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COVER STORY

CAPACITANCE METER

4-digit display reads out any capacitor value between 1-pF and 9999-μF. Measures ceramics, paper, tantalum and electrolytics Story starts on page 37

PINK-NOISE TESTING

Setting up a graphic equalizer is not easy. But when you have a pink-noise source, it can be done quickly and accurately. The how-to procedure starts on page 44

VIDEO MODULATORS

Individual reports on all of the modulators that we could locate. Must reading if you are planning to buy one to use with your computer or TV game or TV camera. Turn to page 47

BUILD FLUE BUG

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- ★ R-E Tests Leader Audio Analyzer
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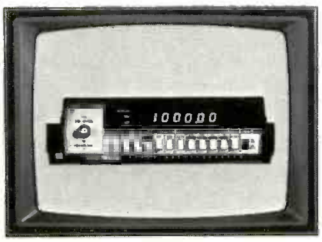

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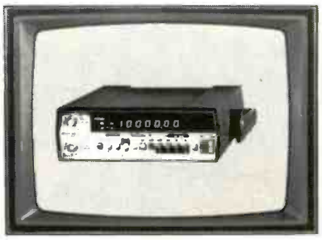

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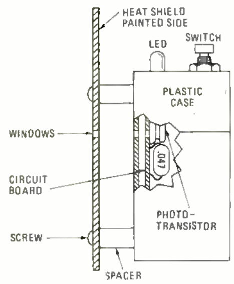
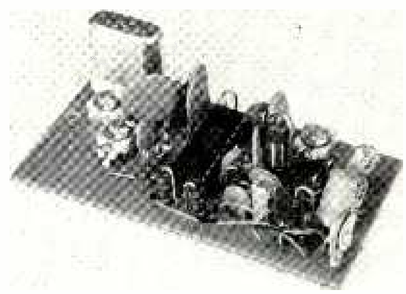
SEPTEMBER 1978 Vol. 49 No. 9

ON THE COVER

A low-cost build-it-yourself capacitance meter you'll want on your bench. Get all the details. Turn to page 37 now.



Final Assembly of Flue-Bug. Spend a few dollars and save a bundle. Story starts on page 41.



ATV Research Pixe-Plexer. One of many video modulators reviewed in this issue. Turn to page 47.

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looking ahead

CB tariff hike: To protect the domestic CB equipment industry from foreign competition, President Carter has ordered import duties increased, following the finding by the U.S. International Trade Commission that American manufacturers were injured, or were likely to be injured, by imports (see **Radio-Electronics**, May, 1978). Tariffs were increased April 11 from 6% to 21%. After one year, they'll drop to 18%; the next year to 15%, then revert back to 6% after four years.

For ailing American CB manufacturers, the effects should be immediately beneficial. For some of them, actual survival was at stake. (Some, of course, have already gone out of the business; a few have gone into bankruptcy.) For CB buyers, the new duties mean price increases. As soon as the duty-increase order was issued, several manufacturers announced price increases; others are coming, and it's forecast that the general price level will rise 10% to 15%. Since CB prices have been extremely depressed and there is currently an oversupply, many bargains are still available. But the departure of many firms from the field, cutbacks in production by others—and now the duty increase—should mean that further price increases are in the works. The time to buy seems to be now.

Audio revolution: It's coming one way or another, but not without plenty of dispute and controversy. Trouble is, audio appears to be headed for two completely different revolutions. There's a big dispute as to which one will come first, and whether they're actually complementary or whether one will pre-empt the other. The potential revolutions involve new recording materials and techniques.

For years, the tape and tape equipment industries have been conferring about a potential new type of coating for magnetic tape which uses fine metal alloy particles instead of oxides, with startling improvements. Now 3M has announced it will introduce metal-particle tape cassettes under the name "Metafine" this year. The 3M tape is claimed to deliver maximum output 5 to 10 dB greater than chromium dioxide tapes or double that of standard tapes, with lower distortion and better frequency response. The only trouble is that it will require new equipment for recording, because of differences in bias, erase current and other parameters (it can be played back on standard recorders in the chrome bias position). The 3M people say the performance is so much better than traditional tapes that tape speed can be reduced by an order of four to achieve about the same performance, or at current speeds open-reel performance can be attained on a cassette recorder.

Tandberg has introduced tape decks which will use Metafine, and 3M says more hardware will be on the market before the year is over and the first Metafine cassettes, in the C90 configuration, will be priced somewhere between high-quality cassettes and open-reel tape, perhaps in the $10 range. Following 3M's announcement, Fuji said it would have metal tape as soon as there was equipment on the market which could use it.

Other tape manufacturers, all of which have been developing metal tapes, denounced 3M's move, saying that standards were necessary before such tape could be introduced. BASF, Memorex, Maxell and TDK all indicated that they thought it was unfortunate that 3M had, in effect, jumped the gun with its own standard. 3M, on the other hand, said the exact formulation and characteristics of Metafine had been reached in consultation with recorder manufacturers which will adopt the standard.

The other revolution: Some tape and equipment manufacturers thought that metal tape, revolutionary as it is, would be overtaken by an even more revolutionary development—digital audio recording. Several manufacturers have shown high-priced pulse code modulation (PCM) digital recorders based on videocassette recorders. Sony, Hitachi, Panasonic, JVC and Mitsubishi all have demonstrated prototype machines, generally quoting potential $3,000 to $4,000 cost. Some professional studio digital recorders are already on the market. Digital recorder performance is phenomenal—one set of specs quotes 85-dB dynamic range, no wow or flutter and virtually linear frequency response.

Mitsubishi and Philips have already announced development of digital disc recording systems based on optical videodisc techniques. RCA is experimenting with digital audio recordings compatible with its capacitance videodisc system. Matsushita, the Japanese parent of Panasonic and Quasar, has demonstrated a PCM version of its mechanical videodisc which is pressed from standard PVC phonograph record material on standard presses.

Which comes first—metal tape or digital recording—and are they compatible? Nobody will answer the first part of the question, but 3M and some other tape companies state that metal tape is suited to digital recording. Others insist that conventional oxide is far better for digital recording and they doubt that metal tapes will even work.

CB of the future: A new "deluxe" personal radio service to supplement, and possibly eventually replace, the present CB on 27 MHz, has been proposed in a study by the FCC's Personal Radio Planning Group. The recommendations are advisory only, but give some clue to the FCC's thinking about personal radio. The proposal envisions a new narrowband FM service, in either the 222-224 or 900-MHz areas, designed for microprocessor-equipped transceivers. Among the advanced features seen for equipment operating on the new band are automatic transmitter identification to reduce policing problems, a selective calling system which automatically switches transmitter and receiver to a vacant channel once contact is made on a calling channel, interconnection with telephone service, repeaters to extend calling range.

Although the 900-MHz transceivers probably would cost 20% to 30% more than those in the 222-MHz area, the study said the higher frequency may be more desirable, because in the 222-MHz band amateurs would have to be relocated at a cost to them of perhaps $24.5 million in new equipment. The FCC was careful not to be too specific about the future of the 27-MHz band, but it did note that this current band would become less attractive as sunspot activity reaches a peak between 1980 and 1984, and it saw no relief from problems of interference to other services, even if current emission standards are further tightened.

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

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FCC reviews open competition for long-distance phone service

When you make a long-distance phone call today, you are billed for that call along with all local messages and it appears on one bill. And although there are over 1500 phone companies (mainly AT&T) providing long-distance service all over the U.S., individual communities are served by only one company, this service being called "sole source service."

Now other companies are requesting permission to compete in providing long-distance service. The system would work something like this: You make a call from New York City to Chicago, using a particular long-distance service company at its New York office, which would then relay your call via microwave to its Chicago station. At this point, your call would be hooked into the Chicago phone circuit and become a local call. Your local telephone company then bills you for all local calls, including the one made to the long-distance service company's New York office. You then pay the long-distance service for the Chicago call.

As a result of an earlier U.S. Court of Appeals ruling, the FCC is now enjoined to find whether it is in the public interest to prohibit competition among individual companies in providing long-distance service. Some of the issues that the FCC could address itself to are: will the service result in better service, more innovation and rate reduction? And since the phone company claims that long-distance rates help subsidize local rates in both cities and rural areas, would opening up the field to competition jeopardize such subsidies?

First digital facsimile message service between U.S. and Japan

It is now possible to send an 8½- by 11-inch page of copy from the United States to Japan in under 26 seconds, using a digital facsimile service developed by RCA Global Communications, Inc. (RCA Globcom).

The system called *Q-Fax* was initiated early this year between San Francisco, Washington, DC, New York City and Japan. Using this system, a printed or handwritten message can be sent or received in languages that do not use roman letters (such as Japanese) without translation. First, a facsimile message is written or typed on forms supplied by RCA Globcom or on a regular 8½- by 10-inch sheet of paper, delivered to RCA Globcom's office in San Francisco, using messenger service, a special line leased from the RCA operating center, or by domestic communications carrier working with the *Q-Fax* service. At the receiving end, in this case Japan, the messages are delivered via messenger or mail service. Copy sent from Japan to the U.S. will be delivered via a domestic network, through the mails, or in San Francisco, Washington and New York, by messenger.

The service operates at 4888 bits-per-second with a 9600- or 2400-bit-per-second capability; the charge per page, $10.

Speech control unit cuts listening time in half

The first portable speech compressor/expander, the *model A7 Speech Controller*, has been developed by the Variable Speech Control Company of San Francisco. The speech controller uses a *Variable Speed Control* system to record speech up to 2½ times faster than normal speech (350 words-per-minute as opposed to an average rate of 100 to 140 words-per-minute). The instrument can also be slowed to 60% of the normal speech rate. There is no accompanying distortion at either high or low levels.

The ultra-high speed helps shorten by half the amount of time needed to tape minutes of meetings, lectures, interviews, etc. Blind or visually handicapped persons can record information as fast as a normal reader. The slow-speed function is helpful in learning a foreign language, in remedial teaching and in absorbing difficult technical data. And, of course, business office dictation and transcription are simplified since the material that is recorded can be speeded up or slowed down to match typing speed.

Standard cassettes are used for both recording and playback modes, and slide controls handle playback speed and volume. Other features include a built-in condenser mike plus a hand-held mike with a remote on-off switch; a three-digit tape counter; a PAUSE switch; cue and review controls; and an earphone jack. The *model A7 Speech Controller* sells for $295.

Children's electronic spelling aid developed by TI

Spelling B, a handheld electronic learning aid that teaches children from five to 10 how to spell, has been introduced by Texas Instruments. The calculator-based device uses its memory bank of 264 words to teach through word-picture association and games. A colorful picture book accompanies *Spelling B*.

TEXAS INSTRUMENTS' SPELLING BEE is a calculator-based device that uses games and activities to teach children from six years old up how to spell 264 most-used words. The learning aid comes with illustrated picture book.

Pressing the GO pushbutton on the device allows a randomly selected number to be displayed; this number represents one of the 264 words retained in memory. The word describes one of the familiar objects illustrated in the picture book. The child uses the number to discover the matching picture and then presses the *Spelling B*'s alphabet keys to spell the word. A "Right" or "Wrong" answer is keyed in. The child also has a second chance to spell the word right; if the second try misfires, the correct answer is displayed on the readout. Scores are shown after each set of five games, and the game can be played on three different levels of proficiency.

Spelling B requires one 9-volt battery, it weighs 14 ounces and measures 6.6 × 4.6 × 1.7 inches; it sells for a suggested retail price of $30.

New expanded VCR line now on market

Jack Sauter, division vice president of marketing for RCA Consumer Electronics, has announced the development of the company's expanded line of *SelectaVision* video cassette recorders and cameras. The development is attributed to "the market acceptance of 'SelectaVision' and indications that the public is moving towards increasing purchases in this new dimension in television enjoyment."

The new line includes three VCR player/recorders (one of them in a four-hour programmable format), two black-and-white cameras and two color cameras. The *model VCT400* programmable recorder is designed to allow four recordings at differ-

continued on page 12

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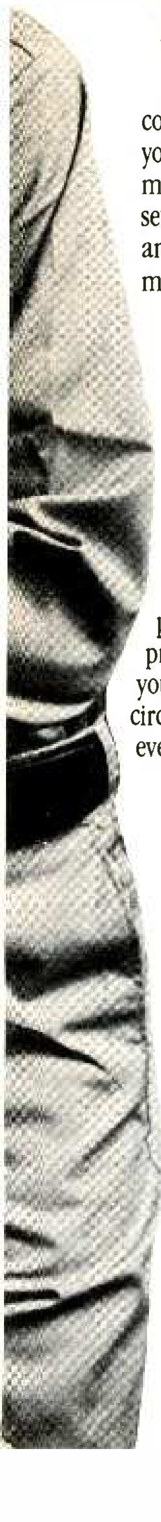

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Likewise, as part of your audio training, you construct a 4-channel stereo amplifier and tuner, complete with cabinet and speakers. You even assemble professional-grade test instruments, so you know what makes them tick, too. Then you use them in your course, keep them for actual TV and audio servicing work.

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More than 60 years and a million students later, NRI is still first choice in home study schools. A national survey of successful TV repairmen shows that more than half have had home study training, and among them, it's NRI 3 to 1 over any other school. (Summary of survey on request.)

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continued from page 6

ent times, channels and even days of the week. It features varactor tuning and electronic program indexing that allows faster access to each program on a two-hour or four-hour cassette and carries an optional retail price of $1200. A deluxe recorder, the *model VCT201*, contains six IC's; it has an electronic timer to preset the time and channel for both beginning and end of unattended recording. It has an optional retail price of $1075. The model *VCT200* recorder has been redesigned with improved circuitry to provide a sharper picture and carries an optional price tag of $1000.

The *model BW003* black-and-white camera ($299.95) has a pop-up viewfinder, 16-mm lens, built-in mike, redesigned power supply and a new AC outlet. The *model BW004* camera ($399.95) has a zoom lens for wide-angled shots and closeups with three power magnifications; the built-in viewfinder comes with a tally light and is calibrated for proper picture composition.

The first RCA color cameras for use with the VCR's are the *model CC001* and model *CC002*; the latter camera features a professional grade zoom lens and electronic viewfinder.

Boris, the talking chess computer, teaches and plays the game

While there are already a few chess computers on the market, Chafitz, Inc., of Rockville, MD, has designed the first randomly programmed "talking" computer that can both teach and play a good game. They have named the computer Boris.

In the words of Steve Chafitz, company president, "Boris is the result of major advances in integrated-circuit technology." Until now computer chess games have required large commercial devices for high-level games; now it is possible to perform those games on postage-stamp-sized microprocessors.

Here are some of Boris' capabilities: It can play against opponents at all skill levels—from the rank amateur to the most advanced chess master. It can teach elements of the game; any player unsure of a move can ask the machine what to do next. You can also change places with the computer in the game and learn how to overcome sticky chess situations. Boris also is programmed to comment on the play, being given to such remarks as "illegal move," "congratulations," "I expected that" and even "good move!"

The position programming allows the human opponent to set up any board position to play specific strategies. Each chess piece rank is displayed electronically so that you can keep track of each piece at all times. Boris will solve all "mate-in-two" problems, and no player has to play the same game twice, due to the computer's random programming. Priced at $299.95, Boris comes in a walnut case complete with chessboard and a set of chess pieces. It is expected to be marketed via department and specialty stores.

Four-hour VCR's marketed in Europe

A four-hour videocassette recorder has been developed by Grundig AG (Germany) for the European market (with a five-hour cassette on the way). The Grundig *model SVR4004* VCR will also be sold under license in the United Kingdom.

The Grundig device closely follows the European debut of Philips' three-hour cassettes and Sony's 3⅓-hour *Betamax* recorder. Priced at $1400, the Grundig VCR features infrared remote drive control, automatic station search, plus programmable channel selection and timing capability of up to 10 days in advance. The four-hour cassette, using 570-meter-long, 16-micrometer thick tape, is expected to retail for about $33 in Germany.

Digital voice protection system safeguards public-safety communications channels

Motorola Communications and Electronics, Inc., has developed a system that effectively prevents unauthorized eavesdropping on public safety communications channels such as those used by law-enforcement agencies, fire departments and the like. The system is called the Digital Voice Protection (DVP) System and can be incorporated in portable and mobile units, base stations, repeaters, control stations, total area coverage (TAC) stations, consoles and microwave systems.

No actual voice components are used; the signals sound like random noise emissions. A dual technique translates these random signals into clearly understood messages: Regular speech is converted to digital speech via continuously-variable-slope delta (CVSD) modulation. It is then scrambled using a vast amount of unrelated codes, each of which can be loaded into a DVP radio's memory using a code inserter that cannot be activated for visual recall. This insures that the DVP system is accessible to just a few persons.

The system features a narrow RF channel bandwidth. It operates with 25-kHz channel spacing in the UHF band or a 30-kHz spacing in the VHF band. A code-detect feature squelches the speaker system if an incoming code does not match that stored in the receiver's memory. A dual-code detect option allows you to add a second code for special messages.

The DVP system offers dual-mode operation; that is, messages can be sent "in clear" as well as digitally. This makes the system adaptable to existing communications networks on existing channels. As additional protection is needed, the DVP portion of the system can be expanded.

An FCC license is mandatory before the system can become fully operational. Further information can be obtained from Barbara Bennett, Motorola Communications and Electronics, Inc., 2122 North Palmer Drive, Schaumburg, IL 60195. **R-E**

MOTOROLA DVP SYSTEM PROVIDES HIGH-LEVEL VOICE SECURITY FOR public safety communications channels. The system can be integrated into portable, mobile and base-station radios, as well as in total area coverage (TAC) stations and microwave systems.

The function of this function generator is to make your job easier.

B&K-PRECISION
Model 3010 $175

If you stop and think about it, the function of any generator *should be* to make your job easier. When we at Dynascan designed our new Model 3010 function generator, that's exactly what we had in mind.

How did we achieve this? The 3010 was designed inside and out to be convenient and fast to use, and to provide years of trouble-free operation.

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CIRCLE 18 ON FREE INFORMATION CARD

editorial

The Best Is Yet To Come!

It's a marvelous world of electronics that we live in. We've got TV sets with 7-foot screens, video tape recorders, CB radios, digital wristwatch-calculators, TV games, computers, light dimmers, smoke alarms, burglar alarms, garage-door openers . . . . . I guess I could go on for pages. But that's what we have now, today, in our hands. And that's only the beginning.

In 1908 when this company started publishing magazines about electronics—our first publication was called **Modern Electrics**—the word "electronics" had not yet been coined. And about the most electronic device around was the DeForest audion—a diode with a third element—a control grid. Little did we know where we would be only a few short years later.

Today in 1978 we are surrounded by electronic devices. If you took them away, many of us might consider that we had been pushed back into the dark ages. But what about tomorrow? What will the *new* electronics devices be? Will they even be electronics?

We recently asked the readers of this magazine on our Free Information card to tell us what they thought the next breakthrough in consumer electronics would be. Out of thousands of responses not one reader mentioned any device not in current use. But here are some that we have come up with. Some of our ideas border on science fiction, yet man on the moon, television, and satellite communication were science fiction only a few short years ago. Here goes . . .

1. Total communications system and computer terminal on your wrist.
2. Direct electronic learning machines. Couple brain to recorder. Play the tape (hologram) and you *know* the subject.
3. Direct-couple TV camera to brain, restoring vision to the blind.
4. Electronic anti-gravity (I know that gravity is not an electronic field and therefore cannot be countered, directly, by an electronic signal. But maybe there's an electronic field that can shield physical objects from the effects of gravity).

There's four items to consider. Please don't devote any effort toward proving them unworkable; many experts have proven that airplanes won't fly and that the world is flat. Do send me your look at future electronic devices and if you've built something special, tell me about it too. We'll publish the great ideas and your name. Think up the impossible and send it to me. Do it quickly or by the time the post office delivers your idea, it may have already been built.

Larry Steckler

LARRY STECKLER
Editor

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CIRCLE 19 ON FREE INFORMATION CARD

letters

PINK NOISE/GRAPHIC EQUALIZER

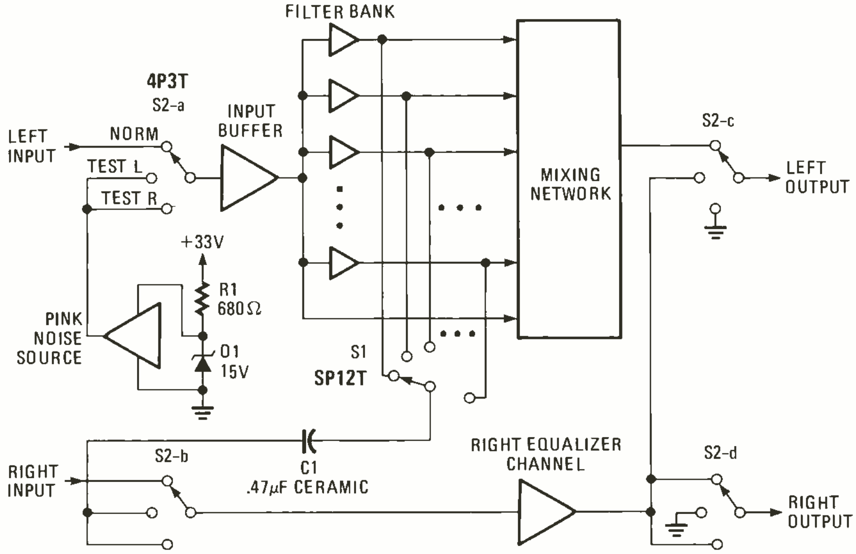
The pink-noise tester described in the January 1978 issue ("Pink Noise Generator Tests Your Hi-Fi," page 43) will not test the equalizer described in my article, "Graphic Equalizer For Your Stereo System," in the May 1978 issue, page 37. However, it *is* an excellent testing tool.

The pink-noise article suggests shorting out the filter section; this produces a phase-shift oscillator.

Furthermore, with the given topology on the equalizer described in the May 1978 issue, turning off the filter (e.g., installing a switch in series with R_{in}) will cause that band to be flat, not attenuated.

Other errors I have observed:

1. Figure 1-c—the switch arm is misdrawn.
2. Figure 2—the values of +12 dB and −12 dB are reversed.
3. The equalizers of Fig. 1 are not true graphic equalizers—they have ripples in their frequency response of typically 3-dB



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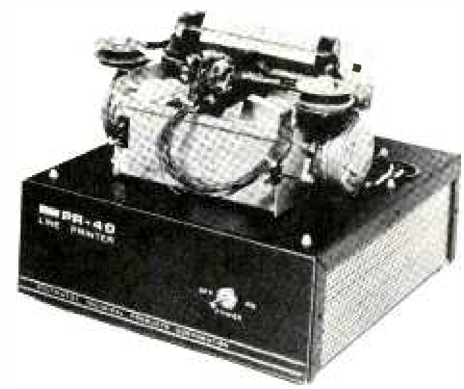

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LETTERS

continued from page 16

P-P at a flat setting. To my knowledge there are no consumer versions of this type equalizer available. Furthermore, the circuit of Fig. 1-b seems to be copied from the *National Audio Handbook* and that circuit also oscillates.

The diagram shows a graphic equalizer/noise tester system. In this diagram, switch S1 can be replaced with a test probe, capacitor C1 only prevents clicks. Resistor R1 and diode D1 can be replaced by a battery, and switch S2 can be replaced by reconnecting patch cords. The pink-noise generator is available from West Side Electronics, Box 636, Chatsworth, CA 91311, for $9.95 postpaid; the graphic equalizer is available from Synergistic Sound Systems, 1608 S. Douglas Avenue, Loveland, CO 80537, for $90 postpaid.

To adjust the equalizer, turn switch S2 to "Test Left." Adjust the *right*-hand channel controls until the output of your system is independent of the position of S1 (adjust the bottom right-hand band with S1 connected to the bottom left-hand band, etc.). Adjust the left-hand channel slide potentiometers to be the same as the right-hand channel. Change switch S2 to "Test Right." Repeat the adjustments to the right-hand channel. Simple! There's plenty of room inside and on the rear panel of the equalizer to mount the pink-noise generator and switches.

JOE GORIN

TELEPHONE ACCESSORY

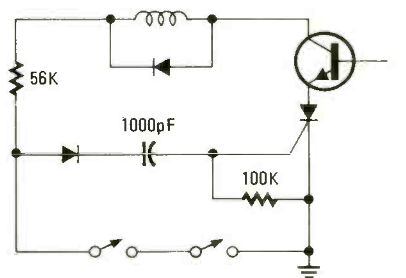
The Autodialer and Cassette Interface featured in the May 1978 issue seems to be designed on the assumption that burglars are polite. But I doubt that the typical burglar is going to stop to close a window or back door after gaining access.

If S1 in Fig. 1 (see May, 1978, page 41) is not reclosed, the SCR will refire itself immediately after every one of the infrequent pulses from the unijunction transistor.

Furthermore, an appreciable "open" period on a phone line is required to disconnect it at the exchange. A mere flick of relay RY1-3, even if attained, will probably not do the trick. So what you have is what the phone company calls a "calling party hold." It will tie up the line indefinitely.

WARNER CLEMENTS
Beverly Hills, CA

Mr. Clements is correct for all but the momentary break switches. My application was on automatically closing doors in which this problem never showed up. On a later use of the circuit, however, this did indeed prove to be a problem, and was



remedied by replacing capacitor C1 with a 100,000-ohm resistor and placing a 1000-pF capacitor in series with the gate lead of the SCR between the diode and the 100K resistor as shown above.

JULES GILDER

COSMAC-1802 GROUP

I am sure that many of your readers would be happy to know that we are forming a COSMAC-1802 User's Group, that will include Basic Elf, Elf-2, Super-Elf, VIP, Infinite, etc.

The purpose of the group will be to correspond and exchange software and ideas, plus we will possibly publish a newsletter. Membership is *free*. Anyone who is interested should write to: Patrick Kelly, P.O. Box 7162, Los Angeles, CA 90022.

PATRICK KELLY
Los Angeles, CA

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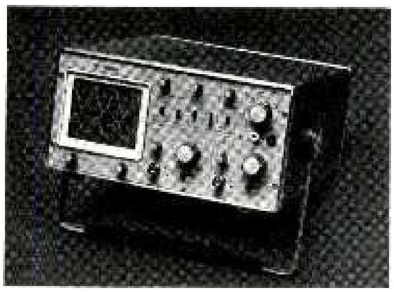

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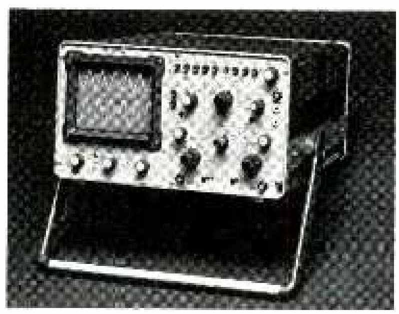

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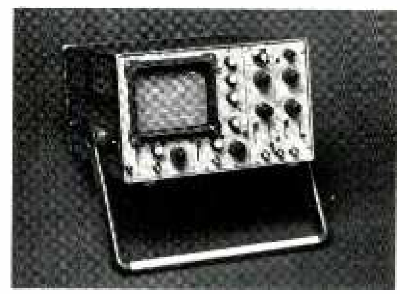

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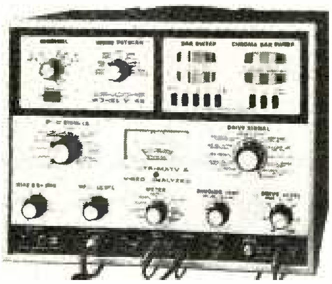
equipment reports

Sencore Model VA-48 TV-VTR-MATV-Video Analyzer



CIRCLE 101 ON FREE INFORMATION CARD

SENCORE, INC. (3200 SENCORE DRIVE, SIOUX Falls, SD 57107) has produced a new analyzer, the *model VA-48* TV-MATV-VTR-Video Analyzer. Since lack of space will keep me from discussing all its many features, I'll just cover the most interesting and important details.

The *model VA-48* generates RF/IF and video signals. It generates all the standard color-bar, dot, crosshatch, single-dot and single-cross patterns, plus two other unusual ones that we'll discuss later on. It can develop these signals at RF, on all VHF and on six UHF channels (four channels are fixed, two are tunable). It has an IF output for use as a tuner substitute, and two more outputs for injecting signals at higher levels into the second and third video intermediate frequency stages. A switchable 4.5-MHz crystal can be used for tuning. In the IF signal stage, the three most important trap frequencies and a sound IF are provided.

On the other side of the panel, a DRIVE SIGNAL selector switch can deliver drive signals for vertical and horizontal-output stages, for either tube or transistor stages; horizontal drive pulses for SCR (*S*ilicon-*C*ontrolled *R*ectifier) horizontal-output stages; two vertical and horizontal composite sync signals, one designed for tubes, the other for transistors; a horizontal keying pulse, a 1000-Hz audio signal; and a 3.58-MHz oscillator signal. The last position of the control lets you inject any of the video patterns as a video signal. The video output is also fed to the VTR standard jack; this is a fixed 1.0-volt P-P signal, with negative-going sync. The DRIVE LEVEL control handles the output level and polarity of all other signals. A P-P voltmeter on the panel reads the amplitude of any drive signal, from 10 volts up to 1000 volts. Two special scales are used for peaking and nulling.

The *model VA-48* also has a RINGING TEST circuit that was developed by Sencore for testing flybacks and yokes; the same meter is used as an indicator. The meter can also be used as an external meter for signal tracing; there is an input jack just below it.

On the bottom of the panel to the left are a BIAS-B+ SUB control plus jacks. This can be used for DC biasing or as a DC power supply for modules and circuits that do not need more than 1.0 amp. The voltage is adjustable from 0 to 35.

There are only three output cables (one is a common). The RF/IF signals originate from a BNC jack and shielded cable with screw-on

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baluns and adapters for connection to any RF or IF circuit. The drive signals have a coax cable with clips. Cables are provided for the meter input, and the VTR (*V*ideo *T*ape *R*ecorder) output jack and cable has a phono plug that matches all standard VTR inputs. All these cables fit into a compartment on the back of the case.

The RF/IF signals can be adjusted from 100 μV to 5000 μV. The control is marked from 0 to 5; the point marked "1" means 1000 μV, a standard level for CATV/MATV systems. In the TUNER SUB position of the RF/IF SIGNAL selector switch, full output is used; there are two more selector settings for checking the second and third IF's for stage-by-stage signal injection. *All* the output signals of the *model VA-48* are phase-locked to the crystal-controlled RF/IF signals; this includes the RF/IF/video signals and even the drive signals. No matter what signal is used, it will show a stable pattern.

Now here are the goodies: There is a 3.58-MHz oscillator drive signal on the drive signal control. This signal can substitute for the oscillator in the TV set; its amplitude is adjustable. Reversing the polarity of this produces a 3.58-MHz signal with a 90° phase shift. All video patterns can be used for signal-tracing video stages, even up to the picture-tube input.

The feature that really got me all excited was one providing two sweep patterns; one is called Bar Sweep and the other, Chroma Bar Sweep. These modes are patented by Sencore, and with them, you can actually align the IF stages of a TV set by feeding the RF output into either the tuner test point, antenna or IF input. You can view the output at the video detector using a scope, or just by looking at the TV screen! The bar sweep signal consists of numerous bursts of different frequencies for checking the IF response at these points. This is a practical and usable version of the multiburst signal used in VITS (*V*ertical *I*nterval *T*est *S*ignal).

The carrier is modulated with the different frequencies. The first frequency (at the left of the scope or TV screen) is a staircase pattern forming black, grey and white bars, then a white bar (the white flag in VITS) at the right. Between these bars is a set of five video frequencies: 188 kHz, 755 kHz, 1.51 MHz, 3.02 MHz and 3.56 MHz. By the way, these frequencies are not sinewaves but carefully clipped and regulated squarewaves! If your scope has a very wide bandpass, you can see this squarewave pattern. All these frequencies are plainly marked on the panel, and each one can be switched in or out. The panel also shows the patterns that appear on the TV screen *and* the scope patterns at the detector output.

To check the IF alignment (one of the most useful tests because it tells you whether it does need alignment or whether the trouble lies somewhere else) you just feed the signal into the RF input and look at the output. No bias boxes, disabling horizontal output, etc., are needed. For example, if the low-frequency bar at the left is sharp, you know that the low-frequency response is OK. If the 3.56-MHz bar on the right is blurred or even missing, this tells you the high-frequency response of the IF is off; the scope pattern should show all the bars at the same amplitude. The IF touchup control makes them like this if there is no problem in the IF. The 40-page operator's manual for the *model VA-48* includes some quick tests for determining the amplitude of the bars without using a scope. All you do is adjust the brightness control.

For color-bandpass alignment, a different set of three bars is used—3.08 MHz, 3.56 MHz and 4.08 MHz—whose amplitude is different from that of the others (it must be in order to get the correct output). This signal can be used as RF/IF modulation or as a video signal. The P-P value of the *input* signals is regulated so that the output shows a pattern similar to the Bar Sweep—three bars of equal amplitude. On the TV screen, the middle bar is blue; the outside bars have no color but will show small stationary rainbows. Again, the frequencies of the bars, the screen pattern and the scope patterns are shown on the *model VA-48* panel. These frequencies can also be switched in or out. The same brightness-control test can be used here; just turn the control down and see which bar goes out first.

The usefulness of this instrument is limited only by the ingenuity of the user. By providing the best test for any stage's performance (injecting a known good signal and checking the output) you can pinpoint a great many troubles in a very short time. The instruction manual contains a great many tests with diagrams, control settings and all. All you need for checking any color TV set is the *model VA-48*, a good digital meter and a scope.

You can use the *model VA-80* for quick-testing video tape recorders/players. You test tape recorders by feeding in any video signal, (such as the two bar sweeps) record them and then play them back. Players can be tested by injecting the video signals and tracing them through the circuitry. Any kind of problem will show up under these tests.

The *model VA-48* is not a low-cost instrument (it costs $975), but it can be an inexpensive one if it is used properly, since it should pay for itself in a short time in decreased servicing time. **R-E**

Chemtronics Model SD5 Solder/Desolder System

UNSOLDERING COMPONENTS ON PC BOARDS has been a source of conversation and argument for some time. It is as important as soldering and difficult to do correctly. It's hard to get a multilegged component out with the old "melt and jerk" system! The solder-wick technique, in which a woven copper braid absorbs the molten solder, has always been popular. However, there are minor drawbacks. (I always manage to burn my finger by holding it too close to the end!) And if you hold the wick too far back, it could be a bit too limp.

Now, Chemtronics has developed a new alternative—the *model SD5 Solder/Desolder System*. This system solves one of the main problems—trying to use the wick in a small coil. (I always kept mine on the floor under the bench along with the solder, also coiled.) The *model SD5 System* has a tiny reel with a 2.5-inch *Teflon* probe in the end. You pull the wick up through this probe and out as far as you want. You can hold the reel in the palm of your hand and apply the wick right to the desired place. (Hint: Don't pull out more than about one-half inch of the wick; this gives you better control over it.) This unit is called the *model D5 Desoldering Tool*. Despite the small size of the reel, it holds 5 feet of wick that
continued on page 32

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EQUIPMENT REPORTS

continued from page 26

comes in 0.1-inch and 0.06-inch sizes for very fine work. There are refills available; you just pull out the *Teflon* probe and insert it in the refill.

The *model D5 Desoldering Tool* plugs right into the end of a spool of Chemtronics solder! The *Teflon* probe can be pushed back down inside the spool for convenience, for use in tool kits, etc. The *SD5 Solder/Desolder System* lets you keep the solder and wick right under your hand for instant use. The 60/40 solder (with a pure water-white rosin flux core) is

CIRCLE 102 ON FREE INFORMATION CARD

available in 1-pound and ½-pound spools.

The wick is not tinned; this allows much faster solder absorption. The 0.1-inch size is just right for most work. If you run into a very tight place, you can trim the end of the wick at an angle to get right at it. For larger joints, place the wick on the joint and push down on the *Teflon* probe; this spreads the braid out to cover the joint.

This is one of those handy little items that doesn't look very impressive at first glance, but in use proves to be a real timesaver. (Just the elimination of scorched fingertips is a big plus!) Here's another suggestion. After the reel is empty, why not roll up some of the solder and thread it up through the probe? This would give you a useful item for either your workbench or tool kit. I haven't tried it yet but it ought to work. You'd have to buy another *model D5 Desoldering Tool* to obtain the extra probe, but this won't be expensive. The wick refills come without the probe, which you can just pull out of the original reel.

One last benefit of the wick system that I almost overlooked. The wick also acts as a heat sink to help prevent picking-up of PC-board conductors, heat damage to delicate components, and so on. I used it on the base of a transistor; just three passes of the desoldering

continued on page 34

EQUIPMENT REPORTS
continued from page 32

tool and the transistor dropped out of the underside, with the holes left looking neat and clean.

The *model SD5 Solder/Desolder System* comes in different sizes: with 16-gauge solder, \$12.66; with 18-gauge solder, \$12.86; and with 21-gauge solder, \$13.74. You can get the *model D5 Desoldering Tool* with a .06-inch wick, \$2.29; with a .10-inch wick, \$2.45. Wick refills are obtainable: .06-inch size, \$1.49; .10-inch size, \$1.65. Prices are suggested retail prices. All are available from Chemtronics, Inc., 45 Hoffman Avenue, Hauppauge, NY 11787. **R-E**

Heathkit's Model EC-1100 BASIC Programming Course

THE HEATHKIT BASIC (*B*EGINNER'S *A*LL-PURpose *S*ymbolic *I*nstruction *C*ode) course consists of a packed, 14-section manual plus appendixes in loose-leaf form, a programming workbook and a final examination in a sealed envelope. (The course was developed by Heath Company, Benton Harbor, MI 49022.)

The manual is different from most other BASIC manuals in that it doesn't try to impress you with introductory concepts that discourage you from going any farther. The text is written in an uncomplicated, bright manner, making learning fun rather than a chore. A semiprogrammed approach presents information that is closely followed by related questions. The correct answers are camouflaged in dark red boxes, and if you have no willpower, the answers can be totally covered with a card. However, like all self-study courses, you are on your honor and you will only get out of the course what you are willing to put in. Certain places in the text direct you to the workbook in which you answer additional questions and write program segments based on your accumulated knowledge at that point. Those who already have Heathkit or other computers with a BASIC interpreter perform the experiments detailed in the workbook. Hands-on experience gained by actually running programs is an extremely powerful supplement to the written material.

The workbook includes some simple but interesting programs, such as "Name the State Capital," how to calculate parallel resistances and how to plot random number distributions. The appendixes include background information on converting from one number system to another, plus the details of Benton Harbor BASIC and extended Benton Harbor BASIC.

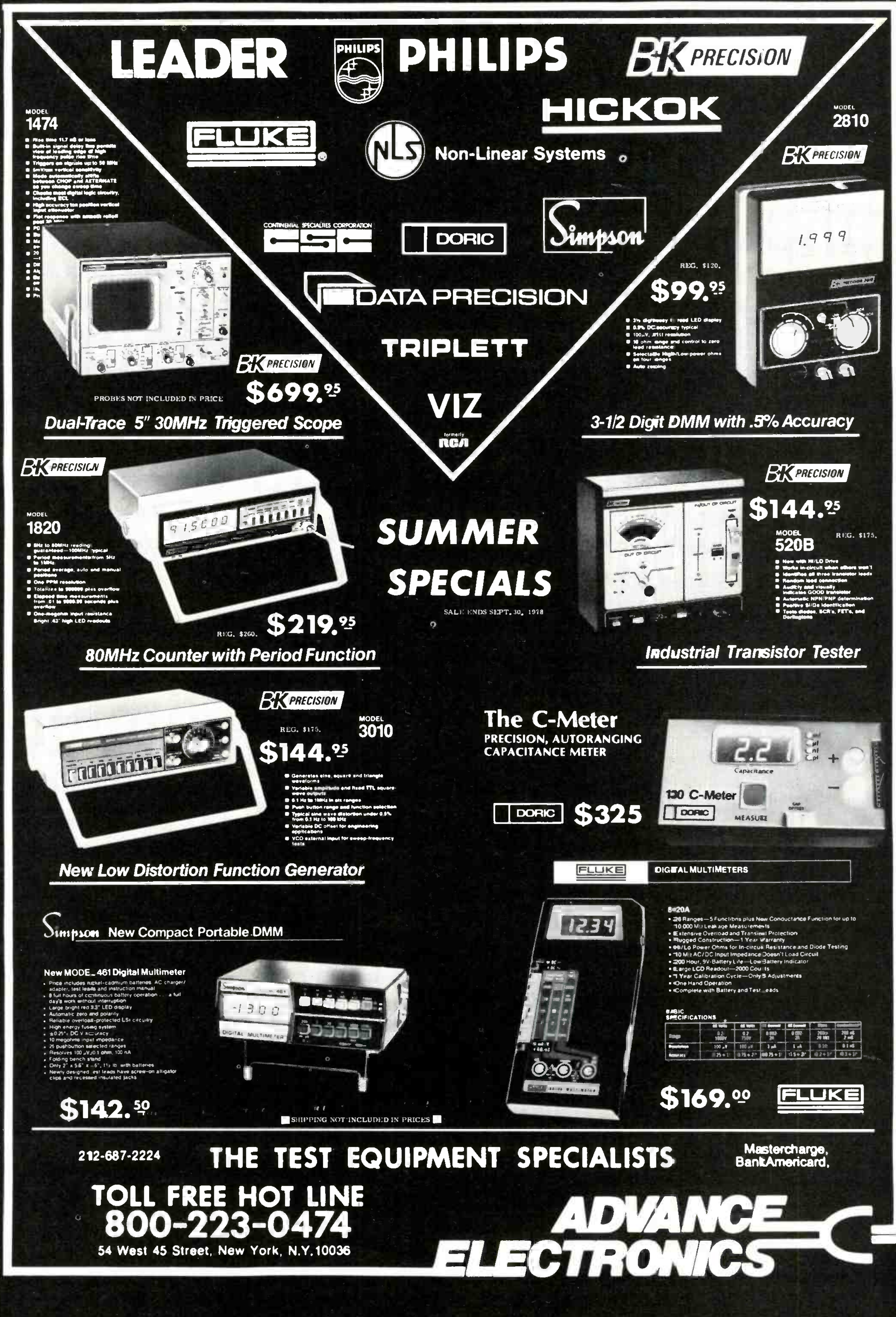
CIRCLE 50 ON FREE INFORMATION CARD

As soon as you have enough fundamentals under your belt, you are introduced to flow charts and you learn how to break down programs into smaller, more easily handled segments or subprograms. The emphasis is on planning your work by carefully defining the problem before actually writing a program.

The overall philosophy of this course concerns building—starting with a "one-room doghouse," proceeding through a "kennel" and up to a "monument." After working through statements, lists, arrays and strings, you arrive at the "monument"-building section, where a problem of moderate complexity is traced from its initial concept all the way through the bells and whistles.

The program developed in this section is Blackjack. In discussing card arrangement, modulus arithmetic is explained and used to represent the 52 cards of the deck. The cards are assigned numbers that can be converted into their individual values and suits. The BASIC random function RND is used to "shuffle" the deck. When you are finished, you have a BASIC listing for a deluxe version of Blackjack. To run the program on any particular computer some minor changes may have to be made. By that point you should be competent enough to implement these changes easily. In addition to knowing BASIC, you must be familiar with the way the operating system of your computer is initialized, how the BASIC interpreter is called up and the way BASIC language programs can be stored and recalled in memory or on tape or disc.

The *model EC-1100* course (which sells for \$29.95) is particularly useful in view of the nearly universal acceptance of BASIC by microcomputer buffs. **R-E**



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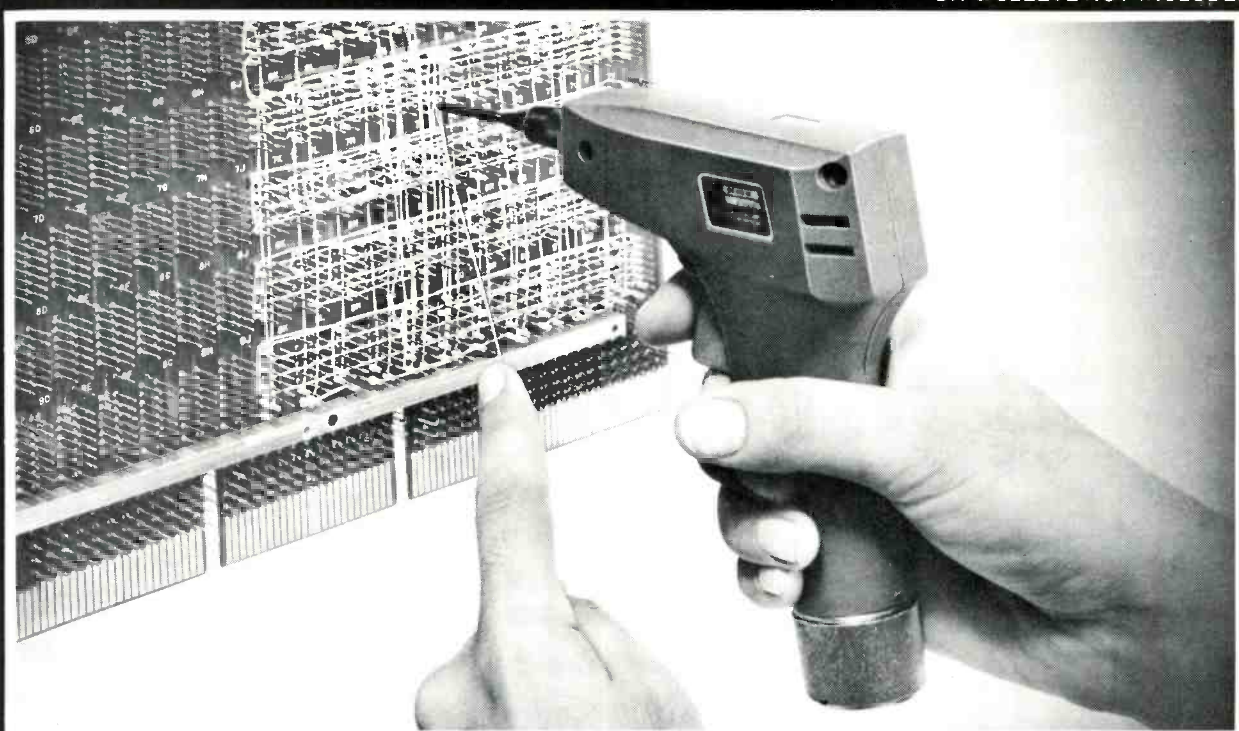

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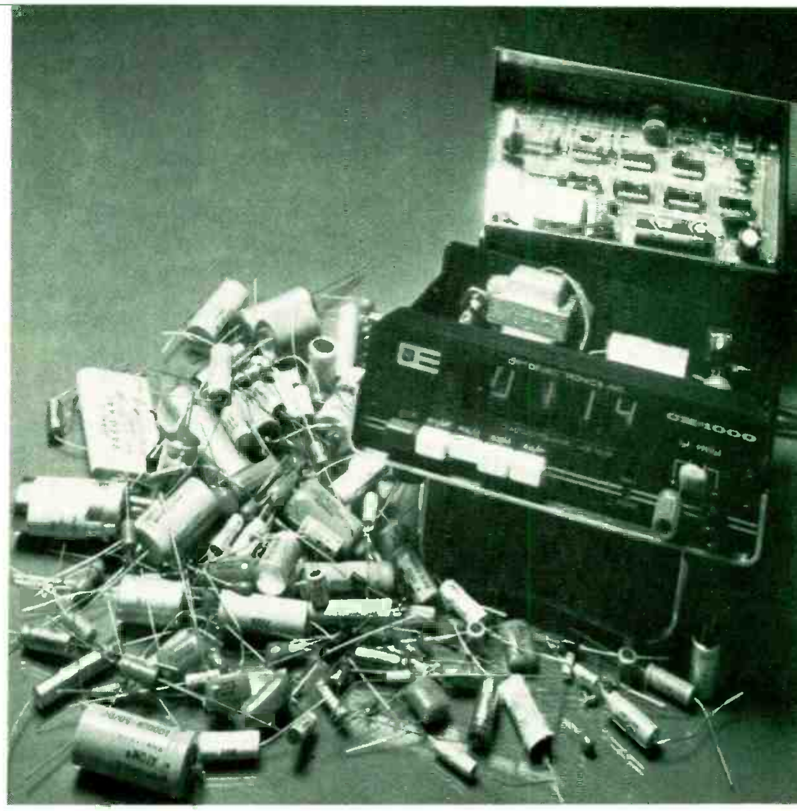
CIRCLE 66 ON FREE INFORMATION CARD

BUILD THIS

pF → .01F Digital Capacitance Meter



A valuable addition to the experimenter's workbench or technician's tool kit this meter verifies the value of suspected capacitors and performs quality-control checks on project components.

BILL WILSON AND BILL OWEN*

CAPACITOR VALUES FROM 1 PF TO 9,999 μF are easily measured using the *model CM-1000* Digital Capacitance Meter. This wide measurement range is achieved using a carefully designed capacitance measuring circuit. A quartz-crystal timebase, 1% film resistors, and a precision SE555 integrated circuit timer (SE instead of NE prefix indicates premium part) yield 1%, ± 1 count accuracy. Four jumbo LED digits and four pushbutton ranges with automatic decimal point placement make capacitance measurement convenient, reliable, and accurate.

To measure a capacitor simply connect its leads across the counter's input terminals on the front panel. Polarized capacitors such as electrolytics and tantalums must be connected with positive lead to the "+" terminal and negative lead to the "−" terminal. Simply depress the appropriate range switch and the counter comes alive displaying the capacitance count with up to four digits of resolution. Open capacitors cause the counter to read zeros while a shorted device causes a very large reading that may not stabilize. Leaky capacitors tend to read much higher than their labeled value and will indicate different values from range to range.

Of course it's no trick to sort through

*Product Engineers, Optoelectronics, Inc.

SPECIFICATIONS

Capacitance Ranges

R1/pF	0000—9999 pF
R2/μF	.0000—.9999 μF
R3/μF	00.00—99.99 μF
R4/μF	0000.—9999. μF

Accuracy (Typical factory calibration at T_a+70°-79°F.)

R1/pF, R2/μF	± 1% of reading, ± 1 count
R3/μF	± 1.5% of reading ± 1 count
R4/μF	± 2% of reading ± 1 count

Timebase

Ref. oscillator frequency	3.579 MHz
Ref. oscillator accuracy	± 0.05%

Power Requirements

Input voltage	105-125VAC 60Hz
Input power	3.5 watts

Environmental

Operating temperature range	+5° to +45° Celsius
Storage temperature	−10° to +65° Celsius

Physical Dimensions

Overall dimensions	3"H × 7½"W × 6½"D
Approx. weight	2½ lb

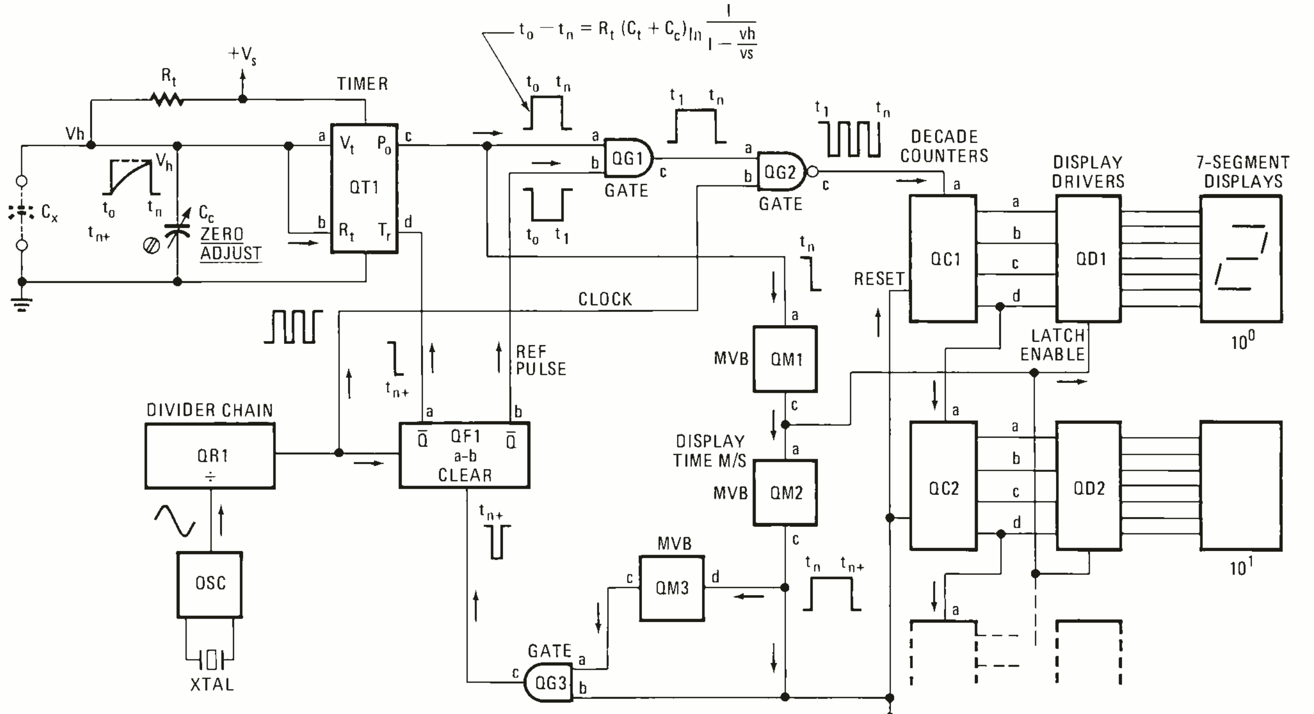


FIG.1—BLOCK DIAGRAM of the digital capacitance meter. Precision is based on characteristics and adjustment of the timer IC.

your junk box capacitors using the capacitance meter just as you would use an ohmmeter to check resistors. Bargain capacitor assortments can be checked for a real savings because hard to decipher military codes, color bands, or no markings at all present no problem with this meter. You can perform quality-control checks on the capacitors you are using in your construction projects. Air variables and ceramic trimmers are frequently unmarked and can be checked for minimum and maximum values or even calibrated in terms of angle of rotation.

Almost all components have a certain amount of capacitance that can affect circuit performance. Wire bundles, coax cable, and twisted pairs all can be easily checked if suspected of causing problems. Two different samples of coax can be compared for minimum capacitance per foot. Other components that can be checked for capacitance include rectifiers, transistors, LED's and other devices.

The capacitance meter's accuracy and resolution are important factors when selecting critical capacitor values. Precision RC networks and oscillators are easily constructed with precisely known capacitor values. A capacitor's temperature stability is of critical importance in many circuits and can be checked by heating or cooling the component and measuring its change in capacitance.

In some instances it is not convenient to measure capacitance at the meter's front panel terminals. A probe can be used for remote capacitance measurements. It will of course add its own capacitance to the measurement. The probe's capacitance can be subtracted from readings or the front panel zero adjustment can be reset. By using the capacitance meter probe, the distributed capacitance

The following parts are available from Optoelectronics, Inc., 5821 N.E. 14 Avenue, Fort Lauderdale, FL 33334.

CM-1000K Complete Kit	$129.95
CM-1000WT Factory Wired & Tested	179.95
CM-1000 PC Boards Only	24.95
P-1000K Cap. Counter Probe Kit	3.95
P-1000 Assembled Probe	6.95

Add 5% shipping, handling and insurance, for foreign orders add 10%. Florida residents add 4% State Sales Tax.

PARTS LIST

Resistors are 10%, ¼ watt unless otherwise noted
R1—243,000 ohms, metal film, 0.25%, ⅛ watt
R2—11,300 ohms, metal film, 0.25%, ⅛ watt
R3—2430 ohms, metal film, 1%, ⅛ watt
R4—220 ohms, 5%
R5, R8, R21—100 ohms, carbon potentiometer, 1 watt
R6—243 ohms, metal film, 1%, ⅛ watt
R7—33 ohms, 5%
R9, R11—10,000 ohms
R10—3300 ohms
R12, R14—330 ohms
R13—6.8 megohms
R15—8.2 megohms
R16—180 ohms
R17-R19—2200 ohms
R20—1000 ohms
R22—11 megohms
R23-R26—100 ohms
R27, R28—4700 ohms
C1—47 pF NPO disc
C2—15-60 pF, ceramic trimmer
C3, C13, C19, C23—0.47 μF, 50 volts
C4, C5—3.3 μF tantalum
C6—.001 μF
C7, C8, C9, C11, C12, C14, C17, C20, C27, C28—0.1 μF
C10—.01 μF
C18—.02 μF
C21—3300 μF, 16 volts, electrolytic
C22—220 μF, 25 volts, electrolytic
C24—33 pF NPO disc
C25—8.2 pF NPO disc
C26—470 pF disc
D1-D4—1N4002 silicon rectifier diode
IC1—556 dual timer
IC2-IC4, IC12, IC14, IC16, IC18—74LS90 decade counter/divider
IC5—74LS73 flip-flop
IC6—4001 quad NOR gate
IC7—74LS04 hex inverter
IC8, IC9—74LS00 quad 2-input NAND gate
IC10—SE555 precision timer
IC11—voltage regulator, 7805
IC13, IC15, IC17, IC19—4511 BCD to 7-segment decoder/driver
DIS1-DIS4—MAN-6680 7-segment LED display
XTAL1—quartz crystal, 3.579 MHz
S1-S5—5-gang SPST pushbutton switch
T1—power transformer, 117 VAC primary, 10 VAC secondary
J1, J2—insulated banana jack
F1—120-volt, 125-mA fuse
Miscellaneous: PC boards, 1 8-pin IC socket,
4 16-pin IC sockets, 14 14-pin IC sockets, line cord, hardware

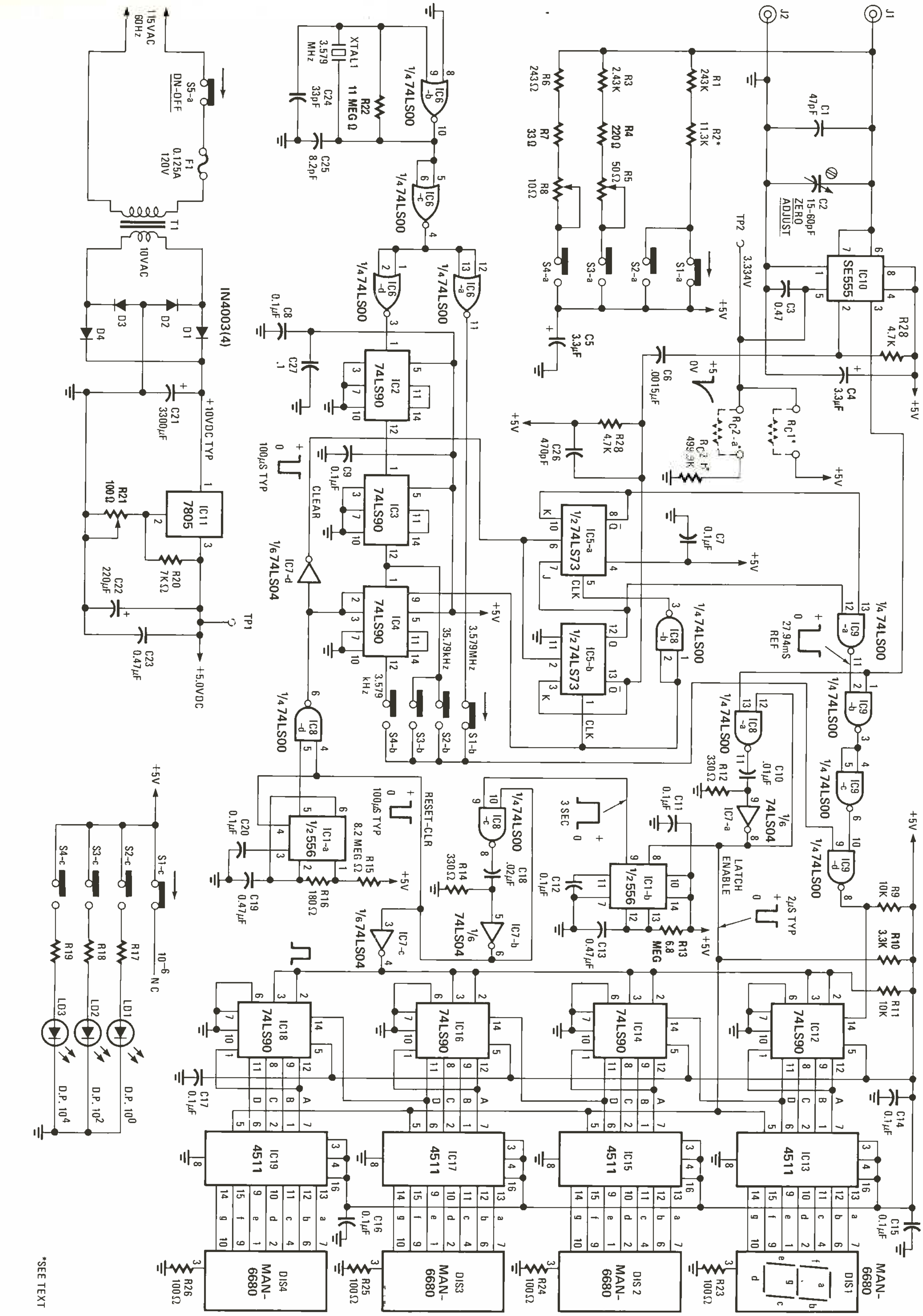


FIG. 2—SCHEMATIC DIAGRAM of the capacitance meter. Maximum values of the four ranges are 9999 pF, 0.9999 μF, 99.99 μF and 9999 μF. Accuracy is $\pm$1% of reading $\pm$1 count.

