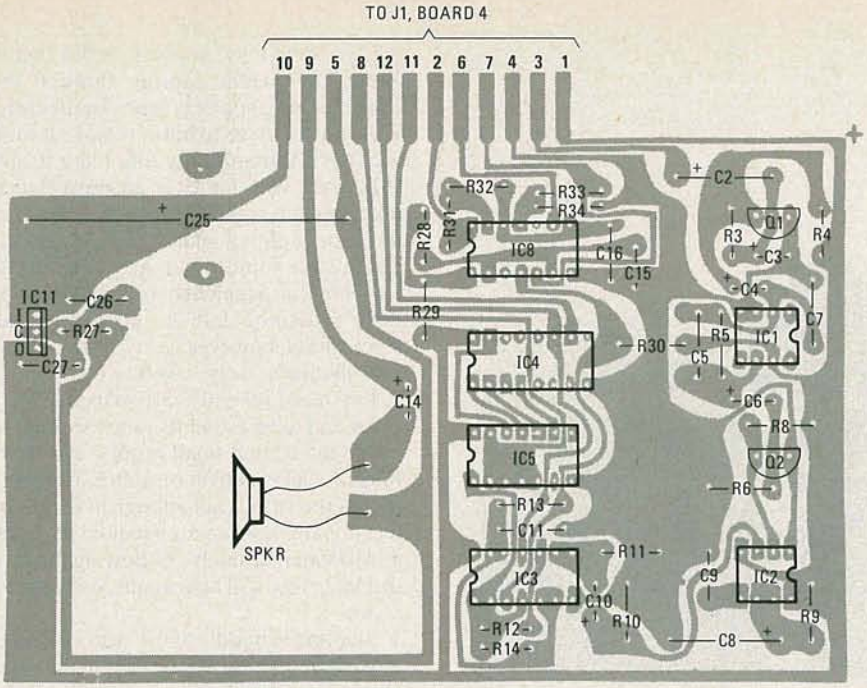


FIG. 12—WHEN MOUNTING IC11 on board 2, be sure to leave the leads long enough so that they can be bent to allow the device to lie flat.

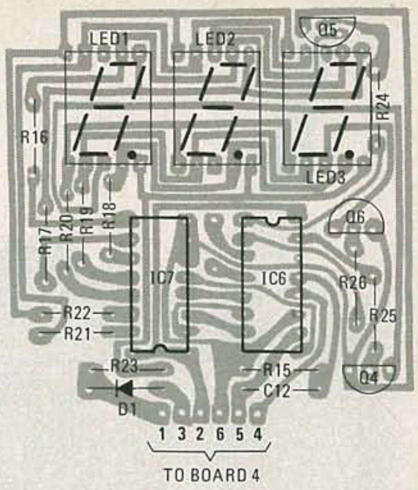


FIG. 15—PARTS-PLACEMENT DIAGRAM for board 5 is shown here.

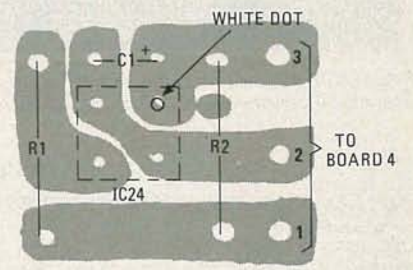


FIG. 16—BE SURE that IC24 is aligned as shown when mounting it on board 6, the sensor board.

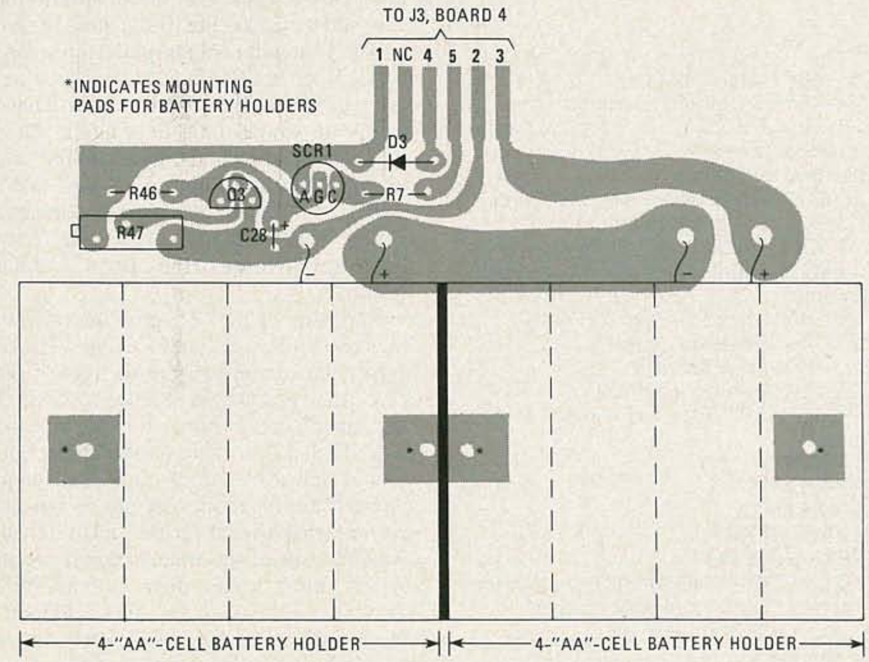


FIG. 13—THE BATTERY HOLDERS are mounted to the pads indicated by asterisks in this parts-placement diagram for board 3.

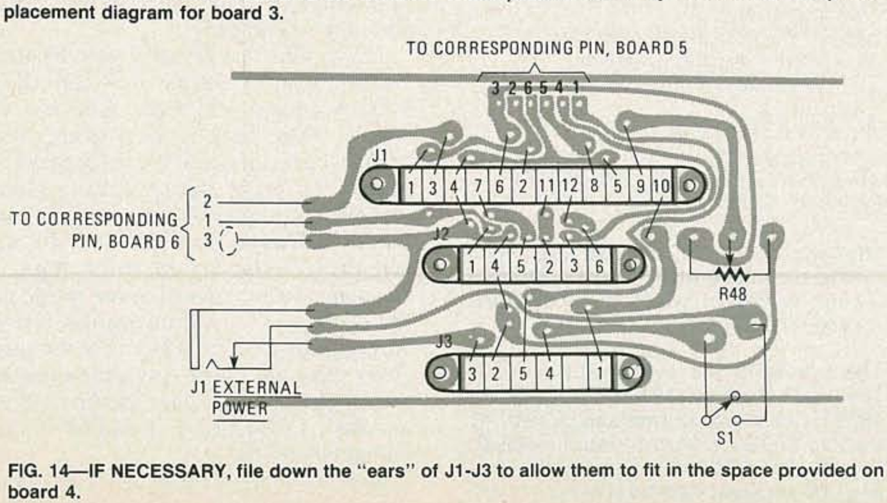


FIG. 14—IF NECESSARY, file down the "ears" of J1-J3 to allow them to fit in the space provided on board 4.

the one that will be described here. With the exception of forming the plastic for the heart-shaped case, construction details for both types are essentially the same. If you build the plain case, be sure it is large enough to hold the display board comfortably; dimensions for the heart-shaped case are given in Table 2.

Like the bottom part of the case, the display case is made of acrylic plastic. A short piece of 3/8-inch diameter chrome-plated copper tubing is used to connect the two cases. Figure 21 is a template for the front of the heart, which is made from a piece of 1/4-inch opaque red plastic. A rectangular piece of 1/4-inch *transparent* red plastic is used as a lens; it is cut as indicated and glued in the display cutout. Be careful to get none of the solvent cement on the surface of the lens. The lens should stick out in front about 1/8-inch so small strips of black plastic can be glued to the edges to form a bezel. The lettering is standard dry-transfer type; I have found that it is much easier to apply before the lens is glued to the case. After the lettering is applied, spray the case with clear lacquer to protect the type.

The side of the heart-shaped display case is made from a single piece of black acrylic plastic. **Being very careful and wearing protective gloves,** heat the strip and bend it to fit around the heart. **The plastic gets very hot,** so protective gloves are a must. The easiest way to heat

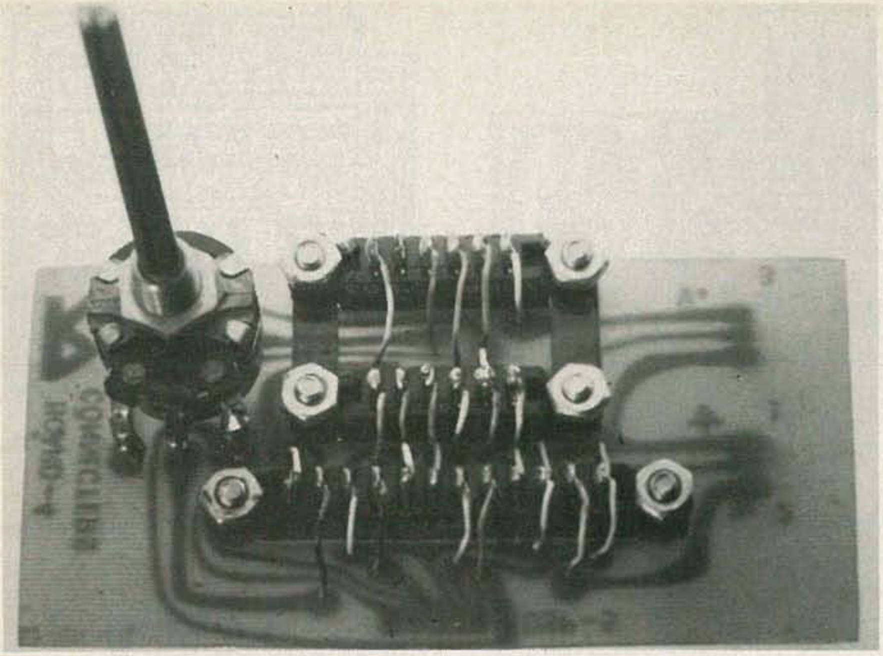


FIG. 17—RESISTOR R48 and switch S1, a single unit, are soldered directly to board 4. That unit's mounting hardware is used to secure the board to the case.

PARTS LIST

All resistors ¼-watt, 5% unless otherwise noted
R1—270 ohms
R2, R4, R11, R13, R39, R41, R43, R45—10,000 ohms
R3, R46—470,000 ohms
R5, R6, R35—1 megohm
R7, R31, R33—390 ohms
R8, R9—30,000 ohms
R10, R14, R38, R40, R42, R44—100,000 ohms
R12—12 ohms
R15, R24-R26, R29, R36—1000 ohms
R16-R22, R27—160 ohms
R16-R22, R27—160 ohms
R23—15 ohms
R28, R32—22,000 ohms
R30—4700 ohms
R34—27 ohms
R37—10 megohms
R47—500,000 ohms, multiturn potentiometer, PC-mount
R48—300 ohms, potentiometer, panel-mount with switch (commonly used in TV receivers)

Capacitors
C1, C3, C4, C6, C14, C28—0.47 µF, 35 volts, tantalum
C2—10 µF, 35 volts, electrolytic
C5—0.1 µF, ceramic disc
C7, C9, C11-C13, C18, C19, C22-C24, C26, C27—0.01 µF, ceramic disc
C8, C17—4.7 µF, 35 volts, electrolytic
C10—3.3 µF, 35 volts, tantalum
C15—68 pF, ceramic disc
C16—.005 µF, ceramic disc
C20—47 pF, ceramic disc
C21—8 pF, ceramic disc
C25—2200 µF, 16 volts, electrolytic

Semiconductors
IC1—741 op-amp
IC2—555 timer
IC3—4093 quad 2-input NAND Schmitt trigger
IC4—4020 14-stage binary ripple counter
IC5—4012 dual 4-input NAND gate
IC6—4553 3-digit binary counter
IC7—4543 BCD-to-7-segment latch/decoder/driver
IC8—556 dual timer
IC9, IC10—4089 binary rate multiplier
IC11—7805 5-volt regulator
IC12-IC15—4508 dual 3-state 4-bit latch
IC16-IC19—4040 12-stage binary ripple counter
IC20—4001 quad 2-input NOR gate
IC21—4017 decade counter
IC22—4049 hex inverter
IC23—5369 60-Hz timebase
IC24—FPA104 infra-red emitter/sensor array
Q1—2N3391
Q2—2N3904
Q3—2N2222
Q4-Q6—2N3906
SCR1—ECG 5400
LED1-LED3—FND500 0.5-inch common-cathode 7-segment display
D1, D2—1N914 or 1N4148
D3—1N4001
XTAL1—3.579545 MHz color-burst reference crystal
SPKR—8 ohms, 2-inch diameter
S1—SPST switch (part of R48)
J1—12-contact edge connector
J2, J36-contact edge connector
J4—subminiature N.C., chassis-mount
B1-B8—1.5-volt "AA" cell

Miscellaneous: PC boards, two "AA" side-by-side battery holders. Velcro strip, plastic for cases, wire, shielded cable, solder, etc.

The following are available from Hal-Tronix, P.O. Box 1101, Southgate, MI 48195: Set of six etched and drilled PC boards, $39.95; Board 1 (double-sided), $19.95. Add $2.00 for shipping & handling; MI residents add 4% tax.

the plastic is over an open candle flame. Move the plastic rapidly through the flame to make sure it is heated uniformly. If the plastic starts to burn, remove it from the flame **immediately** and blow it out. Whenever working over an open flame, take sensible precautions such as wearing the correct gloves and protective glasses. There's no point to building a heart-rate monitor if an accident happens to you and there's nothing left to monitor. In all seriousness, however, as with any project you should be very careful.

I've made several heart-shaped display cases and have found its much simpler to create the bend a small portion at a time. Plastic is an excellent insulator so while a part of the strip is hot enough to bend, the rest remains cool enough to hold its shape and be handled safely. Following the procedure below will help assure you of good results.

Start in the middle of the strip and make the first bend in the top middle of the case. Don't force the plastic to bend, because it will snap; when it's hot enough it will bend easily. Bend the plastic around the case and then dunk the whole thing in cold water. That will cool it rapidly and set the bend. Keep holding it until the shape has set or the strip will deform and you'll have to do the whole thing over again. Now make the bend around one side of the case all the way to the bottom. When that's done, cut off the excess plastic so the end is flush with the bottom of the case. Then form the other side of the case in a similar fashion.

Referring to Fig. 21, glue the front of the case to the side with solvent cement. Apply the cement only to the rear of the piece to avoid marring the front. Glue in the inner support-piece for the chrome pipe. Drill a ⅜-inch hole through the bottom of the case assembly and continue it through the inner support-piece. Put the chrome pipe in and keep the end of it flush with the top of the inner support-piece. When that's done, drill a small hole through the back of the inner support-piece and the chrome pipe. Push in a wire brad that has been covered with epoxy and set the assembly aside so the epoxy has time to harden.

Make sure that board 5, the display board, fits in the display case correctly. Glue two pieces of plastic as shown in Fig. 21 to the back of the case at either side of the board. Hold the black acrylic-plastic rear of the display case in place and drill two holes through it into those pieces of plastic. The holes are for the screws that secure the rear cover. A piece of sponge foam is glued to the inside of the rear cover to hold the display board firmly in place. The pattern for the rear cover should be traced, using the sides of the case as a pattern, once the red heart is attached. LED1-LED3 should fit in the cutout behind the lens.

Drill a ⅜-inch hole in the center of a

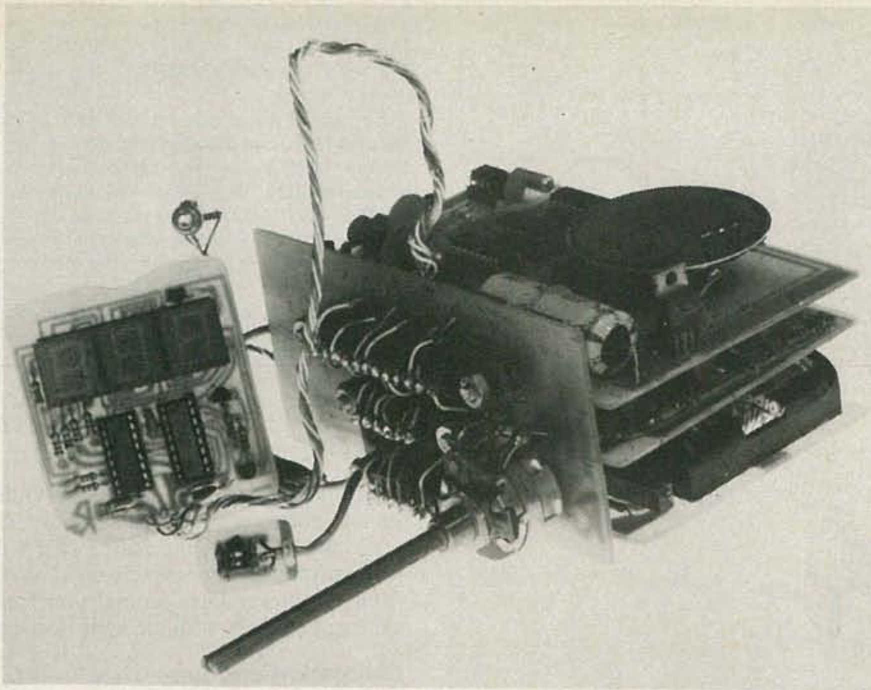


FIG. 18—WHEN ALL OF THE BOARDS are completed, they are connected together as shown here.

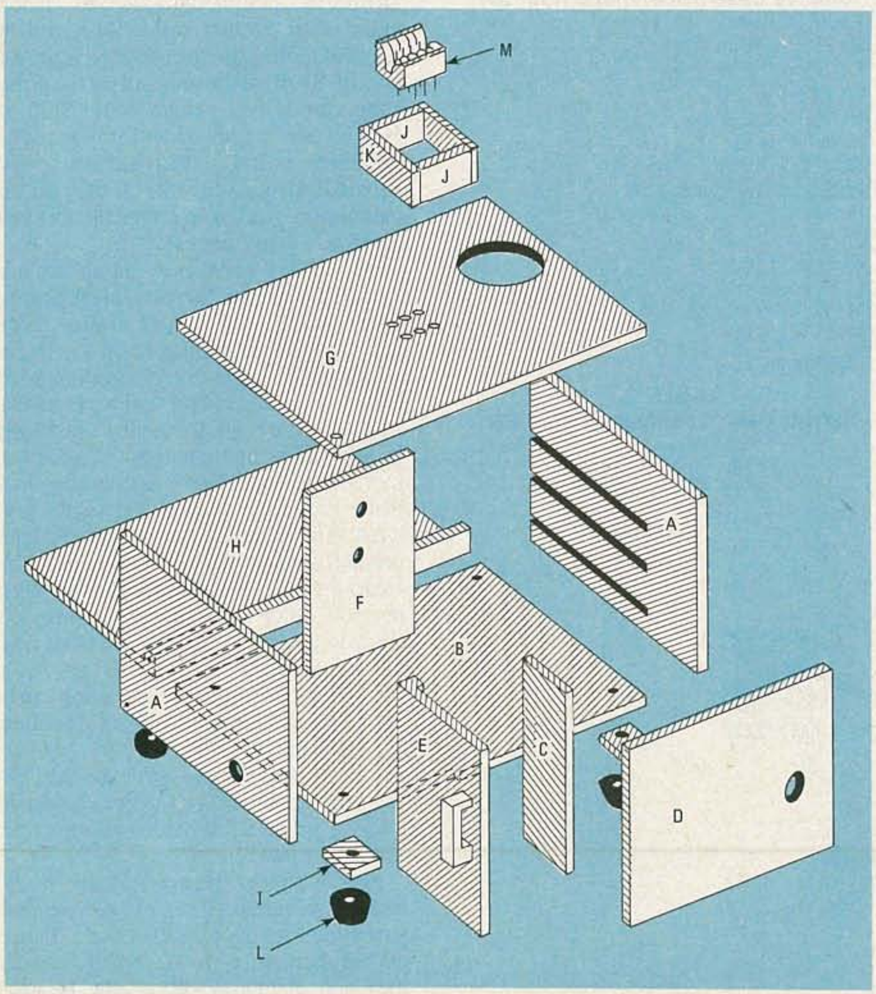


FIG. 19—EXPLODED VIEW of the Heart-a-Matic's bottom case. The dimensions for that case are given in Table 1.

¾-inch-square piece of black plastic and slide it onto the bottom of the chrome pipe. That is the top of the assembly that connects the display case to the base. Route the wires from board 5 through the pipe and solder them to a small piece of double-sided circuit board with three "fingers" on each side as shown in Fig. 20. Cut the wires from board 5 about six inches longer than necessary for a tight fit; they will be pulled up inside the display case when the assembly is finished and will allow the board to be removed from the case without your having to unsolder anything. Make sure you solder the wires in the same order you did on the matching piece of edge connector mounted on the top of the bottom case. Use an ohmmeter to verify that the wires go to the proper places. Assemble the rest of the display base, making sure that the ears on the circuit board fit snugly in the slots you have cut in the side pieces. The plastic parts can be assembled with solvent cement but the slots will have to be filled with epoxy. When the whole assembly has set, sand it down smooth for best appearance.

The dimensions of the plug retaining walls on the top of the case should be measured with the display case plugged into its connector. It is important that they be high enough to provide support. Once they are cut and glued into place, you're almost finished. All that's left is the small case for the sensor board.

TABLE 1
Bottom Case Dimensions (Fig. 19)

A: 4¾ × 2¾ in.
B: 5⅛ × 4¾ in.
C: 1 × 2⅝ in.
D: 4⅛ × 2¾ in.
E: 2¾ × 1¼ in.
F: 2⅝ × 4¼ in.
G: 5⅜ × 4⅞ in.
H: 4¾ × 2¾ in.
I: 1 × 1 in.
J: ⅜ × 1 in.
K: ⅜ × 1¼ in.
L: 1-in diameter
M: 6-connect double-sided .156 in. center edge connector

Sensor case

The sensor board is housed in the case as shown in Fig. 22. Dimensions are given in Table 3. Use about two feet of shielded cable to connect the sensor board to board 3. To assemble the sensor, attach a strip of Velcro to the bottom of the case with epoxy. The strip should be long enough to wrap around your finger and attach to the bottom of the case. Use one part of the Velcro material (it comes in two parts) for the strip and attach a small piece of the other part to the strip on the bottom of the case. Cut a piece of conductive foam to fit inside the case and slit it so the sensor, IC24, can poke through. Sol-

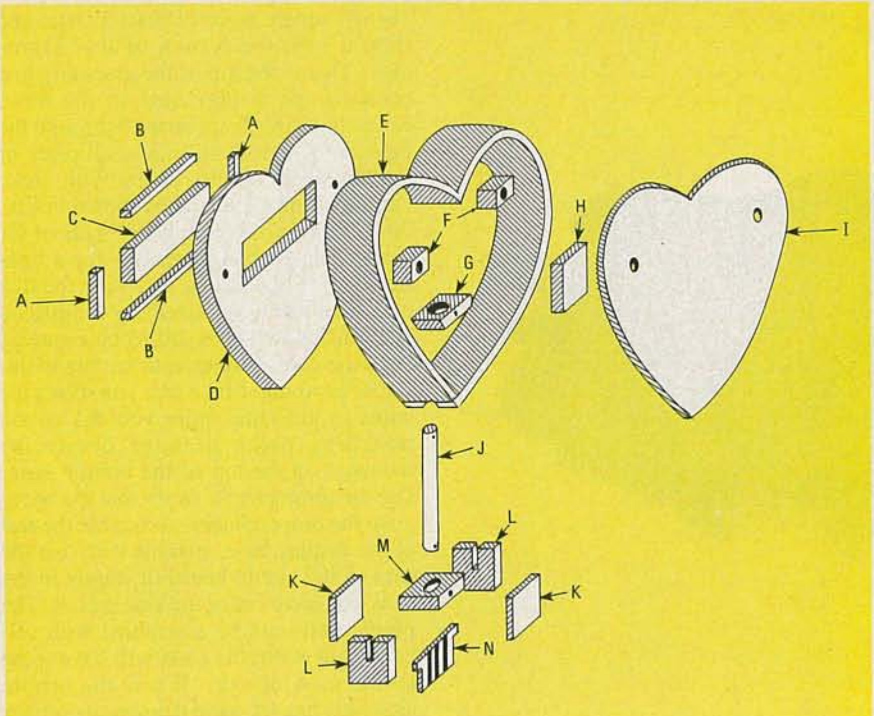


FIG. 20—EXPLODED VIEW of the heart-shaped display case and its connector. The dimensions are given in Table 2.

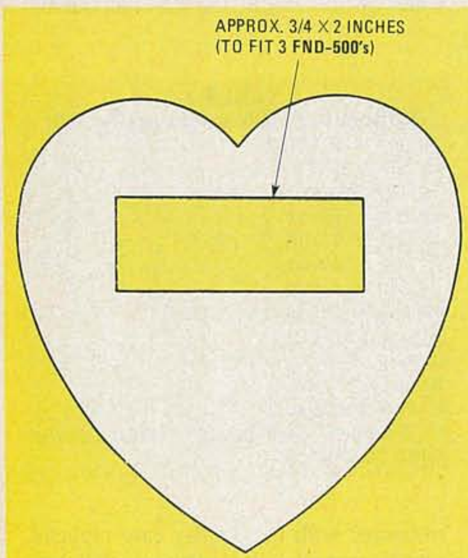


FIG. 21—USE THIS TEMPLATE for the front of the heart-shaped display case.

TABLE 2
Display Case Dimensions (Fig. 20)

A: ¾ × ⅛ in.
B: 2⅛ × ⅛ in.
C: 1⅞ × ¾ in.
D: See Fig. 20
*E: 1⅜ × 12¼ in.
*F: ½ × ⅜ in.
*G: 1⅛ × ¾ in.
*H: 2 × 2 in. foam
*I:
*J:
K: ¾ × 1 in.
*L: ¾ × ¾ in.
*M: ¾ × ¾ in.
*N: ¾ × ½ in.
*: See text

TABLE 3
Sensor Case Dimensions (Fig. 22)

A: ½ × 1 in.
B: ½ × ½ in.
C: 1 × ¾ in.

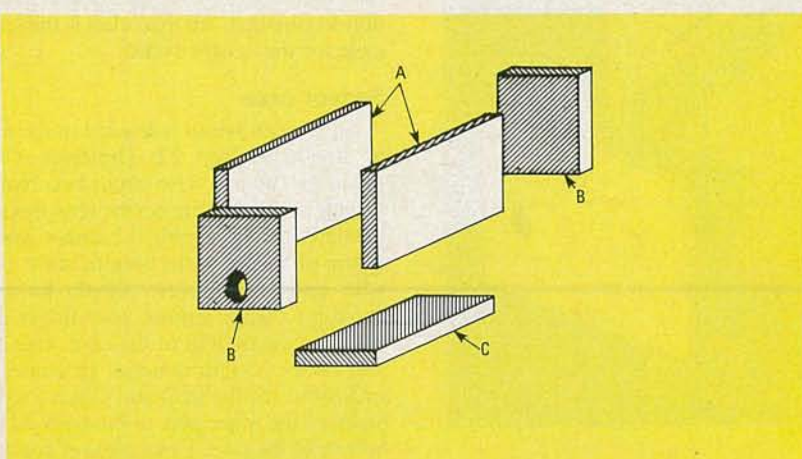


FIG. 22—THE DIMENSIONS for the small sensor case shown here are given in Table 3. Be sure to drill a hole for the connecting cable.

OOOOOOPS

Several errors appeared in Part 1 of the Heart-a-Matic construction article in the September 1982 issue. The correct value for capacitor C25 is 2200µF, 16 volts—not 2200µF. Jack J4 should be wired so that the battery is out of the circuit when a plug carrying external power is inserted. The sentence on page 48 that reads in part..."a rate multiplier will not...output a number of pulses that is *always* an *average*..." is wrong—it will. Finally, the correct price for the set of six PC boards is $39.95.

der a small piece of hook-up wire to the ground plane on the board and poke the other end of it into the foam. That will help prevent the ever-present 60-Hz field from the power lines around you from causing problems with the input section.

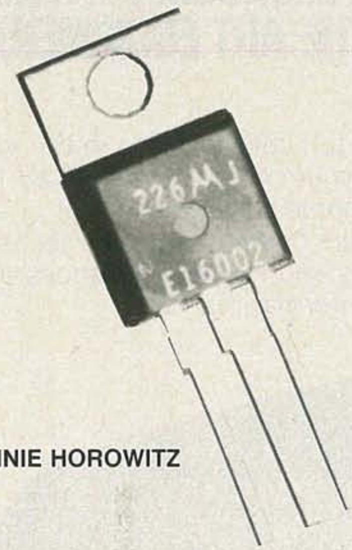
Calibration and use

The Heart-a-Matic needs no calibration other than setting the low-battery-warning trip-point by adjusting R47 on board 3. Connect a variable power-supply to the unit at J1 (EXTERNAL POWER) on the side of the case and set it to eight volts. Slowly adjust R47 until the decimal points in the display light and stay lit. Turn off the unit and set the power supply to deliver twelve volts. Turn the Heart-a-Matic back on and slowly reduce the input voltage. The decimal points should light at eight volts. If they do, the calibration process is complete and your project is ready for use.

