SPECIAL SECTION—USING RF SIGNAL GENERATORS

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Radio-Electronics

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

COVER STORY

DIGITAL THERMOMETER

Add it to your DMM. It reads out in °C or °F at the flip of a switch and it's a cinch to build. Turn to page 29

DARKROOM TIMER

Digital countdown in seconds or minutes and seconds controls your enlarger. Puts your darkroom into the year 2001. Turn to page 33

VIDEO MODULATORS

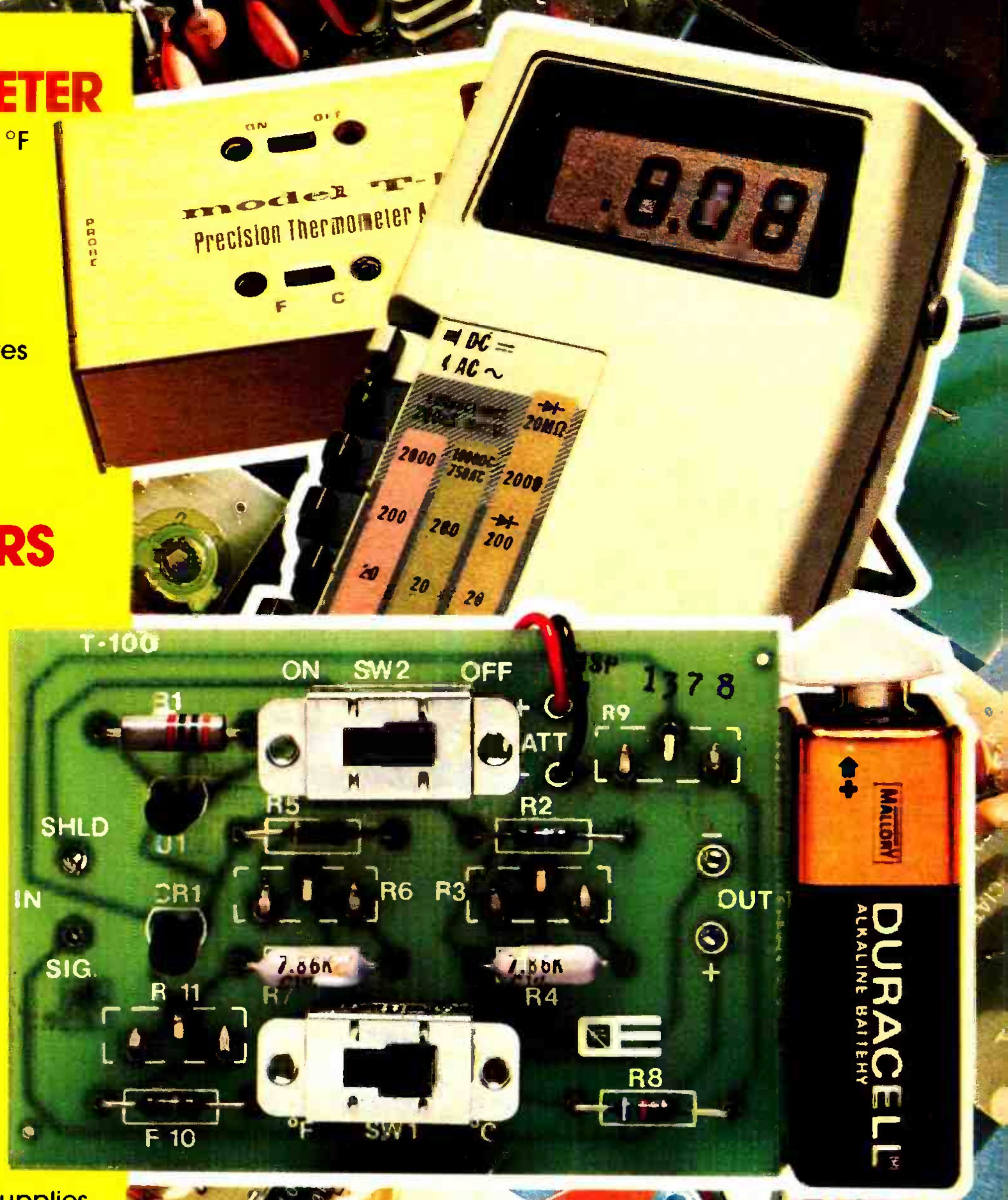
Roundup of all that we could locate. Use them to turn any TV into a video monitor. Story starts on page 38

INVESTMENT

A computer program that lets you compare dollars in the bank with your pet investment. Story is on page 32.

PLUS

- ★ Computer Corner
  Programmable timer
- ★ Hobby Corner
  Build expanded-scale voltmeter
- ★ Service Clinic
  Pulse-width modulated DC power supplies
- ★ R-E Tests Revox B-760 Tuner
- ★ R-E Tests Shure V15—Type IV Cartridge
- ★ State Of Solid State



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A GERNSBACK PUBLICATION

NEW ASTRO-FANTOM™ CB ANTENNA

GOES WHERE NO CB ANTENNA HAS GONE BEFORE!

SUPERIOR PERFORMANCE FOR AUTO, TRUCK, MARINE, RV, MOTORCYCLES AND HOME USE

It Mounts On Glass Transmits and Receives THRU Glass

Now from the AVANTI Research Laboratories comes a sleek, 22″ full 1/2 wave antenna, so unique that it mounts on glass, transmits through glass and receives through glass...yet requires no grounding to metal as do conventional 1/4 wave antennas. No holes to drill...no clamps, clips or magnets to ever mar or scratch your car's finish! No pinched cables to run in through doors, windows or trunk. The Astro-Fantom is a handsome, low profile antenna that provides the ultimate in convenience!

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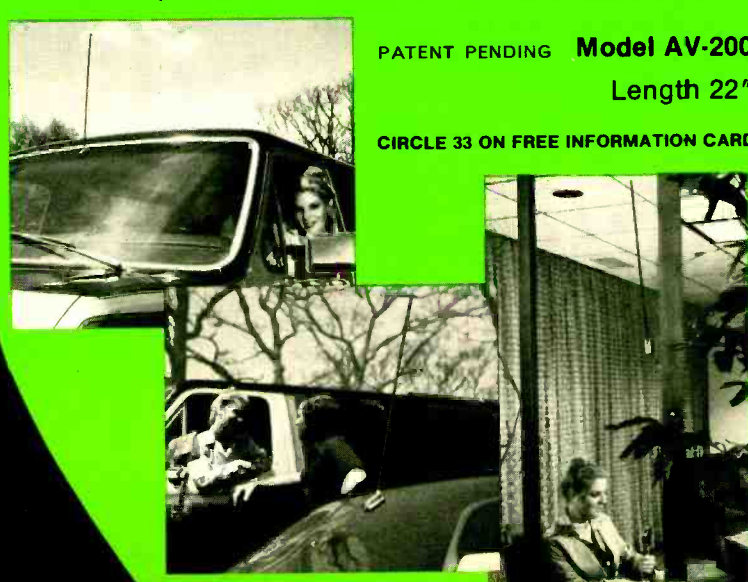
ONE MOUNT SATISFIES EVERY NEED. Astro-Fantom's unique mount attaches anywhere there's a metal framed window. Front, side, or rear of vehicle, boat and motorcycle windshields, even home installation.

CLEAREST COMMUNICATIONS. Avanti's exclusive space age co-inductive™ coupling box actually rejects static and interference as it establishes a highly tuned circuit to transmit and receive radio signals through the glass.

FULL 360° SIGNAL. Astro-Fantom's full 1/2 wave design eliminates dead spots and directional problems found in conventional CB antennas.



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Length 22″

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Radio-Electronics®

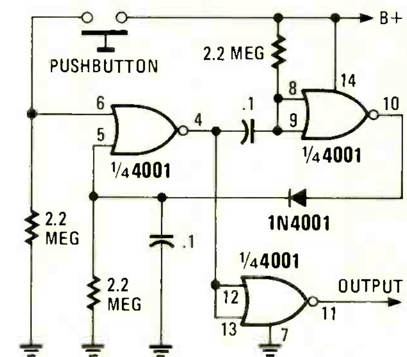
THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

Electronics publishers since 1908

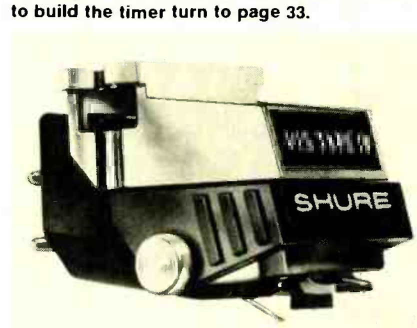
AUGUST 1978 Vol. 49 No. 8

ON THE COVER

Sitting on a background of video modulators is a digital thermometer add-on for a digital multimeter. It's a highly accurate instrument that reads out in both °C and °F at the flip of a switch. Story starts on page 29.



SIMPLE TEST CIRCUIT is used to set up your new digital darkroom timer. For details on how to build the timer turn to page 33.



NEW PHONO CARTRIDGE plays stereo discs so well that it earns a "Superb" from our test lab. For all the details turn to page 44.

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looking ahead

Calculator evolution: Just a short time ago, it seemed that the pocket calculator market was about to dry up. Prices were tumbling well below $10, and it was evident that sooner or later everybody would have one, and that would be it. Well, calculators are doing nicely, thank you. World production this year will be about 70 million units, and the little calculators are being introduced in forms which were unheard-of just a couple of years ago.

It's no longer price, but sophistication, which sells calculators. Of course, not everyone needs a complex scientific calculator, but we are now seeing a marked trend to ultra-sophisticated calculators just about anyone can use—even people who have never heard of a logarithm or a cosine. One manifestation of the trend is the slim calculator, about the size of a credit card, with liquid crystal readout—some with a battery life so long that replacement probably won't be needed for the life of the instrument. Another is the calculator combination—such as the combination calculator, pocket watch, stopwatch, perpetual calendar and alarm clock.

The next generation pocket calculator almost certainly will be microprocessor-equipped, with alphanumeric keyboard and display. One of the forerunners of this trend is the Toshiba Electronic Notebook, which contains a CPU and a RAM chip. In addition to traditional calculator functions it has a secret memory—or rather 30 memories that can store information for recall at will. By punching in letters or numbers, or combinations of both, the user can use it to store telephone numbers, addresses, remind him of appointments, and so forth. For example, you might punch in the name of your wife and the readout will display her birthday. Of course, you can do the same thing with a memo pad, but this is electronic, and it's only $80.

Obviously, the line between calculators and mini- or microcomputers is blurring rapidly. A far more deluxe gadget than the Electronic Notebook, but performing some of the same functions, is the Mind Reader, developed by a California company called CTI. This $495 desktop accessory has an alphanumeric keyboard, electronic alarm and a 12-digit fluorescent display, and can be programmed as a complete office reminder—alerting its owner to the time of a meeting, the subject and so forth.

And while we're on bigger-than-pocket gadgets, the latest in computer chess games is a compact unit named Boris, which can play at all skill levels—and also kibitzes. The digital readout talks back to the player with such words and phrases as "Stalemate," "Is this a trap?" and "Congratulations." It's $300.

Back to the pocket. Calculators are changing so fast that John McDonald, president of Casio U.S.A., says the life of a calculator model is now only one year before it's replaced by an updated unit. As to the average life of a calculator itself, he estimates it's about four years before it's replaced—not because it wears out but because the user finds something better or more titillating. This suggests that we're becoming a nation of calcoholics.

CATV vs. VCR: "Record one TV program while you watch another." So proclaim the ads for home videocassette recorders, or VCR's. But some VCR buyers are finding out this isn't always completely true. The fact is that under certain conditions, cable TV subscribers who own VCR's must choose between the ability to record all available channels or to watch one channel while taping another.

This is true when the home cable terminal has a converter box to provide extra channels above and beyond the 12 conventional VHF ones. These channels are the so-called mid-band and super-band channels, usually identified by letters instead of numbers and they often include any pay-cable channels such as Home Box Office, which present top commercial-free entertainment, including recent movies—obviously prime home taping material.

The problem is that cable TV channels in these cases are selected through a converter box, normally connected between the cable and the TV set. The VCR has its own tuner, of course, which can select only the standard VHF and UHF channels, but not the special lettered channels. If the converter is connected directly to the home cable input and its output to the VCR, the tuner in the converter governs the signal fed to both the VCR and the TV. All the channels may be tuned, but the VCR can record only the same signal which is being fed to the TV. If the setup is changed and the cable fed directly into the VCR, with the converter installed between the VCR and the TV, the VCR can tune only to the numbered channels, while the TV can receive any of the cable channels since it (but not the VCR) is governed by the converter. Thus, if a viewer should wish to record Home Box Office he must use the first setup and can't view another program at the same time. If he wants to watch one show and tape another, he can't tape Home Box Office.

Most VCR suppliers who are aware of the problem, as well as most cable companies, suggest the addition of a second converter, available from the cable company at an additional monthly charge. In many such cases the cable companies insist on doing the installation themselves (at a fee) to assure that their equipment is operating properly. [Perhaps some **R-E** readers can offer a better—or cheaper—solution; we'd like to hear from you.]

VCR's to come: It's new-model time, and this applies to VCR's as well as TV sets. In addition to updating its basic Betamax unit with built-in electronic clock-timer and remote pause control (**Radio-Electronics,** June, 1978), Sony also unveiled the first home portable VCR, which weighs about 17 pounds, can be operated from battery or AC and can be carried by a shoulder strap. As a companion, Sony will have a color camera weighing less than five pounds. They're both due later this year.

Among other coming VCR attractions will be a portable recorder and camera from Panasonic, and a home VCR from JVC which permits still-frame and slow motion as well as letting the user scan the picture during the fast-forward process for accurate location of any scene. And RCA is expected to introduce a VCR with built-in one-week programmer to permit automatic channel-switching and off-on cycling during unattended recording.

DAVID LACHENBRUCH
CONTRIBUTING EDITOR


Here's a new tool repair shops can really use.
5yr. warranty
ON REPLACEMENT TV PICTURE TUBES.

new & timely

1977—a banner year for CB applications and sales

The Federal Communications Commission reports receiving almost five million CB radio applications in 1977 (1976 saw more than five million such applications).

John Sodolski, vice president of the Electronics Industries Association and head of EIA's Communications Division, adds that more CB transceivers were sold at retail in 1977 than since 1958. With such a good sales record, Sodolski feels confident that "consumer interest in CB radio is still running high." The use of CB radios in such crises as the blizzards and floods of recent months, he notes, are a clear indication that people are buying CB's for emergency use and for the peace of mind that results from knowing that these devices can be used in emergency situations. It is estimated that at present there are about 30 million CB's in use.

Computer-controlled optical scanning machine can read to blind

The New York Public Library has recently installed what has been described as one of the "most valuable rehabilitation aids (for the blind) since the invention of Braille." This device is a machine containing an optical scanner that actually "reads" material via a computer-generated voice.

The scanner began life as a computer science project developed by an M.I.T. student who, later realized its potential as an aid to the blind. What it does is beam a ray of white light across a printed page, and then convert the material into digital data that the computer analyzes and converts into an actual voice reading. The machine reads a selection by consulting 1000 preprogrammed pronunciation rules and exceptions; it recognizes each letter by its shape. There are controls for adjusting voice speed, repeating sentences or phrases, or spelling out words. So far, the only complaint seems to be that the New York Library machine speaks in a foreign accent!

James Gashel of the National Federation of the Blind asserts that "the device would make pleasure reading possible for those whose literary diets had been limited to Braille textbooks" and some recorded material. A blind reader can learn to operate the machine in 20 hours, as opposed to the many months (and even years) involved in learning Braille. The New York Library's machine is one of 15 in existence and the only one installed in a public library.

Electronic bank machines prey to fraud and embezzlement

Along with the convenience and speed of electronic bank transactions (i.e., cash machines) has come a perhaps not-unexpected side effect—criminals and con men

ULTRA-THIN BATTERY FOR WATCHES

AN ULTRA-THIN SILVER-OXIDE BATTERY, developed by Panasonic, is suitable for electronic watches using LCD displays as well as for any other application requiring a low-profile cell. Called the *model WL-5*, the battery has a diameter of 0.4555 inch and measures only 0.085-inch thick. The battery has a nominal output voltage of 1.5 VDC 40 mAH over a temperature range of -10°C to 60°C; a long storage capacity; and, because the silver oxide allows for a minimum variation in the internal resistance, the voltage is stable.

(and women) have learned how to manipulate the machine and the system to defraud both the public and the banks. Although some of the reported cases involve mail fraud, the main weakness lies in the machines themselves, which require you to dip a card and use a special code to withdraw, deposit, transfer funds and pay bills.

While most of these transactions are undertaken without incident, almost all the cases of theft involve the misuse of the cash dispenser cards. Bank officials, wary of the adverse publicity and unwilling to advertise the vulnerability of the machines, have tended to soft-pedal the incidents. However, it was estimated that in 1977 the total nationwide loss of both consumer funds and bank assets ran into $2.5 million.

Some of the ways criminals have taken advantage of the card system:

- Preventing a customer from completing a transaction by posing as an official, then completing the transaction themselves.
- Intercepting bank cash cards and code numbers sent via the mail.
- In one bizarre case, a customer was mugged outside a cash machine and forced to hand over both card and code. The thieves made off with about $400, although the victim's bank balance only contained $130!

Banks by and large have tried to make up the losses privately on a case-by case basis. Many have strengthened their security systems and attempted to close system loopholes. The U.S. Congress is presently reviewing legislation that would limit customer liability, require bank receipts from automatic tellers, and make some transactions reversible. And in N.Y. State the Attorney General is trying to stop the unsolicited mailing of cash credit cards.

Top-name computer equipment sold at auction

Some famous names in computer equipment will fall under the auctioneer's gavel this summer. The auction is run by Newman Computer Exchange, which buys up quantity lots of new and reconditioned equipment from leading manufacturers and sells them via mail-order catalogs. The auctioned items are selected from overstocked merchandise or slow movers.

Minimum bids are established on the equipment (which this year includes some top-rated items such as Commodore's PET). The equipment is sold at the highest bid above the minimum price set, regardless of the loss to the company.

Chuck Newman, vice president of the firm, stressed that only mail bids would be accepted, and individuals appearing in person at the auction cannot outbid the highest mailed-in bid received.

The estimated value of the merchandise to be auctioned this year will exceed $1,000,000. Opening date for the bids has been set for July 31. For further information, write Newman Computer Exchange, Dept. R58, Box 8610, Ann Arbor, MI 48107, or call Chuck Newman (313) 994-3200.

Hickok/Forest Belt Workshops drawing nets Grand Prize winner

Hickok Electrical Instrument Company and the Forest Belt Training Workshops

GRAND PRIZE WINNER at opening ceremony for Forest Belt's 1978 Training Workshops is William T. Ricks (left). He is shown being presented with a Hickok instrument by Forest Belt (right). Karen Ruff (center) drew Ricks' name from a list of six finalists.

continued on page 12

We've done the impossible again!
A versatile and superior frequency counter kit for only $89.95

...et about price/performance trade-offs ...a frequency counter. In Sabtronics' ... features you once expected to pay ...ollars for. But you pay only our low,

...s frequency counter, using LSI ...formance and input character... ...he specifications: You will see ...s guaranteed all the way to ... input impedance allows you ...peration. And you'll see a ... the frequency range; con... ...or best resolution; and ... an optional pre-scaler. ...ase, and its excellent ...tics. And a full 8-digit ... point, leading zero

...res together only ... Sabtronics' ad... ... your own skill ... follow instruc... ...ave this fine ...ould other-

...days. If ...r full

Brief Specifications
• Frequency Range: 20 Hz to 100 MHz guaranteed (10 Hz to 120 MHz typical) • Sensitivity: 25 mV RMS, 20 Hz to 70 MHz (20 mV typical); 45 mV RMS, 70 MHz to 120 MHz (30 mV typical) • Selectable Impedance: 1 MΩ at 25 pF, or 50 Ω • Selectable Attenuation: X1, X10, or X100 • Accuracy: ± 1 Hz plus time-base accuracy • Ageing rate: ± 5 ppm/yr • Temperature stability: ± 10 ppm, 0° to 50°C • Selectable Gate-time: 0.1 sec, 1 sec., or 10 sec. • 8-digit LED display with floating D.P., overflow indication • Input: 9-15 VDC, 350 mA (550 mA with optional prescaler) • Input protection: 150 V RMS, 20 Hz to 10 kHz; 30 V RMS to 2 MHz; and 3 V RMS to 100 MHz • Optional prescaler extends frequency range to 650 MHz. (Available soon)

RE 6

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Please send me ______ Sabtronics Model 8100 Frequency Counter Kit(s) at $89.95 each $______
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*Canada $6.50. All other countries $19.00 Airmail.

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...orkshops ...78

...orkshops have been ... Belt 1978 CB Service ...s a three-day Advanced ... Workshop, to be con... ...—one in Indianapolis, Sep... ...0, and again in Captiva Island ...e South Seas Plantation) on ...er 13–17. The latter workshop ses... ...ers two extra days that can be used ... for personal consultation or relax... ...on. The other workshop offered will be in ...dvanced Communications Servicing, also to be held twice—Indianapolis, September 11–13, and Florida, November 6–10.

The Advanced Video Servicing Workshop will deal with video cassette recorders, digital TV tuning, VIR color control, plus new alignment and troubleshooting procedures. The Advanced Communications Servicing Workshop will feature FM two-way radio systems, advanced PLL, SSB, marine radio and more.

Fees for the Indianapolis Workshops, $495; for Florida, $595. Included in the fees are lodging; breakfast, lunch and coffee breaks; and an Awards Banquet. Spouses are invited to attend on a no-workshop fee basis. Enrollments close August 4 for Indianapolis; September 15 for Florida. Send check or money order to: Forest Belt's Training Workshops, Box 68120, Indianapolis, IN 46268.

New School offers audio electronics workshop for beginners

The New School for Social Research in New York City this past summer provided a workshop for beginning electronics students. The three-hour-per-week, six-session course emphasized basic skills and information needed to assemble kits, purchase components and design and construct audio-digital equipment. Students learned how to solder, prepare PC boards and point-to-point wiring techniques. The course fee was $75, and students were asked to bring their own tools.

Steve Ohr, the New School's audio-visual director and course instructor, believes that "providing individuals with a working knowledge of electronics will serve them in many ways long after the course has been completed." R-E

...a to ...ance, ...one city ...close by), ...ould come ...n that of the ...cturer is then ...sive travel costs ...placing service reps ...new customer. Such ..., staggering losses to ...il companies in the mini ...uter field.

... to the problem is "third ...nance" such as that offered by ...which the computer manufactur... ...ssign service responsibility to a ...ny having offices in many diverse .... Another alternative, Harmon went

...formation center with 24 ...gy and fuel economy ...r $400.

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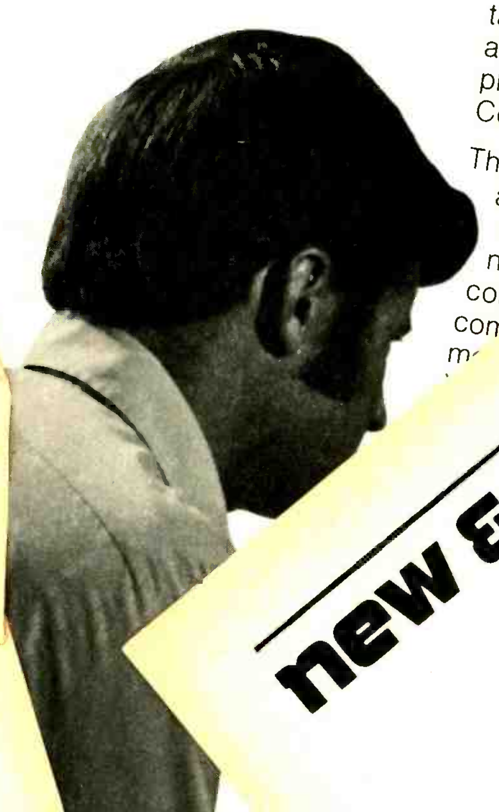

393 Washi

new & timely

continued from page 6

recently conducted a final drawing for the Grand Prize offered to six finalists from earlier contests sponsored by the 1977 Workshops. Last year, each Workshop culminated in an Awards Banquet, at which the first drawing was held. The first name drawn had the option of selecting either a prize on the spot, or electing to go for the Grand Prize; the second name drawn would "get what was left."

At the San Antonio Awards Banquet, the second name was that of William T. Ricks, who automatically became a finalist in the Grand Prize contest. This year, at an opening ceremony for the 1978 Forest Belt Workshops, his name was drawn from among the six finalists. The Grand Prize was the *Comm-Line* CB Service Rack, containing seven test instruments and accessories, which Ricks will find most useful for his modest repair business near Dallas.

Both Hickok and Forest Belt have announced that Hickok test instruments will be awarded during the five Forest Belt Workshops planned for 1978. For details, write: Forest Belt's Training Workshops, Box 68120, Indianapolis, IN 46268.

Automotive computer handles 24 different functions

A self-contained 24-function automotive computer called the *Prince On-Board Computer* has been developed by the OBC Products Division of Prince Corporation, Holland, MI. The computer is compact, weighs less than 1 pound, is easy to operate and presents no installation problems. It can be connected via a speed transducer and a fuel flow transducer, both supplied with the unit; and it can be mounted on or under the dash or overhead.

Now as to what it can do: An LED display provides information on such vital statistics as miles to destination, vehicle location (at ... time), ETA, miles per gallon, cost per ... time of arrival, fuel need, time of day, ... addition, the unit contains an alarm ... lse alarm, five memories with

individual entry and recall and automatic memory scan. All the controls are easy to get at and color-coded.

In sum, the *On-Board Computer* provides significantly more information to the driver than has been available up until now . . . and, it is hoped, will provide a safer and more hassle-free drive. The company estimates the cost of the *On-Board Computer* will be about $400 and that it will appear on the market by early 1979.

Inadequate field service can jeopardize future of computer companies

Speaking before the Association of Field Service Managers (AFSM), George Harmon warned that lack of adequate field servicing could cause many new computer companies to go out of business. Harmon, president of AFSM and vice president of the Service Division of Pertec Computer Corporation, emphasized that servicing a data-processing system requires the same dedication as that given other office machinery, "but it is almost impossible for a small computer company to position a repairman 20 minutes from each customer—and n... go broke."

The problem lies in not being ab... control where sales originate. For in... a first customer can be based in... (with a service technician place... but then subsequent sales ... from areas far removed fr... original sale. The manu... faced with either exte... and/or the necessity of... to take care of each ... costs can result ... many young, sm... and microcom...

One answ... party maint... Pertec, in... er can ... comp... are

on, would be to offer sales to regions that can be serviced within a one-hour travel-time limit. Whatever solution is tried, it is important to keep in mind that with computer companies proliferating almost d... field service is a "major factor in pr... costing . . . if a company doesn't ... service operations under contro... the distinct possibility of going ... ness."

Two new Forest Belt ... scheduled for late 1...

Two new Training ... added to the Fores... series. The first ... Video Servicin... ducted twice ... tember 18-... FL (at T... Novem... sion ... eith... a...

We've done the impossible again!
A versatile and superior frequency counter kit for only $89.95

Now you can forget about price/performance trade-offs when you select a frequency counter. In Sabtronics' Model 8100 you get features you once expected to pay several hundreds of dollars for. But you pay only our low, low price of $89.95!

Dare to Compare. This frequency counter, using LSI technology, has the performance and input characteristics you demand. Note the specifications: You will see that the frequency range is guaranteed all the way to 100 MHz; and a high or low input impedance allows you to select for high-frequency operation. And you'll see a sensitivity that holds well over the frequency range; convenient selectable gate-time for best resolution; and selectable attenuation; and even an optional pre-scaler. Note the highly accurate time base, and its excellent ageing and temperature characteristics. And a full 8-digit LED display with floating decimal point, leading zero suppression, and overflow indicator.

You would expect to find all these features together only on a much higher-priced instrument. But Sabtronics' advanced digital technology combines with your own skill — you assemble this kit from our easy-to-follow instructions — to make it possible for you to have this fine frequency counter at a fraction of what you would otherwise expect to pay.

Free 10-day trial
Examine the 8100 Frequency Counter Kit for 10 days. If not completely satisfied, return unassembled for full refund of $89.95 purchase price.

sabtronics
INTERNATIONAL INC.
13426 Floyd Circle · Dallas, Texas 75243
Telephone 214/783-0994

Brief Specifications
• Frequency Range: 20 Hz to 100 MHz guaranteed (10 Hz to 120 MHz typical) • Sensitivity: 25 mV RMS, 20 Hz to 70 MHz (20 mV typical); 45 mV RMS, 70 MHz to 120 MHz (30 mV typical) • Selectable Impedance: 1 MΩ at 25 pF, or 50 Ω • Selectable Attenuation: X1, X10, or X100 • Accuracy: ± 1 Hz plus time-base accuracy • Ageing rate: ± 5 ppm/yr • Temperature stability: ± 10 ppm, 0° to 50°C • Selectable Gate-time: 0.1 sec, 1 sec., or 10 sec. • 8-digit LED display with floating D.P., overflow indication • Input: 9-15 VDC, 350 mA (550 mA with optional prescaler) • Input protection: 150 V RMS, 20 Hz to 10 kHz; 30 V RMS to 2 MHz; and 3 V RMS to 100 MHz • Optional prescaler extends frequency range to 650 MHz. (Available soon)

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electronics at home.

NRI offers you five TV/Audio Servicing Courses

NRI can train you at home to service Color TV equipment and audio systems. You can choose from 5 courses, starting with a 48-lesson basic course, up to a Master Color TV/Audio Course, complete with designed-for-learning 25" diagonal solid state color TV and a 4-speaker SQ™ Quadraphonic Audio System. NRI gives you both TV and Audio servicing for hundreds of dollars less than the two courses as offered by another home study school.

All courses are available with low down payment and convenient monthly payments. All courses provide professional tools and "Power-On" equipment along with NRI kits engineered for training. With the Master Course, for instance, you build your own 5" wide-band triggered sweep solid state oscilloscope, digital color TV pattern generator, CMOS digital frequency counter, and NRI electronics Discovery Lab.

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NRI's Complete Communications Course includes your own 400-channel VHF transceiver

NRI's Complete Communications Course will train you at home for one of the thousands of service and maintenance jobs opening in CB; AM and FM transmission and reception; TV broadcasting; microwave, teletype, radar, mobile, aircraft, and marine electronics. The complete program includes 48 lessons, 9 special reference texts, and 10 training kits. Included are: your own "designed-for-learning" 400-channel VHF transceiver; electronics Discovery Lab™; CMOS digital frequency counter; and more. You also get your all important FCC Radio-telephone License, or you get your money back.

CB Specialist Course also available

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c… ued from page 6

recently conducted a final drawing for the Grand Prize offered to six finalists from earlier contests sponsored by the 1977 Workshops. Last year, each Workshop culminated in an Awards Banquet, at which the first drawing was held. The first name drawn had the option of selecting either a prize on the spot, or electing to go for the Grand Prize; the second name drawn would "get what was left."

At the San Antonio Awards Banquet, the second name was that of William T. Ricks, who automatically became a finalist in the Grand Prize contest. This year, at an opening ceremony for the 1978 Forest Belt Workshops, his name was drawn from among the six finalists. The Grand Prize was the *Comm-Line* CB Service Rack, containing seven test instruments and accessories, which Ricks will find most useful for his modest repair business near Dallas.

Both Hickok and Forest Belt have announced that Hickok test instruments will be awarded during the five Forest Belt Workshops planned for 1978. For details, write: Forest Belt's Training Workshops, Box 68120, Indianapolis, IN 46268.

Automotive computer handles 24 different functions

A self-contained 24-function automotive computer called the *Prince On-Board Computer* has been developed by the OBC Products Division of Prince Corporation, Holland, MI. The computer is compact, weighs less than 1 pound, is easy to operate and presents no installation problems. It can be connected via a speed transducer and a fuel flow transducer, both supplied with the unit; and it can be mounted on or under the dash or overhead.

Now as to what it can do: An LED display provides information on such vital statistics as miles to destination, vehicle location (at any time), ETA, miles per gallon, cost per mile, time of arrival, fuel need, time of day, etc. In addition, the unit contains an alarm set/audio pulse alarm, five memories with individual entry and recall and automatic memory scan. All the controls are easy to get at and color-coded.

In sum, the *On-Board Computer* provides significantly more information to the driver than has been available up until now . . . and, it is hoped, will provide a safer and more hassle-free drive. The company estimates the cost of the *On-Board Computer* will be about $400 and that it will appear on the market by early 1979.

AUTOMOTIVE COMPUTER provides motorists with a driver controlled information center with 24 functions. At a touch of the button, vehicle location, trip information, time of day and fuel economy data can be displayed on the LED digital display. The unit is expected to retail for $400.

Inadequate field service can jeopardize future of computer companies

Speaking before the Association of Field Service Managers (AFSM), George Harmon warned that lack of adequate field servicing could cause many new computer companies to go out of business. Harmon, president of AFSM and vice president of the Service Division of Pertec Computer Corporation, emphasized that servicing a data-processing system requires the same dedication as that given other office machinery, "but it is almost impossible for a small computer company to position a repairman 20 minutes from each customer—and not go broke."

The problem lies in not being able to control where sales originate. For instance, a first customer can be based in one city (with a service technician placed close by), but then subsequent sales could come from areas far removed from that of the original sale. The manufacturer is then faced with either extensive travel costs and/or the necessity of placing service reps to take care of each new customer. Such costs can result in staggering losses to many young, small companies in the mini and microcomputer field.

One answer to the problem is "third party maintenance" such as that offered by Pertec, in which the computer manufacturer can assign service responsibility to a company having offices in many diverse areas. Another alternative, Harmon went on, would be to offer sales to regions that can be serviced within a one-hour travel-time limit. Whatever solution is tried, it is important to keep in mind that with computer companies proliferating almost daily, field service is a "major factor in product costing . . . if a company doesn't have its service operations under control, it faces the distinct possibility of going out of business."

Two new Forest Belt Workshops scheduled for late 1978

Two new Training Workshops have been added to the Forest Belt 1978 CB Service series. The first is a three-day Advanced Video Servicing Workshop, to be conducted twice—one in Indianapolis, September 18–20, and again in Captiva Island FL (at The South Seas Plantation) on November 13–17. The latter workshop session offers two extra days that can be used either for personal consultation or relaxation. The other workshop offered will be in Advanced Communications Servicing, also to be held twice—Indianapolis, September 11–13, and Florida, November 6–10.

The Advanced Video Servicing Workshop will deal with video cassette recorders, digital TV tuning, VIR color control, plus new alignment and troubleshooting procedures. The Advanced Communications Servicing Workshop will feature FM two-way radio systems, advanced PLL, SSB, marine radio and more.

Fees for the Indianapolis Workshops, $495; for Florida, $595. Included in the fees are lodging; breakfast, lunch and coffee breaks; and an Awards Banquet. Spouses are invited to attend on a no-workshop fee basis. Enrollments close August 4 for Indianapolis; September 15 for Florida. Send check or money order to: Forest Belt's Training Workshops, Box 68120, Indianapolis, IN 46268.

New School offers audio electronics workshop for beginners

The New School for Social Research in New York City this past summer provided a workshop for beginning electronics students. The three-hour-per-week, six-session course emphasized basic skills and information needed to assemble kits, purchase components and design and construct audio-digital equipment. Students learned how to solder, prepare PC boards and point-to-point wiring techniques. The course fee was $75, and students were asked to bring their own tools.

Steve Ohr, the New School's audio-visual director and course instructor, believes that "providing individuals with a working knowledge of electronics will serve them in many ways long after the course has been completed." R-E

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editorial

A Computer In Every Home—Fact Or Fantasy

NOT SO LONG AGO, INDUSTRY EXPERTS WERE PREDICTING THAT CALCULATORS AND DIGITAL watches were going to be the next major revolution in consumer electronics. Soon afterwards, when the markets for these items became saturated and sales leveled off, the consumer electronics industry turned its attention to CB radio. With a little bit of help from the Federal Government (40 channels or bust), sales of CB radios nose-dived and a new, more lucrative, product was needed. Out of this search came projection TV, video games, VTR's and home computers.

Although sales predictions for these products vary widely, my concern is with one product that is doomed to failure—the *home* computer. Keep in mind that there is a definite and distinct line drawn between the hobby and home computer markets. **Hobby computers** are those systems designed for electronics enthusiasts, those that will take the system home, experiment with it, learn about it and then modify it. Whether the hobbyist intends to use his computer for stock market analysis, personal finances, income tax preparation or just plain game-playing, matters little. The point is that he will be learning about computers, how they work, how to program them and, more important, how the microprocessor works. After gaining the necessary knowledge, he will look towards applying the computer and the microprocessor to solve real everyday problems.

The **home computer,** however, is directed toward the masses. Here the industry is looking for mass volume sales and is touting the home computer as a home appliance able to solve a host of problems for the homeowner. Who is the industry trying to fool? Does the industry really expect John Q. Public to take the computer home, learn to program it, interface it and use it to solve problems? The same John Q. Public that calls a service technician only to discover that the line cord isn't plugged into the wall outlet? And what sort of problems does the industry expect the home computer to solve? Can anyone name a single application that is more meaningful to the home-owner than a $1000 solar energy converter? The silence is deafening. To put the home computer in perspective, it's a solution looking for a problem.

There are those that tout the computer as a central control unit for the home. It could handle such tasks as controlling lights, appliances, lawn sprinkler systems and the like. Total nonsense! Do we need a $1000 system for these tasks? We certainly don't need a CRT, a floppy disc and 32K of RAM. Microprocessor IC's are inexpensive. The control tasks can be handled easily with an 8008; an 8080 or Z-80 simply isn't required. Why not put a microprocessor IC in each appliance we wish to control rather than building a single central control unit. This would certainly be more economically desirable.

As far as hobby computers are concerned, the knowledge gained from these systems is worth every penny spent. It is the users of these systems that will find meaningful applications for the microprocessor. **Radio-Electronics** will, therefore, continue to provide tutorial, applications and construction-oriented hobby computer articles.

How about sending us your opinion on the future of the home computer? What problems around the home do you foresee the microprocessor solving? Get busy designing circuits to solve those problems. For it is you that comprise that segment of the population that comprehends, understands and has the know-how to accomplish these feats. And it is you, therefore, that is a most vital force within the consumer electronics industry.

Art Kleiman

ART KLEIMAN
Managing Editor

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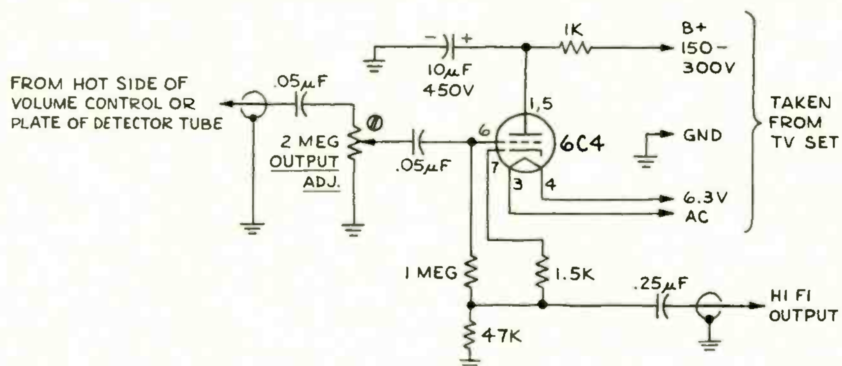
letters

TV AUDIO-TO-STEREO ADAPTER

With reference to Robert E. Thomas II's letter in the January 1978 issue regarding his attempts to feed TV audio into his hi-fi system, I have been conducting numerous experiments of this type for many years, and have made several observations:

1. If you wish to feed the audio from your TV into the input of your mono or stereo amplifier or receiver, be *sure* both sets have power supplies that are fully transformer-isolated. Many portable and low-priced sets do not, and have their chassis connected directly to one side of the AC line and are dangerous to connect into. To find out, check your set's schematic.
2. If your TV set is a tube type, it probably has a high-output, high-impedance quadrature detector. If so, a cathode follower must be installed in the set, close to the sound detector tube or the volume control. A suitable circuit is shown in the diagram. This cathode follower can be built in a minibox, and takes its heater and B+ voltage from the TV set.
3. If the set is solid-state, its detector is of a lower impedance and can be tapped directly. However, use low-capacitance shielded cable and keep it as short as possible. Include a 1.0 μF, 100-volt capacitor in the hot side of this lead (at the TV end) to prevent unwanted DC voltages from being coupled. As with tube sets, the volume control immediately follows the sound detector in most cases. This, in turn, varies the gain of an amplifier stage. If so, audio does not appear on the volume control and must be traced with a scope. Again, check the set schematic.
4. Even if the set has no power transformer, you can still disconnect the small speaker in the set and bring leads out to a better speaker. Be sure that the impedance of the new speaker matches the original and insulate all connections, since they may be hot. Select an efficient speaker



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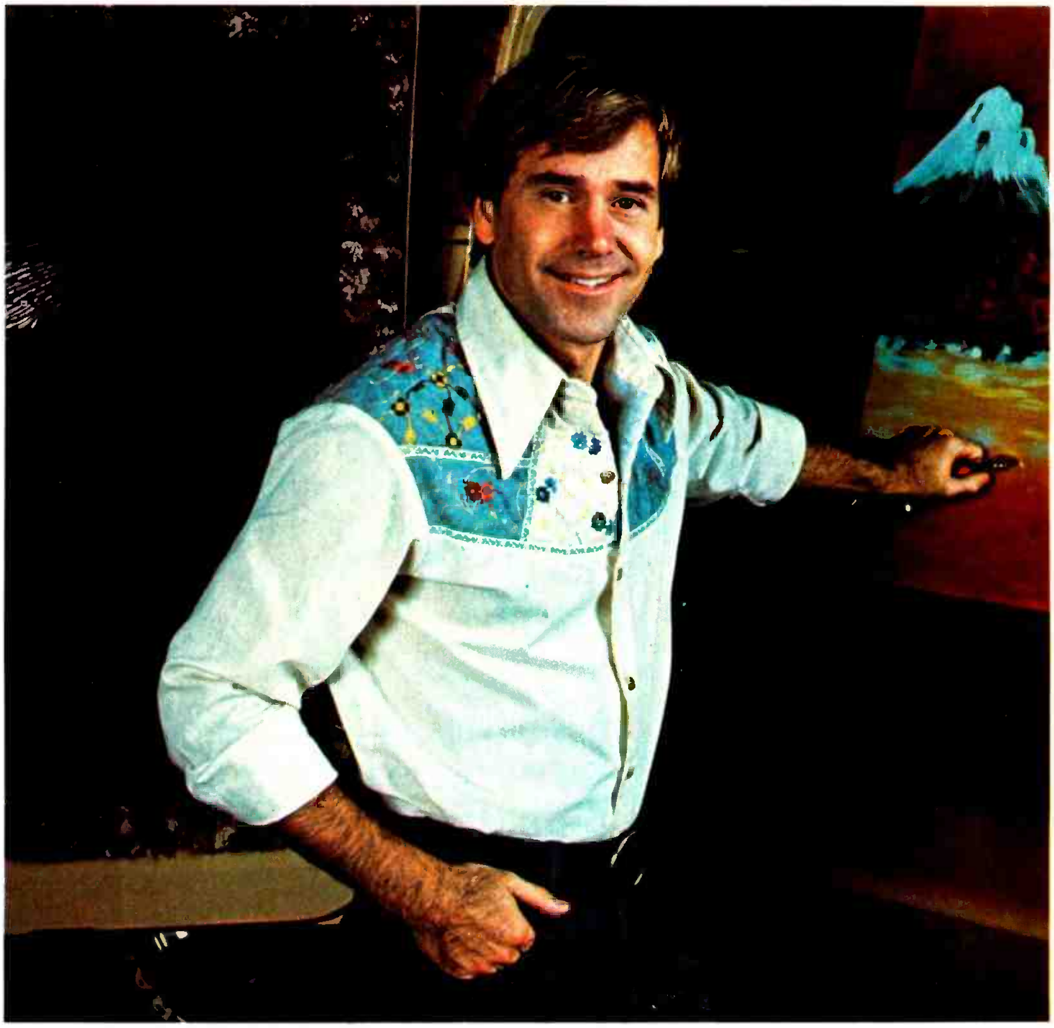
You gotta shop around.



When you do, you'll probably pick CIE. You can't afford to settle for less when it comes to something like electronics training that could affect your whole life.

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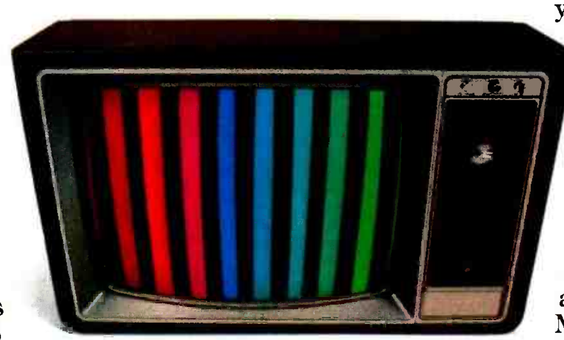

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LETTERS
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since you will have only one or two watts to work with.

5. Don't expect concert-hall sound from TV programs. Most TV stations compress the audio rather tightly, and the frequency response is about 100 Hz to 5 kHz, mainly due to the narrowband telephone lines used by the networks in their audio links. You will, nonetheless, overcome the worst villain in TV sound reception—the obnoxious resonances and distortion characteristics of the small speakers used in most sets.

MICHAEL KILEY
Palos Heights, IL

DIGITAL CLOCKS

I enjoyed the article "Unusual Electronic Clocks" (April, 1978, page 40) since I have constructed many digital clock kits from past articles.

The electronic designs are unique, but the designers do not seem to understand the geometry of a mechanical clock's pendulum. The centers of the pendulum radii are too low to make it a realistic "swing." Mechanical pendulum centers are around the "12 o'clock" position. The Bullet clock is the worst offender.

There is also a serious problem in the mechanism of the face of the Amelect Grandfather Clock. The hours *only* advance when the minutes reach 60, so that when the minutes are at say 55, you do not know what hour it is five minutes before. The hours should progress 1/60th for every 12 minutes, just as a mechanical clock does.

HAROLD CORNELL
Big Flats, NY

Regarding your comments about the physical appearance of the electronic pendulums of the Amelect, Bullet and Solid State Time clocks, I can only assume that, similar to myself and others, the designers of these electronic simulations were not aware of the normal mechanical parameters associated with pendulum geometry.

As for the Amelect clock not having more hourly positions, this was certainly a reasonable design compromise to reduce the components count (your suggestion would require 48 more LED's) and design complexity (extra counting circuitry would be needed). If you simply read hours, minutes and seconds in that sequence, there's no ambiguity.

FRED BLECHMAN

COMPUTER CORNER ERROR

The Computer Corner column in the February 1978 issue uses an erroneous example for the relative addressing mode. The machine instruction given ($30EE_{16}$) will jump to address $9F0_{16}$, since EE_{16} equates to a displacement of -18_{10}. To jump from address 1002_{16} to $10F0_{16}$ would require a displacement of 238_{10}, which is outside the range of this addressing mode.

ROGER J. HENN
Offutt AFB, NE

As the text preceding the example indicates, a displacement of 238_{10} is outside the range of the relative jump. Mr. Henn is correct in stating that the example is wrong. The example should have read:

JR NC, 1080H 00110000 01111110
byte 1 byte 2
JR instruction is at location 1000_{16}. A jump is executed if carry flag = 0. The jump address is 1002_{16} (program counter contents) + $7E_{16}$ or 1086_{16}.

However, Mr. Henn's correction is in itself wrong. The machine instruction 30EE will jump to $FF0_{16}$ rather than $9F0_{16}$. Score two more victims (Mr. Henn and me) for the rigors of hand-assembling instructions. A microcomputer would never have made the error.

WILLIAM BARDEN

REAL ENERGY CRISIS

In the editorial in the April issue of **Radio-Electronics**, you say that you would like to have intensive work carried out to raise the efficiency of photovoltaic cells to 50%.

It may surprise you, as indeed it surprised me, to learn that it is physically impossible even to reach 30%.

You will agree that the theoretical maximum efficiency of an internal combustion engine is a figure quite a bit lower than 100% and that there is just no way to exceed this.

I would suggest that while work on alternative forms of energy proceeds, the waste of petroleum should be slowed down.