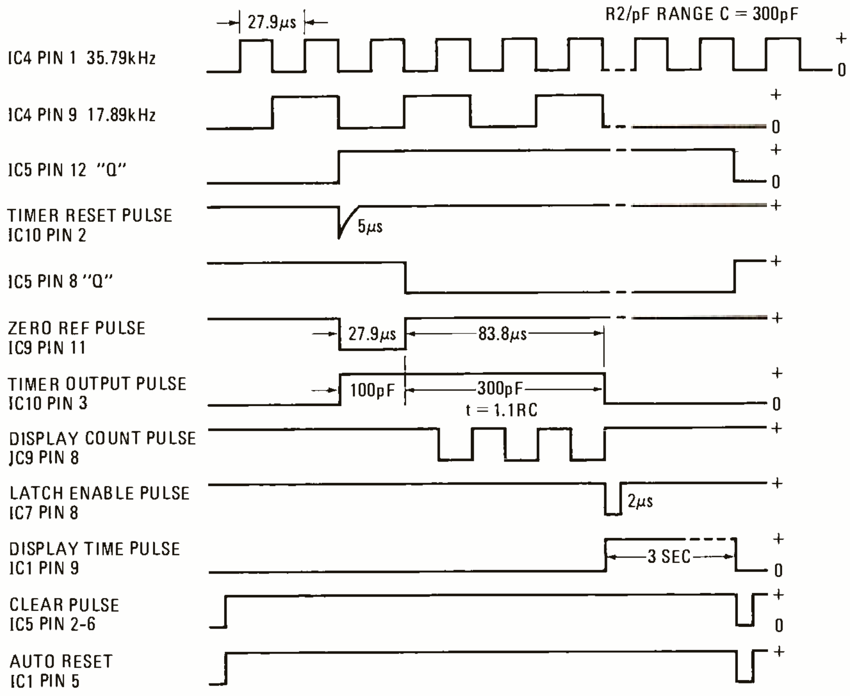
associated with materials, components, and assemblies (PC board runs, switches, terminals, etc.) can be measured.

Circuit description

The capacitance measuring circuit is shown in simplified block form in Fig. 1. The capacitor to be measured, C_x, is connected across the input terminals and appears in series with resistor R_t and voltage V_s. (Disregard capacitor C_c for the moment.) Upon application of a trigger pulse to input "d" of timer QT1, input "b" of QT1, which was previously held internally at ground potential, is set to its high state allowing voltage V_s to charge the capacitor C_t through resistor R_t. The charge voltage, V_h, appearing at input "a" of QT1 reaches a level—after a period of time—that follows the relationship, $V_h = V_s\ (1 - e^{-t/RC})$ where V_s equals the supply voltage and $e^{-t/RC}$ is an exponential function with R and C expressed in megohms and microfarads and "t" in seconds. If R is 1 megohm and C is 1 μF the V_h after 1 second, "t" becomes: $V_h = V_s\ (1 - 0.368) = 0.632V_s$. If the monostable circuit QT1 has an input threshold level V_r at "a" that will activate a reset condition at exactly $0.632V_s$, then the output will be a pulse whose duration is equal to T = RC.

The pulse output of timer QT1 enables gate QG2 and allows clock pulses from frequency divider QR1 to flow through to the counter stages QC1 and QC2. The BCD input to display drivers QD1 and QD2 from the counter stages is decoded to provide segment data to the display when enabled by a pulse from QM1, a one-shot multivibrator that is triggered when the pulse output of QT1 goes low at the end of the timing period, t_n. Multivibrator QM1 also serves to trigger multivibrator QM2, the display time monostable which resets the counter stages and the reference pulse flip-flop QF1, which in turn triggers timer QT1 and begins another measurement cycle. Astable multivibrator QM3 insures the logic is reset if for any reason a normal reset pulse does not occur, as when power is first applied.

On the diagram you see an additional capacitor, C_c, across the input terminals in parallel with capacitor C_x. Because shunt capacitance exist across the input measuring terminals, lead wires and semiconductor junctions, the combined distributed values appear in parallel with the capacitor to be measured and when attempting to measure low values of capacitors, significant errors occur in the readout as $T = R(C_x + C_L)$ where C_L is the combined distributed capacitance. Capacitor C_x is adjusted to produce a pulse width output from timer QT1 that is equal in duration to a reference pulse from flip-flop QF1 ($T_o - T_1$). When both pulses are compared at the inputs of QG1, the output of QG1 will remain low and gate QG2 will not be enabled. But when the pulse from timer QT1 is longer



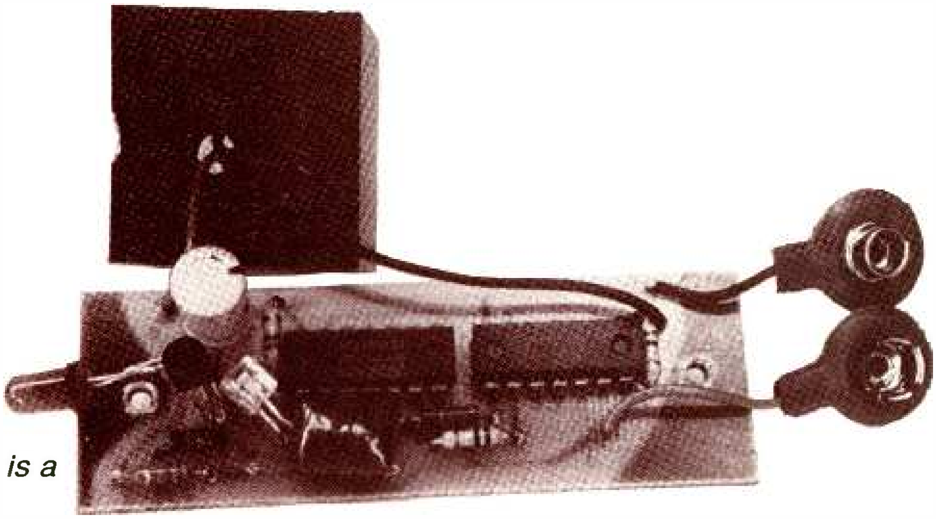
TIMING CHART for the model CM-1000 digital capacitance meter. Helpful in troubleshooting and in understanding circuit operation.

in duration, the output of gate QG1 goes high and enables gate QG2. Consequently, clock pulses are fed into the counter stages. The period $T_0 - T_1$ represents the "zero" compensation adjust interval with the time $T_1 - T_n$ representing the time period due to the capacitance under measurement. The total period is approximately equal to $R(C_x + C_c + C_L)$.

Practical circuit

The actual digital capacitance meter circuit as shown in Fig. 2 operates in the manner previously described. A 555 timer (premium version) is used as the pulse-width generator. The timing chart helps understand circuit operation. The internal threshold level of the 555 is given as 2/3 V_{CC} (V_s in the example). This ratio is established by internal resistors within the 555 timer and if these resistors are held accurate then $t_h = 1.098RC$. As the current through R_t (R6, R7 and R8 in Fig. 2) increases, the saturation voltage across the internal discharge transistor within the device increases and can exceed 100 mV at 10 mA. Consequently the capacitor under measurement will not be fully discharged prior to the reset trigger pulse; thus, $t_h = RCln\ V_s/1 - V_A - V_{sat}$ where V_{sat} equals the saturation voltage across the discharge transistor at the measured current. An external means of setting the 555 threshold level is afforded through the control voltage input (pin 5), trimmer. Compensation resistor R_c1 (or R_c2-a and R_c2-b) sets the value to exactly $2/3V_{CC}$ (3.334 volts for the V_{CC} voltage shown). (The digital capacitance meter kit comes with a precision 555 timer and a compensating resistor to be installed at R_c1 or R_c2-a so the device delivers precisely 3.334 volts DC at test point TP2 to insure the specified 0.1% accuracy. If you obtain your own 555 timer, you'll have to experiment with resistive compensating networks to get the desired voltage at TP2.) Capacitor C_3 at pin 5 must have low leakage as it also shunts the internal resistor network. A leakage current up to 100 nA can exist at pin 7 during the output high state but with the R_t values shown this does not contribute to significant errors. Finally, there exists a propagation delay between the trigger pulse and output risetime of the 555 which must be considered on the low ranges. It should also be mentioned that noise and AC line components appearing at the input terminals can introduce serious errors; good grounding and shielding practices should be used throughout. The clock pulses are obtained from a time-base oscillator using a readily available 3.579-MHz crystal. The divider chain IC6, IC2, IC3 and IC4 provide four ranges, 1—9999 pF, .0001—to .9999 μF, .01—99.99 μF and 1—9999 μF. Capacitors with high leakage and/or series resistance will produce errors in readout. Capacitors with high leakage should be read on the highest range possible (low R_t) and capacitors with high series resistance read on the lowest range possible. *If a capacitor reads differently on two or more ranges, this generally indicates a high leakage factor* (assuming proper calibration of R_t on each range). The range resistors (R_t) should be accurate to within .25% and temperature stable. The counting and display circuits shown are conventional, with utilization of low-power (74LS) TTL devices and some CMOS decoders to minimize current consumption (about 250 mA for the unit shown). The display provides four decades of readout giving good measurement resolution on all ranges.

Flue Bug



An open fireplace damper is a constant source loss of air-conditioned or furnace-warmed air in your home. This low-cost electronic device warns you to close the damper as soon as the fire is out.

FRED BLECHMAN, K6UGT

IF YOU OWN A FIREPLACE, THERE CERTAINly have been times when you've forgotten to close the damper after the fire went out. Prior to the energy crisis this was not a terribly serious omission. Now, however, with energy conservation and the escalating cost of utilities, it has become much more important to close the damper to reduce the cost of heating or cooling your home. A 48-inch-perimeter open fireplace flue can allow 8% of air-conditioned or furnace-warmed air to escape your house! So, to save money and help conserve energy, you can build the Flue-Bug, available in kit form for under $10.

You may wonder, why such a strange name? Well, this gadget simply "bugs" you until you close the fireplace-flue damper. The unit winks and blinks after the fire has gone out—and it keeps blinking for days until you notice it and shut it off. It does *not* itself close the damper, it simply reminds *you* to close it.

How it works

The circuit, shown in Fig. 1, uses two standard CMOS (*C*omplementary-*S*ymmetry *M*etal-*O*xide *S*emiconductor) integrated circuits: IC1 is a quad 2-input NAND gate, and IC2 is a hex inverter. In other words, IC1 has four separate NAND gates, each with two inputs, and IC2 contains six separate inverters. Figure 2 shows the logic symbols of the two types of IC's used in this design. Figure 2-a shows a 2-input NAND gate, in which output pin 3 is LO (near ground) only when *both* inputs are HI. All other inputs result in a HI output. Figure 2-b shows an inverter that simply changes a HI to a LO, or a LO to a HI. With these facts firmly in mind you'll be able to follow the circuit explanation. For such a seemingly simple task, the circuit is quite complex.

A photo-Darlington transistor is used to sense light and radiated energy from the fireplace. Small holes in the heat shield, case and PC board allow light and heat, from the desired direction only, to impinge on the phototransistor. This biases the junctions and allows the current to flow from collector to emitter. Therefore, when you aim the Flue-Bug at the fireplace from about 5 feet away, the phototransistor senses when a fire has been lighted and when it has gone out. When the fire is out, then the Flue-Bug will start blinking.

The circuit explanation that follows is almost a minicourse in digital logic. You don't have to understand it to use the Flue-Bug, but it does illustrate some basic digital design, and by following this detailed description you can analyze many other circuits. Figure 3 shows how to follow the changes in logic states during reset, standby, fire on and fire out.

Assume that the phototransistor does *not* sense a fire. Pressing the reset pushbutton pulls pin 1 of IC1 LO, thus making pin 3 HI, regardless of the state of pin 2. Pin 4 is therefore HI. Since the phototransistor does not sense a fire and its dark-resistance is therefore quite high, input pin 5 of inverter IC2-c is LO, making output pin 6 HI. Since both inputs to NAND gate IC1-b (pins 4 and 5) are HI, output pin 6 goes LO, bringing pins 2 and 13 LO. This keeps pin 3 HI, and the circuit is stable. Since output pin 11 of NAND gate IC1-d is HI (because pin 13 is LO), output pin 2 of inverter IC2-a is LO, keeping NAND gate IC1-c output pin 8 HI. This keeps output pins 4, 8 and 10 of inverters IC2-b, IC2-d and IC2-e LO. Transistor Q2 does *not* conduct in this state, so the light-emitting diode (LED1) does not light up.

When the RESET button is released, IC1-a pin 1 is pulled HI by the positive voltage through resistor R2, but nothing else in the circuit changes.

Now, light the fireplace and the phototransistor "sees" the fire. This drastically lowers its collector-emitter resistance, and the input of inverter IC2-c goes HI, so its output goes LO. This pulls IC1 pins 5 and 12 LO. Output pin 6 of NAND gate IC1-b goes HI, making pins 2 and 13 HI. Since pins 1 and 2 are now both HI, the output of NAND gate IC1-a goes LO,

PARTS LIST

All resistors ¼ watt, 5% carbon.
R1-R3—100,000 ohms
R4—16 megohms
R5—22,000 ohms
R6—5100 ohms
C1—.047 µF, mica
C2—22 µF, 10 volt, electrolytic
LED1—red, jumbo light-emitting diode
Q1—photo-Darlington transistor (Motorola MRD-14B or GE L14H)
Q2—2N2222, 2N3904 (or equiv.) NPN switching transistor
IC1—74C00 CMOS quad 2-input NAND gate
IC2—74C04 CMOS hex inverter
S1—normally open pushbutton switch, miniature
Misc.—Battery snaps; plastic case (2⅞-in.-square × 3⅛-in. long, sprayed with silver paint); heat shield (3½ × 4¼ × .03-inch-thick aluminum); two No. 4-40 × ¾-inch screws; 2½-inch-long spacers; solder (2U6 or equiv.); 9-volt battery.

The following items are available from Interfab Corp., 27963 Cabot Rd., Laguna Niguel, CA 92677:

Kit FB-2: Complete parts kit, including PC board, all holes predrilled, battery not included; instructions, $9.50 postpaid. Assembled and tested, $12 postpaid.

California residents add state and local taxes as applicable.

pulling pin 4 LO, making the output of NAND gate IC1-b HI, thus latching this part of the circuit. (NAND gates IC1-a and IC1-b are wired as a flip-flop.)

Note that output pin 8 of NAND gate IC1-c is still HI (pin 13 went HI, but pin 12 went LO), therefore, the LED is still not on. However, when the fire goes out, the phototransistor resistance increases and, at some point, forces pin 5 of inverter IC2-c LO. This makes the output of this inverter HI, pulling IC1 pin 12 HI. Since pin 13 is already HI, NAND gate IC1-d changes state, and its output (pin 11) goes LO. This is inverted by IC2-a, whose output goes HI, thus making pin 10 of NAND gate IC1-c HI. Pin 9, the other input to NAND gate IC1-c, is already HI, through resistors R3 and R4 from pin 8. Since both inputs of IC1-c are now HI, pin 8 goes LO, causing several things to happen. Inverters IC2-b, -d and -e (operating in parallel for greater current capability) change state to a HI output and forward-bias transistor Q2. This allows LED1 to flash on, powered by the charge from capacitor C2.

Meanwhile, note what happens back at NAND gate IC1-c. (See Fig. 4.) When pin 8 went LO, inverter IC2-f changed state to a HI output, releasing a charge into capacitor C1, which then discharged through R4 to the LO at pin 8. The voltage at point A drops until pin 9 (through resistor R3) is brought below the threshold voltage, and NAND gate IC1-c changes to a HI output. This cuts off the LED, and causes

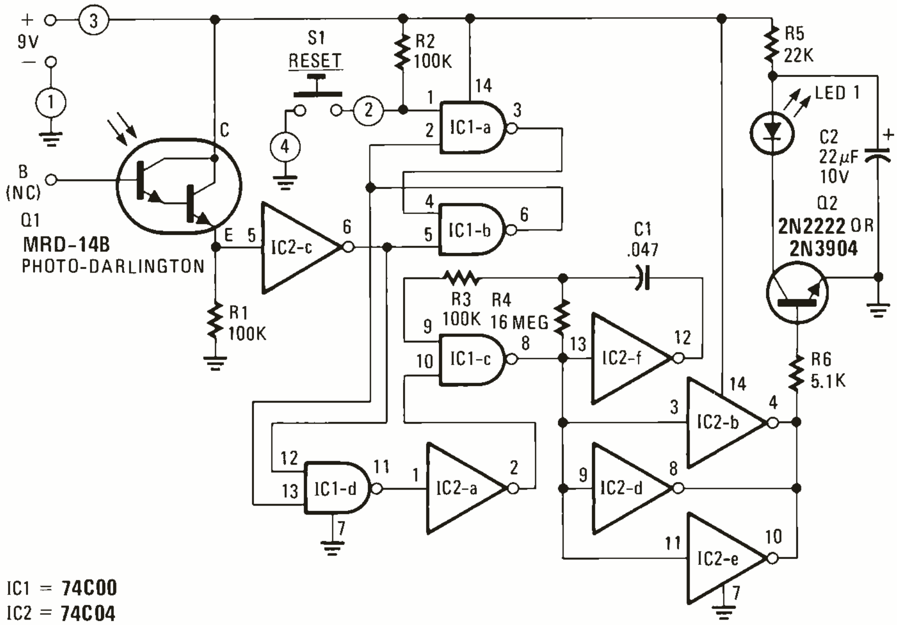


FIG. 1—FLUE-BUG is built using 2 CMOS IC's. Light-sensitive photo-Darlington transistor is used as sensor.

inverter IC2-f to change to a LO output state. Now capacitor C1 charges through R4 until point A rises to the transfer voltage. Fed through resistor R3, this transfer voltage is seen by pin 9 of NAND gate IC1-c as a HI, therefore, its output goes LO and the LED starts blinking. This circuit is a gated astable oscillator, and as long as pin 10 is held HI, the LED will flash at a slow rate (determined by C1 and R4). When the RESET button is pressed, or the phototransistor again senses light, gate IC1-c pin 10 is pulled LO and the oscillator stops in the LED-off condition.

Note that during the time that inverters IC2-b, -d and -e have a LO output and the LED is off, capacitor C2 is being charged through resistor R5. When Q2 is biased-on (inverters IC2-b, -d and -e HI output), the capacitor C2 charge flows

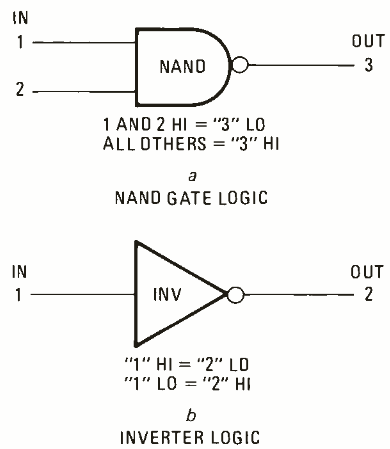


FIG. 2—POSITIVE INPUT LOGIC. NAND **gate is shown in *a* and inverter is shown in *b*.**

PIN #	74C00 (IC1)				74C04 (IC2)			
	RESET	STANDBY	FIRE ON	FIRE OUT	RESET	STANDBY	FIRE ON	FIRE OUT
1	L	H	H	H	H	H	H	L
2	L	L	H	H	L	L	L	H
3	H	H	L	L	H	H	H	
4	H	H	L	L	L	L	L	
5	H	H	L	H	L	L	H	L
6	L	L	H	H	H	H	L	H
7	L	L	L	L	L	L	L	L
8	H	H	H		L	L	L	
9	H*	H*	H*	*	H	H	H	
10	L	L	L	H	L	L	L	
11	H	H	H	L	H	H	H	
12	H	H	L	H	L	L	L	
13	L	·L	H	H	H	H	H	
14	H	H	H	H	H	H	H	H

NOTE:
*MEASUREMENT REQUIRES VERY HIGH IMPEDANCE INSTRUMENT (ABOVE 50 MEGOHMS) OR CIRCUIT ACTION IS AFFECTED.

FIG. 3—TRUTH TABLE shows logic state of IC pins during normal operation.

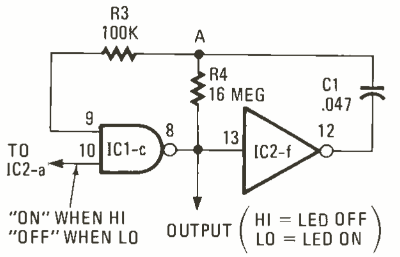


FIG. 4—GATED ASTABLE OSCILLATOR as used in the circuit shown in Fig. 1.

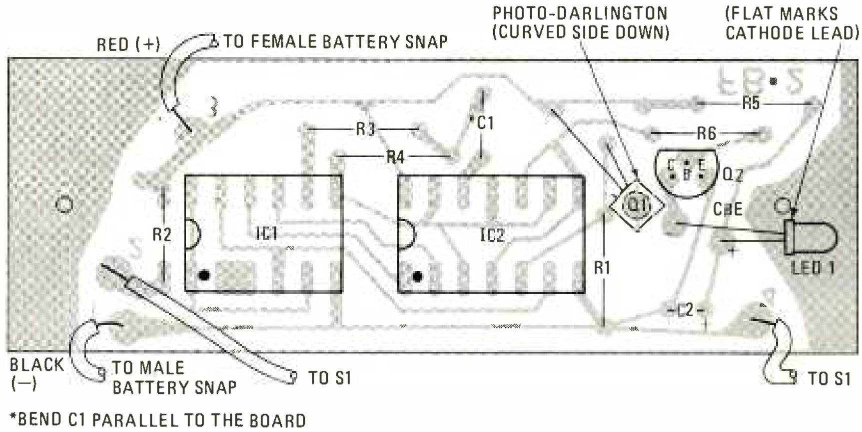


FIG. 6—COMPONENT PLACEMENT diagram.

through the LED to provide a bright "blink" of short duration. Thus, battery power is conserved, yet the flashing LED is visible in brightly lighted surroundings. The battery drain is only 5 μA during reset or standby, 80 μA when the fire is lighted and an average of approximately 2 μA when the LED is blinking. This means that a standard zinc-carbon battery will last about a year in normal use, or about 10 days' blinking.

Construction

Constructing the Flue-Bug is much easier than understanding the circuit operation. Be sure to use small-diameter rosin-core solder, a low-wattage soldering iron and a magnifying glass to check your soldering. (The kit contains detailed step-by-step instructions that should be followed closely.)

The PC board pattern is in Fig. 5; and the parts layout is shown in Fig. 6. Be sure to properly orient the IC's, electrolytic capacitor C2, LED1 and transistors Q1 and Q2. The red-lead female battery snap goes to the PC board positive trace, and the black-lead male snap goes to ground. Position the phototransistor over the small hole in the PC board, with the curved face toward the hole. Bend capacitor C1 down, after soldering it to the PC board to allow room for the battery inside the case. Mount the LED, as shown in Fig. 6, with the lead that is closest to the "flat" on the base of the LED going to the connection near phototransistor Q1. Mount pushbutton switch S1 in the cover corner hole, with two wires going to the PC board.

Connect a standard 9-volt transistor radio battery to the snaps and test the unit before the case and heat shield are installed. With the battery connected, shield phototransistor Q1 from the light and press the RESET button. If the LED was blinking before you pressed the button, it should now stop. Next, expose the phototransistor to the light—nothing should happen. Cover phototransistor Q1 again, and the LED should start blinking immediately, thus demonstrating the surprising light sensitivity of the Flue-Bug.

If the device doesn't work properly, the most likely causes are wrong parts placement or orientation, or poor solder joints or solder bridges. Figure 3 shows the states of all pins on both IC's under all conditions. You can check these states with a multimeter having a sensitivity of 20,000 ohms-per-volt or better.

Before assembling the PC board and battery into the case, pretap the holes at each end of the PC board by twisting a mounting screw into each hole to form threads. Figure 7 shows the complete assembly. Carefully slide the battery-PC board assembly into the case, making sure the phototransistor is opposite the case hole. Place the cap on the case so that the LED projects through the upper hole. Using screws and spacers, attach the hèat shield so that the unit stands upright. Make sure that the bare metal side of the heat shield faces outward (to reflect heat from the plastic case) and that the black-painted side faces the unit (to prevent reflected ambient room light from falsely triggering the phototransistor). **R-E**

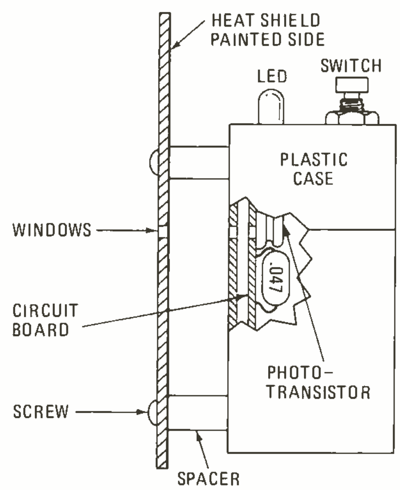


FIG. 7—FINAL ASSEMBLY of Flue-Bug.

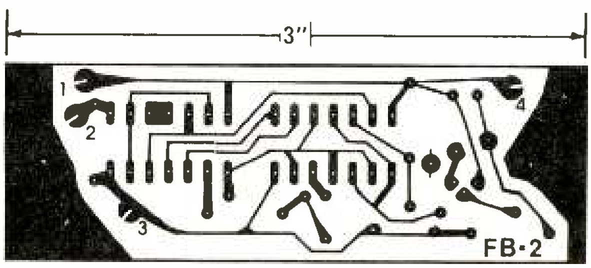
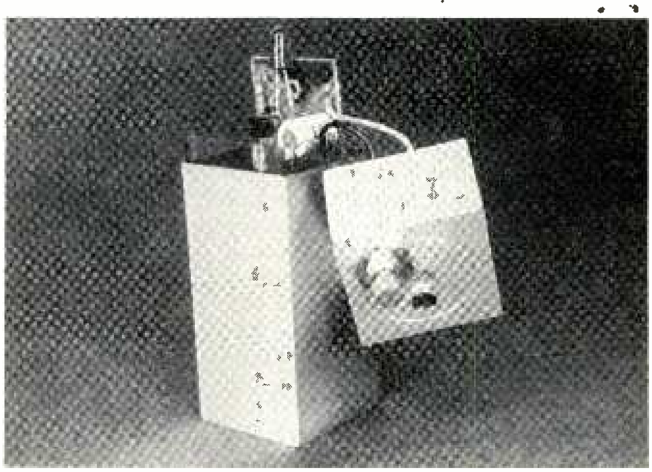
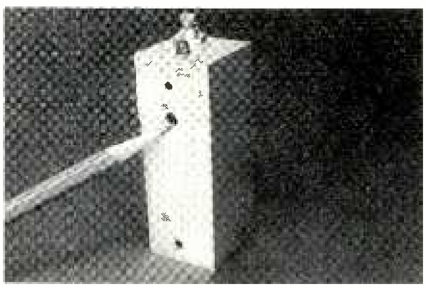


FIG. 5—PRINTED-CIRCUIT BOARD shown full size.



FLUE BUG with housing cover removed. Reset button is in top. Heat shield is on far side of case and can't be seen.



PENCIL POINTS TO WINDOW. Similar aligned windows are in heat shield and circuit board.

Audio Testing With Pink Noise

One of the most common uses of the graphic equalizer today is in tailoring the response of an audio system to fit a particular need. The use of a pink-noise generator simplifies making the equalizer adjustments.

JEFFREY G. MAZUR

MY ARTICLE "PINK NOISE GENERATOR Tests Your Hi-Fi" (January 1978 **Radio-Electronics**) described a simple and inexpensive device that could be used to properly set up a graphic equalizer. Since the use of pink noise has generally been restricted to sophisticated audio engineering labs, many readers were unfamiliar with the techniques involved. This article will therefore attempt to explain in greater detail how a Pink Noise Generator works and how best to use it.

Once again let's recall what pink noise and white noise are. These signals are a mixture of all frequencies (in this case all *audio* frequencies) with precise amplitudes. White noise contains all frequencies at the same amplitude while pink noise has a 3 dB-per-octave rolloff associated with it (see Fig. 1). Incidentally, the color pink was chosen as an analogy to the frequencies of the light spectrum. Red light corresponds to the lower-frequency portion of the visible spectrum and a mixture of all frequencies produces white light. Thus, a mixture of light with a heavier emphasis on the lower frequencies (equivalent to a high-frequency rolloff) results in the color pink.

To generate pink noise you begin with a source of white noise such as the MM5837 IC, as described in my earlier article. This device contains a 17-bit shift register and an oscillator that generates a pseudorandom digital sequence. Unlike traditional semiconductor junction noise sources, the MM5837 provides a signal of uniform noise and output amplitude. This signal is then fed through a −3 dB-per-octave filter to give pink noise. Since the minimum rolloff with a single-stage filter is 6 dB-per-octave (due to the reactance of a capacitor), a special design is needed to achieve the required 3-dB rolloff. This technique involves cascading several stages of lag compensation. The result is shown in Fig. 2. Figure 3 plots the response of this circuit, in which the "ripple," or deviation from a linear slope, is found to be ±½ dB.

The filter, together with the MM5837, yields a pink noise output, as shown by the curve in Fig. 4. Note that this curve is not an ordinary frequency-response plot; it represents the energy spectrum of the noise in ⅓-octave segments. This is achieved by passing the signal through successive bandpass filters corresponding to the frequencies along the horizontal axis. Thus, the curve represents the type of response you should expect when using the individual filters in a graphic equalizer. Figure 4 shows the output is quite flat. The large deviations at the low end are the result of the extreme low frequencies (0 Hz-15 Hz) generated by the pink noise generator. (Although the noise generator frequency output extends from essentially zero, it is not shown in Fig. 4 because the curve-plotter used begins at 30 Hz.) The true reading is taken as the average value of the waveform.

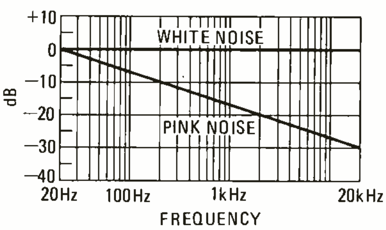


FIG. 1—SPECTRUMS of white noise and pink noise.

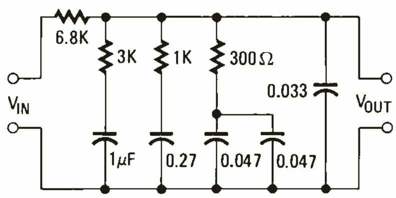


FIG. 2—PASSIVE FILTER with a −3 dB-per-octave rolloff.

Graphic equalizers

Now that you have a good source of pink noise, how can you use it? For a high-quality audio system, one of the goals is to achieve a flat frequency response. This means that the music you hear from the speakers will most closely resemble the sound heard by the recording engineers. Most electronic equipment contained in a stereo system can reproduce these frequencies quite accurately. For example, amplifiers commonly have frequency-response specifications of ±1 dB over the entire audio spectrum (20 Hz–20 kHz). However, in speakers, such flatness is rarely achieved. To make matters worse, speaker response depends largely upon its location in the room with respect to walls, furniture, etc. In fact, the room itself can account for frequency-response fluctuations of ±10 dB or more. This is due to resonances within the room, absorption of sound by curtains and carpeting, as well as reflections from the walls, etc.

A graphic equalizer allows you to electronically alter the system's frequency response to compensate for any mechanical and accoustical problems encountered in the speaker and room. With ten or more tone controls the graphic equalizer lets you adjust system response octave by octave to flatten out the overall frequency response. The problem of setting each control accurately is solved by using the pink noise generator.

Determining equalizer settings

When testing with pink noise you must be careful not to misinterpret the results. A strict procedure should be followed to eliminate any problems before they affect the final equalizer settings. Start with all

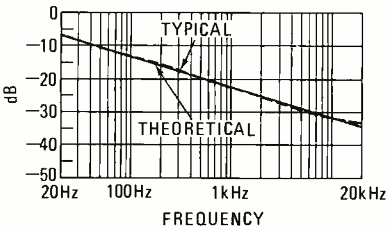


FIG. 3—FREQUENCY RESPONSE when using −3 dB-per-octave filter. Note deviation from ideal response of approximately ±½ dB.

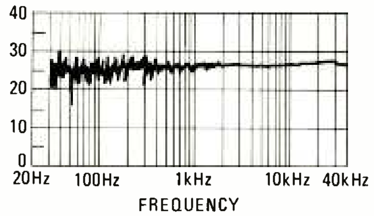


FIG. 4—PINK NOISE GENERATOR OUTPUT. Curve does not represent frequency response; it shows the energy distribution of the output signal.

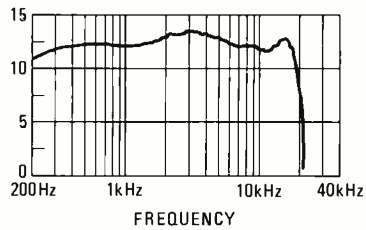


FIG. 5—TYPICAL FREQUENCY RESPONSE for the Superscope *model EC-1* microphone. Curve was obtained in an anechoic chamber with a controlled (constant) sound field.

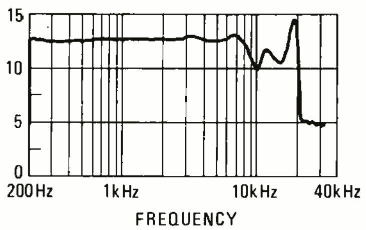


FIG. 6—MICROPHONE RESPONSE for Superscope *model EC-5*. Curve was obtained in an anechoic chamber with a controlled (constant) sound field.

the equalizer controls in their mid-position. Then, connect the pink noise generator to a suitable input of the system. Since most low-level electronics are reasonably flat, any place before the power amplifier will usually be adequate. Any auxiliary, tuner, or tape input is fine. A microphone is set up, placed in a normal listening position and connected to some sort of level-indicating device, e.g. the mike input of a tape recorder with a VU meter. If you use a tape recorder, make sure that there are no automatic-level (ALC) or frequency-dependent circuits that affect the meter reading.

With the pink noise generator on, you should hear a static-like sound from the speaker. Set the volume control so that a VU reading of 0 is obtained with the meter input level (MIC or RECORD level control on a tape recorder) about three-fourths of the way up. Next, check for background noise. Turn the pink noise generator off. The level meter should drop almost all the way down. Any residual reading is either due to electrical noise (i.e., hum) or background noise such as a TV set or nearby conversation. If the meter does not drop by at least three-fourths (−10 dB) do not proceed until the background noise is reduced. Next, turn the generator back on (the VU meter should read 0) and place all the equalizer controls to their minimum positions. As each control is turned down, the meter reading should drop and, finally, with all the controls down it should read less than two-thirds scale (−8 dB). If this does not happen, then there is too much leakage through the equalizer. Try turning on a high-cut (hiss) or low-cut (rumble) filter, or both. Remember that for these filters to have any effect, the pink noise must be applied before the equalizer circuits, as is usually the case with auxiliary or tuner inputs. If a filter is necessary to reduce the leakage noise, then leave it on when setting all controls except for the extreme control it affects. That is, if the low-cut filter is needed, leave it on when setting all but the lowest frequency control on the equalizer.

Then, set one control (usually the one affecting a frequency of 1 kHz) to its middle or 0 position and readjust the volume control for a VU reading of 0. Then, turn this control back down and raise each of the other controls one at a time until the 0 VU level is reached. Mark this position of each control in pencil on the equalizer (or take note of its position on a scale alongside the control), after which return the control to its minimum position. When all the controls have been marked, place them at their recorded positions; this setting represents the flattest response for the system. Note that when you set the lower-frequency controls, the level meter may oscillate back and forth with the low-frequency "beat" produced by the pink noise generator. By watching the needle carefully, however, you should be able to set it to bounce equally on either side of the 0-VU level.

Microphone frequency response

A vital part of pink noise testing relies on the frequency response of the microphone used. It is important to have some idea of its true frequency response. Many manufacturers supply some information, sometimes in the form of a graph; but unless the graph specifically refers to the unit you own, there may be some question as to its accuracy.

Electret condenser microphones offer the best frequency response for a reasonable price. Superscope, for example, manufactures a *model EC-1* microphone that sells for about $10 and gives a fair response (see Fig. 5). The *model EC-5* mike (about $30) is an excellent mike and has a very flat frequency curve (see Fig. 6) that makes it quite suitable for pink noise testing. The odd response between 10 kHz and 20 kHz should not concern you. Since one control usually covers this entire octave, you can use the average value over this range. In this case, let's estimate the overall response of the mike in this octave as −2.5 dB. By setting this control for a reading of −2.5 dB during setup, you can effectively cancel out the nonflatness of the microphone. Set the equalizer controls for the same reading that would correspond to the frequency response of the microphone for that octave. This can be applied to any mike whose frequency response is known no matter what the actual response looks like. If your meter is not calibrated in decibels, this can be approximated by setting the control for the 0 level and then altering it the required amount by reading the dB scale usually supplied for the equalizer controls.

Finally, once the equalizer has been set for a flat frequency response, minor alterations can be made to suit your individual taste or to correct for other equipment deficiencies. Several settings may be required to account for varying room acoustics. For example, if there are curtains in the room that are sometimes open or closed, make a response test each way. Any control settings that differ for each situation should be clearly identified so that the proper setting can be made.

A few words of caution

The above procedure will work only with equalizers whose controls follow some regular pattern; that is, each control must cover some multiple or submultiple of an octave. For this reason, parametric equalizers, which are extremely useful and whose popularity is growing, cannot be set up this way; they require a real-time or spectrum analyzer for proper setup.

A final note

Since the MM5837 is a digital 17-stage device, it cycles through its entire sequence in about 1½ seconds. Thus, the noise exhibits a noticeable repeating pattern that may make the pink noise generator unsuitable for use in psychological testing or wind and rain sound effects. These uses may require a more conventional white-noise source such as that obtainable from a reversed biased transistor. **R-E**

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1. BOHN, DENNIS, *Audio Handbook*, National Semiconductor, 1977, pp. 2-56–2-59.
2. SHANEFIELD, DANIEL, "Audio Equalizers," *Stereo Review*, May, 1976, pp. 64–67.

Pioneers Of Radio

The worlds of electric and electronic communications owe much to pioneering researchers and inventors. Among them are Thomas A. Edison, Heinrich Hertz and Sir Oliver Lodge.


THOMAS ALVA EDISON

FRED SHUNAMAN

ONE EVENING IN NOVEMBER, 1875, THOMAS Edison, working alone in his laboratory, discovered what he believed to be "an entirely new force." Working with a magnetic vibrator, which included an iron-core coil and an interrupter similar to an old-fashioned doorbell, he noted that sparks jumped from the iron core to any metal body brought close to it. A wire connected to any metal part of the vibrator carried this new force and sparks appeared if the wire was touched to any large metal object. Even if the wire was turned back on itself and formed into a ring, and the end of the wire touched any part of the ring, a spark occurred, which was contrary to any of the then-known laws of electricity. "This," said Edison, "is simply wonderful and a good proof that we are dealing with a not-now-known force."

Further tests confirmed his opinion—the new force did not affect an electroscope or galvanometer, and would not attract small bits of dry cotton wool.

However, Professor Edwin Houston of Philadelphia, who had conducted somewhat similar experiments in 1871, disagreed. He and his colleague, Elihu Thomson, repeated the earlier experiments (see **Radio-Electronics**, December 1975, page 26), and showed that the effects were due to "induced currents" and that the reason Edison could not detect them with (direct-current) instruments was that each current was immediately followed by an "inverse current" that neutralized it.

Edison must have been convinced, for in 1885 he applied for a patent on a "Means of Transmitting Signals Electrically." The patent drawings showed a coil with a low-voltage primary and a rotary circuit breaker to interrupt the primary current. One end of the high-voltage secondary was grounded, the other was attached to a condensing surface suspended as high as possible. One patent drawing depicts this condensing as a wide metal-foil ribbon between the two masts of a ship.

Edison put this invention into use with a "grasshopper telegraph" for communication from a moving train. A foil-covered board on a car roof was the mobile antenna—the telegraph wires served as the trackside antenna. (The system was a success but abandoned after a few weeks because of lack of business.)

The short distance covered by this only practical application of his invention may be one of the reasons Edison's radio was brushed off as an "induction device." The other—and more important—reason is a matter of language. In 1885 (the year after the transformer was invented) induction meant *electrostatic induction* unless otherwise specified. Today it means *magnetic induction*, and modern electronics historians read it as such in the old accounts. Yet before electric waves were known, any electric action at a distance was attributed to electrostatic induction.

Both in the language Edison used and in the distances he expected to cover, it was quite clear that he was not speaking of magnetic induction. He said:

"If sufficient elevation can be obtained to overcome the curvature of the Earth . . . signalling may be carried on by static induction without wires . . ." (obviously beyond the visual horizon). And in explaining his grasshopper telegraph, he told a reporter: "This invention uses what is called static electricity."

Heinrich Hertz

THERE ARE MANY ANSWERS TO THE question, "who invented radio?" But the only answer to "who *discovered* radio?" is Heinrich Hertz!

However, not even this great discovery was entirely new. The Irish physicist Fitzgerald had predicted radio waves and, together with Oliver Lodge, had attempted to reproduce them on wires. Von Bezold of Germany had conducted experiments somewhat similar to those Hertz would perform. "Unfortunately," said Hertz, "their researches did not help me—I learned of them subsequently."

Hertz had noted—like others—that electric discharges produced effects on metal objects separated in space from the discharge. He also noted that these cases were always accompanied by a spark. The effects, he said, depended not only on their theoretical possibility, but also on a "special and surprising property of the electrical spark that could not have been foreseen by any theory."

Therefore, in 1887 Hertz began to work with spark discharges, developing what became the familiar spark-coil transmitter. To detect any waves that might be produced, he used what was called a Reis spark micrometer. This device was an incompletely closed wire loop or rectangle, leaving a small opening at the wire ends. The purpose was not simply to try detecting a spark-discharge effect. He had done that before with a Leyden jar. He wanted to discover if the effects repeated consistently—were in fact *waves* following each other at a regular rate.

Any waves, Hertz reasoned, must ". . . act with a much stronger effect on a circuit having the same period of oscillation than upon one with only a slightly different period." Varying the size of his detector loop, he found that indeed the spark was strong at a certain size, and diminished as the loop was made bigger or smaller than the ideal size. Making a graph of this effect, Hertz produced the first "tuning curve."

Next, Hertz attempted to reflect the waves, using a sheet of zinc, 4 meters long and 2 meters wide, fastened to the end wall of his laboratory. The detector showed points between the transmitter and the end of the room where the sparks were bright, others where they were small or invisible. Thus, he was positive he had produced standing waves in space and was able to measure the transmission wavelength. By calculating the frequency, he was able to estimate the velocity of the waves, and discovered they traveled at or

continued on page 57

VIDEO MODULATORS

turn your TV into a video monitor

If you are into VTR's, TV games or TV cameras for security and surveillance applications; a video modulator may be needed to feed the signal into an ordinary TV set used as a monitor. This concluding story looks at modulators now available

FRED BLECHMAN K6UGT

IN THE LAST TWO YEARS VTR'S, TV GAMES, VIDEO CAMERAS AND home computers have been brought into many homes. Many of these devices have their own CRT monitors. To use an ordinary TV set as a monitor, you'll need a video modulator to develop the video-modulated RF carrier. This month we continue a discussion of available modulators begun last month.

Since the video signal from the computer consists of pulses with sharp rise- and falltimes, the edges of the pulses become rounded in the process of going from video to modulated VHF, then through the TV video bandpass amplifiers to demodulated video. Although the modulators could only be rated "good" (not "excellent") for this use, the resulting TV display was certainly usable. Letters and numbers on the TV screen were relatively sharp. The punctuation marks, extremely important in some programming, however, were not clear. In other words, for *reading* data on the TV screen, a video modulator would be adequate, especially if the characters are large. However, for small characters or for *programming*, you should consider using a video monitor or modifying your TV to provide a video input jack.

The documentation provided with the modulators tested varied from excellent to nonexistent. Some manufacturers were very careful to point out the FCC restrictions on their use and potential for interference with your neighbors' TV reception. Others totally ignored the subject! ATV Research, on the other hand, is aware of FCC regulations regarding devices that connect to TV antenna terminals (the FCC designates these devices as Class 1 TV devices). Therefore, ATV Research includes several suggestions with their video modulator kits:

1. If the unit is not being built within existing shielded equipment, enclose it in a metal box.
2. Use only coaxial-type input and output connectors, such as BNC or SO-239.
3. Do not use a higher operating voltage than is specified for the unit.
4. Never connect the unit to the TV antenna terminals without *dis*connecting the TV antenna or using an antenna changeover switch with at least a 60-dB attenuation.
5. Stop operating the unit immediately if you are causing interference with your neighbors' sets.
6. Do not sell or lease these units in assembled form.

Now let's take a detailed look at the products each manufacturer is offering in alphabetical order.

Advanced Computer Products
P.O. Box 17329, Irvine, CA 92713

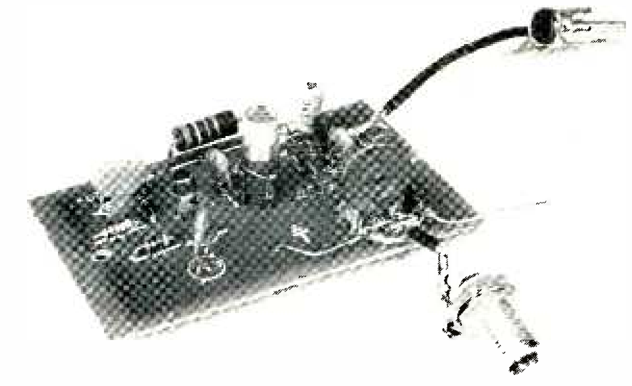
The *model U1001* RF Modulator is the lowest-priced assembled unit that can be used with a standard NTSC video signal, and it will also handle audio. Four mounting tabs and smooth top and bottom surfaces make this unit east to mount. The RF output is pretuned to TV Channel 3, but can be changed to Channel 4 by grounding the switch terminal. The input voltage is not critical, since this modulator circuitry appears to be regulated internally. The power drawn is 18 mA at the recommended 9 volts DC.

This modulator has double shielding and gives the appearance of a high-quality unit. However, the performance of the unit tested was disappointing in a computer environment. The interference rejection was poor, apparently due to low RF output. Although there were no external adjustments, popping off the flanged covers revealed several screws that could be adjusted to increase the output. We did not attempt to do this, since the documentation provided with the unit was only a simple connection diagram.

If you are inclined to experiment, this looks like it has the makings of a great unit. Considering that it is completely assembled and includes audio (all for $7.95), it might well be worth the effort of adjusting some tuning screws. And, used outside of the computer environment, it worked fine.

Advanced Video Products
5835 Herma Street, San Jose, CA 95123

The *model RF-1* comes in kit form and can be easily assembled in 30 minutes, using the step-by-step instructions; a large, clear schematic; a components layout; and a photograph of the finished unit. There is no component crowding, and slug-tuning the VHF output frequency from Channels 2 to 6 is easily and precisely performed with the tuning wand provided. The video input potentiometer can be set with your fingers or a small screwdriver. The overall performance of this unit was among the best tested. A Zener-regulated power-input circuit allows the modulator to be used over a broad range of input voltages (9 volts to 20 volts) without affecting the output. Two large mounting holes are provided on the PC board. No connectors or cabinet are provided, and no precautions against interference are mentioned in the documentation.

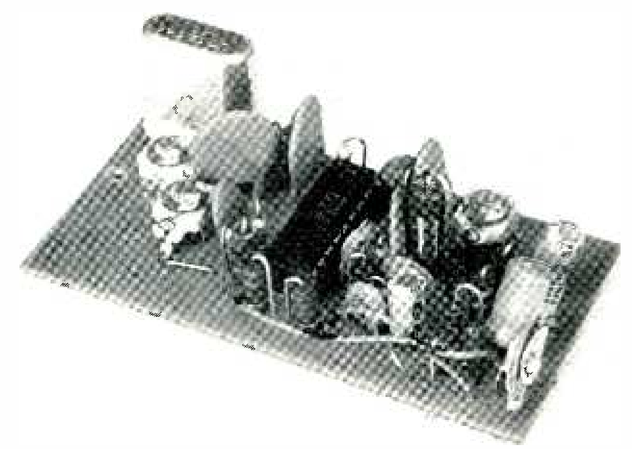


MODEL RF-1 rf modulator from Advanced Video

ATV Research

13th and Broadway, Dakota City, NE 68731

Both ATV Research units have excellent, clearly printed detailed instructions, including schematics and precautions regarding interference and FCC restrictions. Both units use a printed-circuit inductor (with spiral rectangular turns) for the VHF tank circuit, and output channel tuning is performed by adjusting a small trimmer capacitor with an insulated tool (not provided).



ATV RESEARCH PXP-4500 Pixe-Plexer

PXV-2A PIXE-VERTER made by ATV Research

The *model PXV-2A Pixe-Verter* is the only video modulator tested that requires a *negative* power-supply voltage. This is no problem if the ground connection between it and its associated inputs and outputs is properly polarized or isolated.

It takes only about 30 minutes to assemble the *Pixe-Verter*, but you must work carefully because the components are somewhat crowded together, and several PC board holes must be enlarged for the parts to fit on the board. Also, you will have to decide which TV channel you want to use, since a jumper to one of the turns of the printed-circuit inductor determines the output-frequency range. Two mounting holes are provided, and, because both the input video level and output frequency control are adjustable, it is easy to interface with the video source and TV set, using your own connectors. However, be careful of the supply-voltage polarity! No case is included.

The *model PXP-4500 Pixe-Plexer* is designed for the advanced experimenter and hobbyist who wants exceptional versatility. However, along with such versatility come complexity and many options.

The *Pixe-Plexer* is built around a National Semiconductor LM1889 TV video modulator 18-pin IC. This IC is designed to interface audio, color difference and luminance signals to the TV receiver's antenna terminals. The LM1889 consists of a sound subcarrier oscillator, quadrature chroma modulators, and RF oscillators and modulators for two low-VHF channels. The *Pixe-Plexer*'s external components, including a 3.58-MHz TV color crystal, are on a PC board with a 24-hole breadboarding section. This design allows you to use the LM1889 with various experimental input and output circuits, as a sort of breadboard. And for even more flexibility, a 10-page reprint of the LM1889 data sheet is included that contains various circuits. The ATV Research PC board was designed for a multipurpose circuit; *you* determine what options you want.

This unit is not for beginners. It takes about 1½ hours to assemble, and interfacing requires that you provide a relatively high current demand (from 40 mA to 50 mA at 15 volts) and biasing voltages. You may need an external power supply if your video source cannot supply 50 mA at 15 volts. Also, because the *Pixe-Plexer* handles audio as well as video, this unit may be more complex than is needed for simple applications. Tuning requires adjusting three trimmer capacitors and a small potentiometer, plus varying bias voltages for some applications; no tuning tool is included. Two large mounting holes are provided, but no case or connectors.

California Industrial

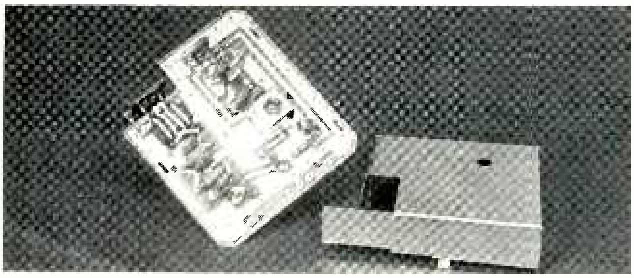
P.O. Box 3097K, Torrance, CA 90503

The *model CA-010410* comes already assembled, complete with metal case, an RCA phono-jack RF output connector, and four mounting tabs protruding from the side of the case. (Double-sided tape could also be used for mounting.) Access holes allow precise tuning to Channels 3 or 4, but a miniature hex tuning wand is needed to turn the slug. The unit has no adjustment for video input level or supply voltage. It works very well at a 1.5-volt input, with only 0.5-mA drain, so a AA-size battery cell can operate it for several hundred hours. However, the video input signal must be limited or VHF output overmodulation results. You can install a small 1K potentiometer to accomplish this easily. A mating RF connector and 15 feet of coax cable are included.

The RF output jack, an RCA phono-type, is mounted directly onto a PC board, with no center-hole clearance. Therefore, the RCA plug you use to mate with it may need to have the male center terminal shortened, or it will be stopped by the PC board before the outer shell makes contact. The input connections are three wires to which a small transistor socket mates nicely. The shielded container is easily opened, and the unit can be removed in one piece with desoldering, since the entire circuit is built on a single PC board. The unit's construction is of very high quality, and built around a μA3086 IC. Although the brief instructions include a schematic and connection information, they do not contain a circuit explanation or any precautions. In the comparison tests, this unit's performance was among the better of those surveyed. This was the smallest and least expensive preassembled unit designed to work with a standard NTSC negative-sync video signal. It also uses far less power than any other unit tested, therefore, battery operation is practical.

Delta Electronics
7 Oakland St., Amesbury, MA 01913

The *model 5500R Videocube* (described in **Radio-Electronics**, August, 1977) is one of the most sophisticated kits we surveyed. The two-sided PC board can be assembled easily in 45 minutes, and the top shield included with the kit provides the necessary RF radiation protection. The kit also contains an antenna switch, and the unit's output is designed to feed directly into 300-ohm TV antenna terminals. (It has an on-board balun coil to convert the 75-ohm unbalanced circuit output to a 300-ohm balanced line that connects to the antenna switch.) There are no mounting holes, but double-sided tape could be used on the shield for mounting the unit.



VIDEO CUBE 5500-R from Delta Electronics

The modulation technique involves adding a resistor to ground at the video input, with the value based upon the video-signal amplitude. This resistor sets the forward bias on a signal diode that controls the amount of RF signal fed from the oscillator section to the output. Positive video signals tend to cut off the diode, while negative video signals (such as the sync pulses) increase diode conduction, thus providing the RF negative modulation needed at the TV terminals. This technique seems best suited to interfacing with game circuitry, rather than with a standard 75-ohm camera or computer video. In any case, extra components and some tinkering are required for best results. For example, to connect the *Videocube* to a computer, the instructions recommend using a circuit containing three resistors and a tantalum capacitor. A footnote adds that the two resistor values must be "adjusted for optimal display." In testing this modulator, we used some typical values for this network, and the operational results were still the poorest of all the units tested! Furthermore, adjusting the slug-tuned coil to the proper output frequency is difficult without a special tool, which is not supplied in the *Videocube* kit. No doubt additional experimentation will improve the results.

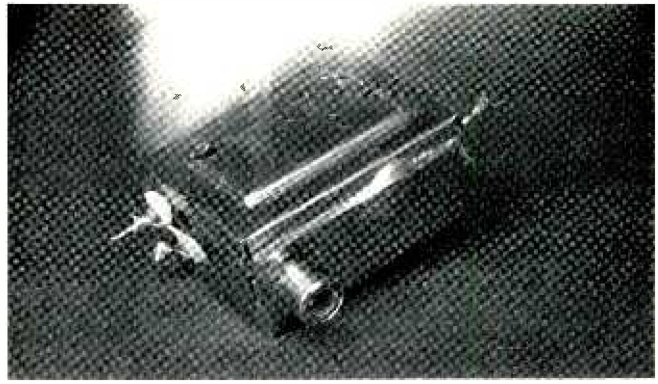
The kit's documentation provides a great deal of information, most of which was included in the August 1977 **Radio-Electronics** article, plus FCC interference test requirements.

Electronic Systems
P.O. Box 212, Burlingame, CA 94010

You can assemble this unit (*model 107*) easily in 30 minutes, and four corner mounting holes are provided. No shield or cabinet is supplied, and no interference precautions are mentioned in the brief, but adequate, assembly instructions. Half of the board is taken up with a rectifier/filter/regulator circuit that allows you to use a 12-VAC center-tapped transformer for the power source. If you use a 5-volt DC source (about 10 mA) these components are *not needed.* The modulator circuitry is simple, uncrowded and performs well. However, there is no input video-level control potentiometer, and you must set the output frequency by squeezing or opening the 3$\frac{3}{4}$-turn hand-wound open tank coil! You can buy the PC board alone for $7.50 and use your own components (standard resistors, capacitors and a standard 2N2222 transistor) to save money if you plan to run this device on 5 volts DC. No connectors are supplied.

Formula International, Inc.
12603 Crenshaw Blvd., Hawthorne, CA 90250

This unit is small, inexpensive, comes already assembled and



E & P MODULATOR from Formula Int'l and Godbout.

is completely shielded, but it cannot be used with a standard negative-sync video input signal. If your video source has *positive* sync, or can be inverted to positive sync by taking it from a different point in the output circuit, this unit is the *only* video modulator tested that can operate with a standard U.S.-manufactured TV set. (You might also be able to invert the input signal with a simple transistor circuit.) No video input control is provided either. This same unit (marked E & P on the case) is also sold by Godbout Electronics and both are pretuned to TV Channel 3.

There was no schematic included and no precautions concerning RF interference. Two mounting tabs or double-sided tape can be used to secure the unit on a flat surface. An RCA phono-type jack is used for the VHF output connection.

Godbout Electronics
Oakland Airport, CA 94614

This unit is identical to the Formula International unit, therefore, the same comments apply, except that no documentation at all was received with this unit. Since Godbout is normally very good about documentation, this omission was probably unintentional.

