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Radio-Electronics

THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

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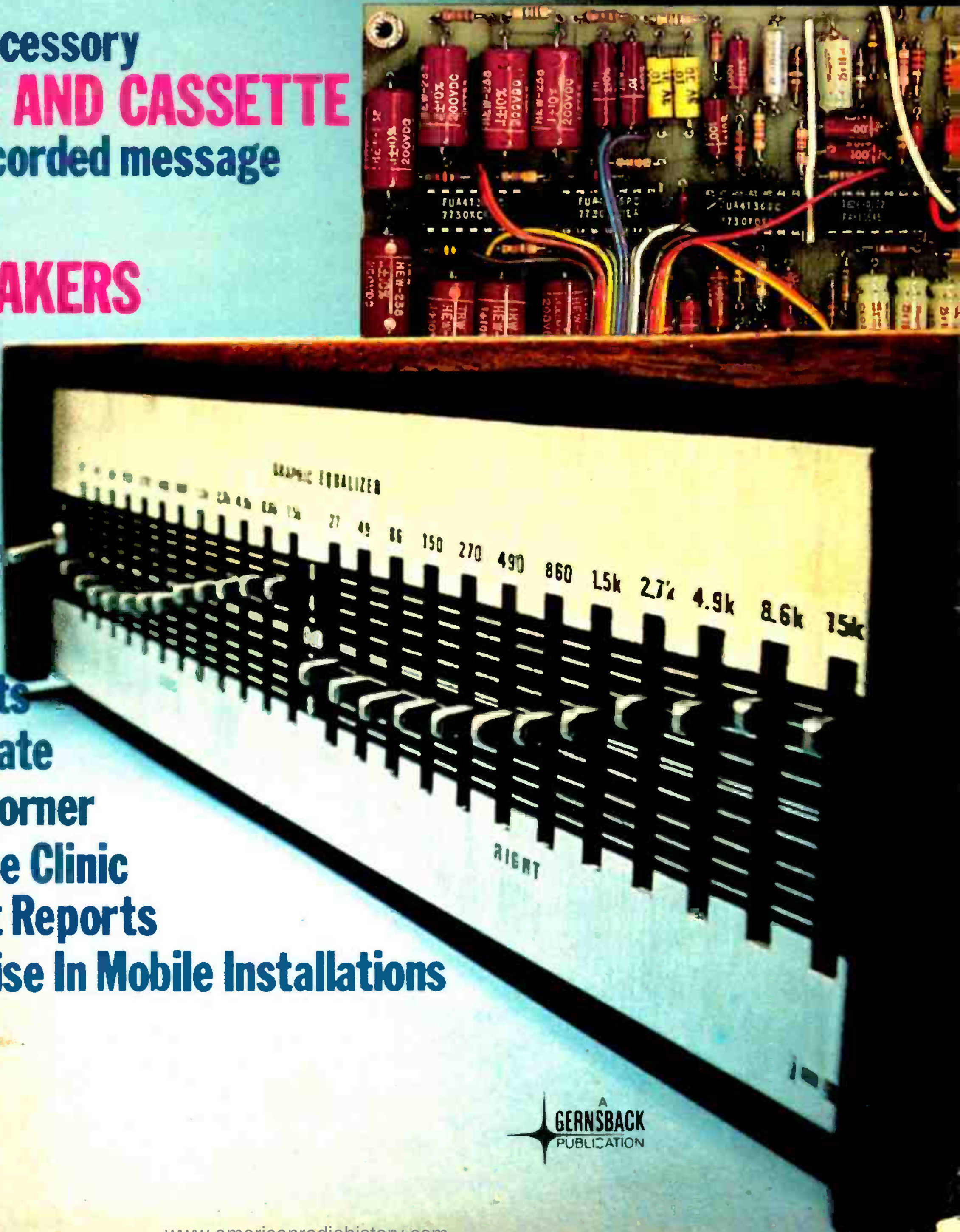
with 12 bands and super specs



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The RF-4800. If you had a short wave receiver as good. You wouldn't still be reading. You'd be listening.