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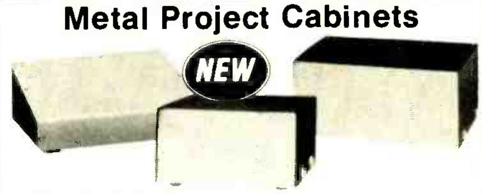

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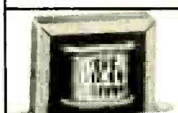

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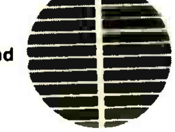

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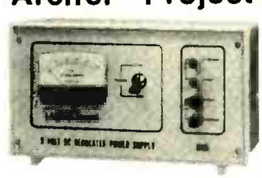

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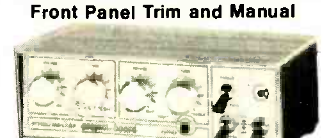

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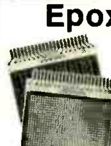

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equipment report

American Technology Corp. Model GTS-10 General Television Servicer

CIRCLE 101 ON FREE INFORMATION CARD

ABOUT TWO YEARS AGO, THE AMERICAN TECHnology Corporation (225 Main Street, Canon City, CO 81212) developed a color-bar generator, the *model ATC-10*, that they called a TV Servicing System. Now, we have the second generation, *model GTS-10*. It looks similar to the earlier model at first glance, but there are significant differences. ATC has used the feedback received from TV technicians all over the country to make some changes. All the most useful functions of the earlier *model ATC-10* have been retained, some of the less-useful ones have been deleted and others have been added.

The *model GTS-10* still provides three color-bar patterns: The standard; the Vectór (a color-bar pattern without the brightness component to create sharper "petals"; and the invaluable 3.58 Monitor. The latter pattern creates color bars with the burst gated-out so that the color oscillator can be checked without your having to add any jumpers, etc., to the set. The pure red raster is still there (for fast purity checks), and blue and green rasters have been added.

Another new feature is the Color Trio: The top half of the screen shows a saturated red, the lower left blue and the right green. All colors are fully saturated for checking the TV set's automatic color control, etc. This feature can also display a handy three-leaf vector pattern. For quick gray-scale adjustment, the Gray Quad pattern is divided into four segments—white, light gray, dark gray and black. This can be used to instantly check the video response, especially for low frequencies.

For convergence, the *model GTS-10* provides a special pattern called Hatchdots. This is a standard crosshatch, with dots in the squares around the outside of the pattern, and one center dot. If you prefer using dots only, they can be produced by using the next switch position. The center dot is marked by omission of the dots above and below it. And I almost forgot to mention that the sixth bar of all color-bar patterns is also marked by gating out a portion in the center. This gives positive identification of the blue bar for tint-control tests, etc.

All three input signals needed for TV servicing are present: RF, IF and video. The RF/IF control is the attenuator for both of these. To obtain an RF signal, push the gain-control knob in; for an IF signal, pull the knob out. Both RF and IF signals come out at the BNC jack just below and through the same output cable. Baluns are provided for the RF output so that any TV input can be matched. A pair of clips on the IF adapter lets you connect to the

continued on page 27

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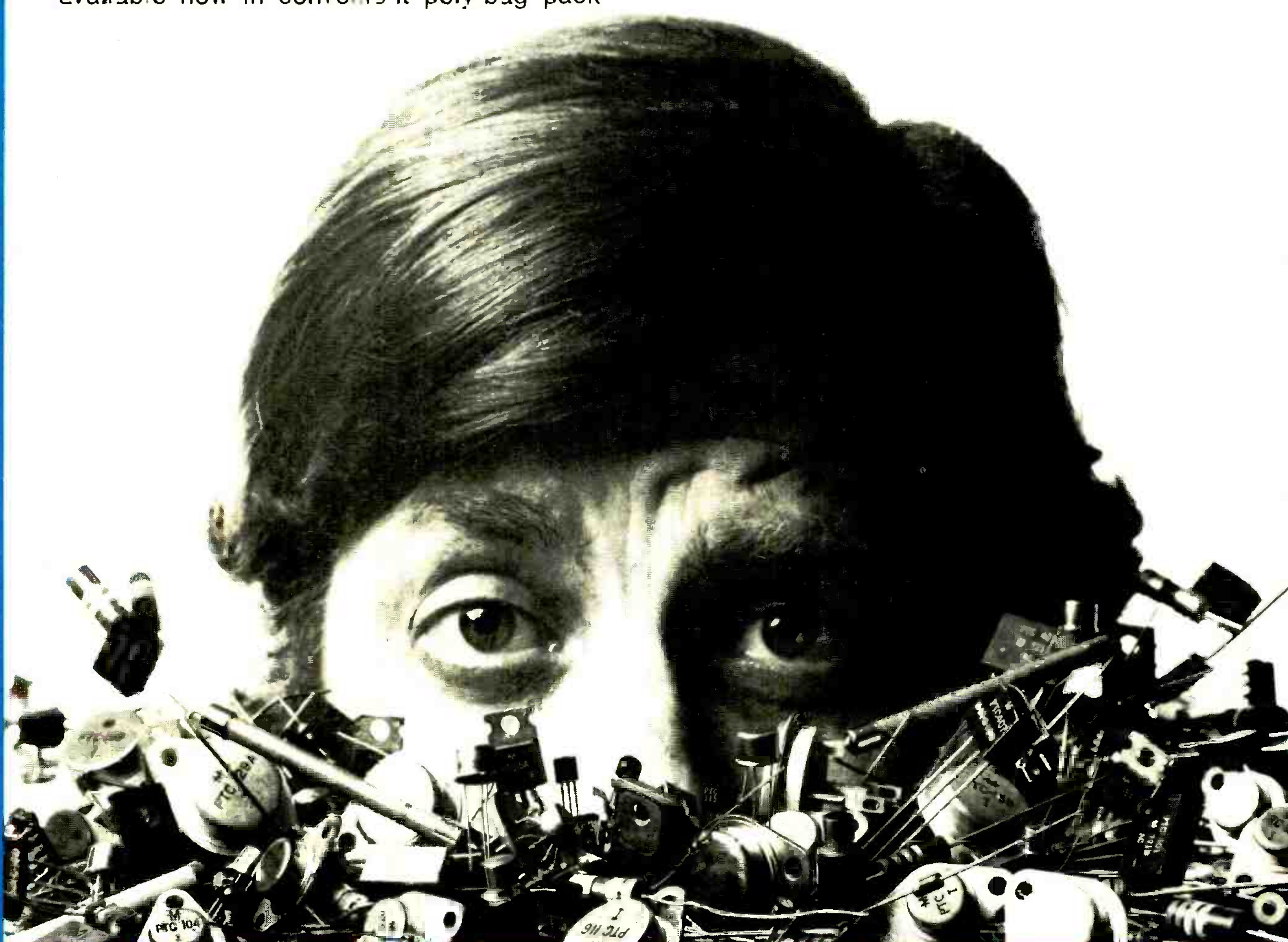

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For a limited time only WESTON offers this handsome carrying case...FREE...with any Model 6000 DMM you buy.

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The Model 6000 is the renowned "Drop-Proofed" digital multimeter with standard built-in autoranging for its five measurement functions over 26 broad ranges. All ranges, including resistance, are provided with complete overload protection and automatic zero calibration.

The Model 6000 comes with a "Hold" feature to retain the LCD reading after the probe is removed. This allows measurements to be made in crowded circuitry or high voltage areas with greater safety. The meter is housed in a high impact molded plastic case to isolate inputs and to provide greater ruggedness and durability. The inside of the 6000 is coated with a conductive paint to shield the circuits from industrial radio frequency interference noise and insure more accurate readings. A sturdy, patented plastic handle makes the meter easy to carry, acts as a tilt stand during bench operation, and folds down to protect the display face during storage.

The Model 6000 also has two new optional features . . . a manual range hold button to override autoranging, and a display backlight button for reading the meter in very low illumination areas.

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CIRCLE 26 ON FREE INFORMATION CARD

EQUIPMENT REPORTS
continued from page 24

TV set's IF input for tuner-substitution tests.

The video output has its own output jack and control on the left of the front panel. The video signal level ranges from 0 volt to 1.6 volts P-P. Either positive-going or negative-going sync may be used. Again, just push or pull the control knob. This output is ideal for tests on either VTR's or video tape players. The Chroma control adjusts the saturation of the color bars. Pulling this control knob out turns on a 4.5-MHz signal for fine-tuning the TV set. The RF output is crystal-controlled on Channel 2 or Channel 3, this is optional. Signal levels can be varied from about 5 μV to 100,000 μV for an excellent check of tuner sensitivity, automatic-gain control, etc. Horizontal or vertical trigger signals are available at three front-panel jacks. This helps lock the scope patterns very solidly for easier evaluation. Both video and RF/IF outputs can be used simultaneously.

This instrument lets you make some fast signal-tracing tests through the color, video stages, etc. With a dual-trace scope, feed the video signal into the upper trace, then check the output of the stage on the lower trace. Any loss of gain, distortion, ringing, or other problems will show up instantly. Sync problems can be adjusted by injecting the RF/IF signal into the front end. This feature is handy for those sets that have a sync takeoff ahead of the video detector.

The 4.5-MHz and the 3.58-MHz outputs (actually, the latter is 3.579545 on the nose!) can be used to set the 4.5-MHz trap to eliminate beats (worms) in the color, as well as for correct fine-tuning of the TV receiver. Any of the video patterns can be used as a video signal from this output.

The problem of whether to "interlace or not interlace" signals in color-bar generators has been neatly solved—in the *model GTS-10* you can do either. In most older TV sets and many new ones, a noninterlaced signal yields more stable convergence patterns without a 30-Hz beat. In normal operation, the *model GTS-10*'s signals are not interlaced. However, some late-model sets using countdown circuitry do not operate well with a noninterlaced signal. So, for interlaced signals, just turn the function selector knob all the way to the last clockwise position marked # START I'LACE. This is a spring-return control, so after setting you can just release it. From then on, all the signals will be interlaced. For noninterlaced signals, turn the knob back counterclockwise to OFF and then back to ON, and there you are.

All video patterns, sweep signals, burst, etc., are developed by crystal oscillators and IC countdown circuitry. There are two master clock oscillators (used for different purposes)—one at 14.318182 MHz, the other at 14.255245 MHz (they are separated by four times the line-scanning frequency). The first is counted down to give a precise frequency of 3.579545 MHz, the standard color-oscillator reference frequency used in broadcasting. A total of five crystal oscillators are used.

The instruction manuals are worthy of special mention—they are a two-volume set! The first manual, entitled *In The Home Servicing*, is small and discusses in great detail the many previously rough tests that can be made with the *model GTS-10*: video frequency response, tuner sensitivity, automatic-gain control action, color-oscillator check or setup, and many others. Volume 2, entitled *In-Shop Servicing*, shows bench-type tests using a scope. With a dual-trace scope, you can make instant in-out signal-tracing tests of any TV stage—video, color, etc. For instance, as mentioned before, you can feed the video signal into the top trace and the stage output to the lower trace. Stage gain, frequency response, distortion and even that most difficult test, phase-shift—all can be read off the screen. Any of the video or color patterns can be used for these tests. Vectorscope analysis is equally simple, especially with a dual-trace scope.

Full calibration data is also given, if it is ever needed, plus simple accuracy tests for clock oscillators, etc. The schematic diagram is included, as well as 8 pages of logic diagrams for all circuits. The *model GTS-10* uses standard transistors and IC's, and is covered by a two-year warranty.

All test leads and cables stow in a compartment in the back of the handy, all-metal case, which also has aluminum side bars to protect the front panel plus a carrying strap.

By the way, the first instruction manual shows how you can instantly identify those pesky hum-bars and crawling lines in the TV picture. (These could be caused by the TV set itself or by the input signal from CATV/MATV systems.) Just place one of the convergence patterns of the *model GTS-10* on the TV set. If the bars are still there, with the control knob set to interlace, and the signals originate in the TV set, the bars will crawl slowly *up* the screen. Switch to the noninterlace position on the switch, the bars move *down*. This gives positive proof that the bars are caused by a fault in the TV set itself and not by the cable system. To see shading bars at their worst, select the Vector and noninterlace positions. This instrument is handy for bench troubleshooting.

The price tag on the *model GTS-10* is $349. **R-E**

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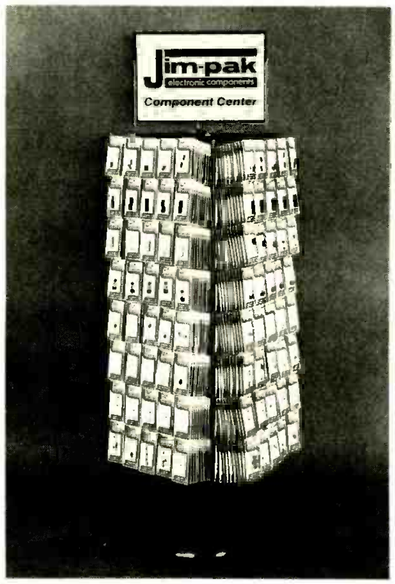

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Digital Thermometer Add-On for your DMM

A simple, easy-to-build accessory converts your digital voltmeter into a handy thermometer for monitoring semiconductor case temperatures, photographic chemicals and numerous other uses around the lab, home and workbench.

BILL OWEN*

HOW OFTEN HAVE YOU WORRIED ABOUT a component that was running hot to the touch? The part could be safely within specifications or in danger of burning out. If you include a digital thermometer as part of your test gear then you simply measure the component's temperature and check the data book for temperature limits. The capability to reliably and accurately measure temperature can also help to get a handle on more complex temperature problems such as specifying heat sinks, crystal oscillator drift and op-amp stability.

Several major manufacturers of digital multimeters now offer a thermometer option built in or as a separate accessory. Now you can build a simple thermometer conversion circuit for your digital voltmeter that is as good as any and better than most of the commercial units and at one-third the cost.

The temperature sensor is an integrated circuit developed by Analog Devices Inc. as a precision temperature-dependent current source. Of the many advantages this sensor enjoys over others, its accuracy of 0.5° and its range of from −55° to +150°C are most impressive. Because it is a current source with only two active leads, the sensor is virtually free from noise pickup even when remoted over hundreds of feet of cable. Its tiny TO-52 metal-can transistor package allows for fast temperature response. Other features will be apparent as we use the temperature sensor to build the T-100 direct-reading thermometer.

The T-100 has a 10 mV-per-degree output that enables any digital or analog voltmeter to directly read Fahrenheit or Celsius by the flip of a switch. Resolution is to 0.1° with a 3½-digit voltmeter and to 0.01° with a 4¼-digit meter. Total current consumption is about 3 mA, giving the T-100 many hours of operation from an inexpensive 9-volt battery.

While we have mentioned only electronics, the T-100 is ideally suited for a wide variety of other applications. Simply dedicate a voltmeter to exclusive use and you have a thermometer to monitor inside, outside, aquarium, swimming pool, greenhouse, darkroom chemical, freezer, cooking, air conditioning and an almost infinite list of other temperatures.

Circuit description

Figure 1 shows the AD590K temperature transducer's linear current output of 1 μA per degree Kelvin. The Kelvin degree is the same size as a Celsius degree; however, the Kelvin temperature scale is 273.16° higher than the Celsius scale. Zero degrees Kelvin is called absolute zero because it can be shown that colder temperatures cannot exist. There is also an absolute Fahrenheit temperature scale (Rankine) that is 459.69° higher than the regular Fahrenheit scale.

Figure 2 is the schematic of the thermometer accessory. The transducer's output current is scaled by the combination of resistors R10 and R11, or by R8 and R9 depending upon the position of the CELSIUS/FAHRENHEIT switch S1. The voltage developed across scaling resistors R8 and R9 is equal to 10 mV per degree Kelvin or 10 mV per degree C + 2.73 volts. Similarly, the voltage across the R10, R11 combination is equal to 10 mV per degree F + 4.59 volts. These output voltages follow naturally from the Kelvin to Celsius and Kelvin to Fahrenheit conversion equations:

T Celsius = T Kelvin − 273.16°

T Fahrenheit = 9/5 T Kelvin − 459.67°

To read Celsius and Fahrenheit directly we must generate reference voltages of 2.73 and 4.59.

The LM334Z is a precision current source with a 2-mA output that is set by resistor R1. The current output is used to bias a LM329DZ precision 6.9-volt temperature compensated Zener reference.

This device is actually an integrated circuit with many advantages over the usual Zener diode. A big advantage is the low current level required (1 mA) for stable operation. The IC1/IC3 combination provides a very stable, low-power voltage reference for the voltage dividers. The voltage divider formed by R2, R3 and R4 generates the 2.73-volt reference and the divider formed by R5, R6 and R7 generates the 4.59-volt reference. The correct reference is selected by the switch S1 and connected to the "minus" output terminal. The thermometer's output then is the voltage difference between the + and − output terminals.

Construction

Assembly of the thermometer circuit

*Product Engineer, Optoelectronics, Inc., Ft. Lauderdale, FL board is simple and straightforward. The foil pattern for the PC board is in Fig. 3 and the components placement is shown in Fig. 4. Trimmer resistors R3, R6, R9 and R11 are mounted on the foil side of the PC board. The thermometer shown here uses a custom aluminum enclosure for the circuit board and battery. The two slide switches were installed in the cabinet top and the PC board aligned for proper fit with the cabinet bottom before soldering. Grommets were fitted in each end of the cabinet top. Small diameter coax cable was inserted in the hole labeled PROBE and zip cord in the hole labeled VM in the cabinet top. The coax center conductor and shield are soldered to the PC connections labeled SIG and SHLD, respectively, in Fig. 4. The zip cord is soldered to the holes labeled OUT with the red banana plug soldered to the "+" wire and the black banana plug to the "−" wire. The 9-volt battery snap is connected to BATT holes with the red wire soldered to "+" and the black wire to "−."

The AD590K sensor was prepared by cutting off the case lead and staggering the + and − leads leaving the + lead longer. Figure 5 shows a cross section of the probe assembly. The sensor leads will not short together if the coax conductor and shield are staggered to match as shown. The shield lead is connected to the sensor's + lead. The sensor is soldered on the end of the coax and the connection potted in with epoxy glue to make it waterproof. A nylon shell was used to house the coax connection and provide a seal for the sensor. The shell was slid over the free end of the coax with the larger diameter end going on the cable first.

A 5-minute setting epoxy is used to pot the sensor. A very small amount was mixed and an even coat applied to the bottom of the sensor. The sensor was then held tightly against the end of the nylon shell and kept centered until the epoxy became set.

Next, an amount of epoxy to sufficiently fill the probe was thoroughly mixed. The probe tip was held down and epoxy was applied between the shell and coax using a toothpick. The epoxy flows down

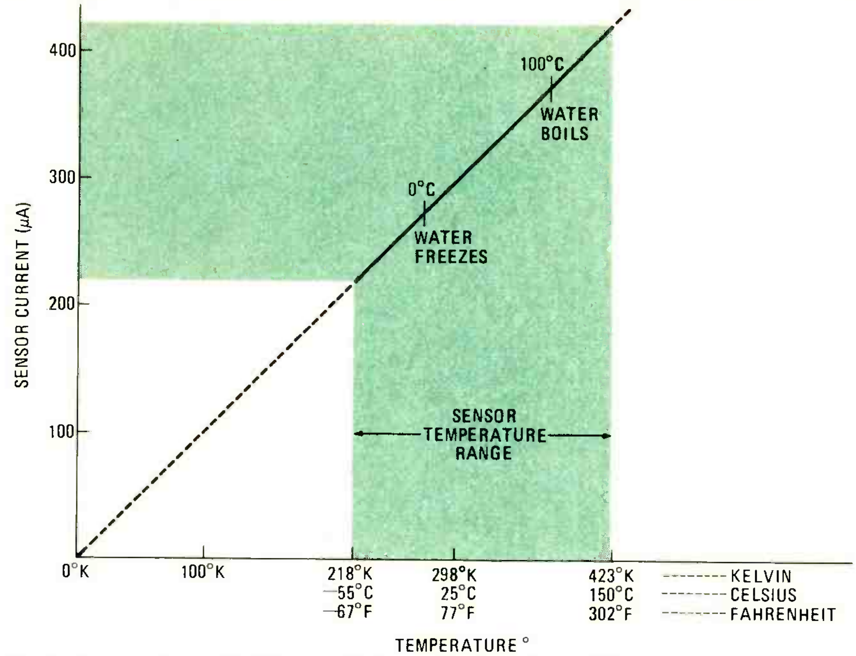


FIG. 1—CURRENT OUTPUT of the AD590 is linear at 1 μA per degree Kelvin.

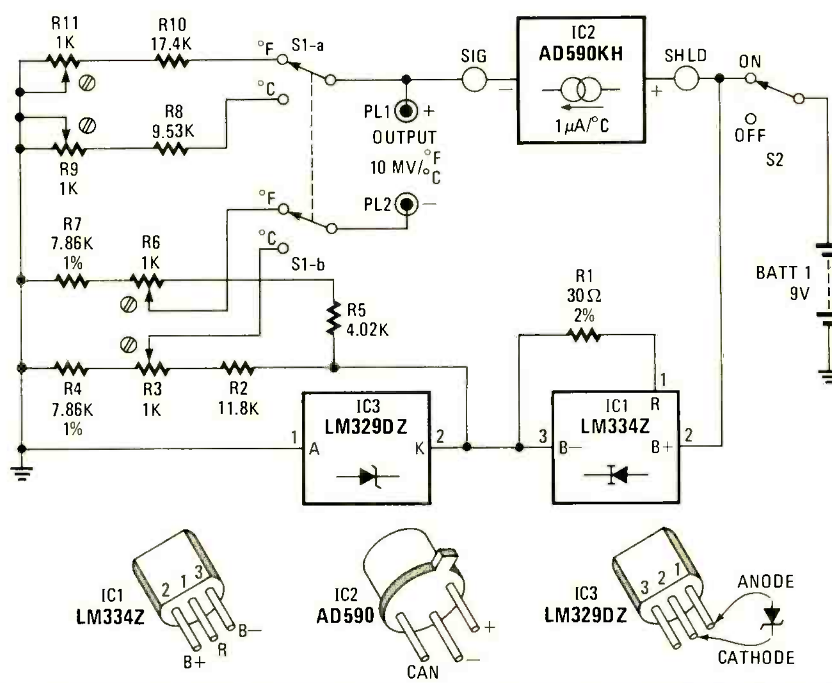


FIG. 2—SCHEMATIC OF THE T-100 thermometer accessory for a digital voltmeter. The circuit is essentially a resistive bridge with the temperature sensor as one of its legs.

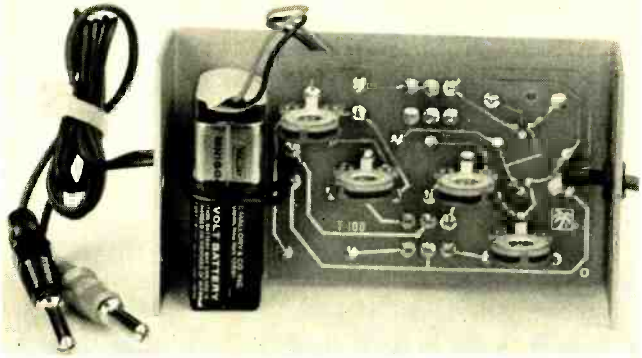
PARTS LIST

R1—30 ohms, 2%
R2—11,800 ohms, 1%
R3, R6, R9, R11—1000 ohms PC mount trimmer potentiometer
R4, R7—7860 ohms, 1%
R5—4020 ohms, 1%
R8—9530 ohms, 1%
R10—17,400 ohms, 1%
IC1—LM334Z constant-current source (National)
IC2—AD590K linear temperature-dependent current source (Analog Devices)
IC3—LM329DZ precision temperature-compensated voltage reference (National)
S1, S2—miniature DPDT slide switch
BATT1—9-volt battery, transistor radio type
PL1, PL2—banana plugs, 1 red, 1 black
Misc: RG-174/U coax, 4 feet or as needed; 2 feet of lightweight ZIP cord, nylon probe shell (see text), PC board, case screws and assorted hardware.

The following items are available from Optoelectronics, Inc., 5821 N.E. 14th Avenue, Ft. Lauderdale, FL 33334. Phones: (305) 771-2050 and 771-2051. Epoxy (used in probe assembly) and 9-volt battery must be purchased separately.

Kit T-100RE—Complete parts kit less case and switches. $30.00
Kit CAB 10S—Deluxe prepunched gold anodized and screened aluminum cabinet with switches, screws, grommets and rubber feet. $9.95.
T-100WT—Factory-wired, tested and calibrated thermometer. $59.95.
TP-100K—Additional probe kit with 6 feet of coax. $14.95.

Florida residents add state and local taxes as applicable.



DIGITAL THERMOMETER with rear cover removed shows internal layout. Note four trimmers are mounted on foil side of PC board.

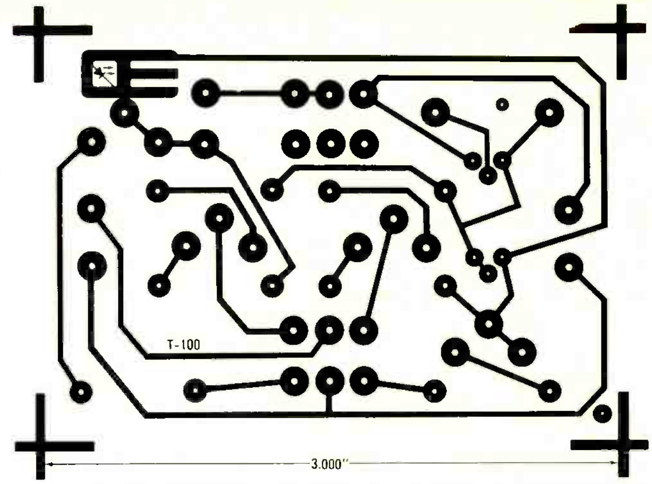


FIG. 3—PRINTED CIRCUIT PATTERN for the digital thermometer accessory.

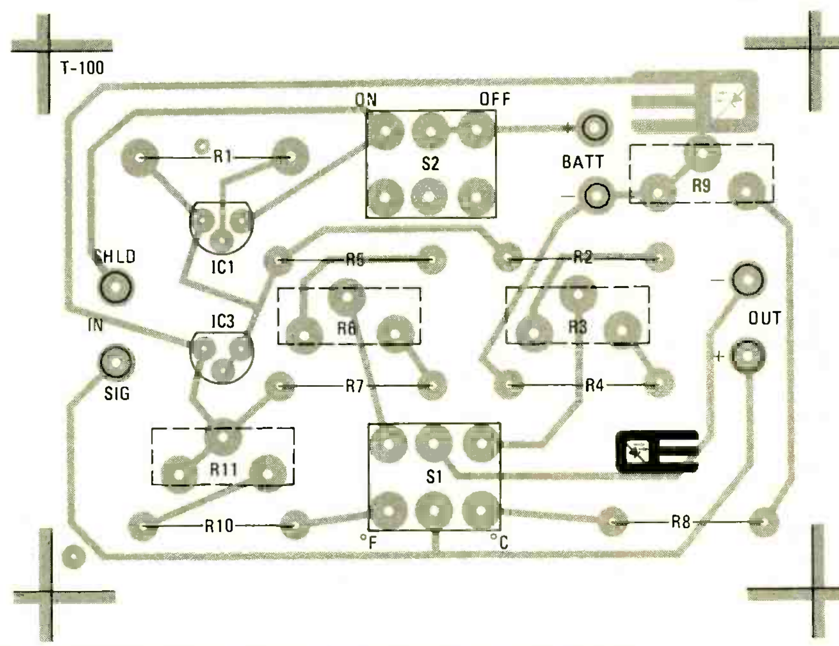


FIG. 4—THE PARTS LAYOUT is an indication of the simplicity of the device.

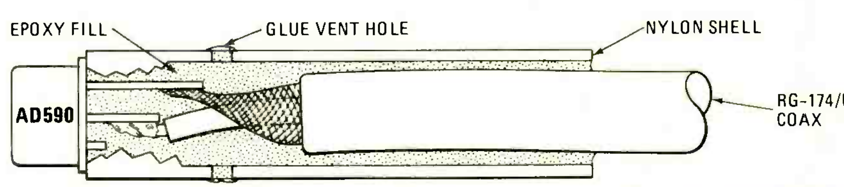


FIG. 5—DETAILS OF THE PROBE ASSEMBLY. The potting compound seals the probe against moisture and other contaminants.

the coax and into the space inside the shell. Tapping the probe tip on the table helps the epoxy flow. As the probe space fills, the epoxy seeps out of the vent holes in the sides of the shell. Any excess can be wiped away. Keep the coax centered in the end of the shell while the epoxy sets. Allow the epoxy to cure overnight before subjecting the probe to mechanical stress or excessive temperatures.

(The plastic probe shell is made from a 1-inch-long ¼-inch O.D. plastic spacer with one end counterbored to accept the outside diameter of the RG-174/U coaxial cable. (See Fig. 5.) A reasonably good substitute can be made using ¼-inch O.D. shrinkable tubing. Connect the cable to the sensor and fill the void in the tubing with the potting compound. When the compound has fully cured, apply just enough heat to shrink the tubing.—*Editor*)

Calibration

The voltage reference in the thermometer can be more stable than the internal voltage references in some digital voltmeters. Calibration should be done with the voltmeter that will be used with the T-100.

Connect the negative voltmeter lead to thermometer ground. The center lugs (wipers) on trimmers R9 and R11 are grounded as is the black (negative) battery lead. Connect the voltmeter's positive lead to the center terminal on trimmer R3 and adjust R3 to read 2.73 volts. Move the voltmeter's positive lead over to the center terminal of trimmer R6 and adjust R6 to read 4.59 volts.

The thermometer's output is linear so calibration for the entire range can be performed at one known temperature. Although the AD590K had 0.5° linearity over its entire range, we have found that it is even more accurate between 0° and 100°C. This means that to realize the accuracy potential of the device, we should have a temperature standard accurate to 0.1°C or better. Certified thermometers accurate to 0.1° are expensive and not readily available. For calibration we must then rely on some less precise methods.

Method 1. A 50% mixture of water and crushed ice that is well stirred in a styrofoam container should come to equilibrium within 0.5°C of 0.0°C in 15 to 30 minutes.

Method 2. Boiling water, containing no chemical impurities at standard atmospheric pressure (29.92 inches of mercury) should come very close to 100.0°C. Altitude and pressure corrections must be made.

Method 3. A good-quality accurate clinical thermometer can be used to compare readings within its range. Errors arise in reading the thermometer as well as from trying to have two different sensors track a changing temperature when they have differing time constants.

After calibration, the Celsius and Fahrenheit ranges on the thermometer should be reconciled using the conversion formulas:

$$T_F = 32°F + 9/5\ T_C$$

and

$$T_C = (T_F - 32)\ 5/9.$$

This completes the construction and calibration, and your thermometer accessory is ready to use. At first you'll probably have just one or two applications but as you become more familiar with it, the digital thermometer will become increasingly valuable. **R-E**

Investment Evaluation Program

FRED BLEECHMAN

HAVE YOU EVER MADE AN INVESTMENT IN stocks or metals and then wondered some time later if you would have been better off leaving the money in the bank? Or perhaps you'd like to know how much an investment must grow before it equals what you'd make leaving the money in the bank, at regular bank interest. The Investment Evaluation Program, written in TRS-8Ø Level I BASIC uses only 2464 bytes of RAM (*R*andom *A*ccess *M*emory), so it can be run on the least expensive 4K RAM TRS-8Ø.

The program is very straightforward, and has a handy subroutine for calculating the number of days between any two 20th century dates. The calculations are based on daily compounding of interest; if you want to change to monthly, quarterly or yearly compounding, you'll have to change lines 16Ø, 17Ø, 2ØØ, 25Ø and the subroutine starting at line 5ØØ.

Using the program is easy! After carefully entering and checking each line, type RUN and enter.

To illustrate, let's say that on July 20, 1974 you purchased 404 ounces of silver bullion for $2098.38, including a service charge of 60¢ per ounce and 6% sales tax. You would like to know how the value of that bullion now compares with the same amount of money if it had been left in savings at, say, 5.25% annual interest, compounded daily. The day you want to calculate up to is July 1, 1978.

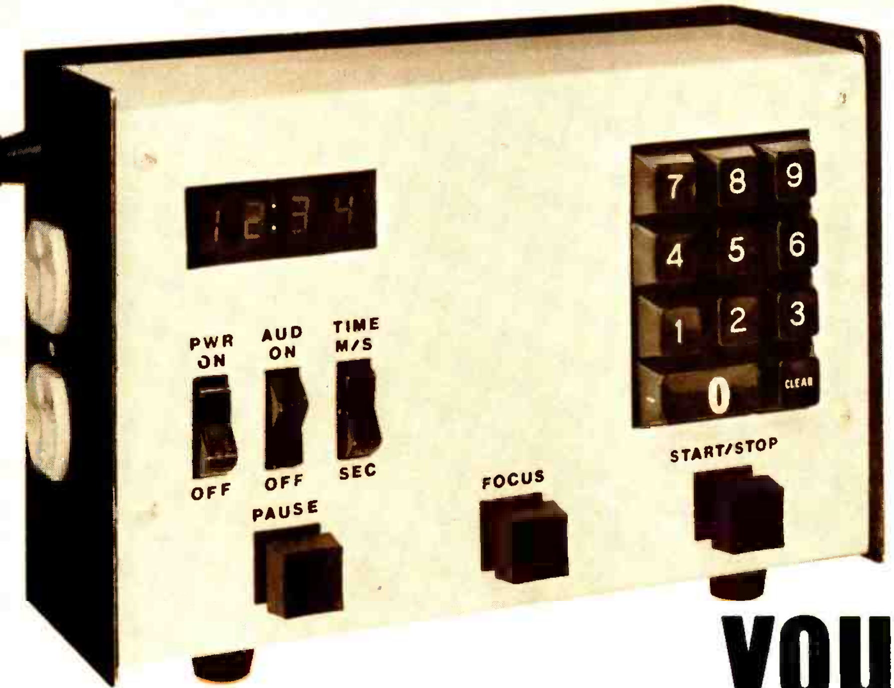
Set up the program on the computer and enter your name, social security number, 2098.38 invested at 5.25 as the questions are asked. Enter Ø for the days calculation, then enter 7,20,74 for the start date and 7,1,78 for the end date. The computer will tell you the number of investment days is 1442. Enter this number and the computer will print out, after about 40 seconds, the total interest ($483.58) and the new principal of $2581.80. (Don't mind the 16¢ error in addition of the interest and new principal. As a matter of fact, even the interest calculated is slightly off, due to rounding-off during the 1442 multiplications!).

Enter 404 for the number of ounces of silver bullion and the value of silver per ounce on the calculation end date—say, 5.28. The computer now displays that your investment is worth $2133.12 and that you have now *lost* $448.676 (there's that slight inaccuracy again!) compared to having left your money in your savings account. It also tells you that silver on that date would have to be worth $6.39058 per ounce for you to just break even!

You can then press break to end the program, or perform another calculation. This same program can also be used to determine the future value of stock, bonds, gold, silver, etc., for break-even at some future date if you plan a particular investment. **R-E**

R-E will publish reader letters telling how to adopt this program to run on other hobby computers. Let us hear from you

```
100 CLS:P.
105 REM * COPYRIGHT 1978 FRED BLECHMAN * FOR TRS-80 I—4K *
110 P."          INVESTMENT EVALUATION":P.:P.
112 P."THIS PROGRAM COMPARES AN INVESTMENT WITH PUTTING THE"
113 P."SAME AMOUNT OF MONEY IN A SAVINGS ACCOUNT WHERE IT EARNS"
114 P."DAILY INTEREST. IF YOU WISH TO CHANGE THE PERIOD TO"
115 P."MONTHLY OR YEARLY, CHANGE LINES 160,170,200 & 250. . . ."
116 P.". . . . .AND THE SUBROUTINE STARTING AT LINE 500."
120 P.:P.
125 IN."WHAT IS YOUR FIRST NAME";A$
126 IN."WHAT IS YOUR SOCIAL SECURITY NUMBER";B$
130 A=0:B=0:C=0:D=0:E=0:F=0:G=0:H=0:I=0
131 J=0:K=0:L=0:M=0:N=0:O=0:P=0:Q=0:R=0
132 S=0:T=0:U=0:V=0:W=0:X=0:Y=0:Z=0
140 IN."WHAT IS THE DOLLAR AMOUNT INVESTED";P
150 IN."WHAT IS YOUR REGULAR SAVINGS INTEREST RATE(%)";R
155 P.
160 P."HOW MANY DAYS ARE INVOLVED? IF YOU WANT THE NUMBER"
170 P."OF DAYS CALCULATED (20TH CENTURY ONLY) ENTER 0";D
180 IF D=0 GOSUB 500
185 IF D=0 GOTO 155
186 P.
190 P.". . . . . . .PATIENCE! . . .I'M CALCULATING THE ANSWER. . . ."
195 P."             (TAKES ME ABOUT 10 SECONDS FOR 365 DAYS)"
200 S=R/36500:V=P
205 REM * CALCULATE INTEREST AND ADD TO PRINCIPAL *
210 FOR X=1 TO D
220 I=V*S:V=V+I:T=T+I
230 NEXT X
235 P.
240 P."          THE TOTAL INTEREST IS";T
250 P."THE VALUE OF $";P;"AFTER";D;"DAYS AT";R;"% IS";V
255 P.
256 REM *COMPARE PRESENT VALUE OF INVESTMENT TO SAVINGS *
260 P."HOW MANY SHARES,BARS,OUNCES,ETC.,DO YOU OWN?"
265 IN."   (TO RECALCULATE INVESTED AMOUNT,ENTER 0)";H
270 IF H=0 GOTO 130
275 P.
280 IN."WHAT IS THE PRESENT VALUE OF EACH SHARE,BAR,ETC.";M
290 Q=H*M
295 P.
300 P."YOUR INVESTMENT IS NOW WORTH $";Q;",";A$;"."
310 Z=V-Q
315 P.
320 IF Z>0 P.A$;"-";B$;",YOU HAVE LOST $";Z;"COMPARED TO SAVING!"
330 IF Z<0 P.A$;"-";B$;",YOU HAVE EARNED $";-Z;"MORE THAN SAVINGS!"
335 P.:P."THE 'BREAK-EVEN' POINT IS $";V/H;"SHARES,BARS,ETC."
340 P.:P."PRESS BREAK TO END PROGRAM. . . . . ."
350 GOTO 130
360 END
500 REM * SUBROUTINE FOR CALCULATING DAYS *
510 DATA 0,31,28,31,30,31,30,31,31,30,31,30,31
520 REM * DETERMINE NUMBER OF DAYS FROM 0 TO START *
525 P.
530 IN."WHAT IS THE INVESTMENT START DATE(M,D,Y)";A,B,C
540 E=A
550 GOSUB 1000
560 F=F+B
570 G=F+C*365
580 REM * DETERMINE NUMBER OF DAYS FROM 0 TO END *
590 IN."WHAT IS THE INVESTMENT END DATE(M,D,Y)";J,K,L
600 E=J
610 GOSUB 1000
620 F=F+K
630 N=F+L*365
640 REM * CALCULATE AND ADD LEAP YEARS *
650 O=INT( (L-1900)/4):U=INT( (C-1900)/4):W=O-U
660 X=(N-G)+W
665 P.
670 P."THE NUMBER OF INVESTMENT DAYS IS";X
680 RETURN
1000 F=0
1010 FOR X=1 TO E
1020 READ Y
1030 IF Y=28 THEN IF (L/4)-INT(L/4)=0 THEN Y=29
1040 F=F+Y
1050 NEXT X
1060 RESTORE
1070 RETURN
```



BUILD

Digital Timer for your Darkroom

The ideal timer for today's darkroom. This one counts down in your choice of minutes and seconds, or seconds only.

RAYMOND G. KOSTANTY

LAST MONTH WE INTRODUCED THIS unique digital darkroom timer. In this issue we will complete the article, presenting the remaining construction details and final setup, test, and operating steps.

As stated, the timer's internal capacity is 8 digits. To alert you that more than 4 digits have been entered, the output of IC16-10, which is high if any digit is present, is combined with D5 in IC16 and used to unshort LED 3 (allowing it to light) if any digit is present in the D5 position.

In the minutes/seconds range, 41 must be subtracted each time a whole number of minutes (2:00, 5:00, etc.) is displayed. The zero-zero detector output, IC14-1, goes high if a zero is present in both D8 and D9 positions. Pin 11 of IC4 is low when a zero is detected. Recalling that D8 goes high before D9 does, IC15-4 will be high during D8 if a zero is present. Latch IC15-d remembers this high and enables IC14-6, the J input to a flip-flop. If the zero is also present during D9, IC15-3 will go high and clock IC14. This makes IC14-1 go high and enables IC8-13, which changes the normal —, delay, blank and 1 sequence to the required —, delay, 4 and 1 sequence. Latches IC14-a and IC15-b and d are reset each time IC6-3 is high.

Counter IC1 divides the 60-Hz square-wave generated on the power supply board by 6 to produce 10 Hz. The PAUSE switch halts timer operation by grounding the base of Q1 and the clock pulses into IC1.

On the power supply board, Fig. 4, a 555 IC is connected as an astable oscillator to generate the audio tone when gated on by the signal at input K. The tone's frequency is inversely proportional to R6, R7 and C2.

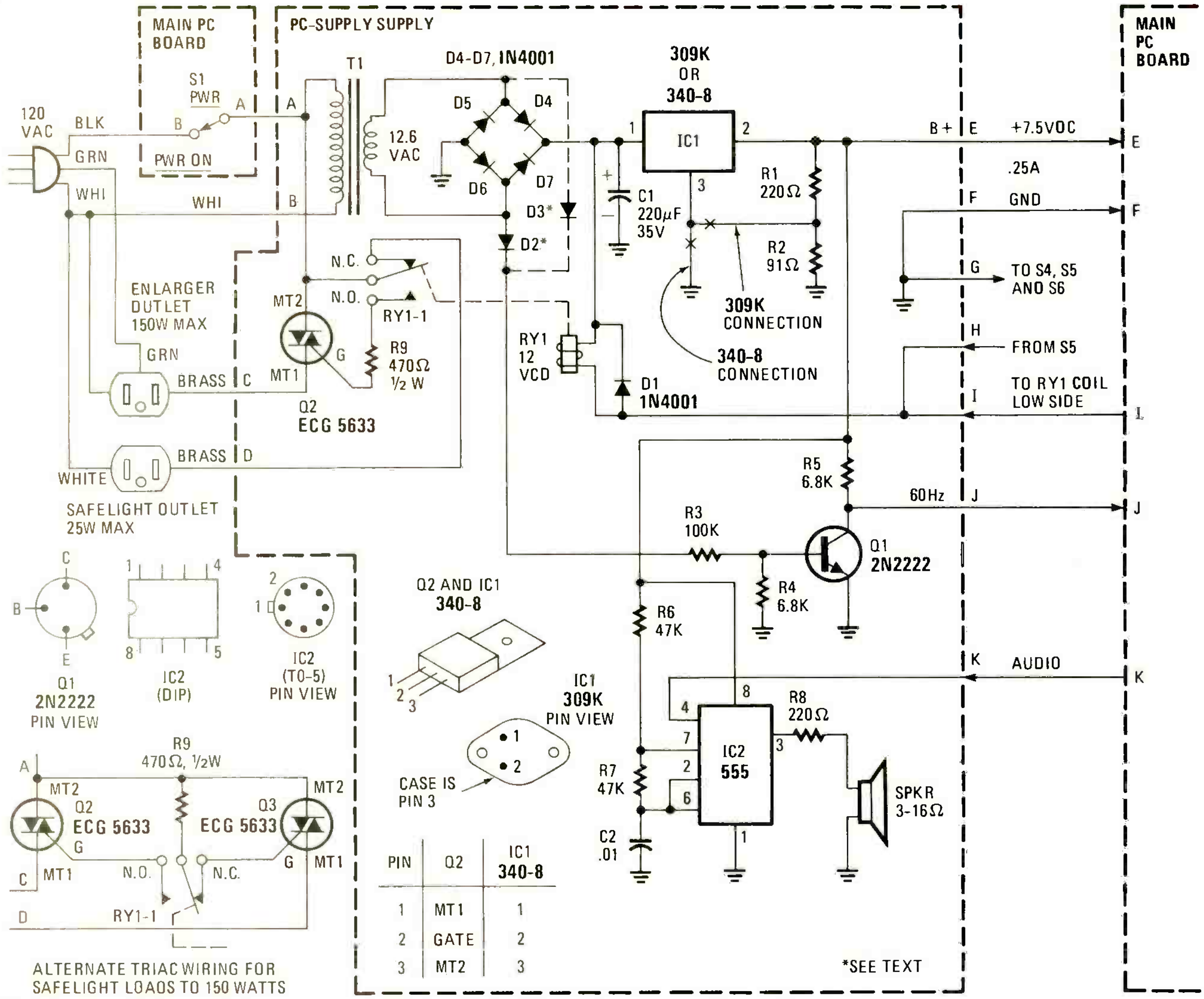
The relay directly switches the line voltage to the low-power safelight outlet when de-energized, and indirectly switches line voltage via the triac to the high-power enlarger outlet when energized. The maximum load that can be connected to the enlarger outlet is determined solely by the triac rating. Heavier safelight loads can be driven by adding a second triac as shown in the Fig. 4 inset.

Transistor Q1 amplifies the half-wave rectified 60-Hz signal applied to its base and converts it to an approximate square-wave.

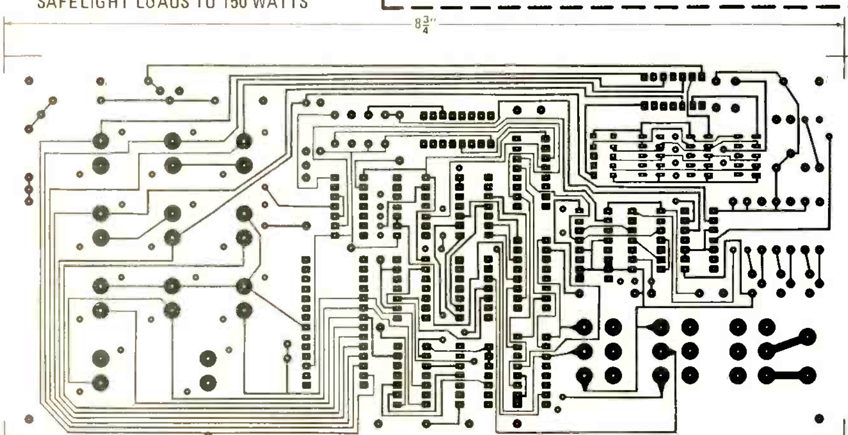
Assembling the timer

Start assembly with the power supply. The board will accomodate speakers up to 2½ inches in diameter, but will be supplied with mounting holes for a 2-inch speaker. If using a larger speaker, drill one No. 28 hole (hole S in Fig. 9) such that the part of the hole closest to the speaker center is just tangent to the diameter of the speaker. Solder all small components into their appropriate locations. If using a 309K as IC1, fasten it with two No. 6-32 $\times$ $^3/_8$ screws with the head of one of them in firm contact with the foil which serves as the connection to the case of IC1, and install R1 and R2. Clip leads 1 and 2 to about $^1/_8$ inch. Resistors R1 and R2 are not used when a 340-8 is used as IC1.

If the timer is to be used on 60-Hz power, do not use D2 or D3, but instead solder a jumper in the D2 position. (For 50-Hz operation, use a transformer with a 50-Hz or 50 to 60-Hz primary, and use D2 and D3, which will change the output of Q1 to 100 Hz. On the main board, cut the connection from IC1-1 to IC1-6, and jumper IC1-1 to IC1-13 to change IC1 to a decade divider to give the required 10-Hz output.) Mount the transformer with two No. 6-32 $\times$ $^3/_8$ screws, again with the heads on the foil side. Solder the transformer, relay and IC2 in place. The IC may be soldered without a socket. The triac doesn't need a heat sink for loads up to 150 watts, and is supported by its leads. For loads between 150 and 600 watts, mount the triac on a heat sink whose thermal resistance doesn't exceed 3 °C-per-watt. In each of the three speaker holes, install a 6-32 $\times$ $^3/_8$ screw, heads on the foil side, and fasten one nut firmly to each screw. If the holes were properly drilled, the speaker should be able to rest on the nuts just installed. Install one additional



PIN	Q2	IC1 340-8
1	MT1	1
2	GATE	2
3	MT2	3



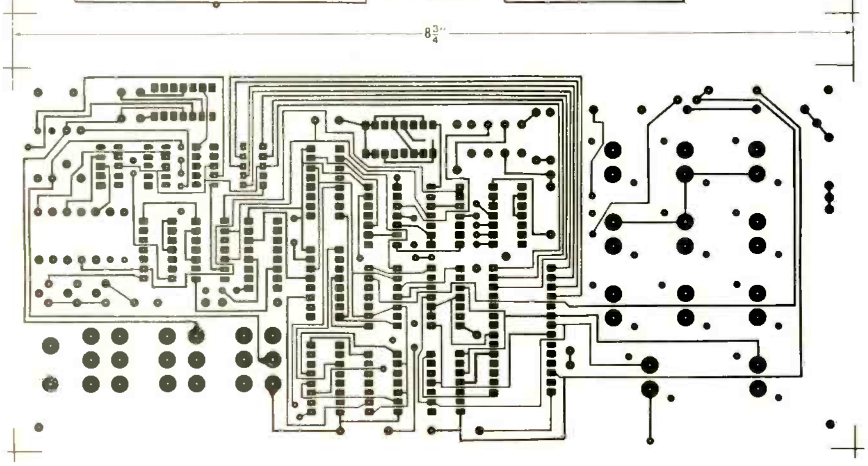


FIG. 4 (above)—POWER-SUPPLY CIRCUIT also contains the audio circuit that develops 1-second pulses.