The Heart-a-Matic is simple to use. Attach the sensor to your finger and secure it snugly with the Velcro strip. There should be light pressure against your finger. If it's too tight, the blood supply will be restricted and sensor will have nothing to detect; if it's too loose, the sensor will be affected by ambient light. A good way to make sure the sensor is operating is to place it against the pulse-point in your wrist. The change in blood volume there is much greater than in your finger and the Heart-a-Matic can easily pick it up without too much concern about pressure. Keep in mind the fact that different fingers have different capillary configurations and that often a reading can be gotten from one finger and not a another. The sensor and input circuitry are very sensitive, though, and there shouldn't be any problem in using a finger to detect the pulse. I've gotten reliable readings from my cat's paws!

Although the Heart-a-Matic is extremely accurate, it is by no means a substitute for a doctor's checkup. There is all the difference in the world between data and diagnosis. While the Heart-a-Matic can tell you what your heart rate is, only your doctor can tell you what it means. **R-E**

How to Design Analog Circuits —Amplifying AC Signals



MANNIE HOROWITZ

One of the most important uses for the transistor is in an amplifier circuit. This month, we'll look at how a one-stage transistor amplifier works, as well as how to design one.

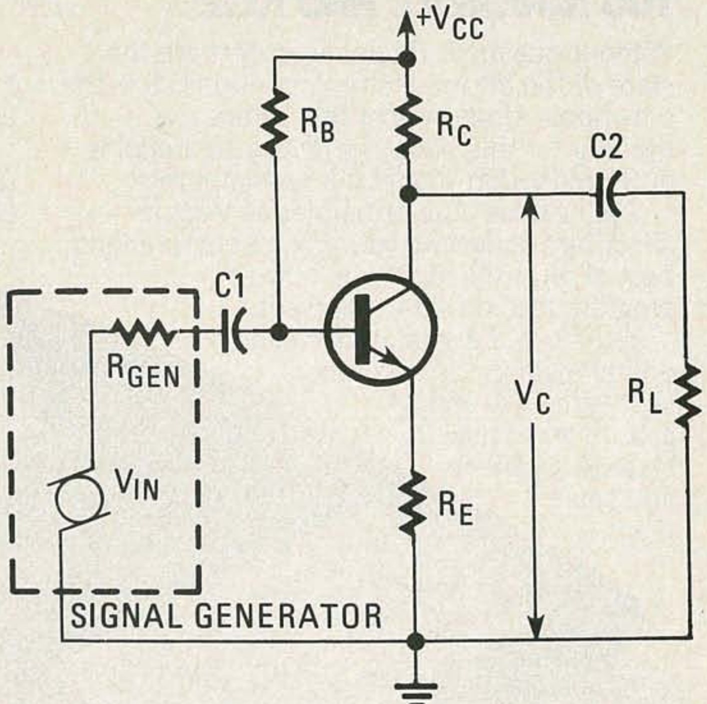


FIG. 1—COMMON-EMITTER AMPLIFIER using a bipolar transistor.

IN THE PREVIOUS PART OF THIS SERIES, WE looked at different bias circuits and analyzed the DC behavior of a one-stage transistor amplifier. But merely biasing a transistor at the quiescent operating point does not produce a functional circuit. The transistor must also be capable of amplifying an AC signal.

When an AC signal is applied to a transistor amplifier stage, many of the transistor parameters, such as gain (β), change from the nominal DC value. Also, for the circuit to be functional, several components must be added to the basic DC circuit. For example, a load resistor must be included so that the output signal can be obtained; and capacitors must be added so that the AC signal does not upset the DC bias voltages. This month, we will analyze the behavior of a one-stage transistor amplifier when an AC signal is applied to it. We will also look at a complete step-by-step design example.

AC bipolar transistor analysis

Last time, we discussed several bias circuits for establishing the collector-to-emitter voltage (V_{CE}) at the quiescent operating point (no-input signal condition). For our analysis of AC operation, we'll use the simplest bias circuit that we described last time, as shown in Fig. 1. The circuit shown in Fig. 1 also includes a sinusoidal voltage source, a load resistor, and two capacitors.

The sinusoidal AC voltage source is V_{in} and since no voltage source is perfect, its internal impedance is not equal to zero. Here, the internal impedance of the generator is shown as R_{gen}.

The signal from the generator is connected to the base of the transistor through capacitor C1. That capacitor prevents the bias current provided by R_B from flowing into the generator and to ground through R_{gen} and thus upsetting the quiescent operating point. At the same time, the value of the capacitor is large enough to allow the AC signal from the generator to pass through it to the transistor.

The AC signal that appears at the base of the transistor is amplified by the transistor. The resulting amplified signal appears across R_C and is applied to the load resistor through capacitor C2. Capacitor C2 prevents the DC voltage at the collector of the transistor from appearing across load resistor R_L while passing the amplified AC signal present at that point in the circuit. Capacitor C2 prevents the DC collector voltage from being affected by the presence of R_L in the circuit.

The voltage across R_C is $I_C \times R_C$, where I_C is the DC collector current. Because of that, the collector voltage is:

$$V_C = V_{CC} - I_C \times R_C$$

If capacitor C2 were not present, R_L would complete a DC current path from V_{CC} through R_C to ground. The additional current, I_L, would add to I_C to determine the total DC current flowing through R_C. The voltage across R_C would be $(I_C + I_L)R_C$. The voltage at the collector (V_C) would drop to $V_{CC} - (I_C + I_L)R_C$.

But what is R_L doing in the circuit? It represents the AC load on the output of the transistor. If this were an audio power amplifier, R_L could represent the im-

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pedance of a loudspeaker. If this collector circuit were connected to the input of a second transistor to get additional gain, R_L would be the input impedance of that second transistor circuit.

The circuit around the transistor affects the operation of the transistor just as the various transistor parameters affect the overall circuit performance.

We discussed alpha and beta and described how DC current at the input of a transistor is amplified and appears at the output. The output current is beta times the input current. A similar amplification takes place due to the AC current gain, or AC beta, of the transistor. Although the Greek letter β is usually used to indicate that parameter, some specification sheets use the hybrid parameter, h_{fe}. They both have the same meanings.

The AC beta and DC beta can be derived from the common-emitter curves of the transistor. A typical set of curves is drawn in Fig. 2. Let us assume that a load

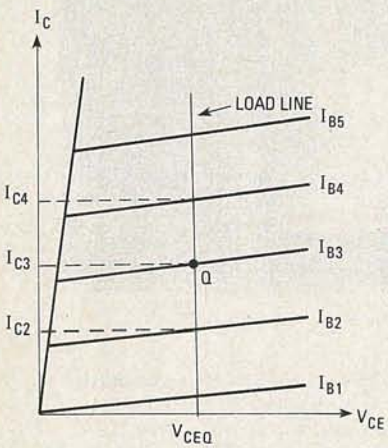


FIG. 2—TYPICAL CHARACTERISTIC CURVES of a bipolar transistor.

line was plotted and that the quiescent operating point, Q, was chosen as shown. At the quiescent operating point, the idling base current is I_{B3}, the idling collector current is I_{C3}, and the collector-to-emitter voltage is V_{CEQ}. Since the DC beta (β_{DC}) is simply the ratio of collector current to base current at any one point on the curves, β_{DC} is equal to I_{C3}/I_{B3}.

The AC beta, β_{AC}, is the ratio of a change in collector current to a change in base current at a specific collector-emitter voltage, V_{CEQ}. We can use that concept to determine the value of β_{AC} from the curves. It is equal to:

$$\beta_{AC} = \frac{I_{C4} - I_{C2}}{I_{B4} - I_{B2}} = \frac{\Delta I_C}{\Delta I_B} \qquad (1)$$

Hereafter, as is commonly done throughout our industry, we will refer to the AC beta simply as beta and apply the symbol β to it. For the DC beta, we will retain the symbol β_{DC}.

It is difficult to determine the AC alpha of the transistor from the curves because

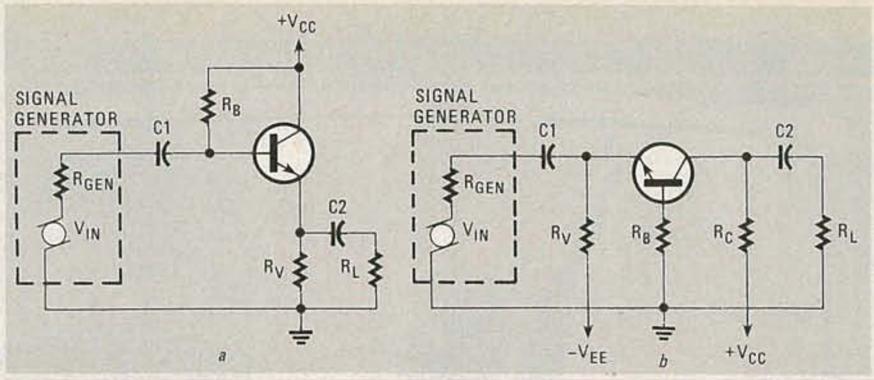


FIG. 3—DIFFERENT CIRCUIT CONFIGURATIONS for the bipolar transistor. The common-collector circuit is shown in *a*. The common-base circuit is shown in *b*.

the section of the curves that we are interested in are almost perfectly horizontal and, as a result, alpha is very close to 1. However, α_{AC} (or α) can be determined from the AC beta using the same equation used for determining β_{DC}.

$$\alpha = \frac{\beta}{1 + \beta} \qquad (2)$$

Another important parameter when analyzing the AC performance of a transistor is the emitter resistance. When we were analyzing the DC performance of a transistor, R_E was an actual resistor connected to the emitter of the transistor and it was the only resistance of significance in the emitter circuit. But when an AC signal passes through the transistor, there is also an internal AC resistance that is in the emitter of the transistor itself. That resistance, r_e, can be determined from the following equation:

$$r_e = \frac{26}{I_C} \qquad (3)$$

In equation 3, I_C is expressed in milliampers and r_e in ohms. When analyzing the AC performance of a common-emitter transistor amplifier, the resistance in the emitter circuit is $r_e + R_E$. When that is reflected as a resistance into the base circuit, the sum is multiplied by the AC beta.

The collector resistance, r_c and r_d, were discussed in the article on bias circuits that appeared in the September issue. The methods for determining those resistances were covered there and those methods remain the same.

As a final parameter to be noted here, we will consider the base resistance, r_b. That is usually an insignificant factor when doing a design. The AC resistance r_b is considered as being in series with the base. It is usually between 500 and 1000 ohms—values that can be ignored in most designs.

AC bipolar-transistor amplifiers

Using the parameters detailed above, we can now define several AC characteristics of the circuit shown in Fig. 1.

The input impedance seen looking into the base circuit itself, is:

$$R_{in} = r_b + \beta(R_E + r_e) \qquad (4)$$

The generator sees that resistance in parallel with R_B because the upper terminal of R_B is connected to $+V_{CC}$ and that terminal is at AC ground through the power supply. (The $+V_{CC}$ terminal is $+V_{CC}$ volts above DC ground. But an ideal voltage source has zero impedance. Because of that, the $+V_{CC}$ point is treated as being at signal or AC ground.)

The output impedance seen looking back into the collector circuit is:

$$R_{out} = \frac{r_d[(R_{gen} + r_b) + \beta(r_e + R_E)]}{R_{gen} + r_b + r_e + R_E} \qquad (5)$$

Note that the impedance of the generator and the base resistance are reflected from the input of the transistor to the output. Both factors therefore appear in equation 5. The load resistance, R_L, sees R_{out} in parallel with R_C. The current gain (A_i) and voltage gain (A_v) for the circuit shown in Fig. 1 are:

$$A_i = \beta \qquad (6)$$

$$A_v = \frac{R_L||R_C}{R_E + r_e} \qquad (7)$$

where $R_L||R_C$ is the resistance of R_C and R_L connected in parallel. The power gain, G, is the product of A_i and A_v.

In the common-collector circuit shown in Fig. 3-a, the input impedance of the transistor is calculated using equation 4, but R_E is usually much larger here than when specified for the common-emitter arrangement. The generator still sees R_B in parallel with R_{in}. As for the output resistance R_{out} (the resistance seen when looking back into the transistor), it is the sum of r_e and the total resistance in the base circuit divided by beta. The resistance in the base circuit is the sum of r_b and the parallel combination of r_{gen} and R_B.

The voltage gain of the common-collector circuit itself is approximately equal to 1. The combination of a relatively low input impedance, a high output impedance (as already stated, R_E is usually specified to be a high resistance) and a voltage gain approximately equal to 1, makes the common collector circuit ideal in buffer amplifier applications. The current and power gains are approximately equal to beta.

The common-base circuit is shown in Fig. 3-b. The input impedance seen by the generator is the parallel combination of R_E and R_{in}, where:

$$R_{in} = r_e + \frac{r_b + R_B}{\beta} \quad (8)$$

The output resistance seen by the load resistance is the parallel combination of R_C and R_{out}, where:

$$R_{out} = \frac{r_c[\beta(r_e + r_{gen}) + (r_b + R_B)]}{\beta(r_e + r_{gen} + r_b + R_B)} \quad (9)$$

The current gain of the circuit is equal to α or slightly less than 1. Both the voltage gain and the power gain are equal to:

$$A_v = G = \frac{R_L \| R_C}{r_e} \quad (10)$$

To find the voltage and power gain of the overall circuit, simply add r_{gen} to r_e in the denominator in equation 10.

A step-by-step design

The equations given in this article can be used to design actual circuits. As an example, let us again consider the circuit shown in Fig. 1. You would start the design of the circuit by knowing the power-supply voltage as well as the beta of the transistor. For this example, let us assume that V_{CC} = 9 volts and that β = 300. Next, determine the load resistance, R_L, that the circuit will be connected to. Let's assume you must feed a 10,000 ohm load. The collector resistor, R_C, should be between 10% and 25% of R_L so that the AC load line will not differ by much from the DC load line. (We will discuss that factor in more detail in a future article on power amplifiers). A good compromise is to make R_C equal to 2700 ohms. The resistance in the collector circuit is 10,000 ohms in parallel with 2700 ohms, or 2100 ohms. If the circuit is to provide a voltage gain of 10, then the ratio of the resistance in the collector circuit to the resistance in the emitter circuit should be 10. Using that information, the emitter resistance should be 2100/10 = 210 ohms. But what portion of the 210 ohms does the r_e in the transistor provide and what portion of the 210 ohms does emitter resistor R_E provide? To determine that, we must know the collector (or emitter) current.

If the power-supply is 9 volts, ideally we want one-half of that or 4.5 volts at the collector. If that were the quiescent collector voltage, the signal could swing, at least ideally, from 0 to 9 volts around the 4.5-volt quiescent setting. To achieve that, 4.5 volts must be across the 2700-

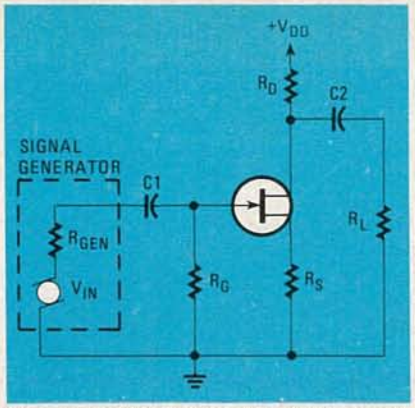


FIG. 4—COMMON-SOURCE AMPLIFIER circuit is shown here.

ohm collector resistor (R_C). The collector current, I_C, is then equal to 4.5/2700 = 1.67 mA. Plugging that information into equation 3, we find that r_e is equal to 26/1.67 = 15.6 ohms. Since the total maximum resistance in the emitter circuit is 210 ohms, R_E can be as high as 210 − 15.6 ohms or 194.4 ohms, Use a standard 180-ohm resistor for R_E.

To get a collector current of 1.67 mA, the base current, I_B, must be 1.67 mA divided by the beta of the transistor. Therefore, I_B = 1.67/300 = 5.6 μA. Base current is provided by the 9-volt supply and flows through R_B, through the base-emitter junction, and then through R_E. Hence the base current, I_B, is equal to $9/(R_B + R_E) = 5.6\ \mu A$. The base-to-emitter voltage, V_{BE}, is ignored because it is negligible compared to 9 volts. Going through the algebra to determine R_B, we find it is about 1.5 megohms.

Taking that one step further, assume the impedance of the generator, r_{gen}, is 10,000 ohms. That 10,000 ohms forms a voltage divider with the input impedance of the transistor. Using equation 4 and ignoring r_b, the input impedance is the parallel combination of $\beta(R_E + r_e)$ and R_B. Solving for the input impedance: 300(180 + 15.6) in parallel with 1.5 × 10^6 = 56.470 ohms. Due to the voltage divider formed by the generator and the input impedance of the transistor, the voltage that appears at the base of the transistor is equal to:

$$\left(\frac{56{,}470}{56{,}470 + 10{,}000}\right) V_{in} = 0.85\ V_{in}$$

Since the transistor receives only $.85V_{in}$, the overall voltage gain of the circuit is the voltage gain of the transistor multiplied by 0.85. The voltage gain of the transistor is calculated using equation 7: A_V = 2100/195.6 = 10.74. The voltage gain for the overall circuit is 10.74 × .85, or 9.1. That is slightly below our desired gain of 10. To increase the gain, R_E must be reduced.

Similar procedures can be used to design common-collector and common-base circuits.

FET amplifiers

Few differences exist between the design procedures for a bipolar transistor amplifier and the design procedures for amplifiers using JFET's and MOSFET's. (The MOSFET is also commonly called an IGFET.) Thus, many of the parameters and design procedures that we've discussed so far can be applied to JFET and MOSFET amplifiers. The primary difference involves the polarity of the bias voltage that is applied to the gate of those devices. (The gate is the equivalent of the base terminal of a bipolar transistor.) In the equations used for determining gain and impedance, there are no distinctions between the FET devices and the bipolar transistor.

The three basic circuit configurations

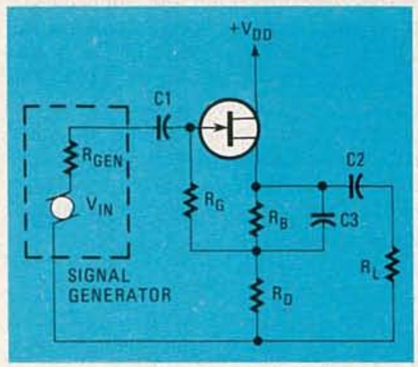


FIG. 5—COMMON-DRAIN FET AMPLIFIER circuit is shown here.

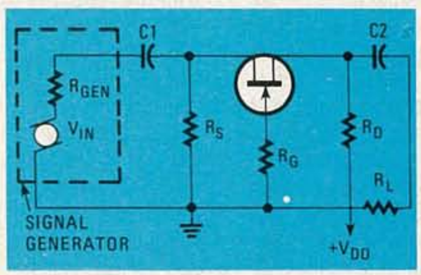


FIG. 6—COMMON-GATE FET AMPLIFIER circuit is mainly used in high-frequency applications.

for the JFET are shown in Figs. 4 through 6. Although the configurations are shown using JFET's, the MOSFET can be substituted instead of the JFET's in those circuits. The common-gate circuit drawn in Fig. 6 is seldom used in audio applications. It is primarily used in high-frequency applications.

Voltage gain as well as the input and output impedances, are the primary concerns of the designer. Because of the high input-impedance of both the JFET and MOSFET devices, the input current is just about zero. Thus, the current gain and the power gain of the device approaches infinity. There are, of course, limits to those gains. Here, the only gain to be considered is voltage gain, A_v. It is related to the transconductance of the FET, g_m. (We will use the term FET to refer to both JFET and MOSFET devices.)

As you may recall, transconductance is

the ratio of a change in drain current to a change in gate voltage. The voltage gain of an FET device in the common-source arrangement is the transconductance multiplied by the AC load impedance connected to the drain of the FET. In Fig. 4, that load impedance is the parallel combination of R_L and R_D. Thus, the equation for calculating the gain of the circuit is:

$$A_v = \frac{g_m (R_D || R_L)}{1 + g_m R_s} \qquad (11)$$

That equation, and the fact that the input and output impedance are R_G and R_D respectively, was noted in the article that appeared in the September 1982 issue. But a complication still exists.

Because of the high input-impedance, capacitance between terminals of the FET become significant. That factor is relatively unimportant when analyzing bipolar transistor circuits because the internal resistance of the bipolar transistor is low. The low internal resistance effectively shorted those capacitances and they had little effect, especially at low operating frequencies. But that is not so with FET's.

As far as the JFET is concerned, capacitances exist between the gate and source, C_{gs}; and between the gate and drain, C_{gd} (sometimes called C_{rss}). When added together, the two capacitances are equal to C_{iss}. That is the input capacitance of a common-source circuit when the output of the transistor is shorted. If the output has a normal load rather than being shorted, the input capacitance is essentially $C_{iss} + g_m R_D C_{gd}$. Because of that capacitance, the gain of the circuit decreases as the operating frequency increases. The frequency at which the gain is down 3 dB (or .707) from its maximum gain is called f_o. That frequency can be calculated using the following equation:

$$f_o = \frac{1}{2\pi R_D (C_{ds} + C_{gd})} \qquad (12)$$

It should be noted that the maximum gain is assumed at about $f_o/4$, while it is about 1/2.24 of its maximum gain at $2f_o$, ¼ at $4f_o$, ⅛ at $8f_o$, 1⁄16 at $16f_o$, and so on.

Note capacitor C_{ds} in equation 12. That is the drain-to-source capacitance. It is negligible in JFET designs, but C_{ds} affects the high-frequency gain significantly in an MOSFET circuit. That is because the drain-to-source resistance (r_{ds}) of the JFET is much lower than the MOSFET. In the JFET, that drain-to-source resistance shunts C_{ds} sufficiently to make it negligible.

You can use equation 12 to calculate the frequency where the gain is down 3 dB from its maximum when the output resistance of the voltage source is insignificant compared to the input resistance of the amplifier. That is frequently true. If, however, the resistance (r_{gen}) is comparable in size to the input impedance of the amplifier, f_o becomes:

$$f_o = \frac{1}{2\pi r_{gen} (C_{iss} + g_m R_D C_{gd})} \qquad (13)$$

The general design procedure is to first determine the gain at low frequencies and then calculate f_o by using equation 12 or 13. As an example, let's consider the circuit shown in Fig. 4 where R_D = 12,000 ohms, R_L = 10,000 ohms, R_S = 470 ohms, R_G = 470,000 ohms, and r_{gen} = 470,000 ohms. Let's also assume that the FET has the following parameters: V_p = 3 volts, I_{DSS} = 2 mA, r_{ds} = 5,000 ohms, C_{gs} = 7.5 pF and C_{gd} = 2 pF. Determine the various characteristics of the circuit.

First, we must calculate g_m at the quiescent operating point. To calculate g_m, we must know the drain current. It is:

$$I_D = I_{DSS}\left(1 - \frac{|V_{GS}|}{|V_p|}\right) = 2\times10^{-3}\left(1 - \frac{|V_{GS}|}{3}\right)^2$$

We do not know V_{GS}, but can determine it from the following equation.

$$V_{GS} = I_D R_S = 470\, I_D$$

Substituting V_{GS} into the equation for I_D and solving for I_D, we find it equal to 1.27 mA. Consequently, $V_{GS} = 470 I_D$ = 0.597 volt.

Using that information, we can find g_m:

$$g_m = \frac{2I_{DSS}}{V_p}\left(1 - \frac{|V_{GS}|}{|V_p|}\right) = \frac{2(2\times10^{-3})}{3}\left(1 - \frac{0.597}{3}\right) = 10.68\times10^{-4}$$

Now, we can use equation 11 to determine the AC voltage gain, which calculates out to be 3.88. If a large-value capacitor were across R_S, the shorted resistor would be considered as being at 0 ohms in equation 11. The equation would then be $g_m (R_D || R_L)$ = 5.82. With the capacitor in the source circuit, the gain has been increased by (5.82 − 3.88) 100/3.88 = 50%.

The input impedance seen by the generator is R_C and that is 470,000 ohms. Since the generator and R_G are both 470,000 ohms, half of the generator's voltage appears at the input of the transistor. Because of that, the gain of the overall circuit including the generator, is just one-half of the gain of the transistor circuit with only its load and biasing components.

Because the generator's impedance is significant, the gain is down 3 dB of the maximum at 9783 Hz. That is determined by substituting 4.7×10^5 for r_{gen}, 9×10^{-12} for C_{iss}, 10.68×10^{-4} for g_m, 1.2×10^4 for R_D, and 2×10^{-12} for C_{gd} in equation 13.

Load resistance R_L sees an output impedance equal to R_D or 12,000 ohms, in parallel with the drain-to-source resistance r_{ds}, which is specified as 5000 ohms. That is true only if R_S is shunted by a large capacitor. Otherwise, the resistance increases to R_D in parallel with R_{out}. With R_s = 470 ohms, as stated previously, output impedance R_{out} is equal to:

$$r_{ds} + (1 + g_m r_{ds}) R_S = 7480 \text{ ohms}$$

As for the common-drain circuit, the input impedance is equal to the resistor at the gate input, while the output impedance seen by the load is essentially R_S shunted by $1/g_m$. The gain is approximately equal to 1.

The common-gate circuit has a voltage gain equal to:

$$A_v = \frac{g_m R_D}{1 + g_m R_S} \qquad (14)$$

The circuit has a low input impedance that is equal to $R_S + 1/g_m$. The output impedance as seen by the load is approximately equal to R_D. Because of its low input impedance, the significance of the capacitances at the input of the circuit are minimal. Hence, the circuit is used primarily in high frequency applications.

Noise

The amplifiers described so far are used to amplify low-level signals. Because of that, the relationship between the amount of noise present in the amplifier and the level of the input signal is significant. To determine the noise contribution of the circuit, we must first determine the lowest significant frequency reproduced by the amplifier (f_L) and the highest significant frequency reproduced by the amplifier (f_H). Then, a signal with a frequency equal to $\sqrt{f_H f_L}$ is fed to the circuit and its maximum undistorted output voltage is noted. The signal is removed and the remaining output voltage is noise. The ratio of signal voltage to noise voltage, expressed in dB, is:

$$\text{dB} = 20 \log_{10} \frac{V_{so}}{V_{no}} = 10 \log_{10} \frac{P_{so}}{P_{no}} \qquad (15)$$

Two noise specifications are frequently used in data sheets. Those are the noise factor, F, and the noise figure, NF. They are related by the equation NF = $\log_{10}$ F. F is defined by the equation:

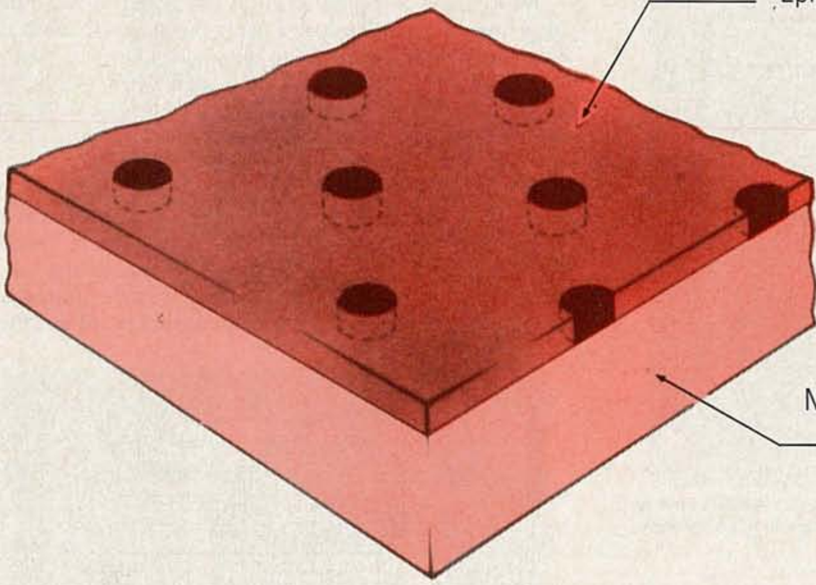
$$F = \frac{P_{si} / P_{ni}}{P_{so} / P_{no}} \qquad (16)$$

where P_{si} is the input power, P_{ni} is the noise at the input generated by the circuit feeding the amplifier, P_{so} is power at the output and P_{no} is noise at the output. Low noise-figures and noise factors are most desirable for a transistor used at the input of an audio amplifier.

Curves are available to help you design low-noise circuits. It is a long and tedious task to apply those curves and they usual-

continued on page 82

ALL ABOUT BUBBLE MEMORY DEVICES



ROBERT F. SCOTT
SEMICONDUCTOR EDITOR

Bubble memories feature the read/write abilities of RAM's, the non-volatility of ROM's, and the mass-storage capabilities of a tape or disk-storage system. This month we'll look at the architecture of those devices and how they work.

Part 2 IN LAST MONTH'S ISSUE, WE INTRODUCED bubble memory devices and saw that bubbles are microscopic magnetic domains in a molecular-thin film of synthetic garnet. These bubbles are only a few micrometers (μm's) in diameter and can be moved about in the film by establishing and controlling a magnetic field across the film. The presence of a bubble at a given location corresponds to a binary "1" and the absence of a bubble corresponds to a binary "0".

In that discussion, we covered the basic theory and development of the magnetic bubble; showing how it is generated, annihilated, and replicated or transferred from one track to another. We left you with a brief word on the serial loop—the simplest of several bubble memory architectural schemes that have been developed.