*The ability to receive short wave broadcasts will vary with antenna size, time of day, operator's geographic location and other factors. You may need an optional outside antenna to receive distant short wave broadcasts.

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CIRCLE 66 ON FREE INFORMATION CARD

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THE MAGAZINE FOR NEW IDEAS IN ELECTRONICS

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MAY 1978 Vol. 49 No. 5

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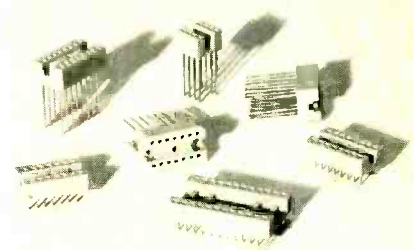
That's a 12-band graphic equalizer you can build for your stereo system. It's just about everything a graphic equalizer should be plus it's fun to build. Check it out. Turn to page 37 now.

THIS MELODY IS PLAYED by some of the electronic clocks described in this issue. You'll find more details on page 51.



IF YOU ARE PROTOTYPING you'll need sockets like these plus a lot of other hardware. Find out what's available and where you can get it. Turn to page 57.

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looking ahead

Projection TV: Projection TV's comeback as a consumer product (the first projection sets were sold in the late 1940's) seems to be gaining momentum, as manufacturers of conventional direct-view television hop on the bandwagon. Here's how the score stands at presstime: Advent, which started the whole thing, has three different sizes of its VideoBeam two-piece system and is expected to introduce a one-piece unit, still using the same three-tube approach. Electrohome of Canada, which makes the electronics for the VideoBeam system, is offering the Advent two-piece system there as well as a single-lens, single-tube conventional projector using what basically is a lens system in front of a small-screen television set. As many as 60 small companies assemble projection systems using TV sets made by others.

Cool at first to projection TV, existing set manufacturers are now looking at giant-screen television as an added market. General Electric is expected to show its first home projection system this month. "There's no question we'll be in it," says a Magnavox spokesman, but he states the product probably won't be on the market till next year. Sony, which has had a single-tube system on the market for several years (in fact, it started the trend to single-tube projection), is expected to come out shortly with a one-piece three-tube system.

Mitsubishi is already marketing a six-foot, three-tube two-piece system which resembles the Advent. Panasonic and Quasar, both subsidiaries of Japan's Matsushita, have demonstrated one-piece, three-tube systems—both using the same projection optics but different electronics and cabinetry—which they say will be offered later this year. Sharp has demonstrated a projection system in Japan and can be expected to offer one here eventually, as can Hitachi, which plans to be a partner with GE in the newly formed General Television of America.

Home projection TV's major problems have been bulk and lack of brightness. The bulk problem has been attacked by the development of one-piece systems that fold up when not in use. There has been no major breakthrough in brightness, but manufacturers are chipping away at the problem through the development of brighter tubes, better lenses and more reflective screens.

CB hurt by imports: The U.S. International Trade Commission has agreed that the American CB radio industry has been injured, or is likely to be injured, by Japanese imports, but split on how to remedy the problem. Three commissioners proposed a stiff increase in import duties on transceivers, while three recommended that domestic CB makers and their employees be declared eligible for special government aid to compensate for the inroads of imports. This leaves the final word up to President Carter, and his decision can be overridden by Congress.

The petition by American CB manufacturers for government action against imports came at a time when overproduction was obvious. Of course, Japanese manufacturers were also hit hard by the slowdown in sales and they have insisted that their competition hasn't contributed to the plight of American manufacturers, which they say is due to market conditions that have affected all CB makers.

Meanwhile, 23-channel CB's continue to show up in the marketplace, even though their sale was officially banned as of January 1. The FCC is cracking down, seizing illegal transceivers and issuing warrants.

In another development, the FCC said it returned nearly $5,000,000 in $4 license fees erroneously paid by CB applicants last year—and the fees keep rolling in. More than 30% of applicants sent money with their applications in January and February. The FCC's license-fee structure was voided by a Supreme Court decision in 1976. CB licenses—as well as all other FCC licenses—are now free, and no money should be sent with applications.