FIG. 5 (left)—COMPONENTS SIDE of the main circuit board. Note the size marked.

FIG. 6 (bottom left)—FOIL PATTERN on the other side of the two-sided board.

nut on each screw to secure the speaker and solder the two speaker connections to their pads. Refer to Fig. 11 for details. Set the board aside.

Continue with the main board. Sockets are highly recommended for all IC's, and imperative for the calculator IC. The displays are installed in Molex *Soldercon* sockets. When using these sockets, do not press them directly against the board unless you are sure that they will not short to foil patterns running between them. All pushbuttons, rocker switches, LED's and displays go on one side, and the remaining parts and jumpers on the other. Mount components in this sequence: resistors, diodes, transistors, jumpers, capacitors and IC1-16's sockets. On the other side, mount the display's sockets and the three LED's. The LED's mentioned in the parts list were selected for their small diameter, .085 inch, and pleasing appearance. Their lead length, however, is only 0.25 inch. To raise the

POWER SUPPLY PARTS LIST

All resistors ¼ watt, 10%
R1, R8—220 ohms
R2—91 ohms
R3—100,000 ohms
R4, R5—6800 ohms
R6, R7—47,000 ohms
C1—220 μF, 35 volts, electrolytic
C2—.01 μF
Q1—2N222, RS-2031 (Radio Shack) or any NPN silicon transistor with a beta between 50 and 150
Q2—200-volt, 10-amp triac. Sylvania ECG 5633 or equal
Q3—Optional, same as Q2. See text.
IC1—309K or 340-8 voltage regulator
IC2—555 timer
D1, D4-7—1N4001, Radio Shack 276-1101 or any 25-volt, 1-amp silicon diode
D2, D3—Silicon diode, see text.
RY1—Relay, SPDT contacts, 12-VDC coil. Guardian 1345-1C-12D, Essex 64-902 or Cornell-Dubilier 603-12V
T1—Transformer, 120 volts to 12.6 volts, 300 mA. Radio Shack 273-1385 or equal
Miscellaneous—Speaker, 3-16 ohms, 2-2½ inches. Power cord, 8 feet, No. 18, 3 conductors. Strain relief.

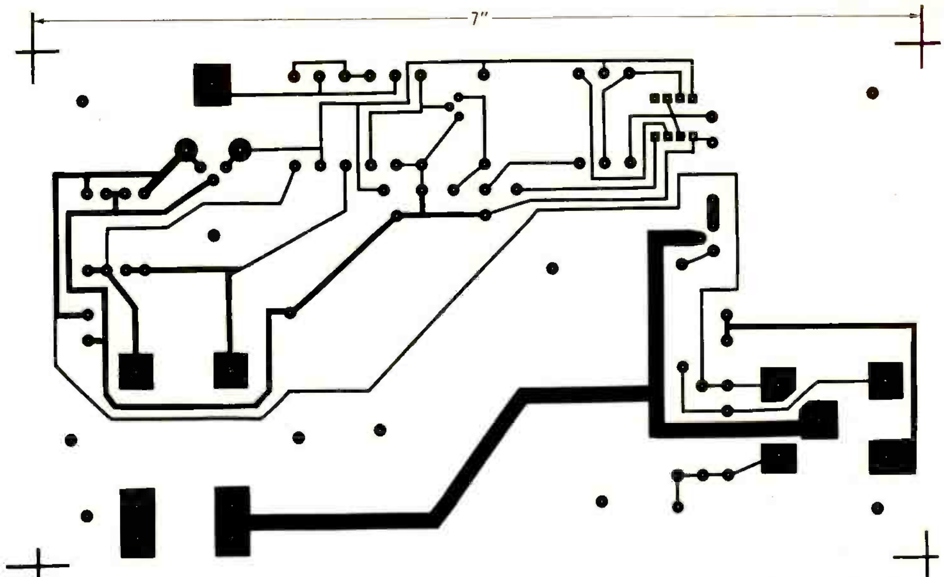
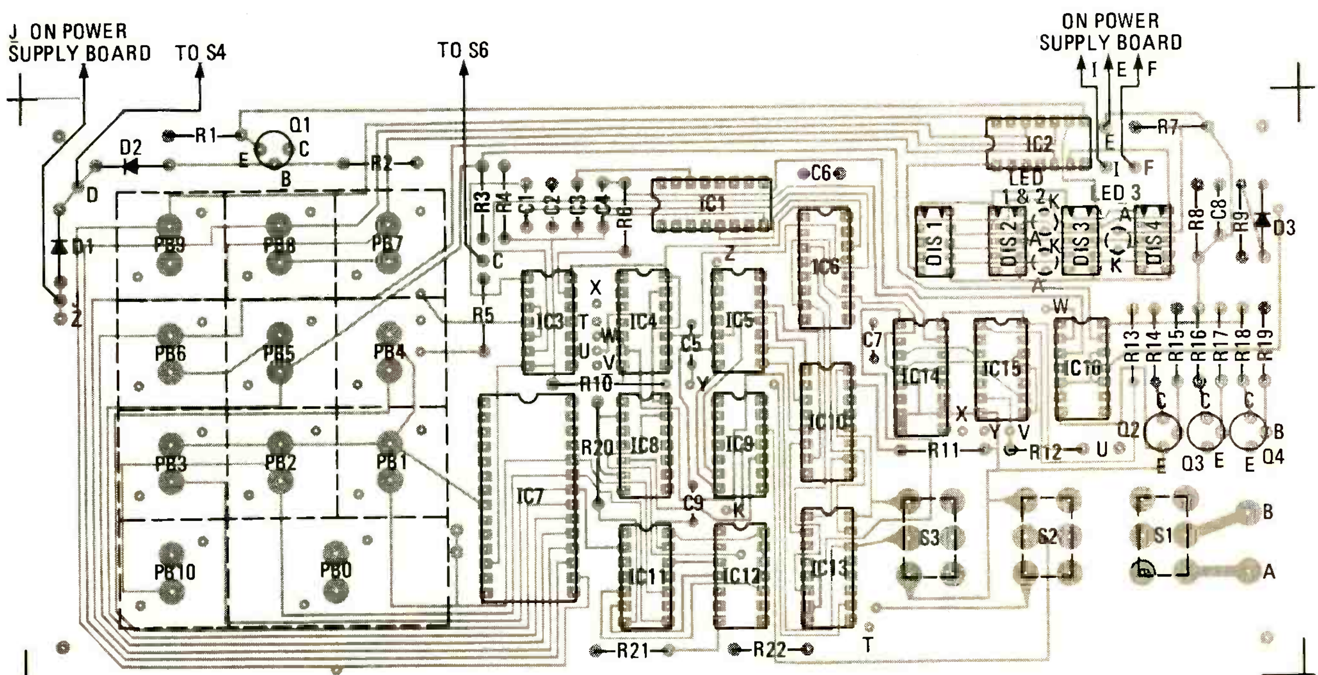


FIG. 7—THE POWER SUPPLY CIRCUIT BOARD is single-sided. Again, be sure to note the dimension across the top as this board is not drawn actual size.

tip of the LED's to the same height above the board as the 7-segment displays (0.6 inch), solder solid-wire extensions to the LED leads or use larger LED's. Finish by installing the switches. Do not install the IC's or displays at this time. Set the board aside.

The case can be easily made as shown in Figs. 10 and 11, or purchased ready-to-use. Strip about 18 inches of outer jacket from the line cord and install the cord through the side of the case with a strain relief. The duplex outlet will have 2 silvery screws in a silvery metal strip on its cold side, and a brass-colored metal strip with either 2 silver or 2 brass-colored screws on the hot side. Break the thin brass strip connecting the 2 screws on the hot side to isolate them from each other. Leave the 2 screws on the cold side in common with each other. Shorten the green and white leads on the line cord from 18 to 6 inches. Connect the green wire to the green screw on the outlet, and the white wire to one of the cold screws. Connect one end of the remaining 12 inches of white wire to the other cold screw, and the other end to one side of T1's primary (hole B in Fig. 9). Connect one end of an 18-inch wire to each of the remaining holes on the power supply board. The wires to holes A and C should be No. 18 gauge. The remaining ones can be No. 24 or 26. Temporarily connect the wire from hole A to the black wire in the line cord. Interconnecting wires should be stranded.

Attach the board to the rear half of the case as shown in Fig. 11. Mount it so the transformer is toward the bottom of the case (when mounted on a wall). The outlets can be on either the right or left side to suit your darkroom's layout. Connect the No. 18 wire from the triac (hole C on the power supply board) to one of the unused hot screws on the outlet sock-



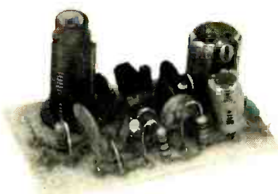
NOTE: HOLES A-A TO K-K ARE JUMPERED EITHER TO POWER SUPPLY BOARD OR TO CABINET-MOUNTED COMPONENTS. HOLES T-T TO Z-Z ARE JUMPERED TO EACH OTHER ON REAR SIDE OF BOARD.

FIG. 8—PARTS PLACEMENT ON THE MAIN CIRCUIT BOARD. Note that the keyboard mounts directly to this board too. As indicated, jumpers connect this board to the power supply board.

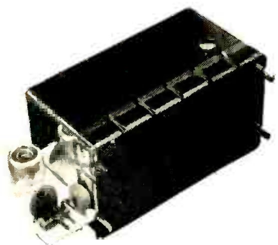
VIDEO MODULATORS

If you are into VTR's, TV games, home computers and TV modulator must be used to feed modulated RF to

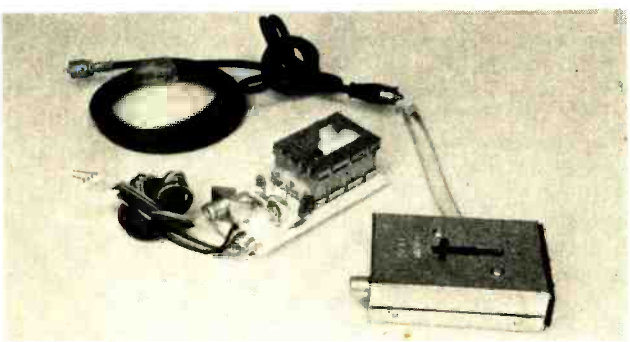
FRED BLECHMAN K6UGT



VD-1 by Ramsey

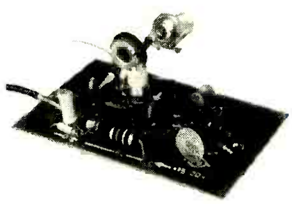


ATARI model CA-010410

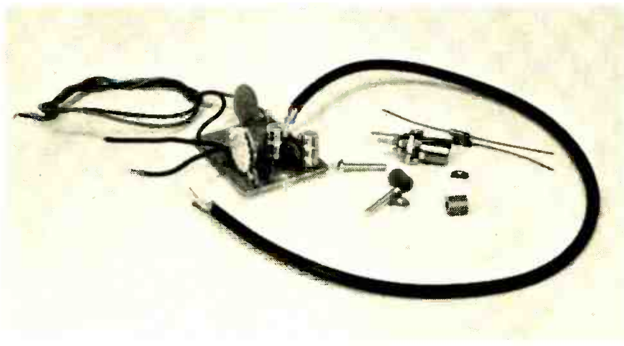


SUP "R" MOD II, cables and switch included

MODEL E & P



RF-1 RF modulator



RFVM-1 sold by Vamp and Quest Electronics

IN THE LAST TWO YEARS FOUR "NEW" ELECTRONIC PRODUCTS have been introduced into the consumer marketplace—video games, video cassette recorders, video cameras and home computers. While these products have been available in some form for several years, their design finally became practical enough for consumer acceptance. Coincidentally, each product uses a video display for its output. A TV screen is essential for playing a video game or watching a video recorder, and most home computers use a video display for the readout, although printers can also be used. Video cameras, long used for closed-circuit security and surveillance systems, are growing in popularity now that video cassette recorders are available for making home movies, and, of course, cameras also use a video display.

Two basic methods make the video signal visible on a picture tube. The most efficient method is to feed the video output of a game, camera, video recorder or computer directly into the video amplifier of a video monitor or TV set. Since most TV sets require rewiring to provide direct access to the video amplifier (and those with a hot chassis can create a dangerous shock hazard), video monitors have generally been used. However, when home video games became popular, it was obvious that the public would not care to buy a special monitor to play the games. Therefore, an old video camera technique was revived—generating an RF signal on an unused TV channel and modulating it with the video signal! By connecting the modulated RF carrier to the antenna terminals of a standard TV set, you could watch the game by simply tuning to the unused channel.

In the beginning, video game manufacturers, to avoid interfering with VHF signals, created carriers in the high UHF band. Shielding problems, signal instability with temperature variation and other design considerations caused the shift to VHF carriers modulated by the video signal. Several million video games were sold (some for as little as $25) complete with built-in video-modulated RF oscillators. The Federal Communications Commission (FCC) then cracked down on the manufacturers, requiring them to test units to rigorous specifications before type approval was issued, in order to try minimizing the spurious radiations being generated to neighboring TV sets—or even to other sets in the home!

With technological advances taking place in the game field, microprocessors and dedicated integrated circuits (IC's) became commonplace among experimenters. Home computers suddenly blossomed from garage and basement labs to full-blown manufacturing plants. Experimenters and hobbyists found an increasing need for some means to couple the video output of their devices to a display. Video monitors have remained a low-production item and are therefore high-priced. TV set manufacturers have not recognized the sales advantage of adding a switch and jack to existing designs to allow direct video input. Therefore, there has been a steadily increasing

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Counter IC1 divides the 60-Hz squarewave generated on the power supply board by 6 to produce 10 Hz. The PAUSE switch halts timer operation by grounding the base of Q1 and the clock pulses into IC1.

On the power supply board, Fig. 4, a 555 IC is connected as an astable oscillator to generate the audio tone when gated on by the signal at input K. The tone's frequency is inversely proportional to R6, R7 and C2.

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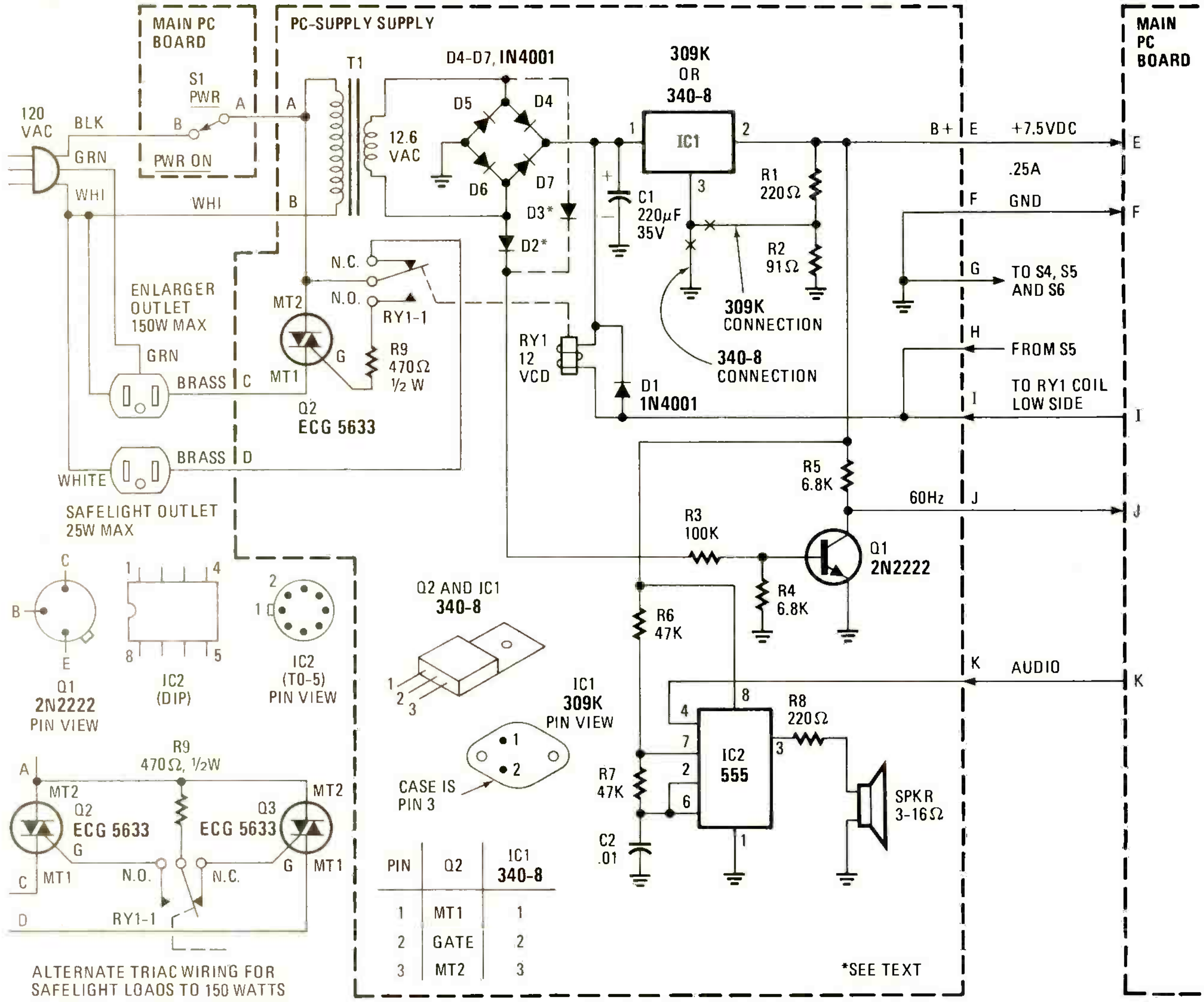
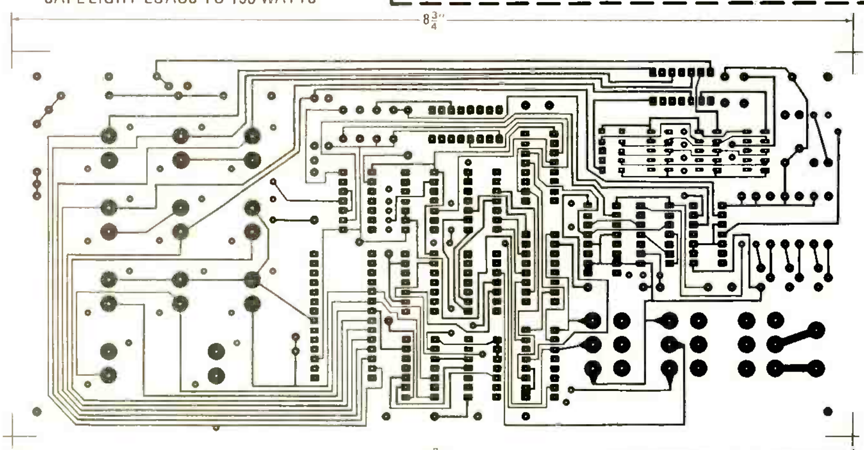
Assembling the timer

Start assembly with the power supply. The board will accomodate speakers up to 2½ inches in diameter, but will be supplied with mounting holes for a 2-inch speaker. If using a larger speaker, drill one No. 28 hole (hole S in Fig. 9) such that the part of the hole closest to the speaker center is just tangent to the diameter of the speaker. Solder all small components into their appropriate locations. If using a 309K as IC1, fasten it with two No. 6-32 × ⅜ screws with the head of one of them in firm contact with the foil which serves as the connection to the case of IC1, and install R1 and R2. Clip leads 1 and 2 to about ⅛ inch. Resistors R1 and R2 are not used when a 340-8 is used as IC1.

If the timer is to be used on 60-Hz power, do not use D2 or D3, but instead solder a jumper in the D2 position. (For 50-Hz operation, use a transformer with a 50-Hz or 50 to 60-Hz primary, and use D2 and D3, which will change the output of Q1 to 100 Hz. On the main board, cut the connection from IC1-1 to IC1-6, and jumper IC1-1 to IC1-13 to change IC1 to a decade divider to give the required 10-Hz output.) Mount the transformer with two No. 6-32 × ⅜ screws, again with the heads on the foil side. Solder the transformer, relay and IC2 in place. The IC may be soldered without a socket. The triac doesn't need a heat sink for loads up to 150 watts, and is supported by its leads. For loads between 150 and 600 watts, mount the triac on a heat sink whose thermal resistance doesn't exceed 3 °C-per-watt. In each of the three speaker holes, install a 6-32 × ⅜ screw, heads on the foil side, and fasten one nut firmly to each screw. If the holes were properly drilled, the speaker should be able to rest on the nuts just installed. Install one additional



PIN	Q2	IC1 340-8
1	MT1	1
2	GATE	2
3	MT2	3



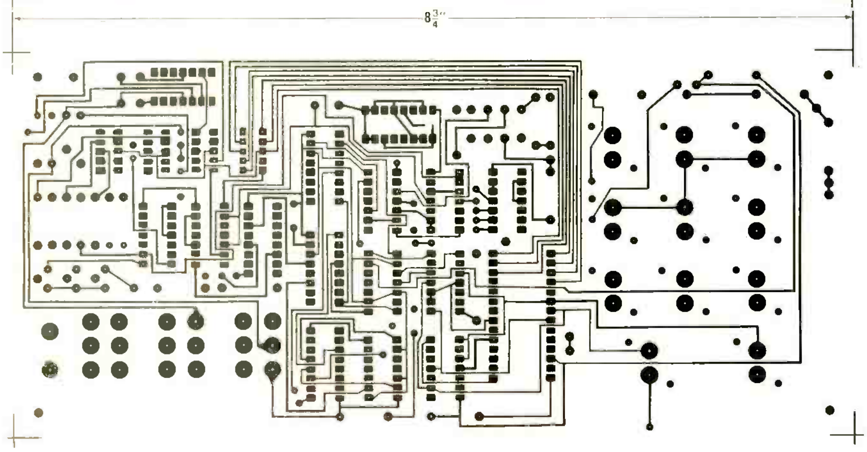


FIG. 4 (above)—POWER-SUPPLY CIRCUIT also contains the audio circuit that develops 1-second pulses.

FIG. 5 (left)—COMPONENTS SIDE of the main circuit board. Note the size marked.

FIG. 6 (bottom left)—FOIL PATTERN on the other side of the two-sided board.

nut on each screw to secure the speaker and solder the two speaker connections to their pads. Refer to Fig. 11 for details. Set the board aside.

Continue with the main board. Sockets are highly recommended for all IC's, and imperative for the calculator IC. The displays are installed in Molex *Soldercon* sockets. When using these sockets, do not press them directly against the board unless you are sure that they will not short to foil patterns running between them. All pushbuttons, rocker switches, LED's and displays go on one side, and the remaining parts and jumpers on the other. Mount components in this sequence: resistors, diodes, transistors, jumpers, capacitors and IC1-16's sockets. On the other side, mount the display's sockets and the three LED's. The LED's mentioned in the parts list were selected for their small diameter, .085 inch, and pleasing appearance. Their lead length, however, is only 0.25 inch. To raise the

POWER SUPPLY PARTS LIST

All resistors ¼ watt, 10%
R1, R8—220 ohms
R2—91 ohms
R3—100,000 ohms
R4, R5—6800 ohms
R6, R7—47,000 ohms
C1—220 μF, 35 volts, electrolytic
C2—.01 μF
Q1—2N222, RS-2031 (Radio Shack) or any NPN silicon transistor with a beta between 50 and 150
Q2—200-volt, 10-amp triac. Sylvania ECG 5633 or equal
Q3—Optional, same as Q2. See text.
IC1—309K or 340-8 voltage regulator
IC2—555 timer
D1, D4-7—1N4001, Radio Shack 276-1101 or any 25-volt, 1-amp silicon diode
D2, D3—Silicon diode, see text.
RY1—Relay, SPDT contacts, 12-VDC coil. Guardian 1345-1C-12D, Essex 64-902 or Cornell-Dubilier 603-12V
T1—Transformer, 120 volts to 12.6 volts, 300 mA. Radio Shack 273-1385 or equal
Miscellaneous—Speaker, 3-16 ohms, 2-2½ inches. Power cord, 8 feet, No. 18, 3 conductors. Strain relief.

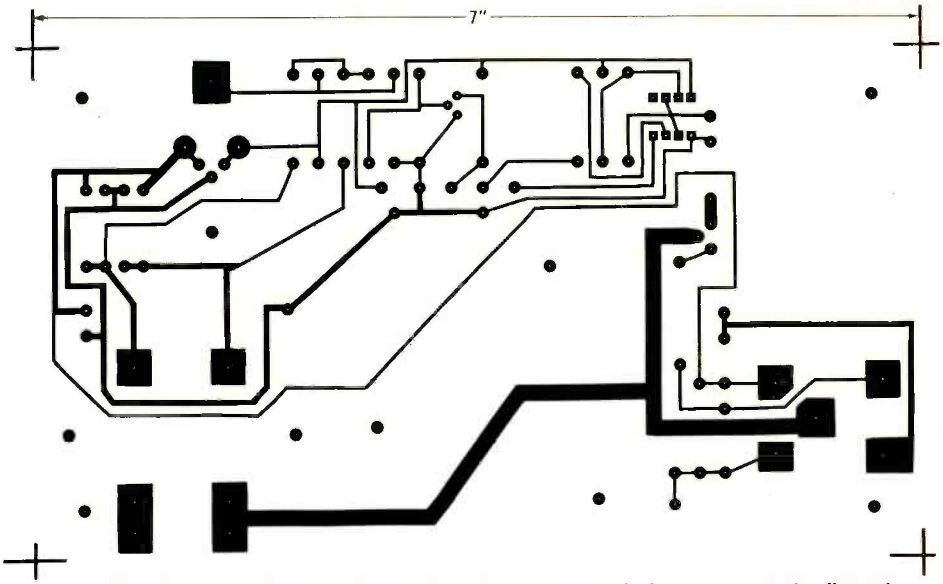


FIG. 7—THE POWER SUPPLY CIRCUIT BOARD is single-sided. Again, be sure to note the dimension across the top as this board is not drawn actual size.

tip of the LED's to the same height above the board as the 7-segment displays (0.6 inch), solder solid-wire extensions to the LED leads or use larger LED's. Finish by installing the switches. Do not install the IC's or displays at this time. Set the board aside.

The case can be easily made as shown in Figs. 10 and 11, or purchased ready-to-use. Strip about 18 inches of outer jacket from the line cord and install the cord through the side of the case with a strain relief. The duplex outlet will have 2 silvery screws in a silvery metal strip on its cold side, and a brass-colored metal strip with either 2 silver or 2 brass-colored screws on the hot side. Break the thin brass strip connecting the 2 screws on the hot side to isolate them from each other. Leave the 2 screws on the cold side in common with each other. Shorten the green and white leads on the line cord from 18 to 6 inches. Connect the green wire to the green screw on the outlet, and the white wire to one of the cold screws. Connect one end of the remaining 12 inches of white wire to the other cold screw, and the other end to one side of T1's primary (hole B in Fig. 9). Connect one end of an 18-inch wire to each of the remaining holes on the power supply board. The wires to holes A and C should be No. 18 gauge. The remaining ones can be No. 24 or 26. Temporarily connect the wire from hole A to the black wire in the line cord. Interconnecting wires should be stranded.

Attach the board to the rear half of the case as shown in Fig. 11. Mount it so the transformer is toward the bottom of the case (when mounted on a wall). The outlets can be on either the right or left side to suit your darkroom's layout. Connect the No. 18 wire from the triac (hole C on the power supply board) to one of the unused hot screws on the outlet sock-

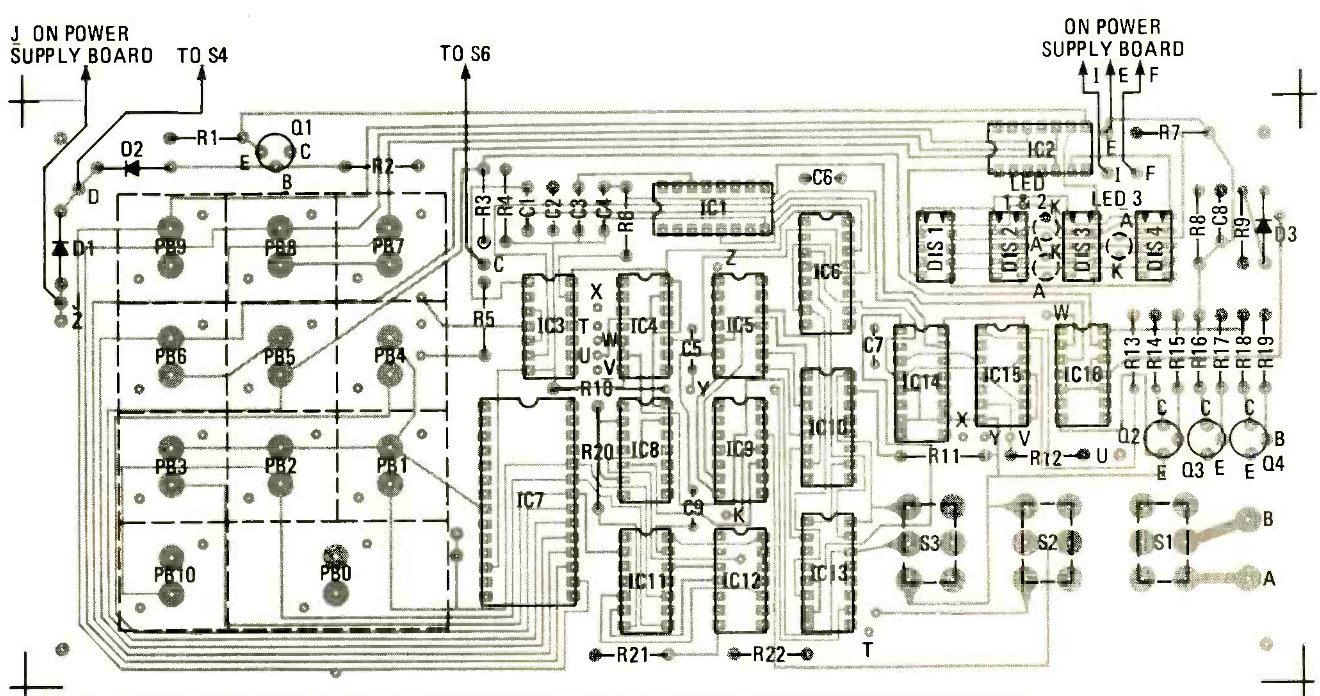


FIG. 8—PARTS PLACEMENT ON THE MAIN CIRCUIT BOARD. Note that the keyboard mounts directly to this board too. As indicated, jumpers connect this board to the power supply board.

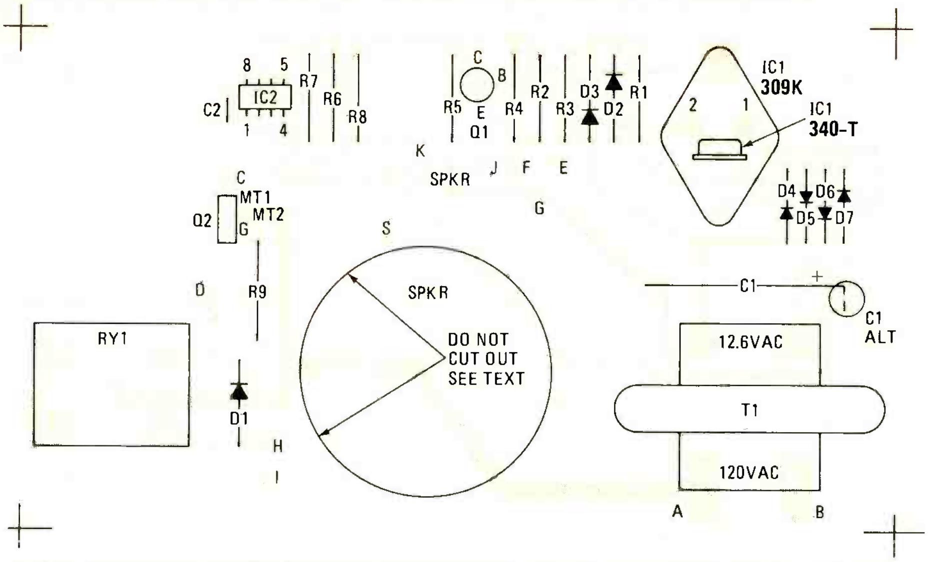


FIG. 9—PARTS PLACEMENT ON THE POWER-SUPPLY BOARD. Note that the speaker and audio circuit components are also placed on this board.

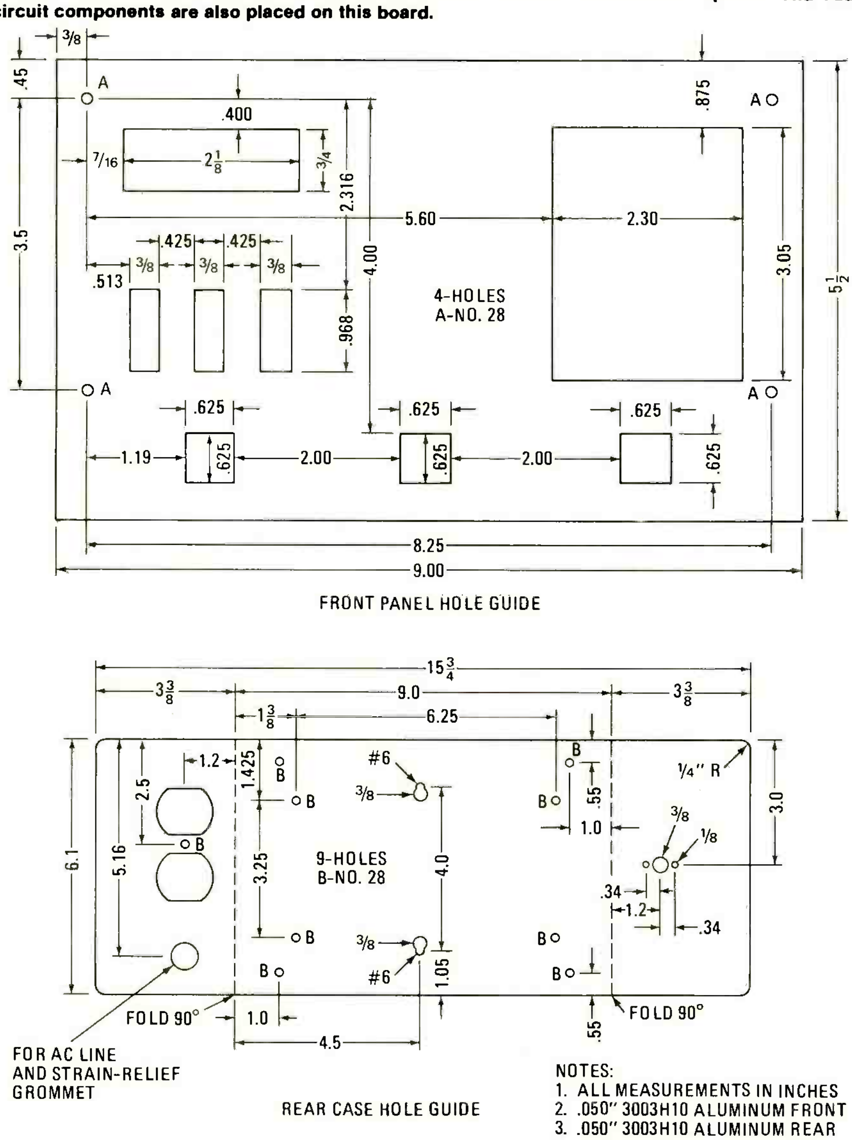


FIG. 10—FOLLOW THESE GUIDES FOR MAKING HOLES in both the front and rear panels of the case. Be sure to follow the listed dimensions accurately.

et, and the wire from hole D to the remaining unused hot screw. Secure the duplex receptacle outlet to the case with a single 6-32 × 3/8 screw in its center hole. Either scrape the paint from below the head of this screw or use a star washer under the head to cut through the paint and into bare metal. It is imperative that the head of this screw be in excellent electrical contact with the case for safety. Mount the phono-type jack used in conjunction with a foot switch as a remote START/STOP switch with two 4-40 × 1/4 screws. Make sure the ground terminal is in intimate contact with bare metal on the inside of the case.

Verify that the clearance between the foil side of the board and the case is adequate, and plug a 15-watt lamp into the socket connected to hole D, the safe-light socket. Plug the line cord into the 120-volt power line. A steady tone should be heard and the lamp should light. Grounding IC2-4 should turn the tone off. Measure +7.5 to +8.5 volts DC at hole E, and 30 to 70 percent of this voltage at hole J. Vary R4 if outside the 30 to 70 percent range. Ground hole H or I and verify that the lamp goes off. Move the lamp to the other outlet and verify that it lights when hole H or I are grounded.

Interconnect the main and power supply boards and the front panel switches and remote START/STOP jack as shown in Figs. 3 and 4. Remove the temporary connection between the line cord's black wire and T1's primary, and make the permanent connections shown in Figs. 3 or 4. Epoxy the red filter in place over the cutout in the panel for viewing the displays. This should be one of the very first things done when assembly initially starts. Connect main board to front panel as shown in Fig. 11.

Testing

With all the IC's and displays removed from the main board, power the unit. Verify that the AC power switch works, and that the FOCUS switch activates the relay. Verify that B+ is present on each of the IC's power pins as shown in the table in Fig. 3. Shut power off and install the calculator IC, the four readouts and IC2. The displays, when power is reapplied, will usually show one, but occasionally two, zeroes in the right position(s). A decimal point will show if the TIME switch is in the SEC position, and a colon if in the MIN/SEC position. The overflow LED and audio will be on. Enter [9], [8], [7], [6] and verify that these digits show on the display. If odd characters appear, look for solder bridges near the display sockets, using a loupe of about 10 power. If none of the numbers appear on the display, check orientation of IC7 in its socket, the voltage at IC7-15 and that IC7-12 is at ground. If these tests pass, measure the voltage at IC7 pins 6, 7 and 8. The voltage at these pins should be high only when a pushbutton is pressed or a switch inside IC8 or IC11 is closed. If high at this time, either one of the pushbuttons is defective, or a solder splash exists somewhere, probably near IC8 or IC11's sockets. After getting the correct results, turn the unit off and then on to clear the display. Enter [5], [4], [3], [2] and verify the display. Again, momentarily turn off the unit, then enter and verify the [1], [0] entry. Turn the unit off and install the remaining IC's, being careful to minimize touching the leads to prevent static elec-

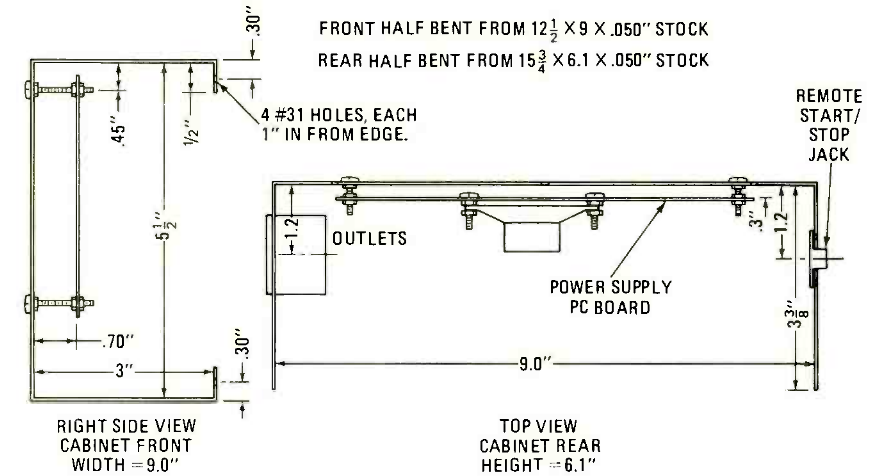


FIG. 11—CASE BENDING INSTRUCTIONS for the builder who wants to make his own case. The detail at the right shows how the speaker is positioned and mounted inside the case.

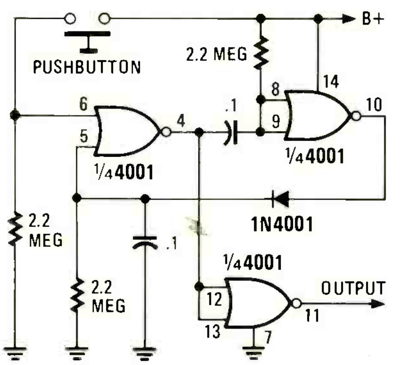


FIG. 12—SIMPLE TEST CIRCUIT produces a single bounce-free output each time you push the switch.

tricity damage. Before applying power to the unit, double check the orientation of the IC's. Apply power and verify that the AUDIO switch works. Enter any 5 digits. When the fifth one is entered, the overflow LED should light. Clear the display using the CLEAR button (one zero will remain). With the TIME switch in the MIN/SEC position, enter any 2 digits and press the START button.

About 0.5 second later, the relay will energize and the timing cycle will begin. Allow it to complete, and verify that the selected time reappears at completion. Enter 2 new numbers and reinitiate the cycle. Interrupt it with a single push of the PAUSE button. A second push should allow the cycle to continue. Interrupt it again, this time with the START/STOP button. The time last entered should reappear in the display.

Enter [1], [1], [0] (1 minute and 10 seconds) and start the cycle. Verify that the display jumps from 1:00 to :59.

Move the TIME switch to the SECONDS position, enter any number and verify operation. The flickering of the display in the SECONDS mode is normal. It occurs because during the computation period, the calculator IC blanks its segment and digit outputs until a valid final answer is produced.

The audio signal produces one beep for each second selected on the minutes/seconds range. In the seconds range, there may be one additional beep more than the number of whole seconds selected, depending upon the size of the fractional seconds entered. For example, an entry of [2] [•] [2] will give 2 beeps, and an entry of [2] [•] [4] will give 3 beeps. An entry of [2] [•] [3] will give 2 solid beeps and maybe a half-hearted third one also, depending upon the speed of your particular calculator IC and the position of its internal oscillator when you happened to start the cycle.

Most discrepancies will be due to construction errors such as miswiring, bad soldering, etc., or defective IC's. I have had difficulties when using 4017's manufactured by MITEL Semiconductor whose part identification prefix is SIL. Usually, one of the 10 outputs refuses to go high. If the failed output is unused, the IC is OK to use since usually the good outputs go high at the correct time. Integrated circuits IC6 and IC10 can be interchanged as can be many other pairs of IC's.

Several innocent-looking capacitors are vital to proper operation. Capacitor C3, if too small or open, will cause timing accuracies to be off as much as 20% or cause the decrementing to look erratic, and make the unit sensitive to line transients. If line transients are suspected of causing large jumps in the display's contents, try increasing C3 to 0.1 μF, adding no more than 0.1 μF from the collector of Q1 on the power supply board to ground, and/or adding capacitance across the secondary or primary of T1.

Capacitor C4, if too small or open, will cause difficulty in entering numbers, self-starting while entering numbers, or premature ending of the timing cycle. If C6 is too small, it could cause 41 to be subtracted at undesired times.

Calculator IC's aren't designed for a 10-Hz counting rate. To make this unit operate reliably at this rate, IC7's internal clock was speeded up by reducing R21 to 75K from the manufacturers' recommended 470K. My prototypes operated properly with three IC's manufactured at widely different times. If R21 is too small, the internal clock will harmlessly stop, while if too large, the timing interval on the SECONDS range will be about double the desired value.

For difficult problems, wire the test circuit in Fig. 12, which produces a single bounce-free output each time the pushbutton is pressed. Break the connection between holes J and J, and connect the test circuit output to hole J on the main board. You can now single-step the timer through its sequences, remembering that 6 pulses are required to produce a single output from IC1-5.

When using a scope to look at the outputs of IC7 or most other points in the circuit, connect the scope's external trigger input to D1 (a convenient test point can be made by inserting a bare loop of wire in the holes adjacent to IC7-10 and IC7-11). Adjust the controls so triggering is on the positive polarity. Connect the vertical input to D1 and adjust the horizontal gain and centering until D1 is high between the first and second vertical lines on the scope's graticule (assuming 10 major divisions and 11 vertical lines). Move the vertical input to D9, IC7-16. If the horizontal controls are properly set, the trace should be high between the ninth and tenth vertical lines. (If your scope's external trigger input is capacitively coupled, add a 100K resistor from D1 to ground.) As an example of using this setup, suppose that pressing the keys would not enter numbers in the display. Suspecting that either KP, KN or KO is always high or continuously being pulsed high, you scope these points. If you noted that KO was high between the fourth and fifth vertical lines, the D4 time slot, you should suspect everything associated with the Minus function (IC8-10, IC8-11 and the drive circuits to IC8-12). Similarly, if 41 isn't being subtracted at whole-minute intervals, enter the numbers [2], [0], [0] and make sure that IC4-11 is low in the D8 and D9 time slots, IC15-4 is high during the D8 time slot, IC15-3 is high during the D9 time slot, IC15-11 is high during the D8 and D9 time slots, etc. Ignore signals occurring during D1 to D4.

Fasten the halves of the case to each other with four sheet metal screws. The timer is ready for use.

Parts substitution

Although the only custom parts are the cabinet and PC boards, several parts are difficult to obtain. For example, Datanetics has a minimum billing of $25, and GI's Los Angeles-area distributors have minimums of $10. But since the calculator IC is not a heavy-demand item, distributors don't stock it and are reluctant to order the necessary quantity from the factory.

The remaining items should all be readily available from R-E's advertisers

continued on page 60

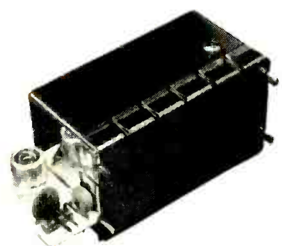
ROUNDUP

VIDEO MODULATORS

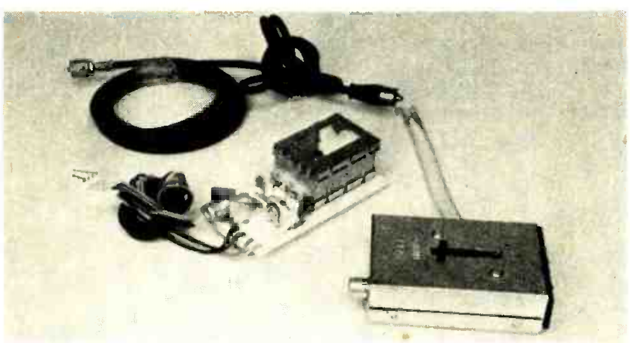
If you are into VTR's, TV games, home computers and TV modulator must be used to feed modulated RF to

FRED BLECHMAN K6UGT

VD-1 by Ramsey

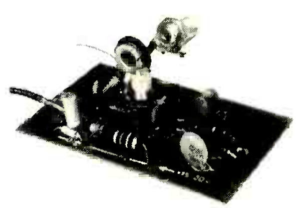


ATARI model CA-010410

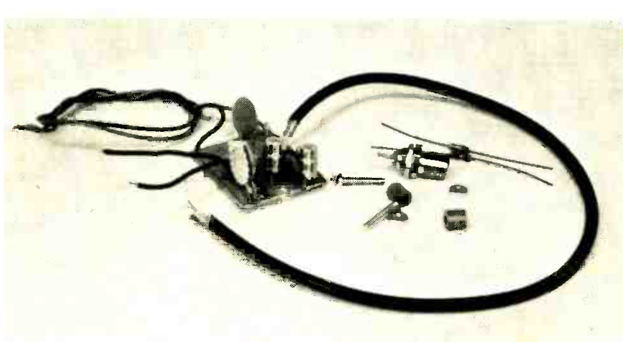


SUP "R" MOD II, cables and switch included

MODEL E & P



RF-1 RF modulator



RFVM-1 sold by Vamp and Quest Electronics

IN THE LAST TWO YEARS FOUR "NEW" ELECTRONIC PRODUCTS have been introduced into the consumer marketplace—video games, video cassette recorders, video cameras and home computers. While these products have been available in some form for several years, their design finally became practical enough for consumer acceptance. Coincidentally, each product uses a video display for its output. A TV screen is essential for playing a video game or watching a video recorder, and most home computers use a video display for the readout, although printers can also be used. Video cameras, long used for closed-circuit security and surveillance systems, are growing in popularity now that video cassette recorders are available for making home movies, and, of course, cameras also use a video display.