The serial-loop track is a long serpentine arrangement as shown in Fig. 9. Bubbles produced by pulsing the generator travel in series around the loop. A bubble reaching the replicator splits in two. One goes to the detector and generates a current pulse that is read as a binary bit. The other bubble either remains in storage, continuing to circulate around the loop, or is erased by the annihilator and is replaced by new data from the generator. All gates used to generate, replicate, detect and erase data are called function gates.

The serial loop is seldom used because of the long access time associated with this scheme. The bubbles must circle around the loop before they can be read. For example, the Fujitsu 64K-bit serial-loop type FMB31DB device has a 370-ms access time while the 64K-bit FBM32A using a major/minor-loop scheme (that we will discuss shortly) requires an access time of only 4.3 ms.

A second disadvantage of the serial-loop system is that production yield is much lower than with other schemes that have been developed. A single defect in any part of a serial loop is cause for rejecting the chip. The other architectural systems that have been developed have greater tolerances for defects in the manufacturing process.

In our earlier story, we showed how bubbles are stretched before being read out by the detector. In an actual bubble memory device, two sets of detector elements are used in a differential detector that eliminates the effect of the rotating magnetic field.

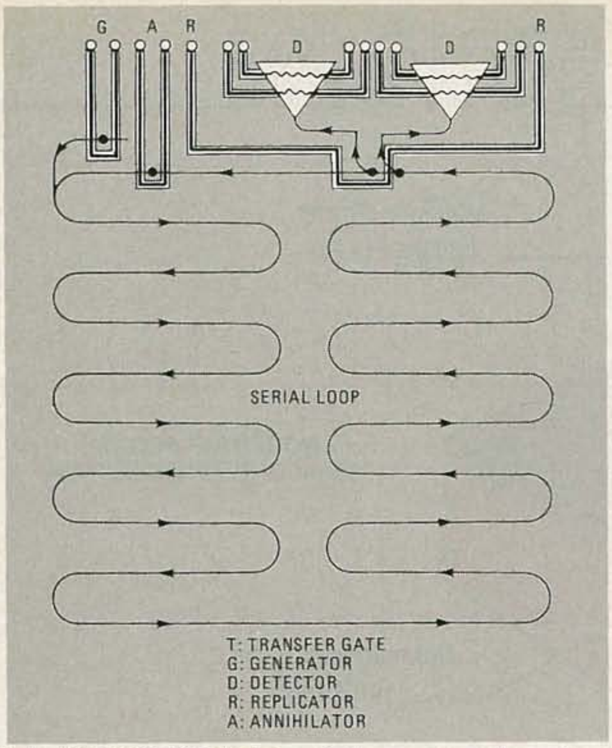


FIG. 9—LOOP ORGANIZATION of a serial-loop memory. Access time is long because bubbles must circulate in series around the loop before they can be read.

Major/minor loop architecture

The major/minor loop system is arranged in a serial-parallel-serial structure—serial input, parallel-loop storage, and serial output. A continuous major loop shift-register feeds into and out of the device while the large number of minor loops serve mainly for storage.

The minor loops are perpendicular and closely adjacent to the major loop. Thus, data generated and placed on the major loop can be loaded simultaneously and in parallel into the top positions of the minor loops for storage. Similarly, the minor loops can be rotated so the desired data blocks can be shifted back to the major loop to be read out.

A typical bubble memory device using a major/minor loop architecture (Motorola's MBM2256, for example) has 282 minor loops, each consisting of 1024 bit positions. Such a device has a potential of 288,768 bits. It will be operated with only 256 active minor loops in the memory. The 26 extra loops are designed into the chip structure to allow for possible manufacturing defects in several loops. In this way, a chip with several defective minor loops can still be used. This greatly increases production yield over that of the serial-loop design. With 256 active loops, we have a 256K memory with a capacity of 262,144 bits.

The locations of defective minor loops are stored in a PROM that is a part of the control circuitry. Data cannot be stored in or read out of a defective loop.

There are three different implementations of the major/minor loop architecture. These implementations are referred to as *transfer gate*, *block replicator transfer*, and *block replicator swap* systems.

The transfer-gate system of major/minor loop organization (see Fig. 10) consists of a major loop to write and read the information and transfer data bits to and from the minor storage loops upon demand. The minor loops are connected to transfer gates at alternate bit positions along the major loop. Information being fed in is loaded on the major loop in alternate bit positions.

Before data can be entered into a particular location, the old information in the minor loops at the desired address is conveyed to their respective loop exits and then transferred or dumped simultaneously into the major loop in what is called a transfer-out operation. The information bits are circulated in succession to the annihilator where they are erased to make room for incoming data from the generator. The data bits entered on the major loop are shifted around until the first data bit is at the entrance to the first minor loop, the second data bit is at the entrance to the second minor loop and so on. Finally, the transfer gate is pulsed and the new data is dumped into the minor loops in a transfer-in operation. The control circuitry assures that the new data is inserted in the "slot" vacated by the old information.

Information to be retrieved is circulated in the minor loop until they are in the correct exit position and then they are transferred simultaneously to the major loop when the transfer gate is pulsed. The data is duplicated by the replicator. One string of data bits is read by the detector; the other string is returned through the transfer gate to the proper address in the minor loops.

The transfer-gate system of major/minor loop architecture provides a fast, reliable system. But—access time is not fast enough for many applications. This is because of the alternate-bit spacing between minor loops. This design also calls for a rather large chip. These disadvantages are eliminated in the block-replicator transfer system shown in Fig. 11 and the block-

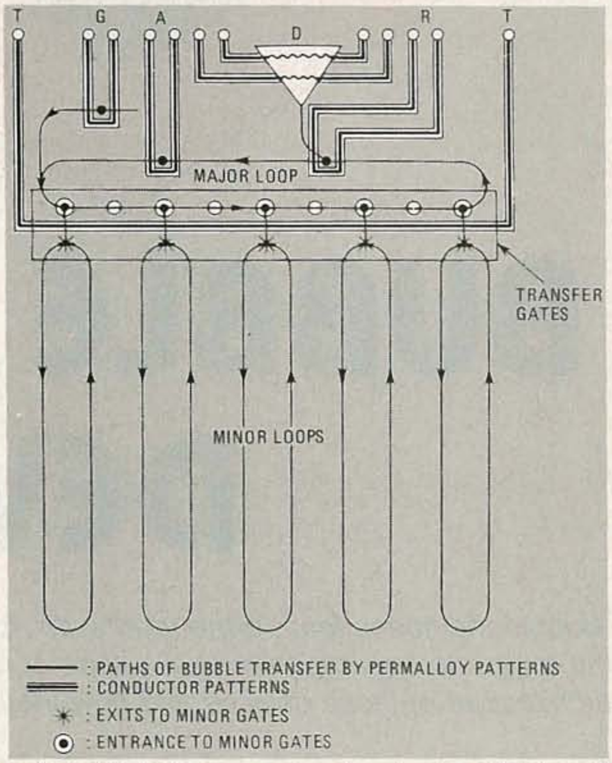


FIG. 10—MAJOR/MINOR loop system using a transfer gate between the major loop and the minor-loop storage bank.

replicator swap system shown in Fig. 12.

The block replicator

In the block-replicator architecture, the major loop is divided into two write lines at one end of the minor loops and two output lines at the other end of the minor-loop bank. The output end of each loop goes to its own replicate/transfer gate feeding into a major-read line. The minor loops are divided into two banks; one storing odd data bits and the other handling even bits. There is a separate generator and input (write major line) for each loop bank. The generators are in series, so identical data is written on both major write lines.

Block replicator transfer system

When new information reaches the entrance to the transfer gates (see Fig. 11) for the proper minor loops, a current pulse is fed through the transfer-gate terminals and the data is loaded into the minor-loop banks for storage. Odd-number bits are loaded into one bank and even bits into the other. The odd bank has an extra bubble position, so identical data bits are offset one bubble position from those in the even bank. Therefore, every other bubble enters a loop—odd bits in one bank and even bits in the other.

Before new information can be entered for storage, old information at the desired address in the minor loops is circulated to the loop exits and transferrred simultaneously onto the major read lines when the transfer gate is pulsed. The bubbles are then conveyed to the detectors where they are read and then destroyed. Auxiliary control circuitry times the rotation of the loops and the transfer and replicate gates so the new information properly replaces the old.

To read out information, the control circuitry rotates the minor loops so the bits making up a specific data block are at the replicate gates. When the BR/T terminals in Fig. 11 are pulsed, the replicated copies are fed along the major read lines to the detectors. The original data bits are kept in storage in the minor loop bank.

The division of the minor loops into odd and even data banks makes the block replicate system twice as fast as the a transfer-gate loop system.

Block replicator swap system

Compare Figs. 11 and 12 and you'll see the close resemblence between the block replicator and swap replicator systems. The differences can be seen along the bottoms of the diagram. In Fig. 12, each minor loop is connected to the write entrance through a swap exit. A bank of swap gates replace the transfer gates in Fig. 11.

In the swap system, old information is transferred to the swap/write exits at the same time that new information is aligned along swap/write entrances to the minor loops. Thus, old data bits and corresponding new data bits face each other across the swap gates. At the proper time, the swap gate is energized and the old and new information swap places.

New data is entered on the minor loops while the old data is swept along the write major lines to be erased by an annihilator.

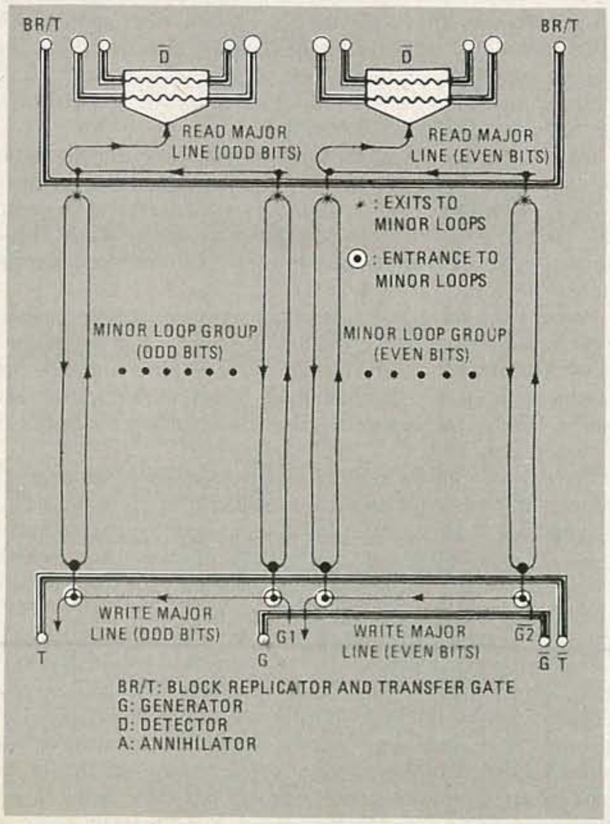


FIG. 11— BLOCK REPLICATOR transfer system is twice as fast as the transfer-gate organization.

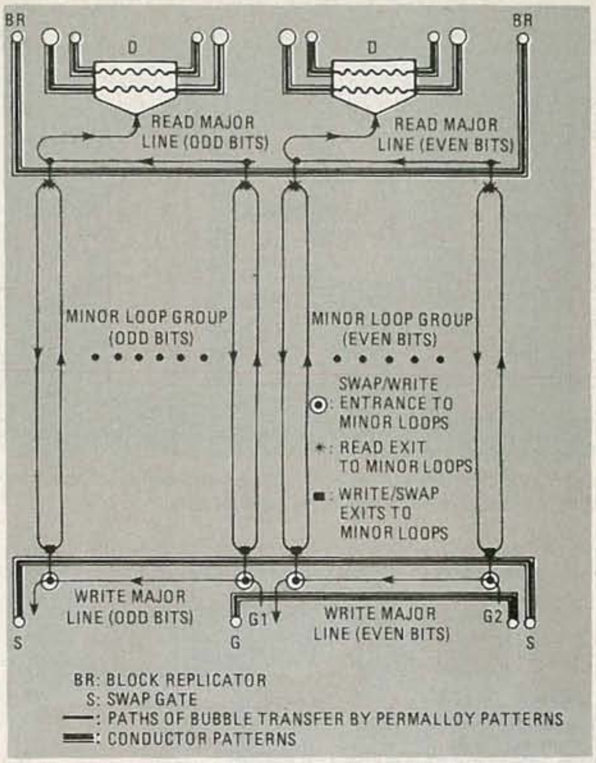


FIG. 12—BLOCK REPLICATOR swap system eliminates the need for old data to be erased before new data can be entered.

Unlike the block replicator transfer system, the swap arrangement eliminates the need to erase old information before writing new.

Peripheral circuits

A number of auxiliary circuit devices are needed to operate a bubble memory storage device. Some of these are called direct peripheral circuits because they connect directly to the bubble memory device. Figure 13 is a block diagram of a magnetic bubble memory system using Motorola's MBM2256 device. The direct peripheral devices are coil drivers, a function driver, and a sense amplifier. The coil drivers feed the X and Y coils with a triangle waveform. The triangle waveform that drives the X coil is 90° out-of-phase with the triangle waveform that drives the Y coil so as to produce a rotating magnetic field. The function driver supplies pulse currents to the function gates. The sense amplifier boosts the detected bubble information signals to a TTL level.

Indirect peripheral devices or circuits are those that control the direct peripheral circuits and provide the necessary interface between the bubble memory system and a microprocessor. The X and Y electromagnetic coils require comparatively high drive currents. The coil predriver is an interface device between the controller and the power transistors used in the coil drivers. The controller provides the timing and control for the coil-driver and function-driver circuits along with timing signals needed.

The MBM2256 is a low-cost, non-volatile solid-state memory device in a 16-pin DIP package approximately 1.1 × 1.15 inches. It is complete with the in-plane magnet coils to develop the rotating magnetic field and a permanent magnet structure to supply a fixed magnetic bias. A magnetic shield protects the device and data from the effects of external magnetic fields.

The memory module has a nominal capacity of 250K bits arranged as 256 storage loops; each with 1024 storage locations. One additional storage (map) loop stores the locations of defective loops and address reference locations. The architecture uses the block replicator swap system. This device can be started and stopped at will and does not lose data when power is either lost or disconnected. The general specifications of the device are listed in Table 1.

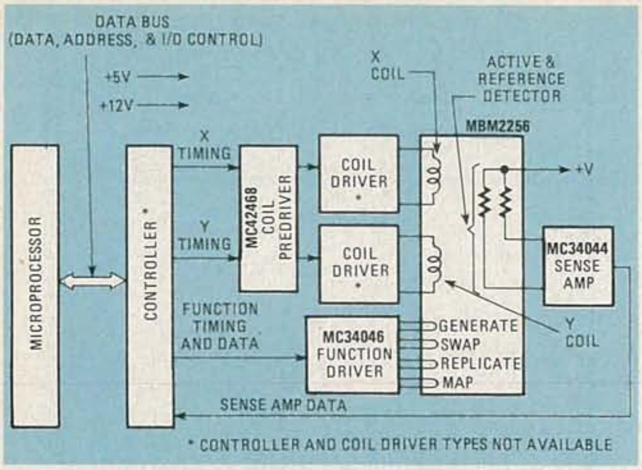


FIG. 13— BLOCK DIAGRAM of Motorola's bubble-memory system. The MBM device uses the block replicator swap system.

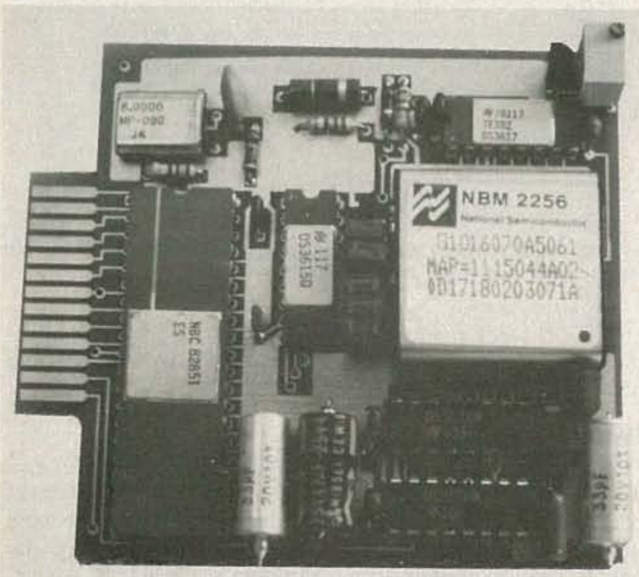


FIG. 14— AN MBM DEVELOPMENT BOARD can be less than 3-inches square and needs just 13 connections for complete interfacing.

The MBM2256, how it works

The device's storage loops have an input track with a swap gate on one side and an output track with a replicate gate on the other. The input track is driven by a generator and the output track leads into an area where the bubbles are stretched so they provide a reliable output signal that can be handled by ordinary electronic circuitry.

To enter data into the MBM2256 magnetic bubble memory, the generators must be fed sequential current pulses according to the data being entered. The swap gate is pulsed as soon as the data block is circulated around the input track and is aligned with the transfer-in gates of the storage loops. The swap gates exchange the new data block with the old in one step.

A read action occurs when the desired data block has been transferred to the transfer-out/replicate gate and the replicate gate is pulsed. The replicated copy of the original data is read by the detectors while the original data is returned to storage.

How bubble memories are implemented

Although a magnetic bubble memory (MBM) device has the performance characteristics of ROM's, RAM's, PROM's and floppy disks, it is not a replacement for any of these devices. Its primary purpose is as a support for the memory devices. (For a comparison of the performance characteristics of the MBM with other magnetic and solid-state memories, see Table 1 in Part 1 of this article in the October 1982 issue.)

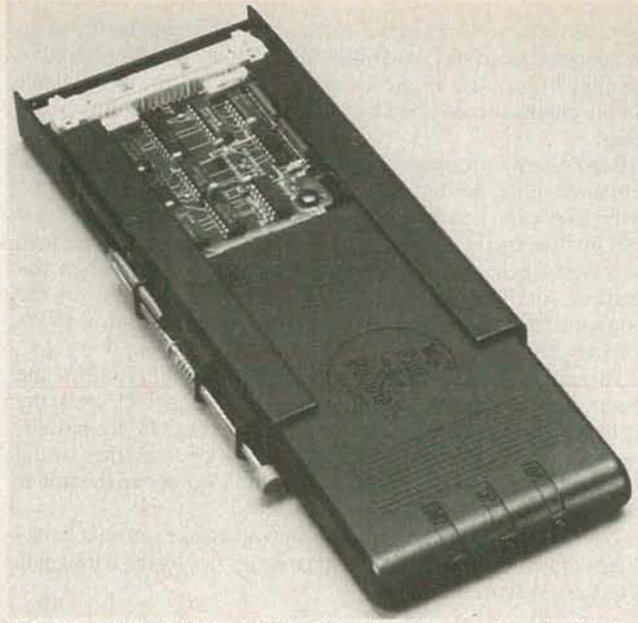


FIG. 15—INTEL'S PLUG-A-BUBBLE basic system consists of a 128 kilobyte system in a cassette that requires no more space than 5¼-inch floppy.

The MBM's ability to store vast amounts of data in a very small space gives it a tremendous advantage in reducing equipment size. It requires less space than either tape or floppy disk; even when several MBM's are paralleled into a 1- or 2-megabyte system. As a rule, the bubble memory manufacturer has a line of support devices designed to go with his system. The user can use a compact development board or plug the components into his PC board with comparatively little effort.

A development board using the MBM system outlined in the block diagram in Fig. 13 can be less than 3 inches square and needs only 13 connector pads for data, address and I/O control signals to and from the microprocessor. Such a board is shown in Fig. 14. (Note that the board in the photo is from National Semiconductor. That company has recently discontinued their work on bubble memories and have dropped those device, and their support devices, from its line. Also note, however, that the Motorola device we've been discussing thus far is identical to the National NBM2256 shown here.)

Intel Magnetics has a bubble memory prototype board featuring up to 512 kilobytes of non-volatile storage that measures 6.75 × 12-inches. The system is designed around the company's 7110 1,048,576-bit (128,000 byte) device. Four 7110's are used in parallel; driven by a single 7220 controller and allied support devices.

Perhaps the most exemplary innovation in bubble memory implementation is Intel's *Plug-A-Bubble* system featuring a removable bubble cassette designed to provide a compact, permanent memory storage system for critical data applications and use in harsh environments. The *Plug-A-Bubble* cassette is shown in Fig. 15.

The system consists of a 7110 128K-byte device with support circuitry in a cassette that measures 0.81 inch high, 6.1 inches long and 3.6 inches wide. It fits into the same space as required by a 5.25-inch floppy disk. The cassette features 48 ms average access time and 12.5 kilobytes-per-second data transfer rate. Ambient operating temperature range is 0° C to 55° C. Non-operating storage temperature range is −40° C to +100° C.

Packaging the complete MBM system in a cassette has three important advantages: First of all, it insures high data integrity because transients in the controller-to-bubble communications are minimized; secondly, the logic is built into the cassette so it can be removed while the system is powered-up, and finally, the self-contained plug-in system makes it possible for the microprocessor to accommodate future developments featuring greater data density. **R-E**

GUITAR AND BASS TUNER

Build this "electronic pitch-pipe" and you'll be able to tune your guitar or bass without disturbing your audience or other performers...and without having them disturb you.

JAMES I. JARNAGIN

ONE OF THE GREATEST PROBLEMS ENcountered by guitar and bass players—especially when performing before an audience—is tuning up. Most musicians in bands or combos use a piano or organ as a pitch reference. If there is no keyboard player, its members usually just tune up against one-another, and hope they wind up in close to the right key.

This tuner has a pitch reference for each string of a standard six-string guitar: E (high), B, G, D, A, and E (low). The unit accepts regular stereo headphones, and the pitch-reference signal is heard in one channel. The instrument being tuned is also plugged into the device, and its amplified output drives the other channel.

Volume controls are provided for both the instrument and the pitch reference, and can be adjusted to override the noise in any room, while the headphones isolate the audience from the tuning-up process. There's also a STEREO/MONO switch. When in the STEREO position, the device operates as described above. However, in the MONO position, the pitch reference and instrument signals are mixed and heard in both channels.

Because of the low frequencies involved, an electric bass is more difficult for most musicians to tune than is a standard guitar. Many times the bassist prefers to tune to a chord, rather than a single-note pitch reference. The tuner provides him with major-triad chords for each bass string: E, A, D, and G. The E (low), A, D, and G guitar-pitches can be used for single-note references.

Circuit description

The heart of the circuit, whose schematic shown in Fig. 1, is IC2, a 50240 top-octave generator. That device uses a single input-frequency to generate all twelve notes of the musical scale. The input signal is provided by IC1, a 4001 quad 2-input NOR gate. Two sections of that IC are used to form an oscillator that runs at approximately 2 MHz. The frequency can be adjusted by trimmer potentiometer R2.

Dual D flip-flops, IC3-IC7, are used as frequency dividers. They divide down the upper-octave frequencies from IC2, thus generating the lower-frequency notes required for the pitch references.

The chords for the bass pitch-references are composed of three notes each. Those notes are taken from various outputs of IC2-IC7 through isolation diodes D1-D12.

All signals are routed to the TONE switch, S3. The wiper arm of that switch is connected through R7 to the input of audio power-amplifier IC8, an LM386. The resistor acts as a volume control for the pitch reference. Another LM386, IC9, serves as an amplifier for the instrument being tuned, with R10 acting as its volume control. The outputs of IC8 and IC9 are coupled, through C5 and C12 respectively, to the headphone jack, J1. Switch S2 STEREO/MONO is used to mix the reference and instrument signals at IC9 for mono operation. Power is supplied by eight "AA" cells connected in series.

Construction

A single-sided PC board (see Fig. 2) was used in the author's prototype. The layout, however, is not critical and other methods of construction, such as wire-wrap, can be used. Sockets should be used for the IC's to eliminate the hazards sometimes encountered when working with CMOS.

The component layout is shown in Fig. 3. Be careful not to use too much heat when soldering the components, and observe the polarities of the electrolytic capacitors and diodes. After all other components have been installed, insert the IC's in their sockets, being sure that they are oriented correctly.

The amplifiers should be shielded from the frequency dividers to prevent extraneous signals from getting into the audio section. The shield can be made from one-inch-wide tin, as shown in Fig. 4.

A drilling guide for the metal case is shown in Fig. 5. Note that all holes are ⅜-inch in diameter except for the ¼-inch hole for the STEREO/MONO switch, S2, on the rear panel. The other hole on the rear panel is for the pitch-reference output jack, J3. Rotary switch S3 is mounted in the center hole on the front panel. All labelling is done using rub-on dry-transfer letters, which should be protected by a thin coat of lacquer. The completed unit is shown in Fig. 6.

Adjustment and operation

Use R2 to calibrate the device, using a recently-tuned piano or a tuning fork as a

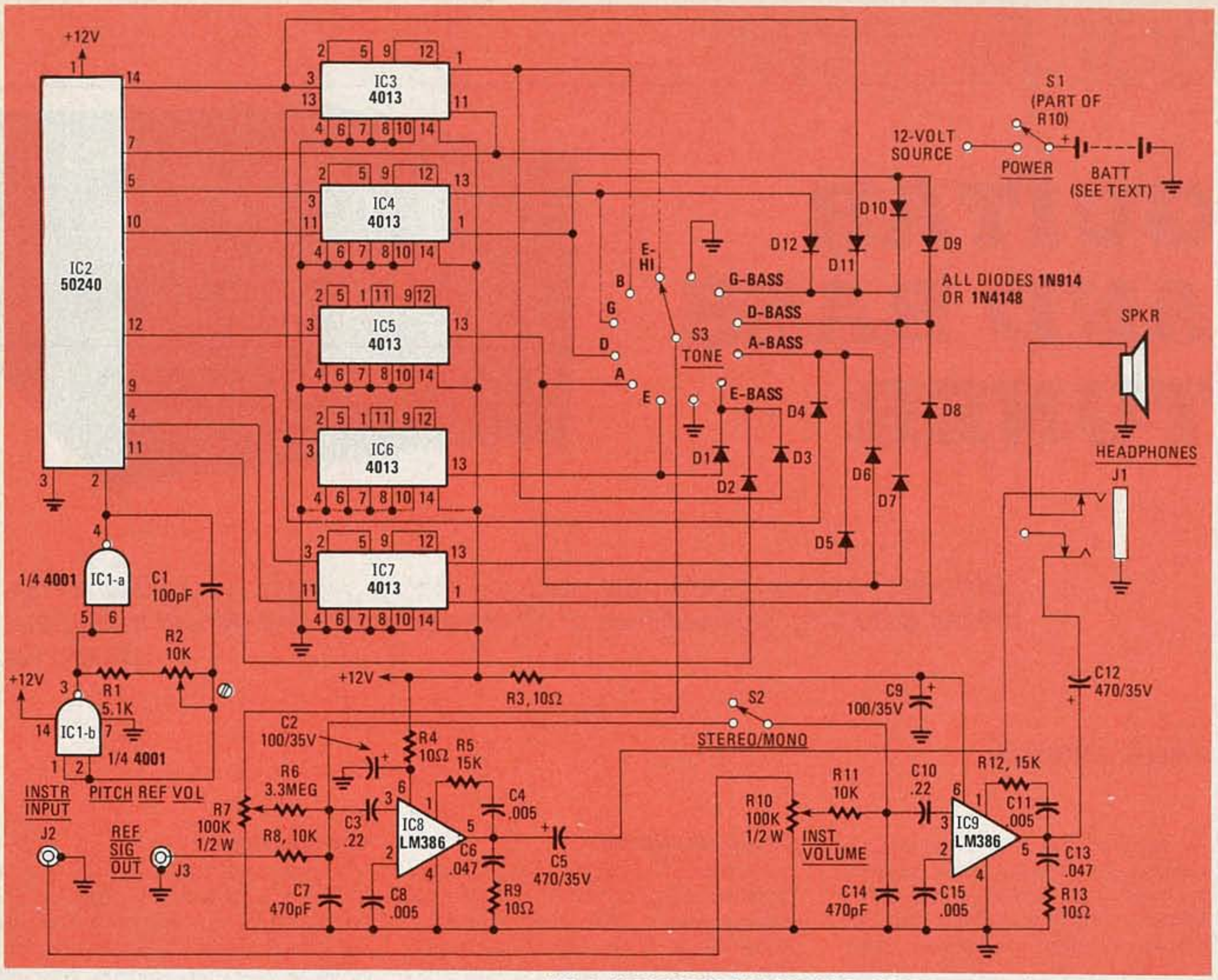


FIG. 1—HIGH-FREQUENCY OUTPUTS of IC2, a top-octave frequency generator, are divided down to frequencies used for instrument tuning by IC3-IC7.