CPU's in toys: Microprocessor games and other amusements are becoming divorced from the television set—in the toy industry, anyway. The recent Toy Fair in New York provided strong evidence that hand-held, desk-top and projector games are substituting for video devices in toy stores. This presumably follows the remarkable success of Mattel's hand-held football, baseball and auto-racing games, which use LED's for displays and feature musical sound effects, and Milton Bradley's desk-top number-matching *Comp IV* game.

Here are some of the new games to entice the kiddies (and their parents) come Christmastime this year: Kenner, which holds merchandising rights to "Star Wars" products, is coming up with a two-player desk-top Star Wars "laser battle," with LED space-ship tracking system and scoring as well as nine sound effects. It also has a remote-controlled *R2D2* robot with sound effects and flashing lights, as well as a space target game. Milton Bradley will offer a missile game with sound effects and a flying saucer color-matching game. Its affiliate Playskool has a robot called *Alphie* that uses a set of plug-in program cards. Mattel is introducing a new game called *Mind Boggler*, said to be a matching challenge game similar to *Comp IV*.

Parker Brothers will field a hand-held gadget with a 2K byte memory, sound effects and lights, featuring six different games including one that permits the user to compose and store his own 48-note musical composition. Ideal has a two-player skeet-shoot game that projects the moving target on the wall, featuring gunshot sound effects and a bright burst when the target is hit. Even toy organs are becoming microprocessor-based; Concept 2000 showed one that automatically plays 12 pre-programmed songs or allows the user to play songs by following LED's mounted above the keys.

Does this mean toy makers are abandoning the television set as a display device? Probably not—but they are waiting for this part of the market to simmer down. Some day, said a Parker Brothers spokesman, "you'll probably see a video version of Monopoly and a lot of our other board games." But, like other toy makers, Parker presumably has lost interest in simple dedicated video games.

Meanwhile, RCA has stopped producing its *Studio II* programmable microprocessor video game, citing a generally disappointing market last Christmas for programmables. More to the point, probably, is the fact that RCA's was the only programmable video game that wasn't in color. The company said it's continuing design and development work on future games, which would mean it's still weighing a color version.

DAVID LACHENBRUCH
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new & timely

"Interference" mars anniversary of Marconi's transatlantic message

It had been planned to mark the 75th anniversary of Guglielmo Marconi's historic first transatlantic communication, but an FCC technicality managed to cross the wires.

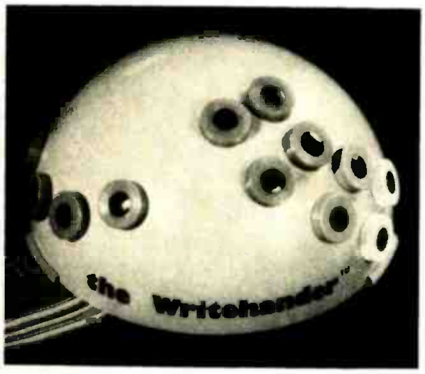
Back in early January, 1903, Marconi sent the first message across the Atlantic Ocean, transmitting it from a wireless station located in Wellfleet, MA, to a sister station on the south shore of England. At that time, flowery messages of greeting and congratulations were exchanged between President Theodore Roosevelt and King Edward VII.

This year, Wellfleet amateur radio operators thought it would be fitting for President Carter and Queen Elizabeth to exchange similar greetings. President Carter agreed; but the FCC ruled against it since there is a regulation forbidding "personal third-party messages" to be sent by amateur radio operators. If the Queen and President Carter had been amateur operators, there would have been no problem!

So, instead of a personal message to the Queen, President Carter released a general statement about how Marconi's invention had paved the way for instant communication "not only between heads of state, but peoples of all nations." The message was transmitted in Morse code via voice transmitter to amateurs around the world.

New one-handed keyboard for typing ASCII code

A hemispherically shaped keyboard, the *Writehander*, has been designed so that you can type ASCII code characters with just one hand. This format not only makes it easy to use while telephoning or sitting in



UNUSUAL DESIGN OF ASCII-encoded keyboard permits typing alphanumeric characters with one hand.

an easy chair, it is an invaluable tool for those with injured or disabled hands who cannot use a conventional keyboard. The *Writehander*'s shape is easy to hold, and it comes with two different switch spacings to accomodate different hand sizes.