Two basic methods make the video signal visible on a picture tube. The most efficient method is to feed the video output of a game, camera, video recorder or computer directly into the video amplifier of a video monitor or TV set. Since most TV sets require rewiring to provide direct access to the video amplifier (and those with a hot chassis can create a dangerous shock hazard), video monitors have generally been used. However, when home video games became popular, it was obvious that the public would not care to buy a special monitor to play the games. Therefore, an old video camera technique was revived—generating an RF signal on an unused TV channel and modulating it with the video signal! By connecting the modulated RF carrier to the antenna terminals of a standard TV set, you could watch the game by simply tuning to the unused channel.

In the beginning, video game manufacturers, to avoid interfering with VHF signals, created carriers in the high UHF band. Shielding problems, signal instability with temperature variation and other design considerations caused the shift to VHF carriers modulated by the video signal. Several million video games were sold (some for as little as $25) complete with built-in video-modulated RF oscillators. The Federal Communications Commission (FCC) then cracked down on the manufacturers, requiring them to test units to rigorous specifications before type approval was issued, in order to try minimizing the spurious radiations being generated to neighboring TV sets—or even to other sets in the home!

With technological advances taking place in the game field, microprocessors and dedicated integrated circuits (IC's) became commonplace among experimenters. Home computers suddenly blossomed from garage and basement labs to full-blown manufacturing plants. Experimenters and hobbyists found an increasing need for some means to couple the video output of their devices to a display. Video monitors have remained a low-production item and are therefore high-priced. TV set manufacturers have not recognized the sales advantage of adding a switch and jack to existing designs to allow direct video input. Therefore, there has been a steadily increasing

turn your TV into a video monitor

cameras in security and surveillance systems, a video TV set used as monitor. Here's what modulators are about.

market for a separate video-modulated VHF oscillator that allows the owner of a video game, camera, recorder or home computer to use the device with a standard TV set.

These VHF oscillators have many different names: RF modulator, VHF modulator, RF oscillator, video-to-TV interface, video-to-RF modulator, etc., but in this article we will use the general term of "video modulator," even though this is technically incorrect. (The device is *not* modulating the video—it is being modulated *by* the video!) Some manufacturers have sensed the need for this device among hobbyists and experimenters, and the Comparison Chart shows 14 video modulator sources. Many of these devices (and maybe others) are available at computer shops.

Figure 1 shows a simplified block diagram for a typical video

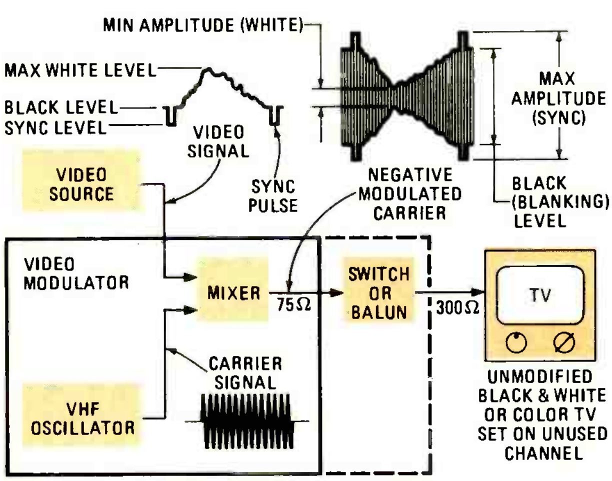
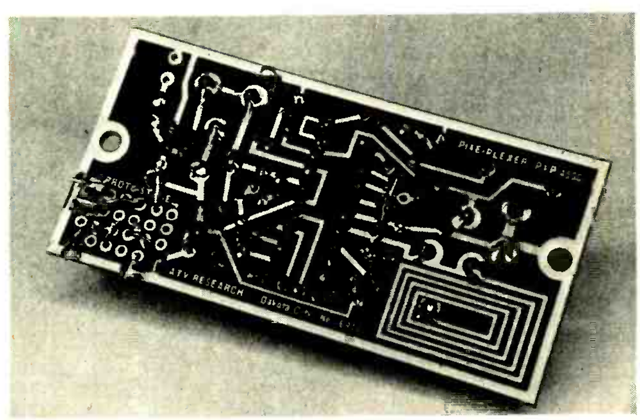


FIG. 1—BLOCK DIAGRAM OF VIDEO MODULATOR.

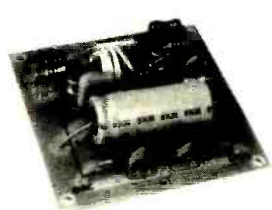
modulator. The video signal from the camera, computer, recorder or game should be the standard NTSC (*N*ational *T*elevision *S*ystem *C*ommittee) format used in the United States, Japan, Canada and Mexico. This means that the picture carrier is modulated so a *decrease* in scene brightness causes an *increase* in output power. This is known as *negative* modulation polarity. With negative modulation polarity, the picture content may vary the transmitter output power from 15% for white level to 75% for black at the blanking level. The horizontal sync pulse rides atop the blanking pulse—extending into the blacker-than-black level at 100%. The tunable VHF oscillator generates a sinewave on a locally unused TV channel; this sinewave signal becomes the carrier. In the mixer, the video signal amplitude-modulates the VHF carrier with *negative* modulation polarity. This modulated VHF carrier connects to the antenna terminals

TV-1 video to TV interface

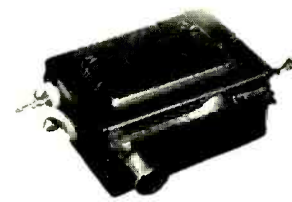
PXV-2A Pixe-Verter



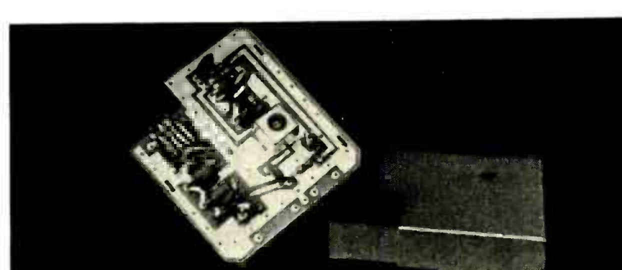
PXP-4500 Pixe-Plexer from ATV Research



Model 1-7 RF modulator



E & P video modulator



VIDEO CUBE 5500-R from Delta Electronics

COMPARISON CHART – VIDEO MODULATORS

MANUFACTURER OR DISTRIBUTOR	MODEL	PRICE ($) KIT	PRICE ($) ASSEMBLED	OUTPUT CHANNEL NO. 2	3	4	5	6	SUPPLY VOLTAGE (DC)	VIDEO INPUT CONTROL	RF-SHIELDED	INPUT CONNECTOR	OUTPUT CONNECTOR	PERFORMANCE: MIN. VIDEO INPUT (PEAK-TO PEAK)	RF REJECTION	SIGNAL SOURCE: VIDEO CAMERA	VIDEO RECORDER	MICROCOMPUTER	SIZE (CM.) LENGTH	WIDTH	HEIGHT	SOFTWARE: DOCUMENTATION	SCHEMATIC	USE DIRECTIONS	PRECAUTIONS	SHIPPING AND REMARKS
ADVANCED COMPUTER PRODUCTS P.O. BOX 17329 IRVINE, CA 92713	U1001 RF MODULATOR WITH AUDIO	—	7.95		✓	✓			9	N	Y	N	①	②	P	G	G	P	8	5.5	2.5	P	N	N	N	SHIPPING: 5% + $.50 INSUR. CAL. RES. ADD 6% TAX. OUTPUT INVERTED. SEE TEXT.
ADVANCED VIDEO PRODUCTS 5835 HERMA SAN JOSE, CA 95123	RF-1 RF MODULATOR	12.00	—	✓	✓	✓	✓	✓	9-20	Y	N	N	N	.4	G	E	E	G	8.3	5.2	2.5	G	Y	Y	N	SHIPPING: C.O.D. CHARGE. CAL. RES. ADD 6% TAX. TUNING WAND INCLUDED.
ATV RESEARCH 13TH AND BROADWAY DAKOTA CITY, NE 68731	PXV-2A PIXEVERTER	8.50	—	✓	✓	✓	✓	✓	–5 TO –6.5	Y	N	N	N	2	F	G	G	F	5.1	3.2	2.0	E	Y	Y	Y	SHIPPING: POSTPAID. NEGATIVE SUPPLY VOLTAGE REQUIRED.
	PXP-4500 PIXEPLEXER	24.50	—		✓	✓	✓	✓	15	N	N	N	N	④	G	G	G	G	7.7	3.8	2.3	E	Y	Y	Y	SHIPPING: POSTPAID AUDIO INCLUDED.
CALIFORNIA INDUSTRIAL P.O. BOX 3097K TORRANCE, CA 90503	CA-010410 ATARI RF MODULATOR	—	13.95		✓	✓			1.5-12	N	Y	N	①	.8	F	E	E	G/F	6.5	3.2	2.8	P	Y	N	N	SHIPPING: $1 FOR ORDERS UNDER $15. CAL. RES. ADD 6% TAX. WILL OPERATE ON PEN CELL. 15 FT. COAX & RF CONNECTOR INCLUDED.
DELTA ELECTRONICS 7 OAKLAND ST. AMESBURY, MA 01913	5500R VIDEO-CUBE	13.95	—		✓	✓			5-12	N	Y	N	N	4	P	F	F	P	6.3	5.6	2.8	G	Y	Y	Y	SHIPPING: POSTPAID. MASS. RES. ADD SALES TAX. MUST BE TAILORED TO CIRCUIT – SEE TEXT.
ELECTRONIC SYSTEMS P.O. BOX 212 BURLINGAME, CA 94010	NO. 107 RF MODULATOR	13.50	—	✓	✓				5VDC OR 12VAC CT	N	N	N	N	2	G	E	E	F	6	6	1.5	F	Y	N	N	SHIPPING: POSTPAID WHEN PAYMENT SENT WITH ORDER. CAL. RES. ADD 6½% TAX. PC BOARD ALONE: $7.60.
FORMULA INTERNATIONAL, INC. 12603 CRENSHAW BLVD. HAWTHORNE, CA 90250	VHF MODULATOR (E&P)*	—	4.50		✓				5-6.5	N	Y	N	①	②	②	③	③	③	6	3.8	2.4	P	N	Y	N	SHIPPING: 10% OUTSIDE CAL. CAL. RES. ADD 6% TAX. MIN. ORDER: $10. OUTPUT INVERTED – SEE TEXT.
BILL GODBOUT ELECTRONICS OAKLAND AIRPORT CA 94614	RF MODULATOR (E&P)*	—	7.50		✓				5-6.5	N	Y	N	Y	②	②	③	③	③	6	3.8	2.4	NO DOCUMENTATION RECEIVED WITH UNIT				SHIPPING: $.50. CAL. RES. ADD 6% TAX. OUTPUT INVERTED – SEE TEXT.
JADE COMPUTER PRODUCTS 5351 WEST 144TH ST. LAWNDALE, CA 90260	TV-1 VIDEO-TO-TELEVISION INTERFACE	8.95	—	✓	✓	✓	✓	✓	5-12	Y	N	N	N	.25	G	E	E	G	3.5	3.5	1.5	E	Y	Y	Y	SHIPPING: $1.25. CAL. RES. ADD 6% TAX. (MADE BY UHF ASSOCIATES) SMALLEST UNIT. COAX INCLUDED.
M & R ENTERPRISES P.O. BOX 61011 SUNNYVALE, CA 94088	SUP "R" MOD II TV INTERFACE	—	29.95		✓				12	Y	Y	①	①	2	G	G	G	G	8.2	3.9	2.5	E	Y	Y	Y	SHIPPING: $1. CAL. RES. ADD 6% TAX. TV SWITCH & COAX INCLUDED.
QUEST ELECTRONICS P.O. BOX 4430E SANTA CLARA, CA 95054	VIDEO MODULATOR (TV-1)	8.95	—	✓	✓	✓	✓	✓	5-12	Y	N	N	N	.25	E	E	E	G	3.5	3.5	1.5	E	Y	Y	Y	SHIPPING: POSTPAID. CAL. RES. ADD 6% TAX. SEE JADE MODEL TV-1 FOR TEXT. COAX INCLUDED.
	VIDEO MODULATOR (RFVM-1)	8.95	—	✓	✓	✓	✓	✓	5	Y	N	N	⑤	.8	G	E	E	F	4.5	3.3	2	E	Y	Y	Y	SHIPPING: POSTPAID. CAL. RES. ADD 6% TAX. SEE VAMP MODEL RFVM-1 FOR TEXT. MOUNTING HARDWARE, COAX & CONNECTOR INCLUDED.
RAMSEY ELECTRONICS P.O. BOX 4072 ROCHESTER, NY 14610	VD-1 VIDEO-TO-RF MODULATOR	6.95	—			✓	✓	✓	5-10	N	N	N	N	.5	F	G	G	F	4.6	2.6	2.5	G	Y	Y	N	SHIPPING: $.75 FOR ORDERS UNDER $10. N.Y. RES. ADD 7% TAX. LEAST EXPENSIVE KIT.
UHF ASSOCIATES P.O. BOX 24 JENNER, CA 95450	TVS-100	⑥	⑥		✓	✓			15-20	Y	Y	①	①	1	G	E	E	G	16	5	2	⑥	⑥	⑥	⑥	⑥ AUDIO INCLUDED.
VAMP, INC. P.O. BOX 29315 LOS ANGELES, CA 90029	RFVM-1 RF-TO-VIDEO MODULATOR	8.95	—	✓	✓	✓	✓	✓	5	Y	N	N	⑤	.8	G	E	E	F	4.5	3.3	2.0	E	Y	Y	Y	SHIPPING: $1 FOR ORDERS UNDER $15. CAL. RES. ADD 6% TAX. MOUNTING HARDWARE, COAX & CONNECTOR INCLUDED.

NOTES: E = EXCELLENT G = GOOD F = FAIR P = POOR Y = YES N = NO *E&P STAMPED ON CASE IS ONLY IDENTIFICATION
① RCA PHONO JACK. ② NOT TESTED – SEE TEXT. ③ UNIT WILL NOT WORK WITH NTSC VIDEO – SEE TEXT. ④ VARIES WITH INTERFACE CIRCUIT.
⑤ F-59 CONNECTOR SUPPLIED. ⑥ INFORMATION NOT AVAILABLE. WRITE COMPANY FOR SPECIFICATIONS, PRICE AND AVAILABILITY.

of a standard black-and-white or color TV set. When the TV set is tuned to the VHF carrier frequency, the information contained on the video signal is displayed conventionally. For most units tested, a TV antenna switch or a balun transformer (75 ohms to 300 ohms) is needed for connection to the TV antenna terminals.

Evaluating the modulators

Bob Buckner, an electronics consultant, built all the kit units reported on, and did the majority of the data compilation. He and I did the comparative testing together. Gene Hill, co-owner of UHF Associates, provided most ot the units for building and testing, with the understanding that the "chips fall where they may" in the evaluations. (As it turned out, the two UHF Associates units were outstanding, and the reader will have to take my word that my objectivity was not influenced by the cooperation of UHF Associates!)

Twelve different video modulator designs were examined for this article, although some were available from more than one source. Each design was different in circuitry, layout and components, although some similarities existed. Two sources distribute the E & P unit: Formula International, Inc., and Godbout Electronics. Although this was the least expensive assembled unit, it appears to be wired for a *positive*-sync, video input signal, since we could not receive anything except a *negative* picture that would not synchronize with the TV. Inverting the input video signal with a properly biased transistor circuit would probably allow this unit to be used with a standard TV set. However, this was not tried.

Figure 2 shows the schematic of the UHF Associates *model*

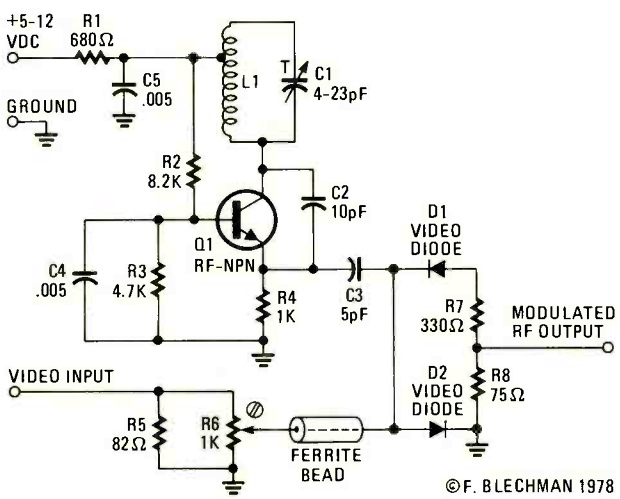


FIG.2—UHF ASSOCIATES *MODEL TV-1* schematic diagram.

TV-1 modulator, distributed by Jade Computer Products and Quest. The VHF frequency is generated by a tuned Hartley oscillator circuit. Resistors R2, R3 and R4 bias the transistor, with tapped printed-circuit inductor L1 and trimmer capacitor C1 forming the tank circuit. Adjusting C1 determines the frequency. Capacitor C2 provides positive feedback from the tank circuit to the emitter at Q1. Capacitor C4 provides an RF ground for the base of Q1. Bypass capacitor C5, together with resistor R1, filters the radio frequencies generated in the tank circuit to prevent radiation from the power-supply lines.

The video signal enters the parallel combination of resistors R5 and R6; this combination closely matches the 75-ohm impedance of most video cables. Resistor R6 is a small screwdriver-adjusted potentiometer that is used to control the video input level to mixer diodes D1 and D2. These diodes are operated in their nonlinear region to mix the video signal with the VHF carrier. With no video input, the VHF carrier, which is loosely coupled to the mixer by capacitor C3, passes through D1 to voltage divider R7–R8. The output impedance is 75 ohms, to match standard video coaxial cable. As the video signal leaves video level control R6, it encounters the ferrite bead; this bead blocks any RF on the video-input line, yet passes the video signal on to diodes D1 and D2. This video signal effectively biases the diodes, allowing them to conduct or block the carrier signal, thus modulating the carrier. For example, as the video signal amplitude goes positive, D2 is forward-biased toward ground, so the carrier amplitude is decreased. However, as the video signal goes *negative*, and grows even *more* negative to the sync level, D2 cuts off and the maximum carrier amplitude (minus the diode voltage drop) passes through D1 to R7–R8. Therefore, white-level video signals yield the lowest VHF carrier output, and sync pulses are the highest, as shown in Fig. 1!

Comparison chart

The sources, prices and shipping information shown in the Comparison Chart were correct as of early March, 1978. The output channels and supply voltages are those specified in manufacturer's literature. Some units might be tunable beyond the specified channels. The supply voltages are all positive, except for ATV's *Pixe-Verter*, which requires a negative voltage. The video input on those units designated in the chart with a "Y" (for "Yes") consists of a small potentiometer, usually with a screwdriver slot for adjustment. Most units do not have video input or VHF output connectors, this being left up to the user's discretion to suit a particular application. Those units that *do* have connectors use standard RCA phono jacks, except for the Vamp unit, which has one F-59-type RF connector supplied with the kit.

The performance parameters were judged based on comparisons with other units. The peak-to-peak video voltage was measured using an oscilloscope, with the "minimum" standard being that point below which the picture quality was noticeably affected. For those units with a listed voltage range, the test was conducted at the minimum voltage.

Since a video modulator might be operated in or near a computer terminal, each modulator was used to display a color signal while near a Radio-Shack TRS-80 computer, and the interference from the computer was evaluated. In many cases, the interference was hardly noticeable, even though most units were unshielded and clip leads were used for making some connections. Probably if shielded wire and connectors are used and a metal enclosure is placed around each unit, the RF interference from the computer would not be a problem.

The most difficult judgment involved was that of picture quality using a black-and-white video camera and a color TV video signal. The camera was an FS II from Advanced Video, and all the negative-sync-output modulators provided good to excellent results, except for the *Videocube*. The *Videocube* requires special matching, depending on the mating circuits, and the results could probably be improved by further refinements.

The color video source was the video output of an RCA *SelectaVision* video cassette recorder, and most units provided a surprisingly good picture. in some cases, jockeying of video input level and supply voltage was required; once tuned properly, however, the color and contrast were good. Again, the exceptions were the positive-sync units, which were unusable with a standard video signal.

The test that really "separated the men from the boys" was when we tried to receive a video signal from a computer through the TV front end! The Radio Shack TRS-80 computer was used with each video modulator and displayed on a Midland *model 15-023* 12-inch black-and-white TV set. The computer produces 16 lines at 64 characters-per-line, and the results were compared with a direct video connection to the TRS-80 12-inch black-and-white video monitor. Under no conditions in our tests could a video modulator duplicate the clarity that was obtained by this direct connection to the video monitor. This is not really surprising when you consider that the effective video bandpass of even a good TV receiver is no more than 4.0 MHz, while the video monitor is rated at 5.5-MHz maximum bandwidth.

Next month we'll continue this discussion and then take a detailed look at the products of each manufacturer as listed in the comparison chart. **R-E**

Radio-Electronics Tests ReVox Model B-760 FM Tuner

CIRCLE 102 ON FREE INFORMATION CARD

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LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

ANYONE READING THE PUBLISHED SPECIFICATIONS of the *model B-760* stereo FM tuner manufactured by Studer ReVox America, Inc. (1819 Broadway, Nashville, TN 37203), and familiar with the new U.S. tuner measurement standards as adopted by the IHF and the IEEE, will immediately realize that the manufacturer's specs are not written in accordance with the approved standards (as of this writing). We realized that this would make it difficult to compare published claims with actual measured performance, but we also felt that it was appropriate to measure this fine tuner in exactly the same way that we measure other tuners. This, as we came to learn, was particularly important in distortion measurements where 40-kHz deviation signals resulted in one distortion reading, while full 75-kHz deviation yielded another.

The front panel of the *model B-760* is shown in Fig. 1. The left side of the front panel contains a POWER on-off switch, with a superimposed indicator light and phone jack just below. A switch immediately to the right of these controls is used for introducing optional Dolby noise reduction (our unit was not equipped with this extra circuit module), and a light above this switch illuminates when the Dolby unit is activated. The volume control just below is then used for varying the headphone output level. The selected-station frequency is displayed digitally above two meters (a signal-strength meter and a center-of-channel meter). Pushbuttons below the meters are used to store frequencies in the system's memory bank, introduce a station blank for any given memory pushbutton, add or cancel a fixed 25-kHz to the tuned-to frequency that is displayed and select manual tuning, which then permits you to use the conventional rotary tuning knob in the usual fashion. As you turn this knob, displayed frequencies move up or down in 50-kHz increments.

The 15 numbered pushbuttons to the right of the tuning knob are used to store favorite station frequencies. While in the manual mode, if you tune to a station that you wish to retain, just press the STORE IN MEMORY pushbutton and the numbered station selector pushbutton desired; from then on, pressing that particular numbered pushbutton instantly tunes to the selected frequency.

To the right of the 15 memory buttons are a stereo indicator, a SEPARATION switch for maximum or high-blend stereo reception and a MONO override pushbutton. A companion switch selects interstation muting or interstereo muting (this switch allows only stereo signals to come through). A muting indicator light is located above this switch, while below is another pushbutton that overrides both forms of muting.

Hidden secondary controls are located behind the upper bezel showing the trade name and model number; this bezel swings down to disclose the controls. Figure 2 shows the group of switches at the left of this area, including slide switches for selecting de-emphasis (75 or

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50 μs as well as 25 μs if an optional Dolby unit is installed) and a MEMORY MODE switch. In the READ ONLY mode of this switch, new information cannot be programmed into the tuner (to prevent accidental cancellation of previously stored frequencies), while in the READ WRITE mode, frequencies can be programmed into any of the 15 memory locations. Three tiny rotary controls at the right (see Fig. 3) are used to adjust the stereo-only and interstation muting thresholds and to adjust output level

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from one of the tuner's sets of outputs.

The left-hand side of the rear panel (shown in Fig. 4) contains vertical and horizontal scope-connection jacks for observing multi-

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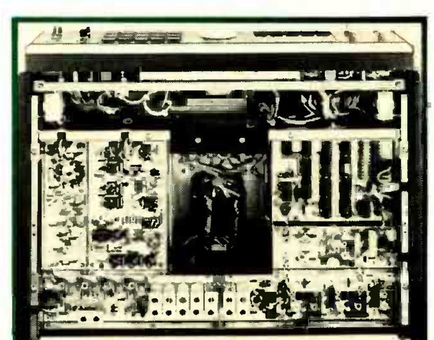
path, fixed-level and variable-level output jacks and a DIN multipin connector. A voltage selector knob chooses the correct power-line operating voltage, and a separate line cord is provided to match either foreign or domestic power requirements. To the right of these controls is a receptacle that accepts a supplied 300-ohm plug to which a 300-ohm transmission line can be connected; next to this plug is a coaxial connector for a 75-ohm transmission line from antenna to tuner.

Circuit highlights and construction

Figure 5 shows an internal view of the *model B-760* tuner with the internal shields removed. The complexity of the layout is due to the fact



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that it contains 65 IC's, 63 transistors, 2 diode matrices (91 diodes), 42 diodes, 19 varactor

MANUFACTURER'S PUBLISHED SPECIFICATIONS:

Usable Sensitivity (for 40-kHz deviation, 46-dB S/N): mono, 2.0 μV (11.2 dBf); stereo, 20 μV (31.2 dBf). **AM Suppression:** 70 dB. **Selectivity** (referred to 300-kHz separation and 40-kHz deviation): 80 dB. **Capture Ratio:** 0.9 dB. **IF Rejection:** 110 dB. **Image Rejection:** 106 dB. **Frequency Response:** 30 Hz to 15 kHz, ± 1 dB. **Harmonic Distortion** (mono and stereo, L = R): 0.15%. **S/N Ratio:** 75 dB. **Stereo Separation** (40-kHz deviation, 1 kHz): 42 dB. **Subcarrier Suppression:** 65 dB. **Output Level:** 1.16 V (400 Hz). **Power Requirements:** 100, 120, 140, 200, 220 or 240 V, 50 to 60 Hz, 40 watts. **Dimensions:** 17¾ W × 5.94 H × 13⅜ inches D. **Weight:** 26 lbs., 7 oz. **Suggested Retail Price:** $1145.

(variable-capacitance) diodes and 3 bridge rectifiers. Of particular interest to those not familiar with a frequency-synthesized, digital readout tuner is the circuit design used for these functions.

The electronic storage of station frequencies and their addresses is accomplished by a 16-bit by 12-bit CMOS random access memory (RAM). The stored information is retained in RAM as long as the unit remains connected to the power outlet, and in the event of a power failure, replaceable alkaline batteries (stored behind the tilt-down front bezel) can be used so there is no loss of information. Extremely low current consumption (less than 10 μA) makes storage in RAM possible for over a year from the battery supply.

The front end of the tuner contains two broadband amplifying stages, followed by six tuned filters and a symmetrical push-pull mixer stage. Eighteen dual-varicap diodes are used for tuning all tuned circuits including the local oscillator. The IF section is designed as a phase-linear toroid filter in a separate screened compartments and is completely passive. An IC-equipped broadband limiter features six amplifying stages. An automatic-gain control circuit allows the signal-strength meter to display input-signal values logarithmically, so that meaningful readings are possible from a few microvolts to more than 100 mV. The FM detector is a digital demodulator type that uses a line-demodulating principle. A phase-locked-loop circuit is used in the multiplex decoder section and, unlike most of these circuits, discrete parts were used for the phase-locked loop (not an IC). Interference frequencies above 53 kHz are suppressed through the use of a phase-linear 100-kHz low-pass filter, a bandpass filter (23 kHz to 53 kHz) and separate 114-kHz and 130-kHz rejection filters plus a 19-kHz pilot tone rejection filter.

Lab measurements

Table 1 summarizes our lab measurements, which were taken in accordance with IHF measurement standards; they therefore do not readily lend themselves to comparison with the manufacturer's currently published specifications. The 50-dB quieting value was exceptionally good in both mono and stereo, as were the ultimate signal-to-noise ratios obtained for a 65-dBf input signal at 100% modulation. Image, IF and spurious rejection measurements were limited by our test equipment, which can only read these figures up to 100 dB (hence, the "+" notation after each one).

We encountered difficulties when we began to measure harmonic distortion at the three prescribed test frequencies in mono and stereo. As long as we used the DIN values of 40-kHz deviation, distortion readings were quite low; but as deviation was increased to meet U.S. standards, the readings began to rise over the last few kHz of modulation. The distortion figures shown in parentheses are those obtained using $\pm$40-kHz modulation, while the higher figures are those obtained using $\pm$75-kHz modulation. Although the high-deviation results were not bad, they would have been much better if the design had been adjusted for U.S. modulation extremes. The significance of this difference is of little importance if you are listening to a station that carefully monitors its modulation depths, but, as most people know, many stations not only reach but sometimes even exceed the 100% modulation limits. It is common practice for many popular and rock music stations to use high compression levels (decreasing dynamic range) and, at the same time, push modulation to the limit so that they will be the "loudest station on the dial" as you traverse the FM frequency band.

TABLE 1

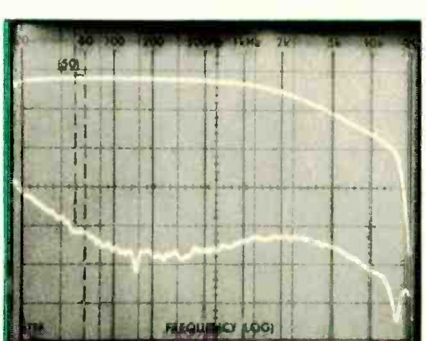
RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Studer/ReVox** Model: **B-760**

FM PERFORMANCE MEASUREMENTS

SENSITIVITY, NOISE AND FREEDOM FROM INTERFERENCE	**R-E Measurement**	**R-E Evaluation**
IHF sensitivity, mono: (μV) (dBf)	2.0 (11.2)	Very good
Sensitivity, stereo (μV) (dBf)	7.0 (22.1)	Very good
50-dB quieting signal, mono (μV) (dBf)	2.1 (11.6)	Excellent
50-dB quieting signal, stereo (μV) (dBf)	26.0 (33.5)	Excellent
Maximum S/N ratio, mono (dB)	84	Superb
Maximum S/N ratio, stereo (dB)	75	Superb
Capture ratio (dB)	0.9	Superb
AM suppression (dB)	70	Superb
Image rejection (dB)	100+	Superb
IF rejection (dB)	100+	Superb
Spurious rejection (dB)	100+	Superb
Alternate channel selectivity (dB)	85	Excellent
FIDELITY AND DISTORTION MEASUREMENTS		
Frequency response, 50 Hz to 15 kHz ($\pm$dB)	1.0	Very good
Harmonic distortion, 1 kHz, mono (%)	0.26 (0.14)	Fair, see text
Harmonic distortion, 1 kHz, stereo (%)	0.28 (0.14)	Good, see text
Harmonic distortion, 100 Hz, mono (%)	0.3 (0.15)	Fair, see text
Harmonic distortion, 100 Hz, stereo (%)	0.4 (0.18)	Fair, see text
Harmonic distortion, 6 kHz, mono (%)	0.20 (0.16)	Good, see text
Harmonic distortion, 6 kHz, stereo (%)	0.22 (0.16)	Very good, see text
Distortion at 50-dB quieting, mono (%)	2.8	Fair
Distortion at 50-dB quieting, stereo (%)	0.7	Good
STEREO PERFORMANCE MEASUREMENTS		
Stereo threshold (μV) (dBf)	7–100 (22.1–45.2)	Excellent
Separation, 1 kHz (dB)	42	Excellent
Separation, 100 Hz (dB)	40	Excellent
Separation, 10 kHz (dB)	34	Excellent
MISCELLANEOUS MEASUREMENTS		
Muting threshold (μV) (dBf)	4–30 (17.2–34.7)	Excellent
Dial calibration accuracy ($\pm$kHz at MHz)	"Perfect"	Superb
EVALUATION OF CONTROLS, DESIGN, CONSTRUCTION		
Control layout		Excellent
Ease of tuning		Superb
Accuracy of meters or other tuning aids		Excellent
Usefulness of other controls		Excellent
Construction and internal layout		Superb
Ease of servicing		Very good
Evaluation of extra features, if any		Excellent
OVERALL FM PERFORMANCE RATING		Very good, see text

Stereo separation was very good, and as claimed. Figure 6 is a scope photo showing a continuous plot of separation and frequency response (including 75-μs de-emphasis). Vertical divisions in Fig. 6 are equal to 10 dB of amplitude difference. The frequency response of the desired channel (shown by the upper trace) was well within 1 dB of the prescribed curve from 30 Hz to 15 kHz.



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The variable muting and variable stereo-only threshold controls cover a wide range and enable users to take proper advantage of these features regardless of signal conditions in their areas.

Summary

An overall product analysis is given in Table 2, together with our summary comments.

As indicated, the sound quality was excellent, with background noise on strong-signal stations pushed so far down as to be inaudible both in mono and stereo. Construction details (not apparent in the photos) include totally modular design, chrome-plated shield plates and zinc castings for the front-panel side sections and light alloy profiles to complete the subdued-looking front panel and its hinged bezel. Rear-panel connections are recessed so that plugs never interfere with a back wall or surface against which the unit is to be mounted.

Many of you may be familiar with ReVox's superb open-reel tape decks that, although they are often purchased for home use, are regarded generally to be of true professional

B-760 UPDATE

After we completed our lab measurements, we advised the U. S. headquarters of Studer ReVox in Nashville of our findings regarding harmonic distortion readings when we applied full (U.S. standard) modulation to the prototype unit supplied to our lab.

The company immediately sent a *Telex* to the European headquarters, and has since been advised that this early prototype was typical of detector bandwidth requirements in Europe, where stations are often crowded even more closely together than in the U.S. Studer ReVox also reported that modifications incorporated in *model B-760* units being shipped to the U.S. have resulted in a lowering of the THD figures so that their present published specification will read 0.1% THD (for 40-kHz modulation) as compared with 0.15% THD as first specified. Units presently in production are typically running 0.05% distortion for 40-kHz deviation and around 0.1% for a full ±75 kHz modulation, such as is practiced in the U.S. The manufacturers appreciated our bringing this matter to their attention, and we, in turn, thanked them for their prompt response and action. If their currently reported distortion measurements prove to be the case with units now being shipped to the U.S. (and that would mean all units, since our measurements were conducted upon a first available prototype), this would negate our only criticism of this excellent tuner.

TABLE 2

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Studer/ReVox** Model: **B-760**

OVERALL PRODUCT ANALYSIS

Retail price	**$1145**
Price category	**High**
Price/performance ratio	**Very good**
Styling and appearance	**Excellent**
Sound quality	**Excellent**
Mechanical performance	**Superb**

Comments: **Compared with previously tested frequency-synthesized, crystal-controlled digital readout FM stereo tuners, this latest entry from Studer ReVox is something of a bargain. Of the other two popular models currently available (Sherwood's *model Micro/CPU 100* and Lux's *model 5T50*), the former has nonvolatile memory for four favorite stations, while the latter "remembers" up to seven. The ReVox model (selling for considerably less) stores in its memory up to 15 of your favorite FM stations and will, like other frequency-synthesized tuners on the market, guarantee tuning accuracy (and, hence, lowest distortion) that is governed only by the accuracy of the reference crystal—in this case, 0.005%, or 5 parts-per-million. An additional (if not obviously) advantage is that the ReVox model can be tuned in increments of as little as 25 kHz. This means that it will not only take care of European FM station frequency assignments (these can be as little as 50 kHz apart from each other in certain countries); but if you want to use a wireless FM microphone with this tuner, its tuned-to frequency does not have to be a multiple of 100 kHz, or 200 kHz, and you would still be able to tune to it with great precision and low distortion. The one design flaw was that the IF-detector section could not handle U.S. high-modulation levels, as explained in the text. Even so, the measured distortion levels were, in most cases, lower than the inherent distortion of the program sources (and modulation practices) of many FM and stereo FM stations in the U.S. We believe that once ReVox is aware of this problem, a quick fix will be found, since at lower modulation levels (up to 70% of U.S. standards), distortion is as low as one could expect from an otherwise excellent tuner.**

quality and ruggedness. It appears that much of the same design philosophy has been applied to the *model B-760* tuner, and it should enjoy good acceptance from those audiophiles who really care about the quality of their FM equipment. If there had not been a small problem in measuring distortion, our overall product rating might have been an "excellent" or even a "superb." Under the present circumstances (which may well be modified by the manufacturer) we can only assign a "very good" to this product, taking due account of its price and other remarkable performance and convenience features. **R-E**

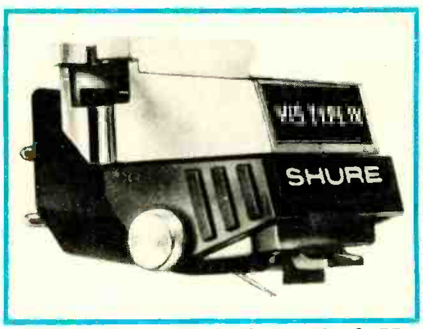
Shure V15 Type IV Phono Cartridge

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

SHURE BROTHERS' LATEST CONTRIBUTION TO phono cartridge science is the *model V15 Type IV*, a pickup that introduces several new design features that, altogether, significantly improve its trackability—the ability of the stylus to stay in contact with both walls of a record groove at extremely light tracking forces. The *model V15 Type IV* is shown in Fig. 1.

The effective stylus mass in the *model V15 Type IV* has been lowered to 0.29 milligram, a reduction of approximately 12% compared with Shure's *model V15 Type III* cartridge. This reduction was accomplished by using a telescoped shank structure and a lightweight, high-energy magnet. The *model V15 Type IV* also incorporates a two-function bearing system that Shure claims has been independently optimized for low and high frequencies. Another feature of the stylus assembly is its hyperelliptical nude diamond tip.

Very low-frequency record warps (between 0.5 Hz and 8 Hz) can result in changes in the distance between the cartridge and the record. These changes can cause groove skipping, cartridge bottoming, signal wow and even amplifier or speaker overload. The *model V15 Type IV* cartridge features a built-in, viscous-damped dynamic stabilizer. Because it is viscous-damped, the stabilizer also resists sudden warp-caused changes in motion, thereby maintaining a proper vertical tracking angle and stylus tracking force.



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CIRCLE 103 ON FREE INFORMATION CARD

Static charges on a record can attract the cartridge to the record surface, again changing the arm-to-record distance, vertical tracking angle and stylus tracking force. Static electricity also discharges through the stylus and amplifying system and is often heard as rapid pops and clicks. The *model V15 Type IV* deals with this problem by having a group of over

MANUFACTURER'S PUBLISHED SPECIFICATIONS:

Frequency Response: 10 Hz to 25,000 Hz. **Trackability** (at 1-gram tracking force, mounted in SME tone arm): 29 cm-per-second at 400 Hz; 42 cm-per-second at 1 kHz; 47 cm-per-second at 5 kHz; 37 cm-per-second at 10 kHz. **Output Voltage** (at 1 kHz, 5 cm-per-second peak recorded velocity): 4.0 mV-per-channel. **Channel Balance:** within 2.0 dB. **Channel Separation:** minimum, 25 dB at 1 kHz; 15 dB at 10 kHz. **Optimum Load:** 47,000 ohms in parallel with 200-pF to 300-pF capacitance per channel. **Inductance:** 500 mH. **DC Resistance:** 1380 ohms. **Tracking Force Range:** 0.75 gram to 1.25 grams. **Force Exerted by Dynamic Stabilizer** (added to arm tracking force setting): 0.5 gram. **Mounting Centers:** 12.7 mm (standard, 0.5 inch). **Net Weight:** 6.4 grams. **Suggested Retail Price:** $150.

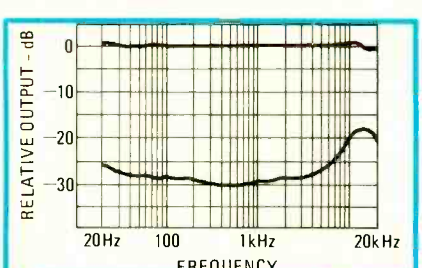
10,000 electrically conductive fibers in the dynamic stabilizer. This brush-like arrangement sweeps the record grooves, picks up the static electricity and discharges it through the cartridge ground terminal. The fibers also sweep the record grooves free of dust, and are ultra-fine with an approximate diameter of 7.6 microns (0.0003 inch).

Three types of replacement stylus assemblies are available for the *model V15 Type IV* cartridge. The *model VN45HE* is a hyperelliptical nude diamond-tip stylus assembly, which is the exact replacement for the stylus assembly supplied with the original cartridge. It is identified by a black grip and a black nameplate. The *model VN4G* stylus assembly features a 0.0006-inch-radius spherical (conical) nude diamond tip, and is identified by a black grip and a gray nameplate. For playing monophonic 78 RPM records, a biradial (elliptical) nude diamond tip is provided in the *model VN478E* replacement stylus assembly. This tip has radial dimensions of 0.005 inch by 0.0025 inch, and will track at forces between 3/4 gram and 1 1/4 grams.

Laboratory measurements

Results of our laboratory measurements of the *model V15 Type IV* cartridge are summarized in Table 1. Two types of test records were used to measure cartridge frequency response. The first record, STR-100 (manufactured by CBS Records) offers constant velocity signals up to 500 Hz, at which point the cut switches to constant velocity (5 cm-per-second). The second record, CBS STR-130, is recorded using the standard RIAA recording curve. We translated the first results (from the STR-100) below 500 Hz to the equivalent of constant velocity so that a flat response curve could be presented. For the STR-130 tests, we used a laboratory preamplifier that has an accuracy of better than ±0.2 dB over the entire RIAA range from 20 Hz to 20,000 Hz. We suspect that the small deviations in these test records are probably greater than any deviation from the flat response of the cartridge itself, and so we averaged the two results to plot the final response curve, (the upper trace in Fig. 2). Shure Brothers, in their own production-line testing, used a frequency-response envelope that is only ±1 dB wide to around 8 kHz, increasing to around ±2.5 dB at 20,000 Hz. This "limit envelope" is shown in Fig. 3. Note that in Fig. 2, our test sample performed considerably better than the limits permitted by Shure, with variations less than ±1 dB from 20 Hz to 20 kHz.

The lower curve of Fig. 2 shows the separation between channels obtained over the entire audio range; again, this separation far exceeded Shure's minimum specifications at the two test frequencies, 1 kHz and 10 kHz.



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Summary

The overall product analysis, together with our summary comments, is in Table 2.

TABLE 1

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Shure Brothers Inc.** Model: **V15 Type IV**

PHONOGRAPH CARTRIDGE MEASUREMENTS

	R-E Measurements	R-E Evaluation
FREQUENCY RESPONSE (Hz-kHz, ±dB)	20–20, 1.0 See Fig. 3	Superb
STEREO SEPARATION		
Separation, 1 kHz (dB)	29.0	Excellent
Separation, 10 kHz (dB)	18.0	Excellent
Separation, 30 kHz (dB)	N/A	N/A
CHANNEL BALANCE, 1 kHz (dB)	0.5	Superb
TRACKABILITY MEASUREMENTS		
Stylus velocity at 1 kHz (cm-per-second)	43	Superb
Stylus velocity at 10 kHz (cm-per-second)	37	Superb
COMPONENT MATCHING CHARACTERISTICS		
Output level, 1 kHz, 3.54 cm-per-second (mV)	3.0	
Optimum load impedance (ohms)	47,000 (200 to 300 pF)	
Tracking force range	0.75 to 1.25 grams	
Cartridge weight (grams)	6.4	
OVERALL PHONO CARTRIDGE RATING		Superb

As with any phono cartridge, the final test is in the listening. Therefore, Shure has developed a test record containing instrumental selections (orchestral bells, flute and harp) of increasing intensity so that you can check trackability under practical musical listening conditions. The record also contains a series of subaudible tones superimposed upon music; this allows you to determine system resonance quite easily. This test record also shows how effective the dynamic stabilizer of the *model V15 Type IV* is in reducing the effects of arm/cartridge resonance, since it is possible to play these bands with and without the stabilizer for comparison. The record (Shure *TTR-115*) is available as a bonus to purchasers of the *model V15 Type IV* cartridge. Needless to say, the *model V15 Type IV* was able to track the most heavily recorded passages of this disc with clarity and extremely good musical definition. Nor could we find any other "obstacle course" records that were beyond the capability of this cartridge. For serious-minded audiophiles who want the very best musical performance from their precious discs, the relatively high-priced *model V15 Type IV* cartridge will prove to be well worth its cost. **R-E**

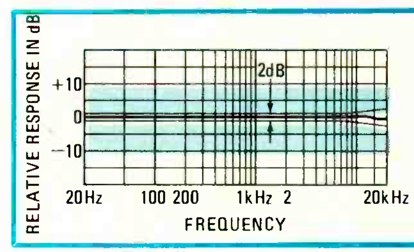

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TABLE 2

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Shure Brothers, Inc.** Model: **V15 Type IV**

OVERALL PRODUCT ANALYSIS

Retail price	**$150**
Price category	**High**
Price/performance ratio	**Excellent**
Styling and appearance	**Excellent**
Sound quality	**Superb**
Mechanical performance	**Excellent**

Comments: We wonder why Shure Brothers calls their newest and most expensive cartridge the *model V15 Type IV*. This seems to suggest a relatively minor updating from the well-accepted *model V15 Type III*. Actually, the *model V15 Type IV* represents a quantum leap in engineering, performance features and concepts over the earlier *model V15 Type III*. Shure has managed to take into account many of the problems that plague the home user of a phonograph system and not just designed a cartridge that performs well under ideal test conditions.

The *model V15 Type IV* achieves the sought-after straight-line frequency response that totally eliminates that peaked high-end shrillness encountered with many other cartridges. This may take some getting used to, since many are conditioned to expect such false high-end response from their records. Proper cartridge loading was made easier, too, since, unlike other Shure models, 200 pF of capacitance (not difficult to obtain with a few feet of audio cable combined with arm-lead and whatever other stray capacitance is "built in" to most systems) smooths out any slight upper-resonance peaks.

Our listening tests convinced us that the clean sound of the highs was also due, in part, to the lower tracing distortion made possible by the new, hyperelliptical diamond stylus tip shape. This shape not only maintains good contact with high-frequency undulations in the record groove, but also maintains that contact over a greater area of the groove wall than do conventional elliptical tips. The dynamic stabilizer, coupled with the graphite fiber destaticizer, really works—its audible benefits are easily discerned, especially on seriously warped discs.

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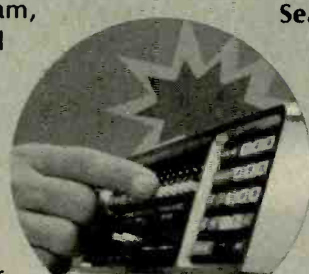

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Forest Belt tells...

What You Need To Know About
SPECIAL SIGNAL GENERATORS

TO FIND OUT WHAT'S WRONG with a TV, hi-fi stereo system, or any other receiver, we must know where the circuitry fails to process its signal correctly. Spot the stage that messes up or blocks a signal, and you're more than halfway to curing the problem.

Two procedures have long served troubleshooters: 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 month's 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. This issue we cover stereo troubleshooting. Next month TV.

Want To Fix Radios? Think Stereo

It takes a particular breed of signal generator to service quality radios. For FM stereo, you can use special-purpose analyzers or take advantage of some of the features of your TV sweep generator.

IT'S GOOD SOMETIMES TO REVISIT THE SO-called "ordinary instruments." Like radios, for instance. Who thinks much about radios these days? Yet there are plenty of them around that need—and are worth—repairing.

Radios fall into four categories:

1. Inexpensive models, which are seldom worth bothering to fix. You can't work on them without charging a sensible fee, and that may be as much or more than a new set costs. Consider these sets as "throwaways."

2. Quite a few AM/FM clock radios and table models are good enough (and cost enough) to be worth making minor repairs. If you are familiar with these sets, they are easy to troubleshoot. A share of their troubles falls among clocks or switches that you typically replace rather than repair. Some table models are stereo.

3. Autosound has become a hot item in the electronics field. A truly elegant car stereo system now costs more than a TV set, even more than color TV in some cases. And in no way is a car stereo owner going to throw *that* away! Some technician will be asked to repair it whenever it doesn't sound right or goes on the blink. Besides that, a great many auto stereo systems are sold and installed by electronics dealers with service facilities. Many underdash and in-dash systems far outperform those available from the car manufacturer. (Indeed, car dealers are dipping into this quality autosound sales market by installing—or having an expert install—systems not provided by the car manufacturer.)

4. Home stereophonic and quadriphonic systems almost invariably include an AM/FM (or FM-only) tuner or receiver. In many systems, this is the prime music source. It has to be sold, installed and serviced periodically. There are few complaints about repair fees on these systems, as long as the repair work is top-notch.