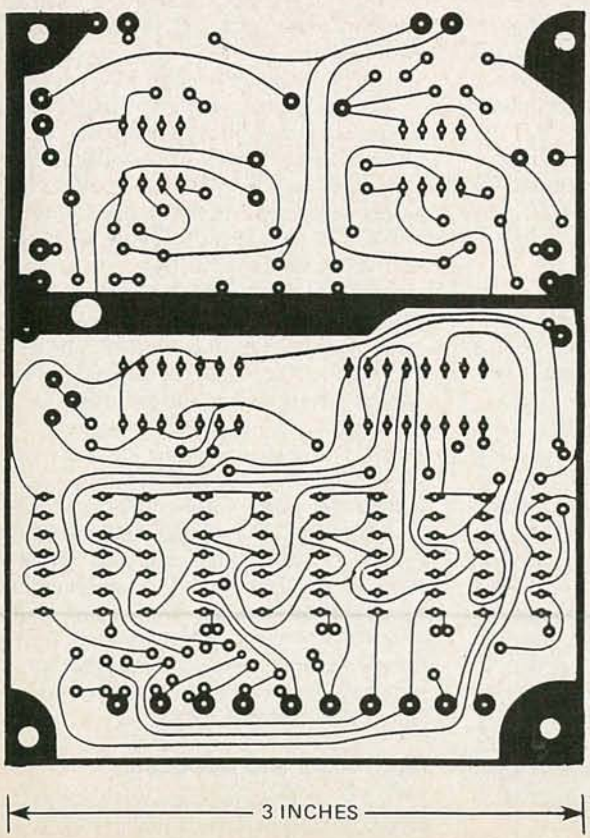


FIG. 2—WHILE TUNER CAN BE HAND-WIRED, a printed-circuit board (left) will make for neater construction.

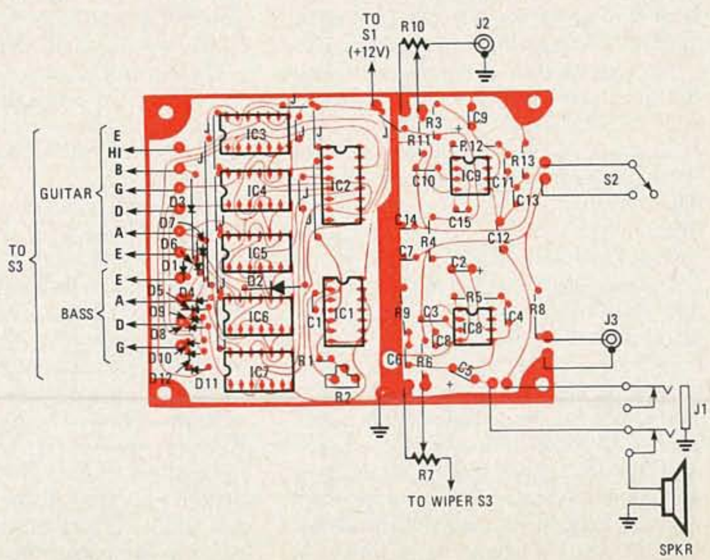


FIG. 3—DO NOT FORGET to install the 11 jumper wires on the component side of the board.

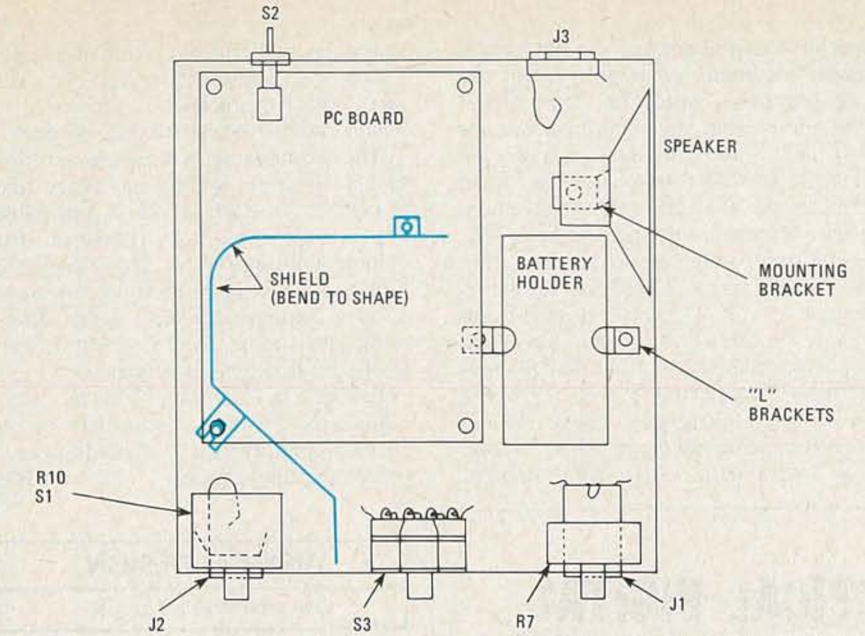


FIG. 4—MOUNTING LOCATIONS for off-the-board parts. Note shield, made of one-inch-wide tin, that keeps noise out of amplifier circuits.

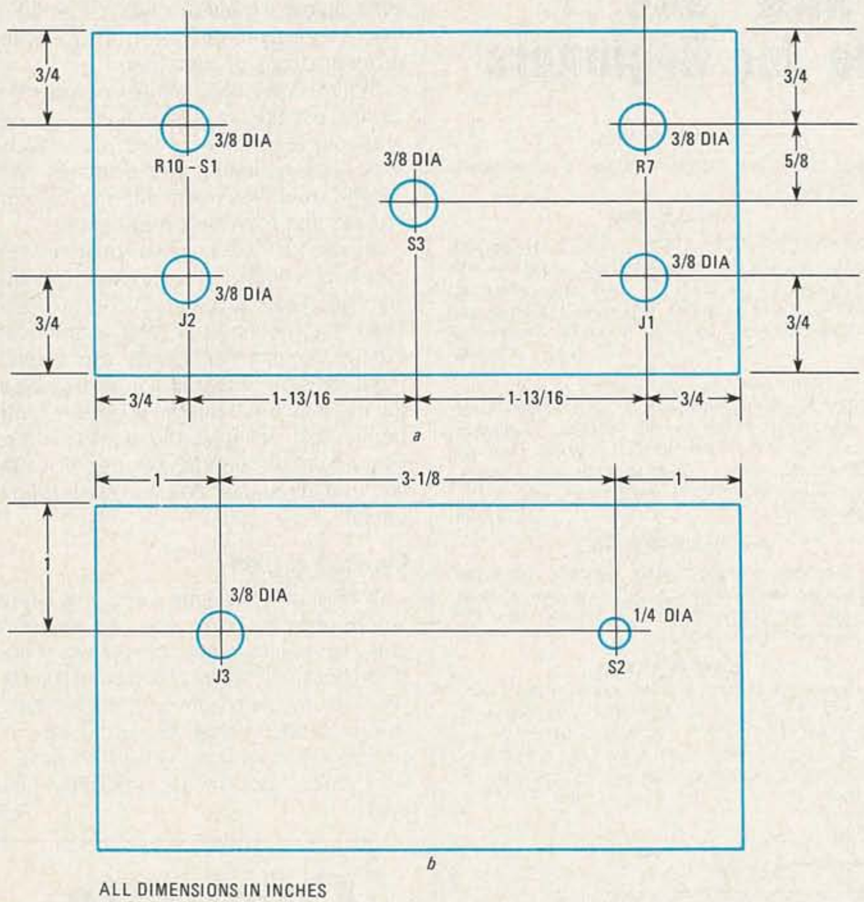


FIG. 5—DRILLING TEMPLATES for front of enclosure (*a*) and rear (*b*). All holes are ⅜-inch in diameter except for the ¼-inch one for S2.

reference. Any of the single notes selected by S3 can be used for calibration, and all the other pitch-reference notes will fall into place. No further adjustment is necessary.

To use the tuner, plug a set of stereo headphones into J1. Next, insert the plug from the guitar or bass into J2. Place S2 in the STEREO position, and adjust volume controls R7 and R11 so the volume of the instrument is about the same as that of the pitch reference. You should be able to hear the beat signal produced by the difference in frequencies between the two. Tune the string until the beat note just disappears.

FIG. 6—AMPLIFIER SHIELD is clearly visible in photo of completed unit. Also note battery pack and vertical mounting of some diodes and resistors.

PARTS LIST

All resistors ¼-watt, 5%, unless otherwise specified
R1—5100 ohms
R2—10,000 ohms, trimmer potentiometer
R3, R4, R9, R13—10 ohms
R5, R12—15,000 ohms
R6—3.3 megohms
R7, R10—100,000 ohms, ½-watt, panel-mount potentiometer, audio taper (S1 is part of R10)
R8, R11—10,000 ohms
Capacitors
C1—100 pF, 50 volts, ceramic disc
C2, C9—100 µF, 35 volts, electrolytic
C3, C10—.22 µF, ceramic disc
C4, C8, C11, C15—.005 µF, ceramic disc
C5, C12—470 µF, 35 volts, electrolytic
C6, C13—.047 µF, ceramic disc
C7, C14—470 pF, ceramic disc
Semiconductors
IC1—4001 quad 2-input NOR Gate
IC2—50240 top-octave generator
IC3-IC7—4013 dual D flip-flop
IC8, IC9—LM386 low-voltage amplifier
D1-12—1N914 or 1N4148
S1—SPST switch (part of R10)
S2—SPST miniature toggle switch
S3—single pole, 12-position, rotary switch (Radio Shack 275-1385 or equivalent)
J1—3-conductor N.C. ¼-inch stereo phone-jack
J2, J3—2-conductor N.O. ¼-inch phone jack
SPKR—8-ohms, 2-inch diameter
BATT—8 "AA" cells in series
Miscellaneous: PC board (optional), IC sockets, battery holder, sheet tin, enclosure, knobs, wire, etc.

If the beat is difficult to hear, try listening for it with S2 in the MONO position. If that is done, both signals—pitch reference and instrument—will be heard from each earpiece.

Old strings on an instrument may also cause the beat signal to be difficult to hear. In that case, simply tune until the two tones sound close or—better still—get a new set of strings.

The beat signal is much more difficult to hear with a bass guitar; however, that instrument can be tuned very accurately using the chords selectable by S3. **R-E**

EQUIPMENT REPORTS

continued from page 33

using the typewriter's self-correcting feature. The correct characters are then typed in and you're all set. For authors, and many other users, the simultaneous typewriter/printer modes are an asset.

There are some things to watch out for, however. For one thing, the printwheels that are presently available are of the standard correspondence-type usually supplied with typewriters, they don't contain the < and > symbols often used in computer programs, nor a few of the other special ASCII characters. To get around those limitations (when necessary) the unit provides a space for characters it can't print; you can write them in later "by hand." While it's not much of a job to write in a few special characters in manuscripts, it can be very inconvenient when you need to do that in a long program listing (you might not get them all in the correct spaces). Characters for which there is no ASCII code are printed using other characters. For instance, the ½ and ¼ are printed by using the ASCII [and] symbols. Note that if the level 2 keyboard is selected (foreign), those ASCII characters will print the Spanish "n" and "N" with tilde. All ASCII control characters, with the exception of BS, HT, LF, CR, DC2, and DC4, are ignored. The DC4 control character is a CONTROL-T, which causes the test message to print.

The second thing to be aware of is that though the print quality is strictly first class, the basic *Praxis 30* is a portable typewriter—it's not intended for commercial-type service. Don't expect to turn it on at nine in the morning, and have it print continuously until 4 that afternoon, day after day; I doubt it can withstand that type of service.

Except for the limitations we mentioned, the *Bytewriter* proved to be an excellent performer, especially for word-processing applications. **R-E**

ANALOG DESIGN

continued from page 74

ly give you no better results than you will get by applying a few rules of thumb. First choose a transistor where F or NF is low. From there on, rules differ for the different types of transistors.

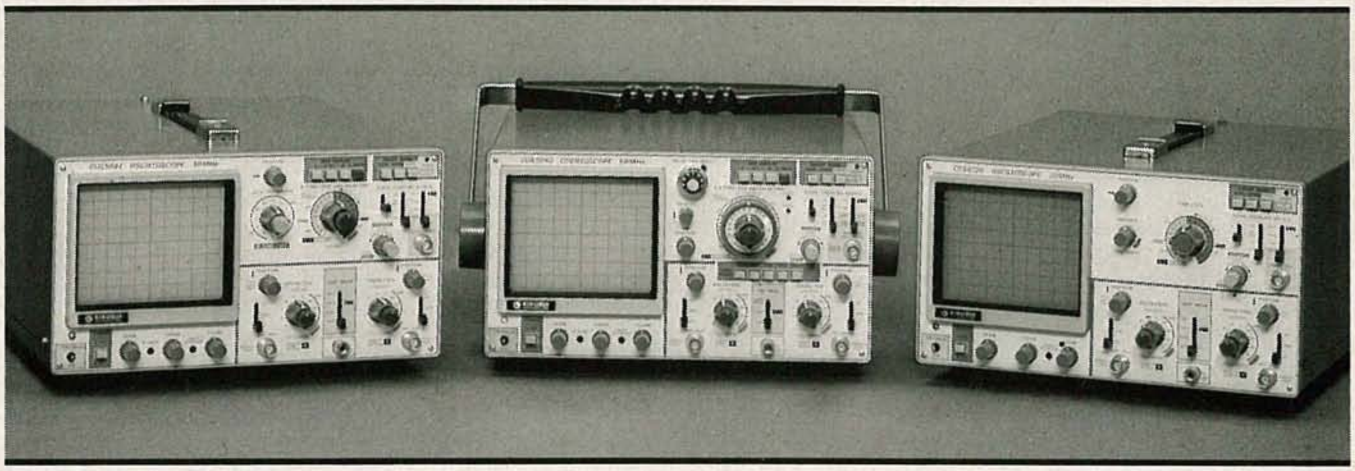
When designing a bipolar transistor circuit, use the smallest practical resistor at the input to the base that is consistent with the functioning of the circuit. As a second rule, keep the idling collector voltage and current at a minimum.

As for FET's, choose a low-noise device with a high g_m. Next, bias the device as close to the I_{DSS} curve as possible to make V_{GS} as close to 0 volt as practical. Finally, do not necessarily use a small input resistor. There is one resistance at the input that will put the noise at a minimum. That value should be determined experimentally through the use of a substitution resistance box across the input circuit.

Increasing gain

We found the gain of a one-stage amplifier to be pretty low. To get more gain, we must connect the output of one transistor to the input of a second transistor. Now the gain of two or more devices determine the overall gain of the circuit. In the next article, we will cover the design procedures for accomplishing that goal. **R-E**

The best 60MHz scope costs only $1100. It's from Kikusui.



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CIRCLE 22 ON FREE INFORMATION CARD

SERVICE CLINIC

More about capacitors

JACK DARR, SERVICE EDITOR

NOT LONG AGO WE DISCUSSED FILTER capacitors—the troubles they can cause, how to identify those problems, and so on. This month, let's take a look at some of the other types.

Bypass capacitors

In all, there are four classes of capacitors used in radio and TV circuits: filter, bypass, coupling, and tuning. *Bypass* capacitors do just what their name implies—they bypass unwanted signals straight to ground or common, to make the bypassed point a perfect ground for RF or any other AC signal. They can cause some easy-to-fix problems and some tough ones. The easy ones are when they're shorted. An unmistakable clue is the complete loss of the normal DC-voltage at the bypassed point, while the supply voltages are OK. A shorted bypass capacitor may also be responsible for dropping resistors heating up, so watch out for that symptom, too.

When bypass capacitors open up, we see something completely different. The former ground point now becomes hot, and all kinds of odd things can happen. Just as with filter capacitors, the most obvious symptom is feedback; we find signals where there should be none and those get into the power-supply circuits and into other stages. That can cause odd oscillations, beats in the picture, color problems, squeals in the sound, distortion, and other difficulties. We'll show you some horrible examples.

An open bypass capacitor in the wrong place can reduce the gain of an RF/IF amplifier stage. How? Look at Fig. 1-a. It shows an IF (or RF) stage with a tuned transformer. The signal voltage is developed between the top of the primary winding and ground. Let's say that the value of resistor R is 1000 ohms, and the impedance of the primary the same. We'll supply a one-volt signal to the primary. (Notice how I always use easy figures?) In normal operation, all of the signal voltage is developed across the primary, for the bottom end of the winding is ground for the signal.

If the bypass capacitor opens, though—as shown in Fig. 1-b—its lower end is no longer at ground potential and the total impedance is now 2000 ohms. We'll get only 0.5-volt of signal across each half of the primary circuit, and the gain of the stage will have been halved, with obvious results.

Fortunately, there's an instrument that will catch open bypass-capacitors in a hurry. You knew what I was going to say, didn't you? Yes—an oscilloscope. For a fast and accurate test of any bypass capacitor, just touch the probe to the bypassed point, with the scope's vertical gain turned as high as possible. You must see no signals at all; if you see *anything*, the bypass isn't working. In tube circuits, you can bridge a new capacitor across the circuit while the power's on. In solid-state sets, *don't!* Instead, turn the power off, tack in the substitute capacitor, and then turn the set back on. If the unwanted signal is gone and the symptom disappears, you've found the problem.

There's one thing you must remember: the capacitor makes the bypassed point "ground." However, if the ground-end of the capacitor isn't *perfectly* grounded, you'll get the same results as you would from an open capacitor! That is especially applicable to PC-board sets, where the board is mounted on a "mother board" or a heavy metal-frame chassis. The metal frame is often the common ground for the whole set. All of the ground points on the PC board must make perfect contact with the common ground, or you'll have the mother and father of all feedback loops! That would have the same effect as opening up every bypass capacitor on the whole board!

Horrible example number one: My own ancient (ca. 1963) CTC-15 had more different trouble symptoms than you could shake a stick at. They were all intermittent, of course, and seemed to point to first one circuit, and then another, as the cause. I hunted and hunted and got nowhere, until one day it hit me. I got out my heavy-duty soldering gun and resoldered all of the seven ground points on the signal PC-board. Bingo! The symptoms went away and haven't come back yet.

The same thing has shown up in many of the newer sets; one Quasar (horrible example number 2) had similar problems. The cure was to run an extra ground-lead from the common of a very large filter capacitor on the back of the PC board over to the metal frame. Always suspect solder joints; to eliminate poor ones, re-do each joint and make sure the solder melts well and sticks cleanly. That takes only a little time and can solve some odd problems.

Horrible example number 3: A tube-type Philco color set had good color, but an odd background. The left half of the screen (vertically) was blue, the right half was gold. For once I got into the correct circuit early on—the bandpass amplifiers. The screen grid in the first bandpass-stage showed signals that shouldn't have been there. Shunting a new capacitor across the old got rid of the signals, and the problem.

I took the original out, and checked it

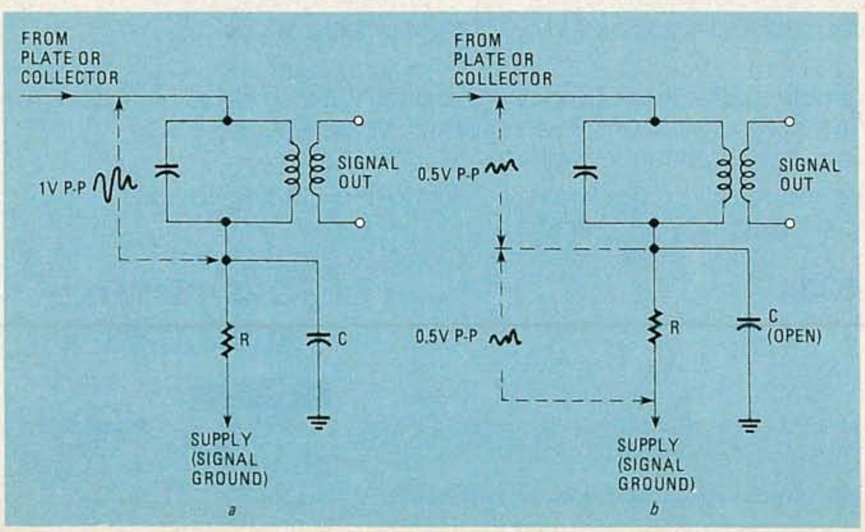

FIG. 1

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on my capacitance bridge just for fun. It looked perfect—the right value, no leakage, etc. When I put it back in, though, the problem came back. Then I noticed that the ground lead of that capacitor went all the way around the tube socket to a ground point on the other side, where other ground leads were tied. Hmm. I shunted the ground end of the capacitor to the chassis right at the body of capacitor with a test prod and the symptoms disappeared. I then soldered the ground end of the capacitor to the nearest ground lug I could find, and there were no more problems. The original ground lead was long enough to have enough inductance at the very high frequencies involved at that stage to cause feedback!

Coupling capacitors

Let's take a quick look at coupling capacitors. They're the easiest to check. The signal going in should be the same as the one coming out. If it isn't, the capacitor is open. That's all there is to it.

If the a coupling capacitor is leaky, the DC voltages in both input and output circuits will be upset and you will probably get distortion and low gain in audio stages. Little low-voltage electrolytics are very common in transistor circuitry; those cause a lot of the problems by opening up.

My guess is that a very common problem with dry electrolytics is an intermittent ground lead on the outside foil of the capacitor. When you find one that is definitely open, don't bother to take it out and check it! The heat of unsoldering the original will probably cure it but the relief will only be temporary. Don't mess around—replace the capacitor.

Here's one more common bypass-capacitor problem. If the emitter bypass-capacitor in common-emitter audio stages opens up, you'll have a horrendous feedback from emitter to base, severe distortion, and loss of gain. A clue to this is the presence of the same amount of signal on both the emitter and base; there should be no signal on the emitter.

I haven't covered all the things that defective capacitors can do to you, but I hope I've given you a few new ideas on the subject. Now, armed with your new knowledge, go out and get 'em! **R-E**

SERVICE QUESTIONS

HARD TO FIND VDR

This 10-year-old Panasonic CT-61P has an open VDR (Voltage Dependent Resistor) across the primary of the vertical-output transformer. I can't get the part from Panasonic. Can you help me?—R.M., Honolulu, HI

That VDR is used as a clamp across the primary to keep the voltage from going too high. It doesn't seem to make much difference in the operation of the set. Something like an Oneida WR-808, rated at 1.0 mA at 550 volts, might do. You could also try putting an ordinary one-megohm resistor across the primary—I've done that in a few cases.

HORIZONTAL DRIFT

If any of your readers have problems with horizontal drift in Zenith 12KB4X (black-and-white) chassis, try this: Increase the value of C402 (part No. 22-7389-05) from 2.2μF to 4.7μF, and increase C509 (part No. 22-7613-14) from .001μF to .0015μF. I hope this will help someone.

Thanks to J.C. of Texas City, TX for this. I'll bet it'll come in handy to someone soon.

BRIGHTNESS PROBLEM

This Tatung color portable came in one day with high brightness, retrace lines and weak color. (Fortunately it was listed as Sams 1752-2, which surprised me.) The video amps, etc. checked out OK, but I found the +522-volts boost up to 630 volts. I checked R908, which should have been 180K; it read about 816K so I replaced it and the problem cleared up.

There's a small discrepancy in the

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Solid State News

Blinking LED's

Available in four colors, a new series of blinking LED's from AEG-Telefunken have such applications as an indicator with "blink" and "off" modes, as panel indicators, and in audio and receiving equipment and alarm systems. The CQZ21 red, V621P amber, V622P green, and V623P yellow, feature an oscillator IC mounted in the same package with the LED. Thus they can replace a standard LED with its external oscillator circuit.

Typical blinking rate is 3 Hz. The LED's operate from a single 5-volt source.—**Telefunken Corp.,** Route 22-Orr Drive, Somerville, NJ 08876. **R-E**

Transistor data manual and catalog

Plastic Power Transistors is a 47-page compilation of data covering the Panasonic line of plastic-encapsulated silicon power-transistors for power amplifier and high-speed switching applications. Types include Darlington, epitaxial-base mesa, and triple-diffused planar technologies. The TIP TO-220-package devices are designed primarily for such low-power applications as power amplifiers and switching power-supplies where high-speed switching is needed.

The TIP series of NPN and PNP devices are available with I_c's ranging from 1 to 10 amps, V_{CEO}'s from 40 to 400 volts, and P_C (collector power-dissipation) ratings from 30 to 80 watts. The higher-power devices are in TOP-3 housings and feature P_C ratings from 60 to 100 watts. The TO-220 packages are directly interchangeable with TO-66 packages and the TOP-3 packs are plug-in replacements for TO-3 cases.—**Panasonic Co.,** One Panasonic Way, Secaucus, NJ, 07094

Liquid crystal display data

LCD Technical Manual (Manual SI-100) is an excellent source of basic technical information on liquid crystal display (LCD) devices. One section covers theory, principles, and structure; another describes conditions and techniques for static and multiplex driving.—**Seiko Instruments U.S.A., Inc.,** 2990 W. Lomita Blvd., Torrence, CA 90505

Transducer information

Pressure Transducer Applications Guide is a 40-page booklet written to acquaint engineers, and electronics and industrial maintenance technicians with typical applications of the high-output semiconductor strain-gage pressure transducers made by Data Instruments Inc. The "General Information" section includes sample-and-hold and digital zeroing circuits, ratiometric and fixed-output interface circuits, and a typical setup for making differential pressure measurements. The "Applications" section includes illustrated solutions to pressure and level-measurement problems in such fields as process control, automotive diagnostics, internal combustion engines, geophysics, hydraulics, oceanography, and medical science. A study of the problems presented and their solutions could possibly provide the answer to a problem that you have in pressure measurement or process control.—**Data Instruments Inc.,** 4 Hartwell Place, Lexington, MA 02173

Semiconductor catalog

Microwave Semiconductors is a 40-page listing of all pertinent electrical, performance, and physical specifications on the lines of semiconductor products from Nippon Electric Co. Most of the devices listed are engineered for UHF and microwave performance. Transistors are covered on 25 pages of tables including small-signal/low-noise, medium power, Class-A power bipolar and GaAs FET's, and Class-C VHF/UHF devices. Diodes include PIN, Gunn, IMPATT, and Schottky types with specifications running well into the GHz range. Also included are as silicon avalanche, laser, and silicon PIN diodes, and LED's.—**California Eastern Laboratories, Inc.,** 3005 Democracy Way, Santa Clara, CA 95050 **R-E** schematic you might be interested in. It tells you to adjust the Sub Brightness DC level to + .83 volt: I think it's supposed to be − .83 volt.—*A.S., San Diego, CA*

Thanks for letting us know. More and more of those sets are turning up.

HORIZONTAL INSTABILITY

I had very poor horizontal lock in a 12-inch Hitachi black-and-white set. You suggested trying adding external DC-bias, but it didn't help—the VCO still shifted the horizontal. I replaced the IC and the picture locked in tightly.

Thanks for the information. I don't see how you do it without being able to confront the sets eyeball-to-eyeball.—*T.E.D.*

Thank you for the feedback!

AN OLD "FRIEND"

I've got an Admiral 20YP4PRS that had a vertical line brighter than the picture down the middle of the screen. I'd had it for years and just recently found a hint to the effect that adjusting the horizontal-drive control would help. I tried it, and it did—without affecting anything else.—W.H., Rochester, NY

That is one of the things we all did automatically back in the old days. The bright line is called a "drive line" and is due to a small bit of non-linearity in the transition between damper conduction (left half of the screen) and horizontal-output tube conduction (right half of the screen). You were actually scanning the same point twice: the beam would stop and back up.

The cure, as you found out, is to reduce the horizontal drive until the line disappears. We used to get a lot of mail about that problem a long time ago, but haven't had anything (until your letter) for years. It brings back memories.

SOME HELPFUL HINTS

Here are solutions to some chronic problems I've run into with RCA CTC-53 chassis.

To equalize the heater string, replace the 11DQ5 with a 6AQ5. That will help to eliminate burned-up cathode resistors and exploded electrolytics in the audio output stage.

Another one: Every time you take the back off one of these sets, check the 120K/220K resistors in the plate circuit of the 6GH6 horizontal oscillator. They get too hot, and their values change downward. Also, while you're in the area, check the resistor from the collector of the sync amp to B+, on the left of the horizontal oscillator. It, too, goes down in value, and blows the sync-amp transistor. I think the correct value is 180K.

Criss-cross vertical red and green lines are due to a bad electrolytic on the convergence board. Shrinking vertical height can be caused by a bad 50-μF electrolytic in the vertical-output cathode circuit.

I hope that this information will be of use to others.—*J.D., Canandaigua, NY*

You bet it will, and thanks a lot.

HORIZONTAL PROBLEMS

I am having several problems with an Admiral T1K8-2B. The B+ drops way down, the HV is very low, and the raster pulls in and folds over in the center of the screen. I've changed the output, driver, and oscillator transistors, and the HV-rectifier with no success. Do you have any ideas?—J.J., Farmington, IA

A couple. For one thing, your problem could be a shorted yoke-return capacitor. In the T1K8-2B, as in many solid-state sets, the flyback transformer and horizontal yoke are connected in parallel across the output transistor. If the yoke or capacitor shorts, the circuit will be overloaded and the symptoms will resemble the ones you have. Try disconnecting the yoke at the line-end of C416: see whether that brings the B+ and HV up to normal. You'll see a very bright vertical line in the middle of the screen: turn the brighness down for luck.

If the capacitor is OK, the yoke may be shorted. You don't see that often due to the low-resistance windings of solid-state yokes, but it can happen. Replace the capacitor with an exact duplicate. **R-E**

On your mark! Get set! GO! to 58 CHANNEL CABLE TV

58 CHANNEL SYSTEMS

Cable TV companies in the U.S.A. are now rushing to expand their channel capability to 58 channels. This new system (called a 400 megahertz system by those in the trade) is presently operational in many areas. This system is required to enable your cable company to carry more channels on their cable. Channels like Showtime, Cinemax, Home Box Office, The Sports Network, etc. The Jerrold 400 converter is in use in many of these systems.