Jade Computer Products
5351 West 144th St., Lawndale, CA 90260

The *model TV-1* is an excellent unit in every respect. It is small, takes about 20 minutes to assemble, has the best sensitiv-

VIDEO-to-TV INTERFACE, model TV-1
by Jade and Quest.

ity of any unit tested and performs as well or better than units costing almost three times as much. It is the smallest unit tested in cubic volume—small enough to fit within the video source enclosure—so no case is supplied. It operates from 5 volts to 12 volts (only 1.5 mA at 5 volts), has an on-board video input-level potentiometer, and is capable of tuning from Channels 2 to 6 with a simple trimmer-capacitor slotted-screw adjustment, using an insulated small-tip tool (not included). A single corner mounting hole is provided.

The documentation is complete, clearly printed and includes a clear photograph of the finished unit. The kit also contains over three feet of miniature RG-174 A/U 0.1-inch-diameter, 50-ohm coaxial cable to aid in interfacing the finished unit. All you need to add are input and output connectors, plus power. The high-quality glass-epoxy PC board is clearly silk-screened to show component and input-output locations, and is solder-masked on the back to prevent solder bridges. The resistors are mounted vertically to save space and, although this gives a crowded appearance, presents no problem in assembly. Most of the board space is occupied by a 4½-turn printed-circuit spiral inductor that is etched on the foil side of the board. Detailed interference precautions are included.

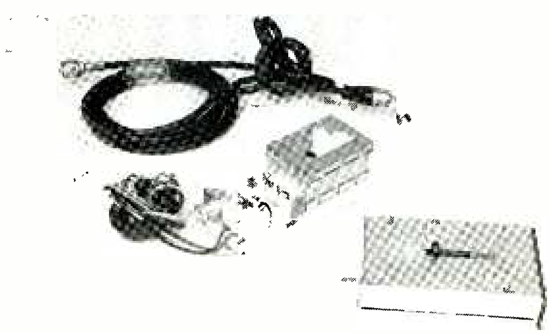
Although I might appear to be biased, since UHF Associates supplied the units and much data for this story, I must report in all honesty that this unit, manufactured by UHF Associates and distributed by Jade Computer Products is—in my opinion—the best buy of any of the units tested. It is also available from Quest Electronics, Byte Computer Shops and Olson Radio (Olson Part No. MP-112).

M & R Enterprises

P.O. Box 61011, Sunnyvale, CA 94088

Available at many local computer shops, or by mail from M & R, the *SUP "R" Mod II* is simple to install and use. It is completely assembled and shielded and comes with detailed illustrated documentation. It is pretuned to Channel 3 and includes a video level control. Included are a 10-foot length of coaxial cable, with connectors at each end, and an antenna changeover switch, plus double-sided tape for mounting the modulator and switch on any smooth, flat surfaces such as a wall or the back panel of the TV set.

M & R ENTERPRISES Sup "R" Mod II. Cable and switch not shown.



SUP "R" MOD II, cables and switch included

This unit is designed for the nonelectronic microcomputer user who is not familiar with a soldering iron and does not wish to learn how to use it. All you need to add is a DC source between +5 and +12V at about 7 mA. Installation is simple, and two ferrite cores are used on the cables to help prevent RF interference with neighboring TV sets.

Quest Electronics

P.O. Box 4430E, Santa Clara, CA 95054

This company offers the *model TV-1* or the *model RVFN-1* at the same price. For details, read the sections on the Jade and Vamp units in this article.

Ramsey Electronics

Box 4072, Rochester, NY 14610

The *model VD-1* kit is the second smallest unit we tested, and construction was easy and fast—about 20 minutes. Unfortunately, the two mounting holes are extremely small, and there is no video input-level control. Therefore, mounting and interfacing this unit takes a little extra effort. The current required at 5-volts input is only 4.5 mA, which probably can be drawn from the video source power supply. All components are mounted vertically on a small but uncrowded PC board, and input and output designations are clearly labeled. The kit comes complete with components layout, schematic and parts list, but without interference precautions. No case, connectors or cable are included.

The output channel frequency is slug-adjustable from Channels 4 to 6, but you need a small hex tuning wand (not supplied). Game, camera or video cassette recorder performance was good, but with a computer, a display with small characters (64-per-line, 16 lines) was only fair. This is the least expensive kit and certainly adequate for noncritical applications.

UHF Associates

Box 24, Jenner, CA 95450

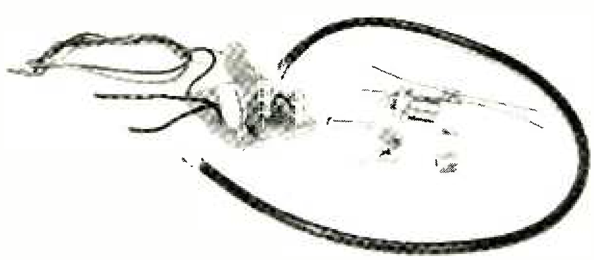
The *model TVS-100* is unusual because it provides both video and audio modulation of a carrier frequency, allowing the TV receiver's sound system to complement the picture information. Designed to plug directly into a S-100 computer bus, the *model TVS-100*'s power requirements are 15 volts at 40 mA. The tuning is more complex than for most other units. A switch selects the Channel 3 or Channel 4 outputs and RCA jacks are used for all input and output connections. On-board level controls are included for both audio and video inputs.

The assembly time for this unit should run from 1 hour to 1½ hours. The unit tested was a preproduction model that performed among the best in all test categories. Price, availability and documentation were not available at the time this survey was made. The *model TVS-100* will probably be available only in kit form because of FCC restrictions on the sale of assembled units without the video source attached.

Vamp, Inc.

Box 29315, Los Angeles, Ca 90029

This small, well-designed kit (*model RFVM-1*) assembles easily in 20 minutes. The excellent documentation includes a schematic and a components lists and layout, and it devotes considerable space to RF interference considerations. Vamp also includes coax cable and an F-59 connector for the output, as well as two extra resistors for creating an RF attenuation network if



RFVM-1 sold by Vamp and Quest Electronics

your unit causes interference. Two mounting holes are provided, as well as two mounting screws, nuts and even two spacers! The on-board video input control is easily set with your fingers (the control has a knurled outer knob), and a small insulated screwdriver (not supplied) can be used to set the RF oscillator trimmer capacitor. The tank coil is etched on the PC board—2½ turns of a rectangular spiral. All it takes to power this simple unit is 5 VDC at 1.5 mA. No case is provided because this small unit could be mounted in the existing case of the video source. Performance was among the best, except when used with a computer terminal. R-E

Innovations In Phono Cartridges

The overall performance of a phonograph record playback system depends largely on the characteristics of the cartridge. This is the story of the Shure V15, type IV that advances the science of record playing.

LEN FELDMEN
CONTRIBUTING HI-FI EDITOR

A WHILE BACK, I, ALONG WITH SEVERAL audio journalists, attended the 1978 Technical Seminar held by Shure Brothers, Inc., of Evanston, IL. At the seminar, we were introduced to Shure's newly designed *model V15 Type IV* phono cartridge, the latest (and most expensive) in a series that began more than a decade ago with the development of the original *model V15* cartridge. This article will present some of the less well-known design considerations and innovations that went into the creation of this new phono cartridge.

Real-versus-theoretical requirements

The requirements of a top-grade phono cartridge (at least on paper) are relatively few. The pickup should, of course, have an extremely uniform amplitude response with respect to frequency (generally, if erroneously, called frequency response). It should be able to follow the undulations in the most heavily recorded record grooves even when low downward tracking forces are applied. Shure calls this quality "trackability," and, in many ways, this term indicates more about a cartridge's tracking ability than does the older compliance specification.

In a moving-magnet phono cartridge, the shank and magnet assembly form the heart of the transducer. The assembly's performance criteria include low equivalent mass; high-resonance frequency (preferably beyond the audio range) and low-resonance Q; high resistance to bending and fracture; and the proper geometrical considerations.

Figure 1 shows the final shank design used in the new *model V15 Type IV* stylus compared with the shank used in the older *model V15 Type III* stylus. This design is called a telescopic shank and uses a precision outer reinforcing tube that is in close contact with the shank. The net effect of the changes made in the stylus was to reduce the overall mass plus the mass of the stylus assembly, while maintaining the same overall geometry and bending strength. In terms of performance, the new shank improves the high-frequency trackability of the cartridge, maintains shank resonance beyond the audio range and improves resonance control by reducing the mass that the bearing must control.

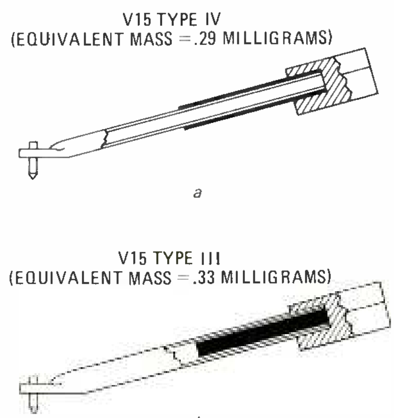


FIG. 1—STYLUS ASSEMBLY of the V15 Type IV is shown in *a*. For comparison purposes, the stylus assembly of the V15 Type III is shown in *b*.

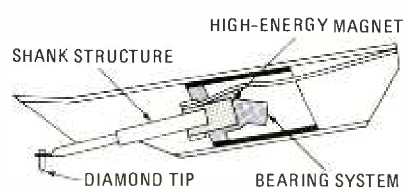


FIG. 2—SHANK STRUCTURE of the V15 Type IV stylus shown as a cross-sectional view.

Figure 2 shows a cross section of the *model V15 Type IV* stylus assembly. In addition to the telescoped shank structure it features a new, lightweight high-energy magnet, a newly designed two-function bearing system, and what Shure terms a hyperelliptical nude diamond tip. All these new features are designed to increase or improve trackability.

How much trackability is enough?

Figure 3 shows the trackability-versus-frequency curve of the *model V15 Type III* and the *model V15 Type IV*, each measured at a 1-gram tracking force. The theoretical maximum recorded velocities that are likely to occur at various frequencies in a modern recording are shown. The small circles show that actual velocities often exceed these theoretical limits. Note that some of these measured velocities actually exceed the trackability of the older *model V15 Type III* and *model V15 Type IV* cartridges, but *model V15 Type IV* shows a significant improvement in trackability over the earlier model. To track the few remaining peak velocities that still fall outside the newer trackability curve, it would be necessary to increase the downward tracking force of the new cartridge to its maximum of 1.25 grams.

Stylus-tip shape

Figure 4 compares the older, elliptical stylus used in the *model V15 Type III* (and many other cartridges) and the newly designed hyperelliptical tip of the *model V15 Type IV*. The *model V15 Type IV*

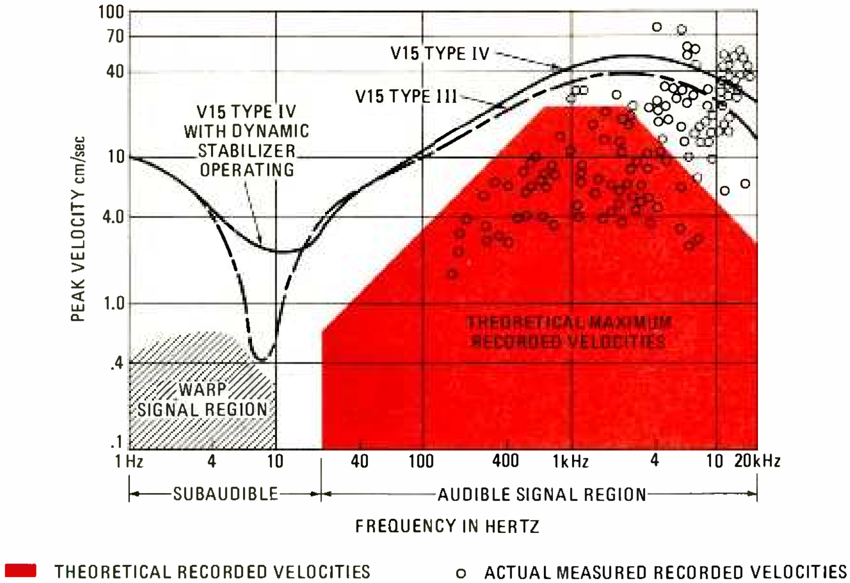


FIG. 3—TRACKABILITY-VS.-FREQUENCY of the V15 Type III and V15 Type IV cartridges as mounted in an SME 3009 pickup arm.

"footprint" (shown in Fig. 4 as a black oval) is longer and narrower than the traditional elliptical tip-groove contact area. The new tip is said to provide as much as a 25% reduction in distortion over the conventional elliptical stylus. Figure 5 is a bar graph showing typical second harmonic and IM distortion levels for various stylus-tip shapes. The optimized contact area of the hyperelliptical tip significantly reduces both harmonic distortion (shown by the white bars) and IM distortion.

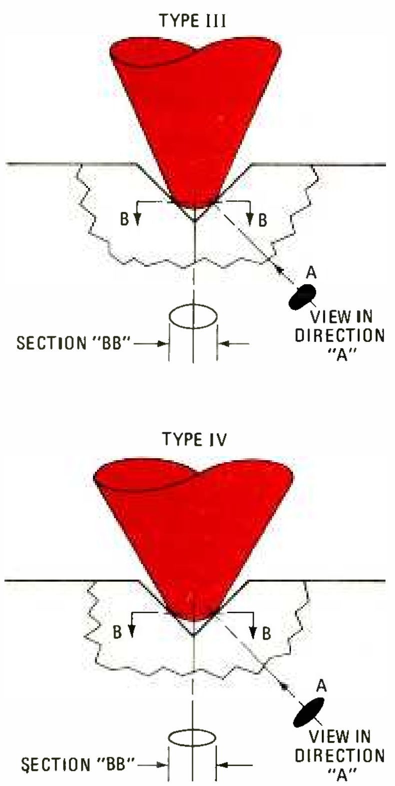


FIG. 4—NEW HYPERELLIPTICAL TIP of the V15 Type IV provides better contact with the record grooves than the conventional elliptical tip of the V15 Type III.

Pickup/arm resonance

It has long been recognized that the conventional phono cartridge arrangement at the end of a pivoted arm has a built-in problem of low-frequency stability. This problem is a result of the resonance that is inherent in the conventional cartridge/arm arrangement.

Figures 6 and 7 show the most serious effects caused by this resonance. The scrubbing motion of the stylus in the groove can actually cause program material to warble in pitch as if the turntable itself were fluctuating in speed. In fact, the groove speed relative to the tip *does* change because a fraction of the velocity of the arm vibration is added to the groove velocity.

For example, at arm resonance, total amplitudes of 1/32 inch are easily observed. If the system resonance is at 8 Hz (typical) the resonance velocity will be about 2 cm-per-second. This velocity will produce a scrubbing velocity of 0.6 cm-per-second along the groove axis. The groove speed at a 4.5-inch radius is about 40 cm-per-second, so the frequency modulation will be about 0.6 cm/ to 40 cm-per-second, or 1.5%—producing a quite audible warbling effect.

Another less obvious result of arm resonance is that the stylus force is "used up" when the arm vibrates. In the previous example, if the pickup compliance is assumed to be 20×10^{-6} cm-per-dyne, 2.0 grams of stylus force will be required to offset the arm vibration alone. Since this is greater than most total stylus-force requirements, mistracking occurs.

The most common excitation force likely to cause such arm vibrations at or near their resonant frequency is record warp. Warps generally occur in a broad low-frequency spectrum extending from about 0.5 Hz to 10 Hz, with maximum occurrences at around 3 Hz or 4 Hz. This form of excitation operates principally in a vertical direction. A minor source of arm vibration is the change in stylus drag force with modulation. Signals having a substantial recorded velocity will increase drag force considerably, and the arm offset angle or the vertical tracking angle geometry will cause a drag-force component to move the pickup. Figures 6 and 7 also show this effect.

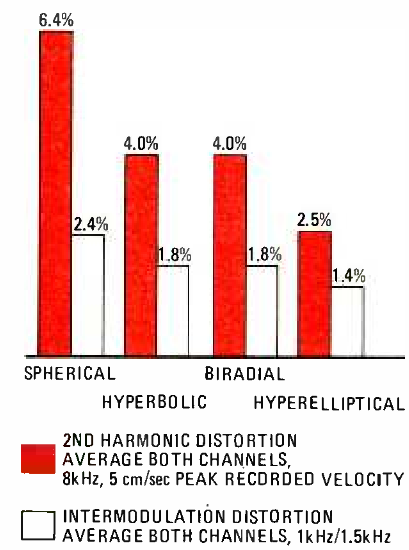


FIG. 5—HARMONIC AND INTERMODULATION distortion for various tip shapes.

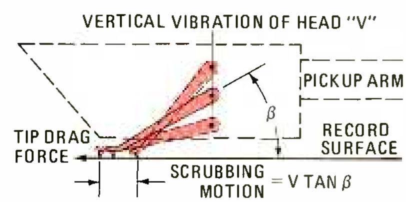


FIG. 6—VERTICAL VIBRATION of pickup arm changes the vertical angle of the stylus and causes a scrubbing motion. This can create a warble in the pitch of the program material.

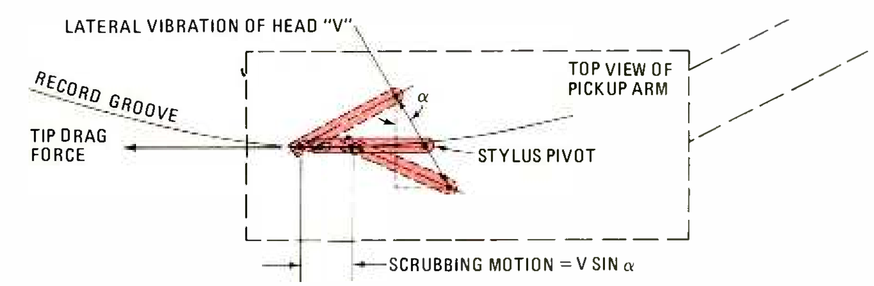


FIG. 7—LATERAL VIBRATION of pickup arm also causes a warble effect in the pitch of the program material.

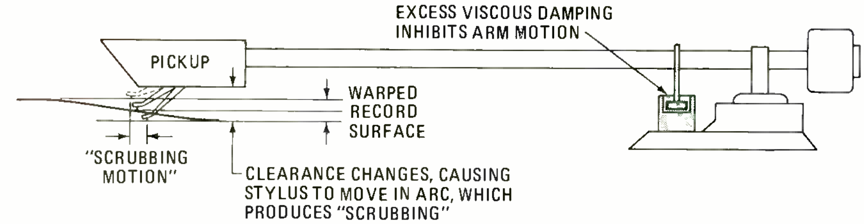


FIG. 8—VISCOUS DAMPING is commonly used to reduce pickup arm resonances. However, this approach also inhibits the pickup arm from tracking severe record warps.

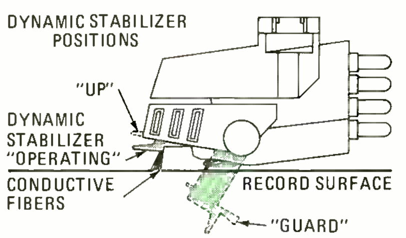


FIG. 9—DYNAMIC STABILIZER of the V15 Type IV has three positions.

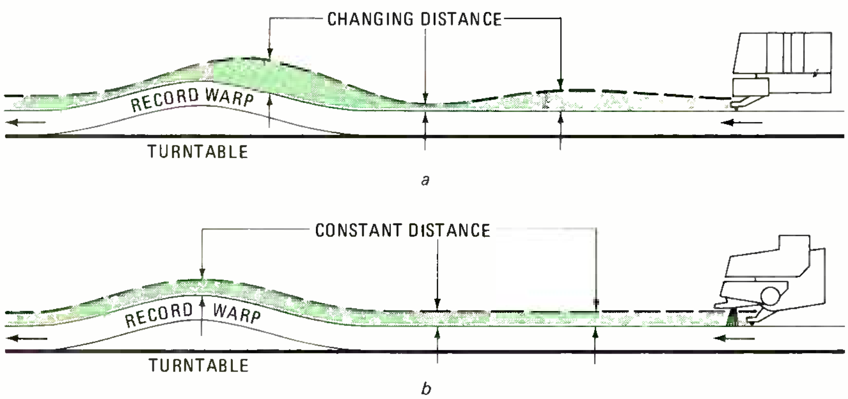


FIG. 10—SEVERE WARPS change the distance between the record surface and a conventional cartridge, as shown in *a*. The dynamic stabilizer maintains a constant distance, as shown in *b*.

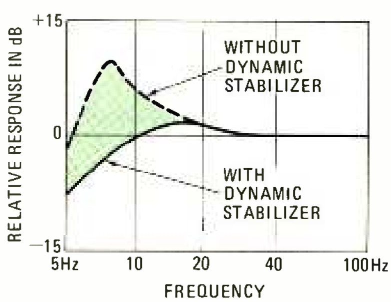


FIG. 11—FREQUENCY RESPONSE showing effect of dynamic stabilizer on the resonance of the pickarm and cartridge combination.

Previous solutions to the resonance problem can be divided into active and passive categories. A passive solution would be the use of a dynamic vibration absorber. An example of this approach is the damped pickup-arm counterweight. Another approach is to attach a pad or brush to the end of the arm, so that it contacts the record surface. Most of the total arm force is applied to the pad, which then overpowers the dynamics of the arm and maintains a constant spacing for the pickup. The problem with using this method is that the pickup arm's progress across the record tends to be controlled by the pad instead of the stylus. In the past, viscous damping applied to arm pivots was also used; however, with high-compliance pickups when the damping is sufficient to control resonance, the arm cannot move fast enough to track severe warps, and the stylus assembly must compensate by changing its protrusion (see Fig. 8).

The *model V15 Type IV* cartridge provides an interesting and practical solution to this problem: The system uses a structure called a dynamic stabilizer, similar in appearance (and partly in function) to the flip-down stylus guard found on many other cartridges. The stabilizer, shown in Fig. 9, has two unique features. The first is a graphite-filament, brush-like structure located on the bottom front edge of the stabilizer. The second is the viscous damped trunnion bearings that replace the standard stylus-guard pivots.

Position 3 ("Guard") in Fig. 9 shows the stabilizer detented downward and functioning as a stylus guard; position 2 is the normal playing ("Operating") position. The graphite filaments contact and ride the record surface, while the viscous damping provided by the bearings of the assembly controls the vertical resonance. The stabilizer filaments are placed as close to the stylus tip as possible, to insure that any motion caused by record warps is applied to both the stylus and the stabilizer simultaneously. The result is that the tone arm closely follows the record irregularities, thereby minimizing warp effects on the stylus.

If you compare the two illustrations of Fig. 10, you will note that in the upper drawing, a conventional cartridge tip fluctuates because of severe record warp, with changes in the distance between the stylus tip and the record surface. The lower half of Fig. 10 demonstrates that when the Shure dynamic stabilizer is used, constant distance is maintained between the stylus tip and the record surface even during severe warps. The dynamic stabilizer reduces the overall resonant Q of the system and raises the resonant frequency, as shown by the frequency-response curves of Fig. 11 (plotted for frequencies below 100 Hz and down to the subaudible range). With the dynamic stabilizer operating the improvement is dramatic.

The *model V15 Type IV* cartridge has a stylus-force tracking range from 0.75 gram to 1.25 grams, and the dynamic stabilizer exerts a 0.5-gram force on the record surface. Thus, the total arm force must be set between 1.25 grams and 1.75 grams. Since the major part of this total force is actually exerted by the stylus, the pickup, rather than the graphite fibers, controls the arm movement across the record, as it should. In position 1 (refer to Fig. 9) the stabilizer is retracted and the fibers do not touch the record surface. The tracking force for this mode must therefore be set for the stylus-force range of between 0.75 gram and 1.25 grams.

According to Shure, small-diameter graphite fibers were chosen for several reasons. Because static electricity can attract the arm and pickup, the fibers help stabilize the tracking force.

The graphite fibers also serve as a record-cleaning brush. Each strand is only 7.6 microns in diameter, enabling it to sweep loose dust from the record grooves and prevent dirt and dust from being ground into the groove walls. Another function of the stabilizer is as a shock absorber. When a pickup arm is accidentally dropped, a conventional stylus assembly receives the full shock upon impact. In addition, the springiness of the stylus assembly can cause it to bounce across the record, thus creating several groove-damage points. In normal operation the viscous damped stabilizer cushions the impact of the dropping arm and prevents such bouncing.

This cartridge is a top-grade performer when measured objectively using carefully controlled and maintained test records. In this design, however, Shure seems to have gone a step farther by taking into account the many nonideal conditions that exist when you play records in the real world of high fidelity at home. These secondary problems, such as static electricity, record-surface dust and impact damage, as well as low-frequency instability caused by arm resonance combined with record warp and the like, are effectively handled by Shure's unusual and innovative dynamic stabilizer. Thus the *model V15 Type IV*, cartridge design truly advances the science of record playing. **R-E**

Radio-Electronics Tests RG Dynamics Pro-16 Dynamic Processor

CIRCLE 120 ON FREE INFORMATION CARD 1

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

OUR FIRST ENCOUNTER WITH A SIGNAL PROCESsor was with a unit produced by U.S. Pioneer Electronics Corp., the *model RG-1*. Even in this early unit, some innovative concepts had been applied to dynamic expansion, and fewer of the "pumping and breathing" effects commonly associated with expanders up to that time were noticeable.

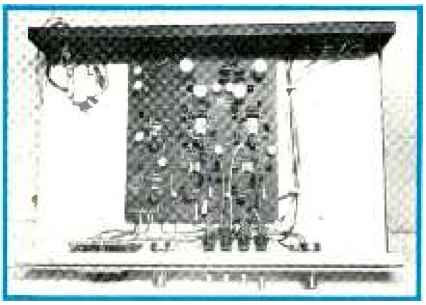
RG Dynamics, Inc. (4448 W. Howard, Skokie, IL 60076) has further perfected those earlier circuit ideas relating to dynamic signal expansion and noise reduction. The present unit is more sophisticated and, more important, it runs rings around the earlier effort in actual performance.

Figure 1 shows a front-panel view of the processor. A brief description of its controls will give you an idea of its enormous control flexibility and variations in expansion that are possible. A dual-channel LED display panel, containing 5 LED's per side, provides a constant visual indication of what sort of signal processing is occurring. The lower pair of LED's light up red and serve as power-on indicators when signal processing is not turned on. They also indicate when the transition occurs between downward expansion and upward expansion. The upper four pairs of LED's are calibrated in 4-dB increments from 4 dB to 16 dB, and indicate the total amount of expansion taking place at each instant. The display greatly simplifies input-level adjustment, and once levels are set correctly for a given program, it can be turned off by a toggle switch or left on, as desired.

A dynamic expansion-control knob is continuously variable and selects the degree of expansion from 4 dB to 16 dB. A second toggle switch selects one of two expansion rates or slopes. Slope number 1 is recommended for FM broadcasts and most popular records (these have usually been highly compressed at their source); while slope number 2 is recommended for use with less heavily compressed program sources. A third switch provides tape monitoring facilities (replacing those on your amplifier or receiver that you could use to connect the *model Pro 16*); this switch also permits processing of signals connected to your system's tape inputs. The remaining switch introduces or defeats processing. At the right of the panel, an input-level control sets the correct level for proper processor operation, as indicated by the LED display.

Technical description

The *model Pro 16* uses several standard IC's and an intelligent circuit board layout; the entire circuitry is contained on a single circuit board that occupies only about one-half the chassis width of the unit (see Fig. 2).



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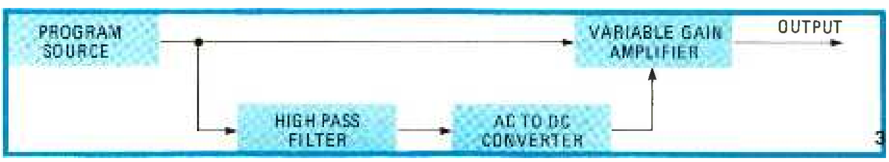
This unit is a peak-expansion/noise-reduction instrument that works on playback-only, unlike some compander systems that require prior program material encoding. Its expansion is determined by the signal itself, using two basic circuit elements. The first is a sensor circuit that samples both program level and frequency content and creates a control signal. The second is a gain-control amplifier that is operated by the control signal. The unit uses a patented peak detector whose outputs are free of ripple and require little filtering. Time constants have been set with an attack time of 600 μs and a decay time of 80 ms. More conventional designs often provide much longer time constants and are therefore not capable of tracking program material accurately. Although there are separate control and amplifier sections for each channel, the inputs of the sensor circuit are partially blended so that a signal appearing in only one channel controls (to a lesser degree) the gain of the other.

While the amplifiers have essentially flat frequency response, the sensor circuit has a shaped frequency response with a broad peak at 2500 Hz, sloping off above and below that frequency. The sensing circuit is therefore most responsive to the frequency range containing the strongest musical signal harmonics. Being frequency-sensitive in this way, the *model Pro 16* is less susceptible to pumping effects.

The output of this section of the sensor circuit is applied to the peak detector, which then produces a DC output that is proportional to the peak values of the applied musical signal. This DC signal is fed to the gain-control amplifier where it controls or varies the system's open-loop gain. A fixed gain of between −4 and −7 dB is applied to all signals below 5 mV (noise-reduction mode) while expansion begins at or above 10 mV (upward-expansion mode). A block diagram is shown in Fig. 3.

Lab measurements

The measurements summarized in Table 1 indicate the signal-handling and distortion characteristics of the *model Pro 16*, but they really do not depict how it operates as an expander. We therefore plotted two sets of curves showing processor gain as a function of mid-frequency input signals. In Fig. 4, maximum and minimum expansion settings were used together with the slope 1 setting, while in



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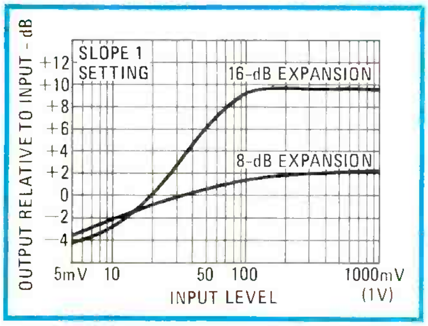
MANUFACTURER'S PUBLISHED SPECIFICATIONS:

Total Expansion: 4 dB to 16 dB, continuously variable. **Downward Expansion:** −4 dB to −7 dB. **Upward Expansion:** 0 dB to 9 dB. **Attack Rate:** 600 μs. **Decay Rate:** 80 ms. **Maximum Output Voltage:** at maximum expansion, 6.5 volts. **Rated Output Voltage:** 1.0 volt. **Minimum Input Required:** level control at maximum, 50 mV. **Harmonic Distortion:** at rated output, maximum expansion, 0.08%. **IM Distortion:** 0.1% (60 Hz and 2 kHz, mixed 1:1, 1 volt out). **Hum and Noise:** 80 dB below rated output, at maximum expansion. **Input Impedance:** 80,000 ohms. **Output Impedance:** 300 ohms. **Power Consumption:** 3 watts. **Dimensions:** 19 W × 3⅓ H × 12 inches D. **Weight:** 6¾ lb. **Suggested Retail Price:** $299.

Fig. 5, the same input-versus-output relationships were plotted using the slope 2 setting. Note that at lower expansion settings (8 dB) there is virtually no difference between the slope 1 and slope 2 modes. For maximum-expansion settings, the slope 1 mode provides steeper expansion. Note, too, that below around 10 mV to 20 mV (depending upon what slope mode and expansion degree are selected) output levels are actually lower than input levels (negative dB readings) indicating downward expansion and attendant noise reduction.



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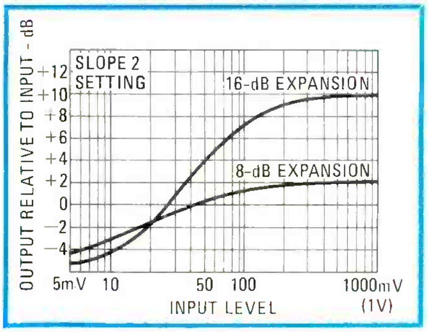

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The more conventional measurements shown in Table 1 clearly indicate that introducing the *model Pro 16* in any high-fidelity signal path in no way degrades the musical signals either in signal-to-noise performance or in any increased overall audible harmonic or IM distortion.

Summary

The real usefulness of a dynamic signal processor such as the *model Pro 16* can be appreciated only by actually hearing the unit perform under a variety of program-source conditions (as mentioned in Table 2, along with our overall product evaluation). If you are looking for exaggerated and unnatural dynamic expansion, this is not the unit for your system. If, however, you want to restore some of the lifelike qualities to compressed material and you can appreciate the resulting improvement, then the *model Pro 16* signal processor offers reproduction improvements with none of the audible drawbacks previously associated with such signal-processing devices. **R-E**

TABLE 1

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **RG Dynamics, Inc.** Model: **Pro 16**

DYNAMIC SIGNAL PROCESSOR MEASUREMENTS

	R-E Measurements	R-E Evaluation
RATED OUTPUT (V): 1.0		
Maximum output (V)	7.0	Very good
THD at 1-volt output (%)	0.047	Excellent
IM at rated output (%)	0.09	Very good
Hum and noise, referenced to 1 volt (dB)	87	Excellent
EVALUATIONS OF CONTROLS, CONSTRUCTION AND DESIGN		
Ease of installation		Excellent
Effectiveness of Indicators		Superb
Arrangement of controls		Very good
Design and construction		Very good
Ease of servicing		Good

TABLE 2

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **RG Dynamics, Inc.** Model: **Pro 16**

OVERALL PRODUCT ANALYSIS

Retail price	$299
Price category	Medium
Price/performance ratio	Superb
Styling and appearance	Very good
Sound quality	Excellent
Mechanical performance	Very good

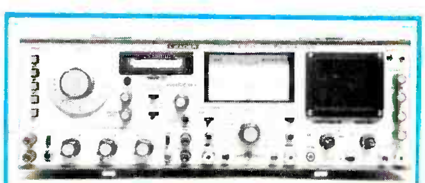
Comments: In the last analysis, a signal-processing device such as an expander, a noise-reduction unit or a peak unlimiter must be judged more by listening than by bench measurement. There is no easy way to measure whether such devices will impose their *own* peculiar sonic aberrations upon the total musical reproduction being heard. Terms such as "breathing" or "pumping" have been applied to these devices. In the case of the *model Pro 16*, these undesirable effects have been reduced to an almost imperceptible minimum and the controls are sufficiently flexible and variable so that proper trade-offs can be made, depending upon the nature of the musical programming being augmented.

Like any device of this kind, it can be overused. Some of our better (and less-compressed) musical test records required a very moderate degree of expansion (around 4 dB to 6 dB total), while much of the FM programming required almost the full available expansion range provided by this unit. By making available two types of expansion slopes as well as variable expansion, RG Dynamics has given you enough control options to properly and effectively handle any expansion requirements of almost any kind of compressed program material. Using the *model Pro 16* for even a short while tends to spoil you. Removing it from the signal path makes just about every program sound squashed and flat, with much of the excitement of live music gone. Yet, that is what we listen to most of the time. Until the predicted transition to digital recording takes place (with all its dynamic range benefits), the serious listener who craves restored dynamic range from his or her program sources may want to install an expander. Given the choices, the *model Pro 16* offers extremely effective expansion capability without any audible disadvantages.

Leader Model LAS-5500 Audio Analyzer

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

IF YOU PLAN TO EVALUATE OR TROUBLESHOOT high-quality audio equipment, you will discover that you need at least a dozen separate test instruments to perform the job correctly. Leader Corporation (151 Dupont Street, Plainview, NY 11803) offers an ingeniously designed instrument, the *model LAS-5500* Audio System Analyzer, which combines at least seven instruments into a single compact package. The Audio System Analyzer (see Fig. 1) contains an audio oscillator, a precision



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CIRCLE 121 ON FREE INFORMATION CARD

attenuator, a highly sensitive wow-and-flutter meter that can also measure tape-speed drift in percent, an AC voltmeter, a 5-MHz bandwidth oscilloscope and a separate twin-8-ohm dummy-load box (see Fig. 2). The dummy load neatly is packed into the lid of the unit along with the necessary interconnecting cables and connectors.

The front panel of the *model LAS-5500* is divided into sections for ease of operation, and switching functions are arranged so that each section can be used independently or internally interfaced with other related sections. The left-hand side of the front panel (see Fig. 3) shows the audio oscillator, with a continuously variable decade frequency knob and five associated multiplier switches. Output level is continuously adjustable by an output-level control, or, the oscillator output can be connected internal-

MANUFACTURER'S PUBLISHED SPECIFICATIONS (PARTIAL):

AUDIO OSCILLATOR:
Frequency Range: 10 Hz to 1 MHz (±3% above 100 Hz). **Output Voltage:** variable to more than 3.0 volts RMS into 600-ohm load. **Response:** ±0.3 dB. **Distortion:** 0.05% 500 Hz to 20 kHz; 0.1% 100 Hz to 100 kHz, less than 1.0% 10 Hz to 1 MHz. **Output Impedance:** 600 ohms.

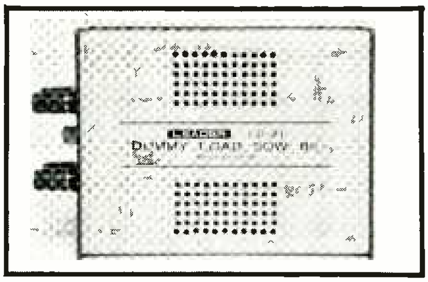
ATTENUATOR:
Input/Output Impedance: 600 ohms, unbalanced. **Range:** 0 to 101 dB in 0.1-dB steps. **Accuracy:** ±2% **Frequency Response:** ±2% to −70 dB, DC to 200 kHz. **Maximum Input:** 0.5 watt (17 volts RMS or +27 dBm).

VOLTMETER:
Range: 30 μV to 100 volts in 12 ranges; −90 dB to +40 dB, referenced to 1.0 volt. **Accuracy:** ±3% of full scale, referenced to 1 kHz. **Frequency Response:** ±3%, 20 Hz to 100 kHz. **Input Impedance:** 10 megohms/65 pF. **Weighted Filter:** JIS "A" curve.

OSCILLOSCOPE:
Vertical Sensitivity: from 10 mV-per-division to 100 volts-per-division. **Vertical Bandwidth:** DC to 5 MHz, − 3 dB. **Risetime:** 70 nS. **Input Impedance:** 1 megohm-per-40 pF. **Maximum Input Voltage:** 600 volt (DC + AC peak). **Horizontal Sensitivity:** 200 mV-per-division. **Bandwidth** (horizontal): DC to 250 kHz, −3 dB. **Maximum Input:** 100 volt (DC + AC peak). **Input Impedance:** 100,000 ohms. **Sweep Frequency Range:** 10 Hz to 100 kHz. **Synchronization:** Internal (+polarity).

WOW AND FLUTTER METER:
Measuring Modes and Frequencies: JIS, CCIR at 3 kHz; DIN at 3.15 kHz. **Input Voltage Range:** 15 mV to 10 volts RMS. **Test Ranges** (5): 0.03% to 3% full-scale. **Response:** 0.5 Hz to 200 Hz(JIS); 0.3 Hz to 200 Hz (CCIR): 0.3 Hz to 300 Hz (DIN).

GENERAL SPECIFICATIONS:
Power Supply: 100, 115, 200 or 230 volts, as specified, 50 Hz to 60 Hz, 36 VA. **Dimensions:** 17.7 W × 5.9 H × 16.9 inches D. **Weight:** 25 lb. **Supplied Accessories:** dummy load (two 50-watt, 8-ohm resistors); low-capacitance probe; assorted plugs and cables; and binding post adapters.



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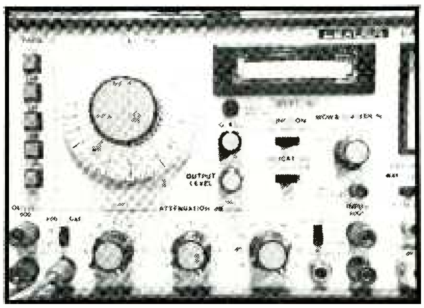
ly to the precision attenuator whose three knobs in the lower part of the front panel provide fixed signal attenuation from 0 dB to −101 dB in 0.1-dB increments.

Figure 3 also shows the wow-and-flutter measuring section with its calibration and drift meter (calibrated to 5% deviation in tape speeds). The AC voltmeter section (see Fig. 4) reads wow-and-flutter in percent, as well as AC volts, dbV (0 dB equals 1 volt) or dBm (0 dB equals 0.775 volt across 600 ohms, or 1 mW). The most sensitive range of this meter is 0.3 mV full-scale; this range permits hum-and-noise readings down to −90 dB below a 1-volt reference. A standard "A"-weighting filter can be introduced into the meter circuit for any S/N measurements that require its use.



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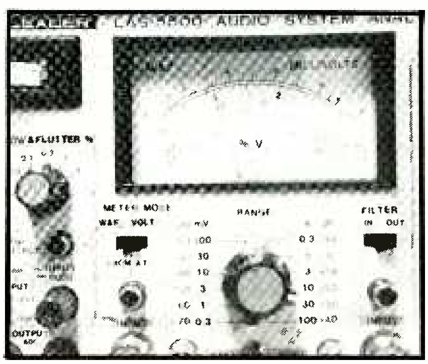

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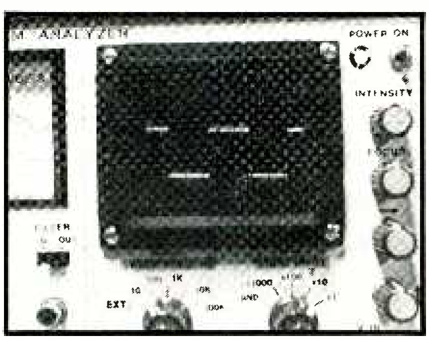
The oscilloscope section is shown in Fig. 5 and Fig. 6. In Fig. 5, a 10-Hz squarewave is displayed that confirms the scope's response down to DC. In Fig. 6, a 20-kHz squarewave was applied to the vertical input and a higher sweep rate was used, thus demonstrating the ease and accuracy with which high-frequency signals can be displayed. The display area is calibrated with an 8 × 10-division nonilluminated graticule, each division measuring 6 mm (approximately, 0.25 inch). Although sweep rate and vertical sensitivity are continuously variable by concentrically mounted potentiometers associated with the sweep-frequency and vertical-input switches, there is no calibration setting. For this reason, if the scope is used as a precise voltmeter, it is necessary to use external calibration voltages or known frequencies. A switch located in the scope section permits you to parallel its vertical input directly across whatever the voltmeter is reading. A switch on the voltmeter selects either of two inputs, labelled LEFT and RIGHT, so that you do not have to constantly change connections back and forth when testing stereo audio equipment. Also provided are an external horizontal input and a switch to select AC, DC or the voltmeter input to the vertical amplifier of the scope section.

Audio oscillator performance

The audio oscillator has a frequency range that extends from 10 Hz to 1.182 MHz. In our tests, the frequency dial was set by eye to the 1-kHz mark and the actual frequency output was 993 Hz, an error of less than 0.7%. At a 20-Hz setting, the output was exactly 20 Hz while at 20 kHz, our frequency counter read a 20,055-Hz output, an error of less than 0.3%. Maximum output voltage was 6.3 volts unterminated and 3.15 volts when terminated in a 600-ohm load.



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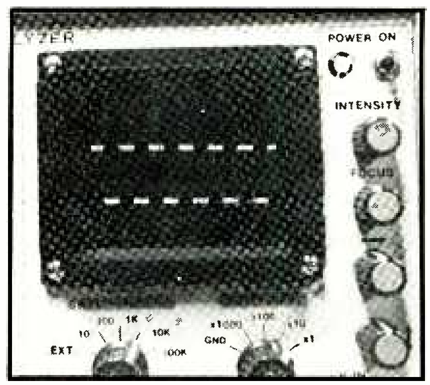
This signal source is adequately low in distortion for making measurements on tape equipment and on all but the current super-specification audio amplifiers. At 20 Hz, harmonic distortion of the audio oscillator's output signal measured 0.18%, decreasing to 0.02% at 100 Hz, 0.01% at 200 Hz, 1 kHz and other mid-frequencies and increasing to a maximum of 0.05% at 20 kHz. Amplitude was uniform over the entire audio range, and the −3-dB rolloff point occurred at 220 kHz.



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Voltmeter accuracy

We checked the AC voltmeter accuracy of the *model LAS-5500* against our digital AC voltmeter, which has an accuracy of better than 0.5% and we discovered that the *model LAS-5500*'s meter accuracy is almost as good at mid-scale, with errors increasing to approximately 1.0% at full-scale. The frequency response of the meter extended to well beyond 200 kHz, as claimed.

Wow-and-flutter measurements

The wow-and-flutter measuring system was easy to use and, with a 3-kHz tone recorded on a standard test record played on a pitch-adjusted turntable, we were able to confirm the accuracy of the drift readings on the calibration meter by using a calibrated strobe disc to set precise 3% deviations from true speed. Sure enough, the drift meter read exactly +3% or −3%. For some reason, the DIN 3.15-kHz signal did not appear at the wow-and-flutter signal-output terminal when that switch position was selected. Instead, the output remained at exactly 3.0 kHz. Perhaps a miswiring of the slide switch in the particular unit tested accounts for this. The various weighting factors incorporated into the wow-and-flutter measuring section permit an easy interpretation of percentages and eliminate having to "estimate" this parameter for tape decks and turntables, which is usually required when using unweighted wow-and-flutter measuring equipment.

Summary

Our overall product evaluation of the *model LAS-5500* is summarized in Table 1. This instrument is a space and time saver for the audio bench. It also greatly reduces the complexity of tests and measurements made on audio equipment. While its price may seem prohibitive at first, if you total the cost of a wide-range accurate AC VTVM, a good audio generator, an accurate wow-and-flutter meter and a wideband oscilloscope, it will become clear that the *model LAS-5500* represents something of a bargain. **R-E**

TABLE 1

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Leader Instruments Corp.** Model: **LAS-5500**

OVERALL PRODUCT ANALYSIS

Retail price	**$1995**
Price category	**Medium-high**
Price/performance ratio	**Good**
Styling and appearance	**Very good**
Sound quality	**N/A**
Mechanical performance	**Excellent**

Comments: We feel that this multifunction test instrument is most suited to service-bench use and, in the laboratory, for measuring tape-recorder equipment performance. Its sinewave signal source, although accurately calibrated and extremely flat in response, is a bit too high in its harmonic distortion content to be used to measure today's super-hi-fi audio amplifiers, preamplifiers and receivers. Since tape recorder distortions are generally of a higher magnitude, the audio oscillator contained in the *model LAS-5500* will not contribute to the overall distortion readings made of tape equipment under test or alignment.

Of course, it would have been nice if the instrument had some form of distortion-measuring device. Used by itself, the *model LAS-5500* can determine amplifier overload or clipping levels only by observing output waveforms on the screen of the wideband oscilloscope provided. The wow-and-flutter meter section cannot be faulted in any way; it offers an easy way to measure this important tape recorder and turntable parameter. The high-quality precision attenuator is handy to have in any lab or shop and is accurately calibrated. The 8-ohm loads, supplied separately, have only a 50-watt rating, although we found this rating can be exceeded for short periods of time without degrading the accuracy of the load resistors. Here again, if you regularly test high-powered audio equipment, you will need higher-power-rated loads. Perhaps the best feature of the *model LAS-5500* is its compact size and arrangement. These days, with all the sophisticated equipment necessary to properly test audio equipment, it's a pleasure to find a multipurpose instrument that not only replaces several separate test equipment items but occupies less than 18 inches of valuable bench space.

PIONEERS OF RADIO

continued from page 46

near the speed of light. With a large prism of asphalt (measuring 5 × 2 × 1.5 feet) he showed also that the electric waves could be refracted like light waves.

With these proofs, the scientific world accepted the idea of electric waves in space.

Hertz's discovery began not only the scientific study of radio, but also attempts to use it to communicate. In India, the physicist Bose read of Hertz's experiments, duplicated them and devised improved apparatus with which he toured Europe and convinced many scientists of the existence of electric waves. And in Italy, just a few-years later, the young Guglielmo Marconi read Hertz's obituary and decided to try to use these waves as a means of communication.

Sir Oliver Lodge

ALTHOUGH SIR OLIVER LODGE IS NOT TOO well known today, he was considered a leader—if not *the* leader—in the wireless field during the 1890's and the early 1900's. The eminent electrical engineer and author, Sylvanus Thompson, for example, attacked Marconi in a letter (*Saturday Review,* London, April 5, 1902) for posing as the inventor of something new. He (Marconi) was, claimed Thompson, merely using "the apparatus of Lodge . . . the original inventor of wireless telegraphy," with a few modifications.

In 1883, the Irish physicist George Fitzgerald surmised at a meeting of the British Association that "Maxwellian" waves might be produced by the oscillatory discharge of a Leyden jar, "if only we had the means of detecting such waves." In 1888, Lodge and two associates set out to produce and detect such electromagnetic waves, using what were later called Lecher wires to detect them. In Lodge's words:

"I found that the waves could not only be produced but also detected, and the wavelength measured, by getting them to go along guiding wires adjusted to the right length for sympathetic resonance. Thus I obtained the phenomenon of nodes and loops, due to the production of stationary waves by reflection at the distant end." In the same year, Lodge learned of Hertz's work in the field, and immediately attempted to transmit waves through free space.

In 1899, he lectured to the Royal Institution on "The Oscillatory Discharge of a Leyden Jar," demonstrating "many of the effects of these waves, both on wires and in free space." He called his detector (a needle point touching an aluminum plate, in circuit with a battery and telephone receiver) a "coherer" because an electric wave caused both the point and plate to cohere, or stick together, thus lowering the resistance and producing a signal in the phones. Shortly thereafter, when Branley announced his metal-filings coherer, Lodge adopted it, believing it more reliable and easy to adjust than his single-point detector.

In 1894, during a lecture in honor of Hertz (who had just died) Lodge demonstrated the detector. He used a mechanical tapper or vibrator to shake the detector filings apart after a signal passed through them. The coherer was thus constantly ready for action. Holding the transmitter key down for a longer or shorter time produced a long or a short signal in the receiver. Using this tapper, Lodge showed how the dots and dashes of the Morse code could be produced with radio equipment.

Lodge felt that Popov, Righi and others may have been influenced by his 1894 lecture. Professor Alexander Muirhead, who was present at the time, certainly was, and Lodge says he "conceived the desire to apply it to practical telegraphy." The result was a successful Lodge-Muirhead venture into commercial wireless.

Sir Oliver was an early proponent of tuning, which he called "syntony," to reduce interference and increase the range of communications. Although both Hertz and Tesla had mentioned the effect of resonance, in 1897 Lodge was able to obtain a patent (British patent 11,875) on syntony. Marconi later bought the patent from the Lodge-Muirhead syndicate, enormously strengthening his competitive position.

Lodge was interested in a wide variety of other subjects, especially psychic phenomena, and spent much of his time in later years pursuing them. He continued to write on radio topics, however, until well into the 1920's. Sir Oliver Lodge died in 1940. **R-E**

You Can

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TAKE THE CET TEST AS PRESENTED IN **Radio-Electronics** each month, one chapter at a time. This month's test questions are on AC circuits. See if you can get 75% or more correct. Also, review your answers as well as the discussion of each question on DC circuits that appeared in the July 1978 issue of **Radio-Electronics.** Join the thousands of electronics technicians who proudly display their CET certificate, and who are helping raise the public recognition of electronics technicians to the highest level. To receive free information regarding where you can take the CET test, write to ISCET: 310½ Main St., Ames, IA 50010.

Chapter 3 questions, AC circuits

1. The test leads of an oscilloscope connected across an ordinary 117-volt 60-Hz power source would show what peak-to-peak deviation if the scope is calibrated for 100 volts-per-inch?

( ) a. 1.17 inches
( ) b. 1.65 inches
( ) c. 2.35 inches
( ) d. 3.3 inches

2. The circuit in Fig. 1:

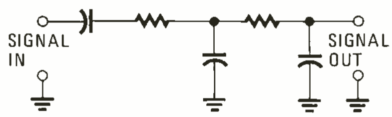


FIG. 1

( ) a. passes low frequencies to ground
( ) b. passes low frequencies to the output
( ) c. is a high-pass filter
( ) d. must have an RC time of less than 1/10th the lowest input signal frequency in order to be effective

3. In a series RLC circuit such as Fig. 2:

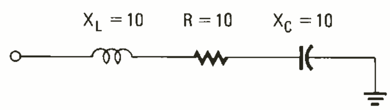


FIG. 2

( ) a. equivalent impedance is 20 ohms
( ) b. X_C and X_L add and are subtracted from R to arrive at the equivalent impedance.
( ) c. equivalent impedance is 30 ohms
( ) d. X_C and X_L cancel. The equivalent impedance is 10 ohms

4. The circuit in Fig. 3 is called:

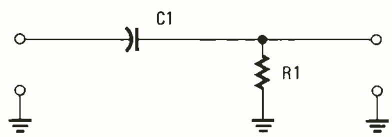


FIG. 3

( ) a. an RC integrating circuit
( ) b. a differentiating circuit
( ) c. resonant circuit
( ) d. low-pass filter

5. In Fig. 4, if the inductive and capacitive reactances (L and C) are equal the frequency at point A is:

( ) a. unequal
( ) b. equal to $\sqrt{R^2+(X_C-X_L)^2}$
( ) c. unknown
( ) d. resonant

6. The circuit in Fig. 4 would be used as:

ANSWERS TO

Before you try this month's questions, let's take a look at the answers to the questions that appeared in the July 1978 issue of **Radio-Electronics.**

Correct answers to DC circuit questions

1. **Correct answer is "b."** Maximum power from a battery to the load will occur when the load is equal to the internal resistance of the battery—in this case: 10 ohms (see Fig. 8).

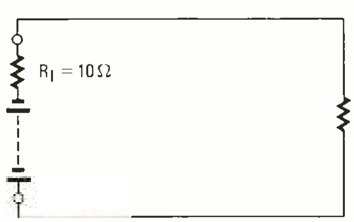


FIG. 8

2. **Correct answer is "b."** The base voltage of the circuit in Fig. 9 is determined primarily by the size of R1 and the small amount of emitter-base current.

3. **Correct answer is "d."** In Fig. 9 a current through R3 (and therefore R2) of 2 mA would give a voltage drop across R2 of only 1 volt under normal operating conditions. Therefore, the circuit has a problem which causes an extremely large R2 drop (4 volts). Of the four choices, "d" is the best: "C2 may be shorted."

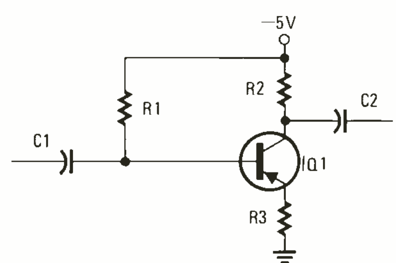


FIG. 9

4. **Correct answer is "b."** No voltage doubling action can take place if rectifier D1 is open. Therefore, the circuit (see Fig. 10) will act as a half-wave 150-volt power supply.

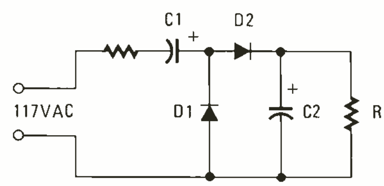


FIG. 10

5. **Correct answer is "d."** D3 through D6 act as a voltage regulator, conducting once the V_O voltage exceeds their combined characteristic "turn-on" point. This maintains a constant voltage at point V_O. (see Fig. 11)

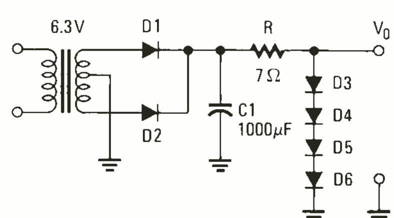


FIG. 11

6. **Correct answer is "b."**

Be A CET

of questions aimed at checking your Certified Electronic Technician

DICK GLASS

( ) a. a trap to eliminate all but a band of wanted frequencies
( ) b. an oscillator

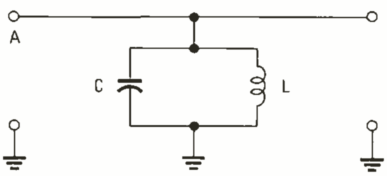


FIG. 4

( ) c. a filter to eliminate low frequencies
( ) d. a filter to eliminate high frequencies

7. What is the time constant for the cathode circuit in Fig. 5?

( ) a. 4700 seconds
( ) b. 470 microseconds
( ) c. 4.7 microseconds
( ) d. 4.7 milliseconds

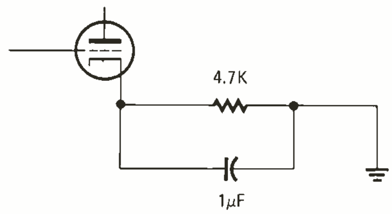


FIG. 5

8. Increasing the size of R in Fig. 6 will have what effect?

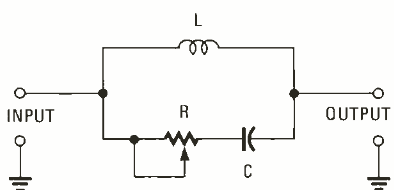


FIG. 6

( ) a. None.
( ) b. It will not change the resonant frequency but will broaden the response curve.
( ) c. It will change the resonant frequency.
( ) d. It will reduce high frequency reactance.

9. What is the reactance of a 5-henry choke coil at 15,750 Hz?
( ) a. 222,700 ohms
( ) b. 494,550 ohms
( ) c. 78,750 ohms
( ) d. 494.5 ohms

10. To reduce 27 mHz Citizens band interference in a TV set, which of the networks in Fig. 7 would you place in series with the TV antenna?

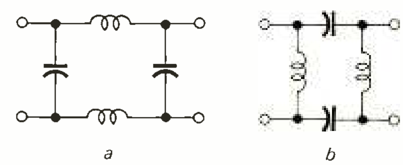


FIG. 7

( ) a. Network A
( ) b. Network B

Be sure to keep this month's issue of **Radio-Electronics** so you can check your answers in the next CET test. The new questions appearing in the next CET test will be on transistors and semiconductors. **R-E**

PRIOR QUIZ

7. **Correct answer is "c."** Removing the input signal will cause grid leak bias to be lost, therefore excessive plate current will develop.

8. **Correct answer is "a."** Current flow is 'against the arrow' in a diode, or in this case: from A to C. When A is

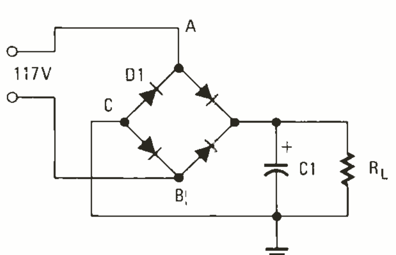


FIG. 12

more positive than C (and B), D1 cannot conduct. (See Fig. 12)

9. **Correct answer is "b."** Without C1, R1 would produce degeneration, i.e.: the cathode voltage would directly 'follow' the signal seen on the grid in

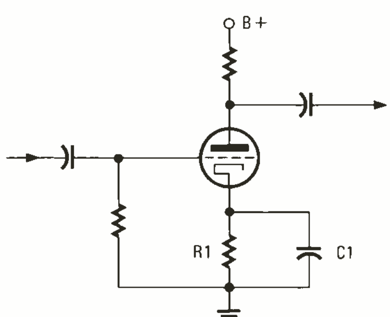


FIG. 13

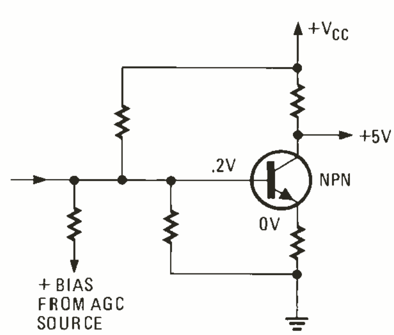


FIG. 14

Fig. 13, reducing the amplification in proportion to the signal strength.