Radio servicing is not yesterday's orphan. It is today's strong, profitable business. You deal with stereo sets, in most cases. And that's no "bubble-gum-and-baling-wire" kind of servicing; it's right up there full of advanced technology.

"Never did like TV sets," one oldtime service tech told me a while back. No need for him to; he makes a respectable living fixing radios. He's good. He knows AM/FM/stereo sets inside out. From table models to hi-fi component receivers, radios are his specialty.

"I didn't think much of transistors, either," he continued. "But you learn what you need to." Watching him work, you'd think solid-state never bothered him at all.

What about IC's? "No problem," he answered. Just like that. Then, after a pause, he admitted, "Well, I have my share of dogs, but I'm learning to trust my judgment with integrated circuits."

Sound Technology model 1000A

So, if you haven't given radios a serious look lately, it's time you did. New technology has been used in them just as in TV sets. And high-grade instruments make the servicing just as definite a process. Haphazard work has no place in troubleshooting stereo radios. They're not difficult to fix, but neither are they simple gadgets that you can repair by guesswork alone.

What it takes

As with any electronics servicing, you first need a no-hesitation way to move directly toward an accurate diagnosis. If you don't have your own logical troubleshooting system, consider the method I call *Easi-Way*. This method is a refinement of *1-2-3-4 Servicing* (see box).

Additionally, you need to know what's in all those sections, stages and circuits, and how they should act normally.

Highly important today, precisely because technology has spread so rapidly into ordinary radios, are special test instruments. Chief among those designed for radio servicing is a multiplex generator. The complex nature of an FM stereo signal dictates that an instrument duplicate dependably the signals and combinations required for testing and adjusting. Just because much of the multiplex circuitry now resides in an IC does not eliminate the need for a distinct test signal. In fact, as you'll see presently, IC servicing makes a good generator absolutely necessary. Without one, you can only guess at what's actually happening in a faulty radio (or in a working radio, for that matter).

Not that there are many choices. Only a few manufacturers build generators now for servicing stereo radios. Table 1 lists those models for which we've been able to obtain information. These multiplex generators each produces a composite stereo signal that contains pilot, L + R and L − R sideband signals. The composite signal can be used alone to test multiplex sections directly, or can be frequency-modulated on an FM-band station frequency so that you can feed it through the RF and IF stages. This latter mode tests the operation of the whole receiver, from antenna terminals to speakers.

Three of the generators listed in Table 1 provide sweep alignment for FM receivers. However, each unit does this differently. The Heathkit *model IG-5237*, for example, provides a sweep at the generator's 100-MHz RF center frequency. The sweep width is variable to 750 kHz, which is sufficient to let you assess the 250-kHz bandwidth needed in the RF and IF stages of an FM stereo receiver. A

[1] Forest Belt wrote six books on *1-2-3-4 Servicing*, published by Howard W. Sams & Co., Inc., Indianapolis, IN 46206. Forest also teaches basic *Easi-Way Servicing*, an advanced version, in his Training Workshops. If you'd like to see us devote one whole special section to the principles of *Easi-Way Servicing*, drop us a note.

5.35-MHz crystal oscillator supplies a fixed RF signal at 10.7 MHz, so that you can "mark" the IF sweep-response curve or prealign the IF adjustments. Moreover, its 17th through 20th harmonics occur at 90.95 MHz, 96.30 MHz, 101.65 MHz and 107.00 MHz. These signals let you check operation and dial calibration in the front end.

On the other hand, Sencore's *model SG165* provides a sweep signal for IF alignment only. A 10.7-MHz center frequency is swept 500 kHz wide, which is quite sufficient for testing full bandwidth (a function of the IF strip anyway, not of the RF section). A 10.7-MHz marker identifies where the precise center of the IF passband should be.

The Sencore generator offers an extra feature for working with AM/FM sets. It furnishes front-end signals at 535 kHz–1635 kHz for AM broadcast receivers. And fixed RF signals at 262 kHz and 455 kHz allow quick, accurate IF alignment in either auto or home receivers that pick up AM broadcasts.

Sound Technology's *model 1000A* provides a unique alignment method. It uses what they call a "dual-sweep" signal. The usual 60-Hz sinewave signal, which frequency-modulates the generator's RF center signal *and* drives the oscilloscope's horizontal amplifier during sweep alignment, is in this case itself modulated with a 10-kHz signal. The result is an unusual scope display that conveys a quantity of information in addition to just bandwidth. Intermodulation distortion, for example, in the whole RF/IF/demodulator system can be calculated directly from the scope display. Also, discriminator alignment can be perfected for minimum distortion, a highly desirable technique for quality hi-fi and autosound stereo receivers.

Of course, all these instruments include the regular composite multiplex signal, similar to the Leader *model LSG-231*. Alignment of RF and IF sections can also be managed with an ordinary RF signal generator, although you cannot easily verify the bandwidth or discriminator symmetry by using single-signal alignment. For correct multiplex alignment, however, you must provide a stereo multiplex signal.

TABLE 1—Stereo Generators

	FM Freq. (MHz)	Pilot Signal (kHz)	SCA Signal (kHz)	Audio Signals (Hz)	RF Output (mV)	Composite Output (V)	Sweep Width (± kHz)	Sweep Base for Scope	RF Markers (MHz)	AM Freq. (kHz)
Heathkit IG-5237	100 (var. ± 2)	19 38	65 or 67	400 1000 5000	n.a.	n.a.	750 (var.)	Yes[1]	10.7 90.95 96.30 101.65 107.00	
Leader LSG-231	100 (var. ± 1)	19	67	1000	0.1 –10	0–1				
Sencore SG165	86–110 tunable	19	67	400, sine- and square wave	FM, 0.1; AM, 100	0–2.5	500 (at 10.7-MHz only)	No		525–1625 tunable
Sound Technology 1000A	88–108 tunable	19	67	1000	0–30	0–5	600[2] (var.)	Yes		

Notes:
[1] Through composite signal jack.
[2] Patented dual-sweep system—see text.

n.a. = information not available.
var. = variable.

Alignment troubleshooting

Communications technicians long ago learned a fast way to diagnose transmitter/receiver faults: alignment. Some TV technicians use this technique for color TV servicing and, of course, in the RF and IF sections of TV receivers.

You feed in an alignment test signal, and trace its effects with an oscilloscope or other appropriate instrument. Along the way, you proceed with alignment. Any stage that does not respond to adjustment, or does not produce the proper effect, must be defective. This combination of injection, tracing and aligning pinpoints just about any defect. At the very least, it helps you diagnose the faulty section and localize the defective stage very quickly.

Let's see how this concept works in the Pioneer *model TX-8500* stereo tuner. This chassis incorporates some of the very latest IC's. It is important to note how this troubleshooting technique uncovers a defective IC as easily as any other component.

For a signal source, we use here the Sound Technology *model 1000A*. You thus gain some familiarity with the dual-sweep signal. For viewing, a Gould *model OS-1100* triggered oscilloscope is used.

Figure 1 is a block diagram of the tuner's sections and stages. Note that a great deal of the tuner's functions are handled inside IC's. All the more reason to approach the system logically.

Using the *model 1000A*, feed a modulated FM signal into the antenna terminals, using a 300-ohm matching transformer. Feed in enough RF to create a signal at the mixer that is large enough to observe on your oscilloscope. For the first steps in our example, the input level is 30,000 μV.

Equipment interconnections are the

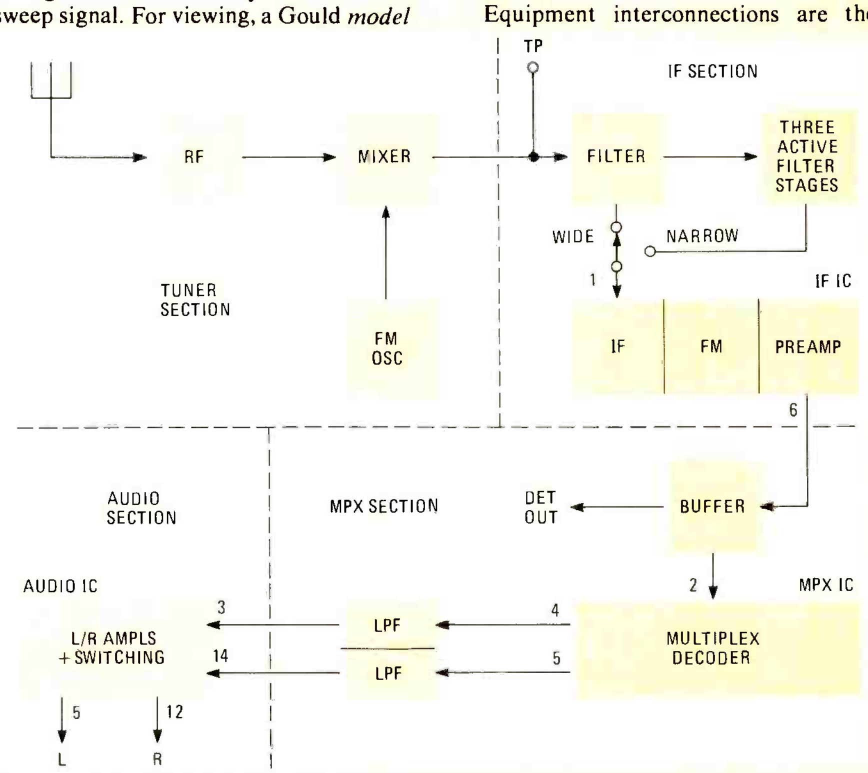


FIG. 1—EVEN WHEN A STEREO FM RADIO is not composed mainly of IC's, as this one is, it must have the stages shown here.

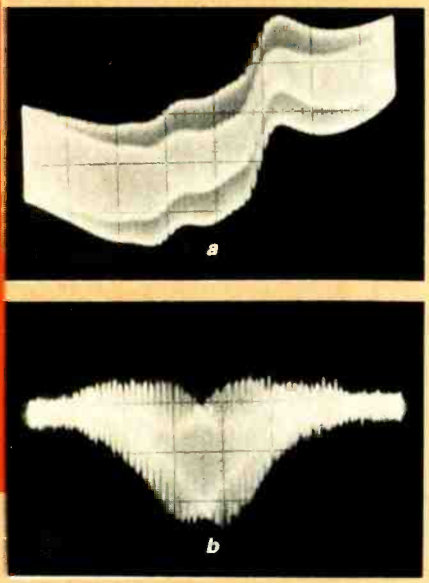


FIG. 2—SWEEP SIGNAL without demodulator probes shows (a) front-end amplification and tunability, and (b) the result of IF filters that determine selectivity and bandwidth.

same as for any sweep alignment. A 60-Hz output from the generator goes to the oscillator's horizontal amplifier. Switch a triggered scope to its X–Y mode of operation. In the *model OS-1100*, this converts Channel 1 into an X-axis or a horizontal channel; in some scopes, the triggered amplifier becomes the X-axis input channel. In this case, the vertical (Y-axis) input goes to Channel 2, and through a cable from the generator. A regular 1:1 scope probe, connected to a jack on the generator, can be used as a test cable for the receiver.

Turn everything on, and give the instrument a few minutes to warm up. Adjust the scope's X-axis input knob to produce a trace that does not overscan the screen. Set the stereo tuner dial and the generator RF output at the same frequency. The *model 1000A* must be set for dual sweep, and its sweep width must be at maximum (about 600 kHz).

Find your first test point; the tuner output is usually handy. Clip the test probe to the high side of the IF feed line, and the common clip to ground. Turn the scope's Y-axis sensitivity control fairly high. You can expect a twisted-looking RF trace to appear, with an amplitude as much as 100 mV, maybe a bit less. Swing the tuning of either the tuner *or* the generator back and forth until you center this curve on the scope trace.

Figure 2-a shows how this dual-sweep trace is likely to look when you check out the tuner's RF section—consisting of the RF amplifier, oscillator and mixer. There is slight (or no) RF signal; if you are unable to tune this sweep curve (move it back and forth by dialing the tuner or generator) this signifies trouble right in the front end. Troubleshoot these stages before you proceed. And *only* when they prove OK are you ready to go on to the IF section.

The *model 1000A* tuner has a narrow bandwidth for weak-signal stations. One filter allows the usual 250 kHz+ bandwidth; the extra filters, when they're switched into the signal path, cut the bandwidth to a sharply skirted, barely 250-kHz bandpass signal. In either mode, the filters determine the IF selectivity. So, your next step is to verify that the filters pass the IF signal properly.

Move your test probe to the output of the filters. In this receiver, a good test point is at the input to the IF amplifier. This is at pin 1 of this particular IC, which is beyond the filter stages.

Filters are passive elements. What active transistors there are in the narrow-band filter stages achieve mainly impedance matching. Therefore, in either mode, there is a signal drop across the filter system. Don't expect more than perhaps 20 mV of signal just past the filters. If there are any tuned circuits between the front end and the IF amplifier, peak them now.

Change the scope sensitivity so that you can observe such a small signal (see Fig. 2-b). The bandwidth-limiting effect of the filters is clearly visible. (If you've never seen a trace like this before, don't worry. It's a result of the unique dual-sweep signal from this *model 1000A* generator. Without it (that is, using a regular stereo signal) you would not be able to see so definitely the effects of the filters.)

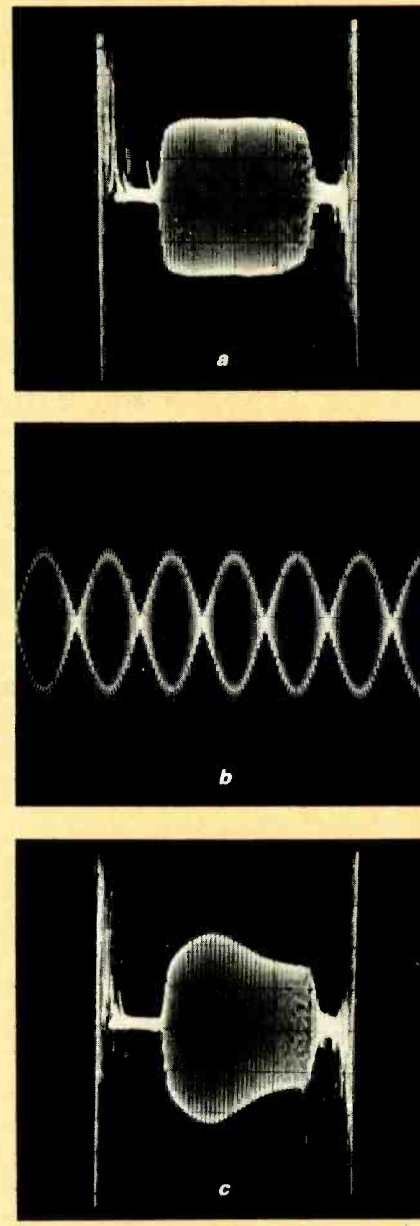


FIG. 4—DUAL-SWEEP PRESENTS unfamiliar but informative response curve (a) at the output of IC that demodulates FM signals. The signal at (b) results at same point when standard stereo signal is fed in. The trace at (c) shows how a slightly misadjusted FM detector can seriously alter the dual-sweep curve, creating considerable IM distortion.

All okay so far? You're ready to move on now to the IF section. Only two things can go wrong with the IC: It can develop an internal short that fouls up DC voltages both inside and out, and the same defect will probably also block or upset the signal operation. Or, the IC can mess up signals even without showing DC symptoms.

Obviously, a signal test is your quickest means of verifying that the IF integrated circuit is operative. The diagram of internal functions for this IC is shown in Fig. 3. The input to the IC is at pin 1, and you've already proved the signal is OK there.

This IC performs many functions: It amplifies the IF signal, demodulates the

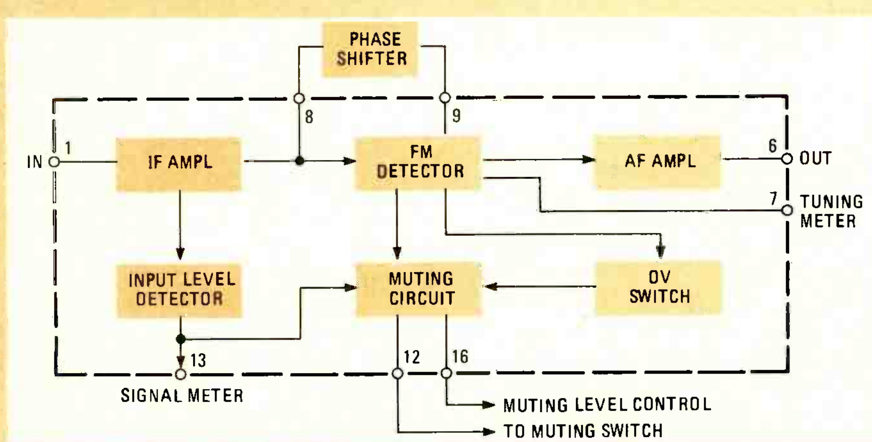


FIG. 3—THIS NEW IC CONTAINS almost everything needed to amplify IF, demodulate FM and amplify composite stereo signals—plus it offers several peripheral functions.

FM signal (the dual-sweep waveform, in this case), and adds some amplification to the recovered signal. Because certain peripheral operations originate here, you should check this IC if one of these is malfunctioning. First, however, you should make a signal check at output pin 6. Figure 4-a shows the demodulated version of the dual-sweep signal.

If you feed a stereo signal into the tuner from the generator, you observe a signal composed mainly of L − R sidebands at this point. Figure 4-b shows this kind of output from the IF integrated circuit. The signal has been demodulated by a quadrature detector in the IC (note the outboard phase-shift stage).

It is important to remember that as you use your scope to trace through the receiver stages, you should keep reducing the generator output to just the proper degree for a clean trace. The best generator RF level for every test can be found by reducing the generator output until the trace begins to look "grassy" or noisy, then by increasing the level just enough to clean up the display. The generator-output setting for all the traces shown in Fig. 4 is about 3000 μV; this setting can vary with different receiver models.

One strong advantage of the dual-sweep signal shows up at this test point. You can spot instantly any misalignment of the FM sound detector. Any humps (Fig. 4-c) in the bandpass display can be attributed to defective demodulation. *Very carefully,* realign first one slug, then the other, inside the detector tuning coil (Fig. 5). A perfectly flat top and bottom for this waveform display indicate absolute minimum intermodulation distortion, which is the worst product of even a slight detector misalignment. You could not detect subtle misadjustments with a stereo pattern, nor with the usual S-curve method of detector alignment.

With IF and demodulation all taken care of, you can now turn your attention to the multiplex section. A buffer amplifier (Fig. 1) feeds a composite stereo signal (or, in our example, the dual-sweep signal) to the detector output jack and to the multiplex decoder IC.

Again, the construction of the IC itself

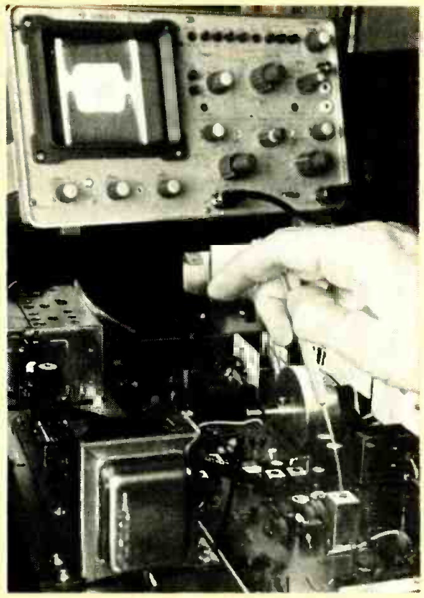


FIG. 5.—TO CORRECT FAULTY DUAL-SWEEP curve in Fig. 4-c, realign FM sound-detector coil at end of IF strip, while observing curve.

(Fig. 6) tells you what your troubleshooting approach should be. Verify that the signal arrives at IC pin 2 for the input. Then, check that pins 4 and 5 generate the demodulated L and R signals.

At this point, you may feel more comfortable switching to a stereo signal from the generator. But first, look at the dual-sweep signal once more at both output pins of the multiplex IC. The two traces should look exactly alike and bear the same amplitude. If so, it proves that the multiplex IC is not altering the overall frequency response. The 10-kHz modulation that is part of the dual-sweep signal has come through properly and without attenuation. The frequency response from 60 Hz to 10 kHz is essentially flat; no tilt has occurred.

Troubleshooting by stereo signal

Changing to a stereo test signal requires some alterations in the equipment connections. Leave the generator feeding between 300 μV and 1000 μV of RF signal into the tuner's 300-ohm antenna input. Set the generator function switch to stereo, the internal signal to L − R or multiplex, and the modulation level to about 80 percent (± 60 kHz).

Move the receiver test probe to Channel 1 of the oscilloscope. The sweep cable from the generator is left disconnected. Set the scope back to triggered operation, and set the scope timebase at 0.2 ms-per-division if the generator's internal audio is 1000 Hz, or at 0.5 ms-per-division if the audio is 400 Hz.

Clip the test probe to multiplex IC pin 2 to monitor the input. Make sure the receiver and generator are tuned to the same frequency. You should find between 0.5 volt and 1.0 volt at this point, depending on the modulation percentage at the generator. (In our demonstration setup, an 80-percent generator modulation results in 0.8 volt of signal input to the multiplex IC.) Figure 7-a shows how an L − R signal looks at this point.

Now, to check multiplex decoding, move the test probe to pin 4 or pin 5 of the IC. These pins should produce exactly equal signal amplitudes, about the same as the input level. The signals should also look alike (you can't check phase with this simple a setup, but it isn't necessary.) Figure 7-b shows how the decoded stereo signal looks.

If the signal is missing or distorted at this juncture, you know that you have to troubleshoot in the vicinity of the IC. Verify that all DC voltages are what they should be on each pin of the IC. If they are not, check whether the voltage change is caused externally or by the IC.

Then, examine the small components around the IC, particularly electrolytic capacitors. Some capacitors are there to introduce phase shifts, others to bypass unwanted signals (your scope can check this), and others to couple signals. In addition, leaky capacitors can upset DC voltages.

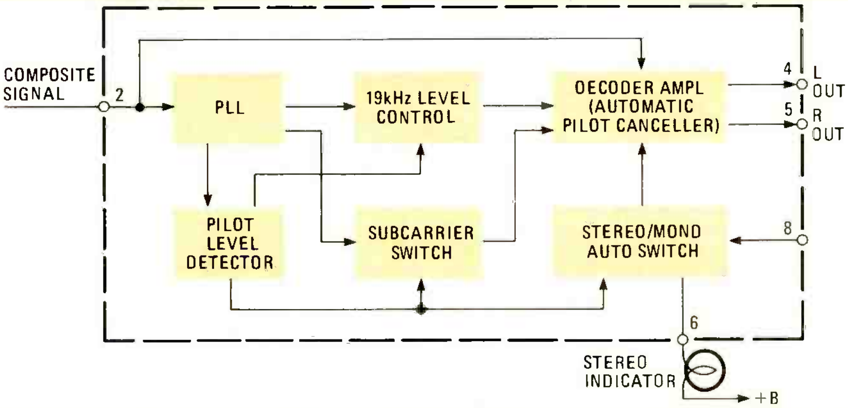


FIG. 6.—SINGLE IC OFTEN PERFORMS all stereo multiplex decoding functions; needs only external low-pass filters following, to eliminate L − R sideband products.

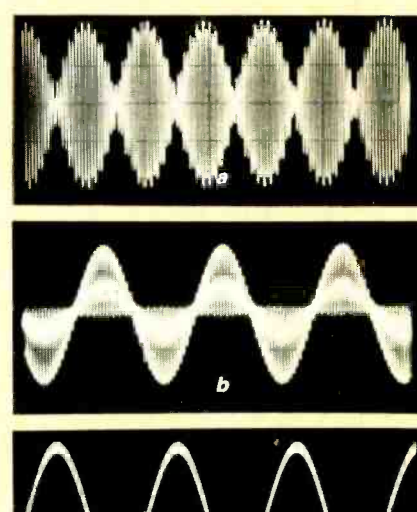


FIG. 7.—WAVEFORMS TAKEN FROM PINS of stereo IC of Fig. 6. (a) Input from FM detector; (b) decoded stereo; and (c) audio signal after sideband products are filtered out.

Finally, if the DC voltage checks OK and none of the components around the IC are bad, but a signal still doesn't show up as it should at the output pins, suspect the IC itself. One last hint: Make sure a defective low-pass filter is not loading down the IC output. Disconnecting the filters will show.

Next in your troubleshooting sequence, verify that the low-pass filters do what they should. You can move the test probe to the input pins of the amplifier IC, and clip alternately to pin 3 and pin 14. Two things happen to the signal. First, the sideband components are removed, leaving only the 1000-Hz sinewave modulation (Fig. 7-c). Second, the filters pull down the amplitude (leaving in our demonstration only 0.2 volt peak-to-peak).

TABLE 2—TV Sweep Generators for FM Radio Alignment

	Frequency (MHz)	Markers Included
Eico 369	3–220, continuous	Tunable
Leader LSW-333	TV VHF/UHF 10.7 83–113	No
Viz WR-514A	TV VHF .05–50, 88–108	For TV only

Pins 5 and 12 are the output pins for the audio IC. The output usually runs between 2 volts and 3 volts peak-to-peak. At this point when you've checked this, the whole audio section of this stereo tuner has been tested. Again, watch out for small parts associated with the IC; any one of them could lead you to think that the IC is bad. But if they are all definitely OK and the voltages supplying the IC are normal, any other trouble must be blamed on the IC itself.

Serious misalignment

So far you have used a step-by-step, align-as-you-go method to troubleshoot an entire FM tuner. A special signal generator supplies the signals, which you track with your scope. The dual-sweep technique offers obvious advantages but calls for an expensive instrument. What if you don't own this particular generator?

You can use this trace-and-align technique with any generator you do have. Some TV alignment generators cover FM frequencies. Table 2 lists some sweep generators that will work for this purpose.

A useful alternative has been included in the Sencore *model SG165* and the Heathkit *model IG-5237* stereo generators. Either of these generators can be used to perform plain sweep alignment of the IF signals and sound detector. The Heathkit unit lets you sweep-align both RF and IF sections, while the Sencore generator provides sweep only for the IF section. Either will do; remember that bandwidth and selectivity are determined in the IF strip and its filters, not in the front end.

The Viz *model WR-50C* RF generator offers something still different—it incorporates sweep outputs at 455 kHz and at 10.7 MHz. Moreover, an external crystal socket lets you plug in a 10.7-MHz crystal, giving a tightly controlled unmodulated RF source; the 20-mV output is ample enough to drive an IF strip.

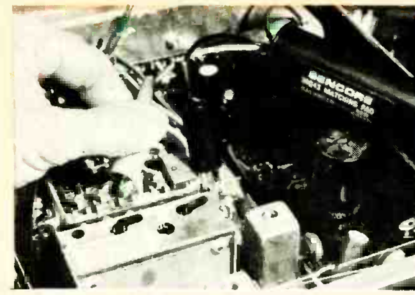
It is not unusual to encounter an FM receiver that has been tampered with by its owner. Serious hi-fi buffs ordinarily know better than to try to fool around with coils in an expensive tuner. But you do encounter serious misalignment problems (sometimes caused by a technician who either doesn't have a proper signal generator or who has not been taught correct alignment procedure). In such cases, you need a fast way to adjust the alignment nearly right. When coils are far from their proper settings, you may be at a loss to correct them by just observing a sweep curve.

Begin with an *accurate* 10.7-MHz signal source. The Sencore *model SG165* has a crystal-controlled, unmodulated 10.7-MHz oscillator. The Heathkit *model IG-5237* has an IF marker output, held tightly at 10.7 MHz by a 5.35-MHz crystal; the output is sufficient to drive the IF's and limiters in most receivers. The Leader *model LSG-16* RF generator has

TABLE 3—RF Generators for FM Alignment[1]

	Model	Frequency (MHz)	Output (mV)	Audio (Hz)	Built-in Calibrator
B&K/Precision	E200D	0.1–54	100	400	Yes
Eico	330	0.1–54	300	400	
Heathkit	IG-42	0.1–30	100	400	
Hickok	257	0.1–54	100	1000	Yes
Leader	LSG-16	0.1–100	n.a.	1000	
Viz	WR-50C	0.085–40	50	600	Yes[2]
Wavetek	3001				

Notes:
[1] AM only; use without modulation.
[2] Also has 455-kHz and 10.7-MHz sweeps.


a

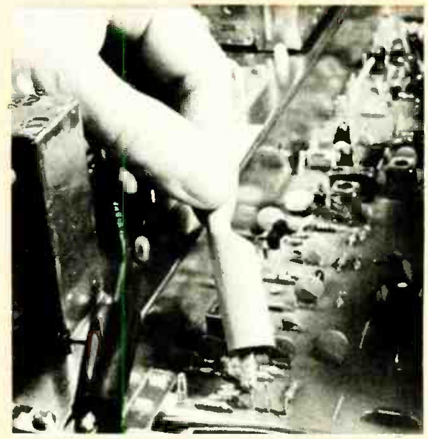

b

FIG. 8.—INJECTION POINTS FOR IF single-frequency or sweep alignment: (a) on mixer tuning capacitor; and (b) at IF input link.

a crystal feature similar to that of the Viz *model WR-50C*.

If crystal control is lacking, any good RF generator will do (see Table 3) if you do two things to insure pinpoint accuracy—which is particularly important with FM stereo demodulators.

1. Turn the generator on for at least an hour's warmup before alignment.
2. Check the output at 10.7 MHz with a frequency counter, and refine it precisely whenever you are ready to make the final sound-detector adjustment.

(The Hickok *model 257* RF generator has a counter output jack, which lets you leave the counter connected for monitoring.)

After selecting a precise source of 10.7-MHz unmodulated RF, feed this signal into the FM tuner mixer. Figure 8 shows two handy points: Clip the generator-output lead to the mixer tuning capacitor, or where the tuner feeds the IF strip on the main chassis board. In a car receiver, you can often clip the lead to the mixer-coil terminal, if it is easier to reach.

Find the electrolytic capacitor that bridges the balancing resistors in the sound detector. Connect a high-impedance DC voltmeter probe at the positive (+) end of the capacitor and the common lead to ground. This is your alignment indicator; if the receiver has a signal-strength meter for FM, you can use that. (Do not confuse this meter with a centering-type tuning meter. They are not similar.)

Rock the generator-output level control up and down to find a signal strength that does not saturate the indicator reading. Noise in the set causes a certain residual no-signal reading on the voltmeter. Set the generator output to make the meter read about halfway between this no-signal voltage and the level at which injecting more signal no longer raises the DC voltage reading. As you bring the IF strip into alignment, you may have to reduce the RF signal to keep this "halfway-between" reading. Otherwise, saturation prevents you from knowing whether your adjustments are improving anything or not.

Start with the last IF can. Adjust first the top slug, then the bottom slug for a maximum meter reading. Work your way back to the first IF coil, peaking the top slug first, then the bottom slug. Go through the whole IF strip at least twice, or until no further improvement can be made.

Do not tamper with the top slug (the secondary) of the sound-detector transformer yet. However, you can peak the bottom slug. You will probably have to revise this setting later, but this procedure presets it to nearly correct.

Now, to set the top slug of the detector, change your meter connection. Connect the probe to the resistor that is in series with the sound output (center tap) of the detector transformer. Be sure the coupling capacitor (if there is one) doesn't get between the transformer and your DC test probe.

Rock the top slug back and forth until you find an exact zero voltage. If the transformer and the diodes are OK, the voltage will swing sharply positive and negative from 0 as you rock the secondary adjustment. You may have to jump back and forth between this adjustment and the bottom slug (change the DC meter connection each time). The two slugs do interact. A little patience (and work) will find the proper zero setting.

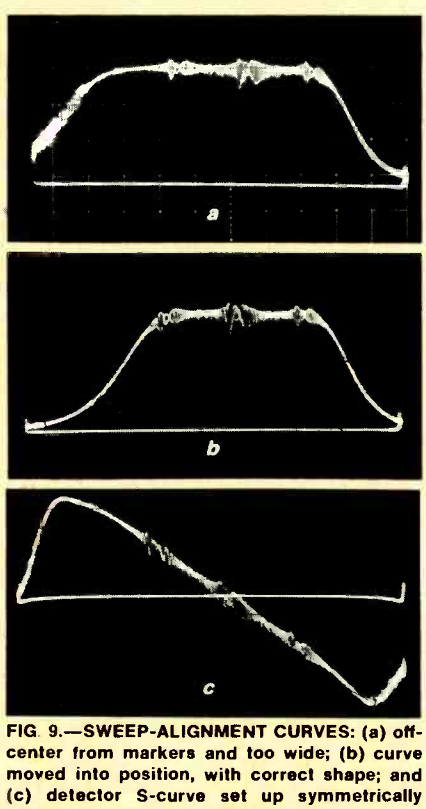


FIG. 9.—SWEEP-ALIGNMENT CURVES: (a) off-center from markers and too wide; (b) curve moved into position, with correct shape; and (c) detector S-curve set up symmetrically around markers, with 10.7 MHz at exact center.

Sweeping IF signals

Now, with the IF coils peaked, you are ready to inspect bandwidth. This demonstration is carried out for you with the Sencore *model SG165*, on a stereo receiver that does not use filters in the IF section. With filters, you seldom find more than one or two IF coils to adjust—typically between the mixer section and the IF strip. However, you generally find a sound-detector coil that may need adjusting.

Use a sweep generator set to 10.7 MHz, and connect the sweep RF to the same mixer or IF point used for your preliminary IF alignment (Fig. 8). Note that with the Sencore *model SG165*, you must use an oscilloscope that has a line-sweep function *inside* the scope, because the *model SG165* does not have a sweep-base output to connect to an oscilloscope. Hence, with this generator, you cannot use the X–Y mode of your triggered scope, and any triggered-sweep operation is impossible. We used the Sencore *model PS163* scope for our test; several other scopes, especially recurrent-sweep scopes, have a line-sweep mode.

The Heathkit *model IG-5237* and the Sound Technology *model 1000A* both have a 60-Hz sweep-base signal to feed a scope. The *model IG-5237* provides it via the composite signal jack, when you set the function switch for RF sweep. All the TV/FM sweep generators listed in Table 2 have a sweep-base output right on the front panel, ready to connect to the horizontal (X-axis) input of any oscilloscope.

This next step is important. Many technicians overlook it and become frustrated trying to set up a sweep trace in an FM receiver.

Disconnect the averaging capacitor that bridges the two balancing resistors in the sound detector. This is the same capacitor to which you clipped your DC voltmeter earlier. For sweep alignment, disconnect the positive (+) end of the capacitor; just leave it dangling. Then, connect your oscilloscope 10:1 probe *to the point from which* you disconnected the capacitor. This places the probe at the cathode end of the diode pair, and an up-direction sweep display on the scope screen. Set the scope input for 0.5 volt-per-division.

The Sencore *model SG165* generator uses post-injection markers; the scope probe therefore goes to a jack on the generator, and another test cable goes from the front panel of the instrument to the scope's vertical (Y-axis) input. To connect the probe inside the receiver, follow the same procedure.

Heathkit model IG-5237

Adjust the generator output to provide just enough signal so that a sweep display doesn't show a lot of "grass" or noise. Don't overdrive the receiver IF strip because this would show a false response. Also keep the markers as small as you can; with post-injection, they won't distort the curve but they can spread out and become confusing.

Now, use IF adjustments to bring about a flat-topped sweep response. Do not turn any single slug very much; presetting made them all fairly close. Watch the three markers, if you're using the Sencore generator. These markers are at 10.6 MHz, 10.7 MHz and 10.8 MHz. The curve should not turn down for skirting until its flat top is beyond the 10.6-MHz and 10.8-MHz markers.

Figure 9-a shows a typical IF response after preadjustment but before sweep touchup. The curve is slightly off-side. The IF cans must be touched up. Otherwise, bandwidth and tuning will not be symmetrical, and stereo recovery may not be dependable—particularly on any marginally distant station.

You will find that in each IF can, one core affects the tilt of the top of the response curve. The other core slides one end or the other of the curve under or out from under the markers. Very little adjustment is needed to place the properly shaped curve, evenly under all three markers, as shown in Fig. 9-b. Also adjust the bottom (primary) slug in the detector transformer.

The flat top of the curve should extend a bit beyond the two outer markers, to give a solid 250-kHz response. Be careful not to extend the top too far, or adjacent-frequency stations will try to capture each others' places on the dial!

Finally, you're ready to adjust the detector coil. Disconnect the scope and reconnect the capacitor you unhooked earlier. Now, find the resistor that comes from the center tap of the detector-coil secondary. This resistor is the sound-output point that precedes any coupling capacitor. Connect your scope probe there.

You may have to increase the scope's vertical-input sensitivity. Otherwise, the S-curve display may be too flat. You may also have to turn down the markers; if they are too large, they may confuse you as to where the center of the curve is.

Now, adjust the top slug of the detector-transformer sound so that the 10.7-

A Methodical Troubleshooting System

Basically, *Easi-Way Servicing*[1] comprises five steps. A brief description of each step gives some idea of how timesaving and direct this troubleshooting technique is.

Step 1: Analyze the Functions in an instrument. Consider a hi-fi system, for example. Operate the equipment and decide whether the trouble lies in a turntable, a tape or cassette deck, in the tuner function, or in the receiver's amplifier. You cannot afford to waste time hunting defects in the wrong equipment. This may seem an obvious point, but it often happens. The trick is to establish specific tests that let you analyze each function more or less independently of all others.

Step 2: Diagnose the Section that operates incorrectly or not at all. In a stereo tuner, it might be the RF section, the IF section, the demodulator, or the multiplex section. In a stereo or quadriphonic amplifier, the malfunction could occur in the preamp section, power supply, voltage amplifiers, tone control, or power amplifier; any of these could be at fault, and you can multiply by two (or four for quadriphonic operation). Diagnose *which* section, and you're way ahead of the game. Naturally, your aim is to focus troubleshooting attention only in the section actually containing the fault. That makes sense, but it's not always the way it happens. Again, the secret rests in specific procedures that prove your diagnosis.

Step 3: Localize the Stage that's bad within the section you diagnosed. I define a stage as a transistor, FET, diode, (or tube) plus its components and wiring.

An IC and its associated components can form a stage. Or an IC can be a whole section. A stage usually processes a signal; some stages process DC voltages (or voltage changes). The fact is, your tests for localizing a bad stage depend largely on what components are in the stage and what they should accomplish. But (a) you have only a few of these stages to test because of steps 1 and 2; (b) the tests are common and seldom complicated; and (c) you save a lot of other testing once you know which stage is bad.

Step 4: Isolate the Circuit that is causing the stage malfunction. Circuits are contained within a stage. Signal circuits include input coupling, output coupling, decoupling or bypass, feedback and tuned circuits. The DC circuits include the collector, base and emitter-supply circuits; bias dividers; and supply branches, etc. In DC-coupled stages, signal and DC circuits involve the same components; but you can test them either as DC-handling or as signal-handling circuits. And, of course, you only have a few circuits to test.

Step 5: Pinpoint the Component at fault, which is the ultimate goal. Obviously, the whole concept involves avoiding having to troubleshoot functions, sections, stages, or circuits that are really OK. All five servicing steps described here point you logically in that direction.

If you're an old-timer and successful, you probably already use all these steps. But it doesn't hurt to review good techniques. These steps are a godsend to technicians who were never taught a direct, straight-moving troubleshooting procedure. **R-E**

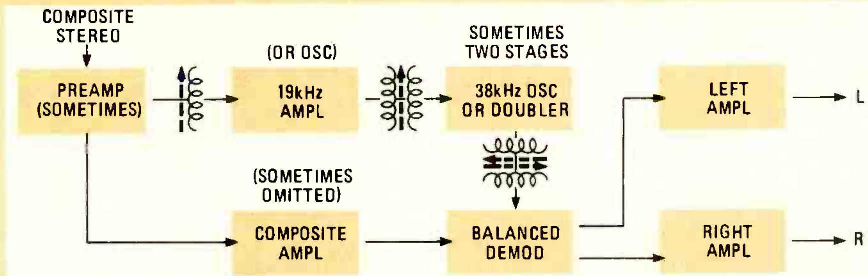


FIG. 10.—STAGES IN NON-IC MULTIPLEX SECTION actually work similar to IC types, but several adjustments are needed to keep them in alignment.

MHz marker is exactly centered on the S-curve. Touch up the bottom slug to make the S-curve symmetrical. Figure 9-c shows the symmetrical S-curve that you're trying for. (*Do not* make any other IF adjustments.)

Work back and forth between the top and bottom slugs. The bottom slug should cause the shoulders of the S-curve to be symmetrical and equidistant from the center marker. The top slug slides the whole curve back and forth around the center marker.

Disconnect the generator and the scope. You know if the IF section is not only operative but in tip-top alignment. Naturally, any nontunable coils you find along the way will alert you to troubleshoot the associated stage. Check the transistor first, then other components. Open bypass capacitors can make a coil tune more broadly than expected, distort the sweep curve to an impossible degree, and make coil-tuning seem erratic. Yet, you might not spot this trouble when you go through the set with an unmodulated IF signal. Nor is a faulty coil uncommon; ordinarily, it will fail completely to tune.

Stereo multiplex alignment

Integrated circuits in modern stereo receivers leave little adjustment either necessary or possible. But there are still many older receivers around that you may have to service. As with the rest of the receiver, alignment makes a fine troubleshooting technique.

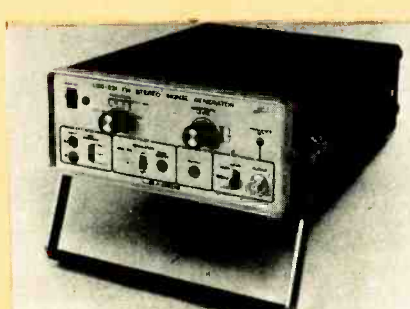
Figure 10 shows the stages you can expect to see in the multiplex section of most stereo receivers. Without a multiplex IC such as that shown in Fig. 6, the balanced-detector system is the most used. The main differences lie in how the pilot signal from the station (or generator) develops a 38-kHz injection signal for recovering the L − R, which then combines with L + R to form the original L and R signals. Some pilot signals lock a 19-kHz oscillator, which then is doubled to 38 kHz. In other sets, the pilot signal is amplified and then locks a 38-kHz oscillator. In either case, a 38-kHz signal goes to a balanced demodulator.

A composite stereo signal is sometimes amplified before being applied to the balanced demodulator, sometimes not.

To troubleshoot, start by aligning the 19-kHz and 38-kHz coils. Connect a 10:1 scope probe at the output of the last coil, the one that feeds the balanced demodulator. You'll find a handy clip-on point at the input end of either diode in the demodulator. Figure 11-a shows the 38-kHz sinewave that is present there. The scope timebase was set for 20 μs-per-division; the vertical input was set for 5 volts-per-division, or whatever voltage it takes for a sizable display.

Peak all the transformers for maximum amplitude of the 38-kHz signal. This is not their final adjustment, but indicates whether any of them are defective. If one transformer fails to tune, investigate the stage around it as described. If there's no 38-kHz signal, use your scope to trace through this branch of the section to discover the reason.

Connect your scope probe to the center



Leader model LSG-231

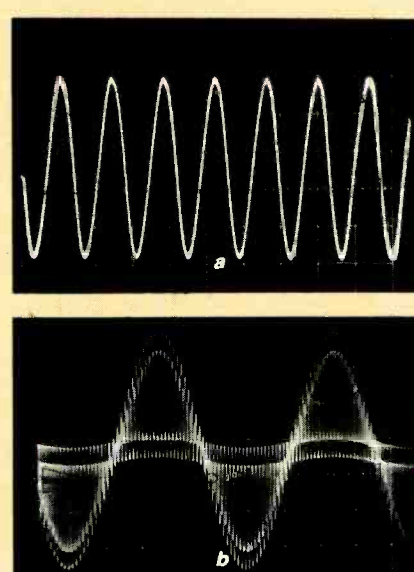


FIG. 11.—PLAIN RF SIGNAL (a) at 38 kHz injects carrier signal into balanced demodulator to beat against L − R sidebands and recover (b) L − R signal for stereo FM reception.

input point of the balanced demodulator. Set the generator to modulate only one side—say, the left side. The composite stereo waveform at the input to the demodulator is distinctive (Fig. 11-b). If it's missing or unduly weak, which means its amplitude is less than at the input of the section, trace backward until you find where the waveform reappears or shows normal amplitude.

A major criterion for good multiplex alignment is *separation:* When you feed a left-side-only signal into the stereo receiver, does any audio signal appear in the right-side amplifiers and vice-versa (of course)?

One easy way to check this is to first measure the output of both amplifiers using a monophonic signal, balancing them equally (which also proves that the amplifier part of the stereo receiver is working), and then switch to a stereo input with only one side modulated.

The meters on the Sencore *model SG165* generator are already calibrated in decibels for comparing separation. Connect the meters to the left and right amplifier outputs. You are still feeding a stereo-modulated RF signal into the receiver's front end.

Turn the left-side modulation on and the right-side modulation off. Crank up the amplifier volume until the left-side meter indicates about three-fourths of full-scale. Then, very carefully tweak each transformer in the multiplex section. Try for a *maximum* left-side output, but with *minimum* reading on the right-side

Sencore model SG165

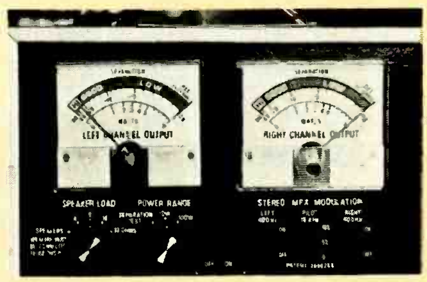


FIG. 12.—SENCORE *MODEL SG165* METERS are calibrated to show exact amount (in decibels) of separation in stereo recovery system of FM radio.

meter.

You'll find it necessary to compromise. You will also discover that these adjustments are extremely critical, and that there is some interaction between transformers. These are the same coils you peaked earlier, but those were rough adjustments. Now you are settling the phase right down to the very best obtainable for the demodulator. Perfect phase results in the best possible separation.

When the left-side output is at maximum and the right-side output is at minimum, set the amplifier volume so that the meter on the left reads exactly full-scale. The decibel scale will show that this establishes a zero-decibel reference. The meter on the right then indicates the decibel difference, the amount of separation. Figure 12 shows a stereo tuner exhibiting 25 dB of separation.

Switch the left-side modulation off and turn on the right-side modulation. Adjust the volume for a full-scale reading on the right-hand meter. The meter on the left should indicate the same low separation achieved with the opposite mode. If the two sides are unbalanced—that is, if separation is greater in one direction than in the other—you must refine the final adjustment, the balanced demodulator transformer. Also you must check the potentiometer separation control, if the set has one.

Finally, separation *in both directions* should meet the radio manufacturer's specification. Naturally, as you go along, defects can simply prevent you from accomplishing the necessary alignment. Once you are accustomed to making alignments tests, you can diagnose a set quicker this way than it takes to read about it. **R-E**

Low-priced programmable TV game IC's introduced

"A winner for next Christmas," says R. C. Norwood, general manager of General Instruments Consumer Products Line, referring to the company's new low-priced programmable (LPP) game set. Norwood indicated that the product has already received an enthusiastic response from such manufacturers (among others) as Radofin and General Electronics.

The LPP system "offers the consumer a large number of game combinations with cartridge flexibility at a console price one-half of that of the programmables currently in the market place." All cartridges provide realistic sound, on-screen scoring and are tailored to both U. S. and European TV standards.

LOW-COST PROGRAMMABLE TV GAME built using new IC's from General Instrument. The game is not microprocessor based. Instead of the cartridges containing ROM memory, each cartridge contains a dedicated game IC.

The LPP uses an AY-3-8615 color video processor IC in the game console. Cartridges currently available are: the 8610 *Supersport* (20 games); the 8675 *Motorcycle* (8 games); and the 8603 *Road Race Set* (3 games). In the planning stage are three other cartridges: *Shooting Gallery* (12 games); *Wipeout* (24 games); and *Warfare* (10 games).

1978-1979 SCTE officers and directors

The Society of Cable Television Engineers, Inc. (SCTE) has announced its slate of officers and regional directors for 1978-1979. They are as follows:

President, Bob Bilodeau (serving to end of 1978 only); eastern vice president, Harold Null; western vice president, Gay Kleycamp; secretary, Judith Scharf; and treasurer, Ed Horowitz.

Regional directors are Frank Bias, Glenn Chambers, Bill Ellis, Jim Grabenstein, John Morovich, Bruce Uerling, and John Weeks.

Moratorium asked on microwave installations in NY area

Because of increased public concern over the possible adverse long-term effects of microwave radiation, New York City's Board of Standards and Appeals has asked Mayor Edward Koch to declare a temporary moratorium on constructing or installing microwave facilities in the area until "satisfactory guidelines" have been established. To date, no studies have been made concerning the long-term effects of such facilities.