OLDER CABLE SYSTEMS

Many systems in use by Cable TV companies have simply been outgrown. Maximum capability was limited to as few as 12 channels (2 - 13). Cable TV companies had no space to put these new entertainment channels, and so, had no choice but to expand their systems. The new channels were placed on frequencies (channels) that could not be received by most TV sets. If you are on a cable system that exceeds 12 channels, the Jerrold 400 will enable you to receive these hidden channels. Using a Jerrold 400 ensures that the number of cable channels offered by your local cable company will not outstrip your tv set's ability to receive these extra channels for years to come.

CONVERTER USE BY CABLE COMPANIES

Cable companies which utilize these "hidden" channels have been providing converters to their customers who have been subscribing to their extra channel services. In many cases, converters purchased by cable customers are just as effective in pulling in those extra channels provided by your cable company. In other cases, the cable company, due to technical considerations, will "scramble" the transmissions on these extra channels. The Jerrold 400 is not a descrambler - but will properly receive any of those "hidden" channels that are not being scrambled. Some of these channels may include weather information, locally originated closed circuit programs, sports, etc. Some cable companies put their "premium programming" on these "hidden" channels without scrambling. The Jerrold 400 would provide perfect reception on these channels.

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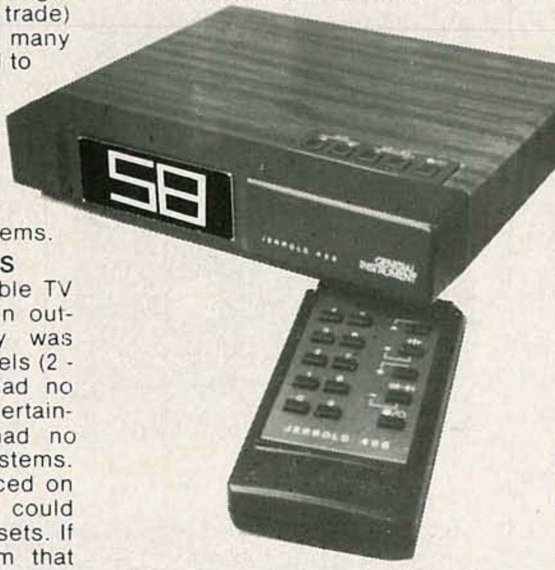
The Jerrold 400 58 channel cable converter is a remote control unit which is activated by a compact hand held infrared transmitter. From your viewing position you have total control over channel selection and TV on/off functions. A bright red digital readout (visible from twenty feet) immediately indicates which



channel you have selected. Changing channels is as easy as pushing a button. You can go directly from any channel to any other channel, or if you prefer, you can step through all the channels in sequence. If you accidentally miss the desired channel, you can easily step through the channels in reverse order. The small hand held control is powered by a single, inexpensive 9 volt battery (included, of course). Back up controls are located on the main control unit in the event of battery failure.

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HOBBY CORNER

A new puzzle, and other goodies

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

A WHILE AGO I INVITED YOU TO SEND IN puzzles that I could publish to amuse (and confound) readers of this department. Here's one from John Cirillo of Fort Worth, TX. It concerns something that he has been wondering about for several years.

It seems that John once lived in an apartment that shared a single porch light with two others. Each of the three apartments had a switch that could turn that one light either on or off regardless of which switch had been used to turn it on or off before.

John says that he never had the opportunity to actually trace the wiring to see how the circuit was designed, but he does have some information. The switches were single pole, double throw. The power was straight 117-volt single-phase AC. The bulb was standard—no double filament or anything like that.

He doesn't know whether there were any concealed relays or other components in the circuit. He considers the use of relays unlikely, however, because the apartments were built/wired in the early 1930's.

There you have it. Can you design a circuit that gives completely independent control of a single bulb by each of three SPDT switches? If you cannot come up with such a circuit, what is the best circuit (smallest number of additional components) that you can devise to do the job?

Send me your solution(s) to John's puzzle. Knowing how it was done will let him sleep better.

AN INVITATION

To better meet your needs, "Hobby Corner" will undergo a change in direction. It will be changed to a question-and-answer form in the near future. You are invited to send us questions about general electronics and its applications. We'll do what we can to come up with an answer or, at least, suggest where you might find one.

If you need a basic circuit for some purpose, or want to know how or why one works, let us know. We'll print those of greatest interest here in "Hobby Corner." Please keep in mind that we cannot become a circuit-design service for esoteric applications; circuits must be as general and as simple as possible. Please address your correspondence to:

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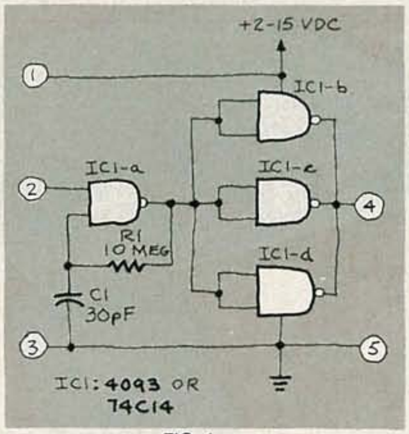


FIG. 1

Versatile Schmitt triggers

You never cease to amaze me with the circuits you design. Here is one well worth passing along. It comes from Frank Petersohn in Vancouver, BC, Canada.

Frank's basic timing circuit is shown in Fig. 1. It uses the four Schmitt gates in a 4093 or a 74C14. He cautions that a National IC should be used for dependable operation (and because it is less easily "blown").

Various signaling (output) devices can be connected to points 4 and 5. Your choice will depend upon the use to which you wish to put the timer; Fig. 2 shows connections to a speaker, LED, relay, and piezo transducer.

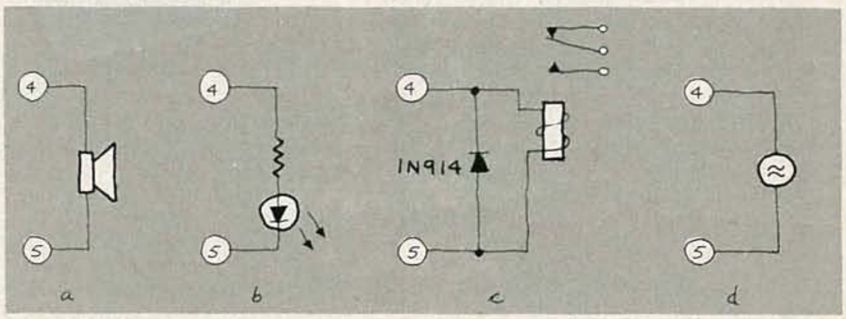


FIG. 2

The "input" side can consist of a wide variety of circuits. Three examples of them are shown in Fig. 3. An SPST switch is used in Fig. 3-a to gate the timer on and off manually.

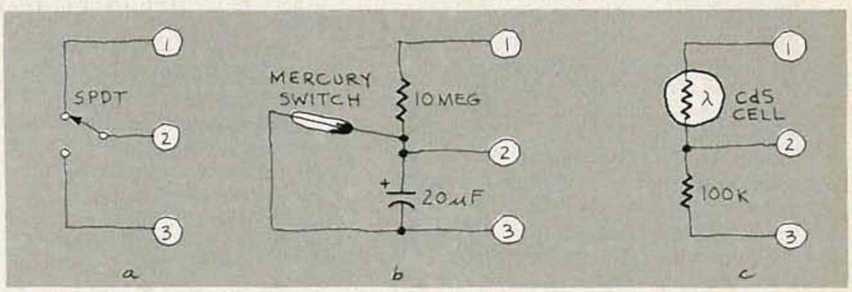
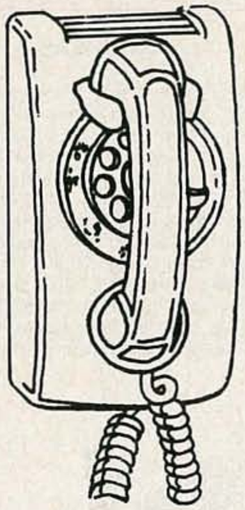


FIG. 3

The addition of the components shown in Fig. 3-b will produce a timer for such things as cooking eggs or limiting telephone calls. It is activated simply by turning the timer over so the mercury switch will close. In Fig. 3-c, a cadmium-sulphide photoresistor is used to make a light/dark detector.

The types of circuits and devices that can be added to each end of the basic circuit are limited only by your imagination. As a result, there are innumerable uses to which it can be put. Consider these few: turn lights on at sunset; sound an alarm when someone opens the refrigera-

continued on page 94



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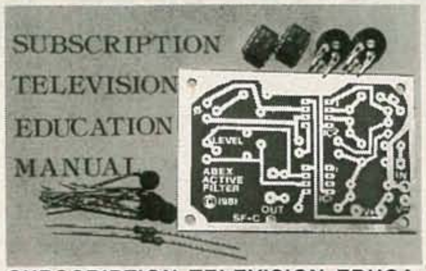

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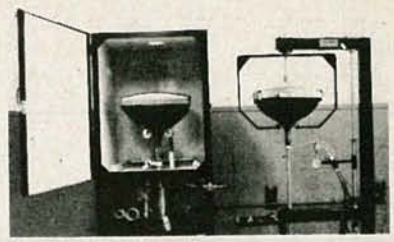

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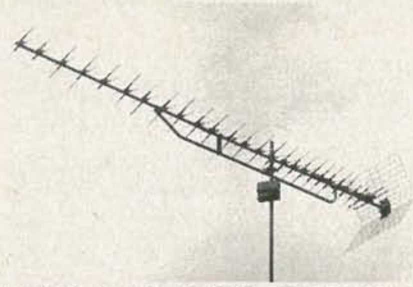

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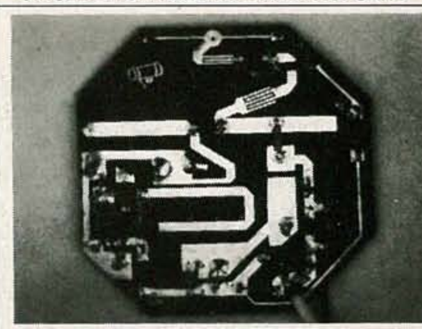

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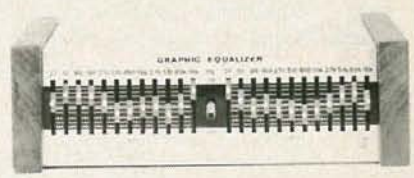

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NEW IDEAS

Voltage freezer

HAVE YOU EVER WANTED TO MEASURE the voltage in a tight spot, only to find that before you could read the meter the test probe had slipped and you had to start all over? Having to hold the probe in place and read the meter at the same time is not only inconvenient, but if you slip, you can cause damage.

The circuit described here can solve that problem simply and easily. It reads and stores the voltage, thus freezing the meter reading even after the probes are removed.

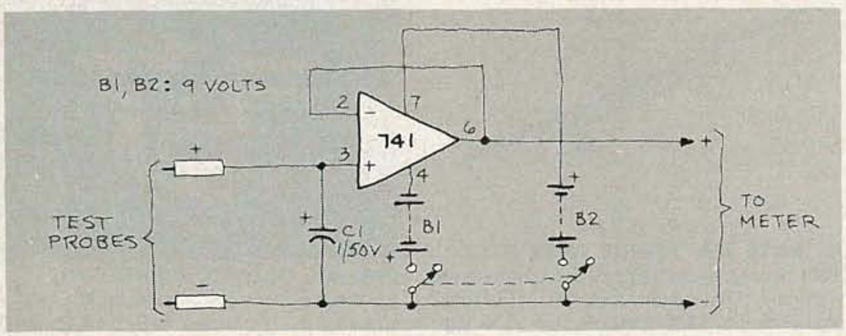


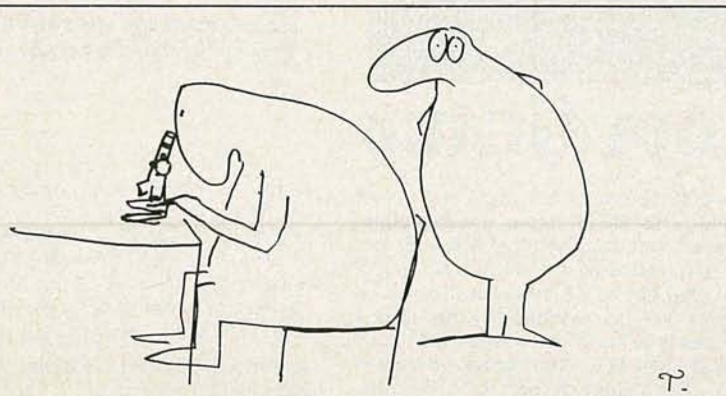
FIG. 1

The major component of the circuit, shown in Fig. 1, is an 8-pin 741C op-amp. The op-amp is configured as a unity-gain voltage follower, with C1 at the input to store the voltage.

The circuit operates as follows: When a voltage is applied across C1, the capacitor charges to that value. When the voltage source is removed, the value is still stored in the capacitor, and can be read on the meter. While the capacitor *does* discharge, the process takes place very slowly due to the very low loading of the op-amp's high-impedance input. The meter is reset very simply: Just short the probes together; that discharges the capacitor.

Any type of construction can be used for the circuit, since nothing is critical. The only thing you should bear in mind is to use a tantalum capacitor for C1, since it will hold a charge much longer than a relatively leaky aluminum electrolytic. Since no input protection is provided, keep the DC-voltage input below the supply voltage. A DPST switch turns the device on and off, and B1 and B2 are nine-volt transistor batteries. Finally, note that pins 1 and 5 of the 741 op-amp are for offset null; such as, those pins are not required for proper circuit operation and can be ignored.

For better performance, use an LF13741 or a TL081 op-amp in place of the 741—those are JFET devices and offer a much higher input impedance than the 741.—*Leonard Lee* **R-E**



"I hate microelectronics repair work. OK, I'm removing the chassis."

NEW IDEAS

This column is devoted to new ideas, circuits, device applications, construction techniques, helpful hints, etc.

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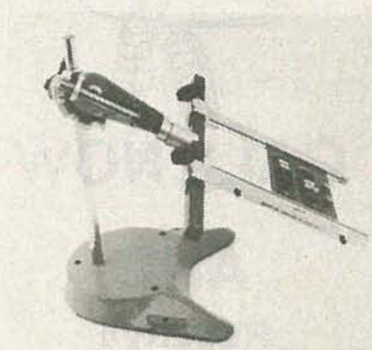

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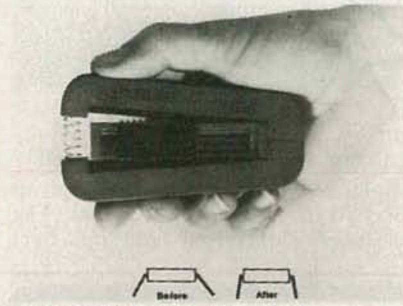

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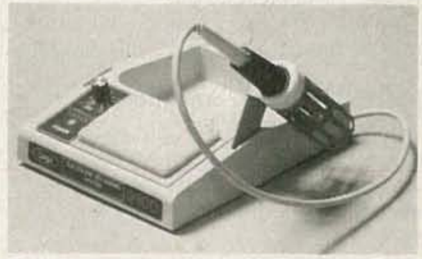

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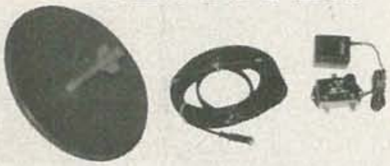

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HOBBY CORNER

continued from page 90

tor to get a forbidden snack; time darkroom processes, and signal the opening of any type of door or cover.

Do a bit of experimenting and let us know what uses you find for this circuit.

"Littlest oscillator" addenda

There were a number of late arrivals in the oscillator contest. Even so, each one was appreciated. There were two, however, that I think you will want to know about.

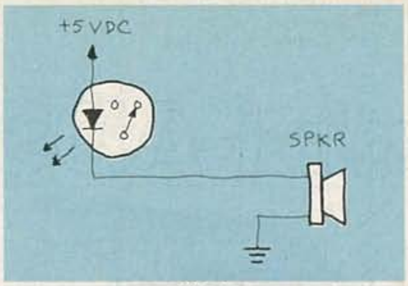

FIG. 4

The first is from Dale Nassar in Amite, CA. He uses a flasher LED in series with a speaker (Fig. 4) to produce a tone. That tone leaves something to be desired, but it does work. So, Dale came up with a parts count of one small part—except for the speaker, of course.

After suggesting some conventional circuits, Joseph D'Airo of N. Massapequa, NY told of a "no-parts" oscillator. I can't even figure out how to draw a schematic of his non-circuit, but Fig. 5 and the following account should give you the idea.

One speaker contact is grounded. A stiff wire is attached to the speaker frame with the end bent in such a manner that it just contacts the voice-coil lead on the speaker cone. A voltage is applied to that wire.

You have a 50-50 chance of success the first time you wire the "oscillator." If you are lucky, the speaker cone will jump forward and break the contact. Obviously, with no voltage applied, the cone will then fall back and make contact with the wire once again, which will cause it to jump back out. As that happens over and over, a sound will be produced. Adjusting the wire a bit will even allow the sound to be changed somewhat.

If you are not lucky, the cone will jump backward the first time voltage is applied. In that case, contact will not be broken and no vibration—and, consequently, no sound—will be produced. To correct a "wrong-way" cone, all you have to do is reverse the voltage polarity, or reverse the speaker connections.

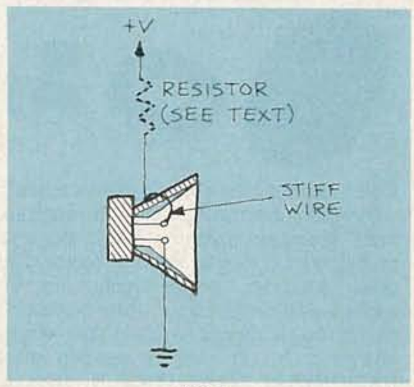

FIG. 5

That is a neat no-parts circuit if the speaker and the voltage are compatible. Fig. 5 shows that you may need to use a series resistor if the voltage is too great for the speaker in order to prevent over-excursion of the cone (or to lower the volume of the sound). With a five-volt supply, start out with a 100-ohm resistor just to play it safe.

Now that's an "oscillator," Joe! Thanks to you, and to everyone who sent in an idea, for sharing your circuits. **R-E**

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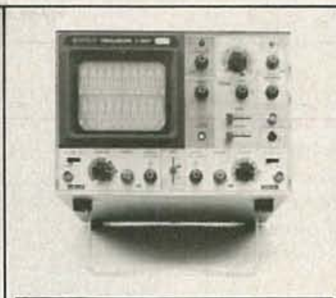

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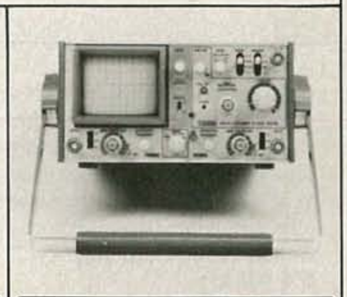

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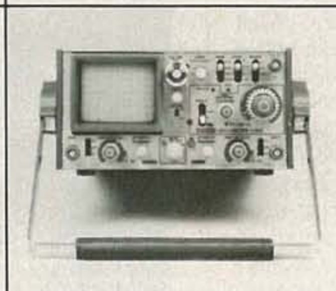

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CIRCLE 25 ON FREE INFORMATION CARD

COMPUTER CORNER

A portable, all-in-one computer

LES SPINDLE*

OF ALL THE PRODUCT DEVELOPMENTS that have shaken up the computer industry in its eventful history, nothing has precipitated as many shock waves as last year's introduction of the *Osborne 1* portable computer (from Osborne Computer Corp., 26500 Corporate Ave., Hayward, CA 94545).

It isn't really the compact size of the machine (shown in Fig. 1) that's so astounding—although that *is* remarkable. It isn't any particular technological innovation, either—the machine features no great breakthrough in that area. What made the industry sit up and take notice (after an initial round of skepticism) was what is offered for the price. Not only does the $1795 computer come with 64K of memory, two disk drives, and a video monitor, but software as well is included!

The brainchild of entrepreneur Adam Osborne quickly caught the attention of an entire industry by offering a product highly competitive with those of the leaders in the field—companies like Apple, IBM, Commodore, and Radio Shack—at a mere fraction of the price you'd expect to pay for such a system. Add to that the added bonus of portability—a great boon to the active businessman—and an overnight phenomenon was born. Over 100,000 Osborne units are expected to have been sold by the end of 1982, with revenues in excess of $100 million. Needless to say, competitors are beginning to rush into the ballpark—with such items as the *Attache* by Otrona (Boulder, CO), the *KayPro II* by Non-Linear Systems (Solano Beach, CA) and the *Courier* by Courier Computer (Anaheim, CA).

How he did it

The questions that the consumer must ask before purchasing such a system are obvious. How does Osborne manage to cut costs so dramatically? Is the product really on a par with an *Apple* or *TRS-80*? Do the advantages of portability result in tradeoffs in performance quality?

Taking the first question, the key to a lot of the price reduction is in the use of standard software, rather than the proprietary programs so often supplied by the major manufacturers. Osborne, long known in the industry for his outspoken—and sometimes vitriolic—opinions, left his writing and publishing endeavors to develop the *Osborne 1* system because he saw an enormous gap in the market just waiting to be filled.

*Managing Editor, *Interface Age* magazine

FIG. 1

The entire small-computer industry was originally founded on the premise of using standard components in order to keep prices down. Only in that manner could the "personal" computer become a reality. Osborne noticed the trend going the opposite way—manfacturers were designing unique operating systems and hardware, moving backward into the trap they supposedly were trying to escape. Software and hardware interfacing were becoming nearly impossible, and each company was becoming an island unto itself. Isolating a corner of the market might result in immediate benefits to a company, but the long-range potential for that strategy was doubtful.

For the consumer, it meant that he was locked into the system he owned and the software that was directly compatible with that equipment. That created severe limitations on the applications to which he could put his computer, and to the peripheral interchanges he could make among other systems that he—or someone else—might own. Osborne's system (which he calls "a stinging indictment of the microcomputer industry") brought standardization back—and enabled him to produce his computers much less expensively.

By working out special negotiations with software manufacturers whereby they provided their popular product lines in exchange for a share of his profits, Osborne was able to offer sophisicated software with a full range of standard business applications. Separate purchase of the software alone would almost equal the $1795 price tag of the complete Osborne system.

As a further cost-cutting measure, the use of strictly standard components for the hardware end eliminated warehousing and inventory costs—not to mention the labor and materials that would have been required to manufacture special parts. The result of all that was a system equal in quality to those produced by the leaders in the field—but at a greatly reduced production-cost. In a ploy similar to Japanese manufacturing strategies, Osborne was able to give his major competitors a genuine run for their money.

A look at the system

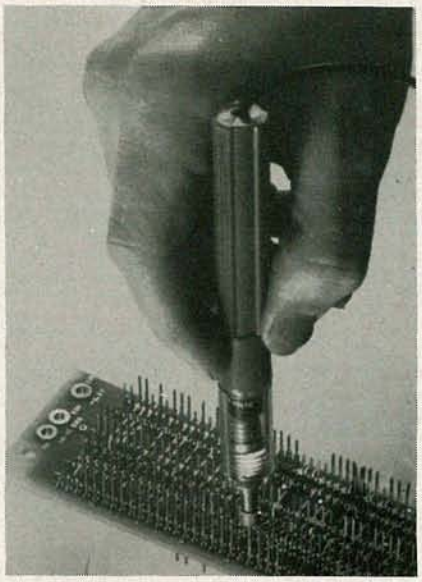
Aside from the attractiveness of its low price, how does the machine rate in performance for serious business applications? Is it cost effective?

continued on page 103

NEW PRODUCTS

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

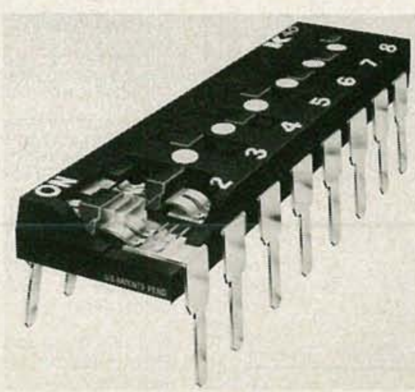
TESTER, the *model 120-113,* is a continuity and voltage tester designed for testing wire-wrap connections. It comes with standard 12-gauge socket connections on each end, which will slip over wire-wrap pins for positive contact without danger of touching adjacent pins and getting incorrect readings.



CIRCLE 141 ON FREE INFORMATION CARD

The *model 120-113* will test for continuity using its own batteries, or will test for the presence of voltages up to 600 volts. It is priced at $23.05.—**Desco Industries, Inc.,** 761 Penarth Avenue, Walnut, CA 91789.

DIP SWITCH, *model K40,* is a miniature 8-position SPST DIP switch that is the same size as a standard IC package, and can be inserted easily into printed-circuit boards. The *model K40* uses bifurcated slide contacts that allow two-point contacts for each switch contact. It is designed for electronic circuitry used in test instruments, computers, computer software, electronic games, appliances, stereo receivers and amplifiers, communications equipment, and other electronic appliances.



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Initial contact resistance is 20 millohms. Current and voltage rating during switching is 100 milliamps maximum at 5-volts DC; during non-switching the rating is 100 milliamps at 50-volts DC. Insulation resistance is 1×10^8 ohms minimum at 100-volts DC (initial). Dielectric withstanding voltage is 500-volts DC minimum. Capacitance is rated at 5 picofarads maximum between adjacent switches.

The *model K40* is priced at 75¢ each in any quantity, C.O.D., with a 24-hour shipping delivery.—**American Research and Engineering,** 1500 Executive Drive, Elgin, IL 60120.

MINI-EXPERIMENTS KITS, the *Edmund Scientifics,* have been designed to teach youngsters the mysteries of science while having fun. Five separate kits comprise the *Edmund Scientifics:* weather, magnets, color, mirrors, and illusions. Each kit includes materials to conduct experiments, a Hall-of-Fame card honoring a scientist in the field, and complete, easy-to-understand instructions.

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The *Edmunds Scientifics* are priced at $9.95 plus postage.—**Edmund Scientific,** 7082 Edscorp Building, 101 East Glouster Pike, Barrington, NJ 08007.

CASSETTE-DECK CLEANER, *model 71300* (shown) and *model 71200* make cassette-deck maintenance a matter of slipping felt cartridges in and out of the cleaning system. The felts clean dirty heads, capstans, or pinch rollers, and are mounted in cartridges that can be replaced in seconds.

The dual gear-driven wiper arm, upon which the head-cleaning felt cartridge is mounted, increases the versatility of the cleaner by assuring uniform cleaning of all types of cassette decks, including those with 3-motor drives and takeup reel sensors; it is suitable for auto-reverse decks, too, because it is equipped with two sets of capstan and pinch-roller cleaning felts.

The *model 71300* includes a ½ oz. bottle of cleaning solution and has a suggested retail

continued on page 102

COMMUNICATIONS CORNER

RTTY and the computer

HERB FRIEDMAN, COMMUNICATIONS EDITOR

THE SAME COMPUTER/MICROPROCESSOR revolution now starting to affect just about every aspect of everyday life has made enormous inroads into the field of communications. It's given us new technologies such as cellular mobile radio, and often breathes new life into old ones.

Generally speaking, after the initial gripes about how "...modern technology takes all the fun out of a hobby," it turns out that microprocessors actually make things more enjoyable by getting rid of the routine drudgery. Amateur RTTY (radioteletype) is a good case in point.

Many years ago, when every city had its "Radio Row" with mountains of surplus equipment, I got hooked on RTTY when someone gave me an old 5-level Baudot (pronounced "baw-dough") code teletypewriter (TTY). With surplus parts I built the TU (transmission unit), a device that converted the received audio-tones to electrical impulses for my TTY's printer, and also worked the other way by converting the electrical impulses from the TTY keyboard to audio tones for transmission.

It was a lot of fun to build and experiment with, but I really hated RTTY operation because the Baudot system made RTTY a nightmare unless signals were 40 dB over S9.

Another problem with Baudot was the fact that it was a 5-level (or 5-bit, if you translate it into computer terms) code. Such a code can generate only 32 possible combinations, yet there are 26 characters in the alphabet—plus ten digits (0 to 9) and punctuation marks. Obviously, a 5-bit code could not transmit all the required characters. So the Baudot code included LETTERS and FIGURES codes which selected one of two character sets. If a LETTERS code was received every character that followed represented a letter. If a FIGURES code was received every character that followed represented a numeral or punctuation mark. That meant that throughout a transmission the operator constantly had to shift back and forth between character sets. The easy way out was simply to spell all numerals whenever possible.

But there was the problem of interference from QRM and QRN. If it struck when a LETTERS or FIGURES code was transmitted, it was more than likely that the receiving station's equipment wouldn't shift to the new character set. More often than not I was asking for repeats, or trying to decode a jumble of gobbledygook. Eventually, I packed away the RTTY gear and left the field to others.