10. **Correct answer is "a."** Reverse AGC would reduce the emitter current by lowering the base control voltage. Forward AGC would reduce the amplifier current by increasing the control voltage past the linear portion of the curve to a point where gain is reduced as collector current is increased. See Fig. 14.

Antique Radios

Bringing them back to life

There is a tremendous amount of interest and a reasonable profit in restoring old radios. This article tells you what radio restoration is all about and how you can become actively involved.

JACK DARR
SERVICE EDITOR

THERE HAS BEEN A TREMENDOUS RISE IN INTEREST IN ANTIQUE radios lately. (The price of the old sets has gone up, too!) Most of these radios are not very hard to fix; in fact, they provide a good place to use logical troubleshooting methods.

The only difficulty you will have will be in a few circuits that were common in the early days but haven't been used for a long time. They are not too hard to handle; you just probably haven't run across them. If you know about them ahead of time, it'll make repairing them a lot easier. (I can speak with authority, because I've worked on 'em when they weren't antiques but the current models!)

Tubes and circuits

The early battery-type vacuum tubes were triodes—'01A, '12, '10, 71A, etc., and the filaments were 5 volts DC. The original filament power source was a 6-volt automobile battery with a small dropping resistor in series. It was a variable resistor (called a rheostat) so you could turn the voltage up as the battery went down. In some very old sets, it was also the *volume control!* I use the term filament instead of heater because these devices were of the "red-hot hairpin in a bottle" type, and the filament was the source of the electrons.

This setup led to an unusual circuit. When these tubes were used with an AC power supply, they developed hum problems. So, the filaments were fed from a center-tapped winding on the power transformer. This equalized the AC voltage from either side of the filament to ground. Since the cathode must have a ground-return to complete both plate and grid circuits, the center tap of the filament winding was grounded. If a high bias voltage was needed, which was usual in older power tubes (the 71A tube needed −40 volts on the grid), a resistor could be connected from the center tap of the winding to ground. Or a positive voltage could be applied to this point. The grid circuits returned directly to ground; therefore, making the filament positive made the grid that much more negative with respect to it. Figure 1 shows these two circuits.

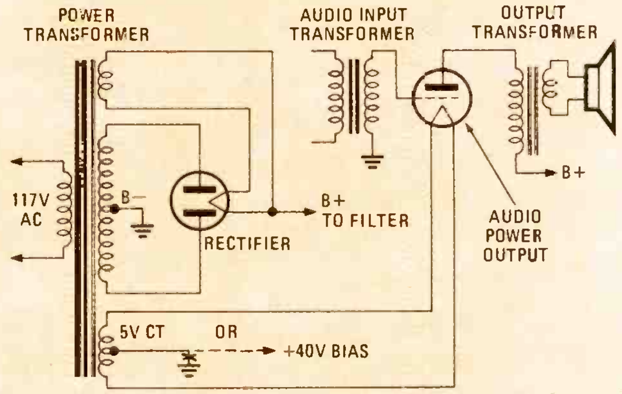


FIG. 1—FILAMENT CENTER TAP is the ground return for the "cathode" circuit. Bias may be applied at this point.

If manufacturers didn't want to use a center-tap filament winding, they connected a small variable resistor across the winding with its slider grounded. In stages like audio drivers that were more sensitive to AC hum, this could be varied for the

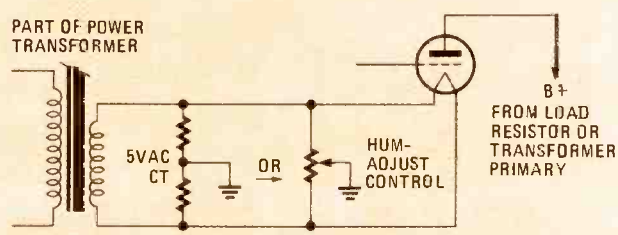
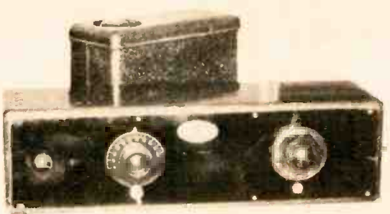


FIG. 2—LOW-OHM FIXED RESISTOR was often used instead of center tap. If adjustable, it could reduce hum. (Later ones on AC tubes were commonly called "humdingers.")

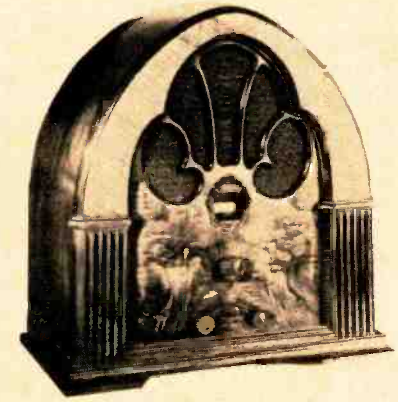


ATWATER KENT model 36, 1927

FRESHMAN MATERPIECE, 1925

FRESHMAN MASTERPIECE, 1925

RADIOLA 60 by RCA



PHILCO CORP. model 90B, 1931

ZENITH model 75 Radio Phonograph, 1930

least hum; therefore, you'll find this marked HUM CONTROL in some of the sets. (See Fig. 2.)

Around 1926, the first tube with a separate cathode sleeve was developed; and, as far as I know, it was the type '27 triode. (Now, we have to use the term heater again!) A year or so later, the first tetrode tube was developed. That was the type '24, the famous "screen-grid" tube with higher gain. (This tube and I went into the radio business in the same year. It's done better than I have!) These tubes got rid of a problem that had bugged designers since the beginning—neutralization!

Other tubes soon followed: the 35/51 and the first 6-volt 0.33-amp tubes, the 36-to-39 group. (The '38 was the first AC-operated pentode with a suppressor grid.) Then along came the '40 tubes, including the famous '47 power-output pentode, that could be found in about half the sets sold in the middle 1930's. We also had the 56/57/58 series, with 2.5-volt heaters. However, all this comes from my fallible memory, so, don't pin me down on it.)

Power supplies

The first radios used batteries. The filament battery was called the "A" battery, and the plate battery was called the "B" battery. If separate batteries were used for grid bias, they were called "C" batteries. These terms hung on when the first AC-power radios were built. (To this day, most of us old-timers use "B+" when we refer to the high voltage DC supply of a radio—even in TV applications, where the proper term is "low voltage DC supply.")

There were some odd components in these circuits that were eliminated in later radios. The stock circuit always had a power transformer. The B+ voltage was fed from the secondary winding, which was always center-tapped, and was the negative return. A full-wave rectifier tube was used, generally a type '80.

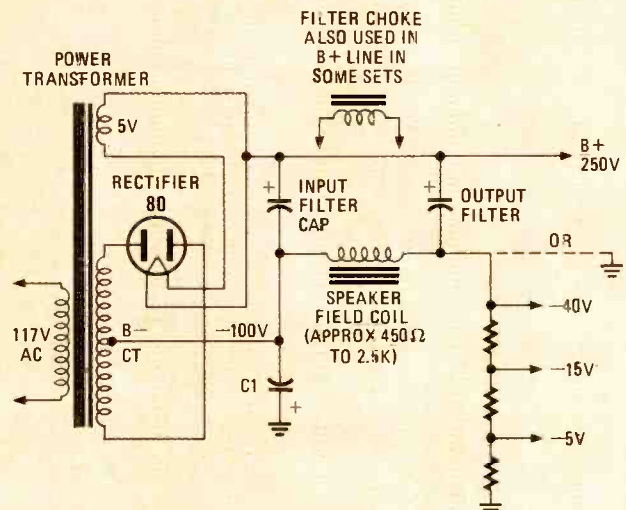
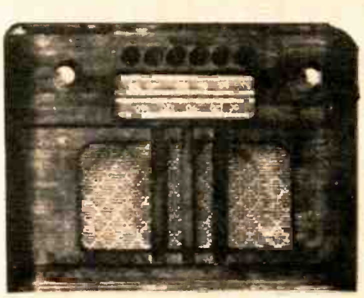


FIG. 3—THE SPEAKER FIELD COIL could be in the positive or negative leg of the power supply. Note that filter capacitors may go to negative terminal.

This negative return was a "B−" supply.

Figure 3 shows one of the old power-supply circuits. Many sets isolated the negative return of the B+ supply at the center tap and ran it through the field coil of an electrodynamic speaker to ground. (An electrodynamic speaker resembles modern dynamic speakers but it had a good-sized field coil to develop the magnetic field and needed a fairly heavy current.) All current drawn by the circuits in the set passed through the field coil, which also acted as the filter choke. In quite a few sets, the field coil was in the positive leg of the B+ supply. It works



RCA model 95T5, 1938

SILVERTONE model 8005, 1941

MODEL 6050 Sears Silvertone

exactly the same since the same current flows on both sides of the power supply circuit.

With the field in the negative leg of the B+ supply, the current developed a negative voltage drop. This drop was taken off and used as bias on stages that needed it. In many radios, some small resistors were used between the field coil and ground to develop lower bias voltages. The unusual feature in this circuit lies in the connection of the *input* filter capacitor. Note that the negative connection does not go to ground but to the B−line. Connecting this capacitor to ground when you replace it results in a terrific hum. In quite a few of these old radios, another capacitor (C1) was added, as shown in Fig. 3. This capacitor was connected with its negative lead to the center tap, and positive lead to ground.

Bleeders

Voltage regulation wasn't so great in most antique sets. To improve this situation somewhat, many sets used a long string of resistors connected from the B+ voltage to ground. This type of resistor was called a bleeder resistor. Its function was to draw a certain constant "bleeder" current, placing a partial load on the power supply. As a result, variations in the load currents of the various stages did not cause so much change in the voltage. Atwater-Kent was one manufacturer who used this circuit extensively.

Figure 4-a shows a typical bleeder circuit. This bleeder was connected directly to ground. Figure 4-b shows another type

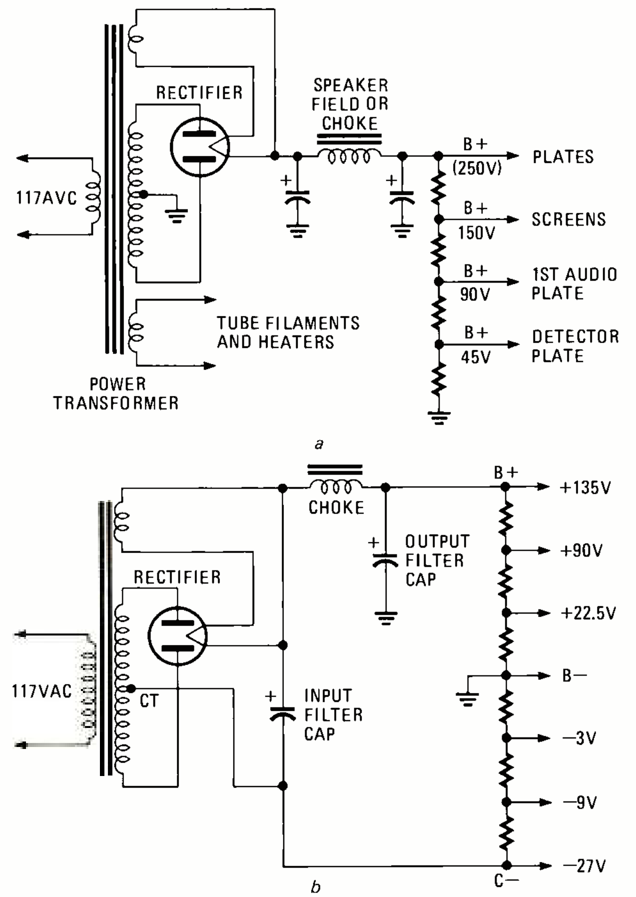


FIG. 4—BLEEDER DROPS THE B+ voltage for different stages of the receiver, while stabilizing the power-supply output(*a*); and (*b*) bleeder with negative end for bias.

that had a tap connected to ground and more resistors going to B− at the transformer center tap, so that they could tap off negative voltages for biasing.

Signal circuits

The oldest radios are all TRF (*T*uned *R*adio *F*requency) types. This means there was a string of RF amplifier stages, one after the other (cascaded) with a detector and audio amplifiers. There were two reasons why: First, this was the first radio receiver circuit, and second, RCA held a patent on the superheterodyne circuit! That circuit was invented during World War I by Major Edwin Armstrong. (Yes, "FM Armstrong" himself.) So, for quite a while, if you owned a superhet radio, it was an RCA model. Eventually all radios became superhets.

The TRF's comprise a string of up to three amplifier stages. More than three stages resulted in stability problems, to say nothing of tuning problems. The first sets had three separate tuning capacitors. Dials were calibrated from 0 to 100. (This resulted in your having to log the settings, with entries like "KDKA: 47-51-42"!)

Then a three-gang capacitor was developed that would track, and then the ad men had a field day selling "one-dial tuning"! Before then, however, some wild and wonderful schemes were used. The Atwater-Kent units drove all three tuning capacitors from the middle shaft, with the outboard capacitors driven by small belts made of thin brass on metal drums. (If you need a replacement for these, cut some thin strips of brass shim stock, and solder the ends together.) To prevent slippage, a tiny hole in the belt slipped over a pin on the drum.

The superheterodyne radios generally used separate triode oscillators with a tetrode mixer. The most popular (but not universal) intermediate frequency was 175 kHz. The IF transformers were generally tuned by a pair of mica compression trimmers, accessible through holes in the top of the shield cans. Some later transformers used powdered-iron cores, with a long, thin brass screw coming out the top and bottom. Since the ends of these screws were split (they broke off very easily, which caused problems) we soldered a nut on the end of the screw and used a *Bakelite* hex-tool to tune them). Some manufacturers used fixed-tuned IF transformers (the early Majestics, for instance) tuned them up at the factory and then ran the shield can full of hot tar. This is what I call an early example of encapsulation!

Several manufacturers followed the same procedure with the DC power supplies. The filter capacitors and chokes were mounted in a big square tin can and filled with tar. This is where the term filter block came from! You replaced the whole thing if any single part blew.

Servicing—parts substitution

Servicing the old sets can be fairly easy, especially if you have a schematic. Even though it was common practice then to omit DC voltage readings from the diagram, it's not difficult to check them. In early TRF sets with triodes, the B+ voltage is about +180—the voltage of four 45-volt B-batteries in series. This voltage will be used as plate voltage on the RF amplifiers and audio output stage, with about +90 volts on the first audio stage and still less on the detector stage—from +22.5 volts to +45 volts. These voltages are tapped-off the bleeder resistor, and negative bias is picked up as discussed earlier.

In the superheterodyne sets and in later sets using tetrodes, the B+ voltage is about +250 for plates, with about +100 to +150 on the screen grids.

Many sets used grid-leak detectors (see Fig. 5). The grid-leak resistor and grid capacitor were often unmarked. The resistor

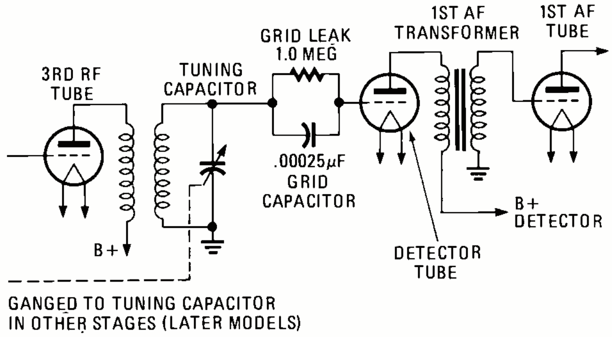
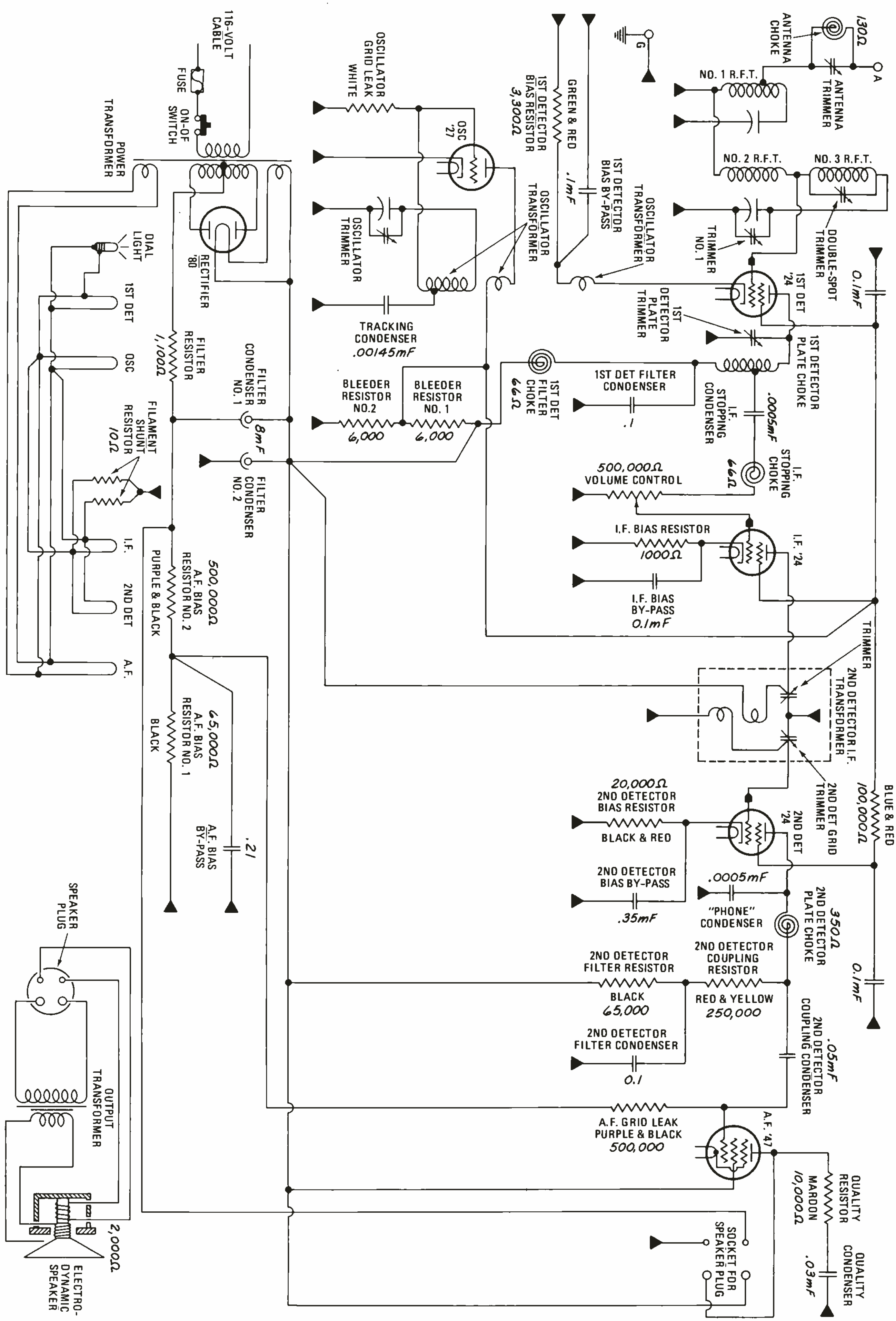


FIG. 5—GRID-LEAK DETECTOR USED in most old TRF radios. In many cases the "leak" resistor went direct from grid to ground.



EARLY SUPERHETERODYNE, the Atwater-Kent models 84 and 84-F.

was a glass-body type with metal end caps and was clip-mounted on the mica capacitor. The resistor value was usually 1.0 megohm, and the capacitor was 250 mmf—now called pF (or 0.00025 μF).

Servicing the B+ line

The first step in servicing the B+ line is to take all the tubes out. Now turn the set on and check the B+ voltages. (To know what reading to expect, check the AC voltage from either plate of the rectifier tube to ground. If it reads about 160 volts RMS, the B+ voltage will be +180. If it reads 220 volts RMS, then the B+ voltage will be about +250.)

The '80 rectifier tube will have to be left in, of course, to read the B+ voltage. If its plate becomes red-hot, turn it off *quickly*, you've got a short. If you check from the B+ voltage to ground, the cause of the short should be easy to find. For an easier test, lift up one end of the bleeder-resistor network. For a ballpark figure, these bleeders averaged about 25,000 to 50,000 ohms total in most sets.

Many older sets used paper filter capacitors with a range from 2 μF to 4 μF. This range was as much as these capacitors could have and still be small enough to fit into the cabinet. They can be replaced by 4 μF–8 μF, 450-working-volt, electrolytic tubular capacitors (noncritical). If the filter is encapsulated, find the shorted capacitor and clip off the lead. Fit the replacement capacitor under the chassis, if any. Make sure to connect the negative terminal to the right place.

The next step was the use of wet electrolytic filter capacitors. The first such type was a huge 3-inch brass or copper can with an insulating disc on top. This type was succeeded by the more familiar-looking aluminum can, which was about 1 inch in diameter. The advantage of the wet electrolytic capacitor was that it was truly self-healing. The can was one electrode, and an aluminum corkscrew was the other electrode; the electrolyte was really a liquid. If the capacitor arced over, it would heal up instantly and be as good as new! The disadvantage was that if you turned the chassis upside down to service it and forgot to tape over the *vents* on top of the filters, all the liquid leaked out and you had to replace all the filter capacitors! These electrolytic types ran about 8 μF at 450 working volts. They can also be replaced by tubular capacitors with the same capacitance or greater and the same working voltage.

Checking bleeders

If you discover that several B+ voltages are off-value, one of the bleeder resistors is probably open, and you'll need the schematic to find the value. If a diagram isn't available, you can determine the approximate resistance by connecting a 25K-50K potentiometer in the place of the open. Turn on the set and adjust the potentiometer until the B+ voltage at that point returns to normal. Use the ballpark voltages previously given as a guide. Then take the potentiometer out and read its value; replace it with a 5-watt wirewound resistor.

The early bleeders varied in type. Atwater-Kent used an odd variety—a large strand of asbestos that had resistance wire wound around it and then was insulated. The wire ends were made of blobs of molded solder, some up to 12 inches long, and they might use eight or ten taps. The underside of the chassis looked like a nest of snakes.

Another common and unpopular type of bleeder was called a *Candohm* (canned ohms). These resistors were flat and wirewound with taps connected to metal tabs. The entire resistor was insulated with empire cloth, a fabric soaked in fish oil, then covered with a tin shield that served as the mounting; hence the name, *Candohm*. This type of bleeder would break down to the grounded tin case, and was prone to developing intermittents. (One stock cure was to run a sharp-pointed knife down the wirewound resistor to make sure it stayed open, and then tack a 5-watt wirewound resistor to the terminals.)

Replacing IF transformers

If one of the IF transformers in an old set is open (a common occurrence) you can often substitute a modern-type IF transformer. Take the old transformer out of the shield can. Now select a replacement transformer and mount it on the chassis in the original hole. For the sake of appearance, you can put the original shield can back, and the set will look just like it did. I used this trick on a beautiful old Scott All-Wave radio that I was overhauling, and the set worked just as well as ever. You can obtain 175-kHz IF transformers in small cans from the J. W. Miller Company, as well as 262-kHz, 455-kHz and even 132-kHz types. Many sets then were supposed to be tuned to 450 kHz or 460 kHz, but any 455-kHz transformer will cover that range.

You may also find open RF coils. In many very old sets, these coils are often single-layer solenoids, wound on forms that are up to 2 to 3 inches in diameter. If those are bad, they can be completely rewound without too much trouble. (Most of the open circuits are at the coil ends and can be repaired by unwinding one turn and resoldering.) If the whole RF coil must be rewound, count the turns as you unwind the original and use the same size wire and the same winding direction. Even oscillator coils can be rewound if they're single-layer coils. If they are multiple-layer or honeycomb coils, a replacement can probably be found in an RF coil catalogue.

Checking tubes

If your tube tester won't check the old tubes, just plug the tubes into the set; if they light up, they may be good. The best tube test is signal-tracing. Feed a signal to the grid and read the signal on the plate. In the RF or IF stages, read the signal voltage at the detector output as you move the signal generator through the IF stages toward the antenna.

Many older tubes had such heavy filaments (to avoid hum; the heavy filaments had a much longer thermal lag between AC cycles) that they can be rejuvenated in the same way as picture tubes. Just raise the filament voltage about 10%, let it heat for a while, then try it.

You may have noticed that I've referred to tubes as " '01A," " '71A," etc. The apostrophe indicates that the last two numbers are the only ones that are really significant. At first, the tubes were designated "201A," "301A," etc. The first digit indicated the brand name—RCA tubes were all marked "2," Cunningham tubes were all marked "3," and so forth. (This description may not be precisely correct, but it gives you the general idea.)

Speakers

The oldest radios used horn speakers. They were driven by what amounted to a big earphone. Next came electromagnetic speakers, or just "magnetic" for short. These speakers had a pair of coils, driven by the output stage, which moved an iron vane or armature connected to a paper cone with an iron rod. Next came electrodynamic or moving-coil speakers, which were similar to those used today.

The big difference is that these old speakers had a "field coil," as I mentioned earlier. Current had to flow through it to provide the magnetic field. Some of the first speakers had their own separate field supply—a transformer, rectifier and filter that energized the field directly from the AC line. The next versions were used in series with the B+ line of the DC power supply. The field coil served as the filter choke.

Any of these dynamic speakers can be replaced by a modern PM dynamic speaker of the same size. Just connect the voice coil directly to the original output transformer, matching impedances, of course. Most speakers were 8-ohm voice-coil types. If the field was used as the filter choke, replace it with a suitable iron-core choke with an inductance around 8–10 henries at 250 mA.

If the output transformer is open, you can find replacements for them. The '12A tube has a load impedance of 10,000 ohms; the '71A's load is 5000 ohms, and so on. You can find the right load impedance for any transformer in supplements at the back

continued on page 97

Forest Belt tells...

What You Need To Know About SPECIAL SIGNAL GENERATORS

SIGNAL GENERATORS FOR TV. Last month, we covered signal generators used in troubleshooting and evaluating stereo systems. This month, we continue the coverage with TV signal generators.

Two procedures have long served troubleshooters in finding out what's wrong with a TV: signal tracing and signal injection. Both are intensely practical; both are fast; both are dependable—when you're sure of the signal being fed into the set.

That's where today's special signal generators come in handy. They produce specific, definite input signals, sometimes for the front end of a receiver, sometimes for a particular section. In either case, you can be sure of what you're dealing with as you diagnose troubles, and this confidence speeds repairs. You cannot always be that certain when you depend on station signals for testing.

A few generators today have evolved into multipurpose instruments that justify the term "analyzer" (which indeed several are called). This Special Section introduces you to some of these unique instruments, and tries to guide you in taking advantage of the new efficient troubleshooting they can provide.

Television Servicing: Modern Generators Make It Easier

The television sweep generator is a very specialized instrument that, in the hands of an expert, can be used to troubleshoot and service modern color television circuits with speed and accuracy.

TELEVISION TEST EQUIPMENT IS WORTH more today than ever before. First, signal generators, particularly the newer color-bar units, are more compact and yet far more stable than they have been up till now. Tight, dependable oscillators and frequency counters, brought about through IC technology, virtually eliminate guesswork—and end your worries about whether the instrument has the jitters or the set has.

Second, video generators have become increasingly versatile as TV sets have become more complex. As you will see, some more recent equipment has even developed some entirely new approaches to video analysis and trouble diagnosis. Such usefulness can save you time and even earn you money, not to mention making servicing easier.

Moreover, the advent of consumer-priced home video recorders promises new things to work on, even though they are a bit more complicated. New challenges are opening up with unlimited potential. Of course, like any other opportunity, it's valuable only if you're ready for it. Preparedness requires that you keep up with the new technology and equip yourself for dealing with it.

For IC's: Old habits into new

Integrated circuits comprise the major change in TV receivers. In certain ways, placing many stages on a single IC eliminates several service and adjustment worries. Today's TV sets have fewer coils to align in the RF, IF and color stages. Integrated circuits turn formerly critical stages into more elaborate designs that are less touchy, yet, because of IC technology, are no more costly.

Unless you have discovered how easy IC's are to troubleshoot, they may leave you in some awe. No doubt about it, they are exotic inside. You may not understand all their architecture, design, composition, manufacture and inner workings. However, you need not worry about servicing them. You probably already have whatever knowledge you need, maybe without even realizing it. All you have to do now is to ease yourself away from certain old troubleshooting habits and acquire some updated thinking. I warn you fairly, however, you do need test instruments. Let's take an example:

A good color generator performs several basic tests. It can prove especially valuable when the color section of a TV receiver you're servicing is peppered with IC's. Trouble-tracing with a station signal may be manageable, but it cannot compare with using a fixed, dependable signal of steady, known characteristics. This is true of the keyed-rainbow pattern (the most commonly used), and of so-called NTSC patterns—which have started reappearing in service-type generators.

Let's take a hypothetical case: One very new-model Zenith color chassis exhibits no picture at all. The sound is OK. At examination, the screen is black. But this often is part of the missing video symptom in recent sets. As it happens, there's a photocell-operated brightness limiter in this set that accommodates room lighting. Flipping a flashlight beam across the photocell causes enough "speckle" to appear on the screen to show that the high voltage and the CRT are working.

Your first thought is—the luminance is blocked. You feed in a steady signal, in this instance a keyed rainbow. Your oscilloscope shows the signal is OK at the video-detector output, and at the input lug of the module that handles chroma and luminance. More tracing proves that the signal is OK at the input to the luminance IC. However, in checking waveforms around the luminance IC, you discover that the signal from the chroma IC is missing. This leads you to make tests at the chroma IC.

Your scope shows that the input to the chroma IC is OK, but there's no output signal at any terminal. One thought of course is that the IC may be defective. But *all* the outputs are missing. A faulty IC could cause that symptom, but the situation should prompt at least some second thoughts. With everything shut down in this IC, perhaps the trouble lies outside it—for example, the DC supply voltage could be missing.

Sure enough, it is. Someone else replaced this IC once before; its predecessor *was* bad. However, one pin wasn't soldered properly during replacement. There's no voltage on the DC input pin, and therefore no operation. No video reaches the R–Y, B–Y and G–Y outputs, nor the luminance IC.

However, one main point you should recognize is the advantage of using a generator signal instead of a station signal. Figure 1 shows the waveforms found at the luminance IC input when you use a station signal, a keyed-rainbow signal, a standard EIA color bar (in what's known

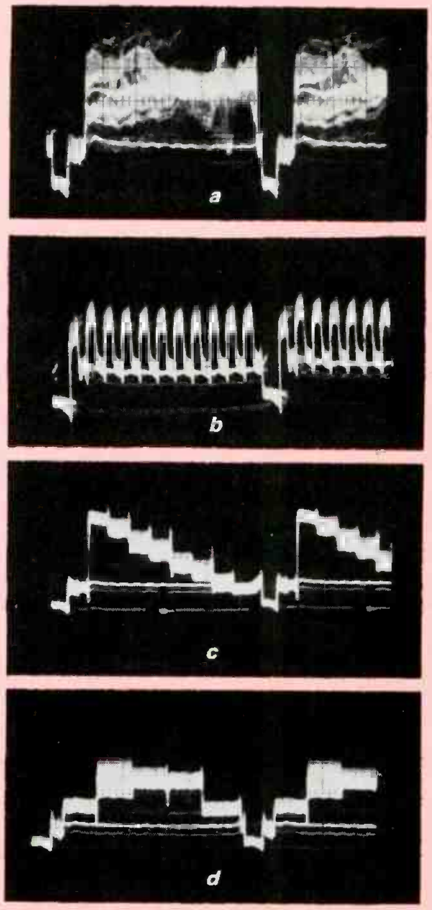


FIG. 1—STATION SIGNAL (top) contains constantly changing video. Fixed patterns from generators make tracing and analysis much easier.

as the NTSC format) and a color-bar pattern developed by Sencore for the new *model VA48* video analyzer. Note that here you deal mainly with *video signal levels*.

Figure 2 shows the same four signals as they appear on your oscilloscope at the input to the chroma amplifier IC. Any of the latter three signals is easier to recognize for tracing purposes than the station signal.

The other major point is that tracing stage operation is the best method of finding IC trouble. No matter how you have approached troubleshooting in the past, today you need a step-by-step, logical way to diagnose faulty sections, localize defective stages and isolate troubled circuits. (For more details, note the box about *Easi-Way Servicing* in last month's Special Section.)

Then, when you have found an IC that doesn't do its job, take the following steps:

1. Check that all signals—such as video, keying, blanking, etc.—are reaching the IC. Often the IC operates incorrectly or not at all when even one signal is missing.
2. Verify that all DC voltages are reaching the pins of the IC. In the previous example, voltage was available at the foil, but could not be measured at the pin on the opposite side of the PC board.
3. Verify that all DC voltages *from* the IC are present. If they're not, do not automatically assume the IC is defective. A loaded circuit may be dragging the voltage down. You know how to isolate that kind of circuit problem—by cutting circuits loose, one at a time.
4. If you do have to replace the IC, do a clean job. Desolder thoroughly, with some form of vacuum device or desoldering braid. Clean out the holes and clean the foil. Insert the new IC solidly against the board, and make sure no pins get bent in the process. Finally, carefully solder each pin with a hot iron. A fast-on/fast-off operation with the iron does the best job; but be sure you apply heat long enough for the solder to flow, or it won't bond the pins solidly to the foil.

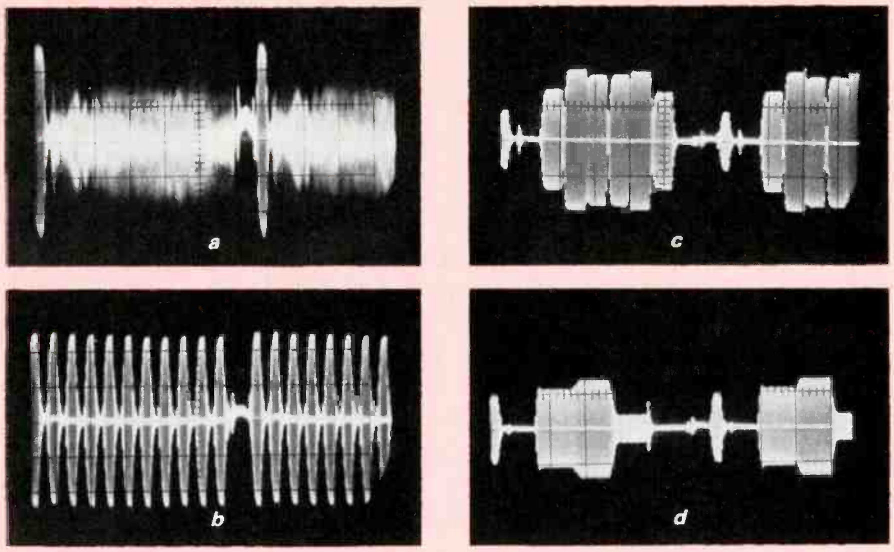


FIG. 2—CHROMA CONTENT of test signals provided by (*a*) station signal, (*b*) keyed-rainbow generator, (*c*) NTSC-type color-bar generator and (*d*) Sencore *model VA48* video analyzer.

Align And Conquer

OK, that takes care of some of the basic troubleshooting procedures around IC's. Now, let's dig a little deeper into the methods of reaching down into the IC.

Many of us still shy away from aligning TV receivers. We often assume (or pretend we believe) that sets don't need alignment. It's true that receivers come from the factory almost perfectly aligned, and often "cooked" in. But that does not prevent aging from affecting color performance. Too often, we just ignore alignment and tell ourselves that it's OK to watch a less-than-perfect picture.

If you're guilty of that attitude, you're losing out on two counts. First, you're missing a chance to show how really top-grade color TV looks. Second (and more important) you're overlooking an exceptionally effective troubleshooting technique that we can call "align and conquer." Many of us have used a version of this technique since the early days of color TV. It works just as well today.

Moreover, with today's alignment generators, there's really no excuse for being afraid to align a set. It is *not* a haphazard process, no matter what oldtimers tell you. Anyone who thinks aligning a TV set is a big job just hasn't discovered how to do it with modern instruments. Only when you try it will you see how easy it is; just a smidgeon of experience makes the whole process fairly quick.

Let's briefly revisit IF alignment because it's the easiest type to understand and to perform. The alignment principles are simple. You adjust a group of coils to certain frequencies, and their response "curves" overlap to render the wideband response that passes video and chroma information in the right proportions.

A few alignment gadgets, some of them designed specifically for certain TV sets, save time. Collect them, keep them all together and use them when the alignment guidelines for a set suggest their application. Likewise keeping a *complete* set of alignment tools (stored in a drawer or in their roll pack) should avoid wasted time and the damaged coils that come from using a wrong tool. Half of all the time that is spent unnecessarily during alignment is a result of being poorly prepared.

It takes only a few minutes to make all the preliminary connections, especially once you are familiar with them. A multi-voltage bias box is necessary. You apply recommended DC voltages to the tuner and IF automatic gain control (AGC) lines, and sometimes to the AFT terminal on the tuner. Some TV alignment generators include these well-filtered DC sources; use your DC voltmeter to make sure that they apply the proper voltage *when connected*. These bias connections are vital because they prevent the stages from being overloaded by the input signal. Signal overload can distort response.

The 60-Hz sinewave used to drive the sweep oscillator in the generator must also be fed over to the scope's horizontal amplifier. With a triggered scope, this means setting the sweep for *external input* (not external trigger). If the instrument is a dual-trace scope, you must set the timebase switch at its X–Y position; one of the two input channels is thus converted to a horizontal input channel, and accepts the 60-Hz sinewave from the sweep generator. You adjust the input-voltage switch of that channel for a comfortable trace width, without overscan.

For IF alignment, a mixer injection point has been provided on virtually every TV tuner. Injecting a sweep signal at the mixer isolates any input-cable effects from the tuned circuits you must align. On a few sets, the alignment instructions recommend using an isolation network. Some generators have cables with proper 75-ohm terminations and do not need this isolation pad. (A 300-ohm termination matches the antenna terminals for tuner alignment, but not this mixer input which is for IF applications.)

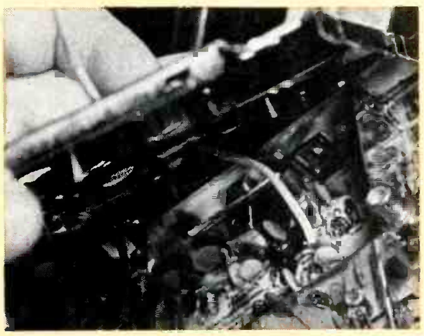
One new modular TV set, which at present lacks service instructions, incorporates varactor tuners with the mixer injection point down inside. During the warranty period, you are supposed to send the entire module to your nearest distributor, who sends it to the factory for any repairs or alignment. But you know how that story generally ends up. Sooner or later, you will have to work on sets like this. Eventually, the company will produce a suitable plug. Meanwhile, wrap a lead around the post and dress the pigtail through the access hole in the cover plate. The cover must remain back in place while you test or align.

Any handy point following the video detector can serve to connect the scope vertical input. You can avoid having to use an isolating pad if you make the connection just after the first video amplifier. You do not need a demodulator probe.

A lot of time can be saved if you keep a sweep generator and scope set up ready for a quick alignment check. You can use an old scope; its response is unimportant. If your instruments are already set up, you just make three or four connections and you have (1) an assessment of the IF response (and color alignment too, as you will see) and (2) an immediate means of diagnosing and correcting discrepancies in the IF or color-bandpass sections.

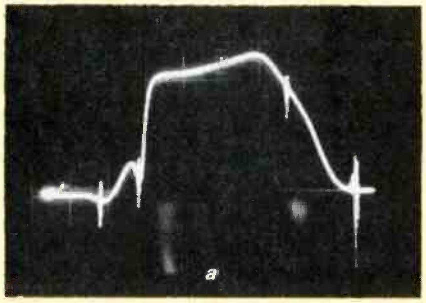
Figure 3-a indicates somewhat the type of curve you're likely to see from the IF strip of a three- to four-year-old set.

DC VOLTAGES from B&K *model 1077* video generator can clamp AGC and AFT lines for troubleshooting or alignment.



MIXER INJECTION POINT in varactor tuner is post on printed board, accessible only with shield cover of tuner lifted.

Normal aging has changed the gain in some stages, and you will note a bit of overpeaking just down-frequency from the picture IF marker (45.75 MHz). The sound trap at 41.25 MHz is fairly close to the value for proper adjustment, and the skirts at both ends are correctly steep for the adjacent-channel sound and picture traps. In other words, only minor touchup



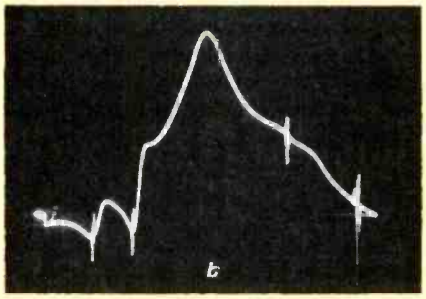


FIG. 3—SWEEP RESPONSE CURVES of video IF, with markers (left to right) at 39.75 MHz, 41.25 MHz, 45.75 MHz and 47.25 MHz. Bottom curve indicates serious alignment flaw.

is necessary. Actually, this set operates well without any control adjustment, and you would be justified in proceeding no further with alignment. This particular set has passed your alignment test.

However, suppose the curve looked like the one in Fig. 3-b. Something in the IF has to be fixed. But what? One quick check involves a slight adjustment of each coil slug. Note its position, then turn each IF adjustment a tiny amount, all the while watching the curve on the oscilloscope. Each time, return the slug to its starting position; this is not yet a touchup. A slug that has little or no effect on the curve is faulty, or its decoupling capacitor is defective. If the tuning peak (or dip) is very slight or broad, you can suspect a faulty amplifier adjacent to that coil or transformer.

This little procedure takes only a few moments. You don't even have to look up which coil is which, until you find the faulty one. This trick may sound oversimple, but it identifies a defective IF coil or trap almost every time. In Fig. 3-b, the 47.25-MHz adjacent-channel sound trap has a faulty capacitor across it.

In another set, two of the three traps seemed to have little effect on the curve, which was severely distorted. It turned out they had a common ground foil, which was cracked and open.

In still another receiver, the sweep curve failed to appear at the video amplifier. Using a probe at the video-detector output revealed no curve there either. Yet, with a demodulator probe and some extra push from the generator, the technician found that RF signal was reaching the IF integrated circuit. (Don't expect to see a conventional sweep curve here, just an RF curve. You can verify that it is generator RF signal by raising and lowering the output level.) Moving to the output pin of the IC, we found a curve. This curve was distorted because some of the coils are *after* this point, between the IF-amplifier IC and the video-detector IC. The IF-amplifier IC was obviously working.

Probing around the video-detector IC showed that signal was going in, but there was no signal going out to the AFT, to the sound IF section, nor of course to the video amplifier. The conclusion was that this detector IC wasn't functioning. Direct current tests were confusing, but the input voltage was there. Conclusion: the IC must be bad and it was.

Yes, you could have traced this problem with ordinary video signals. But you would not have proved that the IF's were OK as you proceeded. Nor, when the faulty IC was replaced, would you be already hooked up to run through a quick video IF alignment—which proved advisable because someone else had fooled around with the alignment before giving up on this tough dog.

Conquering color by alignment

While you're hooked up for sweep tests and adjustments, it's important to inspect the chroma-bandpass response. Fig. 4-a shows the first curve taken without touchup; one of the bandpass coupling transformers is misaligned. A demodulator probe connected to the bandpass-amplifier input, and with the sweep fed in at a video amplifier, both reveal the actual shape and relative amplitude of the color sidebands as fed through these coupling transformers.

You can set the bandpass-amplitude control here to insure that no marked part of the curve drops below about 70% of the peaks. Figure 4-b shows the curve when all are properly aligned and adjusted. Naturally, any defects in this system prevent a proper curve from appearing, and alignment attempts often indicate where the trouble is.

Afterward, it's advisable to view the *overall* curve for color bandpass, including the IF section. Actually, both the IF video and bandpass must dovetail to produce the correct overall response.

So you drop the sweep feed point back to the tuner mixer point. Reset the sweep generator to produce an IF sweep curve of about 45 MHz, as for IF alignment. Be sure the DC biases on the AGC lines are according to the manufacturer's recommendation. Markers at 3.08 MHz, 3.58 MHz and 4.08 MHz indicate the curve points.

As Fig. 4-c shows, properly aligned IF

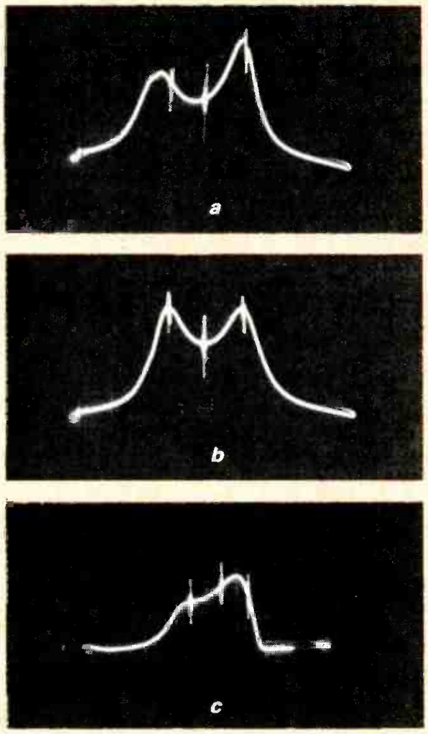


FIG. 4—SWEEP CURVE for bandpass amps, with markers (left to right) at 3.08 MHz, 3.58 MHz and 4.08 MHz. Faulty response from defect in bandpass section is shown at *a*, correct shape for curve, with signal injected at video amp is shown at *b*, and a bandpass curve when video IF stages are included appears at *c*.

and bandpass-coupling stages place a peak between the 3.58-MHz and 4.08-MHz markers, with the 3.08-MHz marker about one-third down the lower-frequency skirt. The 4.08-MHz portion of the curve must not be higher than the 3.58-MHz portion. A slight touchup of the first bandpass stage and then, if necessary, the IF coils (those that affect the *down-frequency* IF skirt) will shape the curve and place the markers as they should be. If in doubt, consult the manufacturer's recommendations for the right shape.

Finally, you must set the color-sync or burst-processing system. Now, you can turn off the sweep setup and revert to a keyed-rainbow pattern generator (or an NTSC-type display, if you prefer). Again, however, your diagnostic and checking technique consists of trying to align the tuned circuits, and of tracing the signal with an oscilloscope if it is missing, inadequate or distorted.

The first adjustment in the color-sync section, for example, involves using a voltmeter. If adjusting the burst input or ringing coils does not show the proper DC peaking at the voltmeter test point, you know approximately where to look for trouble. Then, you should probably use the scope probe to do some tracing and inspecting of waveforms and amplitudes. Verify that the signal reaches the input (see Fig. 5-a). Then you'll ordinarily find test points for tracking it through the burst section.

In most designs, the DC test point for adjusting the burst transformers is at the ACC/(*A*utomatic *C*ontrast *C*ontrol) stage. So any defect that prevents coil adjustment from affecting that DC voltage must exist between the input and the ACC detector. Your scope can verify the continuous waveform produced by the 3.58-MHz oscillator. Figure 5-b shows how this signal looks at the output of the burst gating stages.

Your own IC data

Eventually, if all checks OK during the adjustments, you come to the IC itself. The receiver's service information should tell you all you need to know about signal inputs and outputs around an IC, plus all the DC voltages. However, this often is not the case. You can obtain this information for yourself. All you need is a working TV set, whatever pattern generator you use for color servicing, your oscilloscope, and a digital or analog voltmeter.

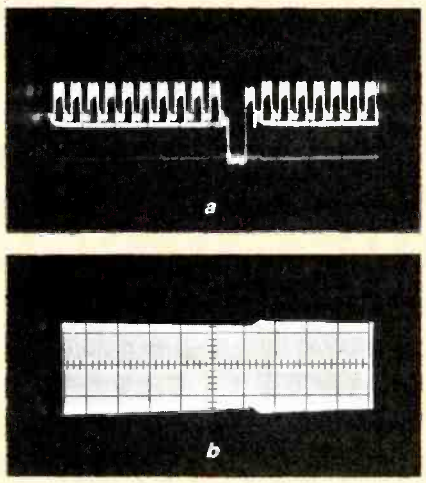
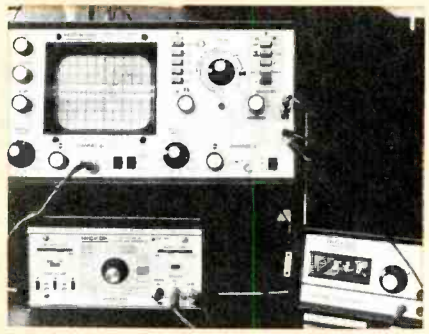


FIG. 5—COLOR-SYNC ALIGNMENT requires burst source and voltmeter (at ACC). Patterns can be traced to burst-processing IC (*a*), and at the output of continuous-wave oscillator (*b*).



TV TEST SETUP of Hickok instruments consists of model 517 double-trace scope, model 246 color-bar generator and 334 DMM.

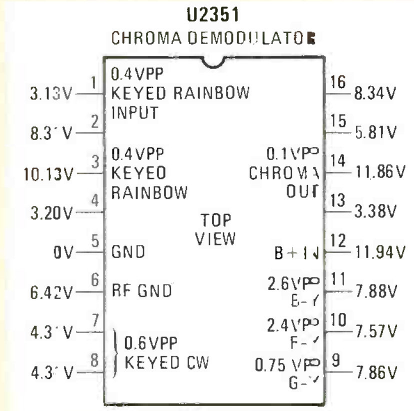


FIG. 6—HOW TO ADD PERTINENT DATA to a base diagram of an IC used in a TV set or similar equipment.

Figure 6 shows a way to record the information that works for any IC; it shows an IC-data diagram for the new U2351 chroma demodulator IC.

A digital voltmeter reads the DC values quickly and accurately. Your scope tells you the peak-to-peak signal values. One key, as you can see, is the use of a steady signal from a color-pattern generator, a keyed rainbow in this case. Use any generator you're accustomed to. What you develop with a diagram like this is a standard against which to compare and evaluate later performance whenever a color section using this IC malfunctions.

Using your regular generator, make diagrams for every IC in all chassis you service often. Keep this IC data with the chassis service information.

Pattern Diagnosis

As any bona-fide technician knows, television diagnosis presents a considerable challenge. Any help in pinpointing trouble a faster, surer way is certainly worth pursuing.

A TV signal is itself extremely complex. To further complicate matters, an awesome array of different signals of many sizes, waveshapes, frequencies, time durations, etc., are developed and manipulated within the receiver. As sets have become easier and steadier to operate, the multiplicity and complexity of signals in the chassis have also grown. However, test instrument designers have kept pace, and as technology advances, so do the generators built to cope with servicing.

Radio technicians got by with simple modulated RF generators. But there was no comprehensive (and affordable) signal generator for TV until B & K Manufacturing Company (Now the B&K/Precision Division of Dynascan) produced the

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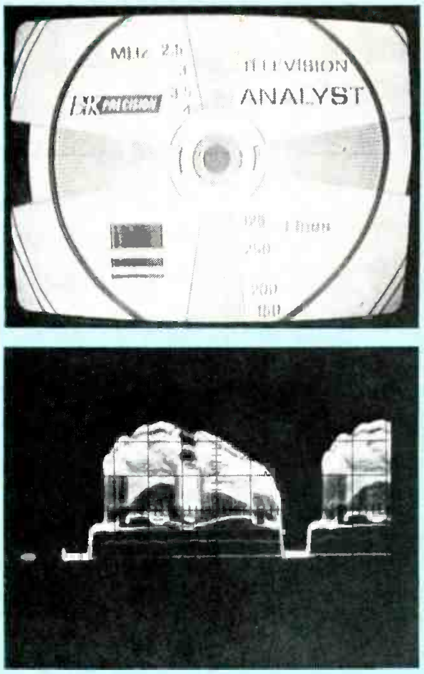

FIG. 7—VIDEO PATTERN generated by B&K/ Precision *model 1077* resembles Indian-head test pattern used in early TV days. Video in waveform stays constant, thereby making tracing easier.

model 1076 Television Analyst more than a decade ago. This was a miniature TV transmitter—a flying-spot scanner that produced a standard circular test pattern (see Fig. 7), sync pulses and drive pulses to feed almost any portion of a TV receiver. Today, its modern descendant, the B&K/Precision *model 1077 Television Analyst*, does these things and more. It's a test-pattern and pulse-waveform generator for servicing virtually any video equipment.

Very recently, Sencore Inc. introduced the first new all-around TV signal source in years. The *model VA48 Video Analyzer* simulates just about every signal a TV set needs. In addition, the *model VA48* brings some new techniques to video diagnosis and troubleshooting.

This unit has no circular test pattern, but it does generate two unique video patterns. One appears on the television screen as a series of vertical lines with different spacings. The top part of Fig. 8 shows the screen pattern. If you're familiar with video testing signals, you may recognize this as a *multiburst* pattern. Its video waveform appears in the lower part of Fig. 8. The test signal comprises short bursts of various frequencies, one after the other.

You may ask, why this particular pattern? It contains several elements. First, on the left is a gray-scale staircase pattern: black, gray and white. It works for any R–G–B gray-scale adjustments, and for checking video-amplification linearity.

Next comes the multiburst pattern, which tests video frequency response all the way to the CRT. This pattern produces one cycle at 188 kHz; then four at 755 kHz; eight cycles at 1.51 MHz; a 16-cycle burst at 3.02 MHz; another at 3.56 MHz; and one final cycle at 188 kHz again. In terms of TV screen resolution, these bursts represent, respectively, 16 lines, 65 lines, 125 lines, 250 lines and 295 lines. A similar frequency-response-vs.-resolution chart on the circular test pattern produced by the *model 1077* is shown in Fig. 7. Both patterns indicate the ultimate response of the TV receiver to details in the video stage.

Sencore calls this video pattern a "Bar Sweep." Once you know how to interpret these bars, it will eliminate the need for conventional sweep alignment. You can even learn to align the TV receiver according to these patterns. The concept is unique, and Sencore has patented the pattern.

The *model VA48* produces another patented color-servicing pattern called the "Chroma Bar Sweep." It is shown in Fig. 9, along with its oscilloscope waveform. A solid center bar is generated at 3.56 MHz, in proper phase to produce a blue output from the chroma demodulator. On each side are modulated signal

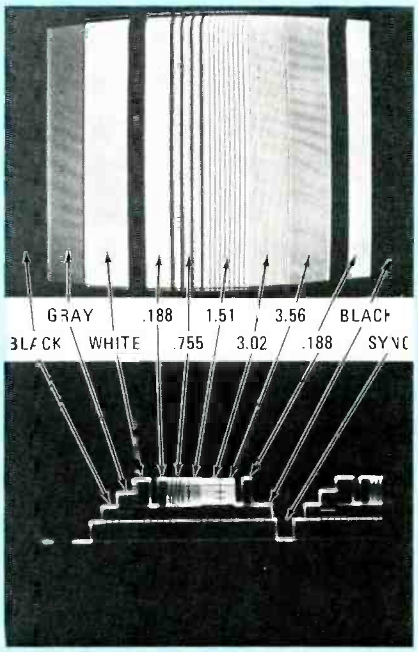

FIG. 8—VIDEO "BAR SWEEP" created by Sencore *model VA48* TV analyzer contains several frequency samples, and reveals IF and video response on screen of TV set.

SENCORE model VA48 video analyzer.

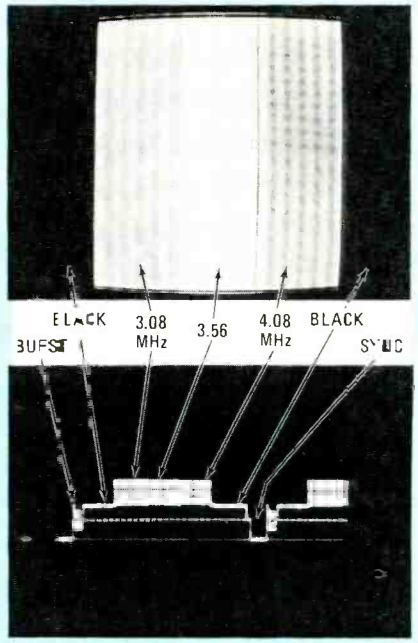

FIG. 9—"CHROMA BAR SWEEP" places blue center bar on screen, with displayed bars of 3.08-MHz and 4.08-MHz signal verifying proper bandpass response. Signal can be injected at tuner or after video detector.

bursts of 3.08 MHz and 4.08 MHz. Just as the other multibursts enable IF alignment without using sweep gear, these bursts are for chroma alignment.

Scoping the patterns

Some of us prefer signal tracing to injecting when working in the IF and video sections of a TV receiver. You usually feed the pattern signal into the antenna terminals because it's the handiest way. Or the *model 1077* and the *model VA48* (and most color-pattern generators) can also be used to supply their signal directly without RF—a volt or two that you can inject right after the video detector. Either way, you use your scope to follow the patterns through successive stages.

You're probably familiar by now with the waveforms produced by a TV test pattern such as that generated by the *model 1077*. They resemble station-signal waveforms. On the other hand, because the *model VA48* instrument is so recent, some characteristics of its pattern may be new to you.

Study the waveform in Fig. 10-a. Signal from the *model VA48* has been fed into the tuner front end, and the oscilloscope probe has been connected at the video-detector output.

Note the amplitudes of the four higher-frequency multiburst signals. Each of the signals has made the trip through the tuner and IF sections without any significant attenuation. A slight reduction in the 3.56-MHz bar is allowable.

Misaligned IF transformers, or even a defective IC, can severely reduce video response. Figure 10-b shows the result of some fault in a detector IC. Both the 3.02-MHz and 3.56-MHz signals are no-

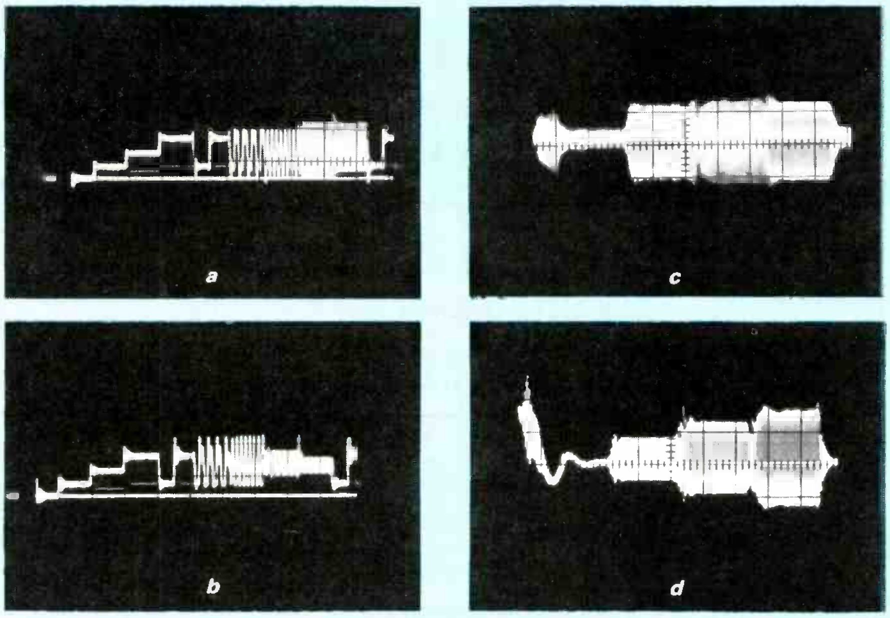

FIG. 10—WAVEFORMS RESULTING from use of test signals generated by Sencore *model VA48*. See text for significance of what these waveforms reveal.

ticeably reduced in amplitude at the video-detector output. Scoped with a demodulator probe, the waveform at the input to this IC was very similar to the original input signal (see Fig. 10-a).