The Board's request arose partly out of a recent decision to deny permission to construct a 180-foot microwave transmission tower in Staten Island. This tower would have formed part of an overall U.S. Coast Guard maritime traffic plan for New York Harbor. If the moratorium is approved, this would be the first time any major metropolitan area in the U.S. has taken such an action to determine health and safety standards for microwave radiation.

Robert Villont announces his candidacy for NESDA president

At a recent meeting of the Washington State Electronics Council, NESDA senior vice president, Robert (Bob) Villont announced that he would seek the presidency of NESDA. In his speech, Villont expressed his main concern was increased NESDA membership, but also stressed that the national office should strive to practice what it preaches to the membership—namely, service to the customer. Washington and Oregon groups have endorsed Villont and pledged continued support in implementing his campaign plans, if he is elected. **R-E**

Reducing CB Interference

Many television interference complaints are caused by the second and third harmonics from CB transceivers. A special test instrument has been developed so technicians can easily measure interference components.

ED PILLER, W2KPQ

JIM SMITH PUSHES THE MICROPHONE button on his CB base station to communicate with a friend on the other side of town. Thirty seconds later, he receives a phone call from an irate neighbor telling him that he's wiping out his favorite football game on Channel 5. How many times (in one form or another) is this scene repeated across the United States? Judging from information provided by the FCC, over 100,000 formal complaints of CB-caused interference are now being received a year. However, for every documented complaint, there may be 50 or more cases that are unreported. Apparently the problem has reached tremendous proportions.

The FCC has cracked down through rules requiring harmonics and spurious radiations from new CB transmitters to be a minimum of 60 dB down from the power output of 3 watts to 4 watts. Furthermore, since many home entertainment receivers may be as much at fault as poorly designed transceivers, Senator Goldwater and Congressman Vanik have introduced bills into Congress that would require RF interference-suppression devices to be incorporated in home receivers at the time of manufacture. In addition, local town boards in some cases have levied fines for interference and have imposed ordinances on antenna structures. Many of these cases are now being tried in the courts since they usurp some of the FCC's jurisdictional powers.

I faced some of these problems from 1951 through 1966 while operating a 1-kW SSB amateur transmitter on the 21-MHz and 29-MHz bands from a 50-foot tower in a suburban area. A situation developed that even when I was out of town, interference complaints were received against my nonoperational station. This was primarily due to the fact that my antenna was the most prominent one in the area. Accordingly, it was the most logical place (in the minds of some) from which these interfering signals could originate. There is a wealth of information available on the causes and cures for RF interference from cases studied in the amateur radio service, and some of the major items will be discussed in this article.

Causes of interference

In seeking to cure interference problems, it is important to diagnose the cause. Suppression techniques can be applied only when the interference path has been located. Generally, interference can be caused by harmonics and other spurious frequencies generated in the CB transceiver itself. It can also be generated through overload and audio rectification in the home entertainment device that is caused by faulty design. It can also be the result of other outside phenomena completely unrelated to the communication devices.

Interference in the home TV set can be caused by front-end overload from a local signal due to inadequate rejection ahead of the first RF stage. During the overloading process, interfering frequencies are generated within the receiver itself. They can also be induced by a strong RF signal being rectified in a particularly sensitive portion of a solid-state or vacuum-tube circuit. Low-level audio circuits are especially vulnerable to this. Interference signals have also been known to enter directly through the power lines, which can act as a receiving antenna and conduct the signal to the affected receiver.

Other sources of interference that may be blamed on the CB'er are completely unrelated to his operations; i.e., corona and noise generated by local power lines and oil burner ignition systems; or line noise caused by vacuum cleaners, electric razors, washing machines, light dimmers, fluorescent lighting and other appliances. Automobile ignition systems, diathermy machines and industrial equipment have also been known to cause interference problems. Improperly adjusted power microphones can cause badly distorted signals as well as spurious products that could affect adjacent-channel CB's and other home-receiving devices. Emissions from the public service, broadcast, amateur and land-mobile bands can also interfere.

In tracking down the interference, it is important to determine a pattern: When does it occur? How often? What are its symptoms? Can voices or call signals be identified? Does the visual or aerial interference occur in accordance with a ranging voice modulation?

Once it is determined that the interference is caused by a local transmitter, a receiver capable of tuning from 2 MHz to 30 MHz could help identify the cause in most cases. Other receivers tuning the 30- to 54-MHz and 144- through 170-MHz frequencies could also identify emissions in other bands that could cause interference. Observing the interference signal on the home set, while listening to it on its fundamental frequency, would be the surest way of identification.

Measurements and tests

In making interference measurements to determine its sources and causes, it is important to make sure that your own CB system is relatively

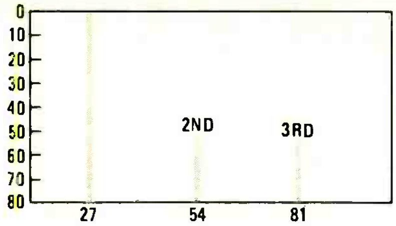


FIG. 1—SPECTRUM ANALYSIS of fundamental, second and third harmonic frequencies.

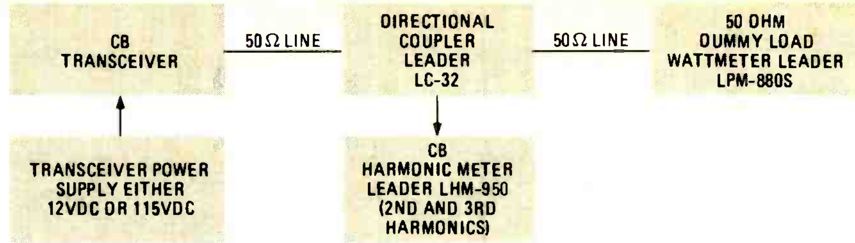


FIG. 2—TEST SYSTEM for harmonic measurements.

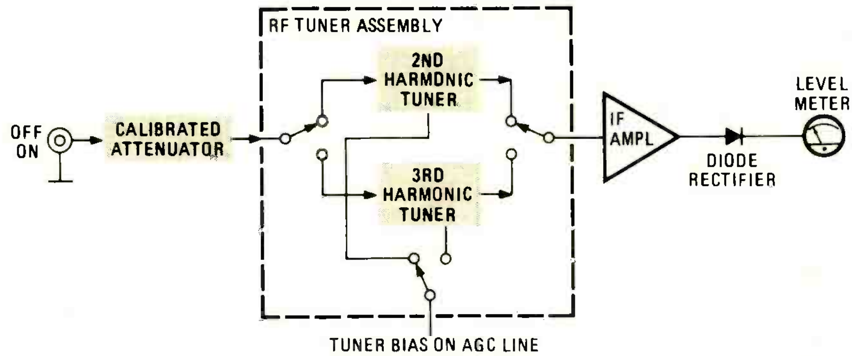


FIG. 3—INTERNAL CONSTRUCTION, ***model LHM-950*** **harmonic meter.**

free from radiating spurious signals. This, of course, can be established by setting up the receiver in a laboratory and making tests with a good spectrum analyzer. The resulting test data would appear on the cathode ray tube of the analyzer. Figure 1 shows the fundamental frequency of 27 MHz and the second and third harmonics at 54 MHz and 81 MHz. The second and third harmonics are normally considered to be a major source of CB interference and should be at least 60 dB down from the fundamental frequency.

Unfortunately, the above lab setup requires very expensive equipment that is normally not available to the average service technician. Leader Instruments Corporation, recognizing this problem, has introduced the *model LHM-950* CB harmonic meter system. This instrument includes a calibrated tunable voltmeter and a directional coupler (*model LC-32*) at a cost of $334.95. When used with a 50-ohm dymmy load, such as the Leader *model LPM-880S*, a complete test system is available for harmonic measurements. (See Fig. 2). Once the test setup is completed, suitable adjustments can be made to harmonic traps within the transceiver.* The effectiveness of add-on low-pass filters in the RF output line can also be determined.

Interference caused by radiation of the second and third harmonics can easily be detected on a home TV set. The second harmonic normally appears on Channel 2, and the third harmonic on Channel 5 or Channel 6.

It is important to note that while the FCC regulations require that harmonic suppression be a minimum of 60 dB, this value may not be adequate under certain conditions. For example, a fringe-area receiver picking up a weak TV signal could be wiped out by the second or third harmonic of a local CB set even though the interfering harmonic is suppressed more than 60 dB.

Figure 3 shows the block diagram of the *model LHM-950*. A signal is coupled from the output of the transceiver via a directional coupler (see Fig. 2) to the input of the *model LHM-950*. A calibrated attenuator feeds the signal through an RF tuner, which then converts it to a 45.75-MHz IF signal. The IF is thereby amplified and rectified. The DC output signal of the rectifier is fed to a calibrated meter. The attenuator is adjusted to bring the reading on-scale, and the second-harmonic tuning is peaked. A reading is then obtained in dBμ (dB above 1 μV). When applied to a calibration curve, a dB reading below the fundamental signal can be obtained. The third harmonic is measured similarly.

*CB transceiver adjustments should only be performed by a technician having a valid first-class or second-class FCC radiotelephone license.

Curing interference

The cure for radio-frequency interference can be very simple or extremely involved and complicated. The simple remedies should be tried first. A good low-pass filter, designed to operate at the output connector of the CB set, should be installed if the measured harmonics do not meet the 60-dB requirement. If interference is still being received on the TV set, a high-pass filter, mounted as close as possible to the tuner, should be installed. This filter attenuates signals below 54 MHz and prevent spurious interference from being generated by an overload condition at the TV set front-end. If interference still persists, the CB set output should be connected to a shielded 50-ohm dummy load. If interference is *still* present, perhaps it is being conducted through the power line or radiated directly from the set itself. A power-line RF could cure the first problem; the second may require extensive grounding and shielding at the CB set.

It is a good idea to substitute another CB set for the one under test and determine if the interference persists. Some CB sets have been known to generate spurious frequencies in the RF-amplifier chain that are not harmonically related to the output frequency. In addition, you can substitute a second TV set to observe if the interference signal disappears. If this is the case, then the fault lies in the TV set rather than in the CB unit.

Summary

RF interference from a CB set can be reduced by applying appropriate measures at the set itself, the affected receiver or in both. A logical system would include trying filters at each place and substituting a different transmitter and receiver in each case. The path of interference should be determined and measures applied to eliminate it. Additional RF interference information can be obtained by contacting the A.R.R.L. or the FCC. In many cases, RF interference filters may be supplied free of charge from the home entertainment equipment manufacturer. **R-E**

A complete RFI (Radio Frequency Interference) packet containing extensive information can be obtained at no cost. Just send a large self-addressed manila envelope with forty-six cents ($.46) postage to the A.R.R.L., 225 Main Street, Newington, CT 06311, and request the information.

To obtain the new FCC booklet on "How to Identify and Resolve Radio-TV Interference Problems," send a check for $1.50 (payable to the Superintendent of Documents) to the Consumer Information Center, Dept. 051F, Pueblo, CO 81009.

FLYBACK SUBSTITUTE

Help! I need a replacement for the flyback in an Ambassador color TV, model 2914. The part number seems to be A29056-A, but it's not listed in Sams or any other sources I could think of.—S. G., Tucson, AZ.

I've been crisscrossing references until I'm blue in the face! With no direct substitute yet. This is a brand name that was made by 10 different companies. From the *type* of part number, it could be a Nivico. A random check of Sams Photofacts turned up a Nivico 7208, and the flyback number is A29056-A. However, no substitute is listed for it either.

You might try obtaining one from JVC, America Inc., 58-75 Queens-Midtown Expwy, Maspeth, NY 11378. Check Sams 1035-2 to see if the circuit looks like yours. Good luck!

TOO MUCH RIPPLE

There's far too much ripple in the DC power supply of this GE model JA chassis. I've checked and replaced the filter capacitors; this didn't help much. What else could cause this?—A. K., Elmhurst, NY.

There's really only one thing left. Check the filter choke. It may have developed an internal short across the windings but not to ground!

(Feedback: "Bingo!") **R-E**

LEADER
PHILIPS
B+K PRECISION
HICKOK
FLUKE
NLS Non-Linear Systems
CONTINENTAL SPECIALTIES CORPORATION CSC
DORIC
Simpson
DATA PRECISION
TRIPLETT
VIZ
formerly RCA
MODEL 1474
Rise time 11.7 nS or less
Built in signal delay line permits view of leading edge of high frequency pulse rise time
Triggers on signals up to 50 MHz
5mV/cm vertical sensitivity
Mode automatically shifts between CHOP and ALTERNATE as you change sweep time
Checks most digital logic circuitry, including ECL
High accuracy ten position vertical input attenuator
Flat response with smooth rolloff
B+K PRECISION
$699.95
PROBES NOT INCLUDED IN PRICE
Dual-Trace 5" 30MHz Triggered Scope
MODEL 2810
B+K PRECISION
REG. $120.
$99.95
3½ digit easy to read LED display
0.5% DC accuracy typical
10 ohm range and control to zero lead resistance
Selectable High/Low power ohms on four range
Auto zeroing
3-1/2 Digit DMM with .5% Accuracy
B+K PRECISION
MODEL 1820
5Hz to 80MHz reading guaranteed—100MHz typical
Period measurements from 5Hz to 1MHz
Period average, auto and manual positions
One PPM resolution
Totalizes to 999999 plus overflow
Elapsed time measurements from .01 to 9999.99 seconds plus overflow
One megohm input resistance
Bright .43" high LED readouts
$219.95
80MHz Counter with Period Function
SUMMER SPECIALS
SALE ENDS SEPT. 30, 1978
B+K PRECISION
$144.95
MODEL 520B
REG. $175.
Now with HI/LO drive
Works in-circuit when others won't
Identifies all three transistor leads
Random lead connection
Audibly and visually indicates GOOD transistor
Automatic NPN/PNP determination
Positive Si/Ge identification
Tests diodes, SCR's, FET's, and Darlingtons
Industrial Transistor Tester
B+K PRECISION
MODEL 3010
$144.95
Generates sine, square and triangle waveforms
Variable amplitude and fixed TTL square-wave outputs
0.1 Hz to 1MHz in six ranges
Push button range and function selection
Typical sine wave distortion under 0.5% from 0.1 Hz to 100 kHz
Variable DC offset for engineering applications
VCO external input for sweep frequency tests
New Low Distortion Function Generator
The C-Meter
PRECISION, AUTORANGING CAPACITANCE METER
DORIC $325
130 C-Meter
DORIC
MEASURE
FLUKE DIGITAL MULTIMETERS
8020A
Extensive Overload and Transient Protection
Rugged Construction—1 Year Warranty
200 Hour 9V Battery Life—Low Battery Indicator
1 Year Calibration Cycle—Only 3 Adjustments
One Hand Operation
Complete with Battery and Test Leads
BASIC SPECIFICATIONS
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FLUKE
Simpson New Compact Portable DMM
New MODEL 461 Digital Multimeter
DIGITAL MULTIMETER
$142.50
SHIPPING NOT INCLUDED IN PRICES
212-687-2224
THE TEST EQUIPMENT SPECIALISTS
Mastercharge, BankAmericard
TOLL FREE HOT LINE
800-223-0474
54 West 45 Street, New York, N.Y. 10036
ADVANCE ELECTRONICS

DIGITAL DARKROOM TIMER

continued from page 37

and local parts houses. Most of the IC's are part of Sylvania's ECG series (just add the ECG prefix to the 4-digit designation given in the parts list), and probably part of RCA's SK series. Do not use Motorola's HEP series because even though they designate their CMOS gates with a 4-digit number between 4000 and 4099, their numbers, in no case, correspond to the industry standard numbers given in the parts list. That is, HEP4001 is not the same as CD4001, ECG4001 or the part specified for IC3 and IC15.

Repeatability, accuracy and short-time limits

The repeatability of any selected interval is about 7.8 ms, the period of the digit-scan frequency. This occurs because operation of the EQUALS key is not syncronized with IC7's internal clock.

The uncompensated accuracy of any interval is a constant dependent upon: 1) line-frequency accuracy; 2) the difference between the relay's pull-in and drop-out time; 3) the phase shift across the transformer (which may delay the triac's turn-on if the relay energizes while the line voltage is close to zero); 4) an extra delay of 0.2 second in IC7 the first time the Equals function is activated. The first three factors will not produce more than about 12 ms of error. The 0.2-second error is compensated for by delaying the relay pull-in by using IC6-7 as the source of the signal to latch IC3. As a result, the accuracy is about 30 ms in the seconds range, and 100 ms in the minutes/seconds range. Though repeatability is much more important than accuracy, if you need high accuracy at short intervals, shunt R2 with any silicon diode, anode to Q1's base, and experimentally add sufficient capacitance from Q1's base to ground to achieve the required accuracy. Start with about 5 μF.

If you print in color, avoid using intervals less than about 0.5 second with incandescent-lamp enlargers because during the warmup and cooling period of the lamp, which could be close to 0.1 second long, the color temperature of the lamp will be too low compared with the steady-state value. This will produce reddish color shifts if printing from a slide, and a cyan shift is produced if printing from a negative. **R-E**

NEGATIVE PICTURE, NO SYNC

The picture goes negative and loses sync on this Sears model 562.10420 chassis. The brightness control behaves like automatic-gain control. I checked the AGC circuit but didn't find anything. Where to now?— G. E., Belleville, IL.

Go right back to the automatic-gain control (AGC) and clamp it with a bias box at about +1.9 volts. If this clears up the problem, then follow through the AGC stage very carefully. These symptoms could indicate leaky transistors.

(Feedback: "That solved it. The AGC keyer and amplifier transistors were both very leaky. Thanks for the help!")

DOUBLE PICTURES

I'm a student trying to fix this Sanyo model 21V65. It has double pictures or double horizontal foldover. Changing the tubes brought no results.—J. S., Virginia Beach, VA.

This is most apt to be a horizontal oscillator/AFC problem. Remove the AFC by grounding it, then see if you can adjust the horizontal-hold control so that only one straight-sided picture appears on the screen. If you can, the oscillator is able to run on-frequency. Put the AFC back in. If the picture goes *out* of sync, the problem is in the AFC, with the most likely cause being the dual-diode unit. Make sure that this unit is perfectly balanced. **R-E**

computer corner

8080 *A demonstration program for the 8253 timer.*

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

IN A PREVIOUS COLUMN, WE INTRODUCED the characteristics of the Intel 8253 programmable interval timer, a 24-pin IC that is very useful in counting and timing operations.

This month's column describes a demonstration program that illustrates the various modes of operation of the timer.

The details of the test circuit are shown in Fig. 1. Although an oscilloscope is handy to monitor the output signal, OUTO, from counter No. 0, we have found it just as useful to use a single 7490 decade counter IC to detect negative-edge transitions at output signal OUTO. The 25-kHz input clock frequency, which has a period, T, of 40 μs, is the input at CLKO.

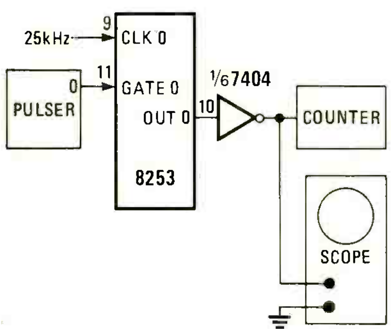


FIG. 1

Before you use the 8253 IC, you must understand the nature of output signal OUTO as a function of the IC's six different modes of operation: mode 0 through mode 5. Intel literature[1] is somewhat confusing in this area, so the diagrams have been simplified by omitting all signals except for the OUTO signal. This permits you to simultaneously compare all six operation modes, as shown in Fig. 2. Note that modes 0 and 1 provide a negative monostable clock pulse of duration NT; mode 2 provides a series of negative clock pulses of pulse width T and period NT; mode 3 provides essentially a squarewave of period NT; and modes 4 and 5 provide a single strobe pulse of pulse width T at a time NT after a trigger pulse has been applied to counter No. 0. Quantity N is a 16-bit timing byte initially loaded into counter No. 0. In our demonstration program, the timing byte is 000 000_8, which corresponds to the decimal number 65,536. At this point, there are two possible actions input GATEO can take:

1. GATEO functions as a *gating* input; when at logic 0, pulses that are input at CLKO do not reach counter No. 0 and no counting occurs. This type of behavior occurs with mode 0, mode 2, mode 3 and mode 4.
2. GATEO functions as a *trigger/reset* input; a positive-edge transition at GATEO resets counter No. 0 and initiates counting. Each time there is a positive edge at GATEO, counter No. 0 is reset. This type of behavior occurs with mode 1, mode 2, mode 3 and mode 5.

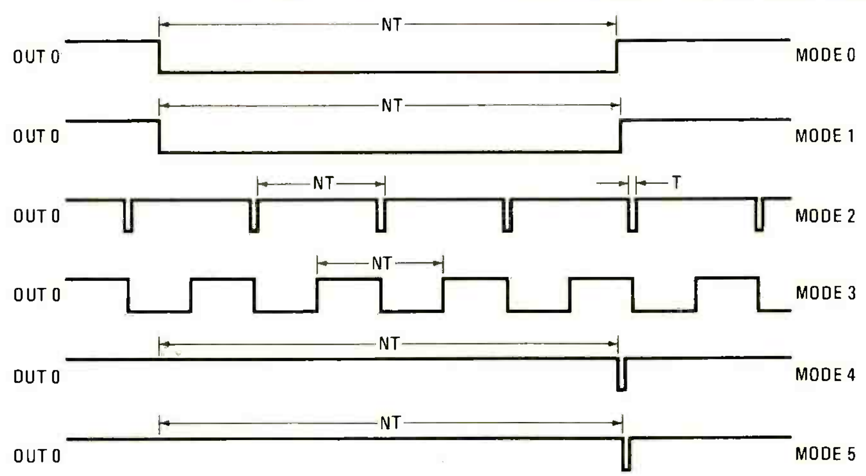


FIG. 2

These different actions can best be observed with the aid of a counter and a value of NT in the range of 3 to 10 seconds. In this case, the value of N is 65,536 and T is 40 μs; so NT = $(65{,}536)(40 \times 10^{-6}) = 2.62$ seconds.

The program that we use to test the 8253 IC is shown in Table 1. Note that a memory-mapped I/O (*I*nput/*O*utput) is used, in which the control register has an address of 200 003_8 and counter No. 0 has an address of 200 000_8. The program is quite simple. First output the control word, 060_8 (mode 0), into the control register. Next, successively load the LO and HI counter bytes, both of which are 000_8, into counter No. 0. Finally, enter a wait loop.

When you execute this program, output signal OUTO goes immediately to logic 0 and remains there for NT seconds, after which it returns to logic 1. You can repeat this behavior only by executing the program a second time starting at memory address 003 000_8.

If you change the control word at location 003 001 to 062_8 (mode 1), start the execution of the program and press the pulser shown in Fig. 1, you will also observe a negative pulse with a duration of 2.62 seconds. If you fail to press the pulser, however, and thus do not apply a positive edge at GATEO, you will observe no monostable pulse. On the other hand, repeatedly pressing and releasing the GATEO pulse at time intervals of less than 2.62 seconds can prolong the monostable pulse indefinitely. In this way, you are able to produce a *retriggerable monostable multivibrator* input.

The control word of 064_8 lets you observe the mode 2 behavior shown in Fig. 2. Repeatedly generating positive edges at GATEO at time intervals of less than 2.62 seconds repeatedly resets counter No. 0 and prevents the short negative clock pulses from appearing. You can accomplish the same purpose by allowing GATEO to remain at logic 0 after you have applied a positive edge. The GATEO input thus exhibits both gating and trigger/reset behavior.

*This article is reprinted courtesy of American Laboratories.

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

TABLE 1—DEMONSTRATION PROGRAM for the 8253 interval timer. The control word at address 003 001 is changed to demonstrate the behavior of the different modes of operation.

Address	Instruction	Label	Mnemonic	Comment
003 000	076	TIMER,	MVIA	/Move control word into accumulator
003 001	060		060	/Mode control word
003 002	062		STA	/Store it within control register
003 003	003		003	/in 8253 interval timer chip
003 004	200		200	
003 005	076		MVIA	/Move LO counter byte into accumulator
003 006	000		000	/LO counter byte
003 007	062		STA	/Store LO byte in counter #0
003 010	000		000	
003 011	200		200	
003 012	076		MVIA	/Move HI counter byte to accumulator
003 013	000		000	/HI counter byte
003 014	062		STA	/Store HI byte in counter #0
003 015	000		000	
003 016	200		200	
003 017	303		JMP	/Wait
003 020	017		017	
003 021	003		003	

The mode 3 behavior (control word of 066_8) is similar to that for mode 2, except that a nearly symmetrical squarewave is produced. Deviations from symmetry occur when the counter byte is an odd number, and are most evident when the counter byte is very small.

In mode 4 (control word of 070_8), the positive edge of the $\overline{\text{WR}}$ pulse, which is applied at pin 23 of the timer when you execute the STA instruction at 003 014, initiates counting that produces a negative clock pulse of pulse width T. The time duration between the positive edge and the pulse is 2.62 seconds. The GATEO input acts as a gating input, with a logic 0 inhibiting the counting process.

Finally, in mode 5 (control word of 072_8), a positive edge at GATEO initiates counting. Repeatedly generating positive edges at GATEO at less than 2.62-second time intervals repeatedly resets counter No. 0 and prevents the appearance of the single negative clock pulse.

It should be noted that in all modes, counter action begins on the first negative clock transition after $\overline{\text{WR}}$ (pin 23) or GATEO goes to logic 1; and that $\overline{\text{WR}}$ can initiate counting in all modes except mode 1 and mode 5.

Although in many 8253 timer applications, the primary purpose is to generate the proper output signal at OUTO (as shown in Fig. 2), you can also read the contents of the 16-bit counter *without affecting the counting operation.* By inputing a control word of 000_8, 100_8, or 200_8, you can latch the 16-bit count of either counter No. 0, counter No. 1, or counter No. 2, respectively. You can then read the two bytes into the 8080A IC, with the LO counter byte first and the HI counter byte second.

To discuss complex counter applications in any detail is beyond the scope of this article. However, a 16-bit frequency counter has been described elsewhere,[2] and a scheme has been proposed[3] for measuring the half-life of a radioactive substance. **R-E**

REFERENCES:

1. *Intel Data Catalog, 1977,* Intel Corp., 3065 Bowers Ave., Santa Clara, CA 95051.
2. Lynne, P., "Implementing an LSI Frequency Counter," *Byte 2* (11), 146 (1977).
3. DeJong, M. L., private communication. (Professor DeJong will implement a number of counting schemes in a physics laboratory, and would be interested in corresponding with others who have similar interests.)

hobby corner

Build an inexpensive expanded-scale voltmeter to monitor AC line voltage.

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

FEW THINGS ARE MORE FRUSTRATING TO those of us who know something about electricity than the hot weather "brownout." This occurs when the power company reduces the voltage in an attempt to make the supply go around. There were brownouts during the past several summers, and it is possible the situation will become worse before it gets better. Not only is it frustrating when the usually reliable AC voltage is cut by 5%, 10% or more, it is potentially *harmful* to your home appliances.

If you reduce the input voltage to a motor, the result is that the operating temperature rises. Reduce it enough and the temperature becomes so high that it burns the insulation off the coil wires, and that's the end of the motor.

Most motors can operate at a 10% or greater voltage reduction with no more effect than just running a little warmer than usual. The amount of undervoltage a given motor can tolerate safely depends upon its design and its load (i.e., how hard it is working).

Thus, you can see that there is no magic voltage figure that applies equally to all motors. If you have a motor that operates at or near its maximum load, it may be the first to go while others are seemingly unaffected.

On the other hand, it is not good for any motor to operate at higher than normal temperatures. Such operation over a period of time, whether all at once or broken up into many intervals, shortens the life of a motor. You don't want a motor to operate that way unless it must.

There are two things you can do: Raise the voltage or turn the motor off. The former can be a very expensive operation but sometimes it is necessary.

It is much more practical to turn the motor off or not start it up when the voltage drops. Do not use your washing machine or dryer until later; postpone using your power saw; and turn off a nonessential fan or air conditioner.

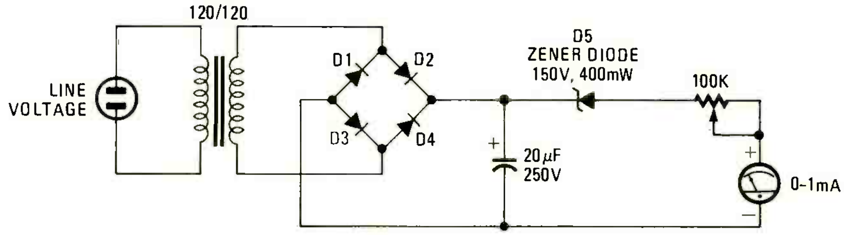
However, you have to know at the time when the voltage is down—reading about it later won't help. Of course, you could hook your VOM or VTVM to the power line but you do use them for other things. Not even a 150-VAC panel meter is the easiest instrument to read accurately. What you should have is a line-voltage monitor and now is the time to build it.

AC line monitor

The problem with a VOM or a panel meter is that the scale graduations are very small and set close together. Sometimes they are marked in units of 5 volts or even 10 volts, which does not make for very accurate readings. If the meter scale went from a low of 100 volts to a high of 125 volts, for example, you could read it much more easily.

That's just what an expanded-scale meter is: the bottom of the scale is left off or highly compressed, and the top is expanded to fill all or most of the space.

Figure 1 shows both an expanded-scale meter and the method for attaching it to the power line. I *strongly recommend* using an isolating transformer. If you do not own or cannot find an inexpensive transformer with a secondary winding close to 120 volts AC, you can use two small filament transformers placed back-to-back, as seen in Fig. 2. These transformers can be 5, 6.3, or 12.6 volts, or almost anything as long as they are the same. They can also be the smallest transformers you can find since very little power is drawn from them.



D1, 2, 3, 4 - SILICON DIODES, 50mA, 250 PRV (1N4004 OR EQUIVALENT)

FIG. 1

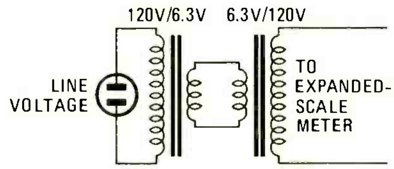


FIG. 2

How it works

Here's how the meter operates: Diodes D1 through D4 rectify the AC voltage to DC voltage, and the capacitor smooths out most of the ripple. The Zener diode, D5, doesn't allow any appreciable amount of current through until its Zener voltage is reached, thereby effectively eliminating the bottom part of the scale. The potentiometer is used to set the meter during calibration. Any milliammeter with a scale from 0 to 1 can be used but choose one that comes apart easily so that you can change the scale markings.

Obviously, what the circuit is doing is measuring any change in a DC voltage that is caused by a change in the AC line voltage. The reason for this roundabout method of checking is to avoid a complex AC circuit that functions no better than this one.

Calibration

To calibrate the expanded-scale voltmeter requires a variable AC voltage source and a way to measure it. The most convenient variable AC source comes from a adjustable-voltage autotransformer (known also as a *Variac*) if you can borrow one. Figure 3 shows how to connect this transformer. The AC meter across the *Variac* output can be any accurate VOM, VTVM, DMM, etc.

First, set the transformer to put out 120 volts (or the normal voltage in your area) and adjust the potentiometer until the expanded-scale voltmeter reads about three-quarters full-scale. Do not change the potentiometer after making this adjustment. Mark "120" on the face of the scale right under the needle of your expanded-scale voltmeter.

Next, change the variable-voltage transformer to another voltage and mark that on your new meter. Continue changing and marking until there are as many gradations as you will need. Now your expanded-scale voltmeter is ready to connect to the power line.

Substitute variable-voltage supply

Here are a couple of ways to perform the calibration if you can't locate a variable-voltage transformer. One method requires an old model-train transformer (from back in the days when these trains

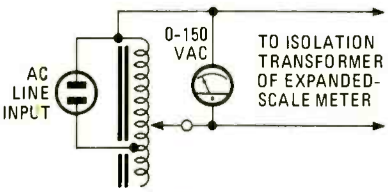


FIG. 3

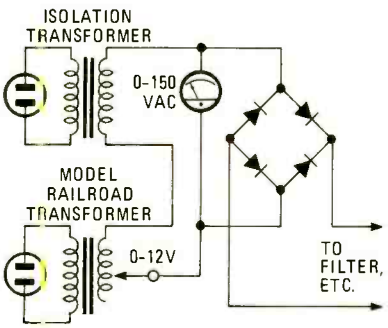


FIG. 4

ran on AC). Connect the secondary in series with the secondary of the isolation transformer (see Fig. 4).

The variable AC output (usually from 0 to 12 volts or 16 volts) will *either* add to *or* subtract from the output of the isolation transformer. Perform the calibration up or down (as needed) and then switch the output leads of the train transformer. This will cause the total output to vary in the other direction and you can complete the calibration. (Incidentally, that train transformer is a handy item to have around the workbench.)

You can also use several filament transformers, although this is a less convenient method. Connect them as shown in Fig. 5

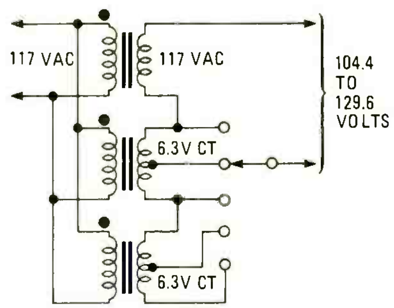


FIG. 5

to obtain various fixed points on the scale. Reversing one or more secondaries will provide additional points. Assuming you have a 117-volt AC line, the combination shown in Fig. 5 will yield outputs of 104.4, 107.55, 110.7, 117, 120.15, 123.3, 126.45 and 129.6 volts. [For voltages below 117, you must reverse the phase (connections) to the primary winding of the 117-volt isolation transformer.] Of course, other filament voltages will yield other results.

The Zener diode

The useful range of your expanded-scale voltmeter will depend upon both the exact voltage of the Zener diode and the internal resistance of the meter. In my setup, a 145-volt Zener produces a range of 95 volts to 125 volts. Of course, the top and bottom readings also vary with how the calibration potentiometer is set; for example, I can easily change mine to read from 105 volts to 135 volts.

You can actually tailor your expanded-scale voltmeter to your specific needs. Lowering the Zener voltage by 5 volts or 10 volts expands the *range* (compresses the scale—the gradations are closer together). Using a Zener with a higher voltage rating causes just the opposite effect (it expands the scale more), but if the Zener voltage exceeds the DC voltage applied, the meter will not register.

It is easy to adjust the Zener voltage in the circuit. When Zener diodes are placed in series, their voltages add (just like resistors). So, five 30-volt diodes in series act just like a 150-volt unit. Thus, you can place smaller Zener diodes of assorted values in series to obtain any value you need. **R-E**

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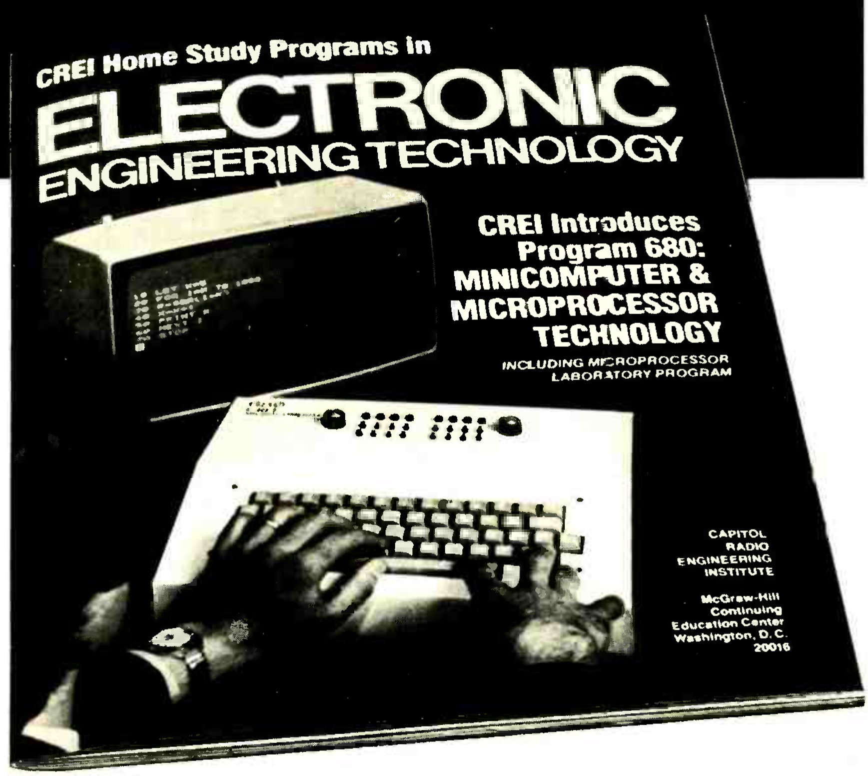

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state of solid state

An in-depth look at a temperature transducer and precision voltage reference all on one IC. Plus a look at some new developments.

KARL SAVON, SEMICONDUCTOR EDITOR

CONTAINED WITHIN THE DATA SHEET FOR the REF-02 +5-volt precision voltage reference are the terms, *regulator* and *thermometer*. The REF-02 is a bandgap reference that uses the predictable temperature characteristics of silicon-diffused junctions to create a stable voltage. It does not use a constant-starting point such as a Zener, but much the opposite. It takes the temperature-variable junctions of two silicon transistors and sets them against each other to produce a near-zero temperature coefficient.

There is also a temperature-dependent output available at a terminal on the package. An accurate thermometer can be constructed by combining the reference and temperature-dependent outputs in an external operational amplifier. The thermometer can be calibrated directly in degrees Fahrenheit, Celsius or Kelvin, and can have a linear scale factor that can be adjusted by choosing different resistor values. Typical scale factors are from 10 mV/°C to 100 mV/°C. Measuring the output voltage on a digital voltmeter then gives direct temperature readings.

The thermometer has another unique feature. It can be calibrated accurately at a single temperature, which can be room temperature. Although it requires an accurate 100-mV source as part of the calibration procedure, repeated adjustments at two known temperatures, such as the boiling and freezing points of water, do not have to be made.

The REF-02 circuit is shown in Fig. 1. The circuit does not have many inputs and outputs and fits easily in an eight-pin TO-99 case. Included are an input terminal for the power supply; an output for the precisely regulated voltage; a terminal marked TEMP, which is the temperature-dependent voltage; a trim terminal, and ground (three terminals are not connected).

You could not tell from a cursory glance that the heart of the circuit is just two transistors. Transistors Q1 and Q2 have been proportioned in current and area so that the current density in Q1 is one-sixteenth of the current density in Q2. The emitter area of Q1 is four times that of Q2, which means if both transistors carried identical currents, the current density in Q1 would be one-fourth that of Q2. In addition, collector resistors R3 and R4 scale the currents in Q1 and Q2 in the ratio of 1:4. The product of the two factors gives a 16:1 current-density ratio.

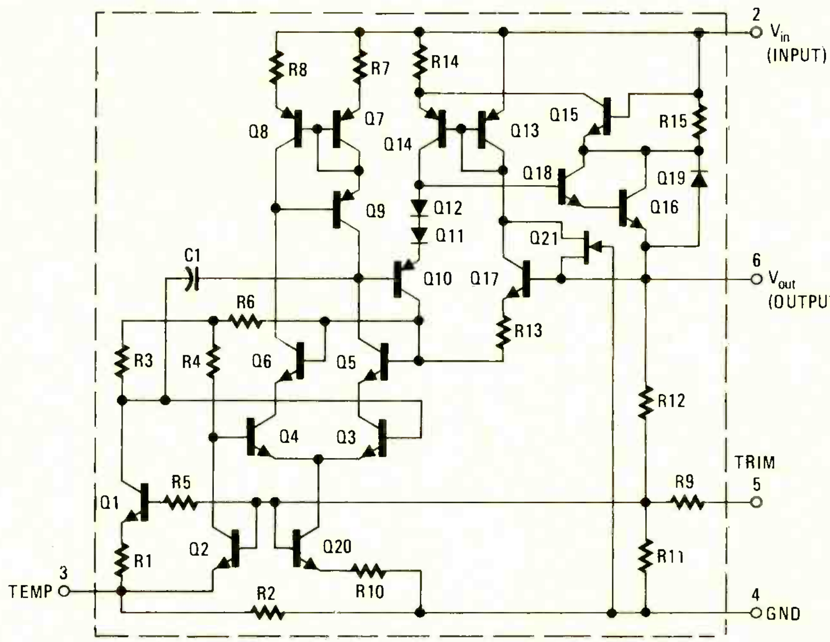


FIG. 1

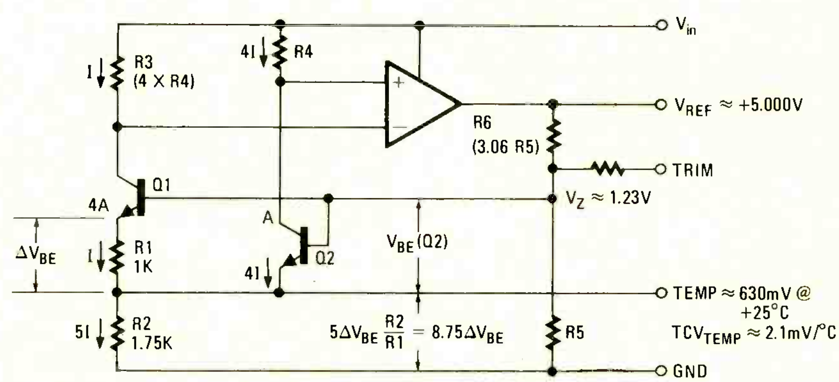


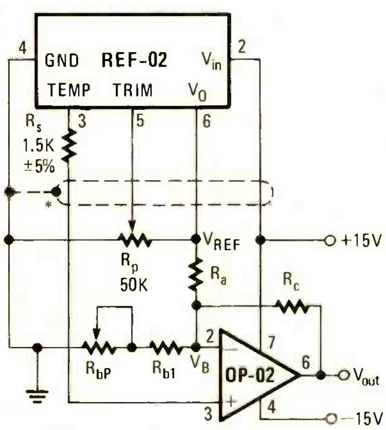
FIG. 2

The diode equation relates the base-to-emitter voltage of a diode or transistor to its temperature and current. One form of the diode equation is $V_{be} = kT/q \ln I_c/I_s$. Here's a good opportunity to exercise the natural logarithm function on that gift scientific calculator!

First with respect to the constants, k is Boltzmann's constant, which is a physical constant equal to 1.3804×10^{-23} joule/°K, and T is the absolute temperature of the junction in degrees Kelvin. Celsius temperatures are converted to Kelvin by adding 273. Kelvin and Celsius degrees represent identical temperature increments, but −273°C or 0°K is known as absolute zero. The q term is the charge on an electron equal to 1.6021×10^{-19} coulomb, I_c is the diode or transistor collector current, and I_s is the saturation current.

At first, it might seem that the voltage across a silicon junction increases directly as temperature because of term T at the beginning of the equation. However, the saturation current is itself highly dependent on temperature, and, in fact, the temperature coefficient of the junction is negative. The coefficient is in the order of -2.1 mV/°C, with its precise value determined by the manufacturing process.

Even though the equation appears to show that V_{be} would be zero at 0 degrees Kelvin, the temperature-dependent I_s-term decreases toward zero at a rapid rate. If absolute zero is approached as a limit, the 1.23-volt bandgap voltage of silicon results. Another approach is to take the -2.1mV/°C coefficient and determine what happens at absolute zero. The junction voltage would be the room-temperature voltage, or around 0.6 volt, plus the increase that results from the 293 (273 + 25)-degree drop in temperature, or $298 \times 2.1 \times 10^{-3} = 0.628$ volt. The bandgap voltage is therefore about 1.23 volts. It turns out that if this voltage is generated by adding two terms by the method described in following paragraphs, a zero coefficient voltage is theoretically produced.



*UP TO 10 FEET OF SHIELDED 4-CONDUCTOR CABLE.

FIG. 3

The diode equation becomes very interesting when you compare the voltage across two diode junctions with different current densities. Recall that when you take the difference between the logarithms of two numbers, the result is the same as the logarithm of the ratio between the numbers: Ln A − Ln B = Ln A/B. Substitute numbers for A and B and verify it on your calculator. If the voltage between two junctions is calculated by subtraction, the equation now looks very much the same as before, except that the Ln term operates on the ratio of the current densities in the two junctions: $\Delta V_{be} = kT/q$ in J_1/J_2. You may have seen this expression before to describe the input to a differential amplifier that produces specific currents in the two input transistors. The kT/q term at room temperature calculates to about 26 mV. To double the current in a transistor, it takes 26 Ln 2, or about 18 mV. A significant change in the equation is that because it was created by subtracting two equations with I_s-terms, *the temperature-variable saturation current has dropped out*. Now, the temperature coefficient is entirely due to the T-term in the numerator and has a positive sign.

In summary, the temperature variation of a single transistor junction has a negative temperature coefficient, while the difference in voltage between two semiconductor junctions with different current densities has a positive temperature coefficient.

In Fig. 2, the components associated with the internal operational amplifier function are replaced with an amplifier symbol, but essential feedback and gain determining resistors are retained.

As mentioned previously, the current density in Q1 and Q2 are in the ratio of 16:1. We can now calculate the differential voltage between the base-emitter junctions from the diode equation. The current in Q1 and Q2 is maintained in a 4:1 ratio by the 4:1 ratio of the collector resistors. Negative feedback around the operational amplifier requires that the input voltage at the inverting and noninverting inputs be identical; so the current through R3 in the Q2 collector must be four times as great as the current through R3 in the Q1 collector.

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service clinic

Pulse-width modulated DC power supplies and how to troubleshoot them.

JACK DARR, SERVICE EDITOR

WE'RE CONTINUALLY DISCOVERING NEW uses for known circuits. Pulse-width modulation (PWM) has been around for some time. Actually, the basic principle has been used for DC voltage regulation in TV sets. If I'm not mistaken, Sony's *model KV-1722* was the first chassis to use a PWM circuit.

The basis of a PWM circuit is a controllable switch, to which a DC voltage supply (rectified and filtered) is fed from the AC line. This switch is normally off. Sony uses a gate-controlled switch (GCS) that behaves similar to a silicon controlled rectifier, but it can be turned on or off by control pulses to create a series of pulses; you'd probably call this circuit a chopper. Figure 1 is the block diagram of a basic PWM circuit.

GCS on or off. The error amplifier controls the *pulse width* of the modulator. In the Sony circuit, this is a monostable multivibrator. If the output voltage goes down, the pulses become wider; when the output voltage goes up, the pulses grow narrower.

If the output pulse becomes narrower, there is less *total energy* in it. A smaller amount of energy is sent to the filter capacitors, their charge decreases, and the output voltage goes back down to normal. A wider pulse sends more charge into the capacitors, with the result that the voltage goes up to normal. Remember, this all takes place within a *very short period of time*, the regulation action is almost instantaneous. Figure 2 shows the difference between the normal

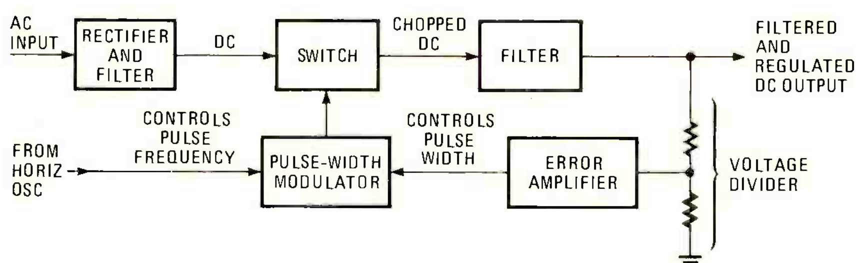

FIG. 1

Let's see how this circuit behaves. As you should know, the DC output voltage of a power supply is developed from the *charge* in the filter capacitors. All that the power supply does is recharge the capacitors at regular intervals, when the load current discharges them. Therefore, there's a given amount of charge (energy) in the capacitors, and the voltage will remain fairly constant under normal current drain. In the PWM circuit, the chopped DC power supply simply feeds in pulses containing just enough energy to recharge the capacitors and hold the voltage constant.

Now, if the load current increases, more energy is being taken out than is being fed in and the output voltage drops. If the current decreases, less energy is removed and the voltage goes up. In either case, an error amplifier senses the *change* in load voltage. This stage controls the action of a switching-pulse generator. This is the stage that turns the

pulse with a 30% duty cycle (as used in the Sony circuit), a 10% duty cycle and a 50% duty cycle. Note that all duty cycles have the same *peak voltage*. Therefore, the amount of *power* that is fed to the capacitors depends entirely upon the duty cycle of the switch.

In most circuits, this switching action occurs at the horizontal frequency, and is controlled by pulses fed back from the horizontal oscillator or the flyback. The *frequency* of the monostable multivibrator is controlled by these pulses, and the *duty cycle* is controlled by the value of the DC output voltage, through the error amplifier. (There's a key point in here, which we'll deal with later; just remember it.)