To operate the keyboard, place four fingers on four pressure switches and your thumb on one of eight other pressure switches. The four finger switches operate the lower four bits of the 7-bit ASCII code and select the group of characters (out of 16 groups) that contains the character you want. With your thumb, you press the appropriate switch from among the eight thumb switches to select the desired character.

The *Writehander* does not need a computer to operate any terminal that accepts parallel 7-bit ASCII code signals. Connection to the terminal is via ribbon cable with appropriate lines for the 7-bit ASCII code, a 1-bit fixed parity, strobe and acknowledge signals and the power and common ground lines. The *Writehander* can be powered from a 200-mA DC supply from 5 volts, regulated, or 7 to 25 volts unregulated. It carries a price tag of $98.

RCA fiber-optic cables used in optical communications

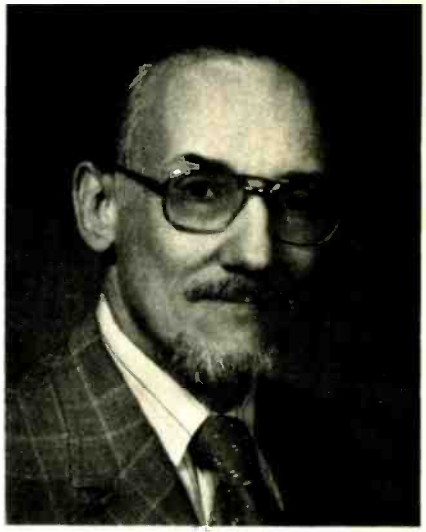
RCA's recently developed optical communications system features fiber optics, a technology that enables light waves to be transmitted via small lightweight glass or plastic cables. Dr. Ralph Simon of RCA explains that communications systems using fiber optics are capable of transporting a large amount of data, are not prone to static interference and are tamper-proof. Since data is transmitted at light frequencies, such a system has a great advantage over conventional wire or radiowave transmission because a single fiber-optic strand has the transmission capacity of hundreds of telephone wires.

The RCA communications system consists of a transmitter containing a high-speed gallium-aluminum-arsenide LED and a receiver consisting of a silicon photodiode.

Designed to be used in digital-data computer links, digital telecommunications and other optically isolated data systems, the fiber-optics data link sells for $850, minus the fiber-optics cable, which is available in different lengths at additional cost.

Ben Tongue becomes a Fellow in Radio Club of America

Ben Tongue, president of Blonder-Tongue Laboratories, was recently awarded a Fellowship in the Radio Club of America for "his outstanding contributions in the field of TV reception products." Before his association with Blonder-Tongue, Mr. Tongue was responsible for designing and producing the first audio and ultrasonic scanning spectrum analyzers for Panoramic Radio Corporation. Additionally, he holds over 30 patents, most in the field of low-noise, wideband amplification, and is also a director of Databit, Hauppauge, NY.



BEN TONGUE

Among his other credits Mr. Tongue lists membership in IEEE; two professional honor societies; the Antenna Committee of EIA; the Association of Computing Machinery; and the Audio Engineering Society.

Revised FCC/CB regulations—questions and answers

Revised FCC regulations governing CB equipment standards went into effect January 1, 1978. These regulations were devised to reduce the severity of current and potential interference posed by CB equipment, and specifically prohibit the marketing of any equipment not conforming to the new noise-reduction regulations.

To guide the general public, as well as those in the CB fraternity, the FCC has provided some typical questions received by the Commission, plus answers:

1. Can you still use your (previously acquired) CB after January 1? Answer: Yes.
2. Is it legal to sell your 23-channel CB to anyone? Answer: No.
3. What types of CB equipment are affected by the ban? Answer: All currently available 23-channel CB's; all units with fewer than 23 channels purchased prior to September 10, 1976; any receiver or transmitter with separate CB band not approved by the Commission; and most CB converters.
4. Are hand-held CB's (walkie-talkies) affected by the ban? Answer: Any such unit with a built-in mike, permanent antenna, internal batteries and receive and transmit

continued on page 12

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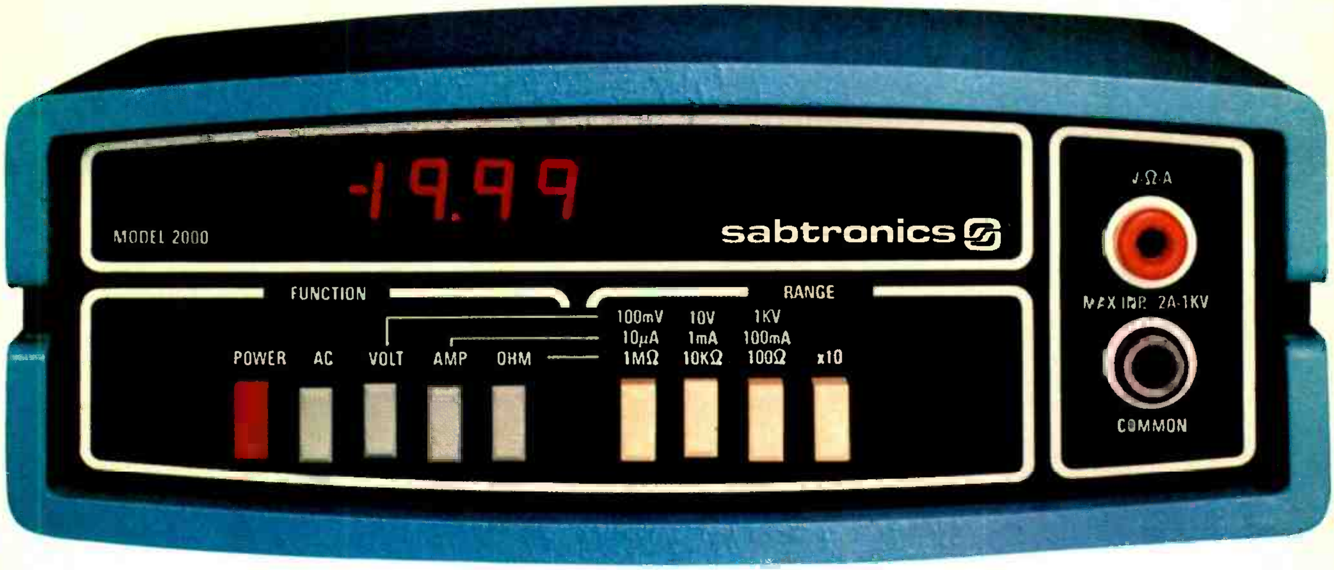

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continued from page 6

capabilities can be sold until *August 1, 1978*.

5. Can you trade in a CB for other radio gear? Answer: Yes, since the dealer is specifically prohibited from reselling the equipment. (It is of course up to the dealer to accept the trade-in or not.)

6. Will it be possible to give away 23-channel CB's? Yes, but only to family members, friends or charity; as door prizes; or as store giveaways (i.e., to the first 10 people entering the store on a given day). Prohibited are any transactions in which the recipient receives something of value from the giver, or any offer made to the customer if he agrees to purchase another item, or if he must pay to enter the store.

7. Can a 23-channel radio be sold for the parts it contains? Answer: Yes, but the generating components from both receiver and transmitter must be removed.

8. Is it legal to remanufacture a 23-channel CB radio in order to conform to the new regulations? Yes, if the unit is rebuilt to 40-channel operation, modified to meet the new standards, reidentified as a different model and has received a new grant of type acceptance from the FCC.

9. Can you sell a car, van, mobile home, etc., that has CB equipment in it? Answer: Yes, if the equipment has been permanently installed as an in-dash unit prior to January 1.