Enter ASCII

But one day—a couple of years ago—the FCC decided to join the 20th century and authorized ASCII for amateur RTTY. ASCII—the *A*merican *S*tandard *C*ode for *I*nformation *I*nterchange; to pronounce, rhyme with "pass key"—is an 8-level (or 8-bit) code. It uses seven levels or bits for characters and one for parity, parity being an error-check that lets us know that a received signal has a reasonable chance of being what was actually sent. The 7-bit signal provides for 128 characters, which include upper and lower case alphabets, numerals, punctuation, and 32 non-printing control codes such as those for carraige return, bell, formfeed, tabs, etc. ASCII even provides special codes that can shift in and out of character sets other than English.

Best of all, since each ASCII code represents a specific character or punctuation mark, losing a character or two doesn't destroy everything that follows because there's no character-set shift.

As with Baudot equipment, in addition to the transmitter, receiver and TTY, all that's needed for ASCII-type RTTY is the TU.

ASCII made RTTY fun again, at least for me, but it took a long time. The model 33 surplus TTY I was using could print 110 wpm (*W*ords *P*er *M*inute) at top speed, and since I am a rotten typist who must go back for many corrections (which isn't easy on a TTY), and can't really think while reading copy and trying to compose a reply at the same time, the initial excitement was dissipating rather rapidly.

Enter the computer

Then someone suggested I try using my Heath *H-89* computer with the RTTY Communications Processor Software offered by Heath; it makes the *H89* computer function like an intelligent TTY. The installation wound up configured as shown in Figure 1; the only difference between it and a "standard" RTTY system is that my Heath computer replaces the usual mechanical TTY.

The program is so jam-packed with features that there's room here only for the highlights. Among them is a dual or triple split-screen that I can format any way I like to display the incoming and/or outgoing transmissions. I can save incoming, outgoing, or both on disk, or send them to a printer (which is my old model 33 TTY converted for RS-232 operation with the adaptor described in the Fall 1982 issue of **Special Projects**). At the touch of a single key the program starts transmission with a "diddle," CW

continued on page 112

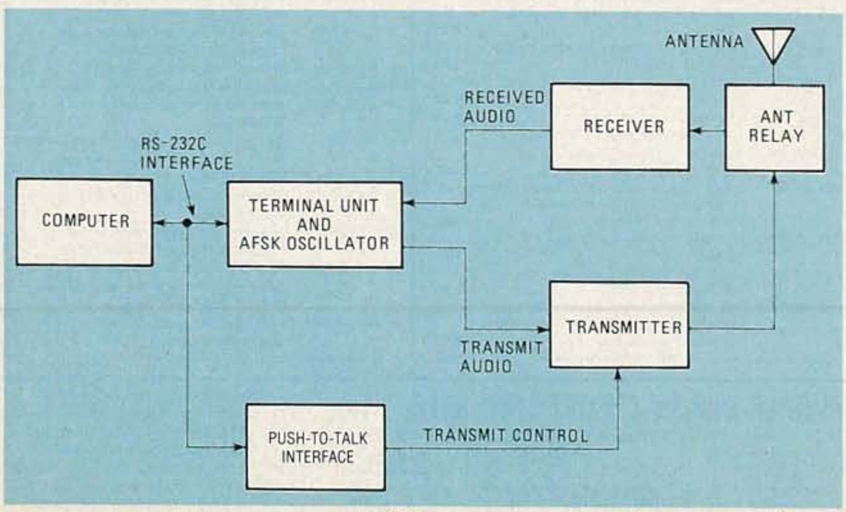
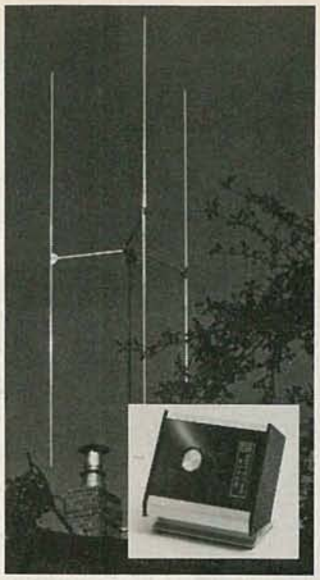


FIG. 1

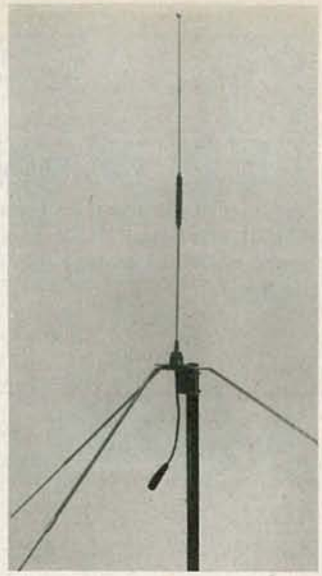
Super Scanner—the Ideal Base Antenna for Sophisticated Emergency Operations

For isolating and pinpointing the origin of emergency or commercial CB communications, there's nothing to compare with The Antenna Specialists' MS119 Super Scanner. This unique antenna is both a superb omnidirectional antenna with tremendous 5.75 dB gain and, with the twist of a knob, a high performance beam exhibiting 8.75 dB gain—like increasing your power seven times. It lets you search with the omni mode, then zero in for maximum range and clarity with the beam mode—all done instantaneously and electronically. The Super Scanner weighs just 17 pounds, is quite simple to assemble and is complete except for standard 50 ohm coax cable.



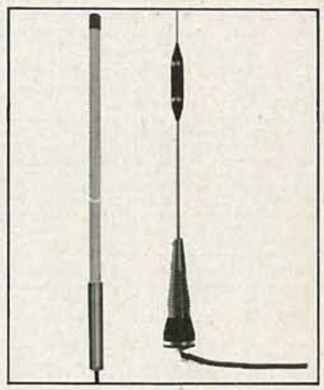
A/S Tri-Band Antenna Helps Get the Most Out of Your Scanner

Many scanner operators, especially those who have a serious purpose for their equipment, have discovered that the built-in whip antenna furnished with the radio simply cannot provide the range necessary to cover all the land mobile stations in their area that might be vitally important to their network. This is especially true in suburban and rural areas, or where portable radios are widely used. The Antenna Specialists Co. offers a wide selection of special antennas for monitor use, both base and mobile. Although some professionals and hobbyists prefer to install separate antennas for VHF and UHF coverage, most find the MONR31 triband model entirely satisfactory and very easy to handle and install. This unit is a high performance professional grade antenna that covers not only low band, high band and UHF but the "T" band as well, through 512MHz. Both the whip and 65" radials are finest stainless steel construction, and the slim, durable phasing coil is weatherproof. It comes complete with SO-239 receptacle (coax cable not furnished).



A/S Professional Antennas Just the Ticket for GMRS Applications

If you're into GMRS, you'll be interested in two models from The Antenna Specialists Company's extensive line of professional land mobile antennas that are especially suitable for typical



GMRS applications. The ASP-705 Super Base Commander® is a high performance UHF collinear fiber glass unit exhibiting a minimum of 10 dB gain (RS329) and accomodating 250 Watts RF power (500 Watts with optional pigtail). Bandwith is 20 MHz (450-470 MHz). The antenna is wind rated at 128 MPH with a safety factor of 1.65. For mobile applications series ASPR660 is recommended for high performance, low profile configuration and lots of mounting options including roof, trunk lip, magnetic and cowl. Two precisely phased ⅝ wavelength collinear radiators provide 5 dB gain at the horizon.

NEW PRODUCTS

continued from page 98

price of $9.95. The deluxe *model 71200* includes a 1 oz. bottle of cleaning solution, spare felt cartridges and tweezers, and a storage case. Its suggested retail price is $16.95.—**ALLSOP, Inc.**, PO Box 23, Bellingham, WA 98227.

CIRCLE 144 ON FREE INFORMATION CARD

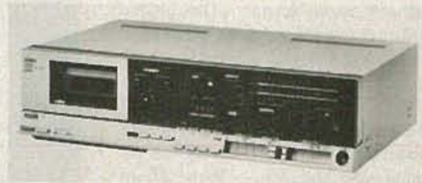
EMERGENCY RADIO Midland *model 77-810,* known as the "Ready Rescue," is a two-way 40-channel radio with 4-watt output power, and a helical antenna that can be attached directly to the unit or mounted on a magnetic base for car rooftops.

Other features include a push-to-talk bar for one-hand operation; on/off volume; squelch control, and an 8-foot cord for the cigarette lighter power adaptor.

CIRCLE 145 ON FREE INFORMATION CARD

The Midland *model 77-810* "Ready Rescue" emergency radio has a suggested retail price of $99.95. There is also a lightweight battery pack, compatible only with the "Ready Rescue", to provide an alternate power source to the dashboard cigarette lighter; that has a suggested retail price of $20.00.—**Midland International Corp.**, 1690 N. Topping, Kansas City, MO 64120.

STEREO CASSETTE DECK, *model AD-3800* has a 3-head logic control, at the heart of which is the microprocessor-controlled *D*igital *A*utomatic *T*ape *A*daptation (DATA) logic system. DATA automatically checks playback output, adjusts bias level, sensitivity, and equalization to extend frequency response, obtain optimum noise-reduction performance, and enhance high-range reproduction—within 16 seconds. It can retain the same setting, if desired, for up to 24 hours.



CIRCLE 146 ON FREE INFORMATION CARD

Additional features include a multi-operational digital electronic display for standard or real-time tape-position indication, memory function, IC logic controls with cue/review operation, switchable MPX filter, auto repeat, timer-standby facility, and three-color 16 LED per-channel peak-level display with peak-hold mechanism. S/N ratio is 75 dB with *Dolby C* on, and frequency response measures 20-20,000 Hz on metal and ferrichrome tapes.

The *model AD-3800* has a suggested retail price of $595.00.—**AIWA America,** 35 Oxford Drive, Moonachie, NJ 07074.

DESOLDERING AID, the WIGAPRY *model WP286,* is a combination lead wiggler and miniature prybar. There is a small hole in the tapered end which enables the tool to be placed directly over a desoldered component lead. With a little gentle wiggling, the lead is free. The other end is shaped like a prybar for leverage, with a small axial slot for lead straightening. The WIGAPRY *model WP286* is priced at $2.95.—**Edsyn, Inc.,** 15958 Arminta Street, Van Nuys, CA 91406.

CIRCLE 147 ON FREE INFORMATION CARD

continued on page 107

COMPUTER CORNER

continued from page 96

One limitation is its lack of graphics capabilities, which are black-and-white only, and provide relatively low-level resolution. There is no provision for sound. The tiny five-inch screen may prove difficult for some people with less-than-perfect eyesight. (A separate 12-inch monitor is available as an extra-cost option, but that cuts down on the portability of the computer, which incidentally, weighs just 23 pounds.)

The computer screen displays 52 characters by 24 lines. Horizontal scrolling is provided for lines that exceed 52 characters. That should be adequate for most word-processing applications.

Disk storage may present limitations for more demanding applications. There is space for only two 5¼-inch disk drives. However, a recently introduced upgrade kit priced at $185 will allow them to be upgraded to double density.

The standard system includes 64K of RAM, a Z80 microprocessor, and the two single-sided, single-density 5¼-inch disk drives capable of storing of 100K each—all in a carrying case with a handle. A hard-disk system can be added using the built-in IEEE-488 bus. Also available are an RS-232C serial port for a printer and a modem slot. A separate battery pack good for five hours of operation can also be added.

Software

The software supplied with the system is what really makes the *Osborne 1* useful as a business tool. The CP/M 2.2 operating system gives the user access to an enormous software library, while the *MBASIC5* and *CBASIC2* languages make custom programming easy. The *SuperCalc* program allows you to prepare financial forecasts and budgets, while the *WordStar* word processor, together with the *MailMerge* mailing-list option, provide further potential.

The *Attache* system by Otrona offers many similar capabilities, although there is a wider range of features, including sound capability and greater disk-capacity. The price is nearly double that of the *Osborne 1*, at $3995.

The *Courier*, with a larger (nine-inch) display, detachable *Selectric*-type keyboard, 64K of memory, and options for a third disk-drive, also sells for $3995.

Competitive in price to the Osborne system is the *KayPro II*, which sells for $1795. It includes a nine-inch display, several business-software packages, the CP/M operating system and a Z80 CPU.

As the competition heats up in the coming months, more and more offerings in the portable category are almost certain to be introduced. R-E

CORDLESS TELEPHONES

continued from page 42

base to call the handset, the *Pacer 9800* allows the handset to call the base as well. A *Pacer 9800D*, which adds a nine-phone-number memory is also available. All *Pacer* phones have a maximum range of 1000 feet.

Radio Shack

Radio Shack currently offers three different cordless phone models: the *ET-300*, their top-of-the-line extended range answer/originate model; the *ET-310*, an answer-only model that is similar to the *ET-300*, and the *ET-350*, a short range answer/originate unit.

Radio Shack claims that their model *ET-300* has a 500-foot operating range. The handset is equipped with a telescopic antenna (an interesting feature of that antenna is that it is connected to an internal switch that will allow the remote to turn on only when the antenna is fully extended), a volume switch, and a pushbutton keypad. That model also has an auto-redial feature—but, as with all other Radio Shack cordless phones, no security feature. The model *ET-310* is similar to the *ET-300*, but it is an answer-only model. Also, the claimed range for this unit is slightly larger—up to 600 feet.

The model *ET-350* is an answer/originate unit with a range of 50 feet. As this unit is intended primarily for indoor use, giving the user more freedom than a cord telephone, the keypad here is *base* mounted. Like the *ET-300*, this model features auto-redial and pulse dialing.

Universal

Universal Security Instruments offers two cordless phones, the *Tote and Talk* (also known as the *TEL-3000*), and the *Talkabout*. The *Talkabout* is an answer/originate model and has a range of about 100 feet. The handset has a spring-loaded switch that automatically switches the phone from "talk" to "standby" mode whenever the handset is placed face down on a flat surface. The pushbutton keypad in that model is housed in the base rather than the handset.

The *TEL-3000* has a handset-mounted keypad and a claimed maximum range of 700 feet. Both Universal models have a built in recharger in the base unit and feature auto-redial.

Webcor

Webcor has four models in its "Zip" cordless-phone line. Their answer-only model, the *525*, has a claimed range of 500 feet. The model *777* is a low range (100 foot) answer/originate unit that features FM duplex-operation and auto-redial. Climbing up the ladder we find the model *555*, with a range of 400 feet.

continued on page 106

NEW BOOKS

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

FUNDAMENTALS OF TELEVISION SERVICING, By Joel Goldberg. Prenctice-Hall, Inc., Englewood Cliffs, NJ 07632. 276 pages including appendix and index; 7⅛ × 9½ inches; hardcover; $18.95.

The successful service technician has to have several qualifications. Those include a basic knowledge of electronics, of how to use electronic test equipment, and of how television sets function. It is assumed that persons using this book have a good foundation in basic electronics theory.

The book is divided into four major sections. The first section describes how television information is transmitted; the second section relates to how that information is processed in a receiver; the third section is devoted to the use of test equipment, and the final section explains how each block, or section, of a set functions. The material is developed using IC technology, and the methods of diagnosis and repair are based on that type of system. The book is illustrated with photos, diagrams, and charts.

CIRCLE 111 ON FREE INFORMATION CARD

THE COMPLETE GUIDE TO CAR AUDIO, by Martin Clifford. Howard W. Sams & Co., Inc., 4300 W. 62nd Street, Indianapolis, IN 46268. 232 pages including glossary and index; 5¼ × 8½ inches; softcover; $9.95.

While cars have been equipped with radios for many years, the trouble has always been that the automobile was never designed for audio. There are vibration problems, space problems, temperature problems, and electrical interference—as well as environmental noises and other considerations. However, most of those difficulties have been overcome and modern car-audio systems are capable of delivering high-quality sound.

Here is a complete guide to car audio. The reader will learn about the various components available and how to plan a system that meets his or her desires. You will learn how to read and interpret specs, compare various units, and become familiar with the special language of auto sound. There is also information on installation, noise suppression, and protection from theft. **R-E**

CIRCLE 112 ON FREE INFORMATION CARD

CORDLESS TELEPHONES

continued from page 104

Featurewise, it's identical to the *777*. That model features the popular walkie-talkie-type styling.

Webcor's top-of-the-line model *575* has a claimed range of 700 feet. Like their other answer/originate models, it too has auto-redial. In addition, it has a security switch that prevents someone else in your area from using your base, or your phone line. The phone not only features a call button on both the handset and base unit, but comes with true intercom capability, allowing communications between the base and handset, even when the base is disconnected from the phone line. All Webcor phones use pulse dialing.

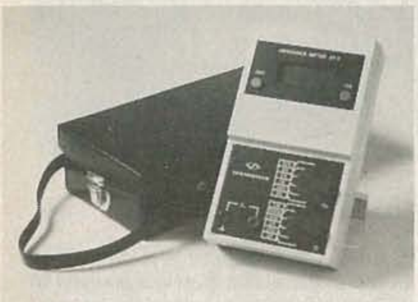
Finding the right phone

Today, cordless phones are available with a wide range of features, and at a wide range of prices. To help you find the right one for you, we've provided a summary of the models we've discussed in this article in Table 1; Table 2 gives the names and addresses of the manufacturers. When picking a unit, be sure that you don't overlook such things as styling, simplicity of operation, and durability. The best way to find which model is right for you is to see and try as many of them as you can. **R-E**

NEW PRODUCTS

For more details use free information card inside back cover.

IMPEDANCE TESTER, *model ZP-3,* can be switched to any of six test frequencies, thus giving a good overall view of the impedance ratios. An easy-to-read digital LCD display



CIRCLE 131 ON FREE INFORMATION CARD

and a six-stage subdivision of the measuring range between 19.99 ohms and 1.999 megohms, always guarantees an accurate readout of the measured impedance. The margin of error never exceeds 5%. The load on the object to be measured in each of the six testing ranges is very slight. After approximately three minutes, the unit automatically switches itself off, thus saving battery power. Should the battery voltage drop below a certain threshold, the readout displays the warning LOBAT. The *model ZP-3* comes with a leather carrying case and test leads, and includes a built-in retractable stand. It is priced at $530.00.—**Sennheiser Electronic Corporation,** 10 West 37th Street, New York, NY 10018.

ANSWERING SYSTEM, the *DuoFone TAD-150,* is a computer-controlled phone-answering system, complete with remote control. The microprocessor-controlled answerer features dual-cassette operation with dual outgoing messages. Its front-panel fluorescent display shows the message number, plus the date and time that each mes-

CIRCLE 132 ON FREE INFORMATION CARD

sage was received. Voice-actuated circuitry records callers for up to five minutes, without gaps, and a cue feature permits easy location of messages for convenient playback.

There is full-function digital remote control, permitting command of most of the system functions from any phone; a four-digit "security code" assures complete privacy for remote-control operation.

The *DuoFone TAD-150* features a built-in digital clock, all-electronic feather-touch controls, LED indicators, instant or delayed answer, and built-in electret mike for recording announcements, dictation, and even two-way phone conversations. It measures 4¼ × 12 × 9¼ inches and requires a 9-volt battery (not included) for memory protection. The compact remote measures 6 × 2¼ × ¾ inches, and requires four "AAA" alkaline batteries (not included).

The *DuoFone TAD-150* is priced at $299.95.—**Tandy Corporation/Radio Shack,** 1800 One Tandy Center, Fort Worth, TX 76102.

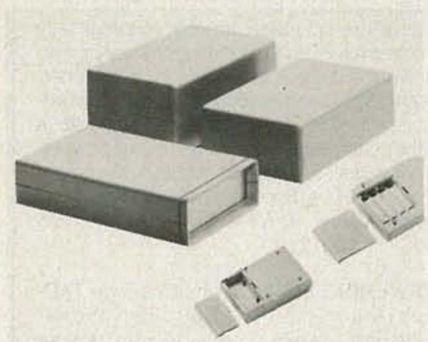
ALARM, *model 702*, the "Lawman", is a powerful vehicle burglar alarm. The underhood-mounted siren produces an ear-piercing 18 watts of power, attracting attention at distances never before possible. The sound is produced in an all-metal housing with its self-contained oscillator and amplifier producing European high-low sound. The electronics and case are protected against

CIRCLE 133 ON FREE INFORMATION CARD

weather and adverse environmental locations. A fully adjustable, sturdy mounting bracket makes for an easy installation in all vehicles. Its electronics sense the unauthorized opening of any compartment or door, setting off the thief-chaser alarm.

The *model 702* "Lawman" is priced at $99.95.—**Wolo Manufacturing Corp.,** One Saxwood St., Deer Park, NY 11729.

ELECTRONIC ENCLOSURES, *Euro Cases*, are precision-engineered, made of high-impact polystyrene, with or without built-in battery compartments. The enclosures feature precise tongue and groove design for instant, maximum-security sealing. Among the many available options are closed or open ends, handles, vent openings, speaker

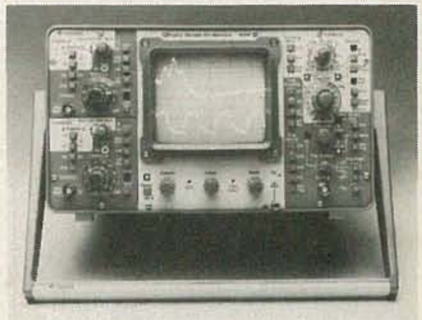


CIRCLE 134 ON FREE INFORMATION CARD

grills, aluminum top plates, and sloping calculator designs.

Extra-large enclosures in the 10-, 15-, and 19-inch sizes are now being made available for the first time. Prices for these new *Euro Cases* are $16.80 each for the 10-inch case; $20.40 each for the 15-inch case, and $24.00 each for the 19-inch case. (Smaller cases, with or without battery compartments, range in price from $3.10 to $8.10 each.)—**European American Industries,** 540 Frontage Rd., Suite 230, Northfield, IL 60093.

DIGITAL STORAGE OSCILLOSCOPE, *model DSO4200*, is a portable, dual-trace DSO that offers maximum sensitivity of 100 μV/cm; high vertical and horizontal resolution



CIRCLE 135 ON FREE INFORMATION CARD

(0.1% and 0.025% respectively) via a 10-bit × 4K store; the ability to select portions of stored waveforms in overlapping 1K segments, and expand them up to × 10 vertically and × 50 horizontally for detailed examination, and a dual-slope trigger window, permitting triggering on signals crossing either a positive or negative threshold. The *model DSO4200* is particularly designed for applica-

CIRCLE 55 ON FREE INFORMATION CARD

tions such as vibration analysis, stress measurement, biophysical engineering, and analytical chemistry.

It is compact (7 × 12¼ × 16½ inches), lightweight (22 lbs.), and can function as a stand-alone bench or portable field-test instrument. An option allows production of low-cost analog plots of stored waveforms on oscillographic or X-Y recorders. Digital outputs are also provided, for direct interfacing with the I/O port of a microcomputer or data-handling system. With an additional IEEE-488 interface option, the scope can be controlled from an intelligent terminal.

The *model DSO4200* is priced at $4700.00.—**Gould, Inc.,** Instruments Division, 35129 Curtis Boulevard, Eastlake, OH 44094.

DMM, *model 3400, Type 2,* is a hand-size, 3½ digit, 24-range digital multimeter featuring basic DC accuracy to 0.15%; AC/DC voltage measurement to 1000 volts; 500-hour battery life, and improved overload protection on all volt and ohm ranges to 1000 volts without fuse blow, plus protection to 600 volts on all current ranges. Additional features include auto-zeroing, auto-polarity, auto-low battery and auto-overrange indication, and both high and low-power ohms.

Like its predecessor, the *model 3400,* the *model 3400, Type 2* is designed for field service, production and maintenance work, vocational training schools, television and communications repair, as well as many other applications.

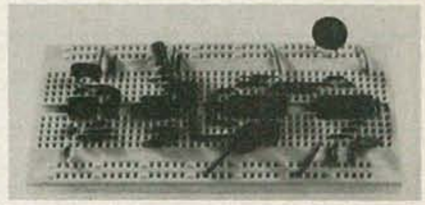
The *model 3400, Type 2* has a ½-inch LCD (Liquid Crystal Display) providing 3 readings per second at a full range of 1999 counts and an easy-to-use single-dial type range and function selector. Its ON/OFF switch is also part of the switch range. Overrange indication is

CIRCLE 136 ON FREE INFORMATION CARD

shown to the user by the DMM's display going completely blank except for the ½ digit. Polarity is displayed during the overrange condition. Three readings per second is the reading rate for the test instrument. A 2-amp 600-volt fuse is provided in the unit for current ranges. Input impedance on all ranges is 10 megohms.

The *model 3400, Type 2* is priced at $125.00.—**Triplett Corporation,** One Triplett Drive, Bluffton, OH 45817.

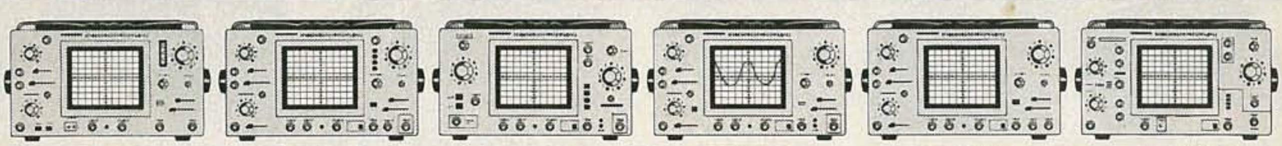
CIRCUIT STRIP, *P/N 923253,* combines the plug-in ease of a 0.1-inch × 0.1-inch solderless tie-point matrix with the convenience of distribution buses for power, ground, and signal lines. Its features include a molded alphanumeric grid for faster and easier identification of every tie-point in a circuit.


CIRCLE 137 ON FREE INFORMATION CARD

As with all other solderless breadboarding units from this manufacturer, components simply plug in, and are connected with ordinary solid hook-up wire. All sizes of DIP's and discrete components with lead diameters up to .032 can be accommodated. The four separate distribution buses of 35 tie-points each can be used for power, ground, clock lines, reset commands, and more.

There are 610 plug-in tie-points in each Circuit-Strip, with a capacity of up to six 14-pin DIP's. They may be mounted permanently with the integral non-shorting, instant-mounting backing. For quick removal, they may be mounted with screws on panels up to ⅛ inch thick. Hardware and mounting templates are provided with every strip.

Circuit-Strip (*P/N 923253*) is priced at $14.00.—**A P Products Incorporated,** 9450 Pineneedle Drive, PO Box 603, Mentor, OH 44060. R-E



NEW LIT.

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

ELECTRONICS CATALOG is 128 pages, letter-size, and offers over 10,000 items stocked in depth. Included are potentiometers, capacitors, resistors, transformers, lamps, switches, battery holders, jacks, plugs, speakers, knobs, fuses, semiconductors, hardware, tools, test equipment, relays, cabinets, meters, and much more. The catalog is available free from **Mouser Electronics,** 11433 Woodside Avenue, Santee, CA 92071.

CIRCLE 121 ON FREE INFORMATION CARD

ENGINEERING MONOGRAPH, *Theory and Operation of the Crown* Multi-Mode *Circuit,* is 13 letter-size pages, plus a sheet of diagrams, explaining how the *Multi-Mode* circuit functions and the effect it has in maintaining signal quality essentially unchanged from input to output. The circuit design is used currently in Crown power amplifier *models PS-200* and *PS-400* for professional sound markets, and in *models PL2* and *PL3* for home audio.

The brochure is available free from *Multi-Mode*, Advertising Department, **Crown International, Inc.,** 1718 W. Mishawaka Road, Elkhart, IN 46517.

CIRCLE 122 ON FREE INFORMATION CARD

MAIL-ORDER CATALOG is 55 pages, letter size, and lists electronics components, test equipment, books, etc. of interest both to engineers and technicians in the industry and to hobbyists. Items of particular interest include a DTMF receiver IC, a 10-amp adjustable regulator, and remote-control transmitters/receivers. Free upon request from **Tri-Tek, Inc.,** 7808 North 27th Avenue, Phoenix, AZ 85021.

CIRCLE 123 ON FREE INFORMATION CARD

RESISTOR CATALOG, *Short Form Catalog SF400C*, is a newly-revised, 8-page 4-color general catalog that simplifies the selection of precision resistors for individual applications.

Specifications of hermetically sealed precision resistors, as well as technical data on hermetically sealed miniature networks for hybrid manufacturing, power resistors, axial-lead resistors, and trimmed potentiometers are provided. Resistance, tolerance, power, TCR, and dimension specifications can readily be matched with particular applications from easy-to-read tables.

The *Short Form Catalog SF400C* is free upon request from Vishay Resistive Systems Group of **Vishay Intertechnology, Inc.,** 63 Lincoln Highway, Malvern, PA 19355.

CIRCLE 124 ON FREE INFORMATION CARD

RADIO SYSTEMS CATALOG, is 16 pages, illustrated, and contains descriptions of over 20 build-it-yourself kits. Several different audio panels are included, as well as 2- and 4-station aircraft intercoms, marker beacon receivers, a 6-channel communications transcriver, and unicom stations. Headsets, radio antennas, and several of the kits may also be purchased fully assembled.

The catalog is free upon request, and can be obtained by writing to **Radio Systems Technology, Inc.,** Airport Industrial Park, Grass Valley, CA 95945. **R-E**

CIRCLE 125 ON FREE INFORMATION CARD

COMMUNICATIONS CORNER

continued from page 100

identification, time and date. Another key then transmits the calls and a personal identification from a preloaded buffer. A third key sends the message I composed on the screen—with all the errors corrected electronically (I can also transmit in real time, errors and all), and a fourth one sends the ending transmission, terminating with the usual NNNN.