The main reason for using this type of power supply is its increased efficiency—it uses less power than the older type of regulator. The PWM regulator can be designed for greater efficiency. The reason for this greater efficiency is the fact

that the GCS is actually off most of the time. With the 30% duty cycle, the GCS is off 70% of the time! This greatly reduces the power that is dissipated by the GCS.

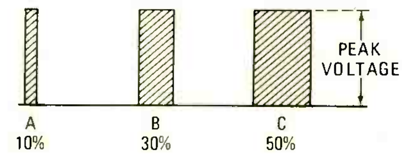

FIG. 2

There are other advantages, some of which have been used before in a different way. First, the basic ripple frequency isn't 60 Hz–120 Hz, but 15,750 Hz. The DC voltage is gated at the horizontal frequency. So, filter capacitors and chokes can be made smaller for the same filtering efficiency. However, both capacitors and chokes must be able to handle a fairly high ripple current at high frequencies. Only low-loss capacitors can be used in order to withstand the dielectric heating. Chokes must be high-Q types and able to withstand heavy RF current. So, do not use stock electrolytic capacitors or chokes for replacements.

This is the same problem we've been experiencing on flyback-derived DC voltage supplies. Stock sinewave diodes don't work well because they draw too much reverse current with a spike pulse. Only the fast-recovery diodes operate properly. The correct diodes, transistors and capacitors must be used, or "the cure will be worse than the disease."

Servicing these power supplies requires even more extensive use of the scope than in the old type of power supplies. You must use the scope to trace the control pulses through their circuits, and make sure they go to the right place, with the correct *waveform*! On a recent TV I found a nice squarewave where the schematic called for a sharp sawtooth waveform. Eventually, I found that two small capacitors contained in the sawtooth-*shaper* circuitry were open. Replacing them brought back the sawtooth waveforms and normal operation of the power supply. These are just some more circuits where "the VOM isn't enough!"

Although PWM circuits look fairly complex at first, they aren't really. Each stage has a definite *function*, and if you check each stage methodically to make sure they are doing their job properly, it

continued on page 78

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STATE OF SOLID STATE

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The differential voltage between the two emitter junctions appears across R1 and is 26 Ln 16, or 72 mV. A positive temperature coefficient of 2.1 mV/°C is produced by amplifying 72 mV by a factor of 8.75 up to 0.63 volt.

The current through R2 is the sum of I and 4I or 5I, already an amplification of five times the current through R1. Resistors R2 and R1 are in the ratio of 1.75K to 1K. The total gain is $(4 + 1) \times 1.75 = 8.75$. Then, to determine the constant reference, just add the junction voltage of a silicon transistor with its negative 2.1-mV coefficient. The base-emitter junction of Q2 increases the voltage across R2 by the required junction potential to the constant 1.23-volt bandgap voltage. To get the rest of the way up to the 5-volt output of the REF-02 at the base of Q1 and Q2, the voltage is amplified by the ratio of R6 and R5, at which point V_{REF} is $1.23 \times (3.06 + 1) = 1.23 \times 4.06 = 5$ volts.

Now, combine the constant output and the variable temperature coefficient output of the REF-02 to construct the thermometer (see Fig. 3). The REF-02 acts as the temperature sensor and may be located remotely by using a shielded cable with the additional precaution of reducing the capacitance loading pin 3 by isolating resistor R_s.

The TEMP output is directly connected to the noninverting op-amp input, and a portion of V_{REF} is summed with a portion of the amplifier output at the inverting op-amp input. As usual, the feedback amplifier forces the inverting and noninverting inputs to be essentially equal. Thus, it is possible to solve the conditions relating the output voltage to the two inputs. An output must be created that can be controlled in temperature coefficient by using a portion of V_{TEMP}, and that can be shifted in DC value by using a portion of V_{REF}.

Since the inverting input must equal V_{TEMP}, the sum of the contributions to the inverting input voltage on pin 2 of the op-amp from V_{OUT} and V_{REF} must also be equal to V_{TEMP}. Superposition is the method used. First, assume V_{OUT} is zero by shorting it to ground and calculate what part of V_{REF} gets to pin 2. At this point, R_b, the sum of the fixed resistor R_{bl} and the variable resistor R_{bp} are in parallel with R_c; V_{REF} is therefore divided by the ratio $(R_b||R_c)/(R_a + R_b||R_c)$.

Similarly, with V_{REF} shorted to ground, the portion of V_{OUT} transferred to pin 2 is $(R_a||R_b)/(R_c + R_a||R_b)$.

Working out the equation for V_{OUT} yields the expression: $V_{OUT} = AV_{TEMP} + BV_{REF}$; where A is equal to $1 + (R_c/R_a||R_b)$ and B is equal to R_c/R_a.

It is also known that V_{TEMP} follows the relationship, $0.632 + 2.1 \times 10^{-3}(T - 25)$, where T is in degrees Celsius. If, for example, you want to calibrate the thermometer to read degrees Celsius directly, and need a scale factor of 0.01 so that 0 degrees produces a 0-volt output and −55 degrees Celsius produces a −0.55-volt output, plug these two temperatures into the above equation and solve for the respective values of V_{TEMP}. You now have two values of V_{TEMP}, you know what V_{OUT} should be at those temperatures and you know that V_{REF} is 5.000V. Now plug these into the equation for V_{OUT} and solve for A and B. For these numbers, you get $A = 4.762$ and $B = 0.47$. If you put these numbers back into the equation for V_{OUT}, the result is $V_{OUT} = 0.01\ T$.

The final accuracy of the circuit depends on the op-amp and the version of the REF-02 reference used. It varies from 0.5% with the REF-02A and OP-02A to 0.9% with the REF-02C and OP-02C. The first combination works over the −55° to +125°C range and has a temperature error of under 0.625 degree at the high limit. The second combination, designed for operation from 0° to 70°C, calculates to a similar maximum temperature error of 0.63 degree. Deviations in the linear characteristic are also specified by linearity and offset errors. Offset error can be eliminated by using

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SERVICE CLINIC

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won't take long to find the cause of the problem. Here's one general-purpose hint: If the entire power supply seems to be out, although the DC input voltage from the rectifiers is normal, look around the *horizontal oscillator* stages. You will see that the entire operation of this circuit depends on the presence of horizontal pulses at the input of the PWM modulator stage. Most of these stages have what is called a starter circuit. This feeds a small pulse of DC voltage to the horizontal oscillator to get it started. Once the oscillator starts, the output stage begins and the normal DC power supply starts up. Remember, this all takes place practically instantly. All the oscillator needs is a starting boost. However, if the horizontal oscillator transistor is bad, or there are faults in the oscillator that make it run off-frequency, you can use external DC power supplies to troubleshoot if necessary. **R-E**

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Next month's issue of **Radio-Electronics** will tell you how to build a digital capacitance meter and also how to repair antique radios. Plus much, much more!

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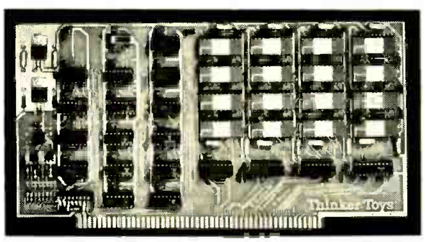

uses the S-100 bus's natural timing and monitors the microprocessor's machine states using T4 states for refresh. Completely assembled, tested and warranted *Econoram III 8K × 8* sells for $149.—**Thinker Toys,** 1201 10th St., Berkeley, CA 94710.

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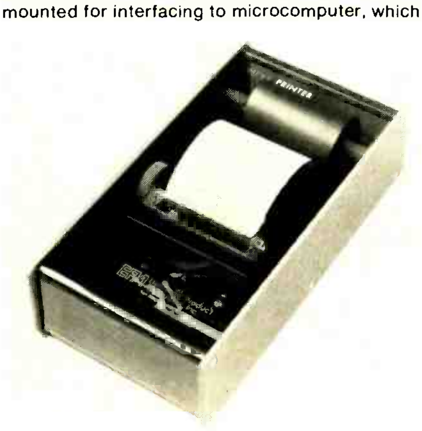
MINIPRINTER, *model MP-44*, is a 5- × 7-dot matrix printer for use with any microcomputer using TTL logic levels. It makes permanent copies on electrosensitive paper at speeds up to 88 characters-per-second, 44 characters-per-line. Both printer and paper supply are board-mounted for interfacing to microcomputer, which



then uses an 8-bit parallel output port to control motor and print. Software can be easily implemented in any computer language, and examples of assembly-language coding for the 6800 and 8080 microprocessors are provided. Coding for the 6800 allows unit to be operated immediately from the *model Micro-80* I/O bus. Price: $257.—**Electronic Product Associates, Inc.,** 1157 Vega St., San Diego, CA 92110.

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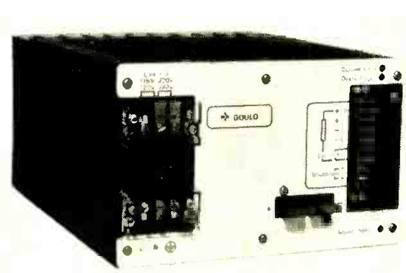

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CIRCLE 107 ON FREE INFORMATION CARD

CRYSTAL-LESS SCANNER, *Bearcat 250*, provides 50-channel monitoring and automatic search, store and recall capabilities. Solid-state circuitry includes non-volatile memory and allows pushbutton frequency programming in five bands: low and high VHF, UHF, "T" band and ham frequencies between 146 MHz and 148 MHz. Other features include a digital clock, priority channel, count feature that displays the number of times any frequency has been received, selective scan- and search-speed control, lockout (to remove unwanted frequencies during scan and search); antenna, external antenna jack and crystal filter. Front-mounted speaker has bright LED

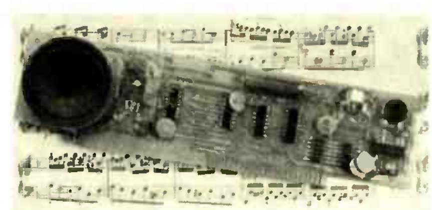
display and comes with mounting bracket. Price: $399.95.—**Electra Co.**, Div. Masco Corp. of Indiana, 300 E. County Line Rd. So., Cumberland, IN 46229.

CIRCLE 108 ON FREE INFORMATION CARD

COLOR-BAR GENERATOR, *model LCG-396*, provides signals for TV alignment and performance tests as well as patterns for adjusting VTR, MATV and CATV systems. Pushbutton on/off control of chroma and luminance. Both fixed and variable output levels are provided. The unit can generate 8 precision color bars as well as dot, crosshatch, center-line single crosshatch and four color rasters. Also featured are a composite video output, two RF channels, scope trigger output and full protection against ambient temperatures. The *model LCG-396* sells for $899.95.—**Leader Instruments Corp.**, 151 Dupont St., Plainview, NY 11803.

CIRCLE 109 ON FREE INFORMATION CARD

S-100 BUS-COMPATIBLE MUSIC BOARD, *model 6*, generates music, sound effects, Morse code, touch-tone synthesis and more. Fully assembled unit features selectable output port address decoding, latched 6-bit D/A converter, audio amplifier, speaker, volume control and phono jack for connection to home audio system. Glass-epoxy PC board has plated-through holes, gold-plated fingers and high-quality components. User's manual (provided with the *model 6*) contains BASIC and 8080 assembly language programs. The *model 6* Music Board is available through computer stores and costs $59.95.—**Newtech Computer Systems, Inc.**, 131 Joralemon St., Brooklyn, NY 11201.



CIRCLE 110 ON FREE INFORMATION CARD

PROGRAMMABLE CLOCKS, *model 3300S, model 3300H*, are designed for auto, marine and aircraft-navigation applications, and come in two time-display formats: Hour/minute/second (*model 3300S*) and hour/minute/.01 minute (*model 3300H*). Both models contain the following features: 6-digit LED display; advance-retard control for fine adjustment of timebase frequency; a countdown timer that counts to zero and back up; auxiliary timer for use as a stopwatch; alarm; and split and remote/split run. Options include a rechargeable NiCad battery pack; a multiple timebase for timing in hour/minute/.01 minute, minute/second/.01 second, or minute/.001 minute; a periodic interval timer to sound beeper at selected intervals; an external alarm jack; and an AC adapter.

Specifications include: accuracy—.001% crystal-controlled, or better than 0.01 minute-per-day; operating temperature—32°F; power re-

quirements—11.0–14.5 VDC, 0.05–0.5 amp. Clock measures 2¼ × 7¼ × 6¾ inches, and weighs 2½ lbs. Prices: *models 3300S* and *3300H*, $329. Options: NiCad battery pack, $30; multiple timebase (*model 3300H* only) $15; periodic interval timer, $15; external alarm jack, $15; AC adapter, $20.—**Custom Control Systems,** 21 E. Canon Perdido St., Santa Barbara, CA 93101.

CIRCLE 111 ON FREE INFORMATION CARD

CB BASE STATION, *model D201A*, is an SSB/AM unit that features tube circuitry and a selectable crystal-controlled or fully tunable receiver; a 4-watt AM output; and a 12-watt PEP SSB output. Controls include an S/RF power/SWR meter; mike gain; RF gain; squelch; clarifier; switchable noise blanker and limiter; and *model Astatic GPD104* mike. Specifications: adjacent

channel rejection, 8 dB+; SSB sensitivity, .1 μV; AM sensitivity, .35 μV. Unit measures 21½ W × 7½ H × 13 inches D. Suggested list price, $995.—**TRAM/Diamond-Corp.,** Box 187, Lower Bay Rd., Winnisquam, NH 03289.

CIRCLE 112 ON FREE INFORMATION CARD

MOBILE TRANSCEIVER, *model PTR-130K*, is a miniaturized unit that provides 100-Hz resolution from 100 kHz to 30 MHz in all modes; frequencies are pushbutton-selectable. The 100-Hz frequency synthesizer contains an RF compressor that increases output by 12 dB, plus cascaded mechanical filters for high-quality selectivity. Unit

measures 6½ × 2½ × 8 inches. Estimated retail price, $650—$700.—**Palomar Electronics Corp.,** 665 Opper St., Escondido, CA 92025.

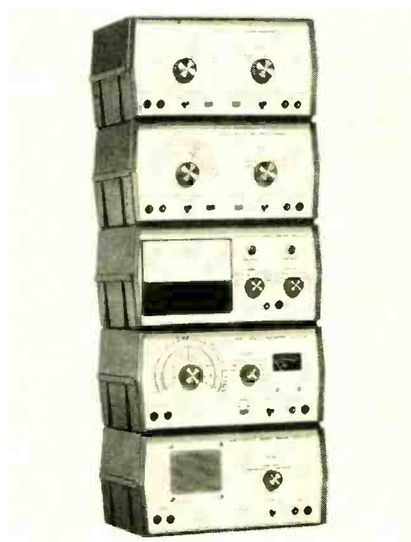
CIRCLE 113 ON FREE INFORMATION CARD

DATA CASSETTES, *Series CDC-1, CDC-2, CDC-3* and *Series DDC-20, DDC-40, DDC-60*, are designed specially for use in hobby and small-business computers. *Series CDC* cassettes come loaded in one-, two- and three-minute lengths and use high-quality computer shells, polyolefin slip sheets, machined guide rollers, stainless steel pins, oversized pressure pads and hubs, and extra-short leaders. The *Series DDC* line of cassettes are loaded with high-density calendared ferric-oxide tape, ideal for most computer applications. Suggested retail prices: *Series CDC*, $4.95—$6.35; *Series DDC*, $4.50—

$5.50.—**Avdex Corp.,** 2280 Grand Ave., Baldwin, NY 11510.

CIRCLE 115 ON FREE INFORMATION CARD

TEST INSTRUMENT KITS, *Series 5280*, comprise a test bench "primer" for electronics beginners. The *model IT-5283* Signal Tracer provides AF/RF tracing; acts as an audible voltohmmeter; reads resistance from 0 to 5 megohms; and can serve as substitute speaker for radio/TV servicing. The *model IM-5284* Multimeter measures AC/DC voltage to 1000 volts, DC current to 1000 mA, and provides 4 impedance ranges to 100 megohms. The *model IG-5280* RF Oscillator has an RF output from 310 kHz to 110 MHz and harmonics can be read to 220 MHz. The *model IG-5282* Audio Generator has sinewave and squarewave output capability and a switchable range from 10 Hz to 100 kHz. The *model IB-5281* RCL Bridge provides separate resistance, inductance and capacitance ranges.

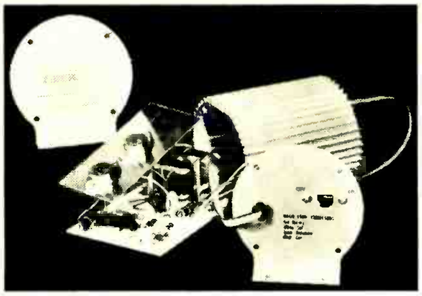


Each unit operates from two 9-volt batteries (plus one C-cell for the *model IM-5284*), or from the *model IPA-5280-1* power supply, which has 5 outputs for simultaneous operation of the instruments. Kits are priced at $37.95 each; the *model IPA-5280-1* power supply costs $24.95. Free catalog available.—**Heath Co.,** Dept. 350-500, Benton Harbor, MI 49022.

CIRCLE 50 ON FREE INFORMATION CARD

BROCHURE describes new General Electric GAP (Guaranteed Active Parts) program for service technicians to order replacement TV parts by phone. Contains map of U.S. with listing of toll-free "800" numbers. Master Charge or BankAmericard/Visa can be used to order parts. Parts obsolescence is eliminated with the GAP program—GAP parts may be returned for full credit if they do not remain active. All requests for the brochure must be made on company letterhead.—**General Electric,** Room 1102, 45 E. 17th St., New York, NY 10003.

CIRCLE 117 ON FREE INFORMATION CARD



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Includes everything except case. 2-PC boards. 6-.50" LED Displays. 5314 clock chip, transformer, all components and full instrucs. Green and orange displays also avail. **Same kit w/.80" displays. $21.95**

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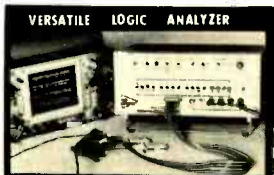

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18 pin	.63	.58	.54	.47	.42	.36
20 pin	.80	.75	.70	.63	.58	.53
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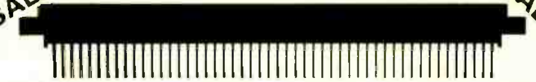

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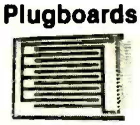

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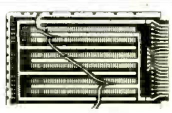

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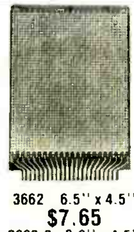

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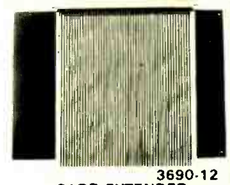

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1/16 Vector BOARD
.042 dia holes on 0.1 spacing for IC's

Phenolic

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169P44	4.5x17"	$4.30	3.87
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Sockets are End & Side stackable, closed entry

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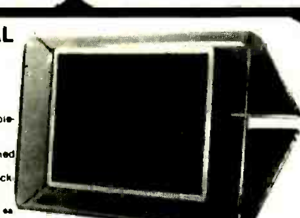

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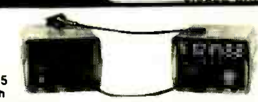

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for .042 dia. holes
(all boards on this page)
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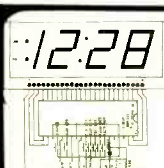
P-149 hand installing tool ...... $ 2.03



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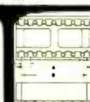

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.042 dia. holes
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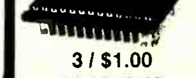

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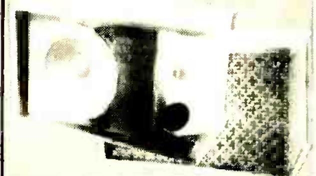

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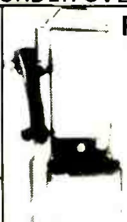

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4007 –	.18	4019 –	.37	4030 –	.33	4071 –	.18
4009 –	.37	4020 –	.90	4035 –	97	4076 –	.97
4010 –	37	4021 –	90	4042 –	.65	4518 –	1.00
4011 –	.18	4022 –	.90	4046 –	1.35	74C10	.22
4012 –	18	4023 –	.18	4047 –	1.50	74C193	.95
4013 –	.29	4024 –	.75	4049 –	.34		
4015 –	.74	4025 –	.18	4050 –	.34		

2708-8K EPROM (450 ns) . . . . $ 9.75
2522 STATIC SHIFT RE6 . . . . $ 1.95
2513 CHARACTER GEN . . . . $ 6.75
2518 HEX 32 BIT SR . . . . $ 2.20
2102-1 (450ns) . . . . $ .99
21LO2-1 (450ns) . . . . $ 1.25
MM5270-4KXI DYN . . . . $ 3.45
MK 4008P . . . . $ 1.95
2101-1-254 x 4 STATIC . . . . $ 2.45
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2114 4K STATIC RAM (450ns) . . . . $ 8.50
5280/2107B 4K DYNAMIC RAM . . . . $ 4.25
TMS 4050L . . . . $ 3.95
5204-4K PROM . . . . $ 4.95
82523 . . . . $ 1.95
AY-5-1013 UART . . . . $ 4.95
8703C TELEDYNE 3 STAGE BINARY 8 BIT A/D CONVERTER $13.50
8080A . . . . $ 9.50

AP BOARDS USED FOR SOLDERLESS BREADBOARDING

264L — 128 FIVE-TIE POINT TERMINALS $12.50
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TC-14 — $4.50   TC-16 — $4.75

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CTS-206-4 four position dip switch $1.45
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2¼" diameter .4V at 500 ma $4.00

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DL-704-.3" C.C. $ .75
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4-1/2"x6-1/2" SINGLE SIDED EPOXY BOARD 1/16" thick, unetched
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2N2646 UJT $ .45
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CCD 202C 100x100 Image Sensor $145.00

VERIPAX PC BOARD $4.00
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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MC6860 MODEM CHIP $9.95
MCM 6571A 7 x 9 character gen $10.75

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PRV	1A	3A	12A	50A	125A	240A
100	06	14	.30	.80	3.70	5.00
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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DB 25S female $3.50

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723 . . . . $ .50
LM 376 . . . . $ 60
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320T-5, 1 or 24V . . . . $ .95
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340T-5, 6, 8, 12 15,18 or 24V $ 95
78 MG $1.35
79 MG $1.35

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2N6233-NPN SWITCHING POWER $ 1.95
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2N1546 PNP GE TO-3 . . . . $ .75
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2N3906 PNP Si TO 92 5/$ 1.00
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2N6109 PNP Si TO-220 $ .55
2N3638 PNP Si TO 5 5/$ 1.00
MPSA 13 NPN Si. . . . . 4/$ 1.00

TTL IC SERIES

7400–	.13	7445–	.65	74151–	.61
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	7490–	.42	74177–	.75
7416–	.22	7491–	.58	74180–	.65
7417–	.25	7492–	.43	74181–	1.90
7420–	.13	7493–	.43	74190–	1.00
7425–	.25	7494–	.67	74191–	1.00
7426–	.22	7495–	.65	74192–	.79
7427–	.19	7496–	.65	74193–	.79
7430–	.13	74107–	28	74194–	.80
7432–	.22	74121–	.29	75325–	1.50
7437–	.21	74122–	.38	74196–	.86
7438–	.21	74123–	.45	74279–	.55
7440–	13	74125–	.40	74367–	.65
7441–	.70	74126–	.40	75491–	.50
7442–	.37	74150–	.94	75492–	.50

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MSD 206 P-DPDT CENTER OFF LEVER SWITCH $ 1.85

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PRV	2A	6A	25A
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200	.75	1.25	2.00
400	.95	1.50	3.00
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8 PIN .17 24 PIN .35
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16 PIN .22 40 PIN .60
18 PIN .25

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68UF	35V	5 $1.00	22UF	25V	$ 40
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4.7UF	15V	5/$1.00	68 UF	15V	$ .50

74LS SERIES

74LS00 –	20	74LS132 –	70
74LS02 –	21	74LS138 –	70
74LS03 –	21	74LS139 –	70
74LS04 –	.23	74LS151 –	65
74LS05 –	24	74LS153 –	65
74LS08 –	23	74LS155 –	82
74LS09 –	23	74LS156 –	62
74LS10 –	20	74LS157 –	62
74LS11 –	20	74LS160 –	80
74LS13 –	40	74LS161 –	80
74LS14 –	80	74LS162 –	80
74LS15 –	.25	74LS163 –	80
74LS20 –	22	74LS168 –	80
74LS21 –	22	74LS169 –	80
74LS22 –	22	74LS170 –	1 50
74LS26 –	30	74LS173 –	1 00
74LS27 –	25	74LS174 –	75
74LS28 –	32	74LS175 –	75
74LS30 –	21	74LS181 –	2 00
74LS32 –	32	74LS190 –	90
74LS37 –	30	74LS191 –	90
74LS38 –	30	74LS192 –	90
74LS40 –	25	74LS193 –	90
74LS42 –	60	74LS195 –	50
74LS47 –	73	74LS196 –	75
74LS51 –	25	74LS197 –	75
74LS54 –	25	74LS221 –	1 00
74LS73 –	35	74LS257 –	70
74LS74 –	35	74LS258 –	70
74LS75 –	50	74LS265 –	25
74LS76 –	35	74LS279 –	50
74LS85 –	1 00	74LS290 –	60
74LS86 –	35	74LS293 –	80
74LS90 –	50	74LS365 –	52
74LS92 –	60	74LS366 –	52
74LS93 –	50	74LS367 –	.52
74LS109 –	.35	74LS368 –	52
74LS112 –	35	74LS375 –	60
74LS113 –	35	74LS386 –	35
74LS114 –	35	74LS390 –	1 50
74LS125 –	45	74LS670 –	2 00
74LS126 –	45		

LINEAR CIRCUITS

LM 101 –	.75
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 –	1.1[illegible]
LM 377 –	1.60
LM 380 –	.9[illegible]
LM 381 –	1.2[illegible]
LM 382 –	1.25
LM 537 –	2.50
LM 553 –	2 50
LM 555 –	.39
LM 556 –	.85
NE540L –	2.25
560 –	2.0
565 –	[illegible]
566 –	1.10
567 –	1.10
703 –	.90
709 –	.25
710 –	.35
741C or V –	.25
747 –	.50
LM 1310 –	2.[illegible]
1456 –	[illegible]
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	2.2[illegible]
600	1.70	2.30	3.60		1.50	3.0[illegible]

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±0.1 PPM TCXO

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This new instrument has taken a giant step in front of the multitude of counters now available. The Opto-8000.1 boasts a combination of features and specifications not found in units costing several times its price. Accuracy of ±0.1 PPM or better — *Guaranteed* — with a factory-adjusted, sealed TCXO (Temperature Compensated Xtal Oscillator). **Even kits require no adjustment for guaranteed accuracy!** Built-in, selectable-step attenuator, rugged and attractive, black anodized aluminum case (.090" thick aluminum) with tilt bail. 50 Ohm and 1 Megohm inputs, both with amplifier circuits for super sensitivity and both diode/overload protected. Front panel includes "Lead Zero Blanking Control" and a gate period indicator LED. AC and DC power cords with plugs included.

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SPECIFICATIONS:
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Resolution—1 Hz to 60 MHz; 10 Hz to 600 MHz
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All IC's socketed (kits and factory-wired)
Display—8 digit LED
Gate Times—1 second and 1/10 second
Selectable Input Attenuation—X1, X10, X100
Input Connectors Type —BNC
Approximate Size—3"h x 7½"w x 6½"d
Approximate Weight—2½ pounds
Cabinet—black anodized aluminum (.090" thickness)
Input Power—9-15 VDC, 115 VAC 50/60 Hz
  or internal batteries
OPTO-8000.1 Factory Wired **$299.95**
OPTO-8000.1K Kit **$249.95**

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FC-50 — Opto-8000.1 (w/TCXO)		**Kit $109.95**
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2SA497	1.44	2SC517	3.60	2SC1239	3.50	2SD188	2.70
2SA634	1.00	2SC634A	.60	2SC1306	3.50	2SD234	.85
2SA636	1.25	2SC710	.49	2SC1307	4.75	2SD235	.85
2SA673	.70	2SC711	.49	2SC1377	4.80	2SD313	1.05
2SA678	.65	2SC735	.49	2SC1383	.50	2SD314	1.50
2SA682	1.49	2SC756A	2.40	2SC1448	1.00	2SD315	1.20
2SA683	.60	2SC778	3.50	2SC1449	.85	2SD358	1.10
2SA699	1.30	2SC781	2.50	2SC1678	2.00	2SD360	1.05
2SA699A	1.45	2SC789	1.00	2SC1728	1.85	2SD427	2.55
2SA733	.49	2SC798	3.95	2SC1760	1.60	2SD525	1.50
2SA777	.99	2SC799	3.25	2SC1816	3.50	2SK19	1.25
2SB54	.49	2SC1000	.49	2SC1908	.49	2SK30A	.75
2SB56	.95	2SC1013	.95	2SC1909	3.75	2SK33	.90
2SB186	.49	2SC1014	.95	2SC1957	1.00	2SK55	1.00
2SB187	.55	2SC1017	1.20	2SC1973	.90		
2SB324	.60	2SC1018	1.00	2SC1975	3.50	3SK22Y	2.20
2SB370	.65	2SC1061	1.25	2SC2028	.80	3SK40	2.00
2SB405	.60	2SC1079	3.95	2SC2029	3.40	3SK45	2.20
2SB415	.65	2SC1096	.80	2SC2091	2.50	3SK49	2.20
2SB461	1.60	2SC1098	1.00	2SC2092	3.25		
2SB463	1.40	2SC1115	3.00				
2SB507	1.40	2SC1170B	4.95	2SD72	.80	4004	3.00
2SC371	.49	2SC1172	5.25	2SD77	1.50	4005	3.00
2SC372	.49	2SC1173	.75	2SD88	4.80	40081	1.50
2SC481	1.50	2SC1209	.75	2SD118	3.00	40082	3.00

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AN136	2.90	LA4400FS	3.40	TA7055P	3.00	UPC20C	3.75
AN214	3.35	LA4400FR	3.40	TA7060P	1.40	UPC41C	2.80
AN239	6.50	LD3120	2.40	TA7061P	1.50	UPC563H2	8.00
AN241	2.40	M5115PR	7.80	TA7063P	1.50	UPC566H	1.25
AN315	3.50	PLL01A	13.50	TA7075P	3.75	UPC575C	2.60
BA511	3.00	PLL02A	8.50	TA7089P	2.90	UPC595C	2.95
BA521	3.40	PLL02A-G	8.50	TA7120P	1.50	UPC1001H2	3.50
HA1202	2.20	SG613	6.75	TA7150P	3.75	UPC1008C	5.75
HA1306	4.90	STK011	7.50	TA7153P	6.90	UPC1020H	3.25
HA1308	4.50	STK015	6.50	TA7203P	4.25	UPC1025H	3.50
HA1322	4.20	STK032	14.20	TA7204P	3.70	UPC1166H	4.50
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7400	.18	7442	1.08	74107	.49
7401	.21	7448	1.15	74121	.55
7402	.21	7450	.26	74122	.49
7404	.21	7451	.27	74123	1.05
7405	.24	7453	.27	74125	.60
7407	.45	7454	.41	74126	.81
7408	.25	7460	.22	74132	3.00
7409	.25	7472	.39	74141	1.15
7410	.20	7473	.45	74150	1.10
7411	.30	7474	.45	74151	1.25
7413	.85	7475	.80	74153	1.35
7416	.43	7482	1.75	74154	1.54
7417	.43	7483	1.15	74157	1.30
7420	.21	7485	1.12	74161	1.45
7422	1.50	7486	.45	74164	1.65
7425	.43	7489	2.49	74165	1.65
7427	.37	7490	.69	74166	1.70
7428	.35	7491	1.20	74174	1.95
7430	.26	7492	.82	74175	1.95
7432	.31	7493	.82	74180	1.05
7437	.47	7494	.91	74181	3.55
7438	.40	7495	.91	74191	1.50
7440	.21	7496	.91	74195	1.00
7441	1.10	74100	1.25	74197	1.00

OEM SPECIALS

1N34	.25	2N2905A	.30	2N3903	.16
1N60	.25	2N2906	.25	2N3904	.16
		2N2906A	.30	2N3905	.16
1N270	.25	2N2907	.25	2N3906	.16
1N914	.10	2N2907A	.30	2N3954A	3.75
2N173	1.75	2N2913	.75	2N3955	2.45
2N404	.75	2N2914	1.20	2N3957	1.25
2N443	2.50	2N3019	1.00	2N3958	1.20
2N508A	.45	2N3053	.30	2N4037	.60
2N718	.25	2N3054	.70	2N4093	.85
2N930	.25	2N3055	.75	2N4124	.16
2N956	.30	2N3227	1.00	2N4126	.16
2N1302	1.25	2N3247	3.40	2N4141	.20
2N1305	.75	2N3250	.50	2N4142	.20
2N1540	.90	2N3393	.20	2N4143	.20
2N1544	.80	2N3394	.17	2N4220A	.45
2N1560	2.80	2N3414	.17	2N4234	.95
2N1605	1.75	2N3415	.18	2N4400	.16
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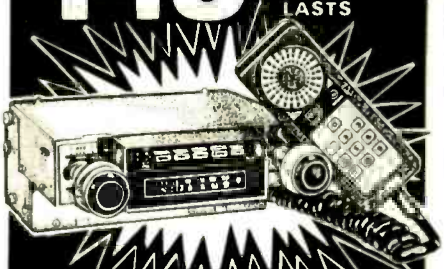

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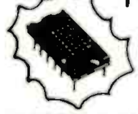

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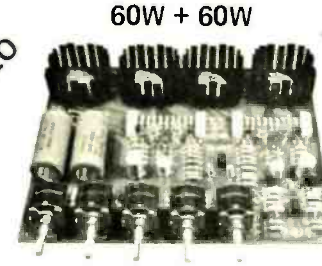

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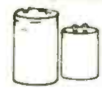

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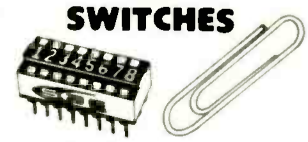

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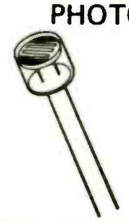

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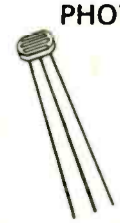

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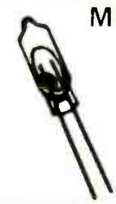

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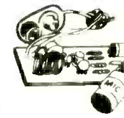
Kit includes: STK-015 Hybrid IC, power supply with power transformer, front Amp with tone control, all electronic parts as well as PC Board. Less than 0.5% harmonic distortion at full power ½dB response from 20—100,000 Hz. This amplifier has QUASI—Complimentary class B output. Output max is watt (10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

ONLY $23.50 each

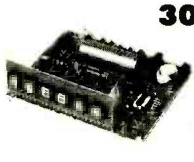
FM WIRELESS MIC KIT



$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

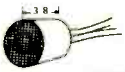
Only ~~$59.50~~ $53.50

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

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 all 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

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!

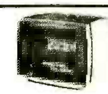
ONLY $5.50 PER KIT

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.

ONLY ~~$28.50~~ ea. SALE! $24.50

HEAVY DUTY CLIP LEADS

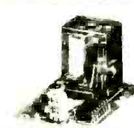
10 pairs — 5 colors
Alligator clips on a 22" long lead. Ideal for any testing.

$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.

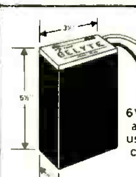
Super Buy Only $22.50 each kit

NEW! 4 KIT EASY-TO-BUILD LED PROJECTS ON ONE BOARD

- HO-Guage railroad crossing blinker
- Variable LED flasher
- Six-bit binary counter
- Wheel of fortune

Kit includes all electronic components and PC Board
Especially designed for experimenters
Guaranteed — they all work!!
(Battery not included)
$12.50 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.

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

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

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

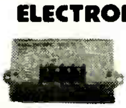
PANEL METER (D.C. Type)

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
Voltage Supply 6～12V $7.50

AU—999

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
- ABCDEF
- Homekey
- ←→Key

SPECIAL $10.50 ea.

2¼" ROUND SPEAKER

8Ω 0.25W
for most sound projects

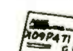
SPECIAL 3 for $2.00

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
3 for $2.00

Low Cost Hexadecimal 16 Key Pad

Designed for Calculator
Can be used for Computer Data Entry Pad or Digital Lock
All key tops blank with super good touch feeling $0.95 each

BIPOLAR LED

Jumbo Size red/green change color when reverse polarity of voltage. Ideal for go/nogo indicator.

Two for $1.50

WIDE ANGLE PANEL METER

1¾" x ¾"
IMA 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

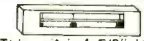
for auto ignition, entry door, burglar alarm, etc.
$6.50 ea. 4 Digits Programmable to Any Combination
CMOS I.C. IN CIRCUIT

400A 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

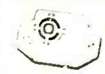
HOUR INDICATOR



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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Slide Switch Smooth action, 4-pole, triple throw. J-5100 80¢

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1N4148 Diode Miniature glass type high speed switching diode. Case AA. J-1002 12 for $1.00

Connector connector w/ unique teflon/solder interconnect peice. J-7100 15/$1.00

Transformer 8V @ 500 ma or 12V @ 190ma. W/ specs. J-5005 $1.50

Wire Special 22 ga. magnet wire w/ solder-through insulation. Appx. 500'. J-7003 $2.50

Mini Cap .005 uf. 500 WVDC 7 for $1.00

Jumbo LED .200" factory prime LED's for experimenters. J4004 5 for $1.

LED Panel Clip Black plastic clip for mounting LED in panels. J-4002 12/$1.

28 Pin Socket Standard, solder-type, low profile 28 pin IC socket. J-7101 40¢

PC Board glass-epoxy PC board blanks. .062" thick.
- 4 x 6 (J-8016) 5 for $3.00
- 3 x 6 (J-8017) 5 for $2.25
- 6 x 6 (J-8018) 5 for $3.60
- 2 x 8 (J-8019) 5 for $2.00

Trimmer Cap 1-3pf miniature PC trimmer cap for crystal circuits, etc. J-3000 75¢

2N3055 Popular audio-type power transistor. J-1001 65¢

Terminal Post Ceramic insulated terminal post, 3/4" 10 for $1.00

Reed Relay Sensitive 12 VDC reed relay, DPST, 1½" long, with P–C leads. J-5047 $1.50

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.5Ω Resistor Wire Wound 1 Watt 25¢

PC Trimmer 20 turn miniature PC mount trimmer pot. 3/4" long, 5K ohm. J-2013 $1.10

BNC Connector 3/8" female BNC type sheilded connector with jacketed 6" leads. J-7102 $1.00

Rubber Edging Black Flexiable Rubber J-8008 10'/$1.60 100'/$12.00

Transformer Unique split primary allows two outputs., 9 or 18 volts at 1.5 amps. W/ specs & data. J-5012 $2.50

PC Board Spacers 1/4" long, 1/8" inside diameter. 20/$1.00

RO170 Diode The famous RO-170 general replacement diode, rated 1000 piv at 2.5 amps. J-1000 20¢ 100 for $14.50

Component Holder component holder for mounting capacitors, power resistors, wire bundles, etc 10 for 50¢

Automotive 2" to 2½" steel screwdriver adjustable **Hose Clamp** J-4 45¢ — **Lamp Socket** Standard automotive type, double contact 75¢

PC Trimmer Pot 3/8" square, top adjustable, screwdriver slotted, single turn 20K ohm @ 1 2 watt Standard PC leads. 90¢

Potentiometer Miniature 1/8" shaft, 1/4" mount potentiometer. 100 ohm value. J-2100 70¢

PC Trimmer Pot Horizontal type, 1K-ohm PC trimmer. J-2101 25¢

POWER RESISTORS 12 WATT 5% DALE 15Ω OHMITE 125Ω each 79¢ *Free Display Bd. W/ Any 20.00 Order

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Trimmer New, CTS miniature screwdriver adjustable. 25K ohm. 4 for $1.00

Heat Shrink Much easier and faster than electrical tape. Twelve 6" peices, ass'td. J-7004 $1.45

MORE NEW ITEMS!

JUMBO LED READOUT ARRAY
By Bowmar. .5 in. character common cathode. Designed for use with multiplexed clock chips 4 digits in 1 pack!
$1.95 LIMITED STOCK

NATIONAL SEMICONDUCTOR JUMBO CLOCK MODULE
MA1008A BRAND NEW!

$6.95 2 FOR $13 (AC XFMR $1.95)

FEATURES:
- FOUR JUMBO ½ INCH LED DISPLAYS
- 12 HR REAL TIME FORMAT
- 24 HR ALARM SIGNAL OUTPUT
- 50 OR 60 Hz OPERATION
- LED BRIGHTNESS CONTROL
- POWER FAILURE INDICATOR
- SLEEP & SNOOZE TIMERS
- DIRECT LED DRIVE (LOW RFI)
- COMES WITH FULL DATA

ASSEMBLED! NOT A KIT!

ZULU VERSION! We have a limited number of the 24 HR Real time version of this module in stock. #MA1008D — $9.95

PERFECT FOR USE WITH A TIMEBASE.

COMPARE AT UP TO TWICE OUR PRICE!

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SPDT. By RAYTHEON. MADE IN USA! WITH HDWR.
99¢ EACH **6 FOR $5**

MOTOROLA 4K RAM's — 99¢ EACH (WITH DATA)
A major U.S. computer mfg. removed these parts from PC boards, then retested them to full specs. Best Memory Buy in the U.S.A.! 4096 x 1 Bits. One of the easiest Dynamic RAM's to use. A complete memory board design using these chips is detailed in the MOTOROLA M6800 APPLICATIONS MANUAL starting on page 4-70. The 6605 is the popular 22 Pin Dip.
8 FOR $6.95 (4096 WORDS OF RAM!) **SURPLUS BUY OF THE DECADE!** MCM6605 470 NS GUARANTEED!

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262. 144KHZ. This frequency is 2 to the 18th power. Easily divided down to any power of 2, and even to 1HZ. New by CTS-Knight. A $5 value!
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You Get: 1—7490; 1—7475; 1—7447; 1—Led Readout. All this for **$1.99** (Led Readout is famous SLA-1. .33 in. By Opcoa.)

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.5 Inch Char. High Efficiency! FND-503-Common Cathode FND-510-Common Anode
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.1 MFD 16V. P.C. leads. Most popular value! By Sprague.
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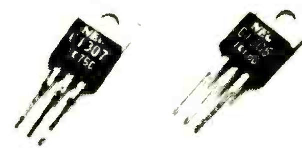

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2SB 54	.59
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2SB 173	.45
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2SB 178	.70
2SB 186	.45
2SB 187	.45
2SB 202	1.60
2SB 220	.70
2SB 303	.59
2SB 324	.70
2SB 337	1.60
2SB 346	.70
2SB 367	1.50
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
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2SB 507	1.60
2SB 509	1.60
2SB 511	1.10
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2SB 527	1.60
2SB 528D	1.60
2SB 529	.90
2SB 530	4.40
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2SB 536	1.60
2SB 537	1.60
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2SB 596	1.60
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2SC

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2SC 184	.59
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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
2SC 684	1.10
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
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2SC 1885	.70
2SC 1908	.59
2SC 1909	3.90
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2SC 2028	.90
2SC 2029	3.90
2SC 2074	1.90
2SC 2076	.59
2SC 2091	2.80
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2SD 142	2.00
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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
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2SD 224	1.90
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2SD 227	.45
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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
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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
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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
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3SK 37	3.00
3SK 39	2.25
3SK 40	2.25
3SK 41	2.50
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MK 10	2.00

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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
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LA 3301	3.00
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M53393	7.60
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STK 015	6.60
STK 016	8.50
STK 022	11.00
STK 032	14.00
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STK 439	11.00
STK 502	8.80
STK 503	9.60
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TA 7064P	1.90
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TA 7075P	4.90
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TA 7108P	1.90
TA 7109P	3.40
TA 7120P	1.90
TA 7122AP	1.90
TA 7124P	1.60
TA 7129P	1.90
TA 7130P	2.80
TA 7136P	1.30
TA 7146P	4.20
TA 7150P	4.40
TA 7159P	2.50
TA 7200P	4.60
TA 7201P	4.60
TA 7203P	3.70
TA 7204P	3.40
TA 7205P	2.90
TA 7310P	3.95
TA 78005M	5.80
TA 78005P	5.80
TA 78012M	6.60
TA 78012P	5.80
TA 78015M	6.50
TA 78015P	5.80
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TC 5081P	3.40
TC 5082	3.90
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UHIC 004	5.80
UHIC 005	5.80
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UPC 563	3.70
UPC 566H	1.60
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UPC 577H	2.25
UPC 592HZ	1.60
UPC 1001H	4.90
UPC 1008C	7.00
UPC 1016C	3.00
UPC 1020H	3.70
UPC 1025	3.40
UPC 1026C	3.70
UPC 1032	2.25
UPC 1152H	3.40
UPC 1156	3.00
UPD 858C	9.50
PLL 01A	8.80
PLL 02A	8.80
SN 7400	.19
SN 7490	.60

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IS 1007	.45
IS 1209	.45
IS 1211	.45
IS 1555	.25
IS 1588	.25
IS 1885	.25
IS 2076	.25
IS 2093	.45
IS 2473	.25
IN 34	.25
IN 60	.25
10D1	.40
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VO 6B	.40
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CIRCLE 2 ON FREE INFORMATION CARD

STATE OF SOLID STATE

continued from page 77

one REF-02 as the sensor and a second one operated at constant temperature to generate V_{REF}.

The calibration procedure begins by measuring V_{TEMP} and the ambient centigrade temperature corresponding to that V_{TEMP} reading. A calibration ratio, r, is calculated from $V_{TEMP}/S(T + 273)$, which equals $R_a||R_b/(R_c + R_a||R_b)$. The numbers in the previous example are $T = 25°C$, $S = 10\ mV/°C$ and $V_{TEMP} = 632\ mV$, so that $r = 0.2121$. Precisely 100 mV is applied to V_{OUT} with the power off and V_{REF} shorted to ground. Variable resistor R_{bp} is adjusted so that $V_B = r \times 100\ mV$ or 21.21 mV. Now the power is turned on and R_p is adjusted so that V_{OUT} equals 0.25 volt. For this procedure the voltmeter used to measure the temperature is convenient for setting up the 100-mV calibration source.

The thermometer is discussed in detail in "Application Note AN-18," Precision Monolithics, Incorporated, 1500 Space Park Drive, Santa Clara, CA 95050.

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.

The MC6802 is available in a plastic package in quantities of 25 for $22 each. 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**

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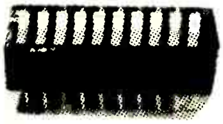

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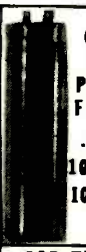

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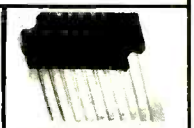

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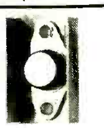

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Single pole normally open dry reed relay. Unbelievable sensitivity,1800 ohm coil with 3 volt pull-in (that's less than 3 ma.) A TTL gate will drive many of these. A CMOS buffer will directly actuate this nifty relay.... MFG. unknown, but I was told they came from IBM. 600 available

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12 vdc 440 Ω coil 4 dpst n.o.

PICTURE IS APPROXIMATION, RELAY HAS FOUR PINS ON ONE END AND TWO ON OTHER. PINS ARE SPACED .1" X 1". 1/2A CONTACTS.

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Type KHP Relay
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650 ohms
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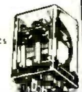

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74C14	1.75
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7403	.17
7404	.19
7406	.40
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7409	.25
7410	.18
7413	.78
7414	.68
7417	.38
7420	.18
7421	.35
7427	.35
7430	.15
7432	.30
7437	.44
7440	.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
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74121	.35
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74141	1.15
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74155	.75
74157	1.00
74161	1.00
74163	1.30
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8836	1.25
8837	2.45
8838	2.45
8859	1.50
8865	1.50
8866	1.50
8867	1.85
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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 44 ON FREE INFORMATION CARD

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 SK 10 $16.50

2.2" x 6.5"

INCLUDING:
Over 100 pieces of precut wire in assorted lengths — free!
Choose 1 color: Red, Black, Blue, Yellow, Green, White, Orange Or Assortment.