If you modulate the RF input signal with the chroma-bar-sweep pattern, you can evaluate the entire tuner/IF/chroma chain. Just scope the output of the chroma amplifier system. Normal bandpass for the entire chroma sideband signal, from 3.08 MHz to 4.08 MHz, delivers a waveform to the chroma demodulator similar to that shown in Fig. 10-c. Levels of the three bar signals fed from the *model VA48* video analyzer are factory-adjusted to allow for the difference in actual response in the receiver amplifiers. If all is correct, the chroma output point shows all three bursts of signal at the same level. But misalignment in the bandpass amplifiers can alter the response.

The result, shown in Fig. 10-d, could also come from video IF misalignment. Suppose the 41.67-MHz, 42.17-MHz and 42.67-MHz markers are *not* properly placed on the IF response skirt (at about 40%, 60% and 80% levels, respectively). This curve discrepancy would, since signal is coming through the IF strip, also distort the curve at the bandpass test point. In this instance, however, the trouble is in bandpass alignment—because the IF waveform, when you use the multi-burst bar sweep, already proved OK.

You can also inject the chroma-bar-sweep signal at the chroma feed point that follows the video detector; this bypasses the video IF strip. However, a bit of "tilt" will occur in the *model VA48* pattern—the first bar is the highest, the second less high, and the third the least high—because of the built-in tilt that accommodates proper video IF alignment. A small amount of practice with a working set will quickly familiarize you with this phenomenon.

Incidentally, if you're in a hurry to fix a set and haven't yet become accustomed to the patented Sencore patterns, the *model VA48* generates a tightly locked keyed-rainbow pattern. You can use it as you would the keyed-rainbow pattern from any color-pattern generator.

Other injection hints

Both generators produce sweep substitution signals for driving the sweep sections of TV receivers. In most TV sets, you merely select the correct pulse signal, set the proper amplitude and connect it. If sweep starts again, you are injecting *beyond* the defective stage or circuit.

Some precautions are worth mentioning. First of all, if you're not already doing so, you should use an isolation transformer to power the TV set. If you don't, you can damage test instruments and sets, and you can give yourself some nasty shocks. Plus, you may damage some IC's and transistors if you're not careful. *Always isolate* the set you're testing.

Here's another precaution to take when working with any chassis using transistors and IC's: Keep the generator-drive controls turned to zero until *after* you make the connections and turn the set on. (Naturally, you turn the set off while you make test connections and insure that they do not accidentally bridge together any terminals. Jumper leads with tiny insulated alligator clips make connections safer on many modular boards.) After the set is operating again, bring up the signal drive slowly and carefully. Transistor and IC stages take less drive than tube stages. Too much signal can be damaging.

DC diagnosis

Remember, you can inject DC voltage, too; it's called *clamping*. This is a valuable technique to use when you're dealing with DC-controlled stages. For example, DC determines the frequency of the voltage-controlled oscillator (VCO) that is part of new 503-kHz sync systems. Various AGC arrangements involve DC voltages—most sets now have three controls for the IF, VHF tuner and UHF tuner. A low-impedance DC voltage that you can vary lets you check DC effects on these controlled stages or circuits.

Here's an example. With a B&K/Precision *model 1077*, the complaint was overload, diagnosed on sight as probable AGC trouble. A DC voltmeter check at the various AGC output terminals of the sync-AGC integrated circuit proved nothing conclusive. A Channel 3 input signal, raised and lowered in level at the input antenna terminals, caused two of the three AGC voltages to vary; however, in an unfamiliar chassis, it's hard to know whether the variations are correct or not. The third voltage, for the VHF varactor tuner, remained steady—with no change at all. Weak input RF appeared OK, but as soon as enough signal was fed in to overcome snow, overload ruined the picture, sync, color and sound.

Two possibilities seemed apparent: Either the IC was not developing proper AGC for the tuner, or the DC voltage was being loaded down along the line or in the tuner.

A clamp voltage from the bias section of the *model 1077* was connected to the tuner AGC line. Altering the "injected" DC voltage did change the gain in the tuner. Overloading could be eliminated by setting this clamp voltage properly. The conclusion was that the sync-AGC integrated circuit was not producing that particular DC voltage properly, even though every other IC function appeared normal. Replacing the IC cured the problem. **R-E**

"Ben's Hardware didn't have a 20-foot ladder. You want me to try Teely's Hardware?"

computer corner

8080 *The 8253 programmable interface timer IC.*

M. DEJONG, C. TITUS, J. TITUS, D. LARSEN and P. RONY*

THIS MONTH'S COLUMN INTRODUCES THE characteristics of the Intel 8253 programmable interval timer. This versatile I/O chip can be used in a wide variety of applications (such as a real-time clock, event counting and period counting) in addition to replacing software-implemented timing loops. For example, interval timers have been used in a number of diverse applications, including a digital cardio-tachometer, a data-logging timer that uses several phototransistors to measure velocities and accelerations, and a program to sample nonperiodic waveforms for subsequent display on an oscilloscope.

The 8253 is a 24-pin IC that requires a single 5-volt supply and contains three independent 16-bit *interval timers*, each of which can be operated in six different modes. An *interval timer* has been defined[1] as a device that measures the time interval between two actions, or a timer that switches electrical circuits on or off for the duration of a preset time interval. Figure 1 shows both the pinout of the 8253 IC and how it can be interfaced with an 8080A/8085-based microcomputer system using memory-mapped I/O.[2]

The 8253 IC contains four internal registers—three interval timers and a control register—that are decoded as memory locations 200 000_8 through 200 003_8 with the aid of address-bus signals A0, A1 and A15 (see Fig. 1 and Table 1). Note in Table 1 that the $\overline{RD}$ and $\overline{WR}$ control inputs determine whether you are loading or reading a specific register. It is not possible to read the contents of the control register.

Table 2 summarizes the coding for the 8-bit control register within the 8253 IC. Bits D7 and D6 determine the selection of the interval timer; bits D5 and D4 determine the nature of the read/write operation of the chosen timer; bits D3, D2 and D1 select the mode of operation of the chosen timer; and bit D0 determines whether the timer counts down in binary or binary coded decimal (BCD).

Figure 2 is the block diagram for a typical 8253 counter. The microcomputer loads the 16-bit down-counter as two successive bytes (a HI byte and a LO byte) via the bidirectional data bus, D0 through D7. If the gate line, GATE, is active, negative-edge transitions at input CLK decrement the counter. When the counter reaches zero, output pin OUT becomes active, its actual behavior depending upon the mode programmed into the control

TABLE 1—ADDRESSING THE 8253 programmable interval timer.

Control Inputs						
$\overline{CS}$	$\overline{RD}$	$\overline{WR}$	A1	A0	**COMMAND**	**Memory address**
0	1	0	0	0	Load counter #0	200 000
0	1	0	0	1	Load counter #	200 001
0	1	0	1	0	Load counter #2	200 002
0	1	0	1	1	Load control register	200 003
0	0	1	0	0	Read counter #0	200 000
0	0	1	0	1	Read counter #1	200 001
0	0	1	1	0	Read counter #2	200 002
0	0	1	1	1	No operation (three-state)	—
1	X	X	X	X	Disable chip (three-state)	—
0	1	1	X	X	No operation (three-state)	—

Note: X = don't care (logic 0 *or* logic 1)

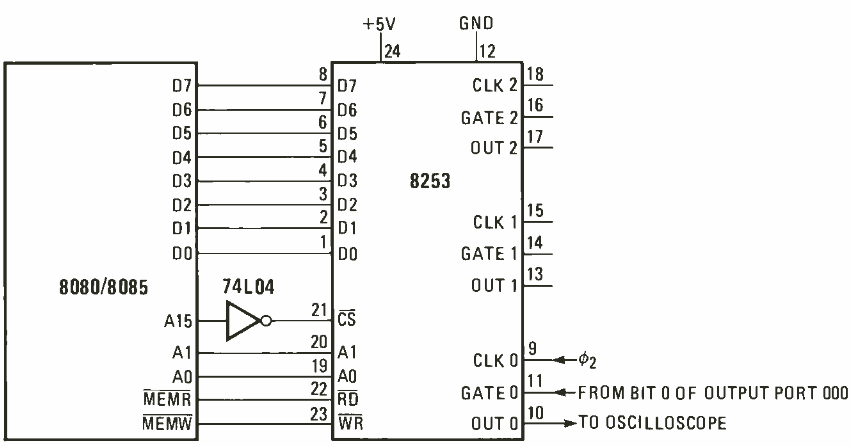

FIG. 1

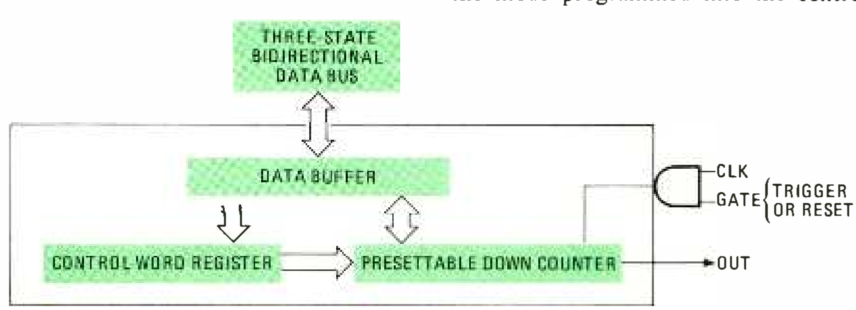

FIG. 2

Dr. DeJong is head of the Department of Mathematics/Physics at The School of the Ozarks. Mr. Larsen, Department of Chemistry, and Dr. Rony, Department of Chemical Engineering, are with the Virginia Polytechnic Institute and State University. Both Mr. J. Titus and Dr. C. Titus are with Tychon, Inc.

TABLE 2 (right)—CODING FOR THE 8-BIT control register in the 8253 IC.

register for the counter (see Table 2). The 8253 IC contains three 16-bit counters, each of which can be programmed independently in any one of the six operation modes. Counter inputs and outputs, CLK, GATE and OUT, for the chosen counter are independent of the CLK, GATE and OUT of the remaining two counters on the IC.

In addition to the address bus, data bus and control-bus connections shown in Fig. 1, inputs CLK0 and GATE0 to counter 0 are connected respectively to the $\phi 2$ (TTL) microcomputer clock output (typically 2 MHz) and to bit 0 of accumulator output port 000_8. Any TTL-level clock with a frequency of less than 2 MHz can be used as input to CLK0, and any suitably debounced switch or source of strobe pulses can be used to control the timer at GATE0. Counter output, OUT0, can be connected to an oscilloscope to observe each of the six timer operation modes.

In a future column, we will discuss a demonstration program for the 8253 interval timer that shows the loading, latching and reading of counter 0 as well as the various output modes. Other reference material[3,4] contains additional descriptions of the 8253 IC.

Bits			Control Function
	D7	D6	
	0	0	Control word is for counter #0
	0	1	Control word is for counter #1
	1	0	Control word is for counter #2
	1	1	—
	D5	D4	
	0	0	Latch both bytes of chosen counter for read operation
	0	1	Load or read only most significant byte of chosen counter
	1	0	Load or read only least significant byte of chosen counter
	1	1	Load or read LS byte first, then MS byte of chosen counter
D3	D2	D1	
0	0	0	Mode 0: Output = 1 on zero counter
0	0	1	Mode 1: Retriggerable variable-width one-shot
X	1	0	Mode 2: Programmable rate generator
X	1	1	Mode 3: Programmable squarewave generator
1	0	0	Mode 4: Delayed strobe (software triggered strobe)
1	0	1	Mode 5: Triggered strobe (hardware triggered strobe)
		DO	
		0	Count down in binary
		1	Count down in binary coded decimal (BCD)

Note: X = don't care (logic 0 *or* logic 1)

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2. Larsen, D. G., Rony, P. R., and Titus, J. A., *The Bugbook[R] VI. 8080A Microcomputer Programming and Interfacing*, E&L Instruments, Inc., Derby, CT 06418 (1977).
3. *Intel Data Catalog, 1977*, Intel Corp., 3065 Bowers Ave., Santa Clara, CA 95051 (1977). Available for $2.50.
4. Osborne, A., *An Introduction to Microcomputers. Volume II. Some Real Products*, Osborne and Associates, Box 2036, Berkeley, CA 94702 (1976).

No matter what the project he's working on is supposed to be—it ends up being a light dimmer.

HOBBY CORNER

When you want to use a different power supply voltage there are some points you must consider. Take a look at them and some typical hobby supplies this month.

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

FROM TIME TO TIME WE RECEIVE INQUIRies about the power supply voltage for a particular Hobby Corner project. The usual question is whether or not another voltage can be used. Since this problem seems to trouble some of you, let's take a look at the main points of power supplies.

The first question is how much voltage? This, of course, varies. A good general rule is to apply the voltage that is specified by the author of the article. In Hobby Corner, I try to show a range of voltages whenever suitable. For example, the designation "5–15 VDC" on a schematic means that any voltage from 5 to 15 will operate the circuit properly. Many other writers do the same thing.

There are times, however, when only one specific voltage is given. In these circuits, applying a different voltage will almost always cause the circuit to function improperly or not at all. Often using another voltage can even destroy components in the project, so you had best play it safe.

Transistor circuits are not *usually* critical in this respect. In addition to studying the schematic, read the text carefully (this applies to *all* projects). Quite often, the power supplies for transistors can be varied a few volts with no harm done, but keep in mind that this is not *always* true.

Many digital circuits using IC's are designed around TTL IC's because they are less expensive and are available in a great many types. These TTL's are also quite voltage-conscious. If you get more than ¼ (0.25) of a volt from the 5 volts they require, you are asking for trouble.

CMOS IC's, on the other hand, are growing in popularity and variety. Although they cost more than TTL's, these IC's have certain advantages. One advantage is that they function with a relatively wide range of applied voltages—normally from 3 volts to 15 volts. (Remember, however, that other components in a CMOS circuit can put more stringent limits on the applied voltage.)

While the information given above will provide you with some general guidelines, it is always advisable to use the voltage specified. That way, you can avoid potential problems that are not always apparent.

How can you provide the required voltage? And what about the usual additional requirement that the voltage be *regulated*? There are many more ways to do this than space permits in this column. You should study power supplies and power supply theory—transformers, diode rectifiers, filter capacitors, discrete and IC regulators, and how they all work together. Then, you can design whatever supply you need.

Some power supplies

In the meantime, here are some power supplies that should keep you going. The first is not actually a complete power supply, but a method of obtaining a lower-regulated voltage from an existing higher voltage supply.

Often an experimenter can obtain a source of DC voltage from an AC supply, or from a battery. If the source is 12 VDC, for example, and he needs 8 VDC, he can obtain it by using a three-terminal regulator, as shown in Fig. 1.

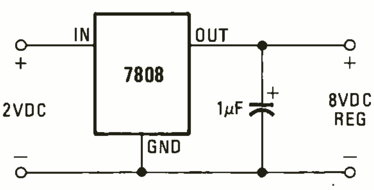


FIG. 1—CIRCUIT USED TO TRANSFORM a DC voltage.

These three-terminal regulators are great little devices. They have built-in protection against overcurrent and overheating. If you accidentally short the output, they simply shut down until the short is removed. Such regulators are available for both positive and negative voltages from 5 volts to 24 volts with a current capacity of up to 1 ampere (and there are ways of increasing that). There are several series including the 78xx, 79xx, 320Kxx, 320Txx, 340Kxx and 340Txx—in which the designation "xx" stands for the voltage output of each regulator—i.e., the *7808* has an 8-volt output.

The three-terminal regulator does use up some voltage so you will have to supply more input than output. Normally, a *minimum* of 2.5 volts more should be applied; e.g., at least 7.5 volts into a 5-volt regulator. The difference in input voltage can be greater but you have to be careful of power dissipation. For example, if your regulator won't operate or it shuts down now and then for no apparent reason, the input voltage may be too great. In many uses, 100% or even 200% over the recommended voltage won't cause trouble.

Building a supply

Now, let's build a power supply from scratch similar to the one shown in Fig. 2. (Of course, this is just one of a number of possible designs.)

In tailoring this circuit for your particular needs, you must work backwards, so to speak, starting with the output. When you decide what output voltage (and current) you need, select the type of regulator that will provide it. In this case, let's use 5 volts and select a 7805 regulator, which has a 5-volt output at a current of up to 1 amp, with a good heat sink.

Since you must apply 7.5 volts or more to the regulator, this, in turn, determines the output of the transformer. The voltage drop in the diode rectifiers is negligible, but you must consider the design of the rectifier.

This is a bridge rectifier, which means that the entire secondary voltage is used—whether or not there is an unused center-tap connection. Therefore, you need a transformer that will provide 7.5 volts across the entire secondary.

You could use a 6.3-volt transformer to provide a *peak* voltage of 8.8 (1.4 × 6.3 volts RMS). This will work just as long as not too much current is drawn out of the supply because filter capacitor C1 charges to the peak voltage. The more current you use (that is, the heavier the load) the less C1 maintains the peak voltage charge and the lower the effective voltage to the regulator becomes. In fact, a point is reached where the regulator won't regulate.

For a light load such as a couple of transistors or IC's, use a 6.3-volt transformer. Otherwise, use an 8-volt, 10-volt, or 12-volt transformer. I would choose a 12-volt transformer since it is easier to find and usually does not cost much more than a 6-volt unit. So, referring to Fig. 2, let's put in a 12.6-volt transformer with a 1-amp current rating.

With respect to choosing the diode rectifiers, there are two important considerations: the PIV (*P*eak *I*nverse *V*oltage) and the load-current ratings. Since our supply has a 1-amp rating, we'll use that value even though in the bridge circuit each diode conducts only one-half the load current. The PIV (also called PRV for *P*eak *R*everse *V*oltage) is the maximum reverse voltage that should be applied to the diode.

In our circuit the PIV is equal to 1.4 times the RMS voltage, or about 18 volts (1.4 × 12.6 = 17.64). Because of its ready availability, we'll use a 1N4001 rectifier, which is rated at 50 PIV at 1 amp. Larger rectifiers could be used just as well. You could also use a ready-made bridge rectifier that contains the four diodes in one block, just as long as it meets the rating requirements.

The final components in the power supply are the capacitors. Capacitor C1 is the filter capacitor, whose function is to

continued on page 96

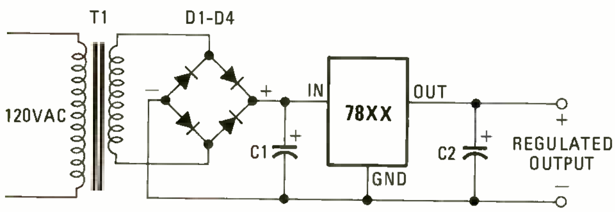


FIG. 2—A TYPICAL POWER SUPPLY.

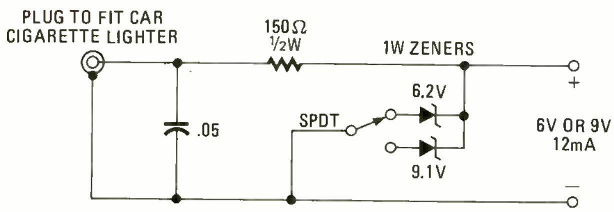


FIG. 3—VOLTAGE ADAPTER for use in automobile.

state of solid state

Microprocessors are inching their way into home appliance applications. Here's a look at how the TMS1100 is teamed up with triacs to control a microwave oven.

KARL SAVON, SEMICONDUCTOR EDITOR

THYRISTORS ARE TOUGH COMPONENTS. Silicon-controlled rectifiers and triacs are more damage-resistant than other semiconductors because their regenerative latching mechanism switches them rapidly through the dangerous half-on, high-dissipation region. Thyristors (especially the versatile triac) are unbeatable in AC power switching applications. Their use in industrial control systems is not new, but their recent availability in low-cost plastic packages is responsible for their growing application to home appliances. Thyristors are present in the horizontal-deflection systems and remote power on-off controls of TV receivers. They are also found in microwave ovens, where moderate amounts of power are switched and modulated. They have proved to be more dependable than relay contacts and conventional transistors.

Microcomputers, too, have moved from their industrial beginnings into the appliance market. The control microcomputer is an inexpensive IC, the result of thousands of hours of human endeavor and accomplishment. Single-IC microcomputers such as the Texas Instruments

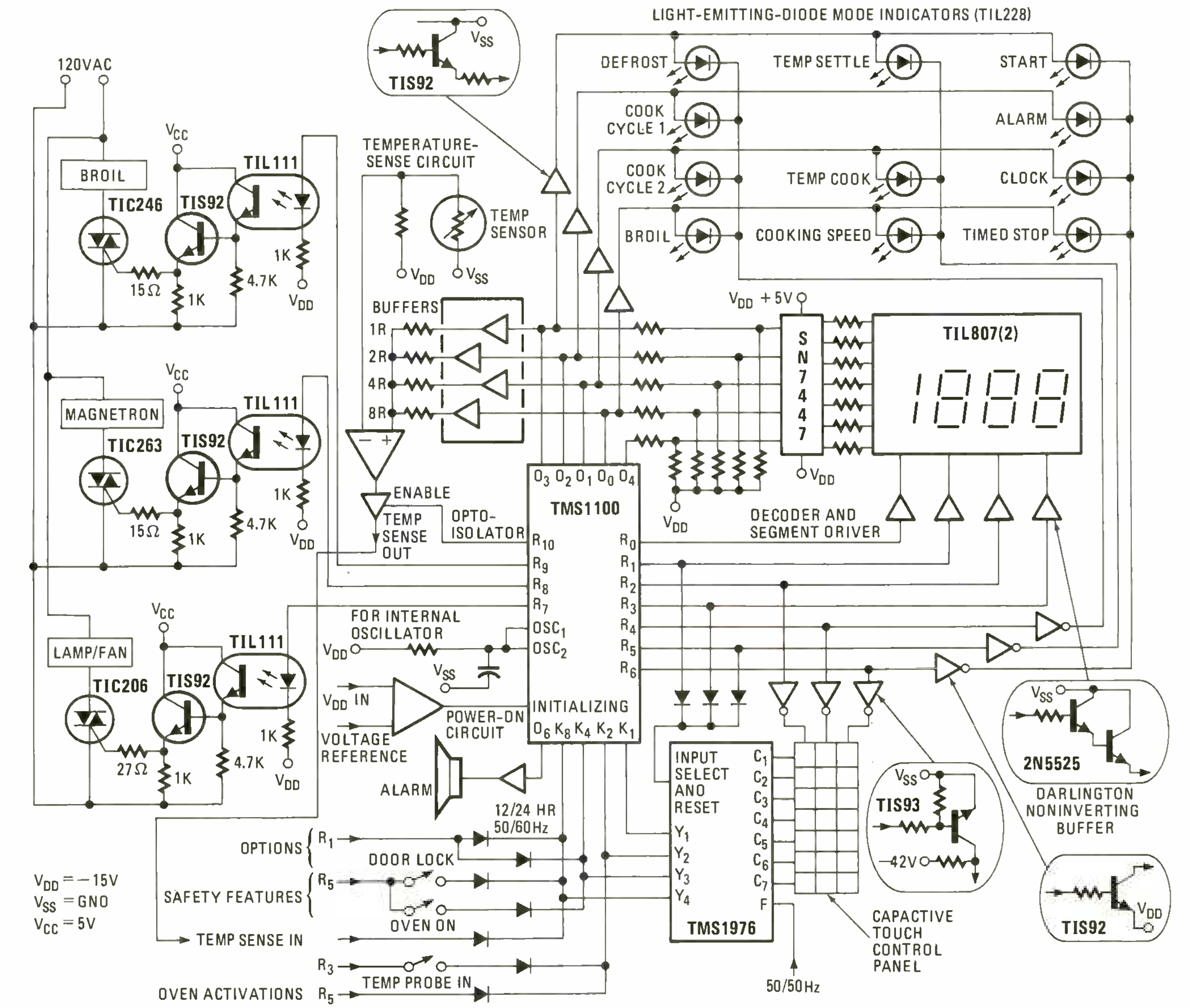


FIG. 1—MICROWAVE OVEN CONTROL system based on Texas Instruments TMS1100 8-bit microprocessor.

TMS1000 contain the central processing unit (CPU), a small amount of RAM (*R*andom-*A*ccess *M*emory) and a substantial block of ROM (*R*ead-*O*nly *M*emory).

Microwave cooking is generally a time-sequential procedure. Each time interval has a different heat setting. Combining a microcomputer with triacs in an oven-controller system eliminates many objections to such an ecologically attractive appliance. The factory presetting of popular cooking procedures and easy user programming of special sequential operations are just two possibilities of such a combination.

Figure 1 shows the partial schematic of a microwave oven-control system built around the TMS1100, a single-IC microcomputer with 2048 eight-bit words of ROM. The ROM is factory-programmed to carry out the control-function algorithms designated by the oven manufacturer. The design approach is competitive with discrete control-logic circuitry, and is more reliable because of the product's reduced component count.

The control system's primary function is to properly activate the oven's power-consuming heat and air-circulation portions: The magnetron, the broiler heating coil and the lamp and fan, shown on the left-hand side of Fig.1. Each element is connected in series with the AC power line and a controlling thyristor. The triacs are chosen to handle the individual circuits' current requirements: the TIC263 controlling the magnetron is rated at 25 amp, the TIC246 is rated at 16 amp and supplies from 5 to 10 amp to the heater element, and the TIC206, rated at 3 amp, supplies about 1 amp to the lamp and the fan.

A triac is the equivalent of two SCR's connected back to back. It can be triggered by either positive or negative gate voltage with respect to main terminal No. 1 (the axial lead merging with the gate lead), although the sensitivity is different depending on the power source and trigger polarities. The triac triggering pulse must only be long enough to insure regenerative latching. This minimum pulse-width requirement varies from about 2 to 20 μs depending on the level of gate overdrive for those triacs shown in Fig. 1. If the gate drive is discontinued by the time the AC signal waveform reverses its polarity, so that the triac current is reduced below its holding current, the triac turns off. Radio frequency interference is minimized if turn-on is restricted to zero crossings of the power-line cycle. In Fig. 1, the three TIS92 emitter-follower transistors supply the turn-on gate current. The series resistors between the emitter of the transistors and the triac gates determine the gate current. These resistors generally supply twice the nominal current to take care of tolerance and temperature variations.

The signals on the triac gate and the driver-follower transistors are referenced to one side of the AC power line. For safety and to prevent power-line or SCR-induced transients from damaging or causing incorrect computer operation, it is necessary to isolate the power circuitry from the processor circuitry and operator controls. Optical couplers are a natural choice for this isolation because only light and high-resistance leakage paths exist between the input and output sides of the circuit. An internal LED provides photon coupling to a phototransistor; a higher LED current provides more light and more current drive to the phototransistor base. Standard couplers provide a voltage isolation of 2.5 kV. Note that the three TIL111 optical coupler inputs are driven by microcomputer outputs R7, R8 and R9. These outputs are controlled by the ROM program permanently stored in the TMS1100 to trigger the triacs in response to predetermined sequences or by direct front-panel control. The SETR and RSTR instruction mnemonics correspond to the machine language codes controlling the status of these outputs.

The controls and displays are directly interfaced to the microcomputer through outputs R_0—R_6, outputs O_1—O_3 and inputs K_1, K_2, K_4 and K_8. The TMS1976 capacitive touch-control IC converts touch into logic levels.

The column being scanned is selected by outputs R_2, R_4 and R_6 under program control, and the six parallel panel outputs feed the TMS1100 through inputs K_1, K_2, K_4 and K_8. Since these inputs are the only microcomputer inputs, they must be shared by other oven functions, including the safety features and temperature-sensing input. These other inputs are strobed by the R outputs not used to scan the touch panel. The LED oven display is multiplexed by driving the segments from microcomputer outputs O_0, O_1, O_2, O_3 and O_4. In this case, the binary computer outputs are decoded by the SN7447 BCD-to-7-segment decoder/driver. The TMS1100 includes a PLA (*P*rogrammable *L*ogic *A*rray), which in some applications is programmed for 7-segment display decoding.

The other LED oven-function indicators are scanned by outputs, R_4, R_5 and R_6 and driven by outputs O_0–O_3. Keyboard scanning is done with the same R outputs used by the display. The input sense instruction (mnemonic KNEZ) can be used to detect an input switch condition, then jump to a routine that determines which input (or inputs) has been activated and respond to it. Then, a few milliseconds or so after the interruption, the program can continue with the display-scan routine.

For additional information on thyristor gating for microprocessor applications, write for *Bulletin CA-191* from Texas Instruments Incorporated, Inquiry Answering Service, Box 5012, M/S 308 (Attn: CA-191), Dallas, TX 75222. R-E

service clinic

The low-voltage regulators in solid-state TV sets can cause a myriad of problems.

JACK DARR, SERVICE EDITOR

WHENEVER THE SERVICE CLINIC MAILBAG becomes very heavy on a particular subject, it's time for a discussion. In this case, the topic is the DC voltage regulators that are used so much in solid-state TV sets. You'll find lots of them, from the very simplest to very complex units.

When something goes wrong in a TV set, the first thing you should do is check the B+ voltage. The logic of this test is easy: Since the B+ voltage supply is common to every stage in a TV set, it must function properly or nothing works. In the older tube-type sets, this voltage supply normally could not go *up*. So, we checked to determine if it was high enough.

The situation is different in solid-state power supplies. The standard circuit feeds rectified and filtered DC (in most cases) to a voltage regulator that drops the voltage by about 25% (a ball-park figure), and then holds it very tightly at that value. You will often find up to six or seven separate DC voltage regulators in these solid-state sets. And, of course, if a circuit has been installed in a set to handle over-voltage problems, it can also cause problems! In solid-state TV, the high voltage is directly proportional to the DC supply voltage. With the DC supply voltages often as low as 25–30, even a very small increase in voltage could cause a considerable effect. For example, 25 volts is fed to a voltage multiplier to produce 25,000 volts. If the supply voltage rises by only *one* volt, the high voltage goes up 1000 volts! So, this voltage must be regulated very tightly. Solid-state circuits hold the supply voltage within very tight limits.

Therefore, when you discover problems in a set that could have been caused by too much output voltage from the horizontal-output stage, you must first check the DC voltage regulators for blown horizontal-output transistors, shorted dampers, etc. Lately, quite a number of assorted problems have been showing up in my mailbag. Practically all of which could have been solved (and eventually were) by checking the DC voltage regulators. The simplest problem was a complaint about a CB radio that "this resistor is burning up." It was in a low-voltage DC supply with a regulated input, and a Zener diode clamp on the output. The Zener was suspected, checked and found to be open. Even after the Zener was replaced, the resistor still burned up! When the *input* voltage was checked, it read +28 volts instead of the +15 volts it should have. The pass transistor in the primary voltage regulator was shorted.

In another mysterious case involving a batch of symptoms in a color TV set, I checked the DC supply voltages in all the affected stages (but not as soon as I should have!) and they were all high. A factory field engineer then suggested plugging the set into a variable-voltage line transformer, and bringing the line up until the DC voltages read the correct value. I did this and all the symptoms disappeared, the set worked beautifully! It didn't take long to pin down a bad regulator circuit and a couple of shorted Zener diodes that were causing all the problems.

It's a good idea to remember variable-voltage line transformers because they are a quick and easy way to get a handle on any case where the problem is DC voltage regulation: Just use the variable-voltage transformer as a substitute voltage regulator. It may help when you run into similar cases.

The simplest and most common circuit is the series regulator (see diagram). In this circuit, a power transistor that can carry the full load current of the circuits is controlled by an error-amplifier stage.

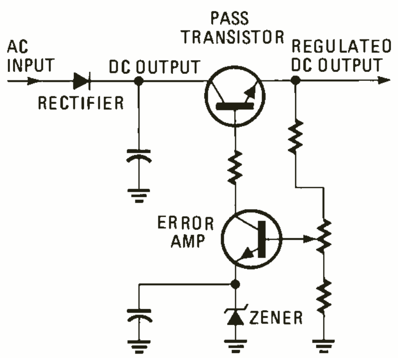


FIG. 1

This, in turn, is controlled by the DC output voltage through a voltage divider network across the output line. In some cases, the regulator transistor (pass transistor) is controlled by a regulator-driver that is itself controlled by the error-amplifier transistor.

Series regulators are subject to the same problems found in all circuits. If the pass transistor opens, there will be no DC output voltage. If it shorts, the full DC voltage will be applied to the load circuits. Faults in the error-amplifier or driver transistors can also cause difficulties. If any one of these transistors fails, be sure to check *all* the others because they may also have blown along with the first one. You will often find Zener diodes used as bias clamps in the error-amplifier stage; be sure to check the diodes for shorts and opens.

Some voltage regulators use quite elaborate circuitry—pulse-width-modulated (PWM) types, triggered SCR's controlled by PUT's, etc. In the future, we'll discuss these various types of regulators and how to test them. Meanwhile, here's a good hint, especially for PWM's—be sure to check waveforms; these are critical! In addition, you should also literally go back to the "oldest test in the book" and make sure that you check the B+ voltage supply first! **R-E**

service questions

SYNC-SOUND PROBLEM

I have a GE model H-3 chassis in which the problem seems to be mostly bad sync and bad sound. There could also be some AGC problems, but overriding it doesn't seem to help. I have an idea that the problem may lie in the input to the sound-sync amplifier V6c. I checked the diode, but I can't get a reasonable reading.—D. M., Longmont, CO.

If the diode is either open or shorted, or if any of the components are bad (the open peaking coil, etc.) this would upset not only the sync but the AGC as well. The AGC input *signal* comes from the plate of V6c, as well as the signal input to the sync-separator. If the video signals to these points are not correct, then you're in the right place!

(Feedback: "We're both right. The problem was in the input circuit. I made more resistance checks and found a high resistance from point 12 to ground, which meant that L157 would be open. After a half hour of work, I removed it. It was open. I replaced it with a 68 μH and no more problems!")

LOW BOOST VOLTAGE

I had a problem with this RCA CTC-19D. The boost was quite low—+850 volts. You wrote that it should be higher than that, which was right! I found that the pincushion transformer had shorted turns in it, which was loading the boost down. The normal boost turned out to be +1080 volts, as you said! Now it works.

Incidentally, how do you check a VDR?—H. B., Brooksville, FL.

With great difficulty! Seriously, the best way to check VDR's is still replacing them with exact duplicates. In a *few* cases, where they are used as shunts in the feedback loop of the vertical stages, etc., you can tell by disconnecting them. Defective VDR in these cases reduces height.

INTERFERENCE IN ANSWERING DEVICE

Our business uses a telephone answering machine. Right across the street is a shop specializing in CB. They work late hours and the CB transmitters trip the device! It gets annoying when you have 50 or 100 extra calls to monitor every morning! How can we get rid of this?—H. I., Lockport, NY.

This problem is apt to be due to the RF signals from the CB getting into the audio input of the answering unit. Try looking up a 250-pF capacitor to ground right at the input jack. If this helps but doesn't cure the problem, open the lead from the input jack to the first preamplifier stage and add a small RF choke in series with 250-pF capacitors to ground on both ends.

This will have no effect on the audio signals since these components are so small. It might be a good idea to add 0.05-μF, 600-volt capacitors to bypass both sides of the AC line to the answering machine; some RF signals may be coming in through the AC line.

ONE CHANNEL, NO COLOR

I have a couple of problems with a Panasonic model CT-62P. The color's gone on Channel 2 plus there's no fine tuning. The color and fine tuning are OK on all other channels. Channel 2 shows only squiggles for color. Any ideas?—R. E., Menasha, WI.

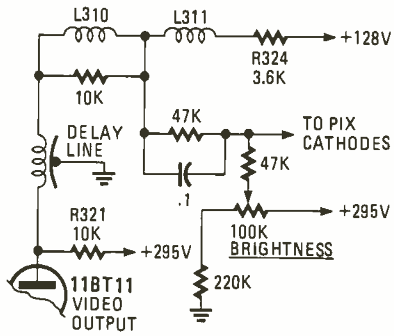
This is a fairly common problem with this type of tuner. It's basically a turret tuner, and each channel strip has its own fine tuning. A tiny gear on the front is engaged by the drive gear and moves the oscillator core. If this little gear has been screwed in too far, the drive gear won't be able to engage it. You can take the cover off and turn till you can remove the

Channel 2 strip without having to pull the tuner. Just turn the gear back out a turn or two by hand, then put it back.

ODDBALL REACTIONS

This Admiral model 19TS341C came in with no picture or sound and the thermistor burned up. After I replaced this, no brightness! If I lift one end of R105 (470 ohms in a +295-volt source, power supply), the brightness comes back. I've checked everything else hooked to this line and I can't find anything wrong. Every time I hook R105 back up, out it goes. Do you have another approach?—H. T., Elizaville, NY.

Well, yes. Try this: Check the high voltage while the raster is on, then hook up R105 and see if you lose the high voltage or if it stays up. If it stays up, *something* is causing the picture tube to be cut off. The video output plate-supply circuit actually has three "legs," two to +295 volts, and one through L311 and resistor R324 back to +128 volts. This arrangement seems to be used as some sort of clamp to keep the picture tube cathode voltages in line. If this voltage line is off, or open, it could cause the cathodes to become too far positive.



(Feedback: "Bingo! Your crystal ball is excellent. Resistor R324 had gone way up in resistance. That did it.")

VOLTAGE MISMATCH

This Audiovox model ID-400 stereo came in with no output at all on the right channel. Changing the output IC brought it back, but there's now a bad distortion in the left channel. When I checked the DC voltages on the two output IC's, I found they don't match exactly, and pin 9 of the left IC reads +7.0 volts. The same pin on the right IC reads 0 volt. There's nothing connected to this pin on either IC. Where do you think the trouble lies?—M. R., Auburn, MA.

There are two fairly good ways of checking IC's: One, if the signal "goes in but won't come out"; two, if the DC voltages "developed inside the IC" are off. Both tests should be used, and if they both give the same result, it should be pretty conclusive. The left IC does seem to be bad. Since nothing external is connected to this pin, this voltage indicates there's something bad inside. Change this IC too. **R-E**

next month

OCTOBER 1978

- **Build A Function Generator**

  Extremely low-distortion unit delivers sine, square and triangle waves from below 2 Hz to above 200 KHz.

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  Keep unwanted intruders out with this system. Perimeter defence stops them at all entry points.

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CIRCLE 42 ON FREE INFORMATION CARD

new products

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

ELECTRIC DRILL, *model 6275 Iso-Tip* and *model 6280 Iso-Tip*, are small-shank tools that accomodate drills and burrs up to ⅛-inch diameter. Drill's small size makes it ideal for prototype work, PC board applications, solder removal. Included are

a collet chuck, 3 collets, 2 drill bits and 10-foot cord. Power requirements: *model 6275*, 110-volt source; *model 6280*, 12-volt supply. Units are housed in sturdy lightweight plastic. Prices: *model 6275*, $27.50; *model 6280*, $23.95.—**Wahl Clipper Corp.**, 2902 Locust St., Sterling, IL 61081.

CIRCLE 106 ON FREE INFORMATION CARD

PORTABLE VOM MULTITESTERS, *models NH-55, NH-67, 80-M, 90-M*. The *model NH-55* measures 0–1 megohm in two ranges, 60 ohms centerscale, and provides a 2000-ohm/volt sensitivity on AC/DC 0—102, 50-, 250- and 1000-volt ranges. Includes two resistance ranges, a dB range and DC range. Comes with test leads, battery and instructions. Optional pouch, *model NH-5P*. Measures 3⅝ × 2⅜ × ⅞ inches; weighs 4 oz, including battery.

The *model NH-67* features 20,000 ohms-per-volt DC and 10,000 ohms-per-volt AC on all ranges. Can measure DC on any of 8 ranges; AC voltage, on 5 ranges. Includes one dB range, 5 DC ranges and 4 resistance ranges. Test leads, battery, instructions; optional carrying case. Measures 5½ × 3½ × 1½ inches; weighs 1 lb, including battery.

The *model 80-M* measures DC voltage on 7 ranges, dB and AC on 6 ranges. Included are 4 DC ranges and 4 resistance ranges. Used with a

power supply, can also measure capacitance and inductance. An optional pouch, *model H-8P*, is available. Unit measures 7 × 5¾ × 3⅛ inches; weighs 2 lb, including battery.

The *model 90-M* (shown) features 50,000 ohms-per-volt DC and 12,500 ohms-per-volt AC on all ranges. DC voltage can be measured on 7 ranges; dB and AC voltage on 6 ranges. Included are 5 DC ranges and 4 resistance ranges. Leads, battery and instructions; optional carrying case, *model H-9C*. Measures 6½ × 4½ × 1¾ inches; weighs 1 lb, including battery.

On all models (except *model NH-55)*, handle doubles as stand. Suggested retail prices: *model NH-55*, $12.50; *model NH-5P*, $1.50; *model NH-67*, $25.50; *model NH-6C*, $2.65; *model 80-M*, $56.50; *model H-8P*, $8.95; *model 90-M*, $41.00; and *model H-9C*, $3.25.—**Mura Corp.**, 177 Cantiague Rock Rd., Westbury, NY 11590.

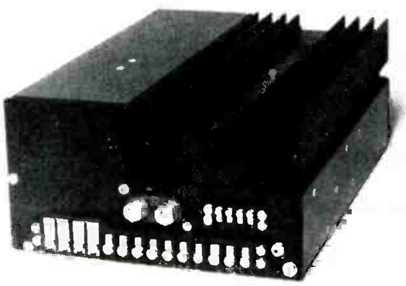
CIRCLE 107 ON FREE INFORMATION CARD

CB BASE STATION MICROPHONE, *Astatic model 1104C*, is preamplified and adjustable for

correct modulation level via master-gain control. Amplifier has external slide controls for volume and tone adjustment. Mike is housed in high-impact plastic and comes in eight decorator colors. Power is supplied by a 9-volt battery; also included is a 6-wire coil cord that allows for relay, electronic or virtually any type hookup. Price: $83.—**Astatic Corp.**, Harbor St., Conneaut, OH 44030.

CIRCLE 108 ON FREE INFORMATION CARD

FOUR-OUTPUT SWITCHING POWER SUPPLY, *model MGQ-300*, features isolated outputs of +5 volts 30 amp, −5 volts 5 amp, and ±15 volts 2 amp, all overvoltage- and current-protected. Unit's temperature range is −10°C to +70°C, with a 2.5%-per-°C derating from 50°C at full output. The *model MGQ-300* measures



12.25 × 3.9 × 7.5 inches, weighs 13 lbs, and operates at either 110 VAC or 220 VAC. Unit price is $695, with quantity discounts available.—**Gould, Inc.**, Electronic Components Div., 4601 North Arden Dr., El Monte, CA 91731.

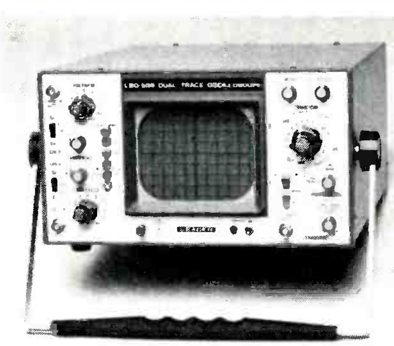
CIRCLE 109 ON FREE INFORMATION CARD

DOUBLE-SIDED PC BOARD KIT, *model 750*, uses photographic methods to produce boards (darkroom not required). Kit includes sensitized

copper-clad boards, ultra-violet light source, exposure glass, clamps, photoresist developer, etchant, trays, resist remover and a .040 drill bit for making IC pin holes. Kit weighs 3 lb, and sells for $25.—**Injectorall Electronics Corp.**, 98-100 Glen Street, Glen Cove, NY 11542.

CIRCLE 110 ON FREE INFORMATION CARD

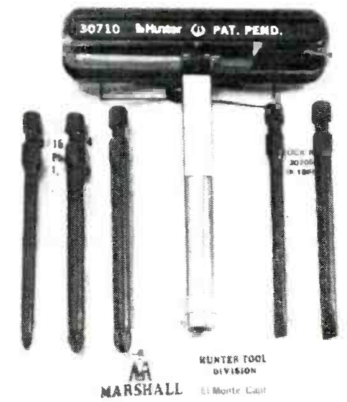
DUAL-TRACE OSCILLOSCOPE, *model LBO-508*, is designed for many industrial, lab and service applications. Specifications include 10 mV-per-centimeter sensitivity, 17.5-ns risetime, sweep speed range from 0.5 μs-per-centimeter to



200 ms-per-centimeter. Other features include add/subtract modes for Channels 1 and 2, automatic chop, automatic triggering, front-panel X-Y operation. Oscilloscope comes complete with probes, measures 6¼ × 10¼ × 14¾ inches and weighs under 14 lb. Price: $689.95.—**Leader Instruments Corp.**, 151 Dupont St., Plainview, NY 11803.

CIRCLE 111 ON FREE INFORMATION CARD

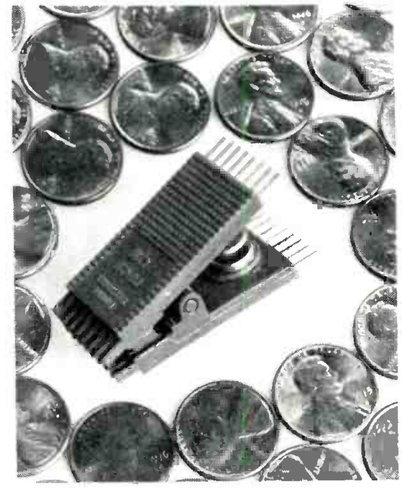
SIX-PIECE TOOL SET, *model 30705, Tork-It*, contains handle (*model 30710)*, three Phillips blades and two slotted blades. The *Tork-It* tool is designed specifically to loosen hard-to-remove screws, and can also be used to tighten or drive



super-hard self-tapping metal or case-hardened screws. Shock-resistant alloy-steel blades are ¼-inch hex drive. Unit comes in plastic kit, convenient for wall hanging or tool kit. Suggested list price, $13.96.—**Hunter Tools**, 9674 Telstar Ave., El Monte, CA 91731.

CIRCLE 112 ON FREE INFORMATION CARD

IC TEST CLIP, *model 4236*, 14- to 16-pin DIP test clip with reduced thickness for testing ultra-dense packages. Has nontarnishable nickel-silver



contacts; the lower contacts measure 1.02 mm and provide a positive electrical connection. The upper-end test points are square, serrated, measure 0.63 mm, and are designed to handle wrapped wire, mini-test clips, or *model 4185* IC jumper cable. A molded barrier between each contact allows live-board connections without shorting adjacent contacts. Glass-filled nylon casing can withstand temperatures to 240°C. Price: $5.75 each.—**ITT Pomona Electronics**, 1500 E. Ninth St., Pomona, CA 91766. **R-E**

CIRCLE 113 ON FREE INFORMATION CARD

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CS-2048 Automatic Cruise Control

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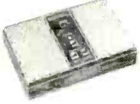

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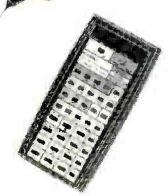

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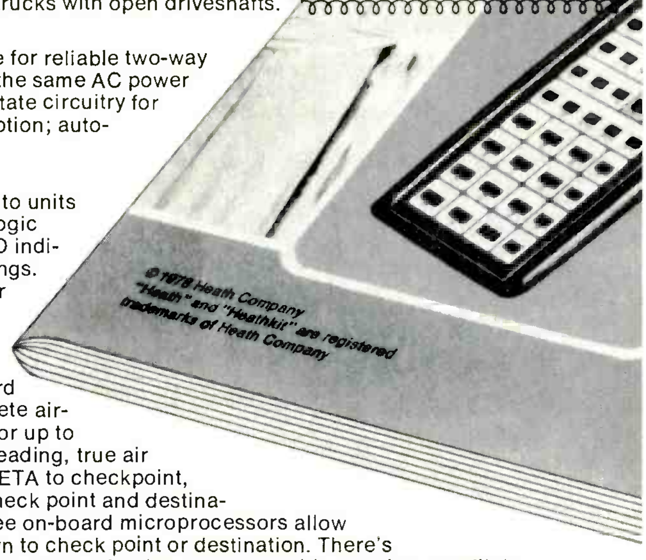

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LOGIC TESTERS, *The Logical Force Sourcebook,* 15 pages, describes three different types of troubleshooting tools—logic probes, a digital pulser (accessories available) and standard and advanced logic monitors. Complete specs are given for each unit.—**Continental Specialties Corp.,** 44 Kendall St., Box 1942, New Haven, CT 06509.

CIRCLE 114 ON FREE INFORMATION CARD

TOOL KITS AND TEST INSTRUMENTS CATALOG, 27 pages describing tool kits with a broad range of applications, including electronic repairs, instrument repairs, field repairs, medical electronics, jewelry making, and many more. Test instruments come assembled and include testers, VOM's, DMM's and oscilloscopes.—**ETCO Electronic Tool Corp.,** Claremont Ave., Thornwood, NY 10594.

CIRCLE 115 ON FREE INFORMATION CARD

MUSIC SYNTHESIZER CATALOG, *Aries Music 77,* 12 pages, describes manufacturer's system, which is not just a keyboard but uses a wide variety of modules to create your own patchcord electronic music synthesizer. These modules include signal sources, controllers and modifiers, and among the units described are an ADSR envelope generator, a voltage-controlled amplifier, a dual mixer, a stereo reverb and output, plus a keyboard group. The catalog also includes two pages of sample systems. Most units are available as kits or prewired. The catalog contains a glossary of terms, a price list and an order form.—**Aries Music Incorporated,** Box 3069, Salem, MA 01970.

CIRCLE 116 ON FREE INFORMATION CARD

PICTURE TUBE SETUP CHART, *78115,* is a 28-page, 5- by 8-inch, spiral-bound, hardcover book that details almost 2000 TV picture tube types, showing the heater and G-1 voltages and socket for each unit number. This list was developed for use with manufacturer's *model LCT-910* Tester/Rejuvenater. Setup chart is available for $6.95, plus postage; or with picture tube adaptors for $17.90, plus postage.—**Leader Instruments Corp.,** 151 Dupont St., Plainview, NY 11803.

CIRCLE 117 ON FREE INFORMATION CARD

SEMICONDUCTOR CATALOG, 1978-1979, 238 pages, lists complete line of Zeners, temperature-controlled diodes, NPN switching transistors, silicon-transient voltage suppressors and high-speed, high-voltage switching transistors. Many of the units are described in detail along with their applications. Devices are listed numerically by category, and both JEDEC and company's type numbers are shown.—**Semiconductor Industries, Inc.,** 2001 W. 10th St., Tempe, AZ 85281.

CIRCLE 118 ON FREE INFORMATION CARD

ANTENNA CATALOG, expanded listing of TV and FM antennas and accessories, MATV equipment, replacement antennas, CB and two-way radio accessories, etc. Among the new products listed are a 75- to 300-ohm indoor/outdoor balun antenna; replacement dipoles; MATV cables and adapters. Also included is a replacement guide for SRA-series and RA-series antenna dipoles and back-of-set antennas.—**RMS Electronics, Inc.,** 50 Antin Pl., Bronx, NY 10462. **R-E**

CIRCLE 119 ON FREE INFORMATION CARD

stereo products

CAR STEREO BOOSTER AMPLIFIER, *model GE-500 AcoustaTrac,* is designed for use with tape decks, radios and speakers having 15-watt (or more) power-handling capacity. A visual display of the amplifier response is shown on an illuminated screen. The all-integrated circuit delivers

over 40 watts of undistorted RMS stereo power; and other features include five frequency slide controls, front-to-rear fader, power indicator light and audio bypass switch. Suggested retail price: $79.95.—**Sparkomatic Corp.,** Milford, PA 18337.

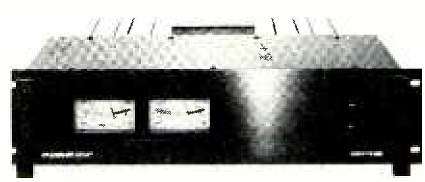
CIRCLE 122 ON FREE INFORMATION CARD

TAPE RECORDER MIXER, *model 2A,* is specially designed for multi-channel recording. The mixer can be used with the *model MB-20* meter bridge, and features four VU meters, independent bus/tape switches for each channel and built-in 1-watt headphone amplifier. Channel pushbuttons are color-coded to correspond to output buses. Controls include a straight-line fader (level control for the input channel) and master fader, which serves as the output-level control. The mike-input jack

accepts a ¼-inch phone plug, the line-in jack accepts a standard phono plug. The line output doubles as the bus output, and the auxiliary output line can be used in parallel with the main line. The *model 2A* accepts several selectable inputs. It can be used either ahead of the tape recorder or it can fit into the output of the multi-channel recorder. Prices: *model 2A,* $400; *model MB-20* meter bridge, $200.—**TEAC Corp. of America,** 7733 Telegraph Rd., Montebello, CA 90640.

CIRCLE 123 ON FREE INFORMATION CARD

POWER AMPLIFIER, *Grandson,* is third in manufacturer's Ampzilla line, and comes in two models, one with 2 power meters calibrated in watts and dB, the other with no meters (utility model). Both are rated at 80 watts-per-channel into 4 ohms from 20 Hz through 20 kHz at less than 3% (typically 0.15%) total harmonic distortion. Transient modulation distortion is reduced to below .01%, and fully DC-coupled circuitry includes servo-control loop to maintain DC offet to less than ±25 mV. The *Grandson* also features an IC-controlled, bias-current regulator, and thermal breakers are provided to protect against output transistor overheating.

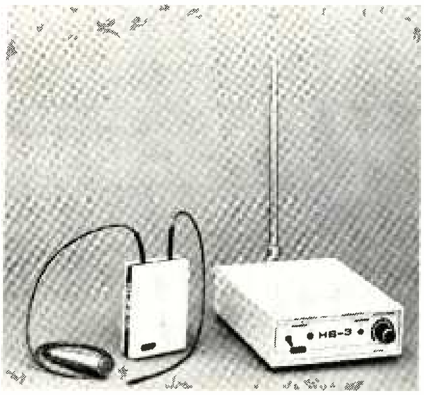


Specifications for both models: Power output (20 Hz to 20 kHz, with both channels driven) is 120 watts-per-channel minimum into 2 ohms, 80 watts-per-channel minimum into 4 ohms, and 40 watts-per-channel minimum into 8 ohms; THD and IM distortion less than .08% (typically .05%) from 15 Hz to 40 kHz into 8 ohms, less than 0.3% (typically 0.15%) from 15 Hz to 25 kHz into 4 ohms, less than 1.0% (typically 0.6%) from 20 Hz to 25 kHz into 2 ohms.

Units measure 19 W × 4¼ H × 11 inches D, and weigh 20 lb. Prices: utility model (without meters) $309; metered unit, $349.—**Great American Sound Co., Inc.**, 20940 Lassen St., Chatsworth, CA 91311.

CIRCLE 124 ON FREE INFORMATION CARD

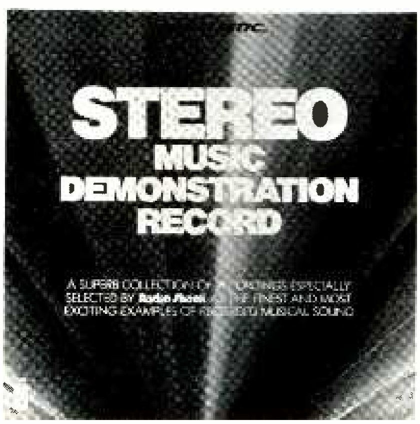
WIRELESS SOUND SYSTEM is a line of high-frequency, high-fidelity wireless microphones and receivers operating in the range from 150 MHz to 210 MHz. The transmitter can be used with either



a regular or a rechargeable battery and a choice of mike heads is available. Further information is available from the manufacturer.—**Edcor**, 3030 Red Hill Ave., Costa Mesa, CA 92626.

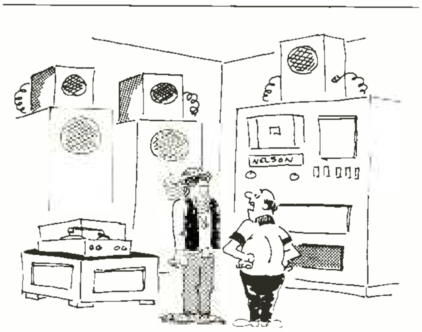
CIRCLE 125 ON FREE INFORMATION CARD

DEMONSTRATION STEREO MUSIC RECORD, on *Realistic* label, contains popular, classical and semiclassical selections designed to demonstrate the full capability of high-quality audio systems.



Record is available exclusively from Radio Shack stores and dealers, and is priced at $3.39 for the disc; cassette tape also available for $3.69.—**Radio Shack**, 1400 One Tandy Center, Fort Worth, TX 76102. **R-E**

CIRCLE 126 ON FREE INFORMATION CARD



*You mean it takes all this equipment just to play Rock and Roll?*______

Solid State News

Here are just a few of the ideas presented in National Semiconductor's *Pressure Transducer Handbook*. The book presents electrical and mechanical possibilities and such applications as flowmeters, pressurized-cable fault location and accelerometers. The handbook is available for $4 from National Semiconductor Corporation, 2900 Semiconductor Drive, Santa Clara, CA 95051.

The pressure transducer makes a good microphone and spans a wide frequency range all the way down to DC. The pressure sensor element goes out to 50 kHz, and the internal amplifier limits this range to 30 kHz. If the pressure port is inserted into a wind instrument, it must be protected from breath moisture by an acoustically transparent material. Electronic attack (the rising portion of the envelope waveshape) processing can add new flexibility to many otherwise physically restricted musical instruments.

Transducers are selected that have bipolar pressure ranges to sense acoustic compression and expansion phases. Gauge types automatically reference the pressure against the natural room pressure. Absolute pressure devices centered around 15 psia can also be used. Parabolic and hyperboloid microphones are constructed by mounting the transducer at the focal points of the reflective structures.

Thermometers

How about constructing a thermometer from a pressure transducer? This is not such an unusual idea because many standard thermometers are pressure oriented. A fluid contained in a closed bulb changes its level as the temperature modulates the pressure inside the bulb. Absolute pressure transducers provide the convenience of an electrical output by connecting a sealed bulb to the pressure port on the transducer. The inner and outer surfaces of the bulb are made absorptive or reflective to suit applications where, for example, it is important to simulate the performance of a cooking implement.

Automotive applications

The automotive electronic possibilities for pressure transducers are attractive. These transducers are already in limited use for measuring oil pressure, manifold pressure, etc. And current interest in emission control and computer-controlled performance optimization opens up a whole spectrum of potential applications. For instance, differential pressure transducers that sense the pressure gradient across a venturi tube in the fuel system can measure fuel flow, which a central automotive microcomputer could convert into miles per gallon.

FM IF subsystem

The Motorola MC3357 is a narrowband FM receiver circuit that includes almost all components between the second mixer and the audio and squelch output. Narrowband FM systems are used in commercial, public safety and ham transceivers, as well as in scanning and paging receivers.