If I want to dress up the basic communications system, an external file can be called up from a disk or tape for transmission. I can preload up to three programmed messages, initiate a local WRU (Who Are You) at the touch of a single key, single-key control a CQ string and...well, just about any of the drudgery can be eliminated by the computer. Essentially, the computer takes care of a lot of what we used to do when we had to prepare messages on punched tape, only now we don't have all of those little specks of yellow paper from the punch holes all over the floor.

My only complaint with computerized RTTY is that the software seems to have some sort of automatic slow transmission when the buffer is almost empty. There's an explanation for it in the documentation but it doesn't quite make sense to me. In any event, although it sometimes gets somewhat irritating to watch the letters crawl onto the screen, that's a relatively small price to pay for having the fun put back in RTTY. **R-E**

PICTURE PHONE

continued from page 50

replacing that IC. You may solve your problem as easily as that.

If you find that you have vertical "barber pole" stripes breaking up the picture that is stored in memory, check IC66, the 3245 memory driver; one of its sections may be bad. And, finally, if you find that a picture stored in memory starts to develop "freckles"—dark or bright pixels appearing one by one until the overall quality of the picture starts to deteriorate, try substituting standard 74157's in place of the "LS" versions for IC's 5, 21, 37, and 53.

That covers only a few of the many things that may keep your Picture Phone from working the first time you apply power, but, if you persevere, you'll locate the problem area(s) and wind up with a first-class device.

Setup

Figure 22 shows how the Picture Phone is to be connected to its associated equipment. Remember that the video output of the unit is intended for use with a monitor; if you use a TV receiver you'll need an RF modulator—those are readily available from most computer stores, or by mail from a number of advertisers in **Radio-Electronics.**

The most imporant factor in transmitting a good picture is good lighting; avoid hot spots and deep shadows. Try not to use a very light or very dark background—such a background may confuse the TV camera's ALC (*A*utomatic *L*ight *C*ontrol).

You can put the MODE switch in the CAMERA position to compose your picture, watching it on the monitor. The front panel BRIGHTNESS and CONTRAST controls will help give you the best-balanced image. To see what you will be transmitting, grab a frame from the camera and switch to the TRANSMIT or HOLD mode (you can grab a frame while in TRANSMIT).

Use

To use the Picture Phone, first place the phone call as you normally would to the other party. The Picture Phone can be on or off at this time, although you'll probably want it on so you can set up your pictures while you're talking. The until will come up in the VOICE mode when you apply power.

When you're ready to transmit slow-scan, grab a frame and inform the party at the other end of the line that you're ready to send video. Then turn the MODE switch to TRANSMIT and push the PICTURE button. That will disconnect the telephone handset from the line and connect in its place the output of the Picture Phone (you don't want your speech mixing with the slow-scan audio).

Every eight seconds you'll see the picture on your video display blink. That indicates that a frame has been completed. If you're in the MANUAL mode, the same frame will be repeated; if you're in the AUTOMATIC mode a new frame will be grabbed. The best time to switch back to VOICE mode is immediately after the finish of a frame. It's good practice to send more than one frame of each picture. Two are good; three may be better under some conditions.

When it's time for you to be on the receiving end, the other party will, of course, inform you that he or she is about to transmit video. Set the MODE switch to RECEIVE and press the PICTURE button. The slow-scan image will start forming from top to bottom, and will be complete in eight seconds. If you want to study a picture at leisure, use the HOLD position. If you do that, any further incoming video will be ignored, and you will be able to watch the same frame for as long as you like.

It may take a little practice to get the hang of using the Picture Phone, but, once you do, your personal and business telephone conversations will become tremendously richer. **R-E**

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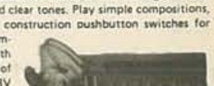

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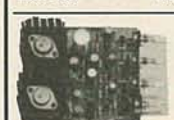

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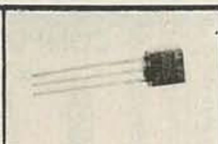

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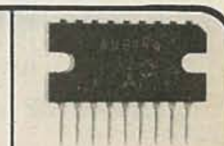

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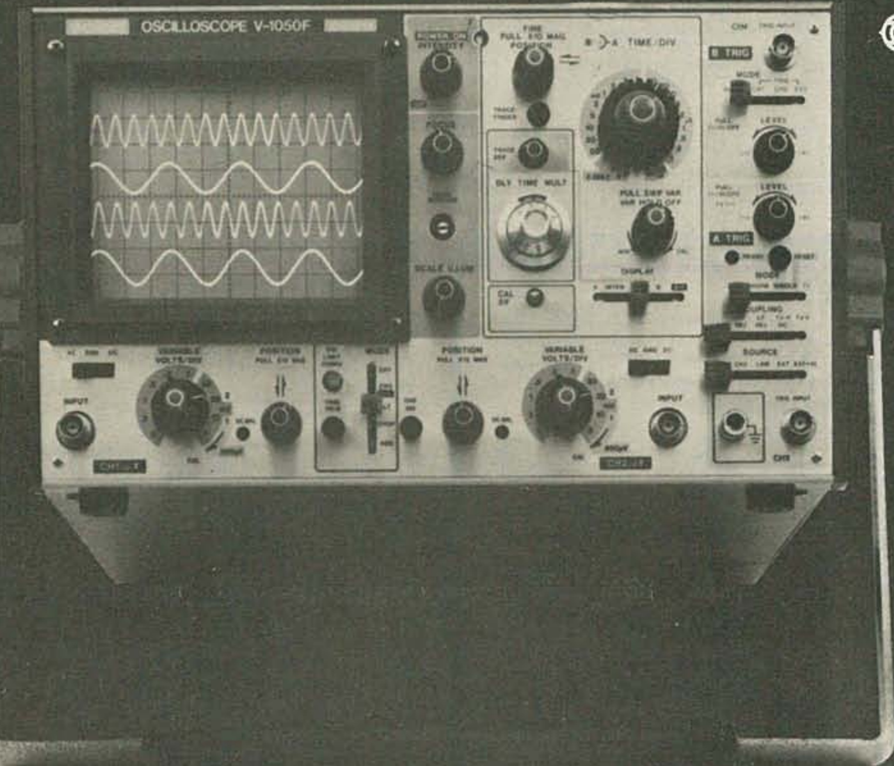

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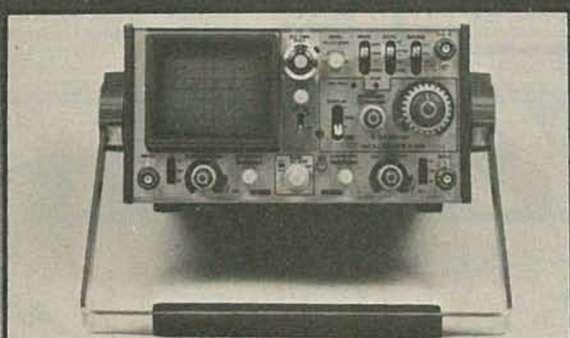

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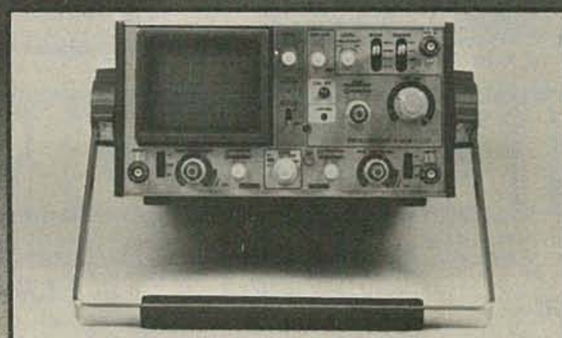

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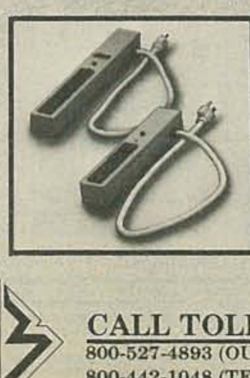

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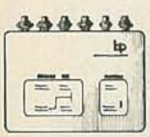

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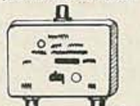

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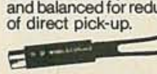

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74LS10N	.24	74LS90N	.42	74LS160N	.67	74LS243N	.99	74LS373N	1.09
74LS11N	.28	74LS92N	.50	74LS161N	.67	74LS244N	.99	74LS374N	1.15
74LS12N	.25	74LS93N	.50	74LS163N	.69	74LS245N	1.25	74LS375N	.60
74LS13N	.36	74LS96N	.69	74LS164N	.58	74LS251N	.55	74LS377N	1.25
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4002	.26	4024	.76	4049	.55	4085	.66	4539	.90
4006	.99	4025	.26	4051	.90	4093	.70	4543	1.65
4009	.46	4026	1.95	4052	.95	4124	3.75	4553	5.53
4011	.26	4027	.60	4053	.95	4510	.99	4556	.75
4012	.25	4028	.75	4060	1.00	4511	.90	4582	.92
4013	.51	4029	.90	4066	.34	4512	.90	4584	.65
4014	.83	4030	.65	4068	.34	4514	1.99	4585	.81
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4019	.65	4041	.90	4073	.26	4526	1.50	74C173	1.60
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2N930	.27	2N5226	.10	MPSA93	.21
2N1613	.36	2N5227	.10	MPS3638	.18
2N1711	.35	2N5400-5401	.19	MPS3638A-5	.18
2N1893	.36	2N5449	.29	MPS3646	.19
2N2102	.35	2N5550-5551	.27	MPS3704	.15
2N2218A	.35	2N5770	.18	MPS5172	.15
2N2219A	.35	2N5771	.32	MPS5551M	.16
2N2221A	.19	2N5830	.39	MPS6513	.15
2N2222A	.25	2N5832-5833	.80	MPS6514	.15
2N2369A	.25	2N5961-5962	.19	MPS6515	.15
2N2484	.27			MPS6516	.15
2N2904A	.32	TIS75	.39	MPS6517	.15
2N2905A	.45	TIS90	.36	MPS6518	.15
2N2906A	.19	TIS91	.28	MPS6519	.15
2N2907A	.25	TIS92	.28	MPS6520	.15
2N3019	.46	TIS93	.28	MPS6521	.15
2N3053	.35	TIS96	.29	MPS6522	.15
2N3054	.67	TIS97	.33		
2N3055	.75	TIS98	.24	PN2222A	.14
2N3702-3711	.12	TIS111	.24	PN2369A	.14
2N3771	1.50			PN2907A	.14
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2N3773	2.25	MPF103	.35	PN3565	.15
2N3819	.43	MPSL01	.14	PN3567	.15
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2N4033	.62	MPSA10	.16	PN3644	.15
2N4036	.65	MPSA12	.21	PN3645	.15
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2N4400-4403	.14	MPSA20	.14	PN4250	.15
2N4410	.16	MPSA42	.24	PN4275	.15
2N4996	.20	MPSA43	.24	PN4888	.15
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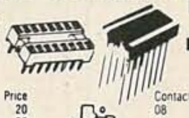

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Contacts	Price	Contacts	Price
08	12	20	20
14	14	22	22
16	16	24	24
18	18	28	28
		40	40

DUAL-IN-LINE WIRE WRAP I.C. SOCKETS

Contacts	Price	Contacts	Price
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14	52	22	88
16	55	24	97
18	57	28	1.19
		40	1.71

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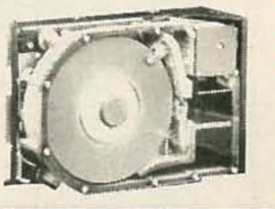

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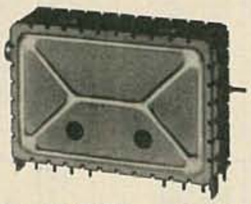

[A] 24.95 **NEW!** [B] 9.95 **NEW!**

[A] **UES-A56F UHF-TV Tuner.** Compact, very sensitive and stable—great for adapter projects, replacement and conversion to 450 MHz ATV band. No moving parts—tuned by 0 to 28VDC control voltage. 75-ohm in/out. 12VDC. With data. **277-220** **24.95**

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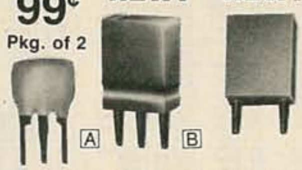

[A] **SFE 10.7MA5-A.** 10.7 MHz FM IF. Ideal for CB-to-10 Meter FM mods. **272-1301** ..... **Pkg. 2/1.99**

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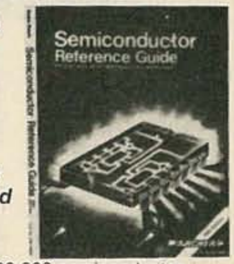

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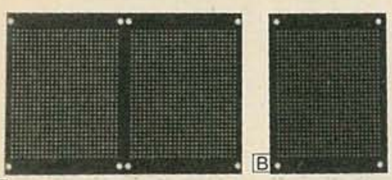
Boards for IC Projects



[A] 2.95 **NEW!** [B] 1.95 **NEW!**

[A] **Two-Section Grid Board.** Each section has 750 contact points, indexed with letters and numbers on both sides—really speeds wiring and reduces errors. .100 × .100 centers for DIP ICs, sockets and headers. **276-161** **2.95**

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[A] **NEW!** 1.59 [B] **NEW!** EMI/RFI Filter 11.95

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[C] **Photoflash Capacitor.** 500 microfarads. Rated 330VDC. **272-1148** **5.95**

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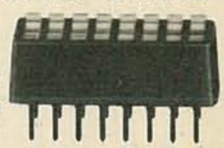

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FULL 8-BIT LATCHED OUTPUT 19-KEY KEYBOARD

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

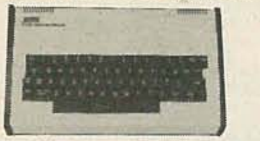
JE600/DTE-HK (After assembled as pictured above) **$99.95**

JE600 Kit 19-Key Hexadec. Keyboard, PC Board & Cmpnts. (no case) .. **$59.95**

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

DTE-HK (case only — 3½"Hx8¼"Wx8¾"D) **$44.95**

JE610 ASCII Encoded Keyboard Kit



The JE610 ASCII Keyboard Kit can be interfaced into most any computer system. The kit comes complete with an industrial grade keyboard switch assembly (62-keys), IC's, sockets, connector, electronic components and a double-sided printed wiring board. The keyboard assembly requires +5V @ 150mA and −12V @ 10 mA for operation. Features: 60 keys generate the 126 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 assembled as pictured above) ...**$124.95**

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NEW! JE212 — Negative 12VDC Adapter Board Kit for JE610 ASCII KEYBOARD KIT Kit/ Provides -12VDC from incoming 5VDC . $9.95

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

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5082-7653	Hi Eff Red	CC - RHD	.99	4/$2.49
5082-7656	Hi Eff Red	Overflow ±1RHD	.99	4/$2.49
5082-7660	Yellow	CA - LHD	.99	4/$2.49
5082-7661	Yellow	CA - RHD	.99	4/$2.49
5082-7663	Yellow	CC - RHD	.99	4/$2.49
5082-7670	Green	CA - LHD	.99	4/$2.49
5082-7671	Green	CA - RHD	.99	4/$2.49
5082-7673	Green	CC - RHD	.99	4/$2.49
5082-7676	Green	Overflow ±1RHD	.99	4/$2.49
5082-7750	Red	CA - LHD	.99	4/$2.49
5082-7751	Red	CA - RHD	.99	4/$2.49
5082-7756	Red	Overflow ±1RHD	.99	4/$2.49
5082-7760	Red	CC - RHD	.99	4/$2.49

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23"Lx5¾"Wx1-3/8"H

MICRO SWITCH 85-KEY KEYBOARD
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Part No. 85SD18-1 . . . . $29.95 each

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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 2¾"H. Wt. 3 lbs.
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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

MULTI-VOLTAGE POWER SUPPLY — +5, +12, −12VDC REG.
Input: 105-125VAC, 47-63Hz / 205-250VAC, 47-63Hz. Output: +5VDC @ 2 amps Adj., 5VDC @ 50mA Fixed, +12VDC @ 1 amp Adj., −12V @ 2 amp adj. Overvoltage protection. Size: 12½"L x 4-7/8"W x 3¾"D.
Part No. RA0250 . . . . $39.95 each

SORENSEN Regulated Power Supplies

SOC 2-6 (Pictured)

Sorensen's open construction (SOC) power supplies are series-regulated solid-state systems, designed to provide reg. DC voltages at 6 levels (2-28 v/range). These units are open-framed on sturdy black anodized aluminum for excellent mounting.

FEATURES: 115/208/230VAC Input @ 50-63Hz. Low Ripple: 1.5mVrms, 5mV P-P maximum. Adjustable current limit. Voltage adjustment control. All schematics and specifications supplied with unit. Series A,B,C,E have three mounting surfaces (Series F, bottom mounting only).

Part No.	Series	Output Voltage Adjustment Range min.	max.	Output Current amps (Adc) @40°C	@50°C	@60°C	Size (Inches)	Weight	Price
SOC 2-6	B	1.9	2.1	6.0	4.5	3.8	5.62 x 4.88 x 2.50	4.3 lbs.	$19.95
SOC 2-25	F	1.9	2.1	25.0	21.5	17.5	16.00 x 4.88 x 4.88	16 lbs.	29.95
SOC 5-18	E	4.25	5.25	18.0	15.0	12.0	14.00 x 4.88 x 2.75	12 lbs.	39.95
SOC 5-25	F	4.25	5.25	25.0	21.5	17.5	16.00 x 4.88 x 4.88	16 lbs.	49.95
SOC 12-11	E	11.4	12.6	11.0	9.2	6.8	14.00 x 4.88 x 1.62	12 lbs.	44.95
SOC 12-15	F	11.4	12.6	15.0	12.75	9.5	16.00 x 4.88 x 4.88	16 lbs.	49.95
SOC 15-5	C	14.25	15.75	5.0	4.2	3.5	7.00 x 4.88 x 3.37	6.6 lbs.	39.95
SOC 15-9.5	E	14.25	15.75	9.5	7.6	5.6	14.00 x 4.88 x 1.62	12 lbs.	44.95
SOC 15-13	F	14.25	15.75	13.0	10.5	8.0	16.00 x 4.88 x 4.88	16 lbs.	49.95
SOC 28-0.8	A	26.6	29.4	0.8	.64	.45	4.00 x 4.88 x 1.62	2 lbs.	24.95

Powertec Sub-Modular DC Power Supplies

220300 (Pictured)

SM Series power supplies include rectifying, filtering, regulating, overload and overvoltage protection functions. You need only connect the sub-module to the appropriate secondary transformer tap and bolt the unit to a heatsink.

REGULATION: LINE; .10% for a change from -10% to +10% input voltage. LOAD; .15% for a 0-100% load change (units below 5V output maintain 5V regulation). OUTPUT RIPPLE: 1mV RMS, 3mV P-P typical, 5mV P-P maximum. INPUT CHARACTERISTICS: Requires low-level AC input. Derate output current 15% for operations at 50Hz.

Part Number	-100 *4.75V to 7.9V	-200 *7.0V to 10.5V	-300 *10.5V to 15.75V	-900 *22.0V to 30.0V	Power Transformer Requirements (Transformers Not Included) Primary	Secondary	Size (Inches)	Wt.	Price
22AA300			0.23A		115-120VAC	17VAC .5A no CT	2.50 x 3.00 x .98	2 oz.	$14.95
22B200		2.2A			115-120VAC	22VAC .3A w/CT	3.00 x 5.75 x 1.18	8 oz.	14.95
22B300			1.7A		115-120VAC	28VAC 2.5A w/CT	2.75 x 5.75 x 1.18	8 oz.	19.95
22C100	6.0A				115-120VAC	16VAC 8A w/CT	2.80 x 7.50 x 1.18	8 oz.	24.95
22C500				2.5A	115-120VAC	48VAC 3A w/CT	2.80 x 7.50 x 1.18	8 oz.	24.95
22D300			6.8A		115-120VAC	28VAC 10A w/CT	3.00 x 7.00 x 3.30	2 lbs.	24.95
22E100	18.00A				115-120VAC	16VAC 24A w/CT	2.90 x 7.00 x 3.30	2 lbs.	29.95

*Voltage Adjustment Range — Current ratings apply over entire voltage range.

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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
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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"	1.95
DJ16-2	924112-24	16	single end	24"	2.19
DJ16-3	924112-36	16	single end	36"	2.49
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"	3.29
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
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

STANDARD DB25 SERIES CABLES

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
DB25P-4	4 feet	1-DB25P	$ 9.95 ea.
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.

$10.00 Minimum Order — U.S. Funds Only
California Residents Add 6½% Sales Tax
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PHONE ORDERS WELCOME — (415) 592-8097

11/82

5¼" Mini-Floppy Disc Drive

Pertec Computer Corp.

FOR TRS-80 MODEL I (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

EXPAND YOUR TRS-80

to 16K, 32K, or 48K

**Model 1 = From 4K to 16K Requires (1) One Kit
Model 3 = From 4K to 48K Requires (3) Three Kits
Color = From 4K to 16K Requires (1) One Kit

**Model 1 equipped with Expansion Board up to 48K Two Kits Required
— One Kit Required for each 16K of Expansion —

TRS-80 16K Conversion Kit

Kit comes complete with 8 each MM5290 (UPD416/4116) 16K Dynamic RAM (*ns) and documentation for conversion.

TRS-16K2 *150ns $14.95
TRS-16K3 *200ns $12.95
TRS-16K4 *250ns $10.95

TRS-80 Color 32K or 64K Conversion Kit

Kit comes complete with 8 ea. 4164-2 (200ns). 64K Dyn. RAMs & conversion documentation. Converts TRS-80 color computers from 4K-32K Memory or 16K-64K Memory.

TRS-64K2 (200ns) $54.95

Universal Computer Keyboard Enclosure

"DTE" Blank Desk-Top Enclosures are designed for easy modification. High strength epoxy molded end pieces in mocha brown finish. Sliding rear/bottom panel for service/component access. Top/bott. panels .080" thick alum. alodine type 1200 finish (gold tint color) for best paint adhesion after modification. Vented top & bottom panels for cooling efficiency.

DTE-20 Panel width 20" **$39.95**

Sprite-style 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

Metal Frame

PWS2107U Cleaned & tested (used) . . . . $ 9.95 ea.
*PWS2107F New . . . . $14.95 ea.

Muffin-style Fan

- 105cfm free air delivery
- 4.68" sq. x 1.50" depth.
- 10 yrs. cont. duty at 20°C
- Impedance protected, ambients to 70°C
- 115V 50/60Hz 14W Wt. 17 oz.

Metal Frame

MU2A1-U Cleaned & tested (used) . . . . . . $9.95 ea.
*MU2A-1N New . . . . $14.95 ea.

JOYSTICKS

JS-5K (Pictured)

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

UV-EPROM Eraser

8 Chips — 51 Minutes

1 Chip — 37 Minutes

Erases 2708, 2716, 2732, 2764, 2516, 2532, 2564. Erases up to 8 chips within 51 minutes (1 chip in 37 minutes). Maintains constant exposure distance of one inch. Special conductive foam liner eliminates static build-up. Built-in safety lock to prevent UV exposure. Compact — only 9.00" x 3.70" x 2.60". Complete with holding tray for 8 chips.

UVS-11EL Replacement Bulb $16.95

DE-4 UV-EPROM Eraser $79.95

Wall Transformers AC and DC Types

AC250 (Pictured)

Part No.	Input	Output	Price
AC 250 (above)	117V/60Hz	12VAC 250mA	$3.95
AC 500	117V/60Hz	12VAC 500mA	$4.95
AC1000	117V/60Hz	12VAC 1 amp	$5.95
AC1700	117V/60Hz	9VAC 1.7 amp	$3.95
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	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

Siemens 8" Floppy Disk Drive

- Single-Sided
- 77 Tracks
- 400/800K Bytes Capacity
- Industry Standard

The **FDD100-8 8" Floppy Disk Drive** (Industry Standard) features single or double density. Recording mode: FM single, MFM double density. Transfer rate: 250K bits/sec. single density; 500K bits/sec. double density. The FDD100-8 is designed to work with the single-sided soft sectored IBM Diskette I, or equivalent disk cartridge. A hard-sectored option is available. Power: 115/230VAC @ 50-60Hz, +24VDC @ 1.7 amps max., +5VDC @ 1.2 amps max. Unit as pictured above (does not include case, power supply, or cables). Size: 8.55"W x 14"L x 4.5"H. Weighs 12 lbs.

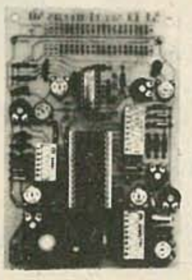
Part No.		Price
FDD100-8	Buy 1 for	$299.95 each
FDD100-8	Buy 2 for	$279.95 each
FDD100-8	*Buy 10 for*	*$249.95 each*

CIRCLE 79 ON FREE INFORMATION CARD

BEC BULLET ELECTRONICS

P.O. BOX 401244R GARLAND, TX. 75040 (214) 278-3553

Sound Effects Kit $18.50



The SE-01 is a complete kit that contains all the parts to build a programmable sound effects generator. Designed around the new **Texas Instruments SN76477 Sound Chip,** the board provides banks of MINI DIP switches and pots to program the various combinations of the SLF Oscillator, VCO, Noise, One Shot, and Envelope Controls. A Quad Op Amp IC is used to implement an Adjustable Pulse Generator, Level Comparator and Multiplex Oscillator for even more versatility. The 3¼" x 5" PC Board features a prototype area to allow for user added circuitry. Easily programmed to duplicate **Explosions, Phasor Guns, Steam Trains,** or almost an infinite number of **other sounds.** The unit has a multiple of applications. The low price includes all parts, assembly manual, programming charts, and detailed 76477 chip specifications. It runs on a 9V battery (not included). On board 100MW amp will drive a small speaker directly, or the unit can be connected to your stereo with incredible results! (Speaker not included). **76477 is included.** Available separately for **$3.15** each.

The Super Music Maker

REVISION 2

$24.95

(Basic Kit)

SEE SPECIAL OFFER BELOW

- Comes with 25 pre-programmed tunes.
- On board 7 watt amplifier drives 8 ohm speaker directly.
- Works on 12VAC or 12 VDC.
- Uses either 2708 or 2716 EPROM for expanded tune playing capability. Listing available pre-programmed ROM's.

A true electronic music maker based on a microprocessor chip. The Super Music Maker is the only kit that allows easy addition of pre-programmed tunes by plugging in one memory chip (ROM). Over 20 different ROM's with over 500 tunes are available. Use the kit for a **Car Horn, Doorbell, Door Announcer,** etc. If you have an EPROM programmer our manual tells you how to program your own tunes. Kit includes quality plated and drilled PC Board and all components.

OPTIONAL ACCESSORIES

DIP SWITCHES One 8 pos., one 5 pos., for tune address **2.00/set**
WALLPLUG TRANSFORMER For operation on 117VAC house current **3.00**
INJECTION MOLDED PLASTIC CASE w/custom front & rear panels, hardware and 2 five pos. rotary switches (replaces DIP switches) **8.00**
HORN SPEAKER 8 watt, 8 Ohm with mounting bracket **6.25**

SPECIAL OFFER

Buy a Super Music Maker kit for $24.95 and get **FREE,** a 2708 ROM pre-programmed with 35 popular tunes. This offer gives you over 60 songs to choose from!

7 Watt Audio Amp Kit $6.95

SMALL, SINGLE HYBRID IC AND COMPONENTS FIT ON A 2" x 3" PC BOARD (INCLUDED). RUNS ON 12VDC. GREAT FOR ANY PROJECT THAT NEEDS AN INEXPENSIVE AMP. LESS THAN 3% THD @ 5 WATTS. COMPATIBLE WITH SE-01 SOUND KIT.

Doomsday Alarm Kit $9.95

If you have trouble sleeping and you would like the rest of the neighborhood to share your misery then this little kit will be for you! There is no way to accurately describe the unearthly howls, screams and tones that come out of this kit. Four separate tone oscillators are mixed, cancelled and stepped at a varying rate. 10 Watts of crazy sounds. A great fun kit or a practical burglar alarm. Complete with PC board and all necessary components less speaker. For 6-12 VDC. ORDER DA-02.

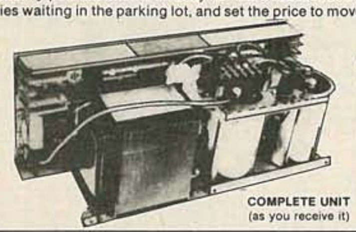
THE PRESIDENT SAYS: "HOGWASH!!"

After taking one look at the TRIPUT POWER SUPPLY our engineer declared that the units were worth several hundred dollars each. He pointed out the engineering, high quality construction and state-of-the-art intergrated design in support of his position. The President of **BEC** more pragmatically pointed out the already full warehouse and the two trailer truck loads of power supplies waiting in the parking lot, and set the price to move them **QUICKLY!**

- UNIT IS COMPLETELY ASSEMBLED!
- Fused primary and DC sections
- HUGE SHIELDED TRANSFORMER
- 2% Load & Line Regulation
- Low Ripple < 100mv.
- Short Circuit Protection
- Overvoltage Protection on all three outputs
- 25A Bridge Rectifier
- Over 60,000 mfd of filters
- High Efficiency **Switching Regulator** reduces heatsink area
- Schematics and service guide included
- Thermal Shutdown
- Statis LED's (3)

3 OUTPUTS
12V @ 8A (12A Int.)
5V @ 10A
-12V @ 5A

INPUT 105 - 125VAC



COMPLETE UNIT
(as you receive it)

62.50
Plus $5.00 Freight
21 lbs. 6 x 5¼ x 12

ONE TIME OFFER! LIMIT TWO (2) SUPPLIES PER CUSTOMER.