PAGE DIGITAL ELECTRONICS
135 E. Chestnut Street 4A
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 20 ON FREE INFORMATION CARD

7400 TTL

SN7400N	.16			SN74160N	.89
SN7401N	.18	SN7472N	.29	SN74161N	.89
SN7402N	.18	SN7473N	.35	SN74162N	1.95
SN7403N	.18	SN7474N	.35	SN74163N	.89
SN7404N	.18	SN7475N	.49	SN74164N	.89
SN7405N	.20	SN7476N	.35	SN74165N	.89
SN7406N	.29	SN7479N	5.00	SN74166N	1.25
SN7407N	.29	SN7480N	.50	SN74167N	1.95
SN7408N	.20	SN7482N	.99	SN74170N	1.59
SN7409N	.20	SN7483N	.59	SN74172N	6.00
SN7410N	.18	SN7485N	.79	SN74173N	1.25
SN7411N	.25	SN7486N	.35	SN74174N	.89
SN7412N	.25	SN7489N	1.75	SN74175N	.79
SN7413N	.40	SN7490N	.45	SN74176N	.79
SN7414N	.70	SN7491N	.59	SN74177N	.79
SN7416N	.25	SN7492N	.43	SN74179N	1.95
SN7417N	.25	SN7493N	.43	SN74180N	.79
SN7420N	.20	SN7494N	.65	SN74181N	1.95
SN7421N	.29	SN7495N	.65	SN74182N	.79
SN7422N	.39	SN7496N	.65	SN74184N	1.95
SN7423N	.25	SN7497N	3.00	SN74185N	1.95
SN7425N	.29	SN74100N	.89	SN74186N	9.95
SN7426N	.29	SN74107N	.35	SN74188N	3.95
SN7427N	.25	SN74109N	.59	SN74190N	1.25
SN7429N	.39	SN74116N	1.95	SN74191N	1.25
SN7430N	.20	SN74121N	.35	SN74192N	.79
SN7432N	.25	SN74122N	.39	SN74193N	.79
SN7437N	.25	SN74123N	.49	SN74194N	.89
SN7438N	.25	SN74125N	.49	SN74195N	.69
SN7439N	.25	SN74126N	.49	SN74196N	.89
SN7440N	.20	SN74132N	.75	SN74197N	.89
SN7441N	.89	SN74136N	.75	SN74198N	1.49
SN7442N	.49	SN74141N	.79	SN74199N	1.49
SN7443N	.75	SN74142N	2.95	SN74200N	5.59
SN7444N	.75	SN74143N	2.95	SN74251N	1.79
SN7445N	.75	SN74144N	2.95	SN74279N	.79
SN7446N	.69	SN74145N	.79	SN74283N	2.25
SN7447N	.59	SN74147N	1.95	SN74284N	3.95
SN7448N	.79	SN74148N	1.29	SN74285N	3.95
SN7450N	.20	SN74150N	.89	SN74366N	.69
SN7451N	.20	SN74151N	.59	SN74367N	.69
SN7453N	.20	SN74153N	.59	SN74368N	.69
SN7454N	.20	SN74154N	.99	SN74390N	1.95
SN7459A	.25	SN74155N	.79	SN74393N	1.95
SN7460N	.20	SN74156N	.79		
SN7470N	.29	SN74157N	.65		

C/MOS

CD4000	.23			CD4070	.55
CD4001	.23			CD4071	.23
CD4002	.23	CD4028	.89	CD4072	.49
CD4006	1.19	CD4029	1.19	CD4076	1.39
CD4007	.25	CD4030	.49	CD4081	.23
CD4009	.49	CD4035	.99	CD4082	.23
CD4010	.49	CD4040	1.19	CD4093	.99
CD4011	.23	CD4041	1.25	CD4098	2.49
CD4012	.25	CD4042	.99	MC14409	14.95
CD4013	.39	CD4043	.89	MC14410	14.95
CD4014	1.39	CD4044	.89	MC14411	14.95
CD4015	1.19	CD4046	1.79	MC14419	4.95
CD4016	.49	CD4047	2.50	MC14433	19.95
CD4017	1.19	CD4048	1.35	MC14506	.75
CD4018	.99	CD4049	.49	MC14507	.99
CD4019	.49	CD4050	.49	MC14562	14.50
CD4020	1.19	CD4051	1.19	MC14583	3.50
CD4021	1.39	CD4053	1.19	CD4508	3.95
CD4022	1.19	CD4056	2.95	CD4510	1.39
CD4023	.23	CD4059	9.95	CD4511	1.29
CD4024	.79	CD4060	1.49	CD4515	2.95
CD4025	.23	CD4066	.79	CD4518	1.29
CD4026	2.25	CD4068	.39	CD4520	1.29
CD4027	.69	CD4069	.45	CD4566	2.25

74C00

74C00	.39			74C163	3.00
74C02	.55			74C164	3.25
74C04	.75	74C89	6.49	74C173	2.60
74C08	.75	74C90	3.00	74C192	3.49
74C10	.65	74C93	2.00	74C193	2.75
74C14	3.00	74C95	2.00	74C195	2.75
74C20	.65	74C107	1.25	74C922	9.95
74C30	.65	74C151	2.90	74C923	8.95
74C42	2.15	74C154	3.00	74C925	14.95
74C48	4.75	74C157	2.15	74C926	11.95
74C73	1.50	74C160	3.25	80C95	1.50
74C74	1.15	74C161	3.25	80C97	1.50

LINEAR

78MG	1.75			LM733N	1.00
LM300H	.80			LM739N	1.19
LM301H	.35			LM741CH	.35
LM301CN	.35			LM741CN	.35
LM302H	.75	LM340T-8	1.25	LM741-14N	.39
LM304H	1.00	LM340T-12	1.25	LM747H	.79
LM305H	.60	LM340T-15	1.25	LM747N	.79
LM307CN/H	.35	LM340T-18	1.25	LM748H	.39
LM308H	1.00	LM340T-24	1.25	LM748N	.39
LM308CN	1.00	LM350N	1.00	LM1303N	.90
LM309H	1.10	LM351CN	.65	LM1304N	1.19
LM309K	1.25	LM370N	1.15	LM1305N	1.40
LM310CN	1.15	LM373N	3.25	LM1307N	.85
LM311H	.90	LM377N	4.00	LM1310N	2.95
LM311N	.90	LM380N	1.25	LM1351N	1.65
LM317K	6.50	LM380CN	.99	LM1414N	1.75
LM318CN	1.50	LM381N	1.79	LM1458CN/H	.59
LM319N	1.30	LM382N	1.79	MC1488	1.95
LM320K-5	1.35	NE501N	8.00	MC1489	1.95
LM320K-5.2	1.35	NE510A	6.00	LM1496N	.95
LM320K-12	1.35	NE529A	4.95	LM1556V	1.75
LM320K-15	1.35	NE531H	3.00	MC1741SCP	3.00
LM320K-18	1.35	NE536T	6.00	LM2901N	2.95
LM320K-24	1.35	NE540L	6.00	LM3053	1.50
LM320T-5	1.25	NE550N	1.30	LM3065N	.69
LM320T-5.2	1.25	NE555V	.39	LM3900N(3401)	.49
LM320T-8	1.25	NE556	.99	LM3905N	.89
LM320T-12	1.25	NE560B	5.00	LM3909	1.25
LM320T-15	1.25	NE561B	5.00	MC5558V	1.00
LM320T-18	1.25	NE562B	5.00	LM7525N	.90
LM320T-24	1.25	NE565H	1.75	LM7534N	.75
LM323K-5	5.95	NE565N	1.25	8038B	4.95
LM324N	1.80	NE566CN	1.75	LM75450	.49
LM339N	.99	NE567H	1.25	75451CN	.39
LM340K-5	1.35	NE567V	.99	75452CN	.39
LM340K-6	1.35	NE570	10.50	75453CN	.39
LM340K-8	1.35	LM703CN/H	.45	75454CN	.39
LM340K-12	1.35	LM709H	.29	75491CN	.79
LM340K-15	1.35	LM709N	.29	75492CN	.89
LM340K-18	1.35	LM710N	.79	75494CN	.89
LM340K-24	1.35	LM711N	.39	RC4151	5.95
LM340T-5	1.25	LM723H	.55	RC4194	5.95
LM340T-6	1.25	LM723N	.55	RC4195	4.49

74LS00 TTL

74LS00	.23			74LS139	.69
74LS01	.23			74LS151	.69
74LS02	.23	74LS51	.23	74LS155	.69
74LS03	.23	74LS54	.23	74LS157	.69
74LS04	.29	74LS55	.23	74LS160	.89
74LS05	.29	74LS73	.35	74LS161	.89
74LS08	.29	74LS74	.35	74LS162	.89
74LS09	.29	74LS75	.49	74LS163	.89
74LS10	.29	74LS76	.35	74LS164	.99
74LS13	.49	74LS83	.75	74LS175	.79
74LS14	.99	74LS85	.99	74LS181	2.49
74LS15	.29	74LS86	.35	74LS190	.89
74LS20	.23	74LS90	.49	74LS191	.89
74LS21	.29	74LS92	.59	74LS192	.89
74LS22	.29	74LS93	.59	74LS193	.89
74LS26	.29	74LS95	.79	74LS194	.89
74LS27	.29	74LS96	.89	74LS195	.89
74LS28	.29	74LS107	.35	74LS253	.79
74LS30	.23	74LS109	.35	74LS257	.69
74LS32	.29	74LS112	.35	74LS260	.55
74LS37	.35	74LS123	.99	74LS279	.59
74LS40	.29	74LS132	.79	74LS367	.59
74LS42	.69	74LS136	.39	74LS368	.59
74LS47	.69	74LS138	.69	74LS670	1.95

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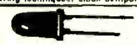
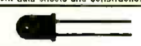
DISCRETE LEDS





.125" dia.			.190" dia.		
XC209	Red	5/$1	XC111	Red	5/$1
XC209	Green	4/$1	XC111	Green	4/$1
XC209	Orange	4/$1	XC111	Yellow	4/$1
XC209	Yellow	4/$1	XC111	Orange	4/$1

.200" dia.			.185" dia.			.200" dia.			.085" dia.		
						XC556	Red	5/$1	MV50	Red	6/$1
XC22	Red	5/$1	XC526	Red	5/$1	XC556	Red	100/$8	.170" dia.		
XC22	Green	4/$1	XC526	Red	100/$8	XC556	Green	4/$1	MV10	Red	4/$1
XC22	Yellow	4/$1	XC526	Green	4/$1	XC556	Yellow	4/$1	INFRA RED LED		
XC22	Orange	4/$1	XC526	Yellow	4/$1	XC556	Orange	4/$1	¼ x ¼ x 1 16		
SSL-22	RT	4/$1	XC526	Clear	4/$1	XC556	Clear	7/$1	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	1.25	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

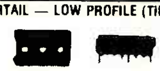
FCM3817	$5.00
MM5725	2.95
MM5736	1.95
MM5738	2.95
DM8864	2.00
DM8865	1.00
DM8887	.75
DM8889	.75
5030	7.95

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 driver 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)

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

SOLDERTAIL STANDARD (GOLD)

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin SG	$.30	.27	.24	24 pin SG	$.70	.63	.57
14 pin SG	.35	.32	.29	28 pin SG	1.10	1.00	.90
16 pin SG	.38	.35	.32	36 pin SG	1.75	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

	1-24	25-49	50-100		1-24	25-49	50-100
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	1.56	1.40

50 PCS. RESISTOR ASSORTMENTS $1.75 PER ASST.

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

Spec Sheets – 25¢
1978A Catalog Available–Send 35¢ stamp

NEW NAME

Jameco ELECTRONICS

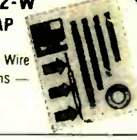
a division of JAMES ELECTRONICS of California

PHONE ORDERS WELCOME (415) 592-8097

MAIL ORDER ELECTRONICS – WORLDWIDE
1021 HOWARD AVENUE, SAN CARLOS, CA 94070
Advertised Prices Good Thru August

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	XR1489	1.39	XR2556	$3.20
XR210	4.40	XR1800	3.20	XR2567	2.99
XR215	4.40	XR2206	4.40	XR3403	1.25
XR320	1.55	XR2207	3.85	XR4136	1.25
XR555	.39	XR2208	5.20	XR4151	2.85
XR556	.99	XR2209	1.75	XR4194	1.45
XR567CP	.99	XR2211	5.25	XR4202	3.60
XR567CT	1.25	XR2212	4.35	XR4212	2.05
XR1310P	1.30	XR2240	3.45	XR4558	.75
XR1468CN	3.85	XR2264	4.25	XR4739	1.15
XR1488	1.39			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

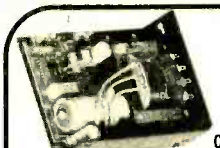
+20% DIPPED TANTALUMS (SOLID) CAPACITORS

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

CIRCLE 45 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

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

	1-9	10+
BES-1	1.39 ea.	1.20

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
63P(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
43P(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

M-530-1 — $1.95/100 pins (minimum order) — $16.00/1000 pins

Pre-packaged in strips

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	16K	EPROM	59.95
5301-1	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**

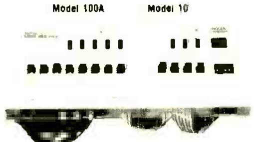
MISCELLANEOUS

11C90	$19.95	MK40240	$17.50
MC3061P	11.95	DS0026CH	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		

PARATRONICS

Logic Analyzer Kit Model 100A

$229.00/kit



- Analyzes any type of digital system
- Checks data rates in excess of 8 million words per second
- Trouble shoot TTL, CMOS, DTL, RTL, Schottky and MOS families
- Displays 16 logic states up to 8 digits wide
- See ones and zeros displayed on your CRT, octal or hexadecimal format
- Tests circuits under actual operating conditions
- Easy to assemble — comes with step-by-step construction manual which includes 80 pages on logic analyzer operation.

(Model 100A Manual - $4.95)

- Some applications are
  — Troubleshooting microprocessor address, instruction, and data flow
  — Examine contents of ROMS
  — Tracing operation of control logic
  — Checking counter and shift register operation
  — Monitoring I/O sequences
  — Verifying proper system operations during testing

PARATRONICS TRIGGER EXPANDER - Model 10

Adds 16 additional bits. Provides digital delay and qualification of input clock and 24-bit trigger word. — Connects direct to Model 100A for integrated unit).

Model 10 Kit - $229.00
Baseplate — $9.95
Model 10 Manual — $4.95

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 — 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

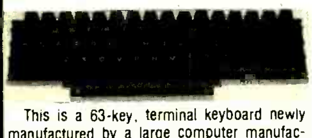
MAX-100 $134.95

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 applica-tion. 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

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$129.95 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 deal. 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

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- 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
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- Uses 3 Penlite Cells

Kit — $39.95
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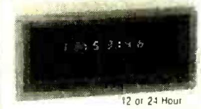
- New Bipolar Unit
- Auto Zeroing
- .5" LED
- Auto Polarity
- Low Power
- Single IC Unit

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.

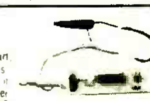
12 or 24 Hour

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

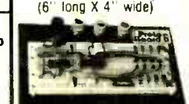
printed circuit board

T²L 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

PROTO BOARD 6
$15.95
(6" long X 4" wide)



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PB103 - 9" x 6"	59.95
PB104 - 9.5" x 8"	79.95
PB203 - 9.75 x 6½ x 2¾	80.00
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(includes power supply)

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14 PIN	$4.50
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☐ 40	3-ft.	1.98	6-ft.	1.99

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☐ 1702A	256 x 8 EPROM	4.95	4.96

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☐ SN7401	.19	.20	☐ SN7464	.19	.20	☐ SN74141	1.79	1.80
☐ SN7403	.25	.26	☐ SN7465	.19	.20	☐ SN74145	.69	.70
☐ SN7404	.19	.20	☐ SN7470	.19	.20	☐ SN74151	1.29	1.30
☐ SN7405	.19	.20	☐ SN7471	.35	.36	☐ SN74153	1.29	1.30
☐ SN7406	.19	.20	☐ SN7472	.19	.20	☐ SN74154	1.75	1.76
☐ SN7407	.39	.40	☐ SN7473	.59	.60	☐ SN74155	.79	.80
☐ SN7409	.39	.40	☐ SN7474	.59	.60	☐ SN74156	.39	.40
☐ SN7410	.25	.26	☐ SN7475	.69	.70	☐ SN74157	.99	1.00
☐ SN7411	.79	.80	☐ SN7476	.79	.80	☐ SN74158	.99	1.00
☐ SN7413	1.19	1.20	☐ SN7480	.19	.20	☐ SN74161	1.25	1.26
☐ SN7416	.35	.36	☐ SN7482	.29	.30	☐ SN74163	1.39	1.40
☐ SN7417	.35	.36	☐ SN7483	.99	1.00	☐ SN74164	.79	.80
☐ SN7420	.32	.33	☐ SN7486	.49	.50	☐ SN74165	.99	1.00
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☐ SN7423	.29	.30	☐ SN7489	3.49	3.50	☐ SN74173	.99	1.00
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☐ SN7430	.29	.30	☐ SN7491	1.29	1.30	☐ SN74175	.99	1.00
☐ SN7432	.45	.46	☐ SN7492	.79	.80	☐ SN74177	.79	.80
☐ SN7437	.19	.20	☐ SN7493	.69	.70	☐ SN74179	1.99	2.00
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☐ SN7440	.19	.20	☐ SN7495	.59	.60	☐ SN74182	.49	.50
☐ SN7443	.59	.60	☐ SN7496	.29	.30	☐ SN74190	1.99	2.00
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☐ SN7447	1.25	1.26	☐ SN74107	.29	.30	☐ SN74193	.99	1.00
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☐ SN7450	.19	.20	☐ SN74114	.25	.26	☐ SN74197	.75	.76
☐ SN7451	.19	.20	☐ SN74121	.59	.60	☐ SN74199	1.50	1.51
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☐ SN7454	.29	.30	☐ SN74126	.99	1.00	☐ SN74251	.79	.80
☐ SN7455	.19	.20	☐ SN74132	1.35	1.36	☐ SN74284	5.99	6.00
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Case code: T=TO-220 Power Tab; V=Mini dip; K=TO-3; H=TO-5; N=DIP.

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☐ 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
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☐ 8R2381	1N4005	600	10 for 1.39	20 for 1.40
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• 1.5 Amp!
• Mini ature!

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☐ 100	1.49	2 for 1.50
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1.5 AMP

☐ 50V	10 for $.59	20 for $.60
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3 Amps, 125 VAC contacts, with chrome handles, complete with mounting hardware.

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Cat. No.	Type	Sale	1¢ Sale!
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* CENTER-OFF

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☐ 50	25	P.C.	6 for 1.00	12 for 1.01
☐ 20	15	Axial	10 for 1.00	20 for 1.01
☐ 20	15	P.C.	10 for 1.00	20 for 1.01

6 AMP CARTWHEEL RECTIFIERS

Cat. 8R3584

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☐ 600	.90	2 for .91
☐ 800	1.19	2 for 1.20
☐ 1000	1.39	2 for 1.40

10 AMP - POWER TABS!

#8R1448 - TRIACS
#8R1590 - QUADRACS

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☐ 100	.69	.70
☐ 200	.88	.89

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

Order by Cat. No.
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☐ #8R2137 MICRO RED LEDS
☐ #8R2790 JUMBO RED CLEAR LEDS

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Order by Cat. No. 8R5210A & voltage & wattage

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☐ 8.2V	5 for 1.	10 for 1.01
☐ 9.1V	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. 8R5210B

5 WATTS	Sale	1¢ SALE
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☐ 6. V	3 for 1.	6 for 1.01
☐ 6.2V	3 for 1.	6 for 1.01
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IMAGINE GETTING A CALCULATOR REJECT FOR ONLY A PENNY!!!!

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LED OR FLUORESCENT CALCULATOR GAMBLE!

PARTS ALONE ARE WORTH MORE THAN PRICE!

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☐ 4-TANTALUM CAPACITORS, 6.8 uF 35V, dipped (#8R5281)	1.00	8 for 1.01
☐ 5__PANCAKE PHOTOCELLS, 600 to 15K ohms (8R2939)	1.00	10 for 1.01
☐ 1__100KHZ MARKER CRYSTALS, approx for marker gen. (8R3896)	1.95	2 for 1.96
☐ 1__MOTHERBOARD EDGE CONNECTOR, 106 pins, .125" (8R3987)	3.50	2 for 3.51
☐ 1__48-PIN EDGE CONNECTOR, .156" spacing (8R3963)	1.95	2 for 1.96
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☐ 1—EECO THUMBWHEEL SWITCH, BCD, 0-7 (#8R2870A)	1.49	2 for 1.50
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☐ 100-MINI DIP ICs, linears, untested 50%+ yield, pop types (#8R3245)	2.00	200 for 2.01
☐ 75-LINEARS, OP AMPS, untested 50%+ yield, amps-dips-minidips (#8R2416)	2.00	150 for 2.01
☐ 100-TTLs & LINEAR MIXED, with 7400s, 50%+ yield (#8R2431)	2.00	200 for 2.01
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☐ 1—8-TRACK TAPE HEAD, with plug' n' cord (#8R3468)	2.50	2 for 2.51
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☐ 150 - TRIMMER CAPACITORS, mica compression, piston, asst'd. (#8R3714)	2.00	120 for 2.01
☐ 60 - YELLOW JACKET MYLAR CAPACITORS, marked, pop values (#8R3476)	2.00	150 for 2.01
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☐ 100 - 1N4148/914 SWITCHING DIODES, 50% + yield. Untested! (#8R2418)	2.00	200 for 2.01
☐ 30 - PC TRIM POTENTIOMETERS, thumbwheel, screwdriver ass't. (#8R3345)	2.00	60 for 2.01
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☐ 10__CALCULATOR KEYBOARDS, 20 keys and more (8R3524)	2.00	20 for 2.01
☐ 10__CRYSTALS, may include CB, Ham & more (8R3250)	2.00	20 for 2.01
☐ 100__TERMINAL STRIPS, from 2 lugs up (8R3136)	2.00	200 for 2.01
☐ 30__NE-2NEON LAMPS, all 100% good (8R2613)	2.00	60 for 2.01
☐ 40-ft. SHIELDED CABLE, 1 cond, mikes, phonos, (#8R3577)	2.00	80 ft. for 2.01
☐ 50__TRANSISTOR ELECTROS, asstd values, styles (8R2747)	2.00	100 for 2.01
☐ 3__SOUND TRIGGERS, sound triggers scr w/amp (8R3625)	2.00	6 for 2.01
☐ 10 - CB CRYSTALS, for phase lock loop, HAM, HC/18 (#8R5050)	2.00	20 for 2.01
☐ 100 - DISC CAPACITORS, long leads, marked, asst'd (#8R2598)	2.00	200 for 2.01
☐ 10__VOLTAGE REGULATORS, hobby LM320, 340, TO-3 (8R3330)	2.00	20 for 2.01
☐ 30__PANEL SWITCHES, slides, rotaries, mod. etc (8R3268)	2.00	60 for 2.01
☐ 200__RESISTOR SPECIAL, ¼ to 1W, carbon, metal (8R3054)	2.00	400 for 2.01
☐ 200__HALF WATTERS, resistors, carbon, metal (8R3046)	2.00	400 for 2.01
☐ 100__NATIONAL IC BONANZA, linears, 7400s ROMS (8R2860)	2.00	200 for 2.01
☐ 15__LM340T VOLTAGE REGULATORS, 5 to 24V, TO-220 (8R2635)	2.00	30 for 2.01
☐ 100__TWO WATTERS, resistors, carbon-metal marked (8R2735)	2.00	200 for 2.01
☐ 100__POLYSTYRENE CAPS, asstd values, voltage, hi-Q (8R2729)	2.00	200 for 2.01
☐ 50__THERMISTORS, resistors that change with temp (8R4089)	2.00	100 for 2.01
☐ 20__BRIDGES, untested, 2, 4, 6, 10, amp, full wave (8R4022)	2.00	40 for 2.01
☐ 25__LAMP'N'SOCKET SETS, micro, 1.5V, T2 (8R3957)	2.00	50 for 2.01
☐ 15__MIXED READOUTS, hobby, untested, .127, .3, .5, etc. (8R3619)	2.00	30 for 2.01
☐ 150__QUARTER WATTERS, resistors, metal film, marked (8R3413)	2.00	300 for 2.01
☐ 100__PLASTIC TRANSISTORS, untested, TO-92 (8R2604)	2.00	200 for 2.01
☐ 200__PREFORMED RESISTORS, ¼, ½, 1W, marked, asstd (8R2608)	2.00	400 for 2.01
☐ 200__PRECISION RESISTORS, ¼, ½, 1W, 1%, 2% marked (8R2428)	2.00	400 for 2.01
☐ 60__DIPPED MYLARS, shiny finish, asst values (8R2597)	2.00	120 for 2.01
☐ 30__VOLUME CONTROLS, audio, linear, asstd values (8R2421)	2.00	60 for 2.01
☐ 30-CLOCK CHIPS, National, hobby & untested, alarm (#8R5089)	2.00	60 for 2.01
☐ 30-MMS262 2K RAMS, hobby, untested (#8R3940)	2.00	60 for 2.01
☐ 10-PUSH SWITCHES, push-to-break, spst, alarms (#8R5289)	2.00	20 for 2.01
☐ 25-CD4000 SERIES CMOS, untested, 50% useable yield (#8R5284)	2.00	50 for 2.01
☐ 1__CHARACTER GENERATOR, 5 × 7 Mostek MK 2002P (8R3898)	4.95	2 for 4.96

7-SEGMENT READOUTS

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

RELAYS!

	Each	2 for
☐ SPDT 12V BLOCK RELAY, 5A contacts (#8R4032)	$1.98	$1.99
☐ SPDT 12V REED RELAY, 1A contacts (#8R4094)	1.49	1.50
☐ SPDT 12V SENSITIVE, 2000 ohm coil (#8R3044A)	1.95	1.96
☐ 1 — SPST 24V REED RELAY, norm open, dip style, 1250 ohms (#8R5175)	1.49	1.50

AMPLIFIERS!

	Each	2 for
☐ 9 WATTS ON A CHIP, Toshiba TA7205 (#8R5057)	4.95	4.96
☐ 3 WATTS ON A CHIP, G-E PA 263 (#8R1522)	1.50	1.51

DIP SWITCHES!

	Each	2 for
☐ 2 SWITCHES ON A DIP (#8R3668)	$ .77	$ .78
☐ 3 SWITCHES ON A DIP (#8R3669)	.88	.89
☐ 6 SWITCHES ON A DIP (#8R3671)	1.29	1.30

FULL WAVE 10 AMP BRIDGE RECTIFIERS!

Order by Cat. No. 8R2447 & 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

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

22 OP AMP & TTL IC FACTORY "DUMP-IN"

V=Minidip
N=Dip
H=TO-5

7 for $1.00
14 for $1.01

☐ LM308V	HiQ FET Input Op Amp
☐ LM311V	Hi Perf volt comp
☐ LM709H	Op Amp
☐ LM1800N	FM Stereo w/PLL Demod
☐ LM3900N	Quad Matched Op Amp
☐ LM558V	Dual 741

Order by Type No.

☐ SN7401	Quad 2 input NAND, O.C.
☐ SN7403	Quad 2 input NOR, O.C.
☐ SN7406	Hex inverter, buffer, driver
☐ SN7410	Triple 3 input NAND
☐ SN7420	Dual 4 input NAND
☐ SN7440	Dual 4 input buffer
☐ SN7450	Expan 2-wide, 2-in AND-OR-INV
☐ SN7451	Dual 2-wide, 2-3-input AND-OR-INV
☐ SN7453	4-wide, 2-in, AND/OR invert
☐ SN7455	2-wide, 4-in, AND/OR invert
☐ SN7464	4-2-3-2-inp, AND/OR invert
☐ SN7470	Edge triggered JK Flip Flop
☐ SN7472	JK Master Slave Flip Flop
☐ SN7496	5 bit parallel in/parallel out shift reg.
☐ SN74164	8 bit serial shift register
☐ SN74195	4 bit parallel access shift register

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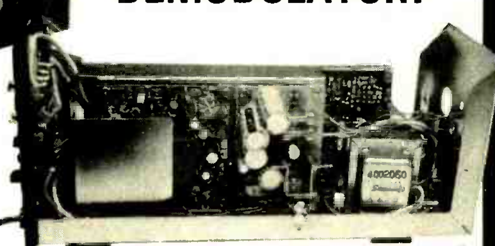

Model QC-04

CD-4 FOUR CHANNEL QUADRAPHONIC RECORD DEMODULATOR!

12.95 EACH!

$9.95 ea. Lots of 3!
$8.95 ea. Lots of 100!

* Operates on 110/220 vac, 50/60 Hz.

HUNDREDS OF PARTS! AN ELECTRONICS GOLD MINE!

Order ETCO No. 020HP099

1500 IN STOCK!

A TOP QUALITY SANSUI UNIT!

Model QC-04 is an all-in-one, self-contained assembly designed to accept the output from a CD-4 quad stereo phono cartridge, and demodulate the four channel information to produce four discrete quadraphonic stereo channels, ready to feed into two stereo or one quadraphonic amplifier!
We don't have too much information on this unit, but it's obviously a top-of-the-line unit. It seems to be designed for insertion into an existing stereo amplifier or preamp — three sides are bare as illustrated; the front panel has standard phono inputs and outputs, and the back panel has two interlocking control switches.

CD-4 RECORDS ARE STILL AVAILABLE!

—so you may want to use this unit for its original purpose. They're sold as is, but could probably be made to operate with a minimum of work. Some parts may be missing. A schematic diagram is included with each unit.

A GOLD MINE OF UNIQUE AND VALUABLE PARTS!

In parts alone, the QC-04 is worth many time our low price! Included on the chassis are: a 25 vdc regulated power supply complete with 110 vac power transformer; four low pass filters and two high pass filters of the best quality; integrated circuits, many regular and field-effect transistors, mini trimmer resistors, controls, capacitors, resistors, switches, etc.

SOPHISTICATED CIRCUITRY COULD HAVE MANY USES!

CD-4 Quadraphonic sound is similar in many ways to multiplex stereo. In effect, each channel on the CD-4 recorded is modulated with a high frequency carrier in addition to the audio signal. The carrier is modulated with rear channel information. The QC-04 contains audio and high frequency amplifiers, and two complete multiplex demodulators. There are probably lots of interesting uses for this unit - some of you bright fellows out there are sure to figure them out!

DEALERS WANTED for this and hundreds of other interesting items. Electronics stores, surplus dealers, Distributors, exporters - write on your letterhead for wholesale prices list. You can make money buying from ETCO!

FREE SURPLUS CATALOG!

Summer "AA" edition. Many more bargains such as this one! Circle the number shown below on the reader information card.

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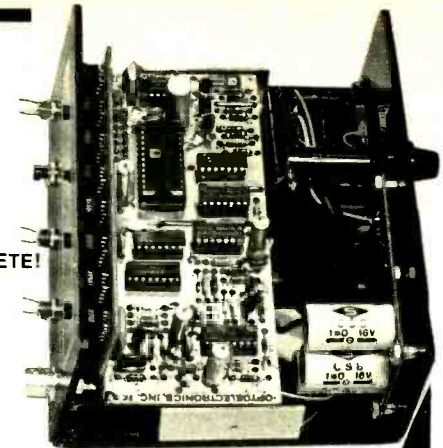
NEW LSI TECHNOLOGY

FREQUENCY COUNTER

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!

KIT #FC-50 C	60 MHZ	COUNTER WITH CABINET & P.S.	$119.95 COMPLETE!
KIT #PSL-650	650 MHZ	PRESCALER [NOT SHOWN]	29.95
MODEL #FC-50WT	60 MHZ	COUNTER WIRED, TESTED & CAL.	165.95
MODEL #FC-50/600 WT	600 MHZ	COUNTER WIRED, TESTED & CAL.	199.95



SIZE:
3" High
6" Wide
5½" Deep

FEATURES AND SPECIFICATIONS:

DISPLAY: 8 RED LED DIGITS .4" CHARACTER HEIGHT
GATE TIMES: 1 SECOND AND 1/10 SECOND
PRESCALER WILL FIT INSIDE COUNTER CABINET
RESOLUTION: 1 HZ AT 1 SECOND, 10 HZ AT 1/10 SECOND.
FREQUENCY RANGE: 10 HZ TO 60 MHZ. [65 MHZ TYPICAL].
SENSITIVITY: 10 MV RMS TO 50 MHZ, 20 MV RMS TO 60 MHZ TYP.
INPUT IMPEDANCE: 1 MEGOHM AND 20 PF.
[DIODE PROTECTED INPUT FOR OVER VOLTAGE PROTECTION.]
ACCURACY: ± 1 PPM [± .0001%]; AFTER CALIBRATION TYPICAL.
STABILITY: WITHIN 1 PPM PER HOUR AFTER WARM UP [.001% XTAL]
IC PACKAGE COUNT: 8 [ALL SOCKETED]
INTERNAL POWER SUPPLY: 5 V DC REGULATED.
INPUT POWER REQUIRED: 8-12 VDC OR 115 VAC AT 50/60 HZ.
POWER CONSUMPTION: 4 WATTS

KIT #FC-50C IS COMPLETE WITH PREDRILLED CHASSIS ALL HARDWARE AND STEP-BY-STEP INSTRUCTIONS. WIRED & TESTED UNITS ARE CALIBRATED AND GUARANTEED.

PLEXIGLAS CABINETS

Great for Clocks or any LED Digital project Clear-Red Chassis serves as Bezel to increase contrast of digital displays.

CABINET I
3"H, 6¼"W, 5½"D

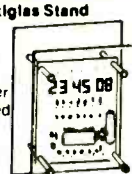
CABINET II
2½"H, 5"W, 4"D

Black, White or Clear Cover
$6.50 ea.

RED OR GREY PLEXIGLAS FOR DIGITAL BEZELS
3"x6"x1/8" 95¢ ea. 4/$3

SEE THE WORKS Clock Kit Clear Plexiglas Stand

- 6 Big .4" digits
- 12 or 24 hr. time
- 3 set switches
- Plug transformer
- all parts included



Plexiglas is Pre-cut & drilled

Kit #850-4 CP

Size: 6"H, 4⅓"W, 3"D

$23.50 ea. 2/$45. Assembled $29.95

60 HZ.

XTAL TIME BASE
Will enable Digital Clock Kits or Clock-Calendar Kits to operate from 12V DC.
1"x2" PC Board
Power Req: 5-15V (2.5 MA. TYP.)
Easy 3 wire hookup
Accuracy: ± 2PPM
#TB-1 (Adjustable)
Complete Kit $4.95
Wir & Cal $9.95

SPECIAL PRICING!

PRIME - HIGH SPEED RAM

21L02-3 400 NS

LOW POWER - FACTORY FRESH

1-24	$1.75 ea.	100-199	$1.45 ea.
25-99	1.60 ea.	200-999	1.39 ea.

1000 AND OVER $1.29 ea.

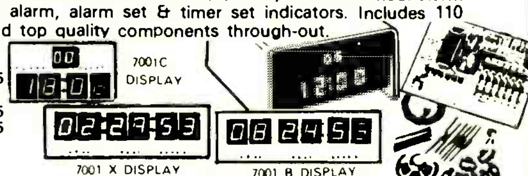
6-DIGIT LED CLOCK CALENDAR KIT

DATE-TIME-SNOOZE ALARM & MORE... KIT 7001

FOR THE BUILDER THAT WANTS THE BEST. FEATURING 12 OR 24 HOUR TIME — 29-30-31 DAY CALENDAR. ALARM. SNOOZE AND AUX. TIMER CIRCUITS

Will alternate time (8 seconds) and date (2 seconds) or may be wired for time or date display only, with other functions on demand. Has built-in oscillator for battery back-up. A loud 24 hour alarm with a repeatable 10 minute snooze alarm, alarm set & timer set indicators. Includes 110 VAC/60Hz power pack with cord and top quality components through-out.

KIT - 7001B WITH 6 - .5" DIGITS $39.95
KIT - 7001C WITH 4 - .6" DIGITS & 2 - .3" DIGITS FOR SECONDS $42.95
KIT - 7001X WITH 6 - .6" DIGITS $45.95



KITS ARE COMPLETE (LESS CABINET)
ALL 7001 KITS FIT CABINET I AND ACCEPT QUARTZ CRYSTAL TIME BASE KIT # TB-1

JUMBO DIGIT CLOCK

A complete Kit (less Cabinet) featuring: six .5" digits, MM5314 IC 12/24 Hr. time, PC Boards, Transformer, Line Cord, Switches and all Parts. Ideal Fit in Cabinet II

Kit #5314-5 $19.95 2/$38.

JUMBO DIGIT CONVERSTION KIT $9.95 ea.

Convert small digit LED clock to large .5" displays. Kit includes 6 - LED's, Multiplex PC Board & Hook up info.
Kit #JD-1CC For Common Cathode
Kit #JD-1CA For Common Anode

PRINTED CIRCUIT BOARDS for CT-7001 Kits sold separately with assembly info. PC Boards are drilled Fiberglass, solder plated and screened with component layout.

Specify for 7001
B, C or X - $7.95

MOBILE LED CLOCK

12/24 HR .4" DIGITS!

MODEL #2001

12 VOLT AC or DC POWERED

- 6 JUMBO .4" RED LED'S BEHIND RED FILTER LENS WITH CHROME RIM
- SET TIME FROM FRONT VIA HIDDEN SWITCHES • 12/24-Hr. TIME FORMAT
- STYLISH CHARCOAL GRAY CASE OF MOLDED HIGH TEMP. PLASTIC
- BRIDGE POWER INPUT CIRCUITRY — TWO WIRE NO POLARITY HOOK-UP
- OPTIONAL CONNECTION TO BLANK DISPLAY [Use When Key Off in Car, Etc.]
- TOP QUALITY PC BOARDS & COMPONENTS - INSTRUCTIONS.
- MOUNTING BRACKET INCLUDED

KIT #2001 COMPLETE KIT $27.95 EA. 3 OR MORE $25.95 ea. 115 VAC Power Pack #AC-1 $2.50 EA.

ASSEMBLED UNITS WIRED & TESTED ORDER #2001 WT [LESS 9V. BATTERY] Wired for 12-Hr. Op. if not otherwise specified. $37.95 EA 3 OR MORE $35.95 ea.

AUTO BURGLAR ALARM KIT

AN EASY TO ASSEMBLE AND EASY TO INSTALL ALARM PROVIDING MANY FEATURES NOT NORMALLY FOUND KEYLESS ALARM HAS PROVISION FOR POS. & GROUNDING SWITCHES OR SENSORS WILL PULSE HORN RELAY AT 1HZ RATE OR DRIVE SIREN KIT PROVIDES PROGRAMMABLE TIME DELAYS FOR EXIT, ENTRY & ALARM PERIOD. UNIT MOUNTS UNDER DASH - REMOTE SWITCH CAN BE MOUNTED WHERE DESIRED CMOS RELIABILITY RESISTS FALSE ALARMS & PROVIDES FOR ULTRA DEPENDABLE ALARM. DO NOT BE FOOLED BY LOW PRICES! THIS IS A TOP QUALITY COMPLETE KIT WITH ALL PARTS INCLUDING DETAILED DRAWINGS AND INSTRUCTIONS OR AVAILABLE WIRED AND TESTED

KIT #ALR-1 $9.95
#ALR-1WT WIRED & TESTED $19.95

VARIABLE REGULATED 1 AMP POWER SUPPLY KIT

- VARIABLE FROM 4 to 14V
- SHORT CIRCUIT PROOF
- 723 IC REGULATOR
- 2N3055 PASS TRANSISTOR
- CURRENT LIMITING AT 1 Amp

KIT IS COMPLETE INCLUDING DRILLED & SOLDER PLATED FIBERGLASS PC BOARD AND ALL PARTS (Less TRANSFORMER) KIT #PS-01 $8.95

TRANSFORMER 24V CT will provide 300MA at 12V and 1 Amp at 5V. $3.50

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KIT INCLUDES: Transformer, PC Board, Large heat sink, Large filtering capacitor

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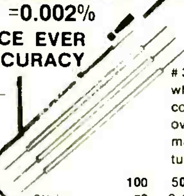

Frequency MHz	Price
1.000	
1.8432	@4.90

Frequency MHz	Price
2.000	
2.0100	
2.097152	
2.4576	
2.667	
3.000	
3.200	
3.2768	
3.5795	@4.50

Frequency MHz	
4.0000	
4.1943	
4.9152	
5.0000	
5.0688	
5.1850	
5.7143	
6.0000	
6.144	
6.400	
6.5536	
8.0000	@3.65

Frequency MHz	
10.000	
14.318	
14.391	
18.000	
18.4320	
20.0000	
22.1184	
27.0000	
32.0000	
36.0000	@2.85
48.0000	

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PRECUT

30 Kynar available in red, blue, yellow, orange, green, black, and white. Saves time cutting and stripping, and yet is about the same in cost as on rolls. Other lengths and sizes available. All lengths are overall, with 1" strip on each end. Colors and lengths cannot be mixed for quantity pricing. Wires come in plastic bags or plastic tubes available at 25c each.

	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

OVER 3000 SOLD
30 MHz LOW COST FREQUENCY COUNTER KIT

COMPARE and SAVE!
$54.95

Features:
- Frequency Range—100Hz to 30MHz min., resolution 100 Hz
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- High Sensitivity—15mV typical
- Xytal Time Base—0.001% 10MHz for better accuracy
- On Board Regulator—No external power supply needed
- All ICs Socketed—Easy to service
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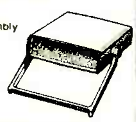
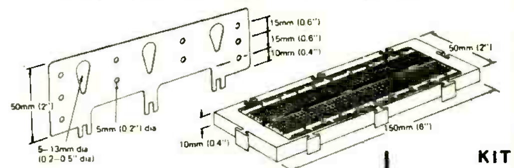
- Tin Plated & Screened Board—For easy assembly

Instrument Case
Perfect for our 30 MHz Frequency



PRICE: $17.50

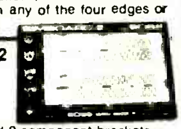
HAMMOND BREADBOARD KIT



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
$ 24.



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

BIMBOARD 3 $ 34.
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.

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
KIT $130.00 (2MHz) $145.00 (4MHz)

8080 A CPU BOARD/KIT

With 8 level vector interrupt. CUP chip clock chip: 8224; x'ytal Freq.: 18MHz: vector interrupt chip: 8214.

BARE BOARD $28.50 KIT $95.00

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.

BARE BOARD $24.00
KIT $120.00

8K STATIC RAM MEMORY KIT

Bareboard $ 24. KITS–
$120.00 (450ns) $135.00 (350ns) $160.00 (250ns)

16K RAM MEMORY KIT

Bareboard $ 24
KIT ~~$365~~– 450ns
$415–

KITS –	8K	16K	32K
250 ns	$ 230.00	390.00	775.00
450 ns	$ 215.00	328.00	615.00

32K RAM MEMORY KIT

Bareboard $30

MINIATURE SLIDE SWITCH DPDT .20 each, 10 for $1.75, 100 for $15.00

PUSH BUTTON SWITCH White, green and yellow 30¢ ea. 4/$1.00

TANTALUM CAP
AXIAL LEADS

1	10V	15¢
1	35V	20¢
3.3	35V	25¢
10	50V	30¢
22	35V	30¢

SOLDER WIK
Quick solder remover

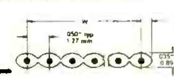
1/32"	5 ft.	
1/16"	5 "	
1/8"	5 "	1.40 ea.
1/4"	2½ "	

6-DIGIT AUTO CLOCK KIT WITH ALARM

Features:
A. Fairchild 0.5" FND 500 Series Display
B. Display Board may be remote
C. X'tal time base
D. P.C. Boards, speaker, IC's and all parts.
E. Detailed instructions

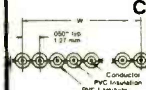
$19.95 KIT # T-1302

28 AWG 7/26 Strand CABLE
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



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 and 6 Digit Alarm Clock Kit

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

DIP SWITCHES

No. of Sw.	Price
2	1.80
3	1.90
4	2.15
5	2.45
6	2.70
7	2.90
8	3.10
9	3.30
10	3.50

DIP PLUGS

	5 pcs	10 pcs	100 pcs
14-pin	3.25	6.00	55.00
16-pin	3.50	6.50	60.00
40-pin	9.50	18.00	150.00

Over 1000 sold
5V 10A Power Supply Kit for your TTL Circuits!

Kit Includes: Extra Large Heat Sink, Power Tr., IC Regulator, P.C. Board, with OVP Circuitry. KIT # T-500

With Optional Rectifiers Filtering Capacitor

$11.95 $14.95

I.C. SOCKETS

	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

Wire Wrap Wire
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White only

1N4148 Diodes

10/75¢
50/3.25
100/5.00

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TI TIP2955 PNP
TIP3055 NPN
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90 WATTS
$2.25 PER PAIR

L.E.D. T-Segment Displays

FND 500	Com Cat.	0.5"	75¢
FND 510	Com Anode	0.5"	75¢
1720R	Com. Anode	1"	4.75
1723R	Com Cat.	1"	4.75

9V Battery Clips

10¢ ea. 10/75¢ 50/3.00 100/5.00

0.2" L.E.D. Lamps

Red	15¢	100/10.00
Green	20¢	100/15.00
Yellow	20¢	100/15.00
Amber	20¢	100/15.00

CASES (bottoms) PANELS (tops)

15° SLOPING PANELS

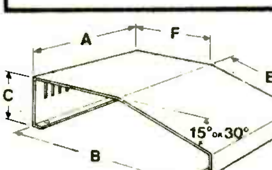
A	B	C	D	E	F	BLUE	GREEN	GOLD	PRICE	WHITE	SAND	BLACK	PRICE
4.0	5.5	2.0	1.1	3.3	2.2	1 - B	1 - G	1 - L	5.50	1 - W	1 - S	1 - K	5.50
6.5	5.5	2.0	1.1	3.3	2.2	2 - B	2 - G	2 - L	6.10	2 - W	2 - S	2 - K	6.10
6.5	8.5	2.0	1.1	3.3	5.2	3 - B	3 - G	3 - L	6.70	3 - W	3 - S	3 - K	6.70
6.5	8.3	3.0	1.3	6.3	2.2	4 - B	4 - 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

A	B	C	D	E	F	BLUE	GREEN	GOLD	PRICE	WHITE	SAND	BLACK	PRICE
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

74 Keys Keyboard

Manufactured by Micro Switch for Honeywell. Full encoded. (Limited Quantity)
$50.00



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Order today. Call 203-624-3103 (East Coast) or 415-421-8872 (West Coast): 9 a.m.-5 p.m. local time. Major credit cards accepted. Or see your CSC dealer. Prices slightly higher outside USA.

Logic Family Switch—TTL/DTL or CMOS matches Logic "1" and "0" levels for greater versatility. CMOS position also compatible with HTL, HiNIL and MOS logic.

PULSE LED—Indicates positive and negative pulse *and* level transitions. Stretches pulses as narrow as 300 nanoseconds to full 1/10 sec. (10Hz pulse rate).

HI/LO LED's—Display level (HI-logic "1", LO-logic "0") of signal activity.

Interchangeable ground lead connection—Provides ground-side input connection via optional cables

Interchangeable probe tips—Straight tip supplied: optional alligator clip and insulated quick-connecting clip available.

Plug-in leads—24" supplied, with alligator clips. Virtually any length leads may be connected.

Specifications

Input impedance better than 300KΩ

Thresholds (switch selectable)	**DTL/TTL**	**HTL/CMOS**
logic 1 thresholds (HI-LED)	2.25V ± .10V	70% Vcc ± 10%
logic 0 thresholds (LO-LED)	0.80V ± .05V	30% Vcc ± 10%

Min. detectable pulse width 300nsec.

Pulse detector (PULSE LED) 1/10-sec. pulse stretcher makes high-speed pulse train or single events (+ or − transitions) visible

Input protection overload, ± 25V continuous; 117 VAC for less than 10 sec.; reverse-polarity, 50V

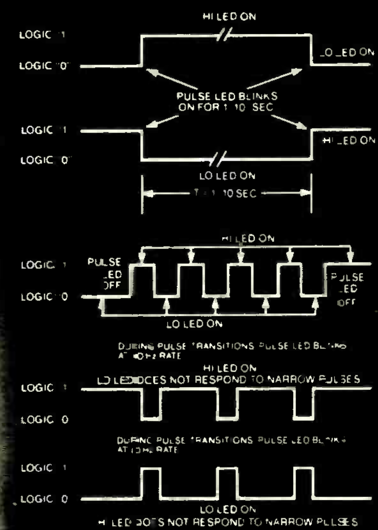
Power requirements 5-15 volts Vcc; 30mA max.

Operating temperature 0-50°C

Physical size (l x w x d) 5.8 x 1.0 x 0.7" (147 x 25.4 x 17.8mm)

Weight 3oz. (.085Kg)

Power leads detachable 24" (610 mm) with color-coded insulated clips; others available



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