The MC3357 operates as low as 4 volts with a typical current drain of only 3 mA. In a battery-operated, hand-held radio it replaces 20 to over 100 discrete components. The circuit has an internal doubly balanced mixer and a Colpitts local oscillator to convert the 10.7-MHz input to the 455-kHz second IF frequency. The signal is amplified by a five-stage emitter-coupled IF amplifier-limiter and is demodulated by a quadrature detector. An external bandpass filter inserted between the converter and the second IF amplifier defines the selectivity. The audio is processed by an active filter amplifier. Typical sensitivity is 5 μV with a 3-kHz signal deviation and 350 mV of recovered audio.

Second-generation MC6800 MPU

Previously, improvements that were made to the MC6800 increased its frequency limits and extended its temperature range. Now, a sufficiently major architectural change has been made that warrants providing the device with a new number.

The MC6802 is completely software- and hardware-compatible with all other members of the M6800 microprocessor family. The MC6802 is an MC6800 with an internal clock oscillator and driver, plus 128 bytes of RAM occupying the first 80 (0000 to 007F) memory addresses. It has a low-power standby mode for memory retention.

The MC6802 is available in a plastic package in quantities of 25 for $22 each. For information, write Motorola Semiconductor Products, Inc., Box 20912, Phoenix, AZ 85036.

Doppler detector diodes

Parametric Industries has announced the PD422 Doppler detector diodes for use in police radar systems and such motion-detection devices as braking systems and intrusion alarms. The diodes are glass encapsulated, hermetically sealed and encased in ceramic for high burnout resistance and high sensitivity. The operating frequency of the PD422 is 10.525 GHz ±250 MHz, and the sensitivity is −60 dBm. The PD0919, which operates at 24.150 GHz ±250 MHz, is also available.

For more information, write Parametric Industries, Inc., 742 Main Street, Winchester, MA 01890. **R-E**

HOBBY CORNER

continued from page 77

smooth out the ripple in the pulsating DC voltage from the rectifier. The value of this electrolytic capacitor is not critical, but I recommend a minimum capacitance of 1000 μF. Anything larger than 2500 μF is probably a waste of money.

As you know, electrolytic capacitors are available in a variety of working-voltage (WV) ratings. The practical rule for specifying this rating is 1½ times the maximum peak voltage applied. In the case of C1, the supply would require a minimum WV rating of 27 ($1.5 \times 18 = 27$). A commonly available rating is 35 WV, which is probably what you will use. You can use a higher WV rating, but it is a good idea not to use more than two or three times the needed value.

The function of C2 is to assist in voltage regulation. It is a high-quality 1-μF electrolytic—usually a tantalum capacitor is recommended—mounted close to the regulator with short leads. You would then select the WV rating. In a 5-volt supply, that would be a minimum WV of 8 ($1.5 \times 5 = 7.5$), although you can cut this figure a little closer on a regulated power line.

This is your basic power supply for solid-state circuits. Using these principles, you can easily design your supply to meet output requirements of 5 volts to 24 volts. Observing current ratings especially, one transformer can even provide more than one regulated output.

The supply should contain a switch and a fuse in the transformer primary and probably a power-on indicator light. In addition, a current meter and perhaps a voltmeter can be advantageous in the output circuit.

As previously stated, because this only scratches the surface of power supply design, don't forget to study other supplies and principles.

A reader circuit

John Holland of Hopkinsville, KY, sent in the handy circuit shown in Fig. 3. This is an adapter that provides regulated voltages of 6 or 9 at the flick of a switch using a 12-volt automobile cigarette-lighter socket. Thus, you can operate your transistor radio without running down *its* battery.

John cautions about getting the Zener diodes' polarity correct. His adapter is constructed in a small box, and the output current is limited to a maximum of 12 mA.

Note that this circuit is more versatile than the one shown in Fig. 1, since it will yield two voltages. On the other hand, it lacks the built-in protection provided by the three-terminal regulator, so be careful about loading it too heavily.

Thanks, John, for sharing your circuit with us. Perhaps other readers will do the same. **R-E**

ANTIQUE RADIOS

continued from page 62-C

of some receiving tube manuals. For example, GE's *Essential Characteristics* manual lists a great many older tubes.

Interstage audio transformers

The old sets all shared a common problem even when they were new—open interstage audio transformers. Winding impregnation hadn't reached its peak at that time. For some reason, the primary windings, with a fairly high positive voltage on them, would corrode at any pinhole in the insulation and then open. You can detect this by the presence of a bright green spot. (This also happened to IF and RF coils with positive voltages.)

If the primary of an interstage transformer is open, you can shunt it with a resistor of about the same value (from 25K–50K) and then connect a coupling capacitor from the plate to the grid of the next stage (see Fig. 6). You may even be able to find

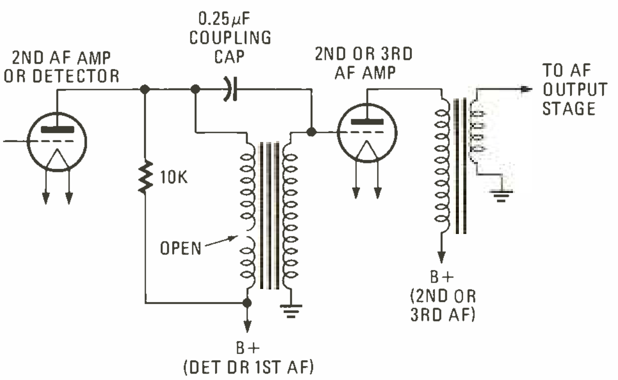


FIG. 6—"QUICK-AND-DIRTY" fix for an open AF transformer.

suitable replacement interstage audio transformers. They are not too critical—a ratio of about 10,000-ohm plate to a 30–50,000-ohm secondary, or a *step-up* of 3:1 or so.

Many old sets had these transformers potted; Atwater-Kent, for example. You might be able to melt the tar, get the old transformer out, then slip a new transformer inside and put the can back! The work—and dirt—is worthwhile only if you wish to maintain the antique appearance of the old set.

Service data

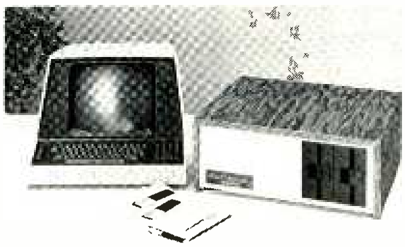
Service data is very helpful on all sets. For reliable data on very old radios, Gernsback's *Official Radio Service Manuals* and John F. Rider's *Perpetual Radio Troubleshooter's Manuals* are invaluable. Volume I of either manual contains most of the real oldies and quite a few more are in Volumes II through V. Another and readily available source of data on antique radios is Volume I of *Most-Often-Wanted 1926-1938 Radio Diagrams*. Mr. M. N. Beitman, at Supreme Publications, Box 46, Highland Park, IL 60035, is the publisher of the *Most-Often-Needed* series of service manuals. He also collects individual volumes and complete sets of Gernsback and Rider service manuals for resale.

One of the annoying things about service data in the early days was the manufacturers' reluctance to give anything but the bare schematic! (Does this sound familiar? There's nothing really new under the sun!) In fact, the Atwater-Kent Company forbade their distributors to inform service technicians about parts values! You asked for a black-and-white resistor and that's what you got.

(We found a way around this situation. Whenever any of us got his hands on a new model Atwater-Kent, he fixed it, then used his ohmmeter to measure all the resistance values! He kept a log of these values and, at the next Radio Trades Association meeting, made copies of everyone else's list. Finally, Atwater-Kent wrote down these values on the schematics, which you can find on many of the early models. R-E

computer products

DISPLAY TERMINAL AND COMPUTERS, *SOROC model IQ 120* terminal and *models HORIZON-1* and *HORIZON-2* computers, are used in tandem to provide a complete system. The *SOROC model IQ 120* offers a 24-line by 80-character display and connects to the *HORIZON* computer with an I/O port at baud rates up to 9600. This terminal has an addressable cursor, upper and lower case ASCII characters and numeric keypad. Comes with limited 90-day warranty.



The *HORIZON* computer offers either single or dual minifloppy disc drive, a 4-MHz Z80A, S-100 motherboard, 16K bytes of RAM, and standard serial I/O interface. Optional expansion to three drives and more than 64K RAM is possible. Extended disc BASIC software included with both *HORIZON* models.

Prices: *SOROC model IQ 120* terminal, $995 (assembled only); *model HORIZON-1* (single-disc)—kit, $1599; assembled, $1995; and *model HORIZON-2* (dual-disc)—kit, $1999; assembled, $2349.—**North Star Computers, Inc.,** 2547 Ninth St., Berkeley, CA 94710.

CIRCLE 127 ON FREE INFORMATION CARD

INTEGRATED COMPUTER SYSTEM, *Bytemaster,* provides either 18K or 32K memory, but can support up to 64K of memory. Expandable system is fully wired to support external peripheral

devices, such as a printer, a monitor, and additional disc drives just by plugging into four available I/O ports. Dressed in heavy metal cabinet mounted on metal yoke, top-of-line *model Master 4* comes assembled, with mini-disc drive and 32K of memory; it sells for $3245.—**The Digital Group, Inc.,** Box 6528, Denver, CO 80206.

CIRCLE 128 ON FREE INFORMATION CARD

COMPUTER SYSTEM, *model MICRO-68,* comes completely assembled and is built around the 6800 microprocessor. The unit features 6-digit LED display, 16-pushbutton keyboard, built-in power supply, 128 words of RAM, and 510 MON-1 Bug PROM. Edge connectors are provided for expansion to 64K of memory and 16-bit I/O. All

memory lines can be buffered on-board. The *model MICRO-68* is housed in a hardwood cabinet with acrylic plastic lid and measures 9 × 16 × 2 inches. Price: $495.—**Electronic Product Associates, Inc.,** 1157 Vega St., San Diego, CA 92110.

CIRCLE 129 ON FREE INFORMATION CARD

COMPUTER PERIPHERALS, external cassette drive and printer, for PET computer. Cassette drive (with a read/write capability of up to 170 kilobytes) is designed for expanded file keeping; it connects to designated I/O port and can be accessed directly from the PET via the basic command. The printer (shown) features up to 80

characters-per-line on 8½-inch roll or fan-folded paper; prints at 120 characters-per-second; and can reproduce all Commodore upper- and lower-case and graphic characters. Prices: cassette drive, $99.95; printer, $595.—**Commodore Business Machines, Inc.,** 901 California Ave., Palo Alto, CA 94304.

CIRCLE 130 ON FREE INFORMATION CARD

ORIGINATE/AUTO ANSWER MODEM, *model USR-330,* is a hardwire, asynchronous, half/full

duplex modem operating in both originate and auto answer modes at a 0–300 baud data rate. The unit uses MOS/LSI circuitry, a crystal-controlled digital receiver and transmitter and active filters. Once interfaced with phone lines and computer, the *model USR-330* answers calls automatically and connects them immediately with the computer. The modem is available with an RS232C interface, a 20-mA current loop, or both interfaces. Comes with its own 115 VAC 60-Hz power supply. Prices: with RS232C interface, $185; with 20-mA current loop interface, $185; and with both interfaces, $195.—**U.S. Robotics, Inc.**, Box 5502, Chicago, IL 60680.

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WIRE-WRAPPING KIT, *model WK-5B,* includes battery-operated wire-wrapping tool (*model BW-630*); wrapping/unwrapping/stripping tool (*model WSU-30*); PC board plus card guides and brackets; edge connector; mini-shear; 14-, 16-, 24- and

40-pin DIP sockets; wire-wrapping terminals; and DIP inserter and DIP extractor. A wire dispenser comes with 50-foot lengths of red, white and blue insulated, silver-plated AWG 30 copper wire. Price: $74.95.—**OK Machine and Tool Corp.**, 3455 Conner St., Bronx, NY 10475.

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SOLDERING WICKS, available in 1/16-inch, 3/32-inch and 1/8-inch widths, are 66 inches long and wound on plastic spools. A special devacuumizing process deoxidizes copper braid while flux is applied. Can be used to desolder PC board

components and solder from joints.—**Multicore Solders,** Westbury, NY 11590. **R-E**

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new books

EASI-GUIDE TO ACCESSORIES FOR CB . . . TWO-WAY . . . HAM RADIO, by Forest Belt and Marti McPherson. Howard W. Sams & Co., Inc., 4300 W. 62nd St., Indianapolis, IN 46268. 144 pp. 5½ × 8½ in. Softcover $3.50.

Every ham operator, CB or two-way radio owner sooner or later wants to upgrade his system with the proper accessories. This handy illustrated guide describes such basic equipment, how to use it and, most important, how to choose what's best for your needs.

Chapters include information on mikes and their accessories, auxiliary speakers, cables and connectors (includes instructions on how to install a base-station antenna), rotators, towers and many more. Chapter 6 and Chapter 7 describe base-station and mobile accessories.

ANALOG AND DIGITAL COMMUNICATION, by W. David Gregg. John Wiley & Sons, Inc., 605 Third Ave., New York, NY 10016. 603 pp. 6½ × 9 in. Hardcover $21.95.

This book prepares the user for participation in the various engineering, scientific and technical aspects of the communications industry. Concepts and systems pertaining to both analog and digital communications are examined and related to practical applications and services. A step-by-step approach explains the similarities and differences of each system. Worked-out examples are provided, with a set of problems given at the end of each chapter.

BASIC SOFTWARE LIBRARY, VOLUME I, Business and Recreational, by R. W. Brown. Scientific Research Institute, 1712 Farmington Court, Crofton, MD 21114. 300 pp. 8½ × 11 in. Softcover $24.95.

The average reader with little or no background in computers can use this book to execute many individualized business and recreational programs with relative ease. All the programs use the BASIC computer language, and have been tested on several computer systems. Each program is introduced by a brief description, a list of possible users, instructions and program limitations (if any) that could arise if run on different systems.

The book is divided into two sections: Business and Personal Bookkeeping Programs tells you how to compute the price and interest on bond purchases; how to do monthly installment accounting; how to compare mortgage terms, etc. Some of the programs in the Games and Pictures section teach you how to program a biorhythm cycle, play various war games, simulate a craps game or a parachute jump. R-E

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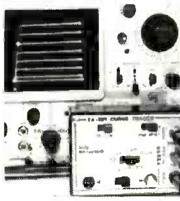

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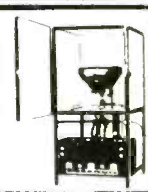

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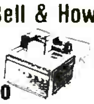

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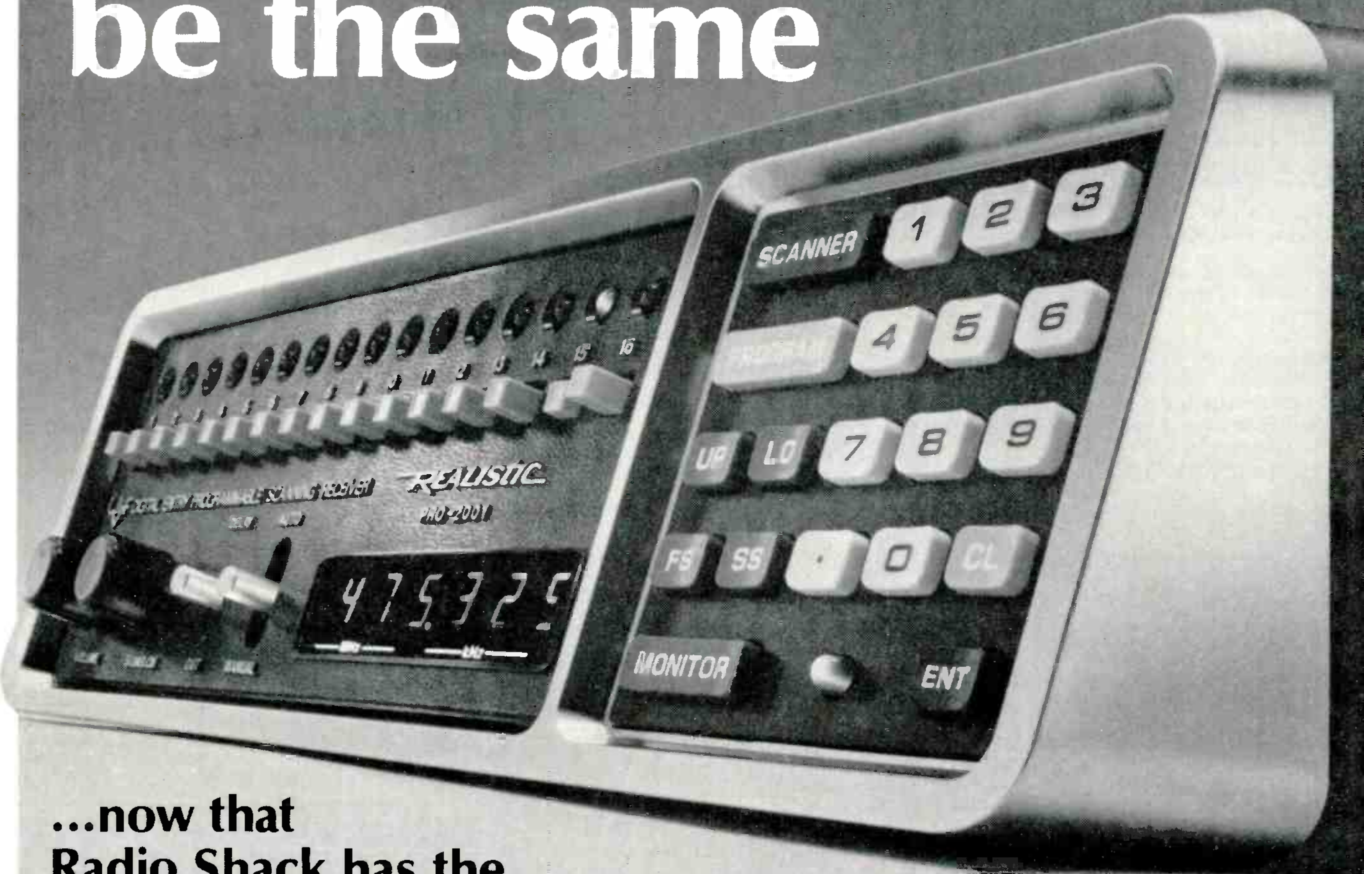

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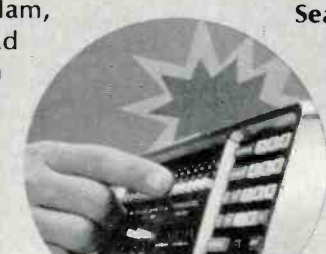

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7422N	1.39
7430N	20
7442N	50
7445N	69
7447N	60
7448N	69
7450N	17
7474N	29
7475N	49
7485N	88
7489N	2.00
7490N	43
7492N	43
7493N	43
7495N	69
74100N	90
74107N	29
74121N	34
74123N	59
74125N	39
74145N	69
74150N	95
74151N	69
74154N	1.00
74157N	69
74161N	87
74162N	87
74163N	87
74174N	96
74175N	90
74190N	1.15
74192N	87
74193N	85
74221N	1.55
74298N	1.65
74365N	66
74366N	66
74367N	66

74LS00 TTL	
74LS00N	25
74LS02N	25
74LS04N	25
74LS05N	25
74LS08N	25
74LS10N	25
74LS13N	40
74LS14N	90
74LS20N	25
74LS22N	25
74LS28N	41
74LS30N	25
74LS33N	39
74LS38N	30
74LS74N	35
74LS75N	47
74LS90N	51
74LS93N	51
74LS95N	1.89
74LS107N	35
74LS112N	35
74LS113N	35
74LS132N	72
74LS136N	35
74LS151N	67
74LS155N	67
74LS157N	67
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CD4044	63
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CD4050	36
CD4051	1.13
CD4060	1.42
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CD4069	40
CD4070	40
CD4071	21
CD4072	21
CD4073	21
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102P3 Transformer	2.25
MA1010A, C or E .84	11.95
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10 per type .03 1000 per type .012
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KEYBOARDS
Hex keyboard $10.95 Fully encoded w/ PC board parts and instructs $24.95
53 key ASCII keyboard kit $60.00
Fully assembled 65.00 Enclosure 14.95

LEDS	
Red TO18	.15
Green, Orange, Yellow TO18	.20
Jumbo Red	.20
Green, Orange, Yellow Jumbo	.25
Cliplite LED Mounting Clips	8/$1.25

(specify red, amber, green, yellow, clear)

CONTINENTAL SPECIALTIES in stock
Complete line of breadboard test equip.
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OK WIRE WRAP TOOLS in stock
Portable Multimeter $18.00

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Batt. oper. General purpose or medical 32-230 F Disposable probe cover. 2 accuracy. Comp. assy. in compact case

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4K EPROM Kit	114.95
I O Board Kit	44.50
Extender Board w/connector	12.50
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3 pos. slide	.25
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Voice actuated switch	[illegible]
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Model 10 Trigger Expander Kit	$229.00
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12V CT 250 ma wall plug	3.50
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MAN72 74	CA CA	300	1.00
DL704	CC	300	1.25
DL707 DL707R	CA CC	300	1.00
DL727 728	CA CC	500	1.90
DL747 750	CA CC	600	1.95
DL750	CC	600	1.95
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FND500 507	CC CA	500	1.35
FND503 510	CC CA	500	.90
FND800 807	CC CA	800	2.20
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4 digit Bubble			.80
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NSN69 9 digit display			.60
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Red	55	47
Black	55	47

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Batt./AC oper. 1mV and .1NA resolution. Resistance to 20 meg. 1% accuracy. Small, portable, completely assem. in case. 1 yr. guarantee. Best value ever! **$59.95**

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RCA CMOS expandable to 64K microcomputer w/HEX keypad input and video output for graphics. Just turn on and start loading your program using the resident **monitor on ROM**. Pushbutton selection of all four CPU modes. LED indicators of current CPU mode and four CPU states. Single step op. for program debug. Built in pwr. supply, 256 Bytes of RAM, audio amp. & spkr. Detailed assy. man. w/PC board & all parts fully socketed. Comp. Kit **$106.95**. High address display option **8.95**; Low address display option **9.95**. Custom hardwood cab., drilled front panel **19.75**; Nicad Battery Backup Kit w/all parts **4.95**. Fully wired & tested in cabinet **151.70**. 1802 software club, 10–12 pg. monthly publication **12.00** per yr.

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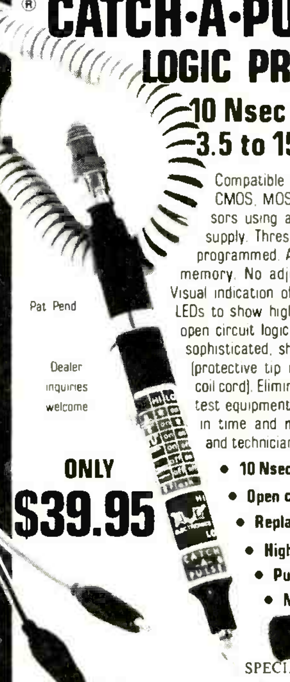

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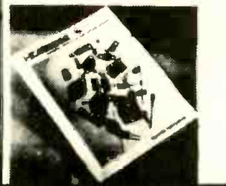

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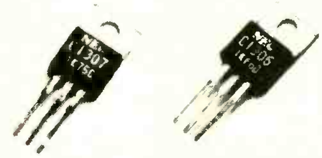

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2SA 495	.45
2SA 496	1.10
2SA 497	1.60
2SA 505	1.20
2SA 509	.70
2SA 525	.70
2SA 530	1.30
2SA 537A	2.25
2SA 539	.59
2SA 545	.59
2SA 561	.59
2SA 562	.59
2SA 564A	.59
2SA 565	1.10
2SA 566	3.40
2SA 606	1.60
2SA 607	1.60
2SA 624	1.10
2SA 627	3.60
2SA 628	.59
2SA 634	.70
2SA 640	.59
2SA 642	.70
2SA 643	.70
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2SA 661	.70
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2SA 715	1.40
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2SA 721	.59
2SA 725	.59
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2SA 841	.59
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2SA 885	.70
2SA 908	11.00
2SA 913	1.20

2SB

2SB 22	.59
2SB 54	.59
2SB 55	.59
2SB 75	.45
2SB 77	.45
2SB 173	.45
2SB 175	.45
2SB 176	.45
2SB 178	.70
2SB 186	.45
2SB 187	.45
2SB 202	1.60
2SB 220	.70
2SB 303	.59
2SB 324	.70
2SB 337	1.60
2SB 346	.70
2SB 367	1.50
2SB 368B	2.15
2SB 379	1.10
2SB 381	.59
2SB 400	.59
2SB 405	.59
2SB 407	1.40
2SB 415	.59
2SB 434	1.20
2SB 435	1.40
2SB 440	.59
2SB 449	1.60
2SB 461	1.20
2SB 463	1.20
2SB 471	1.60
2SB 473	1.20
2SB 474	1.00
2SB 481	1.20
2SB 492	1.00
2SB 507	1.60
2SB 509	1.60
2SB 511	1.10
2SB 514	1.90
2SB 523	1.00
2SB 526C	1.30
2SB 527	1.60
2SB 528D	1.60
2SB 529	.90
2SB 530	4.40
2SB 531	3.40
2SB 536	1.60
2SB 537	1.60
2SB 539	4.90
2SB 541	4.40
2SB 554	10.00
2SB 556	4.90
2SB 557	3.40
2SB 561B	.70
2SB 564	.70
2SB 595	1.90
2SB 596	1.60
2SB 600	7.00

2SC

2SC 183	.59
2SC 184	.59
2SC 281	.59
2SC 283	.59
2SC 284	1.20
2SC 317	1.20
2SC 352A	2.50
2SC 353A	2.50
2SC 367	.90
2SC 369	.59
2SC 371	.59
2SC 372	.45
2SC 373	.45
2SC 374	.59
2SC 377	.70
2SC 380	.59
2SC 381	.59
2SC 382	.59
2SC 383	.90
2SC 387A	.59
2SC 388A	1.00
2SC 394	.59
2SC 403	.59
2SC 430	.90
2SC 454	.59
2SC 458	.59
2SC 460	.59
2SC 461	.59
2SC 478	1.10
2SC 481	1.60
2SC 482	1.50
2SC 484	1.60
2SC 485	1.60
2SC 486	1.60
2SC 493	3.90
2SC 495	.90
2SC 496	.90
2SC 497	1.60
2SC 509	.70
2SC 515A	1.40
2SC 517	3.95
2SC 535	.59
2SC 536	.59
2SC 537	.59
2SC 538A	.70
2SC 562	.70
2SC 563	1.10
2SC 605	.70
2SC 619	.59
2SC 620	.59
2SC 627	2.25
2SC 631	.90
2SC 632A	.45
2SC 634A	.59
2SC 642A	5.90
2SC 644	.45
2SC 645	.70
2SC 650	1.30
2SC 665H	8.50
2SC 668	.45
2SC 680	2.80
2SC 681A	5.80
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2SC 693B	.59
2SC 696	1.95
2SC 708	1.90
2SC 710	.45
2SC 711	.45
2SC 712	.59
2SC 717	.59
2SC 727	1.90
2SC 730	4.40
2SC 731	5.80
2SC 732	.59
2SC 733	.59
2SC 734	.59
2SC 735	.59
2SC 738	.59
2SC 756	2.80
2SC 756A	3.00
2SC 763	.59
2SC 772	.45
2SC 773	.70
2SC 774	2.00
2SC 775	1.95
2SC 776	2.65
2SC 777	3.50
2SC 778	3.60
2SC 781	2.65
2SC 783R	3.60
2SC 784	.59
2SC 785	.59
2SC 789	1.00
2SC 790	1.40
2SC 793	2.80
2SC 799	3.60
2SC 802	3.60
2SC 815	.59
2SC 828	.45
2SC 829	.45
2SC 830H	5.90
2SC 838	.59
2SC 839	.59
2SC 853	.90
2SC 867	4.25
2SC 870	.59
2SC 871	.59
2SC 895	4.90
2SC 897	3.40
2SC 898	4.40
2SC 900	.45
2SC 923	.45
2SC 929	.45
2SC 930	.45
2SC 941	.59
2SC 943	.70
2SC 945	.45
2SC 959	1.50
2SC 971	1.00
2SC 982	.90
2SC 983	1.00
2SC 984	.90
2SC 994	3.90
2SC 996	3.40
2SC 1000BL	.59
2SC 1012	1.50
2SC 1013	1.10
2SC 1014	1.10
2SC 1017	1.40
2SC 1018	1.20
2SC 1030C	2.80
2SC 1047	.70
2SC 1051	4.40
2SC 1060	1.40
2SC 1061	1.40
2SC 1076	39.00
2SC 1079	5.90
2SC 1080	4.40
2SC 1096	1.00
2SC 1098	1.10
2SC 1111	3.40
2SC 1114	3.70
2SC 1115	4.40
2SC 1116	4.90
2SC 1116A	6.60
2SC 1124	1.30
2SC 1127	1.40
2SC 1161	1.90
2SC 1162	1.00
2SC 1166	.59
2SC 1167	6.60
2SC 1170B	6.60
2SC 1172B	8.50
2SC 1173	.90
2SC 1175	.90
2SC 1177	14.00
2SC 1189	1.20
2SC 1209	.70
2SC 1211D	.59
2SC 1212A	1.40
2SC 1213	.70
2SC 1215	.70
2SC 1222	.45
2SC 1226A	.90
2SC 1237	2.25
2SC 1239	3.90
2SC 1279	.70
2SC 1306	2.90
2SC 1307	3.90
2SC 1310	.59
2SC 1312	.59
2SC 1313G	.59
2SC 1316	8.50
2SC 1317	.45
2SC 1318	.45
2SC 1325A	7.60
2SC 1327	.59
2SC 1330	.70
2SC 1335	.70
2SC 1342	.59
2SC 1344	.59
2SC 1345D	.59
2SC 1346	.70
2SC 1347	.70
2SC 1358	5.90
2SC 1359	.59
2SC 1360	1.00
2SC 1362	.59
2SC 1364	.70
2SC 1377	4.90
2SC 1383	.59
2SC 1384	.59
2SC 1396	.70
2SC 1398	1.10
2SC 1400	.59
2SC 1402	4.90
2SC 1403	4.90
2SC 1407	.90
2SC 1419	1.10
2SC 1444	2.80
2SC 1445	3.00
2SC 1447	1.60
2SC 1448	1.60
2SC 1449	1.00
2SC 1451	2.25
2SC 1454	5.60
2SC 1475	1.40
2SC 1478S	.70
2SC 1509	1.10
2SC 1567	1.10
2SC 1567A	1.10
2SC 1584	8.50
2SC 1586	7.60
2SC 1624	1.30
2SC 1626	1.10
2SC 1628	1.30
2SC 1647	1.00
2SC 1667	3.40
2SC 1669	1.60
2SC 1674	.59
2SC 1675	.59
2SC 1678	2.25
2SC 1679	4.25
2SC 1681	.70
2SC 1682	.45
2SC 1684	.59
2SC 1687	.70
2SC 1688	.70
2SC 1708	.59
2SC 1728	1.90
2SC 1730	.59
2SC 1756	1.40
2SC 1760	1.90
2SC 1765	8.80
2SC 1775	.45
2SC 1816	3.90
2SC 1846	.70
2SC 1885	.70
2SC 1908	.59
2SC 1909	3.90
2SC 1913	1.20
2SC 1945	5.60
2SC 1951	1.10
2SC 1957	1.20
2SC 1969	4.90
2SC 1973	1.10
2SC 1974	1.90
2SC 1975	4.40
2SC 2028	.90
2SC 2029	3.90
2SC 2074	1.90
2SC 2076	.59
2SC 2091	2.80
2SC 2092	3.90
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2SD

2SD 16	5.90
2SD 28	2.50
2SD 72	1.10
2SD 75	.90
2SD 77	.59
2SD 81	3.00
2SD 90	1.60
2SD 91	1.60
2SD 92	1.90
2SD 93	2.80
2SD 118	4.40
2SD 130	1.20
2SD 141	1.40
2SD 142	2.00
2SD 143	2.80
2SD 178	1.10
2SD 180	2.50
2SD 187	.59
2SD 188	3.00
2SD 201	3.40
2SD 202	3.90
2SD 204	1.40
2SD 205	1.40
2SD 213	5.90
2SD 217	4.40
2SD 218	4.40
2SD 220	2.50
2SD 223	1.90
2SD 224	1.90
2SD 226A	1.60
2SD 227	.45
2SD 234	1.00
2SD 235	1.00
2SD 236	1.60
2SD 255	1.60
2SD 261	.60
2SD 287	3.70
2SD 288	1.40
2SD 291	2.80
2SD 300	5.60
2SD 313	1.10
2SD 314	1.20
2SD 315	1.20
2SD 325	1.10
2SD 330	1.00
2SD 341	5.60
2SD 350	5.90
2SD 352	.90
2SD 356D	1.10
2SD 357D	1.00
2SD 358	1.30
2SD 359	1.00
2SD 360	1.20
2SD 361	1.00
2SD 370	3.00
2SD 371S	2.80
2SD 380	7.60
2SD 381	1.40
2SD 382	1.40
2SD 388	3.40
2SD 388A	4.40
2SD 389	.90
2SD 390	1.00
2SD 421	8.50
2SD 424	8.50
2SD 425	6.50
2SD 426	4.60
2SD 427	3.00
2SD 525	1.60
2SD 526	1.10
2SD 555A	6.60
2SD 610	1.90
SG 613(tv)	5.95

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2SK 23	1.10
2SK 30	.70
2SK 33	1.10
2SK 34	1.10
2SK 40	.70
2SK 41	1.10
2SK 49	1.30
2SK 55	1.30
2SK 61	1.40
2SK 68	1.30
3SK 22Y	2.55
3SK 35	2.25
3SK 37	3.00
3SK 39	2.25
3SK 40	2.25
3SK 41	2.50
3SK 45	2.50
3SK 48	5.90
3SK 49	2.50
MK 10	2.00

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AN 203	2.50
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AN 217	1.90
AN 239	7.00
AN 247	4.40
AN 274	3.40
AN 277B	2.40
AN 315	3.00
AN 328	3.90
AN 362	3.00
BA 511	2.90
BA 521	2.90
HA 1137	4.90
HA 1138	4.40
HA 1149	5.60
HA 1151	4.40
HA 1156	3.00
HA 1158	5.30
HA 1159	5.80
HA 1196	4.90
HA 1197	3.90
HA 1201	1.50
HA 1202	2.25
HA 1211	1.50
HA 1306W	3.70
HA 1322	4.40
HA 1339	4.40
HA 1339A	4.40
HA 1342A	4.40
LA 1111P	2.50
LA 1201	2.50
LA 1364	4.40
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LA 3301	3.00
LA 4030P	3.40
LA 4031P	3.00
LA 4032P	3.40
LA 4051P	3.70
LA 4400	3.70
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M5152L	2.50
M51841P	2.80
M5320P	2.25
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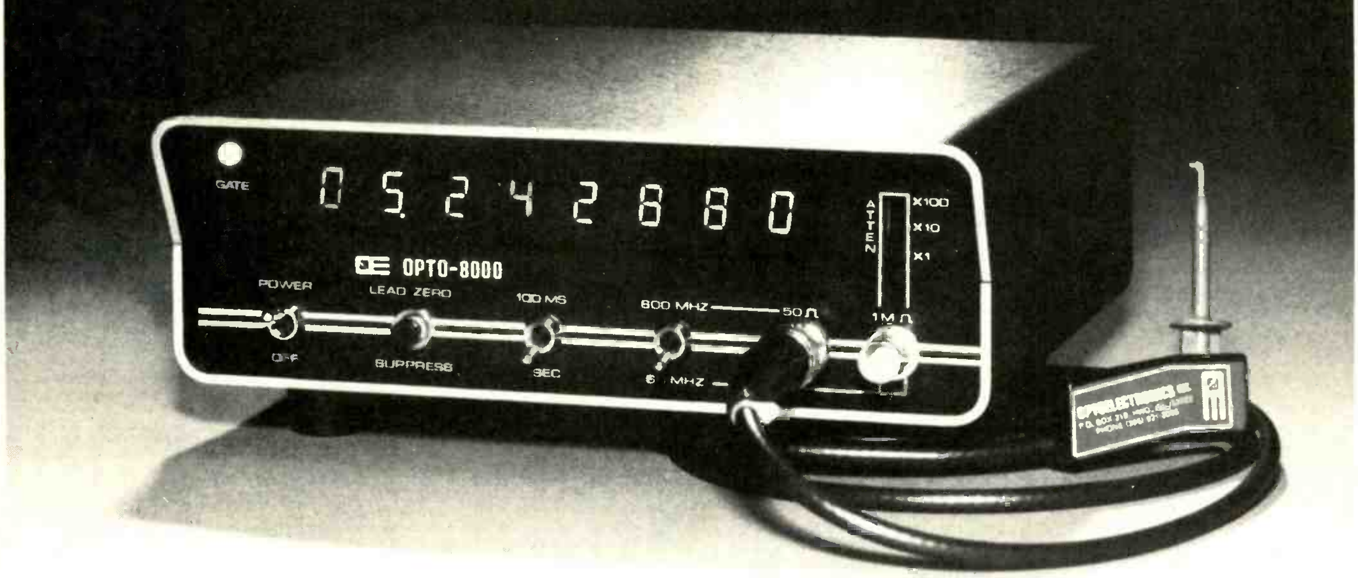
±0.1 PPM TCXO

OPTO-8000.1



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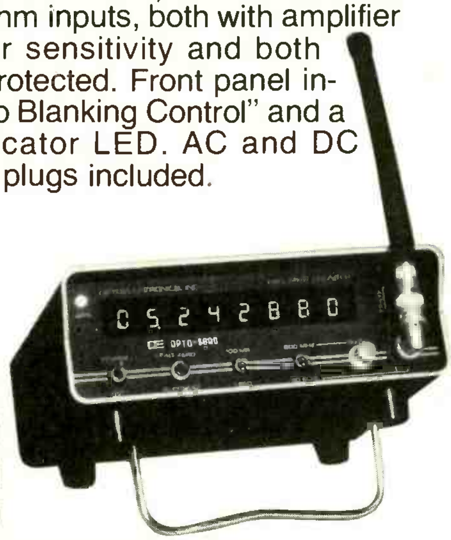

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Approximate Weight—2½ pounds
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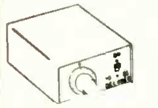

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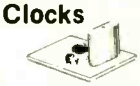

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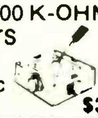

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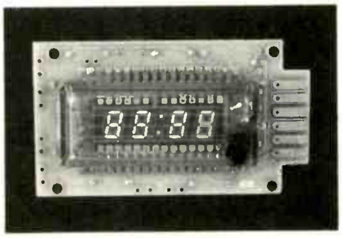

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4002 –	.18	4020 –	.90	4050 –	.35	74C74 –	.45
4006 –	.95	4021 –	.80	4053 –	1.10	74C83 –	1.15
4007 –	.18	4022 –	.90	4055 –	1.25	74C86 –	.40
4009 –	.37	4023 –	.18	4066 –	.70	74C93 –	.75
4010 –	.37	4024 –	.75	4071 –	.18	74C151	1.40
4011 –	.18	4025 –	.18	4076 –	.97	74C160	1.05
4012 –	.18	4027 –	.37	4518 –	1.00	74C161	1.05
4013 –	.29	4028 –	.80	74C00 –	.22	74C174	1.05
4014 –	.75	4029 –	.95	74C02 –	.22	74C175	1.05
4015 –	.75	4030 –	.33	74C04 –	.24	74C193	1.20
4016 –	.29	4035 –	.97	74C08 –	.22	74C901	.48
4017 –	.90	4042 –	.65	74C10 –	.27	74C902	.48
4018 –	.90	4046 –	1.35	74C42 –	.85	74C914	1.70

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This board is a 1/16" single sided paper epoxy board, 4½"x6½" DRILLED and ETCHED which will hold up to 21 single 14 pin IC's or 8, 16 or LSI DIP IC's with busses for power supply connector.

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200	07	.20	35	1.15	4.25	6.50
400	09	25	50	1.40	6.50	9.50
600	11	30	70	1.80	8.50	12.50
800	15	.35	90	2.30	10.50	16.50
1000	20	45	1.10	2.75	12.50	20.00

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MRF-8004 a CB RF Transistor NPN	$ 1.50
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7401–	.13	7446–	.68	74153–	.61
7402–	.13	7447–	.58	74154–	.94
7403–	.13	7448–	.68	74155–	.58
7404–	.15	7450–	.15	74157–	.55
7405–	.13	7472–	.25	74161–	.55
7406–	.16	7473–	.28	74163–	.55
7407–	.20	7474–	.28	74164–	.85
7408–	.18	7475–	.45	74165–	.95
7409–	.18	7476–	.30	74170–	1.68
7410–	.13	7480–	.31	74173–	1.20
7411–	.18	7483–	.65	74174–	.95
7412–	.13	7485–	.87	74175–	.85
7413–	.36	7486–	.28	74176–	.75
7414–	.60	7489–	1.25	74177–	.75
7416–	.22	7490–	.42	74180–	.65
7417–	.25	7491–	.58	74181–	1.90
7420–	.13	7492–	.43	74190–	1.00
7425–	.25	7493–	.43	74191–	1.00
7426–	.22	7494–	.67	74192–	.79
7427–	.19	7495–	.65	74193–	.79
7430–	.13	7496–	.65	74194–	.80
7432–	.22	74107–	.28	75325–	1.50
7437–	.21	74121–	.29	74196–	.86
7438–	.21	74122–	.38	74279–	.55
7440–	.13	74123–	.45	74367–	.50
7441–	.70	74125–	.40	75491–	.50
7442–	.37	74126–	.40	75492–	.50
		74150–	.94		

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100			1.30
200	.75	1.25	2.00
400	.95	1.50	3.00
600	1.20	1.75	4.00

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8 PIN	.17	24 PIN	.35
14 PIN	.20	28 PIN	.40
16 PIN	.22	40 PIN	.60
18 PIN	.25		

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Si 1010 G 10 WATTS	$ 7.80
Si 1020 G 20 WATTS	$15.70
Si 1050 G 50 WATTS	$28.50

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47UF 35V	5 $1.00	10UF 10V	$ .25
68UF 35V	5 $1.00	22UF 25V	$ .40
1UF 35V	5 $1.00	15UF 35V	3/$1.00
2.2 UF 20V	5 $1.00	30UF 6V	5/$1.00
3.3UF 20V	4 $1.00	47UF 20V	$ .35
4.7UF 15V	5/$1.00	68 UF 15V	$ .50
		100 UF 10V	$ .40

74LS SERIES

74LS00	19	74LS132 –	70
74LS02	19	74LS138	.70
74LS03	19	74LS139	70
74LS04	21	74LS151	59
74LS05	21	74LS153	59
74LS08	21	74LS155 –	.62
74LS09	21	74LS156 –	62
74LS10	20	74LS157	59
74LS11	20	74LS160	79
74LS13	40	74LS161	79
74LS14	80	74LS162 –	79
74LS15	21	74LS163	79
74LS20	21	74LS168	80
74LS21	21	74LS169	80
74LS22	21	74LS170 –	1.40
74LS26	29	74LS173	95
74LS27	25	74LS174	72
74LS28	26	74LS175	75
74LS30	21	74LS181	2.00
74LS32 –	25	74LS190 –	88
74LS37	28	74LS191	88
74LS38	28	74LS192	88
74LS40	21	74LS193	88
74LS42	60	74LS195	50
74LS47	73	74LS196 –	75
74LS51	25	74LS197	75
74LS54 –	25	74LS221	1.00
74LS73 –	35	74LS257	68
74LS74	34	74LS258	88
74LS75	50	74LS265 –	25
74LS76	.35	74LS279	50
74LS85 –	75	74LS290	80
74LS86 –	35	74LS293	58
74LS90 –	50	74LS365	49
74LS92	50	74LS366	49
74LS93 –	50	74LS367	49
74LS109	35	74LS368	49
74LS112	35	74LS375	60
74LS113	35	74LS386	35
74LS114	35	74LS390 –	1.45
74LS125	.46	74LS670	2.00
74LS126	46		

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LM 301/748	25
LM307 –	.30
LM 308 –	.75
LM 311 –	.75
LM 318 –	1.20
LM 319 –	.95
LM 324 –	70
LM 339 –	1.10
LM 358 –	.70
LM 370 –	1.15
LM 377 –	1.60
LM 380 –	.95
LM 381 –	1.25
LM 382 –	1.25
LM 537 –	2.50
LM 553 –	2.50
LM 555 –	39
LM 556 –	.85
NE540L –	2.25
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565 –	.95
566 –	1.10
567 –	1.10
703 –	.90
709 –	25
710 –	.35
741C or V –	25
747 –	50
LM 1310 –	2.50
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1458 –	.50
CA3046 –	75
3900 –	.40
8038CC –	3.90
791 –	1.95
LF356H –	1.20

TRIACS / SCR'S

PRV	TRIACS 1A	TRIACS 10A	TRIACS 25A	SCR'S 1.5A	SCR'S 6A	SCR'S 35A
100	.40	70	1.30	40	50	1.20
200	70	1.10	1.75	60	70	1.60
400	1.10	1.60	2.60	1.00	1.20	2.20
600	1.70	2.30	3.60		1.50	3.00

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- Xytal Time Base—0.001% 10MHz for better accuracy
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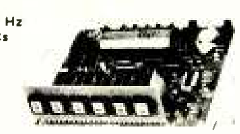

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$54.95

KIT # T-250-30A

KIT INCLUDES: Detailed Instructions (22 pages). All parts including transformer (case not available).

Instrument Case for Kit
H. 2 7/16" W. 8½ D. 9¼"
and in 6 varying heights
also compatible as other instrument housing
Mod. # CH200

Perfect for our 30 MHz Frequency Counter
PRICE: $17.50

6-DIGIT AUTO CLOCK KIT WITH ALARM

Features:
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B. Display Board may be remote
C. X'tal time base
D. P.C. Boards, speaker, IC's and all parts.
E. Detailed Instructions

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5V 10A Power Supply Kit for your TTL Circuits!

Kit includes. Extra Large Heat Sink, Power Tr., IC Regulator, P.C. Board, with OVPCircuitry. KIT # T-500 **$14.95**

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10-40p Mini Capacitance Trimmer
50 ea. 10/$4.50

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	Lo-pro 5 pcs	Lo-pro 10 pcs	Lo-pro 100 pcs	3-Level Wire Wrap 5 pcs	3-Level Wire Wrap 10 pcs	3-Level Wire Wrap 100 pcs
8-pin	0.80	1.50	12.00	1.90	3.50	32.00
14-pin	0.95	1.75	15.00	2.10	3.90	36.00
16-pin	1.05	2.00	17.00	2.50	4.20	39.00
18-pin	1.40	2.50	23.00	3.20	6.00	55.00
20-pin	1.60	3.10	28.00	3.50	6.50	60.00
22-pin	1.80	3.40	32.00	3.75	7.00	65.00
24-pin	1.85	3.50	33.00	4.25	8.00	75.00
28-pin	2.20	4.20	39.00	4.75	9.00	85.00
40-pin	3.50	6.20	59.00	6.50	12.00	100.00

HAMMOND BREADBOARD KIT

BIMBOARD I $9.95 ea.

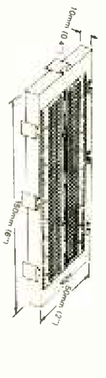
Accepts DIP packages without adaptors or damaging component leads.

Contacts are double sided, nickel silver, current carrying capacity of 1 Amp with less than 10 milliohms contact resistance.

Total of 550 sockets identified by a letter and number matrix for recording experiments

Buss strip section runs up each side of board.

Component bracket (included with each board) will fit on any of the four edges or down the center.



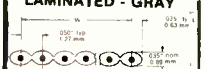
BIMBOARD 2
2 Bimboards and 2 component brackets
1 Aluminum base with 4 insulated Terminals

BIMBOARD 3
3 Bimboards and 3 component brackets
1 Aluminum base with 4 insulated terminals

BIMBOARD 4 $43.
4 Bimboards and 4 component brackets
1 Aluminum base with 4 insulated terminals.

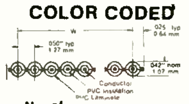
CABLE 28 AWG 7/26 Strand

LAMINATED - GRAY



No. of Conductors	Width	Price/ft
10	0.45"	0.33
14	0.65"	0.46
16	0.75"	0.53
20	0.95"	0.66
26	1.25"	0.86
34	1.65"	1.15
40	1.95"	1.35
50	2.45"	1.65
60	2.95"	2.00

LAMINATED - COLOR CODED



No. of Conductors	Width	Price/ft
20	0.45"	0.54
14	0.65"	0.75
16	0.75"	0.86
20	0.95"	1.05
26	1.25"	1.40
34	1.65"	1.85
40	1.95"	2.15
50	2.45"	2.70
60	2.95"	3.25

4/6 Digit Alarm Clock Kit

Kit includes P.C. Boards, x'former and all parts. 4-Digit $10.95 6-Digit $12.95

PRECUT WIRE WRAP WIRE

30 Kynar in red, orange, blue, yellow, green, black, white.
Pre-stripped both end.

	100	500	1000	5000
2½ in.	.78	2.40	4.30/K	3.89/K
3 in.	.82	2.60	4.71/K	4.22/K
3½ in.	.86	2.80	5.12/K	4.55/K
4 in.	.90	3.00	5.52/K	4.88/K
4½ in.	.94	3.21	5.93/K	5.21/K
5 in.	.98	3.42	6.34/K	5.52/K
5½ in.	1.02	3.65	6.75/K	5.86/K
6 in.	1.06	3.85	7.16/K	6.19/K
6½ in.	1.15	4.05	7.57/K	6.52/K
7 in.	1.20	4.25	7.98/K	6.85/K
7½ in.	1.25	4.45	8.39/K	7.18/K
8 in.	1.29	4.65	8.80/K	7.53/K
8½ in.	1.32	4.85	9.21/K	7.84/K
9 in.	1.36	5.05	9.62/K	8.17/K
9½ in.	1.40	5.25	10.03/K	8.50/K
10 in.	1.45	5.51	10.44/K	8.83/K
Addl. in	10	.41	.82/K	66/K

TRANSISTORS

NPN-General Purpose 30V	10/$1.00
PNP-General Purpose 30V	10/$1.00
2N2222-Switching	10/$1.50
2N3055-150W Power	10/$6.75
2N6059-Darlington Power, 20A HFE 1k Typical	$3.25 ea

Z-80 CPU BOARD/KIT

On board 2708 EPROM addressable to any 4K boundary above 32K. Power-on-jump to any 4K boundary above 32K, or the on board 2708. On board run-stop flip-flop and optional generation of Memory Write allow front panel-less operation.

BARE BOARD $34.00
$130.00 (2MZz) $145.00 (4MHz)
ASSEMBLED & TESTED ADD $50.00

8080 A CPU BOARD/KIT

With 8 level vector interrupt, CPU chip 8080 clock chip: 8224; crystal Freq.: 18MHz: vector interrupt chip: 8214.

BARE BOARD $28.50 KIT $95.00
Assembled and Tested $145.00

REAL TIME CLOCK FOR S-100 BUSS

On board 1MHz Crystal Oscillator; two independent interrupts. 16 bit counter in 10 s steps; and decade steps from 100 s to 10 sec. ASSEMBLED & TESTED $179.95

BARE BOARD $24.00

8K STATIC RAM

	450ns	350ns	250ns
8K Kit	$129.95	$139.95	$169.95

ASSEMBLED/TESTED ADD $25.00

16K STATIC RAM KIT $375

BOARD $24.00 ASSEMBLE/TEST $425.00

32K STATIC RAM

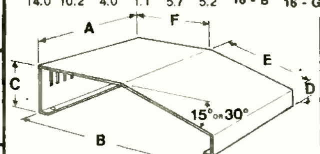
BARE BOARD $35.00

	KIT	ASSEMBLE/TESTED
250ns	$795.00	$875.00
450ns	$625.00	$775.00

MINIATURE CONSOLES

A	B	C	D	E	F	CASES (bottoms)				PANELS (tops)			
15° SLOPING PANELS													
4.0	5.5	2.0	1.1	3.3	2.2	1-B	1-G	1-L	5.50	1-W	1-S	1-K	5.50
6.5	5.5	2.0	1.1	3.3	2.2	2-B	2-G	2-L	6.10	2-W	2-S	2-K	6.10
6.5	8.5	2.0	1.1	3.3	5.2	3-B	3-G	3-L	6.70	3-W	3-S	3-K	6.70
6.5	8.3	3.0	1.3	6.3	2.2	4-B	4-G	4-L	7.30	4-W	4-S	4-K	7.30
10.0	8.3	3.0	1.3	6.3	2.2	5-B	5-G	5-L	7.80	5-W	5-S	5-K	7.80
10.0	11.3	3.0	1.3	6.3	5.2	6-B	6-G	6-L	8.40	6-W	6-S	6-K	8.40
14.0	8.3	3.0	1.3	6.3	2.2	7-B	7-G	7-L	8.80	7-W	7-S	7-K	8.80
14.0	11.3	3.0	1.3	6.3	5.2	8-B	8-G	8-L	9.70	8-W	8-S	8-K	9.70
30° SLOPING PANELS													
4.0	5.5	3.0	1.1	3.7	2.2	9-B	9-G	9-L	5.50	9-W	9-S	9-K	5.50
6.5	5.5	3.0	1.1	3.7	2.2	10-B	10-G	10-L	6.10	10-W	10-S	10-K	6.10
6.5	7.2	4.0	1.1	5.7	2.2	11-B	11-G	11-L	6.70	11-W	11-S	11-K	6.70
10.0	5.5	3.0	1.1	3.7	2.2	12-B	12-G	12-L	7.30	12-W	12-S	12-K	7.30
10.0	7.2	4.0	1.1	5.7	2.2	13-B	13-G	13-L	7.80	13-W	13-S	13-K	7.80
10.0	10.2	4.0	1.1	5.7	5.2	14-B	14-G	14-L	8.40	14-W	14-S	14-K	8.40
14.0	7.2	4.0	1.1	5.7	2.2	15-B	15-G	15-L	8.80	15-W	15-S	15-K	8.80
14.0	10.2	4.0	1.1	5.7	5.2	16-B	16-G	16-L	9.70	16-W	16-S	16-K	9.70

B=Blue, G=Green, L=Gold, W=White, S=Sand, K=Black



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MJE3055 NPN
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4/$1.00

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Yellow	20¢	100/15.00
Amber	20¢	100/15.00

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END 503	C.C.	0.5"	75¢
END 510	C.A.	0.5"	75¢
1720R	C.A.	1"	4.75
1723R	C.C.	1"	4.75

CRYSTALS ± =0.002%

Frequency MHz

1.000	2.4576	4.0000	6.144	10.000
1.8432	2.667	4.1943	6.400	14.318
@5.25	3.000	4.9152	6.5536	14.391
	3.200	5.0000	8.0000	18.000
2.000	3.2768	5.0688		18.4320
2.0100	3.5795	5.1850	@4.25	20.0000
2.097152	@4.75	5.7143		22.1184
		6.0000		27.0000

32.0000
36.0000
48.0000
@3.50

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- Common Cathode Connections — LT1012
- 3½ Digits with Colons — $7.50
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1/16"	5	
1/8"	5	1.40 ea.
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22	35V	30¢

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Output 24V 8A Our Price $80

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Precision Power Supply
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5V 45A ~~$600.~~ $100 ea.

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Fully assembled.
Works on 9-15V D.C.
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With Schematic
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- 6502 - 8 bit MPU with powerful instruction set, 13 addressing modes, multiple interrups, full 65K byte address range.
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- TTY and cassette interface.
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6530	15.95
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6530-003	15.95
6530-004	15.95
6530-005	15.95

0.8" 4 Digit Jumbo Display Alarm Clock Kit

Features:
A. Fairchild 0.8" FSC8000 Display Array
B. Fairchild Super-Chip — F-3817PC
C. P.C. Board, Transformer, Speaker and all parts included (less case)
D. Detailed Instructions

$19.50

60 Hz Time Base IC
MM5369
$1.95

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3815 5-DECADE COUNTER

The 3815 is a 5-Decade Counter which includes a memory with static latches for each counter digit and an output multiplexer. The 3815 is designed to drive a multiplexed display which has a Binary Coded Decimal output and five decoded outputs to strobe the display.

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Bare Board $30.00

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Erase up to 48 ICs each time
$49.50

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Z80A	28 00
CDP1802CD	19 95
2650	24 95
AM2901	22 95
6502	11 95
6800	18 95
6802	25 00
8008 1	9 95
8035	22 00
8080A	11 95
8085	27 00
TMS9900TL	75 00

8080A SUPPORT DEVICES

8212	3 50
8214	9 00
8216	3 75
8224	3 50
8224-4	9 95
8226	3 95
8228	7 95
8238	7 50
8251	9 95
8253	21 95
8255	21 95
8257	21 95
8259	21 95
8275	75 00
8279	20 00

6800 SUPPORT

6810P	4 95
68B10P	6 00
6820P	7 50
6821P	7 50
6828P	11 25
6834P	16 95
6850P	9 75
6852P	11 75
6860P	10 00
6862P	14 50
6871P	28 00
6875P	8 75
6880P	2 50

PROM'S

1702A	4 00
2704	15 00
2708	12 00
2716	30 00
2716 (intl)	38 00
2758	26 60
D3601	4 50
D3604	13 00
5203AQ	5 00
5204AQ	7 50
6834	17 50
6834-1	14 95
82S23B	4 00
82S129B	4 25
8223B	3 50

STATIC RAMS

2L02	1 50
21L02	1 50
21L02 (350)	1 60
21L02 (250)	1 75
4100	10 75
1101A	1 00
2101-1	2 95
2102	1 25
2111-1	3.95
2112-1	2 95
2114 3	11 00
2125L	11 10
2147	37 50
31L01	2 50
3106	3.95
3107	3 95
TMS-4044	9 95
4200A	12 95
TMS-4045	11 00
5101	8 30
74C89	3 25
7489	2 25
74S201	4 50
P8101	4 20
P8155	17 00
P8156	21 00
8599	1 88
9102BPC	1 65

DYNAMIC RAMS

4160/4116	32 00
1103	1 00
2104	4 00
2107B	4 25
2107B 4	3 95
TMS4050	4 00
TMS4060	4 50
TMS4070-2	32 00
4096	4 00
4116/4160	32 00

Z80 SUPPORT DEVICES

3881	12 95
3882	12 95

USRT

S2350	10 75

USART'S

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AY5-1014A	8 25
TR1602B	5 25
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IM6402	10 80
IM6403	10 80

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2515	10 95

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WITH SPECS **50¢**

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Complete Electronics!
- Chimes the hour (ie: 3 times for 3 O'clock)
- Unique "swinging" LED pendulum
- Tick tock sound matches pendulum swing
- Large 4 digit .5" LED readout
- All CMOS construction
- Complete electronics including transformer & speaker; drilled and plated PC boards measure 4.5" x 6.5"

39.95

Reviewed in April 1978 RADIO ELECTRONICS

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WE BOUGHT A LARGE QUANTITY OF THESE HOUSE NUMBERED PARTS AT A BARGAIN PRICE THAT ALLOWS US TO SELL THEM AT A LOW, LOW **39¢**

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- Complete with presettable 24 hr. alarm.
- 9–14 VDC @ 40 to 50 ma.
- Readouts can be suppressed
- EASY, QUICK ASSEMBLY
- All components required included (you supply the speaker).
- Top quality drilled and plated PC boards
  Clock board: 2.6" x 2"
  Readout board: 2 3/8" x .75"

Small enough to mount in the instrument panel!

12.95

FND510 69¢
COMMON ANODE READOUT ½" CHARACTER
LIMIT 24 PER CUSTOMER!