- COD MINIMUM $20.00 • ADD $2.50 FOR COD'S
- UPS DELIVERY ADDRESS MUST ACCOMPANY ALL COD ORDERS
- $1.00 HANDLING ON ORDERS UNDER $10.00
- VISA, MC CARDS OR CHECK
- ADD 6% FOR SHIPPING
- TEXAS RESIDENTS ADD 5% STATE SALES TAX
- ALL FOREIGN ORDERS ADD 25% FOR SHIPPING (CANADA 15%) NO FOREIGN COD'S
- CALL (214) 278-3553 TO PLACE CREDIT CARD OR COD ORDER

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PHASORS

PHASOR PAIN FIELD — Patented and recently developed in our labs is being tested by Gov't for riot control. Soon to come under weapons restrictions as an infernal machine. Easily hand-held. Hazardous IF NOT USED WITH DISCRETION.
PPF-1 PLANS (sold for animal control)............ **$15.00**

INVISIBLE PAIN FIELD GENERATOR — Produces a directional field of moderately intense pain to back of head up to 50'. Cigarette pack size enclosure is easily hidden.
IPG-3 PLANS ... **$7.00** IPG-3K KIT & PLANS ... **$44.50**
IPG-30 (assembled for animal control)............ **$59.50**

PHASOR STUN/BURNING WAND — Produces sufficient electrical energy capable of burning flesh. Intended as a personal defense device.
PSW-3 PLANS .. **$8.00** PSW-3K KIT & PLANS .. **$59.50**

LASERS

RUBY LASER RAY PISTOL — Intense visible red, burns, hazardous, with parts sources.
RUBY PLANS (includes all part sources)........... **$15.00**

CARBON DIOXIDE LASER — Generates 20-40 watts of continuous power capable of burning, cutting, hazardous. (with all part sources)........................ **$15.00**

LASER RIFLE — Produces 200-3000 pulses of 30 watt optical energy. Portable and easily hand-held.
LRG-3 PLANS **$10.00**
LRG-3K KIT PLANS (minus diode)............ **$129.50**

POCKET LASER — For the beginner, visible red "optical version", non-hazardous.
LHC-2 ..... **$5.00** LHC-2K KIT & PLANS **$24.50**

HIGH POWERED PORTABLE ENERGY SOURCE FOR LASERS AND MAGNETIC WEAPONS — Exploding wires, shockwave, etc. Miniature size.
HPS-1 PLANS... **$8.00** HPS-1K KIT & PLANS... **$49.50**

PARTICLE BEAM WEAPON — PLANS........ **$15.00**

SECURITY

INFINITY XMTR — Uses telephone lines for selective home or office listening while away on business or vacation.
INF-1 PLANS........................ **$15.00**

SEE IN DARK — Long range, total darkness.
SD-4 PLANS **$10.00**

LONG RANGE WIRELESS MIKE — Crystal clear quality — miniature.
FBT-7 PLANS... **$7.00** FBT-7K PLANS & KIT... **$34.50**

WIRELESS TELEPHONE TRANSMITTER — Long range, automatic.
VWPM-5 PLANS **$10.00** VWPM-5K PLANS & KIT **$34.50**

Send for **FREE** catalog descripton of above plus hundreds more plans, kits and completed items. We accept MC or Visa or when ordering, send check or money order. We pay shipping charges on orders over $50.00, otherwise include 10% with remittance.

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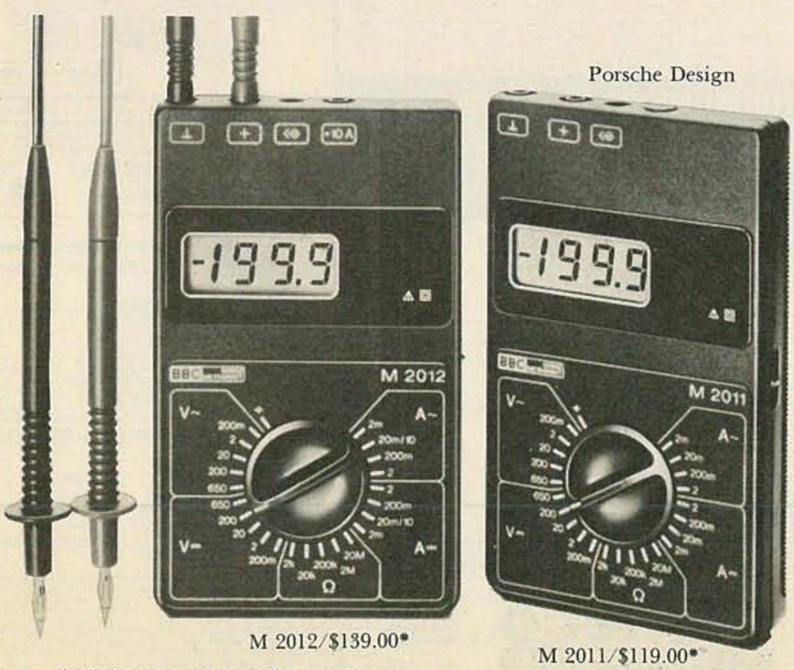
The Finest Craftsmanship Second to None

Porsche Design



M 2012/$139.00*

M 2011/$119.00*

incl. battery, manual and test probes

*Prices subject to change without notice

True Handheld Digital Multimeter

- Pocket Size: 92x154x25mm
- 3½ digit Liquid Crystal Display (13mm)
- Accuracy: 0.25% or 0.5% VDC
- Single Dial Selector for all ranges
- 2 terminals for all ranges, except 10A range in model M 2012
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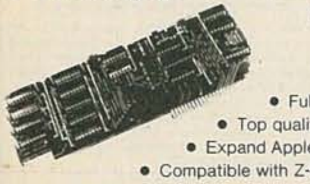
ADVANCED COMPUTER PRODUCTS

SEND $2.00 for 104 PAGE CATALOG

16K Apple™ Ramcard



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ACP
$69.95

- Full 1 year warranty
- Top quality — gold fingers
- Expand Apple II 48K to 64K
- Compatible with Z-80 Softcard™
- 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

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

64K CMOS RAM

S100 (200nS)

Uses 2716's or 6116's $349.00

Assembled & Tested $399.00

MOSTEK 4K RAMS

29¢ ea.

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

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

Stepper Motor

NEW

USED IN DATA PRODUCTS PRINTER
$19.95 ea.

Astec RF Modulator

for COLOR & B/W

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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

1200 BAUD MODEM IC

Features:
- 1200 Baud
- 40 Pin
- 5Volts Only

SL1200 $129.00

PARALLEL ALPHA NUMERIC PRINTER

19 Column Printer prints 16 numerical columns plus 3 columns which have math, alpha and other notations. Each wheel has 12 positions with position 12 blank. Position 11 on numerical columns have decimal point or #. Utilizes 2.75" wide adding machine tape and a dual color ink ribbon. Input data parallel with four bit BCD comparator circuit (schematic provided). Print rate, 3 lines per second. Operating voltage 22-28VDC with typical cycle time of 340mS. Size 6½"W x 3⅛"H x 5⅝"Dp. New. $17.50 ea. 3/$45

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Z8002	69.00	2901	9.90	8035	14.95
Z80	9.95	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	9.75	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	1.99	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 $6.50

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8212	2.75	6820	6.50	6522	9.95
8214	4.95	6821	6.50	6530-X	24.95
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8224	2.95	6834	16.95	6551	19.95
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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
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8257	9.50	6880	2.49	Z80A-SIO	29.95

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

HI-TECH

2513-001 (5V) Upper	$9.50	DAC08	$9.95
2513-005 (5V) Lower	10.95	DAC100	9.95
2513-ADM3 (5V) Lower	13.95	8038 Function Generator	4.50
MCM66710 ASCII Shifted	12.95	MC4024 VCO	2.95
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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
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9400 Volt to Freq Conv	7.25	COM5016	16.95
8750 3½ Digit BCD	13.95	INS8250	15.95
1408L6 8 bit	3.95	AY5-2376	13.75
1408L8 8 bit	5.95	AY5-3600	13.75
DAC01 D 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
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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	CA3065N	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
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NE556N	98	LM3909N	98
NE561T	19.95	LM3914N	3.75
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LM733N/H	98	SN75451N	35
LM739N	1.15	SN75452N	49
LM741CN/H	33	SN75453N	49
LM741CN-14	19	SN75454N	49
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LM748N/H	39	SN75492N	89
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MC1330	1.95	TL494CN	4.20
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74S00	$ 39	74S124	3.69	74S244	$2.99
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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	1.89	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				

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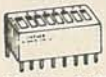

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7403	22	7480	49	74164	87
7404	22	7482	95	74165	87
7405	23	7483	55	74166	1.20
7406	35	7485	65	74167	1.95
7407	35	7486	35	74170	1.69
7408	26	7489	1.75	74172	4.75
7409	23	7490	39	74173	79
7410	22	7491	57	74174	89
7411	29	7492	45	74175	85
7412	29	7493	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
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74LS00	$ 26	74LS113	$ 43	74LS245	$2.20
74LS01	28	74LS114	43	74LS247	1.10
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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
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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
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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
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4031	3.25	4078	35	4566	2.25
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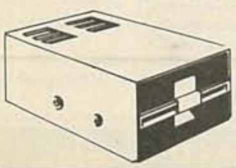

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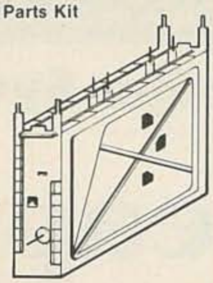

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UHF 470-889 MHZ
CHANNEL 14-83
OUTPUT CHANNEL 3
75 OHM INPUT

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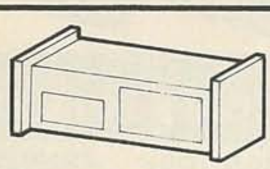

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Microwave Receiver
1.9-2.5 GHZ

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NEW

Microwave Preamp!!!
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- Can be used with all existing stop sign board receivers!!!!
- 1.9-2.5 gHZ Freq. Range

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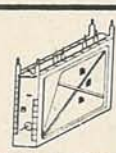

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NEW PWD KIT!!!

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PWD50	Panel Mount Pots 2-5K	$3.95
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PWD70	Ceramic Disc Caps — 37 pcs & Misc. Type Capacitors	$11.95
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PWD110	Misc. Parts—Hookup Wire, Ant. Terminals, Fuse, Fuseholder Dpdt Switch, Line Cord etc.	$8.95
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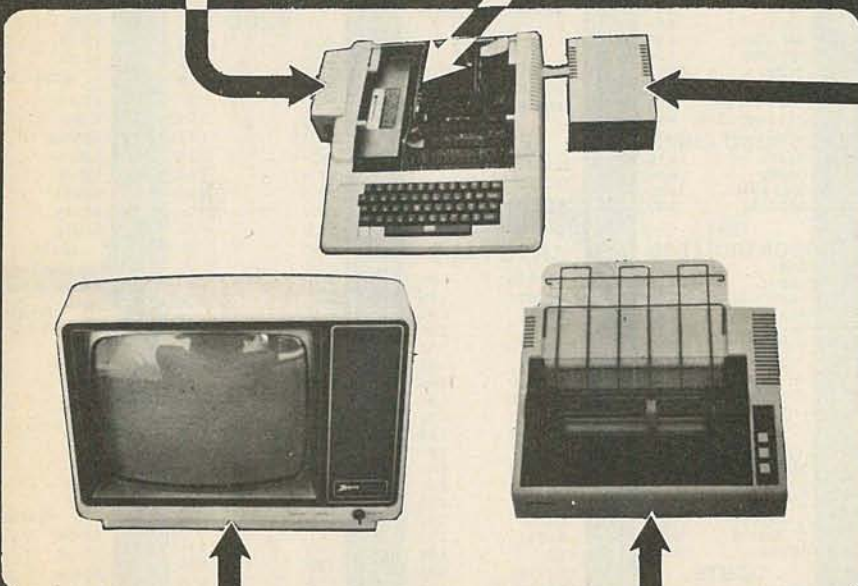

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8155	9.00	8275	16.95
8237	14.00	6845	16.95
3242	6.00	6810	2.50

RAM's / ROM's

RAM's		ROM's	
8264 (4164-2)	11.95	2708	2.95
2114L-3	1.65	2716 + 5V	5.75
4116-3	1.30	2732	9.95
4116-2	1.60	1702A	4.95
21L02-3	.70	2532	9.95
TMS 3409	1.75	2764-25	18.95
MK4027-3	1.95	82S23	1.95
MK4096-11	1.95	82S112	4.00
8116-3	8.95	82S115	4.00
TMS 4060NL	2.95	82S123	1.95
MM5280	1.75	82S129	1.95
2101-1	2.45	82S130	1.95
Z6104-4	2.50	3628A-3	3.00
MK4008P	1.95	AM9214C	2.95
IM7001	2.95	8256-5 (74188A)	1.25
5101E	2.95	74S474	6.95
2111AL	1.95		
MK4802-J3	10.95		
93L422	5.95		

INTERFACE & DRIVERS / SHIFT REGISTERS

INTERFACE & DRIVERS		SHIFT REGISTERS	
1488	.90	MM1402	1.75
1489	.90	MM1403	1.75
8130	2.50	MM1404	1.75
8830	2.50	MM5013	2.50
8833	2.50	MM5055	2.50
8834	2.00	MM5056	2.50
8837	2.00	MM5057	2.50
MM5321	9.50	MM5058	2.50
MM5369	2.50	MM5060	2.50

UART's

TR1602B	3.95	M8868A	8.95
PT1482B	3.25	COM2017	3.75

14 PIN HEADERS .... 3/$1.00
24 PIN HEADERS .... .75
40 PIN HEADERS 1.10
50 PIN EDGEBOARD CONN. 3.95
26 PIN EDGEBOARD CONN. 2.50
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50 PIN RIBBON CONNECTORS $3.25
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3.000, 3.579, 4.000, 5.000, 6.000, 6.144, 8.000, 10.000, 18.000 — $3.25 ea.

7 WATT LD 65 LASER DIODE(IR) $8.95

25 watt Infra Red Pulse (SG 2006 equiv.) Laser Diode (Spec sheet included) $24.95

2N3820 P FET .... $ .45
2N 5457 N FET .... $ .45
2N2646 UJT .... $ .45
ER 900 TRIGGER DIODES .... 4/$1.00
2N 6028 PROG. UJT .... $ .65

DISC CAPACITORS
.1UF 16V .... 10/$1.00 .... 100/$8.00
.01UF 35V .... 16/$1.00 .... 100/$5.00

IN4148 (IN914) 15/1.00

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.22UF 35V	5/$1.00	10UF 20V	– $ .40
.47UF 35V	5/$1.00	22UF 10V	– $ .30
.68UF 35V	5/$1.00	15UF 16V	3/$1.00
1UF 20V	5/$1.00	30UF 6V	5/$1.00
2.2UF 20V	5/$1.00	33UF10V	$ .40
3.3UF 20V	4/$1.00	47UF 20V	$ .85
4.7UF 35V	4/$1.00	68UF 10V	$1.00
6.8UF 35V	3/$1.00	120UF 6V	$ .75
		200UF 20V	$1.75

DIP SOCKETS

8 PIN	.17	20 PIN	.30
14 PIN	.20	24 PIN	.35
16 PIN	.22	28 PIN	.40
18 PIN	.25	40 PIN	.60

RS232 CONNECTORS
DB 25P male $2.75
DB 25S female 3.75
HOODS 1.25

C/MOS

4001	.25	4028	.55	4081	.20	74C32	.45
4002	.25	4029	.75	4082	.20	74C42	1.00
4006	.65	4030	.35	4093	.60	74C73	.75
4007	.27	4034	1.75	4099	1.75	74C74	.50
4008	.70	4035	.75	4501	.95	74C76	.70
4009	.45	4040	.65	4510	.65	74C83	1.40
4010	.45	4041	.55	4511	.65	74C86	.50
4011	.22	4042	.55	4514	1.40	74C90	.90
4012	.22	4043	.45	4515	1.50	74C93	.95
4013	.35	4044	.55	4516	.75	74C154	2.50
4014	.70	4046	.50	4518	1.25	74C157	1.75
4015	.70	4049	.40	4520	.75	74C160	1.20
4016	.30	4050	.40	4528	1.25	74C161	1.15
4017	.80	4051	.80	4553	2.75	74C163	1.15
4018	.50	4052	.75	4566	.90	74C173	1.30
4019	.40	4053	.75	4583	.75	74C174	1.30
4020	.70	4060	.80	4585	.50	74C175	1.20
4021	.85	4066	.50	74C00	.27	74C192	1.30
4022	.80	4068	.35	74C02	.27	74C193	1.30
4023	.22	4069	.20	74C04	.27	74C901	.50
4024	.45	4070	.35	74C08	.27	74C902	.70
4025	.25	4071	.25	74C10	.27	74C914	1.75
4026	.95	4072	.25	74C14	1.20	74C921	3.95
4027	.40	4076	.65	74C20	.27		
		4077	.35				

74S SERIES

74S00	.30	74S74	.70	74S157	1.25
74S02	.30	74S85	1.25	74S158	1.25
74S03	.30	74S86	.60	74S169	1.75
74S04	.40	74S89	1.90	74S174	1.40
74S05	.45	74S112	.85	74S175	1.40
74S08	.40	74S133	.50	74S194	1.10
74S10	.30	74S135	1.10	74S240	1.00
74S11	.35	74S138	1.25	74S257	1.30
74S15	.40	74S139	1.10	74S258	1.30
74S20	.40	74S140	1.70	74S260	1.50
74S30	.40	74S151	1.25	74S280	1.50
74S32	.40	74S153	1.10	74S373	2.25

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CPU's
6502 .... $6.00
8080A 3.75
Z80A 6.00

CRT Controllers
TMS9927NL .... $ 9.95
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8275 .... 16.95

ROM's
2732 .... $ 7.95
2716 .... 4.00

RAM's
2114L-4 .... $1.35
4116-2 .... 1.60
MK4802-J3-2KX8 .... 8.95
93L422 BIPOLAR 5.95
4164-2-64K 9.95
2147 J3 .... 6.95
4118-4 .... 6.95

DISC Controllers
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1791 .... 25.00
1793 .... 35.00
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1797 .... 45.00
D765C 25.00

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CTS 206-8 — 8 POSITION 1.50
CTS 206-10 — 10 POSITION 1.95

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206D — DPDT — 1.50
206P — DPDT — CENTER OFF $1.75

SCR's

	1.5A	6A	35A	110A
100	.45	.60	1.40	
200	.70	.80	1.90	9.00
400	1.20	1.40	2.60	12.00
600		1.80	3.60	15.00

TRIAC's

PRV	1A	10A	25A
100	.45	.80	1.55
200	.84	1.30	2.10
400	1.30	1.90	3.10
600	2.00	2.75	4.30

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IL-5 OPTO ISOLATOR .... $ .45
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PRV	1A	3A	12A	50A	125A	240A
100	.06	.14	.35	.90	4.25	6.00
200	.07	.20	.40	1.30	5.25	9.00
400	.09	.25	.65	1.50	6.50	12.00
600	.11	.30	.80	2.00	8.50	15.00
800	.15	.35	1.00	2.50	10.50	18.00
1000	.20	.45	1.25	3.00	12.50	26.00

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DL-707 C.A. .3" .... $ .75
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FND803 .8" CC $1.95
MAN 54 C.C. Green .... $ .75
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2N1307 PNP GE TO-5 .... $ .40
2N404A PNP GE TO-5 .... 3/$1.00
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2N4908 PNP Si TO-3 .... $1.00
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2N2907 PNP Si TO 18 .... 5/$1.00
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2N3904 NPN Si TO 92 .... 6/$1.00
2N3906 PNP Si TO 92 .... 6/$1.00
2N5296 NPN Si TO-220 .... $ .55
2N6109 PNP Si TO-220 .... $ .55
TIP 31B NPN Si TO-220 .... $ .50
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MJE 3055 .... $ .60
BU205 .... $1.75

TTL IC SERIES

7400	.17	7472	.35	74162	.60
7401	.17	7473	.35	74163	.60
7402	.17	7474	.40	74164	.60
7403	.17	7475	.40	74165	.60
7404	.24	7476	.40	74166	.70
7405	.24	7480	.45	74170	1.60
7406	.33	7483	.50	74173	.75
7407	.35	7485	.65	74174	.65
7408	.27	7486	.42	74175	.60
7409	.24	7489	1.80	74176	.75
7410	.17	7490	.45	74180	.75
7411	.22	7491	.45	74181	1.90
7412	.30	7492	.45	74182	.45
7413	.42	7493	.45	74190	.70
7414	.50	7494	.60	74191	.75
7416	.33	7495	.60	74192	.70
7417	.37	7496	.60	74193	.79
7420	.17	74107	.35	74194	.85
7425	.30	74116	1.50	74195	.45
7426	.30	74121	.35	74196	.75
7427	.30	74122	.39	74197	.75
7430	.17	74123	.42	74221	1.00
7432	.27	74125	.45	74273	.85
7437	.27	74126	.45	74279	.60
7438	.27	74145	.75	74298	.65
7440	.17	74148	1.25	74365	.65
7441	.75	74150	1.10	74367	.65
7442	.45	74151	.50	74390	.90
7445	.70	74153	.60	75324	1.75
7446	.75	75154	1.10	75325	1.50
7447	.85	74155	.50	75492	1.05
7448	.65	74157	.50	8T31	2.00
7450	.17	74160	.85	9601	.75
		74161	.65	9602	.75
				DS0056H	1.50

FULL WAVE BRIDGE

PRV	2A	6A	25A
100			1.40
200	.80	1.30	2.20
400	1.00	1.65	3.30
600	1.30	1.90	4.40

12V DC RELAYS TTL SIZE
S.P. 1200 ohm coil .95
D.P. 400 ohm coil 1.25

74LS SERIES

74LS00	.20	74LS107	.36	74LS197	.85
74LS01	.20	74LS109	.36	74LS221	.75
74LS02	.23	74LS112	.38	74LS240	.90
74LS03	.23	74LS113	.45	74LS241	.90
74LS04	.23	74LS114	.55	74LS242	1.20
74LS05	.23	74LS123	.60	74LS243	1.20
74LS08	.23	74LS124	1.25	74LS244	.80
74LS09	.25	74LS125	.45	74LS245	1.50
74LS10	.23	74LS126	.45	74LS247	.75
74LS11	.25	74LS132	.55	74LS248	1.10
74LS12	.25	74LS136	.45	74LS251	.68
74LS13	.45	74LS137	.95	74LS253	.68
74LS14	.40	74LS138	.50	74LS257	.68
74LS15	.35	74LS139	.52	74LS258	.68
74LS20	.23	74LS151	.38	74LS259	1.40
74LS21	.25	74LS153	.40	74LS266	.80
74LS22	.25	74LS155	.60	74LS273	1.15
74LS26	.35	74LS156	.80	74LS279	.48
74LS27	.23	74LS157	.45	74LS280	1.80
74LS28	.45	74LS158	.48	74LS283	.85
74LS30	.22	74LS160	.70	74LS290	.75
74LS32	.27	74LS161	.70	74LS293	.95
74LS37	.30	74LS162	.80	74LS298	1.00
74LS38	.30	74LS163	.65	74LS320	2.00
74LS40	.40	74LS164	.80	74LS365	.80
74LS42	.44	74LS165	.80	74LS366	.80
74LS47	.65	74LS166	.80	74LS367	.58
74LS51	.22	74LS169	1.75	74LS368	.58
74LS54	.25	74LS170	1.50	74LS373	1.25
74LS73	.35	74LS173	.70	74LS374	1.25
74LS74	.35	74LS174	.45	74LS377	1.25
74LS75	.35	74LS175	.40	74LS386	.65
74LS76	.45	74LS181	1.95	74LS390	1.30
74LS83	.68	74LS190	.80	74LS393	1.30
74LS85	.80	74LS191	.80	74LS398	2.50
74LS86	.40	74LS192	.65	74LS670	1.60
74LS90	.39	74LS193	.66	74LS682	3.00
74LS92	.50	74LS194	.75	81LS97	1.10
74LS93	.60	74LS195	.90	81LS98	1.10
74LS96	.70	74LS196	.85	8T26	1.25
		25LS2539	1.50	8T97	.95
		25LS2569	1.50		

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TL082 CP	.95	LM361	1.75	747	.50
TL084 CN	1.50	LM377	1.60	CA758	1.75
TL084	1.50	LM380	.95	LM1310	1.75
LM201	.75	LM382	.80	1456	.80
LM301/748	.30	LM383	2.50	1458	.50
LM307	.30	LM386	1.40	LM1808	1.75
LM308	.75	LM387	1.25	LM2901	.95
LM310	1.10	LM393	1.00	CA3018	1.95
LM311	.90	LM555	.45	CA3078	1.50
LM318	.75	LM556	.85	CA3080	.95
LM324	.65	9848	3.50	CA3086	.85
LM339	.66	565	1.40	AD2700LD	4.95
LM348	.90	567	.85	AD521KD	9.95
LF351	.75	709	.25	CA3140	1.20
LF353	1.25	710	.45	3900	.45
LF355	1.25	711CH	.40	4136	.85
LF356	1.35	741C	.35	NE566A	1.50
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4116	(200ns)	1.25
4116	(150ns)	1.75
4164	(200ns)	Call

STATIC RAMS

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21L02	(250ns LP)	1.55
2111	(450ns)	2.49
2114	(450ns)	1.75
2114L-3	(300ns LP)	1.85
2114L-2	(200ns LP)	1.95
TMM2016	(200ns)	5.49
TMM2016	(150ns)	6.49
TMM2016	(100ns)	7.49
HM6116	(200ns)	Call
HM6116	(150ns)	Call
HM6116	(120ns)	Call

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8039	7.59	8243	4.75
8080A	3.90	8250	14.90
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8088	34.95	8253	8.75
8155	7.75	8253-5	9.75
8156	8.75	8255	4.50
8185	29.00	8255-5	5.20
8741	39.00	8257	8.50
8748	14.95	8259	6.85
8755	29.95	8272	39.00
8202	27.95	8275	29.00
8205	3.45	8279	9.25
8212	1.80	8279-5	9.95
8214	3.75	8282	6.50
8216	1.75	8283	6.50
8224	2.45	8284	5.50
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8228	4.50	8287	6.50
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6505	7.65
6507	9.90
6520	4.35
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2.4576	3.90	14.31818	3.90
3.2768	3.90	18.0	3.00
3.579545	3.00	18.432	3.00
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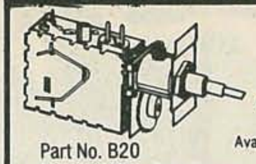

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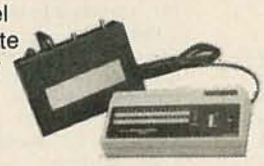

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NE-561	Phase Locked Loop	12.95	11.95
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LM-733N	Video Amp	1.69	1.44
MC-1330	Video Detector	2.49	1.89
MC-1349	Video If Amp	2.06	1.85
MC-1350	Video If Amp	1.75	1.55
MC-1352	Video If Amp AGC	2.69	2.09
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MC-1374P	R.F. Modulator	3.19	2.87
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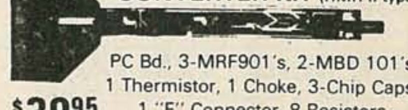

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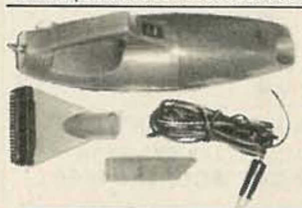

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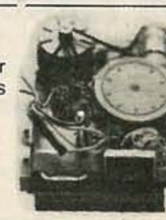

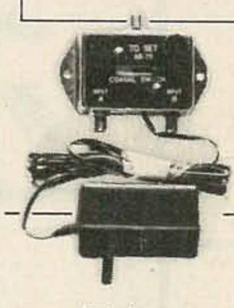

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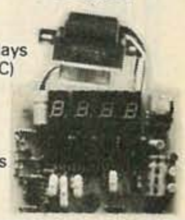

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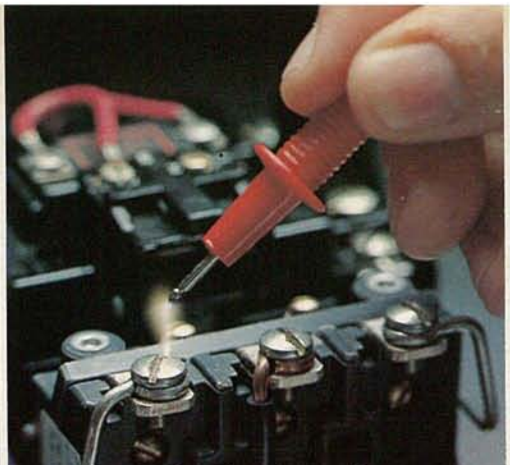

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