CAPACITORS
SMALL SIZE!
2200 MFD @ 16 VDC RADIAL
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POWER SUPPLY KIT PS-14
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Less Case, meters & jacks
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REVIEWED IN 7/78 73 MAG.
15A CONT. 20A INT. 42.95

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9–14VDC 28.95

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150 WATTS
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50¢
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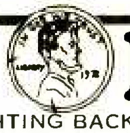

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Your Choice $5.95 — 2 for $5.96

LED OR FLUORESCENT CALCULATOR GAMBLE!

PARTS ALONE ARE WORTH MORE THAN PRICE!

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- ☐ 9R5292 Flourescent
- ☐ 9R5291 LED

Choose from 2 styles: GREEN fluorescent .5" digits; or RED all-LED .125" digits. Both styles feature 8 digits, 22 keys, 4 arithmetic functions, 4 memory functions, percent, equals, clear All units complete, and include operation manual. (Batteries not included) Wt 6 ozs.

PARTS & SEMI "ONE CENTERS"

Quan. Description (Order by Cat. No. in parenthesis)	Sale	1¢SALE
☐ 1-40 CHANNEL CB SELECTOR, w/knob, for PLL circuits (#9R5045)	1.00	2 for 1.01
☐ 1-23 CHANNEL CB SELECTOR, w/knob, for PLL & xtal (#9R5044)	1.00	20 for 1.01
☐ 15-"POP" OPTICAL LENSES, plano-convex, 1" dia, plastic (#9R5043)	1.19	2 for 1.20
☐ 10-IC "DICE", microscopic circuits, teaches theory (#9R5065)	1.19	2 for 1.20
☐ 1-6" HI-FI SPEAKER, full range, for car-n-home (#9R5294)	4.95	2 for 4.96
☐ 1-LED WATCH GUTS, men's, how good? We don't know (#9R5267)	1.95	2 for 1.96
☐ 1-UHF TUNER, solid state, standard type (#9R2927)	1.00	2 for 1.01
☐ 10-SLIDE SWITCHES, asst pop styles (#9R1495)	1.00	20 for 1.01
☐ 4-TANTALUM CAPACITORS, 6.8 uF 35V, dipped (#9R5281)	1.00	8 for 1.01
☐ 5-PANCAKE PHOTOCELLS, 600 to 15K ohms (#9R2939)	1.00	10 for 1.01
☐ 1-100KHZ MARKER CRYSTALS, approx for marker gen. (#9R3896)	1.95	2 for 1.96
☐ 1-MOTHERBOARD EDGE CONNECTOR, 106 pins, .125" (#9R3987)	3.50	2 for 3.51
☐ 1-48-PIN EDGE CONNECTOR, .156" spacing (#9R3963)	1.95	2 for 1.96
☐ 1-METER, 50uA, 1½" square, 0-20db (#9R3705)	1.19	2 for 1.20
☐ 1-SPST RELAY, norm. open 12-24 VDC, 1250 ohms, dip style (#9R5175)	1.00	2 for 1.01
☐ 1-VEEDER ROOT COUNTER, 000-999, resettable, panel mt. (#9R5061)	1.49	2 for 1.50
☐ 2-DUAL GATE MOSFET, sim. to 3N200, 3N197, for RF & Mixer (#9R5101)	1.00	4 for 1.01
☐ 2-LCD THERMAL INDICATORS, 88-108°F, 7x1", flexible (#9R5195)	1.00	4 for 1.01
☐ 1-JOYSTICK, four 100K pots, with knob (#9R3808A)	4.95	2 for 4.96
☐ 1-EECO THUMBWHEEL SWITCH, BCD, 0-7 (#9R2870A)	1.49	2 for 1.50
☐ 1-PLESSEY TV SIDEBAND FILTER, for chan. 3 or 4 (#9R3975)	1.95	2 for 1.96
☐ 2.9V NI-CAD CHARGER PAK, plug-in, 125ma, 125 VAC pri (#9R4098)	1.49	2 for 1.50
☐ 20-DATA ENTRY PUSH-SWITCHES, spst, norm open, for keyboards (#9R5279)	2.00	40 for 2.01
☐ 75-SN7400 TTL ICs, untested 50%+ yield, pop types (#9R2415)	2.00	150 for 2.01
☐ 100-MINI DIP ICs, linears, untested 50%+ yield, pop types (#9R3245)	2.00	150 for 2.01
☐ 30-LM380 AUDIO IC's, 2 watts on-a-dip 50%+ yield (#9R5284)	2.00	60 for 2.01
☐ 75-LINEARS, OP AMPS, untested 50%+ yield, amps-dips-minidips (#9R2416)	2.00	150 for 2.01
☐ 100-TTLs & LINEAR MIXED, with 7400s, 50%+ yield (#9R2431)	2.00	200 for 2.01
☐ 1 JOYSTICK, two 10K pots, for computers, TV games (#9R5037)	2.95	2 for 2.96
☐ 1-8-TRACK TAPE HEAD, with plug'n' cord (#9R3468)	2.50	2 for 2.51
☐ 150-PREFORMED DISC CAPACITORS, mark-d values, asst'd (#9R2605)	2.00	300 for 2.01
☐ 150-TRIMMER CAPACITORS, mica compression, piston, asst'd. (#9R3714)	2.00	120 for 2.01
☐ 60-YELLOW JACKET MYLAR CAPACITORS, marked, pop values (#9R3476)	2.00	150 for 2.01
☐ 150-GLASS ZENERS, 400 MW, untested, better than 50% yield (#9R2740)	2.00	300 for 2.01
☐ 75-CARBOFILM RESISTORS, ¼, ½ watt, 5 & 10%, marked, asst's (#9R3534)	2.00	150 for 2.01
☐ 250-UNMARKED CAPACITORS, polystyrene, molded, pop values (#9R3805)	2.00	500 for 2.01
☐ 300-SILICON SIGNAL DIODES, micro, glass, zeners too! 50% yield (#9R2628)	2.00	600 for 2.01
☐ 8-IC SOCKETS, 14, 16 pin, solder tail. (#9R3621)	2.00	16 for 2.01
☐ 100-1N4148/914 SWITCHING DIODES, 50%+ yield. Untested! (#9R2418)	2.00	200 for 2.01
☐ 30-PC TRIM POTENTIOMETERS, thumbwheel, screwdriver ass't. (#9R3345)	2.00	60 for 2.01
☐ 15-SLIDE VOLUME CONTROLS, asst'd values, duals, singles (#9R3057)	2.00	30 for 2.01
☐ 75-4" CABLE TIES, plastic, like "Ty-wrap" (#9R5218)	2.00	150 for 2.01
☐ 10-CRYSTALS, may include CB, Ham & more (#9R3250)	2.00	20 for 2.01
☐ 100-TERMINAL STRIPS, from 2 lugs up (#9R3136)	2.00	200 for 2.01
☐ 30-NE-2NEON LAMPS, all 100% good (#9R2613)	2.00	60 for 2.01
☐ 40-ft. SHIELDED CABLE, 1 cond, mikes, phonos, (#9R3577)	2.00	80 ft. for 2.01
☐ 3-SOUND TRIGGERS, sound triggers scr w/amp (#9R3625)	2.00	6 for 2.01
☐ 10-CB CRYSTALS, for phase lock loop, HAM, HC/18 (#9R5050)	2.00	20 for 2.01
☐ 100-DISC CAPACITORS, long leads, marked, asst'd (#9R2598)	2.00	200 for 2.01
☐ 100-CAPACITOR SPECIAL, discs, mylar, lytics, more (#9R2738)	2.00	200 for 2.01
☐ 10-VOLTAGE REGULATORS, hobby LM320, 340, TO-3 (#9R3330)	2.00	200 for 2.01
☐ 30-PANEL SWITCHES, slides, rotaries, mod, etc (#9R3268)	2.00	60 for 2.01
☐ 200-RESISTOR SPECIAL, ¼ to 1W, carbon, metal (#9R3054)	2.00	400 for 2.01
☐ 200-HALF WATTERS, resistors, carbon, metal (#9R3046)	2.00	400 for 2.01
☐ 100-NATIONAL IC BONANZA, linears, 7400s ROMS (#9R2860)	2.00	200 for 2.01
☐ 15-LM340T VOLTAGE REGULATORS, 5 to 24V, TO-220 (#9R2635)	2.00	30 for 2.01
☐ 100-POLYSTYRENE CAPS, asst'd values, voltage, hi-Q (#9R2729)	2.00	200 for 2.01
☐ 50-THERMISTORS, resistors that change with temp (#9R4089)	2.00	100 for 2.01
☐ 20-BRIDGES, untested, 2, 4, 6, amp, full wave (#9R4022)	2.00	40 for 2.01
☐ 25-LAMP'N'SOCKET SETS, micro, 1.5V, T2 (#9R3957)	2.00	50 for 2.01
☐ 15-MIXED READOUTS, hobby, untested, .127, .3, .5, etc. (#9R3619)	2.00	30 for 2.01
☐ 150-QUARTER WATTERS, resistors, metal film, marked (#9R3413)	2.00	300 for 2.01
☐ 100-PLASTIC TRANSISTORS, untested, TO-92 (#9R2604)	2.00	200 for 2.01
☐ 200-PREFORMED RESISTORS, ¼, ½, 1W, marked, asst'd (#9R2608)	2.00	400 for 2.01
☐ 200-PRECISION RESISTORS, ¼, ½, 1W, 1%, 2% marked (#9R2428)	2.00	400 for 2.01
☐ 60-DIPPED MYLARS, shiny finish, asst'd values (#9R2597)	2.00	120 for 2.01
☐ 30-VOLUME CONTROLS, audio, linear, asst'd values (#9R2421)	2.00	60 for 2.01
☐ 30-CLOCK CHIPS, National, hobby & untested, alarm (#9R5089)	2.00	60 for 2.01
☐ 30 MM5262 2K RAMS, hobby, untested (#9R3940)	2.00	60 for 2.01
☐ 10-PUSH SWITCHES, push-to-break, spst, alarms (#9R5289)	2.00	20 for 2.01
☐ 25-CD-4000 SERIES CMOS, untested, 50% useable yield (#9R5284)	2.00	50 for 2.01
☐ 1-CHARACTER GENERATOR, 5 x 7 Mostek MK 2002P (#9R3898)	4.95	2 for 4.96
☐ 1-CONDENSER MIKES, sensitive, 500 ohms 1.5 Volts (#9R3178)	4.95	2 for 4.96

7-SEGMENT READOUTS

		ONE CENT SALE
☐ 3½ DIGIT LCD WRISTWATCH DISPLAY (#9R3960)	3 for $1.19	6 for $1.20
☐ SPERRY FLAT NIXIES, orange, .3" dual digit (#9R5014)	3 for 1.19	6 for 1.20
☐ SPERRY FLAT NIXIES, orange, .3", 1½-dig (#9R5015)	3 for 1.19	6 for 1.20
☐ MAN-3 BUBBLE READOUT, .19" red. com, cath. (#9R3338)	6 for 1.00	12 for 1.01
☐ MAN-4 READOUTS, bubble, red, com. anode, .19" (#9R1503)	2 for 1.00	4 for 1.01
☐ FND-10 BLOCK READOUT, .122" com cathode (#9R2082)	2 for 1.19	4 for 1.20
☐ 8-DIGIT READOUT, led, com cathode, red (#9R5190)	1 for 1.95	2 for 1.96
☐ FND-503, .5" red, com cathode, 7-seg. (#9R2949)	1.50	2 for 1.51
☐ FND-500, .5" red, com anode, 7 seg. (#9R2950)	1.50	2 for 1.51
☐ FND-800, .8" red, common anode, (#9R3030)	3.95	2 for 3.96
☐ FND-803, .8" red, common cathode, (#9R3327)	3.95	2 for 3.96

RELAYS!

	Each	2 for
☐ 1-SPST 24V REED RELAY, norm open, dip style, 1250 ohms (#9R5175)	1.49	1.50

AMPLIFIERS!

	Each	2 for
☐ 9 WATTS ON A CHIP, Toshiba TA7205 (#9R5057)	4.95	4.96
☐ 3 WATTS ON A CHIP, G-E PA 263 (#9R1522)	1.50	1.51

DIP SWITCHES!

	Each	2 for
☐ 2 SWITCHES ON A DIP (#9R 3668)	$ .77	$ .78
☐ 3 SWITCHES ON A DIP (#9R 3669)	.88	.89
☐ 6 SWITCHES ON A DIP (#9R 3671)	1.29	1.30

IC SOCKETS!

☐ 8-PIN MINI-DIP (#9R2123)	4 for $1.19	8 for $1.20
☐ 14-PIN DIP (#9R1308)	3 for 1.19	6 for 1.20
☐ 16-PIN DIP (#9R1309)	3 for 1.19	6 for 1.20
☐ 18-PIN DIP (#9R3378)	6 for 1.19	12 for 1.20
☐ 24-PIN MSI/DIP (#9R3886)	2 for 1.19	4 for 1.20
☐ 28-PIN MSI/DIP (#9R3887)	2 for 1.19	4 for 1.20

FULL WAVE BRIDGE RECTIFIERS!

10 AMP

Order by Cat. No. 9R2447 & voltage

PRV	Sale	2 for
☐ 50	$1.29	$1.30
☐ 100	1.49	1.50
☐ 200	1.69	1.70
☐ 400	1.99	2.00
☐ 600	2.25	2.26
☐ 800	2.50	2.51
☐ 1000	2.75	2.76

TTL'S AT "CENT-CIBLE" PRICES

Order By Cat. No. 9R1981 & Type No.

Type No.	Each	2 For	Type No.	Each	2 for	Type No.	Each	2 for
☐ SN7400	$ .18	$ .20	☐ SN7465	.19	.20	☐ SN74153	1.29	1.30
☐ SN7401	.18	.20	☐ SN7470	.19	.20	☐ SN74154	1.75	1.76
☐ SN7403	.25	.26	☐ SN7471	.35	.36	☐ SN74155	.78	.80
☐ SN7404	.19	.20	☐ SN7472	.19	.20	☐ SN74156	.39	.40
☐ SN7405	.19	.20	☐ SN7474	.59	.60	☐ SN74157	.99	1.00
☐ SN7406	.19	.20	☐ SN7475	.69	.70	☐ SN74158	.99	1.00
☐ SN7407	.38	.40	☐ SN7480	.19	.20	☐ SN74161	1.25	1.29
☐ SN7409	.39	.40	☐ SN7482	.29	.30	☐ SN74163	1.39	1.40
☐ SN7410	.25	.26	☐ SN7483	.99	1.00	☐ SN74164	.78	.80
☐ SN7416	.35	.36	☐ SN7486	.49	.50	☐ SN74165	.99	1.00
☐ SN7417	.35	.36	☐ SN7488	.79	.80	☐ SN74166	1.99	2.00
☐ SN7420	.32	.33	☐ SN7489	3.49	3.50	☐ SN74173	.99	1.00
☐ SN7421	.49	.50	☐ SN7490	.99	1.00	☐ SN74174	1.79	1.80
☐ SN7423	.29	.30	☐ SN7491	1.29	1.30	☐ SN74175	.99	1.00
☐ SN7426	.19	.20	☐ SN7492	.79	.80	☐ SN74177	.79	.80
☐ SN7430	.29	.30	☐ SN7493	.69	.70	☐ SN74179	1.99	2.00
☐ SN7437	.19	.20	☐ SN7494	.79	.80	☐ SN74180	.49	.50
☐ SN7438	.25	.26	☐ SN7495	.59	.60	☐ SN74182	.49	.50
☐ SN7440	.19	.20	☐ SN7496	.29	.30	☐ SN74190	1.99	2.00
☐ SN7443	.59	.60	☐ SN7498	.79	.80	☐ SN74191	1.75	1.76
☐ SN7444	.19	.20	☐ SN74107	.29	.30	☐ SN74192	.85	.86
☐ SN7446	1.25	1.26	☐ SN74113	.39	.40	☐ SN74193	.99	1.00
☐ SN7450	.19	.20	☐ SN74114	.25	.26	☐ SN74194	1.25	1.26
☐ SN7451	.19	.20	☐ SN74121	.59	.60	☐ SN74197	.75	.76
☐ SN7453	.19	.20	☐ SN74123	.69	.70	☐ SN74199	1.50	1.51
☐ SN7454	.29	.30	☐ SN74126	.99	1.00	☐ SN74200	3.60	3.51
☐ SN7455	.19	.20	☐ SN74136	.49	.50	☐ SN74251	.79	.80
☐ SN7460	.35	.36	☐ SN74140	.49	.50	☐ SN74284	5.99	6.00
☐ SN7462	.35	.36	☐ SN74145	.69	.70	☐ SN74298	3.75	3.76
☐ SN7464	.19	.20						

POP-AMPS AT "CENT-CIBLE" PRICES

Case code: T=TO-220 Power Tab: V=Mini dip. K=TO-3: H=TO-5: N=DIP.

Type No.	Each	2 for	Type No.	Each	2 for	Type	Each	2 for
☐ LM300H	$ .79	$ .80	☐ LM340T-5	1.49	1.50	☐ LM703N	.59	.60
☐ LM300N	.49	.50	☐ LM340T-6	1.49	1.50	☐ LM704H	.19	.20
☐ LM301V	.45	.46	☐ LM340T-8	1.49	1.50	☐ LM709H	.19	.20
☐ LM301H	.45	.46	☐ LM340T-12	1.49	1.50	☐ LM709N	.49	.50
☐ LM307V	.45	.46	☐ LM340T-15	1.49	1.50	☐ LM733N	.79	.80
☐ LM308V	.29	.30	☐ LM340T-18	1.49	1.50	☐ LM741V	.25	.26
☐ LM308H	.69	.70	☐ LM340T-24	1.49	1.50	☐ LM741H	.30	.31
☐ LM309K	1.49	1.50	☐ LM350N	.49	.50	☐ LM747H	.59	.60
☐ LM311V	.29	.30	☐ LM376V	.29	.30	☐ LM1304	1.49	1.50
☐ LM311H	1.49	1.50	☐ LM377N	2.25	2.26	☐ LM1310	1.79	1.80
☐ LM318V	.99	1.00	☐ LM380N	1.39	1.40	☐ LM1312	2.49	2.50
☐ LM320H-5	.99	1.00	☐ LM381N	1.99	2.00	☐ LM1414V	.19	.20
☐ LM320H-12	.99	1.00	☐ LM386N	1.49	1.50	☐ LM1458V	.39	.40
☐ LM320H-15	.99	1.00	☐ LM531H	1.49	1.50	☐ LM1800N	.79	.80
☐ LM320T-6	1.49	1.50	☐ LM532N	.25	.26	☐ LM3028H	.65	.66
☐ LM322N	1.19	1.20	☐ LM532H	.25	.26	☐ LM3900N	.49	.50
☐ LM324N	1.79	1.80	☐ NE540H	5.95	5.96	☐ LM3909V	1.25	1.26
☐ LM339N	1.79	1.80	☐ LM555V	.75	.76	☐ LM4250	1.20	1.21
☐ LM340K-5	1.49	1.50	☐ LM556N	1.79	1.80	☐ LM75451	.69	.70
☐ LM340K-6	1.49	1.50	☐ LM558V	.39	.40	☐ LM75453	.69	.70
☐ LM340K-8	1.49	1.50	☐ LM558H	.39	.40	☐ LM75491	.80	.81
☐ LM340K-12	1.49	1.50	☐ LM561N	1.00	1.01	☐ LM75492	.80	.81
☐ LM340K-15	1.49	1.50	☐ LM565N	1.00	1.01	☐ LM75494	.60	.61
☐ LM340K-18	1.49	1.50	☐ LM565H	1.00	1.01	☐ PA263	1.50	1.51
☐ LM340K-24	1.49	1.50	☐ LM566	2.49	2.50	☐ DM8864N	1.29	1.30
			☐ LM567	2.39	2.40			

PENNIES FOR YOUR MEMORIES!

Type	Description	Sale	1¢ Sale!	Order by
☐ 1103	1K Dynamic RAM	1.29	1.30	Cat. No.
☐ 5202	2K Prom	2.95	2.96	9R3459 &
☐ 5262	2K x 1 Dynamic RAM	.99	1.00	
☐ 1702A	256 x 8 EPROM	4.95	4.96	Type No.
☐ MM5280	4K x 1 Dynamic RAM	3.95	3.96	

Removed from new tested equipment

1 AMP SCR'S

TO-92 Case, 2N5060 series. Order by Cat. No. 9R2367 and voltage

☐ 30	4 for $1	9 for 1.01
☐ 60	3 for $1	6 for 1.01
☐ 100	3 for $1	6 for 1.01
☐ 150	2 for $1	4 for 1.01
☐ 200	1 for $1	2 for 1.01

1N4000 Epoxy Rectifiers

Order by Cat. No. and Type No. • 1.5 Ampl • Miniaturel

Cat. No.	Type	Volts	Sale	1¢ SALE!
☐ 9R2377	1N4001	50	10 for $ .75	20 for $ .76
☐ 9R2378	1N4002	100	10 for .85	20 for .86
☐ 9R2379	1N4003	200	10 for .95	20 for .96
☐ 9R2380	1N4004	400	10 for 1.19	20 for 1.20
☐ 9R2381	1N4005	600	10 for 1.39	20 for 1.40
☐ 9R2382	1N4006	800	10 for 1.49	20 for 1.50
☐ 9R2383	1N4007	1000	10 for 1.59	20 for 1.60

25 AMP BRIDGE RECTIFIERS

Order No. 9R2273 & voltage

V	Each	1¢ SALE
☐ 50	$1.95	2 for $1.96
☐ 100	1.49	2 for 1.50
☐ 200	1.69	2 for 1.70
☐ 400	1.99	2 for 2.00
☐ 600	2.25	2 for 2.26
☐ 800	2.50	2 for 2.51

BULLET RECTIFIERS!

Order by Cat. No. 9R60884 and voltage

1.5 AMP

☐ 50V	10 for $.59	20 for $.60
☐ 100V	10 for .69	20 for .70
☐ 200V	10 for .79	20 for .80
☐ 400V	10 for .89	20 for .90

CERMET TRIM POTENTIOMETERS

Your Choice 2 for $1.50 4 for $1.51

(m) – multiturn (s) – single turn

☐ 10(m) ☐ 20(m) ☐ 50(m) ☐ 100(m) ☐ 200(m) ☐ 500(m) ☐ 750(m) ☐ 1K(m) ☐ 2K(m) ☐ 2.5K(s) ☐ 5K(s) ☐ 10K(s) ☐ 20K(s) ☐ 200K(m) ☐ 250K(m) ☐ 500K(m) ☐ 1 Meg(m)

Order No. 9R5336 and value

RIBBON CABLE!

Order by Cat. and Conductors 9R3939

Cond.		Sale		1¢ Sale
☐ 26	4-ft.	1.98	8-ft.	1.99
☐ 34	3-ft.	1.98	6-ft.	1.99
☐ 40	3-ft.	1.98	6-ft.	1.99

10 AMP - POWER TABS!

9R1730 - SCR'S

9R1448 - TRIACS

9R1590 - QUADRACS

PRV	Sale	2 for
50	$ .55	$ .56
100	.69	.70
200	1.10	1.11
400V	1.60	1.61

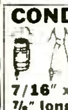
LYTIC KLINIC

Order No. 9R3269 and value — Electrolytic capacitors

UF	V	Style	Sale	1¢ SALE
☐ 10	15	P.C.	10 for $1.00	20 for $1.01
☐ 50	15	P.C.	8 for 1.00	16 for 1.01
☐ 15	25	P.C.	8 for 1.00	16 for 1.01
☐ 50	25	P.C.	6 for 1.00	12 for 1.01
☐ 100	25	P.C.	5 for 1.00	10 for 1.01

CONDENSER MIKE

"TIE-PIN" TYPE



It's a little giant in sound quality. Metal encased with built-in FET circuit, omni-directional freq resp 20-12,000Hz Less tie pin or lapel clip 600 ohm impedance 1.5VDC No. 9R3178 4.95

7/16" x 7/8" long

2 for $4.96

ZENERS!

Order by Cat. No. 9R5210A & voltage & wattage

1 Watt	Sale	1¢ SALE
☐ 7.5V	5 for $1.	10 for $1.01
☐ 8.2V	5 for 1.	10 for 1.01
☐ 9.1V	5 for 1.	10 for 1.01
☐ 10.V	5 for 1.	10 for 1.01
☐ 11.V	5 for 1.	10 for 1.01
☐ 12.V	5 for 1.	10 for 1.01
☐ 15.V	5 for 1.	10 for 1.01

Order by Cat. No. 9R5210B

5 WATTS	Sale	1¢ SALE
☐ 6. V	3 for 1.	6 for 1.01
☐ 8.2V	3 for 1.	6 for 1.01
☐ 15. V	3 for 1.	6 for 1.01
☐ 18. V	3 for 1.	6 for 1.01
☐ 24. V	3 for 1.	6 for 1.01
☐ 30. V	3 for 1.	6 for 1.01

LEDS!

YOUR CHOICE 5 for $1.00 — 1¢ SALE 10 for $1.01

Order by Cat. No.

☐ #9R1788	MICRO TOPHAT RED
☐ #9R1795	JUMBO TAPER CLOUDY
☐ #9R1602	MICRO SINGLE PIN RED
☐ #9R1948	MICRO YELLOW
☐ #9R2135	JUMBO RED
☐ #9R2136	JUMBO TAPER RED
☐ #9R2137	MICRO RED
☐ #9R2790	JUMBO RED CLEAR

COD's MAY BE PHONED

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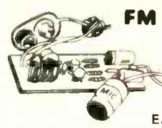
SUPER 15 WATT AUDIO AMP KIT

Uses STK-015 Hybrid Power Amp

Kit includes: STK-015 Hybrid IC, power supply with power transformer, front Amp with tone control, all electronic parts as well as PC Board. Less than 0.5% harmonic distortion at full power ½dB response from 20—100,000 Hz. This amplifier has QUASI—Complimentary class B output. Output max is watt (10 watt RMS) at 4Ω.

ONLY $23.50 each

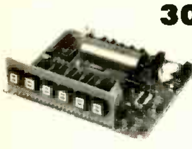
FM WIRELESS MIC KIT



$6.95 EACH KIT

This new model FM wireless MIC kit uses 3 high freq. transistors, works in the FM range (88-108 MHz). It transmits the sound wave fidelity clearly over long distances (up to 250 ft.). Kit comes with all electronic parts, P.C. Board and mini microphone!

30MHZ FREQUENCY COUNTER KIT



Take advantage of this new state-of-the-art counter featuring the many benefits of custom LSI circuitry. This new technology approach to instrumentation yields enhanced performance, smaller physical size, drastically reduced power consumption (portable battery operation is now practical), dependability, easy assembly and revolutionary lower pricing!

- 0.5" red LED 6 digits display
- Resolution: 1 Hz at 1 sec. 10 Hz at 1/10 sec.
- Sensitivity: 10 Mv RMS to 30 Hz
- Internal power supply: 5.2V at 1 amp regulated
- Input connector: BNC type
- Input power required: 117V AC 50/60 Hz
- Diode protected for over voltage input

Model 250-30A

Only ~~$59.50~~ $53.50

Includes all parts, PC Board and Transformer

SOUND ACTIVATED SWITCH

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

Sub-Mini Size Condenser Microphone

$2.50 each

FET Transistor Built-In

FLUORESCENT LIGHT DRIVER KIT

12V DC POWERED

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

Kit includes high voltage coil, power transistor, heat sink, all other electronic parts and PC Board, light tube not included!

ONLY $5.50 PER KIT

MANY SOUND DECISIONS!

Solid state sound indicator operating voltage 6V DC 30μA. Small size approximately ¾" X 1¼".

Model EB2116 (Continuous)
Model EB2126 (Slow Pulse)
Model EB2136 (Fast Pulse)

$3.60 EACH

Continuous — Slow pulse — Fast pulse

POWER SUPPLY KIT

0-30V D.C. REGULATED

Uses UA723 and ZN3055 Power TR output can be adjusted from 0-30V, 2 AMP. Complete with PC board and electronic parts.

0-30 POWER SUPPLY $10.50 each

Transformer for Power Supply, 2 AMP 24V x 2 $6.50
30V DC Panel Meter $4.20

12V DC MINI RELAY

P.C. Board Solder Type

2AMP Contact SPDT $1.30 EA
2AMP Contact DPDT $1.75 EA
5AMP Contact 4PDT $2.20 EA

12V D.C. AUTO DIGITAL CLOCK

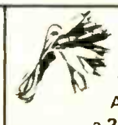
Complete Unit
Not a Kit!

0.4" blue color 4 digits display. Turn off readouts when car is not running. X'tal controlled time base for time accuracy. Special designed case for easy mounting on top of your dashboard. Ideal for car, boat and campers.

SALE!

ONLY ~~$28.50~~ ea. $24.50

HEAVY DUTY CLIP LEADS



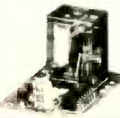
10 pairs — 5 colors
Alligator clips on a 22" long lead. Ideal for any testing.

$1.85/pack

1Watt AUDIO AMP

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

ELECTRONIC SWITCH KIT



CONDENSER TYPE

Touch On Touch Off uses 7473 I.C. and 12V relay
$5.50 each

MINI-SIZED I.C. AM RADIO

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

Only $8.50

"FISHER" 30 WATT STEREO AMP

(15W X 2)

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

Super Buy Only $22.50 each kit

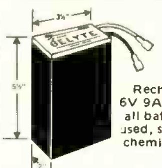
AUTO ALARM KIT

The Crimefighter Auto Alarm is an electronic, self-controlled auto protection system, normally mounted within the glove box of an automobile. Two minutes after turning off the ignition, the alarm automatically turns itself "on". When auto is re-entered, the horn will sound after a 10-45 second entry delay. The automobile owner, by inserting the ignition key, will activate the alarm. Once activated, the alarm will sound for two minutes before automatically turning off. The alarm then resets and is ready to again protect the vehicle from unwanted entry.

FEATURES: Simple installation: 5 wires, Automatically turns on when auto is parked, Adjustable entry time, Extended exit time to allow for unrushed exit from vehicle, Numerous applications include protection of boats, campers, trailers, motorcycles, trucks, Cannot be deactivated by "hot wiring" an auto, Cannot be turned off without ignition key, Negative ground only.

ONLY $14.00 PER KIT

GELYTE



Rechargeable Battery 6V 9AMP hour by Gould all batteries are new unused, solid with no liquid chemicals $9.50 EACH

we pay shipping

5W AUDIO AMP KIT

2 LM 380 with Volume Control
Power Supply 6 ~ 18V DC
only $5.00 ea.

TIMER KIT

Time Controlled from 1-100sec. Ideal to be used as timer delay unit for burglar alarm, photo service, and other purposes. Max. loading 110V, 2 AMP. Supply voltage 12-18V DC.

FT-80 ELECTRONIC IC TIMER $11.50 each

Sub Mini Size PANEL METER

500 UA
ONLY $1.20 ea

MINI-MINI TOGGLE SWITCH

Half size of submini toggle switch rated 3 amp 125V AC contact

		1-9	10-99
MS 2432P	SPST	0.90	0.80
MS 244	SPDT	1.00	0.90
MS 245	DPDT	1.20	1.10

LARGE QUANTITY AVAILABLE FOR OEM

PANEL METER (D.C. Type)

Size 60MM X 66MM
White Face Type

$5.50 ea.

0-50 UA	0-30V
0-1MA	0-50V
0-5MA	0-100V
0-100MA	

ELECTRONIC ALARM SIREN

COMPLETE UNIT

Ideal for use as an Alarm Unit or hookup to your car back up to make a reverse indicator. Light Output up to 130dB

AU—999 Voltage Supply 6 ~ 12V $7.50

LED ALARM CLOCK

COMPLETE UNIT NOT A KIT

- 0.5" RED LED READ OUT
- 24 HRS. ALARM SET
- 10 MINS. SNOOZE SET
- AM/PM ALARM INDICATORS
- SECOND DISPLAY SWITCH
- AUTOMATIC BRIGHTNESS CONTROL
- COMPACT AND HANDSOME PACKING
- 110V AC 60HZ INPUT

$17.50 EACH

TRANSFORMERS

ALL 117 VOLT INPUT

30V	4AMP	$7.50 EA.
36V CT	3AMP	$6.50 EA.
48V CT	3AMP	$6.50 EA.
24V CT	3AMP	$6.50 EA.
12 or 24V	2AMP	$3.90 EA.
24V CT	0.8AMP	$1.80 EA.
12V CT	0.8AMP	$1.80 EA.

SUBMINIATURES TOGGLE SWITCHES

SPDT	OnOff	$1.30 ea
DPDT	OnOff	$1.50 ea
3PDT	OnOff	$1.75 ea

Mini size Rocker Type
Also available at the same price

19 KEY HEXADECIMAL KEY PAD

- 1—0
- Homekey
- ABCDEF
- ←→ Key

SPECIAL $10.50 ea.

AC POWER SUPPLY

Wall Type Transformer

12V AC	Output	200MA	$2.75 EA.
16V CT AC	Output	100MA	$2.10 EA.
6V DC	Output	120MA	$1.90 EA.
12V DC	Output	100MA	$1.90 EA.

MINI SIZE REED RELAY

Approx. 1" square
SPST Normal Open
Contact rated 1AMP
Coil 6 ~ 12V DC
All brand new by AMF
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LINEAR SLIDE POT 500KΩ SINGLE

Metal Case 3" Long
2 FOR $1.20

2¼" ROUND SPEAKER

8Ω 0.25W
for most sound projects

SPECIAL 3 for $2.00

WIDE ANGLE PANEL METER

1¾" x ¾"
1MA Full Scale
(scale marks 0-100)
$1.50 each

PUSH-BUTTON SWITCH

N/Open Contact
Color: Red, White, Blue, Green, Black. 4/$1.00
N/Close also Available 50¢ ea.
LARGE QTY. AVAILABLE

DIGITAL ELECTRONIC LOCK KIT

$6.50 ea.

for auto ignition, entry door, burglar alarm, etc. 4 Digits Programmable to Any Combination

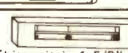
CMOS I.C. IN CIRCUIT

400Ω RELAY AND KEY PAD NOT INCLUDED

I.C. TEST CLIPS

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

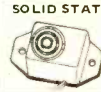
HOUR INDICATOR



This unit is 1 5/8" long operating voltage 4V D.C. will tell you how many hours your circuit or machine has been in service up to 100 hours.

Limited Quantity ONLY $1.75 ea.

SOLID STATE ELECTRONIC BUZZER



Mini size 1" x ¾" x ¾"
Supply voltage 1.5V 12V
Ideal for Alarm or Tone Indicator
$1.50 each

BATTERY POWERED FLUORESCENT LANTERN

FEATURES

- Circuitry: designed for operation by high efficient, high power silicon transistor which enable illumination maintain in a standard level even the battery supply drops to a certain low voltage.
- 9" 6W cool/daylight miniature flourescent tube.
- 6 X 1.5V UM-1 (size D) dry cell battery.
- Easy sliding door for changing batteries.
- Stainless reflector with wide angle increasing lumination of the lantern.

$9.60 EACH
MODEL 888-R

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CD4025	23	CD4069	45	CD4518	1.29
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74C14	3.00	74C151	2.90	74C195	2.75
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74LS03	23	74LS73	35	74LS157	69
74LS04	29	74LS74	35	74LS160	89
74LS05	29	74LS75	49	74LS161	89
74LS08	29	74LS76	35	74LS162	89
74LS09	29	74LS83	75	74LS163	89
74LS10	29	74LS85	99	74LS164	99
74LS13	49	74LS86	35	74LS175	79
74LS14	99	74LS90	49	74LS181	2.49
74LS15	29	74LS92	59	74LS190	89
74LS20	23	74LS93	59	74LS191	89
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74LS22	29	74LS96	89	74LS193	89
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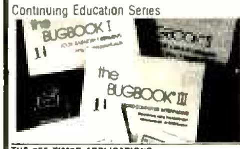

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Starts at basic structure of CMOS devices through integration into MSI.

COMPLETE MANUAL FOR DIGITAL CLOCKS by John Weiss and John Brooks

Familiarizes technician or hobbyist with basic theories behind digital clocks. Includes trouble shooting guides, basic characteristics of clocks, soldering techniques, clock component data sheets and construction tips — **$3.95**

DISCRETE LEDS

.125" dia			.200" dia		
XC209	Red	5/$1	XC22	Red	5/$1
XC209	Green	4/$1	XC22	Green	4/$1
XC209	Yellow	4/$1	XC22	Yellow	4/$1
			SSL-22	RT	4/$1

.185" dia			.200" dia		
XC526	Red	5/$1	XC556	Red	5/$1
XC526	Red	100/$8	XC556	Red	100/$8
XC526	Green	4/$1	XC556	Green	4/$1
XC526	Yellow	4/$1	XC556	Yellow	4/$1
XC526	Clear	4/$1	XC556	Orange	4/$1
			XC556	Clear	7/$1

.190" dia		
XC111	Red	5/$1
XC111	Green	4/$1
XC111	Yellow	4/$1
.085 dia		
MV50	Red	6/$1
.170" dia.		
MV10	Red	4/$1

INFRA RED LED ¼ x ¼ x 1/16 Flat 5/$1.00

DISPLAY LEDS

TYPE	POLARITY	HT	PRICE	TYPE	POLARITY	HT	PRICE
MAN 1	Common Anode-red	270	2.95	MAN 6680	Common Cathode-orange	560	99
MAN 2	5 x 7 Dot Matrix red	300	4.95	MAN 6710	Common Anode-red-D D	560	99
MAN 3	Common Cathode-red	125	25	MAN 6730	Common Anode red ±1	560	99
MAN 4	Common Cathode-red	187	1.95	MAN 6740	Common Cathode red-D D	560	99
MAN 52	Common Anode-green	300	1.75	MAN 6750	Common Cathode-red ±1	560	99
MAN 71	Common Anode-red	300	1.25	MAN 6760	Common Anode-red	560	99
MAN 72	Common Anode red	300	99	MAN 6780	Common Cathode red	560	99
MAN 74	Common Cathode-red	300	1.25	DL701	Common Anode-red ±1	300	99
MAN 81	Common Anode-yellow	300	99	DL702	Common Cathode-red	300	1.25
MAN 82	Common Anode-yellow	300	99	DL704	Common Cathode red	300	99
MAN 84	Common Cathode-yellow	300	99	DL707	Common Anode red	300	99
MAN 3620	Common Anode-orange	300	99	DL741	Common Anode-red	600	1.25
MAN 3630	Common Anode orange ±1	300	99	DL746	Common Anode red ±1	630	1.49
MAN 3640	Common Cathode-orange	300	99	DL747	Common Anode red	600	1.49
MAN 4610	Common Anode-orange	300	99	DL749	Common Cathode-red ±1	630	1.49
MAN 4640	Common Cathode-orange	400	99	DL750	Common Cathode red	600	1.49
MAN 4710	Common Anode-red ±1	400	99	DL338	Common Cathode red	110	35
MAN 4730	Common Anode-red	400	99	FND70	Common Cathode	250	69
MAN 4740	Common Cathode-red	400	99	FND359	Common Anode	350	75
MAN 4810	Common Anode yellow	400	99	FND503	Common Cathode (FND500)	500	99
MAN 6610	Common Anode orange D D	560	99	FND507	Common Anode (FND510)	500	99
MAN 6630	Common Anode-orange	560	99	5082-7300	4 x 7 Sgl Digit-RHDP	600	19.95
MAN 6640	Common Cathode-orange-D D	560	99	5082 7302	4 x 7 Sgl Digit-LHDP	600	19.95
MAN 6650	Common Cathode-orange ±1	560	99	5082 7304	Overrange Character (±1)	600	15.00
MAN 6660	Common Anode orange	560	99	5082-7340	4 x 7 Sgl Digit-Hexadecimal	600	22.50

RCA LINEAR

CA3013	2.15	CA3082	2.00
CA2023	2.56	CA3083	1.60
CA3035	2.48	CA3086	85
CA3039	1.35	CA3089	3.75
CA3046	1.30	CA3130	1.39
CA3059	3.25	CA3140	1.25
CA3060	3.25	CA3160	1.25
CA3080	.85	CA3401	49
CA3081	2.00	CA3600	3.50

CALCULATOR CHIPS AND DRIVER

FCM3817	$5.00
MM5725	2.95
MM5736	1.95
MM5738	2.95
DM8864	2.00
DM8865	1.00
DM8887	75
DM8889	75
5030	7.95

CLOCK CHIPS

MM5309	$9.95
MM5311	4.95
MM5312	4.95
MM5314	4.95
MM5316	6.95
MM5318	9.95
MM5369	2.95
MM5841	9.95
7001	5.95

9374 - 7-segment LED common anode LEDs $.99

IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS

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

SOLDERTAIL STANDARD (TIN)

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

SOLDERTAIL STANDARD (GOLD)

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

WIRE WRAP SOCKETS (GOLD) LEVEL #3

8 pin WW	$.40	.38	.35	22 pin WW	$.95	.85	.75
10 pin WW	.45	41	37	24 pin WW	1.05	.95	.85
14 pin WW	.39	.38	.37	28 pin WW	1.40	1.25	1.10
16 pin WW	.43	42	.41	36 pin WW	1.59	1.45	1.30
18 pin WW	.75	.68	.62	40 pin WW	1.75	1.55	1.40

50 PCS. RESISTOR ASSORTMENTS $1.75 PER ASST.

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

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

$5.00 Minimum Order — U.S. Funds Only
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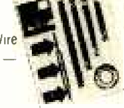
WIRE-WRAP KIT — WK-2-W

WRAP • STRIP • UNWRAP



- Tool for 30 AWG Wire
- Roll of 50 Ft White or Blue 30 AWG Wire
- 50 pcs each 1", 2", 3" & 4" lengths — pre-stripped wire

$12.95

WIRE WRAP TOOL WSU-30
WRAP • STRIP • UNWRAP - $6.95

WIRE WRAP WIRE — 30 AWG

25 ft. min. $1.25 50 ft. $1.95 100 ft $2.95 1000 ft $15.00
SPECIFY COLOR — White - Yellow - Red - Green - Blue - Black

WIRE DISPENSER — WD-30

- 50 ft. roll 30 AWG KYNAR wire wrap wire **$3.95 ea.**
- Cuts wire to desired length
- Strips 1" of insulation **Specify** — Blue-Yellow-White-Red

REPLACEMENT DISPENSER SPOOLS FOR WD 30
Specify blue, yellow, white or red **$1.98/spool**

XR2206KA $14.95
Function Generator Kit (includes chip, P C Board and instructions)

EXAR

XR2206KB $19.95
Function Generator Kit (includes all components, P C Board and instructions)

XR-L555 $1.50
Micro-Power version of the popular 555 Timer and directly interchangeable. Dissipates 1/15th the power and operates down to 2.7 volts. Perfect for battery operation and CMOS circuits

XR2242CP $1.50
Precision timing circuit for generating timing pulses in **minutes, hours** and days or up to 1 year by using two. Reduces cost of time delay circuits. Basic 555 Timer with built-in 8-bit Counter

XR205	$8.40			XR2556	$3.20
XR210	4.40	XR1489	1.39	XR2567	2.99
XR215	4.40	XR1800	3.20	XR3403	1.25
XR320	1.55	XR2206	4.40	XR4136	1.25
XR555	39	XR2207	3.85	XR4151	2.85
XR556	99	XR2208	5.20	XR4194	1.45
XR567CP	99	XR2209	1.75	XR4202	3.60
XR567CT	1.25	XR2211	5.25	XR4212	2.05
XR1310P	1.30	XR2212	4.35	XR4558	75
XR1468CN	3.85	XR2240	3.45	XR4739	1.15
XR1488	1.39	XR2264	4.25	XR4741	1.47

ZENERS — DIODES — RECTIFIERS

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
1N746	3.3	400m	4/1.00	1N4005	600 PIV	1 AMP	10/1.00
1N751A	5.1	400m	4/1.00	1N4006	800 PIV	1 AMP	10/1.00
1N752	5.6	400m	4/1.00	1N4007	1000 PIV	1 AMP	10/1.00
1N753	6.2	400m	4/1.00	1N3600	50	200m	6/1.00
1N754	6.8	400m	4/1.00	1N4148	75	10m	15/1.00
1N959	8.2	400m	4/1.00	1N4154	35	10m	12/1.00
1N965B	15	400m	4/1.00	1N4305	75	25m	20/1.00
1N5232	5.6	500m	28	1N4734	5.6	1w	28
1N5234	6.2	500m	28	1N4735	6.2	1w	28
1N5235	6.8	500m	28	1N4736	6.8	1w	28
1N5236	7.5	500m	28	1N4738	8.2	1w	28
1N456	25	40m	6/1.00	1N4742	12	1w	28
1N458	150	7m	6/1.00	1N4744	15	1w	28
1N485A	180	10m	5/1.00	1N1183	50 PIV	35 AMP	1.60
1N4001	50 PIV	1 AMP	12/1.00	1N1184	100 PIV	35 AMP	1.70
1N4002	100 PIV	1 AMP	12/1.00	1N1185	150 PIV	35 AMP	1.70
1N4003	200 PIV	1 AMP	12/1.00	1N1186	200 PIV	35 AMP	1.80
1N4004	400 PIV	1 AMP	12/1.00	1N1188	400 PIV	35 AMP	3.00

SCR AND FW BRIDGE RECTIFIERS

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

TRANSISTORS

C106B1	50			2N3904	4/1.00
MPSA05	30	2N3055	89	2N3905	4/1.00
MPSA06	5/1.00	MJE3055	1.00	2N3906	4/1.00
TIS97	6/1.00	2N3392	5/1.00	2N4013	3/1.00
TIS98	6/1.00	2N3398	5/1.00	2N4123	6/1.00
TIS133	5/1.00	PN3567	3/1.00	PN4249	4/1.00
TIS135	5/1.00	PN3568	4/1.00	PN4250	4/1.00
40409	1.75	PN3569	4/1.00	2N4400	4/1.00
40410	1.75	MPS3638A	5/1.00	2N4401	4/1.00
40673	1.75	MPS3702	5/1.00	2N4402	4/1.00
2N918	4/1.00	2N3704	5/1.00	2N4403	4/1.00
2N2219A	3/1.00	MPS3704	5/1.00	2N4409	5/1.00
2N2221A	4/1.00	2N3705	5/1.00	2N5086	4/1.00
2N2222A	5/1.00	MPS3705	5/1.00	2N5087	4/1.00
2N2369	5/1.00	2N3706	5/1.00	2N5088	4/1.00
2N2369A	4/1.00	MPS3706	5/1.00	2N5089	4/1.00
MPS2369	5/1.00	2N3707	5/1.00	2N5129	5/1.00
2N2484	4/1.00	2N3711	5/1.00	PN5134	5/1.00
2N2906	4/1.00	2N3724A	65	PN5138	5/1.00
2N2907	5/1.00	2N3725A	1.00	2N5139	5/1.00
2N2925	5/1.00	2N3772	2.25	2N5210	5/1.00
MJE2955	1.25	2N3823	1.00	2N5449	3/1.00
2N3053	2/1.00	2N3903	4/1.00	2N5951	3/1.00

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

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

100 VOLT MYLAR FILM CAPACITORS

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

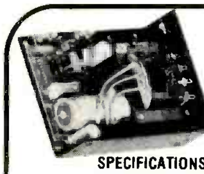
+20% DIPPED TANTALUMS (SOLID) CAPACITORS

1 35V	28	23	17	1.5/35V	30	26	21
15 35V	28	23	17	2.2/25V	31	27	22
22 35V	28	23	17	3.3/25V	31	27	22
33 35V	28	23	17	4.7/25V	32	28	23
47 35V	28	23	17	6.8/25V	36	31	25
68/35V	28	23	17	10/25V	40	35	29
1.0 35V	28	23	17	15/25V	63	50	40

MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS

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

CIRCLE 57 ON FREE INFORMATION CARD



ELPAC POWER SUPPLIES

Completely Assembled

SPECIFICATIONS:

105-125/210-250 Vac, 47-440 Hz Input:

Line Regulation	±0.1%
Load Regulation	±0.1%no-load to rated-load
Output Ripple and Noise	±0.1%p-p,dc to 10 MHz
Input/Output Isolation	100 megohm dc, 900 Vac
Short Circuit Current	35% rated current

PART NO.	RATINGS WATTS	VOLTS	AMPS	PRICE
SOLV15-5*	15	5	3	$36.95
SOLV15-12*	15	12	1.5	36.95
SOLV30-5	30	5	6	59.95
SOLV30-12	30	12	3	59.95
OVP1	over voltage protection for SOLV30-5,-12			9.95

*SOLV15-5, 12 includes OVP installed

NEW! BULB-ENERGY SAVER

Bulb lasts 3 or more times longer. Fits Standard Socket 6 watts to 200 watts

	1-9	10+
BES-1	1.39 ea.	1.20

BULB-ENERGY SAVERS used for years by major industrial users — now available for home or office use. Bulb Savers can cut electrical bills by as much as 3%.

BULB-SAVERS lengthens light life by:

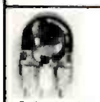
1. Acting as an electrical "shock absorber", turns the bulb on slowly, eliminating the "thermal shock". Bulb life increases 300 percent.
2. Banishes Current "Surges". Cushions line voltage surges when other loads cut power line.
3. Reduces Energy Consumption

CRYSTALS

THESE FREQUENCIES ONLY

PART NO.	FREQUENCY	CASE	PRICE
CY1A	1.000MHz	HC33	5.95
CY1.84	1.8432MHz	HC33	5.95
CY2A	2.000MHz	HC33	5.95
CY2.01	2.010MHz	HC33	1.95
CY2.50	2.500MHz	HC33	4.95
CY3.27	3.2768MHz	HC33	4.95
CY3.57	3.579545MHz	HC33	4.95
CY3A	4.000MHz	HC18	4.95
CY4.91	4.916MHz	HC18	4.95
CY7A	5.000MHz	HC18	4.95
CY5.18	5.185MHz	HC18	4.95
CY6.14	6.144MHz	HC18	4.95
CY6.40	6.400MHz	HC18	4.95
CY6.55	6.5536MHz	HC18	4.95
CY12A	10.000MHz	HC18	4.95
CY14A	14.31818MHz	HC18	4.95
CY19A	18.000MHz	HC18	4.95
CY18.43	18.432MHz	HC18	4.95
CY22A	20.000MHz	HC18	4.95
CY30A	32.000MHz	HC18	4.95

TRIMMERS



10MM size trimmers -.394" Dia.

Part No.	1-9	10-24	25-49	100+
TR-11(valve)	.35	.30	.25	20

Resistance values - 100, 500, 1K, 2K, 5K, 10K, 20K, 50K, 100K, 200K, 1 meg

TRIMPOTS

Single-Turn - 1/2 Watt

Square - Top Adjust - 3/8" Size

Part No.	1-9	10-24	25-49	50-99
840P(value)	.99	.89	.80	.70

Resistance Values - 50, 100, 500, 1K, 2K, 5K, 10K, 20K, 50K, 100K, 200K, 500K, 1 meg

15-Turn - 3/4 Watt

Rectangular Side Adjust 3/4" x 1/4" Size

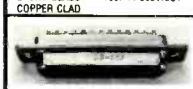
Part No.	1-9	10-24	25-49	50-99
830P(value)	1.35	1.25	1.20	1.15

Resistance Values - 50, 100, 500, 1K, 2K, 5K, 10K, 20K, 50K, 100K, 200K, 500K, 1 meg.

1/16 VECTOR BOARD

	0.1" Hole Spacing Part No.	P-Pattern L	W	Price 1-9	10 up
PHENOLIC	64P44 062XXXP	4.50	6.50	1.72	1.54
	169P44 062XXXP	4.50	17.00	3.69	3.32
EPOXY	64P44 062WE	4.50	6.50	2.07	1.86
GLASS	84P44 062WE	4.50	8.50	2.56	2.31
	169P44 062WE	4.50	17.00	5.04	4.53
	169P84 062WE	8.50	17.00	9.23	8.26
EPOXY GLASS COPPER CLAD	169P44 062WEC1	4.50	17.00	6.80	6.12

CONNECTORS



25 Pin-D Subminiature

DB25P(as pictured)	PLUG	$3.25
DB25S	SOCKET	4.95
DB51226-1	Cover for DB25 P or S	1.75

MOLEX CONNECTOR PINS

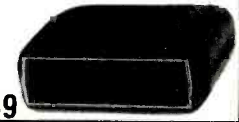
Pre-packaged in strips

M-530-1 $1.95/100 pins (minimum order) $16.00/1000 pins

INSTRUMENT/ CLOCK CASE

Injection molded unit. Complete with red bezel. 4½" x 4" x 1-9/16".

$3.49



MICROPROCESSOR COMPONENTS

P8085	CPU	$29.95	CDP 1802	CPU	$19.95
8080A	CPU	10.95	Z80	CPU	24.95
8212	8-Bit Input/Output	4.95	2650	MPU	26.50
8214	Priority Interrupt Control	7.95	MC6800	MPU	19.95
8216	Bi-Directional Bus Driver	4.95	MC6810API	128 x 8 Static Ram	5.95
8224	Clock Generator/Driver	5.95	MC6820	Periph. Interface Adapter	7.95
8228	System Controller/Bus Driver	5.95	MC6821	Periph. Interface Adapter	11.50
8251	Prog. Comm. Interface	9.95	MC6830L8	1024 x 8 Bit ROM	14.95
8255	Prog. Periph. Interface	10.95	MC6850	Asychronous Comm. Adapter	14.95

RAM'S

1101	256 x 1	Static	$ 1.49
1103	1024 x 1	Dynamic	.99
2101	256 x 4	Static	5.95
2102	1024 x 1	Static	1.75
2107/5280	4096 x 1	Dynamic	4.95
2111	256 x 4	Static	6.95
2112	256 x 4	Static	5.95
2114	4K x 1	Static 450ns	9.95
2114L	4K x 1	Static 450ns Low Power	10.95
2114-3	1K x 4	Static 300ns	10.95
2114L-3	1K x 4	Static 300ns Low Power	11.95
7489	16 x 4	Static	1.75
8101	256 x 4	Static	5.95
8111	256 x 4	Static	6.95
8599	16 x 4	Static	3.49
21L02	1024 x 1	Static	1.95
74200	256 x 1	Static	6.95
93421	256 x 1	Static	2.95
MM5262	2K x 1	Dynamic	3/1.00
MK4027 (UPD414)	4K	DYNAMIC 16 PIN	5.95
MK4116 (UPD416)	16K	DYNAMIC 16 PIN	29.95
TMS4044-45NL	4K	STATIC	14.95

ROM'S

2513(2140)	Character Generator (upper case)	$ 9.95
2513(3021)	Character Generator (lower case)	9.95
2516	Character Generator	10.95
MM5230N	2048 Bit Read Only Memory	1.95

USER MANUALS

1802M	CDP1802 Manual	$ 7.50
Z80M	Z80 Manual	7.50
2650M	2650 Manual	5.00

PROMS

1702A	2048 x 1	Famous	$ 5.95
5203	2048 x 1	Famous	14.95
82S23	32 x 8	Open C	5.00
82S115	4096 x 1	Bipolar	19.95
82S123	32 x 8	Tristate	5.00
74S287	1024 x 1	Static	7.95
2708	8K	EPROM	10.95
2716 T.I.	16K	EPROM	29.95
2716 Intel (2516 T.I.)	16K	EPROM	59.95
6301-1	1024 x 1	Tri-State Bipolar	3.49
6330-1	256 x 1	Open C Bipolar	2.95
74186	512 x 1	TTL Open Collector	9.95
74188	256 x 1	TTL Open Collector	3.95

SHIFT REGISTERS

MM5013N	1024 BitAccumulator Dynamic	2.95
MM5016H	500/512 Bit Dynamic	89
MM5017N	Dual 500/512 Bit Dynamic	2.95
2504T	1024 Dynamic	3.95
2518	Hex 32 Bit Static	4.95
2519	Hex 40 Bit Static	4.00
2522	Dual 132 Bit Static	2.95
2524	512 Dynamic	99
2525	1024 Dynamic	2.95
2527	Dual 256 Bit Static	2.95
2528	Dual 250 Static	4.00
2529	Dual 240 Bit Static	4.00
2532	Quad 80 Bit Static	2.95
2533	1024 Static	2.95
3341	Fifo	6.95
74LS670	4 X 4 Register	1.95

UART'S

AY-5-1013	30K BAUD	$ 5.95

SPECIAL REQUESTED ITEMS

TELEPHONE KEYBOARD CHIPS

AY-5-9100	$14.95
AY-5-9200	14.95
AY-5-9500	4.95
AY-5-2376	14.95
HD0165	7.95
74C922	9.95

ICM CHIPS

ICM7045	$24.95
ICM7205	19.95
ICM7207	7.50
ICM7208	19.95
ICM7209	6.95

NMOS READ ONLY MEMORIES

MCM6571	$13.50
MCM6574	13.50
MCM6575	13.50

TV GAME CHIP SET
AY-3-8500-1 Chip and 2.010 MHz Crystal **$7.95**

MISCELLANEOUS

11C90	$19.95	MK40240	$17.50
MC3061P	11.95	OS0026CH	3.75
MC1408L7	4.95	TIL308	10.20
MC1408L8	5.75	95H90	11.95
LD110/111	$25.00/set		
MC4016(74416)	7.50		
4N33	3.95		

The Sinclair PDM35. A personal digital multimeter for only $59.95

Now everyone can afford to own a digital multimeter

A digital multimeter used to mean an expensive, bulky piece of equipment.

The Sinclair PDM35 changes that. It's got all the functions and features you want in a digital multimeter, yet they're neatly packaged in a rugged but light pocket-size case, ready to go anywhere.

The Sinclair PDM35 is supplied completely assembled with test leads and prods protective wallet and Operator's Manual.

The Sinclair PDM35 is tailor-made for anyone who needs to make rapid measurements. Development engineers, field service engineers, lab technicians, computer specialists, radio and electronic hobbyists will find it ideal.

Technical specification

DC Volts (4 ranges) Range, 1 mV to 1000 V. Accuracy of reading 1.0% ± 1 count. Note 10 MΩ input impedance

AC Volts (40 Hz-5 kHz) Range 1 V to 500 V. Accuracy of reading 1.0% ± 2 counts

DC Current (6 ranges) Range 1 nA to 200 mA. Accuracy of reading: 1.0% ± 1 count. Note: Max resolution 0.1 nA

Resistance (5 ranges) Range 1Ω to 20 MΩ. Accuracy of reading 1.5% ± 1 count. Also provides 5 junction-test ranges.

Dimensions: 6 in x 3 in x 1½ in

Weight: 6½ oz

Power supply: 9 V battery or Sinclair AC adapter (battery not incl.)

Sockets: Standard 4 mm for resilient plugs

Options: AC adapter for 117 V 60 Hz power. De-luxe padded carrying wallet

PART NO.	DESCRIPTION	PRICE
PDM35	Digital Multimeter (Completely Assembled)	$59.95
PDM-AC	117volt AC Adapter	6.95
PDM-DP	Deluxe padded carrying case	6.95

B+K PRECISION **3½-Digit Portable DMM**

- Overload Protected
- 3" high LED Display
- Battery or AC operation
- Auto Zeroing
- 1mv 1Va 0.1 ohm resolution
- Overange reading
- 10 meg input impendence
- DC Accuracy 1% typical

Ranges: DC Voltage 0-1000V
AC Voltage 0-1000V
Freq Response 50-400 HZ
DC/AC Current 0-100mA
Resistance 0-10 meg ohm
Size 6.4" x 4.4" x 2

Model 2800 $99.95

Comes with test leads operating manual and spare fuse

Accessories:

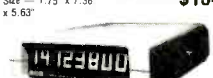
AC Adapter BC-28	$9.00
Rechargeable Batteries BP-26	20.00
Carrying Case LC-28	7.50

CSC CONTINENTAL SPECIALTIES CORPORATION

100 MHz 8-Digit Counter

- 20 Hz-100 MHz Range
- 6" LED Display
- Crystal-controlled timebase
- Fully Automatic
- Portable — completely self contained
- Size — 1.75" x 7.38" x 5.63"
- Four power souces, i.e. batteries, 110 or 220V with charger 12V with auto lighter adapter and external 7.2-10V power supply

MAX-100 $134.95



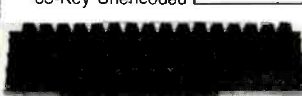
ACCESSORIES FOR MAX 100:

Mobile Charger Eliminator use power from car battery — Model 100 — CLA $3.95

Charger/Eliminator use 110 V AC — Model 100 — CAI $9.95

KEYBOARDS

63-Key Unencoded



This is a 63-key, terminal keyboard newly manufactured by a large computer manufacturer. It is unencoded with SPST keys, unattached to any kind of PC board. A very solid molded plastic 13 x 4" base suits most application. IN STOCK **$29.95/each**

Hexadecimal Encoder

19-key pad includes 1-10 keys, ABCDEF and 2 optional keys and a shift key. **$10.95/each**

$5.00 Minimum Order – U.S. Funds Only
California Residents – Add 6% Sales Tax

Spec Sheets – 25¢
1978 A Catalog Available—Send 41¢ stamp

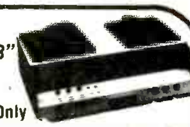
NEW NAME

Jameco ELECTRONICS
a division of JAMES ELECTRONICS of California

PHONE ORDERS WELCOME (415) 592-8097

MAIL ORDER ELECTRONICS – WORLDWIDE
1021 HOWARD AVENUE, SAN CARLOS, CA 94070
Advertised Prices Good Thru September

The Incredible "Pennywhistle 103"



$139.95 Kit Only

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

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

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

The Original the 3rd Hand

$9.95 each

- *Leaves two hands free for working
- * Clamps on edge of bench, table or work bench
- * Position board on angle or flat position for soldering or clipping
- * Sturdy, aluminum construction for hobbyist, manufacturer or school rooms

DIGITAL STOPWATCH

- Bright 6 Digit LED Display
- Times to 59 minutes 59.59 seconds
- Crystal Controlled Time Base
- Three Stopwatches in One: Times Single Event — Split & Taylor
- Size 4.5" x 2.15" x .90" (4½ ounces)
- Uses 3 Penlite Cells

Kit — $39.95
Assembled — $49.95
Heavy Duty Carry Case $5.95

Stop Watch Chip Only (7205) $19.95

imc 3½ DIGIT DPM KIT

- New Bipolar Unit
- Auto Zeroing
- .5" LED
- Auto Polarity
- Low Power
- Single IC Unit

Model KB500 DPM Kit $49.00
Model KB503 5V Power Kit $17.50

JE700 CLOCK

The JE700 is a low cost digital clock but is a very high quality unit. The unit features a simulated walnut case with dimensions of 6" x 2½" x 1". It utilizes a MAN72 high brightness readout and the MM5314 clock chip.

12 or 24 Hour

115 VAC

KIT ONLY **$16.95**

JE803 PROBE

The Logic Probe is a unit which is for the most part indespensible in trouble shooting logic families TTL, DTL, RTL, CMOS. It derives the power it needs to operate directly off of the circuit under test drawing a scant 10 mA max. It uses a MAN3 readout to indicate any of the following states by these symbols (HI) 1 (LOW) 0 (PULSE) P. The Probe can detect high frequency pulses to 45 MHz. It can't be used at MOS levels or circuit damage will result.

$9.95 Per Kit

printed circuit board

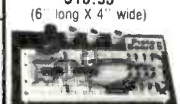
T^2L 5V 1A Supply

This is a standard TTL power supply using the well known LM309K regulator IC to provide a solid 1 AMP of current at 5 volts. We try to make things easy for you by providing everything you need in one package, including the hardware for only **JE225 $9.95 Per Kit**

CSC PROTO BOARDS

CONTINENTAL SPECIALTIES CORPORATION

PROTO BOARD 6
$15.95
(6" long X 4" wide)



PB100 - 4.5" x 6"	$ 19.95
PB101 - 5.8" x 4.5"	29.95
PB102 - 7" x 4.5"	39.95
PB103 - 9" x 6"	59.95
PB104 - 9.5" x 8"	79.95
PB203 - 9.75 x 6½ x 2¾	80.00
PB203A - 9.75 x 6½ x 2¾	129.95

(includes power supply)

PROTO CLIPS

14 PIN	$4.50
16 PIN	4.75
24 PIN	8.50
40 PIN	13.75

INTERNATIONAL ELECTRONICS UNLIMITED

LOW POWER SCHOTTKY - 74LS series

Prime Motorola IC's   Factory warranted
Buy $10.00 -any mix- deduct 10%
Buy $15.00 -any mix- deduct 10%

74LS00	$.18	74LS54	$.18	74LS157	$.44	74LS251	$.66
74LS01	.18	74LS55	.18	74LS158	.53	74LS253	.66
74LS02	.18	74LS74	.26	74LS160	.63	74LS256	.83
74LS03	.18	74LS83	.60	74LS161	.63	74LS257	.44
74LS04	.20	74LS85	.71	74LS162	.63	74LS258	.66
74LS05	.2C	74LS86	.30	74LS163	.63	74LS259	.83
74LS08	.18	74LS90	.42	74LS165	.86	74LS260	.18
74LS09	.18	74LS92	.43	74LS168	.84	74LS266	.29
74LS10	.18	74LS93	.43	74LS169	.84	74LS279	.31
74LS11	.18	74LS95	.74	74LS170	1.27	74LS283	.71
74LS13	.31	74LS109	.26	74LS173	.51	74LS290	.56
74LS14	.48	74LS112	.26	74LS174	.51	74LS293	.63
74LS15	.18	74LS113	.26	74LS175	.51	74LS295	.89
74LS20	.18	74LS114	.26	74LS181	2.17	74LS298	.89
74LS21	.18	74LS122	.33	74LS190	.96	74LS365	.36
74LS22	.18	74LS123	.63	74LS191	.81	74LS366	.36
74LS26	.21	74LS125	.36	74LS192	.64	74LS367	.36
74LS27	.18	74LS126	.36	74LS193	.64	74LS368	.36
74LS28	.20	74LS132	.59	74LS194	.66	74LS378	.69
74LS30	.18	74LS133	.18	74LS195	.64	74LS390	.96
74LS32	.18	74LS136	.28	74LS196	.76	74LS393	.96
74LS33	.21	74LS138	.51	74LS197	.76	74LS395	.96
74LS37	.21	74LS139	.59	74LS240	1.39	74LS490	1.78
74LS38	.21	74LS151	.44	74LS241	1.39	74LS670	1.89
74LS40	.20	74LS153	.44	74LS242	1.32		
74LS42	.60	74LS155	.76	74LS243	1.32		
74LS51	.18	74LS156	.76	74LS244	1.39		

IC SALE

TTL - 7400 - Full Spec

Some items overmarked house numbers
Buy $10.00 -any mix- deduct 10%
Buy $15.00 -any mix- deduct 15%

7400	.10	7441	.75	7491	.64	74163	.75
7401	.15	7442	.35	7492	.39	74164	.65
7402	.14	7443	.45	7493	.39	74165	.75
7403	.12	7444	.60	7494	.59	74166	.95
7404	.14	7445	.50	7495	.59	74170	1.50
7405	.17	7446	.55	7496	.49	74173	1.25
7406	.15	7447	.55	74100	.89	74174	1.05
7407	.15	7448	.60	74105	.38	74175	.65
7408	.18	7450	.15	74107	.25	74176	.70
7409	.15	7451	.15	74121	.29	74177	.70
7410	.10	7453	.13	74123	.32	74180	.40
7411	.19	7454	.10	74125	.45	74181	1.95
7413	.30	7460	.10	74126	.40	74182	.70
7414	.55	7464	.20	74132	.60	74185	1.85
7415	.22	7465	.20	74141	.70	74190	.95
7416	.14	7470	.27	74145	.70	74191	.85
7417	.20	7472	.30	74150	.89	74192	.50
7420	.14	7473	.29	74151	.50	74193	.50
7423	.28	7474	.18	74153	.50	74194	.85
7425	.32	7475	.42	74154	.95	74195	.50
7426	.15	7476	.29	74155	.55	74196	.80
7427	.20	7480	.17	74156	.40	74197	.75
7430	.17	7483	.58	74157	.45	74198	1.40
7432	.15	7485	.75	74158	.55	74199	1.25
7437	.15	7486	.27	74160	.65	74S200	3.25
7438	.15	7489	1.25	74161	.60	74279	.65
7440	.13	7490	.35	74162	.95		

LINEAR CIRCUITS

All guaranteed functional
Some items overmarked house numbers
Buy $10.00 -any mix- deduct 10%
Buy $15.00 -any mix- dedict 15%

LM300H	.49	LM340T (78XX)		LM566CN	1.19	ULN2208	.89
LM301CN	.20	5,6,8,12,		LM567CN	1.19	ULN2209	.89
LM302H	.45	15,18,24	1.19	LM567H	1.49	CA3046	1.19
LM304H	.80	LM370	.65	LM703H	.59	CA3081N	1.49
LM305H	.45	LM372N	2.93	LM703CN	.39	CA3081H	1.97
LM307CN	.20	LM376CN	.25	LM709N	.25	CA3082	1.45
LM307H	.30	LM377N	.95	LM709H	.29	LM3900N	.35
LM308H	.39	LM380N	.79	LM710N	.59	LM7524	.79
LM309H	1.05	LM380-8CN	.59	LM711N	.35	LM7525	.79
LM309K	1.05	LM381N	1.75	LM723H	.55	LM7535	.45
LM310CN	1.07	LM382N	1.75	LM723N	.52	8038B	4.59
LM311CN	.40	LM385K	.25	LM733H	.59	75450AN	.35
LM311H	.50	LM386CN	.49	LM739N	.65	75451CN	.25
LM319N	1.13	LM387CN	.49	LM741CN(8)	.25	75452CN	.25
LM320K		NE531V	1.90	LM741CN(14)	.32	75453CN(351)	.25
5,5.2,12,		NE540L	1.90	LM741CH	.35	75454CN	.35
15	1.29	NE546A	1.09	LM747H	.79	75491N	.65
LM320T (79XX)		NE550A	.75	LM747N	.65	75492N	.75
5,12,15	1.19	LM555CN	.39	LM748CN	.25	XR320	1.19
LM322N	.69	NE556A	.85	LM1310N	2.25	XR2207	1.49
LM324N	.95	LM560N	2.95	LM1414N	.60	XR2567	1.49
LM339N	.69	LM561N	2.95	LM1456CN	1.29	XR4136	1.49
LM340K		LM565N	.59	LM1458CN	.59	XR4202	.69
5,6,8,12,		LM565H	1.39	LM1496N	.89	XR4212	.69
15,18,24	1.29	LM566H	1.39	LM1800N	1.75	XR4739	.69

TTL - 7400

tested and passed logic test-
not full parametric specs
minimum 10 pcs or $1 per item

7400	.05	7460	.05
7401	.07	7472	.12
7402	.05	7473	.12
7403	.05	7474	.10
7404	.06	7476	.12
7405	.06	7483	.18
7406	.09	7485	.25
7407	.09	7486	.12
7409	.07	7491	.20
7410	.05	7493	.14
7416	.12	7495	.20
7420	.06	74100	.40
7423	.12	74107	.12
7425	.12	74123	.18
7426	.09	74125	.22
7427	.09	74126	.22
7430	.07	74132	.22
7432	.08	74141	.25
7437	.07	74145	.25
7438	.07	74150	40
7440	.05	74151	.20
7441	.30	74153	.15
7442	.20	74154	.40
7443	.20	74163	.35
7444	.20	74164	.35
7445	.20	74177	.25
7446	.30	74180	.25
7448	.30	74182	.25
7450	.06	74191	.30
7451	.07	74192	.28
7453	.06	74194	.28
7454	.05	74195	.18

LED DISPLAY, Red 7 seg
NSN74R common cathode
.3" RHD..........$.59

LED DISPLAY, Red 7 seg
MAN72 common anode
.3" LHD..........$.59

LED DISPLAY, yellow 7 seg
MAN82 common anode
.3" LHD.........$.69

RED LED - jumbo 12/$1.00
CLEAR LED - jumbo 15/$1.00

PLASTIC CASES

VERO - dark and light gray nominal O.D.

2514F	2"x4"x1"	$4.34
2516G	2"x4"x1.6"	4.90
2518H	2.6"x 4.7"x1.6"	5.48
2520J	3.2"x6"x2"	6.24
2522K	4.3"x7.4"x2.4"	8.28
2755G	2.6"x4.7"x2.6"	6.74
2760D	4.3"x7.4"x2.4" (w/ handle/stand)	10.78
2525F	2.8"x5.4"x2.4" (ventilated)	5.40
HAMMOND - blue		
1591C	2.6"x4.8"x1.6"	2.65

SUMMER CIRCUITS
ELEKTOR 78
Double issue containing more than 100 circuits - such as high-perf. disc pre-amp, Audio control ampl., LED level indicator, Car ammeter, Bibe speedometer, A/D converter and many more.
with order $3.00
mag only 4.25

IC SOCKETS

Low Profile Solder Tail				Wire Wrap	
8 pin	$.16	24 pin	$.36	8 pin	.45
14 pin	.19	28 pin	.44	14 pin	.49
16 pin	.21	40 pin	.61	16 pin	.55
18 pin	.28				

CERAMIC DISC CAPACITORS - 50V

1pf	22pf	56pf	120pf	270pf	820pf	.022uf
5pf	27pf	68pf	150pf	390pf	.001uf	.030uf
7pf	33pf	82pf	180pf	470pf	.0047uf	.050uf
10pf	47pf	100pf	220pf	600pf	.01uf	.1uf

	1pf/.050uf	.1uf
1-10 per value	$.10ea	$.15ea
10-100	.05ea	.10ea
100-	.04ea	.08ea

2510	Dual 50 bit Shift Reg.	.95
2511	Dual 100 bit Shift Reg.	.95
2518	Hex 32 bit Shift Reg.	1.25
2522	Dual 132 bit Shift Reg.	.95
MM5016	500/512 bit Shift Reg.	.95
SL-5-4025	Quad 25 bit Shift Reg.	.59

CAPACITOR KIT - ceramic disc
50V, 24 values, 10 capacitors each

1pf	33pf	82pf	220pf	820pf	.022uf
5pf	47pf	100pf	270pf	.001uf	.030uf
10pf	56pf	150pf	470pf	.0047uf	.050uf
22pf	68pf	180pf	600pf	.01uf	.1uf

capacitors only...$11.95

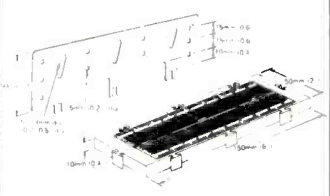
DL 702	.30" Red CC LHD			.79
DL 707	.30" Red CA RHD			.79
DL 33B	3 Dig	.17" Red CC		.29
DL 33B	2 Dig	.17" Red CC		.49
NSN 33	3 Dig	.17" Red CC		.39
HP 5082	4 Dig	.11" Mag. RHD		.39
HP 5082	5 Dig	.11" Mag. RHD		.49
SP425-09	9 Dig	Gas Discharge		.69
Calc Disp	9 MAN	3s on board Red		.79
TI 434	9 Dig	Red		.49

BEZELS - with red filters
140-2 cut-out 1.125" x 2.375" max .062" panel thickness $1.75
140-4 cut-out 1.160" x 4.375" max .125" panel thickness $2.75

TANTALUM CAPACITORS - solid dipped

.1u/35V	$.20	6.8/6	$.25	15/50	$.40
.22/35	.20	6.8/16	.25	22/16	.40
.33/35	.20	6.8/50	.30	33/10	.50
1/35	.20	10/16	.30	47/6	.50
2.2/20	.25	10/25	.35	47/25	.55
2.2/35	.25	10/50	.35	56/6	.65
3.3/35	.25	15/10	.35	100/20	1.25
4.7/16	.25	15/20	.35		

BIMBOARD - BREADBOARD KIT



Solderless breadboard section has 94 breadboard strips of 5 sockets each. 2 bus strips of 40 sockets each. Component bracket for switches lamps etc., accepts leads .01" to .035" diameter. $11.95 ea.

MM5316	Clock Chip	.95
MM5370	Clock Chip	3.95
MM5375AA	Clock Chip	2.95
CT7001	Clock Chip	4.95
2513(caps)	Char. Gen.	3.95
2513(L.C.)	Char. Gen.	3.95
MM1101	256 bit RAM	.65
MM1103	1K RAM	.75
MM5261	1K RAM	.55
MM5262	1K RAM	.95
F93410	256 bit RAM	.95

Silicon SW diode assorted 400 mw $.05ea
1N4148 (1N914) Silicon diode 400 mw .10
1N3064 Silicon SW diode 400 mw .10
1N4006 Silicon rect. diode 600V 400mw .10
Zener diode 400 mw - 2.4V, 3.6V, 5.1V, 6.5V, 6.8V, 10V, 12V, 14.5, 15V, 120V .15
Germanium diode 400 mw .08

TANTALUM CAPACITOR KIT
solid dipped, 12 values, 5 each

.1uf/35V	2.2/35	10/25	33/10
.33/35	4.7/16	15/20	47/25
1/35	6.8/16	22/16	56/6

capacitors only......$14.95

2N1132	PNP	Gen Purp. Ampl	TO-5	$ .69
2N2218A	NPN	Low Power Trans	TO-5	.69
2N2222A	NPN	Low Power Trans	TO-18	.29
2N2223	NPN	Low Power Trans.	TO-5	.69
2N2369	NPN	Low Power Trans	TO-5	.29
2N2904	PNP	Low Power Trans	TO-5	.49
2N2905A	PNP	Low Power Trans	TO-5	.76
2N3227	NPN	Low Power Trans	TO-18	.69
2N3904	NPN	Low Power Trans	TO-92	.17
2N3906	PNP	Low Power Trans	TO-92	.17
SCA 13572	NPN	Pwr Trans - 200V	TO-5	1.75

ELECTRONIC BUZZER

Miniature, Solid State
6V 15ma (4-9V oper.) $1.29 ea.
12V 15ma (8-20V oper.) $1.29 ea.

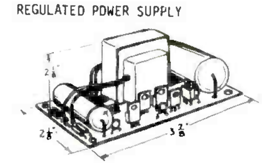
CLOCK KIT - Mark I
6 digit clock kit with one PC board. Accommodates MM5314 clock chip and 6 FND 359 displays contains all components except transformer. Includes 3 switches. Board has terminals for remote displays. $10.95

Carbon Film ± 5% 1/4 w or 1/2 w
15 ea. of 12 values:
100, 220, 470, 1K, 1.5K, 3.3K
4.7K 6.8K, 10K, 33K, 100K, 1M.
$5.45

METAL FILM RESISTORS Rohm QUALITY RELIABILITY
± 1%, 1/4w, ± 50 PPM/°C
Standard Decade Values 10.5 - 464K

Qty.	Ea.	Min 10/value	Min 100/value
1-99	$.20	$.15	
100-999	.20	.10	$9.00/100
1000-			8.00/100

REGULATED POWER SUPPLY



Plus & minus 5V, 12V and 15V.
Uses 3 LM340T and 3 LM320T regulators, 115V/29V CT transformer plus PC board capacitors & diodes. All parts, schematic, instructions
PS-29.........$12.95 + $1.00 Shppng.

TRIMPOT - Single Turn
Mepco - Cermet 8014
.5w, ± 100 PPM/°C ± 20%
500 ohm, 2K, 10K, 20K, 50K, 100K, 500K, 1M.

1-9	10-99	100-999	1000-
$.75ea	.69	.63	.57

Carbon Film ± 5% 1/4w or 1/2w
Usage Evaluated Assortment
5 to 20 ea of 44 values.
$12.95
Supplied in 15 Drawer 60 Comp. Cabinet. $22.95 + $2.00 Sh.

Carbon Film Fesistors ± 5% 1/4w, 1/2w

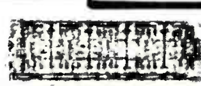
Qty.	Ea.	Min 10/value	Min 100/value
1-99	$.10	$.05	
100-999	.10	.04	$3.00/100
1000-			2.50/100

TRIMPOT - 25 turn
Bourns - Cermet 3299W
PC Mount, vert. adj.
2K, 10K, 20K

1-9	10-999	100-
$1.65	1.50	1.35

PRECISION RESISTOR PACKAGE
Metal Film ± 1% 1/4 watt
Starter Kit - 2ea. 60 values
120 Resistors 10.5 ohm- 464K
$14.95
Supplied in 15 Drawer 60 Comp. Cabinet - $26.50 + $2.00 Sh.

I C BREADBOARD
Silver plated copper circuits holds 5 - 16 pin DIP IC's and interconnection holes. $1.00



UNIVERSAL BREADBOARD
Silver placed copper circuits fits any IC and related components. 2 triple rows of 27 holes for DIP. 3-3/16"x5-1/16" $1.00

VECTOR BOARD - Phenolic
169P44-062 (.1"spacing .42" dia.)
4-1/4" x 4-1/2" x .0625"...$1.15 ea.

COMPLETE SATISFACTION GUARANTEED. SHIPMENT TO US AND CANADA PREPAID UNLESS INDICATED OTHERWISE. OTHER COUNTRIES ADD 10% - EXCESS REFUNDED. ORDERS SHIPPED IN 3 WORKING DAYS FROM RECEIPT. MINIMUM ORDER $10.00 CALIFORNIA RESIDENTS ADD SALES TAX. MINIMUM COD OR CHARGE ORDER $15.00

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VILLAGE SQUARE, P.O. BOX 449, CARMEL VALLEY, CA 93924 USA
TELEPHONE 408 659-3171

SOCKET SALE

WIRE WRAP SOCKETS

14 Pin Wire Wrap	.30	.27/400
16 Pin Wire Wrap	.32	.29/350

EDGE CARD CONNECTORS

44 Pin ST Edge Card Connector	1.75	1.50/10
100 Pin ST Edge Card Connector	3.50	3.00/10
100 Pin WW Edge Card Connector	3.50	3.00/10

All Sockets & Connectors Include Gold.

SOLDERLESS BREADBOARDS 2.2" x 6.5"

SK 10 $16.50

INCLUDING:
Over 100 pieces of precut wire in assorted lengths — free!
Choose 1 color: Red, Black, Blue, Yellow, Green, White, Orange Or Assortment.

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Monrovia, California 91016
Phone (213) 357-5005

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- All others, shipped Ppd in U S. via UPS
- For Blue Label (Air) or 1st Class, add $1
- We accept Visa & Master Charge
- Most orders shipped same day

Dealer Inquiries Invited

CIRCLE 23 ON FREE INFORMATION CARD

INTEGRATED ELECTRONICS

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CMOS

4000	.15
4001	.20
4002	.20
4007	.20
4010	.36
4011	.20
4012	.20
4013	.35
4014	.80
4015	.80
4016	.35
4017	.92
4018	.92
4019	.20
4020	1.00
4022	.83
4023	.21
4024	.75
4025	.20
4027	.34
4028	.79
4029	1.00
4030	.20
4035	.95
4040	1.00
4041	1.00
4042	.70
4044	.60
4049	.35
4051	1.10
4066	.70
4068	.40
4069	.40
4075	.20
4082	.23
74C00	.25
74C02	.45
74C04	.32
74C08	.65
74C10	.25
74C14	1.75
74C20	.26
74C30	.26
74C32	.30
74C42	1.40
74C48	2.75
74C73	1.25
74C74	.75
74C86	1.00
74C90	1.10
74C93	1.25
74C151	2.75
74C154	3.00
74C157	2.10
74C160	1.40
74C162	1.70
74C164	1.75
74C165	1.75
74C174	1.50
74C902	.85
74C904	.85
74C905	3.00
74C914	1.95

TTL

7400	.16
7401	.17
7403	.17
7404	.19
7406	.40
7407	.40
7409	.25
7410	.18
7413	.78
7414	.68
7417	.38
7420	.18
7421	.35
7427	.35
7430	.15
7432	.30
7437	.44
7440	.18
7442	1.00
7445	.70
7446	.70
7448	.70
7450	.25
7451	.25
7453	.25
7454	.35
7460	.22
7472	.40
7473	.40
7474	.40
7475	.55
7476	.45
7483	1.05
7485	1.10
7486	.43
7489	2.00
7492	.75
7493	.65
7495	.78
7496	.85
74121	.35
74122	.49
74123	.65
74126	.65
74132	1.25
74141	1.15
74145	1.10
741481.	1.20
74150	.90
74153	1.10
74154	1.25
74155	.75
74157	1.00
74161	1.00
74163	1.30
74164	1.45
74165	1.35
74166	1.20
74173	1.70
74175	1.05
74177	.90
74182	.95
74191	1.20
74192	1.45
74193	1.35
74195	1.00
74196	1.10
74197	1.10
74199	2.25
74367	.90

Interface

0025	3.50
0026	1.75
8640	1.25
8641	2.75
8806	3.00
8819	1.25
8820	5.00
8830	4.90
8833	2.45
8835	2.45
8836	1.25
8837	2.45
8838	2.45
8859	1.50
8865	1.50
8866	1.50
8867	1.85
8869	1.75
8879	2.25
8880	2.75
8884	2.45
8973	2.95
8974	2.95
8976	2.95
75107	3.25
75450	1.00
75451	.80
75452	.80
75453	.80
75491	1.25
75492	1.40
75494	1.50

Peripheral

8212	3.50
8214	8.50
8216	3.75
8224	4.75
8228	9.90
8251	11.50
8255	10.50
2513	9.50
2516	9.50
1013	6.50

8000 TTL

8T20	3.25
8T97	1.75
8092	.95
8094	.60
8095	.80
8096	.90
8098	.90
8121	2.25
8136	3.25
8220	3.25
8231	2.25
8242	1.75
8250	1.75
8260	2.25
8281	1.00
8334	4.00
8553	6.50
8556	3.25
8599	3.25

LINEAR

301N	.35
307N	.35
308H	1.00
309K	1.25
309H	1.00
318H	1.50
320H-5	.88
320T-5	1.25
320T-12	1.25
324N	1.75
340T-5	1.25
340T-12	1.25
340T-15	1.25
340T-24	1.25
387N	1.25
388N	1.15
555N	.35
556N	.85
558N	2.80
561N	5.00
566N	1.70
567N	1.65
709N	.30
741H	.25
3035	2.40
3401	1.25

74LSxx *

74LS00 .25
through
74LS670 3.95

* For more 74LSxx, refer to our ad in the June issue of this magazine.

If what you need is not listed, ask for it. Send self-addressed stamped envelope.

SPECIAL - - 21L02/450ns (1.50/10up; 1.35/50up; 1.25/100up)
±3 Digit A/D LD130 $5.50
MM5865 Universal Timer $7.50

Minimum order $5.00 US currency. Check or money order only. Add 5% to cover shipping and handling charges. Calif. residents add 6% sales tax. Santa Clara County residents add 6.5% sales tax.

CIRCLE 59 ON FREE INFORMATION CARD

New-Tone Electronics

Quality components at fair prices

HIGH FIDELITY SPEAKERS

8-INCH COAXIAL
Combines a high quality 8" woofer and a tweeter into a pre-phased sound reproducer. Built-in cross-over network. Excellent choice for a low cost Hi-Fi system for autos, vans, or in your home. Frequency response is a smooth 80-15000 Hz. 8-ohm VC, 10 oz. ceramic ring magnet. 25W rating **NT577 $13.99 plus 40 cents postage**

10-INCH WOOFER
The speaker for your "big sound" system. Frequency response is 20-4000 Hz; 8-ohm aluminum VC; powerful 20 oz. ceramic ring magnet and a rubberized accordion-edge suspension for excellent compliance. Handles 50W max. Use with the NT576 for a super system. **NT578 $17.99 plus 40 cents postage**

50W DOME TWEETER
Here is the super tweeter. A rugged 10 cm (4") dome tweeter which handles 50W max. Frequency response is 4000-20000 Hz. 8-ohm VC, 8-oz. ceramic magnet. Your system can have a brilliance you never imagined. **NT576 $6.99**

Resistors Standard values, ±5%, first quality. Packed 5 of one value.
1/4W-5 for $.25 1/2W-5 for $.30

Capacitor Special 3600 mF, 40Vdc Sprague "Powerlytic" $1.89

Relay SPDT, 12Vdc - 5A contacts NT565 $1.79

Sound Activated Switch Complete, ready to use. Built-in microphone's output triggers a Triac which acts as a switch. Measures only 1" x 3". Requires 3-6Vdc. NT527 $1.29

And, the largest inventory of domestic and Japanese transistors and ICs in the United States.

ALL PARTS GUARANTEED
WRITE FOR FREE CATALOG

Minimum Order $5. Add $1.50 Postage and Handling.
Canada add $2.00. N.J. Residents add 5% Sales Tax.

New-Tone Electronics

PO BOX 1738
Bloomfield, N.J. 07003

CB, HAM MICROPHONE
• Noise Cancelling Characteristics • Dynamic Microphone Element
A terrific push-to-talk dynamic microphone with a tailored 100-5000 Hz frequency range for high intelligibility. The "close talk" requirement is effective in eliminating off-axis noise. Originally made by Astatic for Pace. Complete with 4-wire coiled conductor. Can be used with hundreds of CB and Ham rigs. Output impedance is 400 ohms. Black plastic case with molded hanger. **NT566 $6.89**

ALARM HORN . . . Use anywhere a loud audio signal or buzzer is needed — as an alarm, to signal a "high" in your IC projects, as a timer signal, or as a low cost code practice tone generator. Requires only 3-6 volts dc. 1 1/2" diam. **NT553 $.89**

SPDT Miniature Microswitch . . . The real thing! Rated 10A at 125 Vac, 5A at 250 Vac. Body measures 3/4''x1/4''x1/2''. Roller leaf actuated. **Three for $2.29 NT584 $.89**

DPDT-Toggle Switch . . . Rated 6 Amps at 125Vac. 3/8'' bat handle, 5/16'' stem. Gold plated wire terminals. Switch body measures 1/2''x1/2''x3/8''. Made by Cutler Hammer. **NT562 $1.49**

4PDT-Toggle Switch . . . Three position toggle switch with center position "OFF". Rated 6 Amps at 125 Vac. 3/8'' bat handle, 5/16'' stem. Gold plated wire terminals. Switch body measures 7/8''x 1/2''x1/2''. Made by Cutler Hammer. **NT563 $1.99**

NYLON HARDWARE . . . Hard-to-find Nylon screws, nuts and rivets. **NT514 - 50 piece assortment only $1.99**

Socket Extender 14-Pin DIL . . . Raises sockets 2 1/2'' above the chassis. Solder to pc board or plug into an existing socket. Ideal for digital readout devices, IC testing and simplifying layout. **Three for $2.39 NT568 $.89**

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DATA BOOKS • HEAT SINKS • WIRE • TOOLS . . . AND MORE . . . WRITE FOR FREE CATALOG . . . .

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TTL

7400	.21
7401	.21
7402	.21
7403	.21
7404	.21
7405	.21
7406	.25
7407	.25
7408	.21
7409	.21
7410	.21
7411	.21
7412	.21
7413	.25
7414	.89
7416	.25
7417	.25
7420	.21
7421	.25
7423	.35
7425	.33
7426	.25
7427	.33
7428	.28
7430	.21
7432	.25
7433	.30
7437	.25
7438	.25
7439	.50
7440	.21
7442	.53
7445	.70
7446	.70
7447	.70
7448	.70
7450	.21
7451	.21
7453	.21
7454	.21
7460	.21
7470	.30
7472	.30
7473	.30
7474	.30
7475	.49
7476	.32
7480	.70
7483	.70
7485	.89
7486	.28
7489	2.19
7490	.44
7491	.70
7492	.44
7493	.44
7494	.70
7495	.70
7496	.70
74100	1.28
74107	.30
74109	.33
74116	1.24
74121	.35
74122	.44
74123	.61
74125	.40
74126	.40
74128	.40
74132	.70
74141	.88
74145	.70
74147	1.63
74148	1.30
74150	1.16
74151	.70
74153	.65
74154	1.03
74155	.70
74156	.70
74157	.70
74160	.88
74161	.88
74162	.88
74163	.88
74164	.96
74165	1.15
74166	1.26
74170	2.64
74173	1.42
74174	.98
74175	.93
74176	.79
74177	.79
74180	.70
74181	2.15
74182	.79
74184	2.15
74185	2.19
74189	3.50
74190	1.23
74191	1.23
74192	.98
74193	.88
74194	.88
74195	.88
74196	.88
74197	.88
74198	1.49
74199	1.49
74221	.86
74251	1.09
74279	.55
74298	.94
74365	.67
74366	.67
74367	.67
74368	.67

74LS00

74LS00	.28
74LS01	.28
74LS02	.28
74LS03	.28
74LS04	.29
74LS05	.29
74LS08	.29
74LS09	.29
74LS10	.28
74LS11	.28
74LS12	.28
74LS13	.47
74LS14	1.02
74LS15	.28
74LS20	.28
74LS21	.28
74LS22	.28
74LS26	.33
74LS27	.33
74LS28	.33
74LS30	.28
74LS32	.33
74LS37	.33
74LS38	.33
74LS40	.28
74LS42	.67
74LS47	.77
74LS48	.84
74LS51	.28
74LS54	.28
74LS55	.28
74LS73	.39
74LS74	.39
74LS75	.53
74LS76	.39
74LS78	.39
74LS83	.79
74LS85	.49
74LS86	.39
74LS90	.49
74LS92	.57
74LS93	.57
74LS95	.88
74LS96	.98
74LS107	.39
74LS109	.39
74LS112	.39
74LS113	.39
74LS114	.39
74LS125	.49
74LS126	.49
74LS132	.81
74LS136	.39
74LS138	.73
74LS139	.73
74LS151	.75
74LS153	.75
74LS154	1.10
74LS155	.75
74LS156	.75
74LS157	.75
74LS158	.75
74LS160	1.02
74LS161	1.02
74LS162	1.02
74LS163	1.02
74LS164	1.02
74LS168	1.14
74LS169	1.14
74LS170	1.73
74LS173	1.34
74LS174	1.06
74LS175	.84
74LS181	2.50
74LS190	1.18
74LS191	1.18
74LS192	.98
74LS193	1.06
74LS194	.88
74LS195	.88
74LS196	.86
74LS197	.86
74LS240	1.90
74LS241	1.90
74LS242	1.70
74LS243	1.70
74LS244	1.70
74LS245	.79
74LS248	.79
74LS249	.79
74LS251	.79
74LS253	.84
74LS257	.75
74LS258	.75
74LS260	.34
74LS261	2.00
74LS266	.39
74LS273	1.78
74LS283	.79
74LS290	.65
74LS293	.65
74LS295	1.12
74LS298	1.30
74LS365	.67
74LS366	.67
74LS367	.67
74LS368	.67
74LS377	1.50
74LS386	.39
74LS395	1.74
74LS670	2.34
81LS95	.77
81LS96	.77
81LS97	.77
81LS98	.77

74C00

74C00N	.25
74C02N	.25
74C04N	.27
74C08N	.25
74C10N	.25
74C14N	.90
74C20N	.25
74C30N	.25
74C32N	.25
74C42N	.88
74C48N	1.28
74C73N	.72
74C74N	.48
74C76N	.72
74C83N	1.38
74C85N	1.38
74C86N	.40
74C90N	.98
74C93N	.98
74C95N	1.10
74C107N	.70
74C150N	2.90
74C151N	1.90
74C154N	2.90
74C157N	1.90
74C160N	1.18
74C161N	1.18
74C162N	1.18
74C163N	1.18
74C164N	1.10
74C165N	1.10
74C173N	1.10
74C174N	1.16
74C175N	1.16
74C192N	1.38
74C193N	1.38
74C195N	1.10
74C221N	1.90
80C95N	.48
80C96N	.48
80C97N	.48
80C98N	.48
74C901N	.48
74C902N	.48
74C909N	1.78
74C926N	7.80

4000 CMOS

4000	.23
4001	.23
4002	.23
4006	1.23
4007	.23
4008	.79
4009	.44
4010	.44
4011	.23
4012	.23
4013	.40
4014	.96
4015	.96
4016	.40
4017	1.05
4018	1.05
4019	.23
4020	1.14
4021	1.14
4022	.96
4023	.23
4024	.84
4025	.23
4026	1.68
4027	.40
4028	.89
4029	1.14
4030	.23
4033	1.51
4034	3.50
4035	1.14
4040	1.14
4041	.79
4042	.79
4043	.70
4044	.70
4046	1.86
4047	.96
4049	.40
4050	.40
4051	1.26
4052	1.26
4053	1.26
4060	1.58
4066	.79
4069	.23
4071	.23
4072	.23
4073	.23
4075	.23
4081	.23
4082	.23
4502	.95
4510	1.14
4511	1.05
4515	2.80
4516	2.80
4518	1.23
4518	1.14
4520	1.14
4527	1.68
4528	.88

INTERFACE

8093	.40
8094	.40
8095	.67
8096	.67
8097	.67
8098	.67
75450	.88
75451	.61
75452	.61
75453	.61
75454	.61
75491	.81
75492	.84
75493	1.09
75494	1.19
MC1488N	.90
MC1489N	.90

LINEAR

CA3046	.75
CA3086	.50
LF351N	.76
LF356N	1.20
LF357N	1.20
LF13741	.76
LM301AN	.44
LM307N	.64
LM308N	1.00
LM311N	.90
LM317T	3.00
LM317MP	1.90
LM318N	2.70
LM320MP-5	1.30
LM320MP-6	1.30
LM320MP-8	1.30
LM320MP-9	1.30
LM320MP-12	1.30
LM320MP-15	1.30
LM320MP-18	1.30
LM320MP-24	1.30
LM323K	7.50
LM324N	.72
LM325N	2.70
LM326N	2.70
LM327N	2.70
LM339N	1.15
LM340T-5	1.25
LM340T-6	1.25
LM340T-8	1.25
LM340T-10	1.25
LM340T-12	1.25
LM340T-15	1.25
LM340T-18	1.25
LM340T-24	1.25
LM341P-5	.98
LM341P-6	.98
LM341P-8	.98
LM341P-10	.98
LM341P-12	.98
LM341P-15	.98
LM341P-18	.98
LM341P-24	.98
LM348N	1.60
LM349N	1.60
LM358N	.72
LM386	.85
LM1310N	.84
LM1800N	.94
LM1812N	1.70
LM1830N	4.80
LM1889N	1.30
LM2111N	2.00
LM2907N	1.25
LM2917N	1.50
LM3089N	1.50
LM3900N	1.30
LM3905N	.88
LM3909N	.88
LM3911N	1.40
MC1456V	.69
MC1458V	1.50
MC1496N	1.00
MC3302P	.53
[illegible]	.70
NE536T	1.15
NE540L	2.50
NE550N	2.04
NE555V	.48
NE556A	.88
NE558N	2.40
NE559N	2.40
NE560B	2.50
NE561B	2.50
NE562B	2.50
NE565A	1.25
NE566V	1.28
NE567V	1.36
UA709CV	.44
UA710CV	.44
UA711CA	.53
UA733CA	.60
UA741CV	.75
UA747CA	.44
UA748CV	.70
[illegible]	.49
UA7805CU	1.25
UA7806CU	1.25
UA7808CU	1.25
UA7812CU	1.25
UA7815CU	1.25
UA7818CU	1.25
UA7824CU	1.25
UA78L05ACZ	.40
UA78L06ACZ	.40
UA78L08ACZ	.40
UA78L10ACZ	.40
UA78L12ACZ	.40
UA78L15ACZ	.40
UA78L18ACZ	.40
UA78L24ACZ	.40
UA7905CU	1.70
UA7906CU	1.70
UA7908CU	1.70
UA7909CU	1.70
UA7912CU	1.70
UA7915CU	1.70
UA8918CU	1.70
UA7924CU	1.70

MISC IC

MM5314N 3.75

WE PAID SHIPPING AND INSURANCE (on U.S. and Canadian orders)

I.C. SOCKETS

WIRE WRAP SOCKET ARE STANDARD PROFILE

Part No.	Description	Prices		
8-ST	8 Pin Solder Tab I.C. Socket	.17	1.60/10	14.50/C
14-ST	14 Pin Solder Tab I.C. Socket	.20	1.90/10	17.00/C
16-ST	16 Pin Solder Tab I.C. Socket	.22	2.10/10	18.75/C
18-ST	18 Pin Solder Tab I.C. Socket	.29	2.75/10	24.50/C
20-ST	20 Pin Solder Tab I.C. Socket	.30	2.85/10	25.25/C
22-ST	22 Pin Solder Tab I.C. Socket	.33	3.15/10	27.75/C
24-ST	24 Pin Solder Tab I.C. Socket	.38	3.60/10	32.25/C
28-ST	28 Pin Solder Tab I.C. Socket	.45	4.25/10	38.25/C
40-ST	40 Pin Solder Tab I.C. Socket	.63	6.00/10	53.50/C
8-WW	8 Pin Wire Wrap I.C. Socket	.24	2.30/10	20.50/C
14-WW	14 Pin Wire Wrap I.C. Socket	.26	2.50/10	22.00/C
16-WW	16 Pin Wire Wrap I.C. Socket	.30	2.85/10	25.50/C
18-WW	18 Pin Wire Wrap I.C. Socket	.60	5.70/10	51.00/C
20-WW	20 Pin Wire Wrap I.C. Socket	.70	6.65/10	59.50/C
22-WW	22 Pin Wire Wrap I.C. Socket	.84	8.00/10	71.50/C
24-WW	24 Pin Wire Wrap I.C. Socket	.96	9.10/10	81.50/C
28-WW	28 Pin Wire Wrap I.C. Socket	1.12	10.00/10	95.20/C
40-WW	40 Pin Wire Wrap I.C. Socket	1.36	12.50/10	115.00/C

MOLEX I.C. SOCKET PINS

.85/C 8.20/M 38.20/5M 275.00/50M

MICROPROCESSORS

8080A	8-BIT CPU, 2 USEC CYCLE	$ 9.95
8212	8-BIT I/O PORT	$ 3.25
8216	BI-DIRECTIONAL BUS DRIVER	$ 3.25
8224	CLOCK GENERATOR	$ 3.25
8228	SYSTEM CONTROLLER	$ 6.00
8251	COMMUNICATIONS INTERFACE	$10.50
8255	PERIPHERAL INTERFACE	$10.50
1702A	2K EPROM 1 USEC	$ 5.75
2708	8K EPROM 450 NSEC	$15.75
2102AN-4L	1K LOW POWER 450 NSEC RAM	$ 1.69
SC/MP	5 VOLT SC/MP CPU	$ 9.95
2650	MICROPROCESSOR 1.25 MH-2 CLOCK 40 DIL	$24.95

½ WATT ZENER DIODES

.15 1.30/10 11.00/C

1N5226B	3.3V	1N5242B	12V
1N5227B	3.6V	1N5243B	13V
1N5228B	3.9V	1N5244B	14V
1N5229B	4.3V	1N5245B	15V
1N5230B	4.7V	1N5246B	16V
1N5231B	5.1V	1N5247B	17V
1N5232B	5.6V	1N5248B	18V
1N5233B	6.0V	1N5249B	19V
1N5234B	6.2V	1N5250B	20V
1N5235B	6.8V	1N5251B	22V
1N5236B	7.5V	1N5252B	24V
1N5237B	8.2V	1N5253B	25V
1N5238B	8.7V	1N5254B	27V
1N5239B	9.1V	1N5255B	28V
1N5240B	10V	1N5256B	30V
1N5241B	11V	1N5257B	33V

SILICON DIODES

1N4001	.64/10	5.50/C
1N4002	.66/10	5.60/C
1N4003	.68/10	5.80/C
1N4004	.70/10	5.95/C
1N4005	.82/10	7.05/C
1N4006	.90/10	7.75/C
1N4007	.99/10	8.60/C
1N4148	.40/10	3.50/C

SLIDE SWITCHES

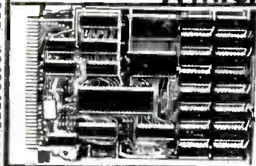
SPST	.15	1.25/10	10.00/C
SPDT	.19	1.70/10	13.00/C
DPDT	.23	2.00/10	19.00/C

Call or Write For **FREE CATALOG**

• DIGI-KEY MEANS QUALITY PRODUCTS

NEW! The "NIBBLER"

A MICROCOMPUTER AT A MICROPRICE!



The NIBBLER is Digi-Key's new low cost personal/hobby computer. Based on National Semiconductor's SC/MP-II microprocessor, the NIBBLER includes 4K NIBL Basic in ROM and 2K of RAM. The NIBBLER requires 5 volts at ⅓ amp providing 110 baud serial ASCII I/O which is easily interfaced with a CRT or Teletype. And our low price of $149.95 is for an assembled and tested system! Software/Hardware manual included with NIBBLER available separately for $5.00.

FEATURES:

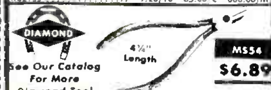
- Assembled and Tested, yet only $149.95
- Standard 4.5" by 6.5" card with 72 pin edge connector pattern
- All IC's are socketed for easy maintenance
- Memory expandable to 28K
- 110 Baud Serial I/O
- It Speaks Basic Beautifully
- 4K NIBL Basic in ROM and 2K of RAM
- Easily Interfaced with CRT or Teletype

CATALOG NUMBER NIB1-ND . . . . $149.95 (not discountable)

SOFTWARE/HARDWARE MANUAL MAN1-ND $5.00 (not discountable)

SILICON TRANSISTORS

MPS918	.16	1.55/10	13.60/C	130.00/M
MPS930	.16	1.55/10	13.60/C	130.00/M
MPS2222A	.16	1.55/10	13.60/C	130.00/M
MPS2369A	.16	1.55/10	13.60/C	130.00/M
MPS2907A	.16	1.55/10	13.60/C	130.00/M
MPS3393	.16	1.55/10	13.60/C	130.00/M
MPS3393	.16	1.55/10	13.60/C	130.00/M
MPS3394	.16	1.55/10	13.60/C	130.00/M
MPS3395	.16	1.55/10	13.60/C	130.00/M
MPS3563	.16	1.55/10	13.60/C	130.00/M
MPS3565	.16	1.55/10	13.60/C	130.00/M
MPS3638A	.16	1.55/10	13.60/C	130.00/M
MPS3641	.16	1.55/10	13.60/C	130.00/M
MPS3643	.16	1.55/10	13.60/C	130.00/M
2N3904	.16	1.55/10	13.60/C	130.00/M
2N3906	.16	1.55/10	13.60/C	130.00/M
2N4124	.16	1.55/10	13.60/C	130.00/M
2N4126	.16	1.55/10	13.60/C	130.00/M
2N4401	.16	1.55/10	13.60/C	130.00/M
2N4403	.16	1.55/10	13.60/C	130.00/M
2N4410	.16	1.55/10	13.60/C	130.00/M
2N5087	.16	1.55/10	13.60/C	130.00/M
2N5089	.16	1.55/10	13.60/C	130.00/M
2N5210	.16	1.55/10	13.60/C	130.00/M
2N3055	.99	9.20/10	85.00/C	800.00/M
MPF102	.36	3.35/10	30.60/C	300.00/M
2N5457	.48	4.50/10	41.00/C	400.00/M
MPSA13	.28	2.60/10	24.00/C	230.00/M
MJ2955	.99	9.20/10	85.00/C	800.00/M



See Our Catalog For More Diamond Tool

MS54 $6.89

ELECTROLYTIC CAPACITORS

VALUE	RADIAL LEADS			AXIAL LEADS		
.47/50V	.10	.78/10	6.20/C	.13	1.10/10	8.50/C
1/50V	.10	.78/10	6.20/C	.13	1.10/10	8.50/C
2.2/50V	.10	.78/10	6.20/C	.13	1.10/10	8.50/C
3.3/50V	.10	.78/10	6.20/C	.13	1.10/10	8.50/C
4.7/35V	.10	.78/10	6.20/C	.13	1.10/10	8.50/C
4.7/50V	.10	.78/10	6.20/C	.16	1.30/10	10.25/C
10/16V	.10	.78/10	6.20/C	.13	1.10/10	8.50/C
10/25V	.10	.78/10	6.20/C	.13	1.10/10	8.50/C
10/35V	.10	.78/10	6.20/C	.16	1.30/10	10.25/C
10/50V	.12	.94/10	7.60/C	.18	1.45/10	11.60/C
22/16V	.10	.78/10	6.20/C	.16	1.30/10	10.25/C
22/25V	.11	.86/10	6.90/C	.16	1.30/10	10.25/C
22/35V	.14	1.12/10	8.95/C	.18	1.45/10	11.60/C
22/50V	.15	1.25/10	9.95/C	.21	1.70/10	13.55/C
33/16V	.11	.86/10	6.90/C	.16	1.30/10	10.25/C
33/25V	.12	.94/10	7.60/C	.18	1.45/10	11.60/C
33/35V	.15	1.25/10	9.95/C	.21	1.70/10	13.55/C
33/50V	.16	1.31/10	10.43/C	.24	1.95/10	15.55/C
47/10V	.11	.86/10	6.90/C	.16	1.30/10	10.25/C
47/16V	.12	.94/10	7.60/C	.18	1.45/10	11.60/C
47/25V	.15	1.22/10	9.74/C	.21	1.70/10	13.55/C
47/35V	.16	1.31/10	10.43/C	.25	2.00/10	16.10/C
47/50V	.17	1.39/10	11.12/C	.27	2.20/10	17.55/C
100/10V	.12	.94/10	7.60/C	.18	1.45/10	11.60/C
100/16V	.15	1.22/10	9.74/C	.21	1.70/10	13.55/C
100/25V	.16	1.32/10	10.52/C	.25	2.00/10	16.10/C
100/35V	.17	1.39/10	11.12/C	.32	2.65/10	21.05/C
100/50V	.29	2.36/10	18.85/C	.33	2.75/10	21.85/C
220/10V	.16	1.32/10	10.52/C	.22	1.85/10	14.55/C
220/16V	.17	1.39/10	11.12/C	.25	2.00/10	16.10/C
220/25V	.25	2.08/10	16.59/C	.33	2.75/10	21.85/C
220/35V	.30	2.47/10	19.75/C	.38	3.13/10	25.05/C
220/50V	.36	2.97/10	23.69/C	.45	3.68/10	29.90/C
330/6V	.16	1.32/10	10.52/C	.22	1.85/10	14.55/C
330/10V	.17	1.39/10	11.12/C	.25	2.00/10	16.10/C
330/16V	.25	2.08/10	16.62/C	.33	2.68/10	21.43/C
330/25V	.30	2.47/10	19.75/C	.37	3.10/10	24.55/C
330/35V	.36	2.96/10	23.69/C	.45	3.68/10	29.44/C
330/50V	.59	4.86/10	38.83/C	.57	4.70/10	37.50/C
470/6V	.17	1.35/10	10.74/C	.25	2.00/10	16.10/C
470/10V	.26	2.12/10	16.95/C	.33	2.75/10	21.85/C
470/16V	.28	2.34/10	18.65/C	.37	3.10/10	24.55/C
470/25V	.35	2.84/10	22.71/C	.45	3.80/10	30.05/C
470/35V	.45	3.71/10	29.62/C	.48	4.00/10	31.80/C
470/50V	.65	5.37/10	42.92/C	.69	5.68/10	45.40/C
1000/6V	.28	2.28/10	18.18/C	.37	3.05/10	24.25/C
1000/10V	.29	2.35/10	18.77/C	.43	3.55/10	28.15/C
1000/16V	.34	2.84/10	22.72/C	.45	3.70/10	29.40/C
1000/25V	.59	4.86/10	38.83/C	.63	5.20/10	41.45/C
1000/35V	.63	5.18/10	41.46/C	.73	6.05/10	48.35/C
2200/6V	.38	3.09/10	24.68/C	.45	3.75/10	29.60/C
2200/10V	.49	4.02/10	32.09/C	.58	4.80/10	38.30/C
2200/16V	.63	5.19/10	41.46/C	.68	5.70/10	45.28/C

MINIBOX METALIZED POLYESTER CAPACITORS

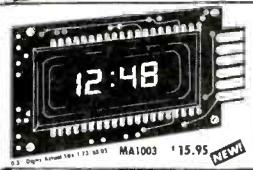
.001/1000V	.16	1.32/10	10.35/C	.0022/1000V	.16	1.32/10	10.35/C
.0033/1000V	.16	1.32/10	10.35/C	.0047/630V	.14	1.15/10	9.00/C
.0068/630V	.14	1.15/10	9.00/C	.01/630V	.16	1.32/10	10.35/C
.022/400V	.17	1.44/10	11.50/C	.033/250V	.17	1.44/10	11.50/C
.047/250V	.15	1.25/10	10.00/C	.068/250V	.17	1.44/10	11.50/C
.1/100V	.19	1.55/10	12.65/C	.22/100V	.26	2.13/10	17.25/C
.33/100V	.35	2.88/10	23.00/C	.47/100V	.41	3.45/10	27.60/C

MA1002 0.5" High Digits

Actual Size: 1.375"x3.05"

MA1010 0.84" High Digits

Actual size: 1.75"x3.75"



MA1003 $15.95 NEW!

CLOCK MODULES

Prices Slashed Beyond All Recognition

MA1002A	.5" LED 12 Hour AM-PM Clock Module		SOLD OUT
MA1002A SET	Module with Transformer & Switches		SOLD OUT
MA1002C	.5" LED 24 Hour Clock Module	~~10.60~~	7.95
MA1002C SET	Module w/Transformer & Switches	~~10.95~~	9.95
MA1003	12 Volt Car Clock with Switches	~~17.60~~	15.95
MA1010A	.84" LED 12 Hour AM-PM Clock Module	~~12.00~~	9.95
MA1010A SET	Module w/Transformer & Switches	~~16.95~~	11.95
MA1010C	.84" LED 24 Hour Clock Module	~~12.00~~	9.95
MA1010C SET	Module w/Transformer & Switches	~~16.40~~	11.95

The MA1002 and MA1010 series clock modules by National Semiconductor are fully assembled and tested clocks using a 4 digit LED display and an MOS integrated circuit on the same board. Simply connect switches and our special transformer and you have a fully functioning clock.

The MA1003 clock module is a fully assembled and tested 12 hour clock using a high brilliance green flourescent display and crystal time base making it perfect for car, boat or other portable use. It operates directly from 12 volts DC so no transformer is needed. Our price includes three push button switches for setting the time.

JMJ DIGITAL DISPLAY BEZEL

NEW

$4.95

PATENTED CHROMAFILTER SCREEN, DIE CAST METAL FRAME MOUNTS IN PANELS UP TO 3/16" THICK, NO EXPOSED HARDWARE, SCRATCH RESISTANT AND EASILY CLEANED, ELIMINATES GLARE.

MOUNTING ADAPTERS AVAILABLE TO SIMPLIFY MOUNTING AND ASSURE PERFECT ALIGNMENT.

400 BEZEL WITH RED FILTER	4.95
420 MOUNTING ADAPTER FOR MA1001 & MA1002	.69
421 MOUNTING ADAPTER FOR MA1010	.69

NEW! POWERACE — SOLDERLESS BREADBOARDING WITH POWER FROM AP

POWERACE 103 — 923103 . . . . . $124.95
POWERACE 101 — 923101 . . . . $84.95
POWERACE 102 — 923102 . . . . . $114.95

POWERACE—for fast, solderless circuit building and testing. All models will accept all DIP sizes—plus TO-5's and discretes with leads to .032" diameter. POWERACE 101 has a variable 5-15 VDC 600 ma power supply. POWERACE 102 features a fixed 5VDC 1 amp power supply, and POWERACE 103 has a fixed 5VDC 750 ma power supply, A fixed plus 15VDC 250 ma power supply and a fixed -15VDC power supply at 250 ma.

5% CARBON FILM RESISTORS

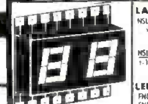
¼ WATT RESISTOR ASSORTMENTS

Catalog Number	Description	PRICE
RS125	Set of 5 each of the 73 standard 5% ¼ watt carbon film resistors in the series 1.0, 1.2, 1.5, 1.8, 2.2, etc. through 1.0 megohm (365 total pcs)	$9.90
RS225	Set of 5 each of the 72 standard 5% ¼ watt carbon film resistors in the series 1.1, 1.3, 1.6, 2.0, 2.4, etc. through 910 kilohm (360 total pcs)	$9.90

½ WATT RESISTOR ASSORTMENTS

Catalog Number	Description	PRICE
RS150	Set of 5 each of the 73 standard 5% ½ watt carbon film resistors in the series 1.0, 1.2, 1.5, 1.8, 2.2, etc. through 1.0 meghom (365 total pcs)	$9.90
RS250	Set of 5 each of the 72 standard 5% ½ watt carbon film resistors in the series 1.1, 1.3, 1.6, 2.0, 2.4, etc. through 910 kilohm (360 total pcs)	$9.90

LED DIGITS AND LAMPS



LAMPS

NSL5053 Dif. Red T-1¾ Lamp w/Mtg. Hdwe. 1.80/10 16.00/100

NSL5056 Dif. Narrow Angle Red T-1¾ Lamp w/Mtg. Hdwe. 1.80/10 16.00/100

LED DISPLAYS

FND507 .5" Single Digit, CA, Red	1.35
FND800 .8" Single Digit, CC, Red	2.50
FND807 .8" Single Digit, CA, Red	2.50

DEVICE TYPE	DIGIT SIZE	FORMAT	DRIVE	PRICE
NSN334		+18	CA, DIRECT	$2.20
NSN373		88 No D.P.	CC, DIRECT	2.20
NSN374		88 No D.P.	CA, DIRECT	2.20
NSN381	Red	88	CC, MULTI.	2.20
NSN382		88	CA, MULTI.	2.20
NSN534		+18	CA, DIRECT	2.60
NSN581		88	CC, MULTI.	2.60
NSN582	0.5"	88	CA, MULTI.	2.60
NSN583	Red	88	CC, DIRECT	2.60
NSN584		88	CA, DIRECT	2.60
NSN734		+18	CA, DIRECT	3.00
NSN781		88	CC, MULTI.	3.00
NSN782	0.7"	88	CA, MULTI.	3.00
NSN783	Red	88	CC, DIRECT	3.00
NSN784		88	CA, DIRECT	3.00
NSB3382		+1888	CA, MULTI.	4.40
NSB3881	0.3"	8888	CC, MULTI.	4.40
NSB3882	Red	8888	CA, MULTI.	4.40
NSB5382		+1888	CA, MULTI.	5.20
NSB5881	0.5"	8888	CC, MULTI.	5.20
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NSB7881	0.7"	8888	CC, MULTI.	6.00
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ACE 200-K

Part No. 923333

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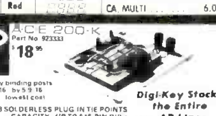

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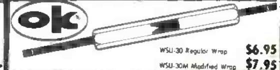

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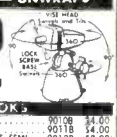

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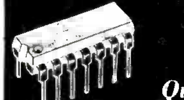

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7	17	27	37	47	57	67	77	87	97	107	117	127	137	147
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