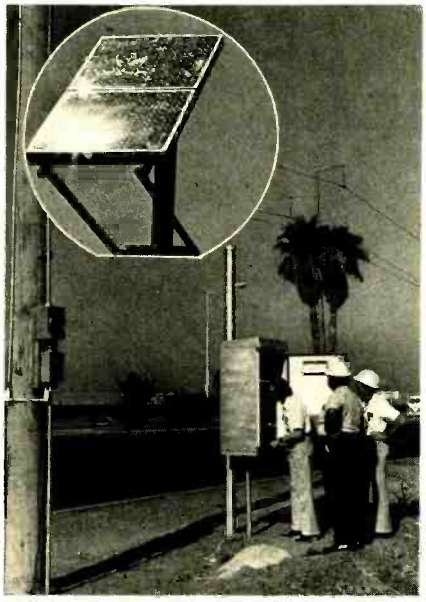
10. Can any 23-channel CB radio bought before January 1 be brought in for repair or exchange if proved defective? Answer: Yes. Repairs are not prohibited, and an exchange is legal since this is not considered marketing—the dealer is still prohibited from reselling the exchanged unit.

Further questions can be directed to John Reed or Frank Rose, Research and Standards Division, Room 7502, Federal Communications Commission, Washington, DC 20554. Any questions concerning particular CB models, CB converters or receiver/transceivers with CB bands should be sent to local FCC field offices, or to the FCC Laboratory, P.O. Box 40, Laurel, MD 20810 (301) 725-1585.

The editorial staff of **Radio-Electronics** wonders how the FCC plans to enforce these new rules. Or, for that matter, what the penalties will be.

Solar energy used to power traffic counter

A solar energy module, developed by Motorola Laboratories, was installed recently to power a six-lane traffic counter in Glendale, AZ. Although conventionally produced power for such counters is usually not expensive, it is often unavailable at counter sites, according to an Arizona Department of Transportation spokesman. Since the solar-cell array is capable of a more than 8-watt power output (due to Arizona's predominantly sunny climate) and can store enough energy in a reserve battery for 14 cloudy days as well as for night operations, it is hoped that the module may be an effective answer to the problem of supplying low-cost energy to the traffic counters.



SOLAR-POWERED traffic counter being tested in Glendale, AZ. Inset shows solar silicon array.

The solar module is composed of many tine pyramidal shapes that intercept light rays, producing an output of about ½ watt per 3-inch cell. The unit's copper connections and glass and stainless steel construction are expected to give it a life expectancy of more than 20 years.

At present, Motorola solar energy modules are being used in remote communications links where conventional power sources are expensive and difficult of access.

Sears, Roebuck enters pay-TV market

Sears, Roebuck & Co., the national department store chain, has recently entered the pay-TV market by installing and marketing National Subscription Television in Los Angeles and environs. Subscribers to NST in LA presently number about 20,000, and it is surmised that the growing demand for pay-TV may have prompted the Sears move as well as the possibility that NST may not be able to keep up with the demand. Sears is the first department store chain to enter the pay-TV market.

RCA photomultiplier tube aids in tracing satellite remains

On January 24, 1978, the Soviet atomic-powered satellite, Cosmos 954, fell to earth over northeastern Canada and disintegrated. Since then, massive efforts were made to recover the dangerously radioactive satellite fragments. Among the methods used in the recovery operations is an RCA-developed photomultiplier tube, a light-sensitive device contained in nuclear detection instruments.

The photomultiplier tube is capable of detecting minuscule amounts of light, which are then converted to an electrical signal that can be measured electronically. Dr. Ralph E. Simon, division vice president, RCA Electro-Optics and Devices, explains how the tube works in a detection device:

"The tubes are encapsulated in an aluminum cylinder behind a scintillation crystal. When in the vicinity of a nuclear radiation source, blue flashes of light are picked up on the faces of several photomultiplier tubes . . . These signals are relayed to an electronic sorting bin that separates light sources by their signals . . . which are read out as TV-like pictures by means of an oscilloscope." The strength of the nuclear source is then interpreted by reading the curves on the scope. Dr. Simon adds that when used in nuclear detection devices, these photomultiplier tubes are more sensitive than Geiger counters. The tubes have been widely used in different areas; for example, in determining the radioactivity of the moon's surface; in monitoring nuclear test results; and in cancer diagnosis and research.

GLASS SURFACES OF PHOTOMULTIPLIER TUBES being treated at RCA Electro-Optics and Devices plant in Lancaster, PA. When installed in nuclear detection instruments, tubes can "see" nuclear radiation as blue flashes of light.

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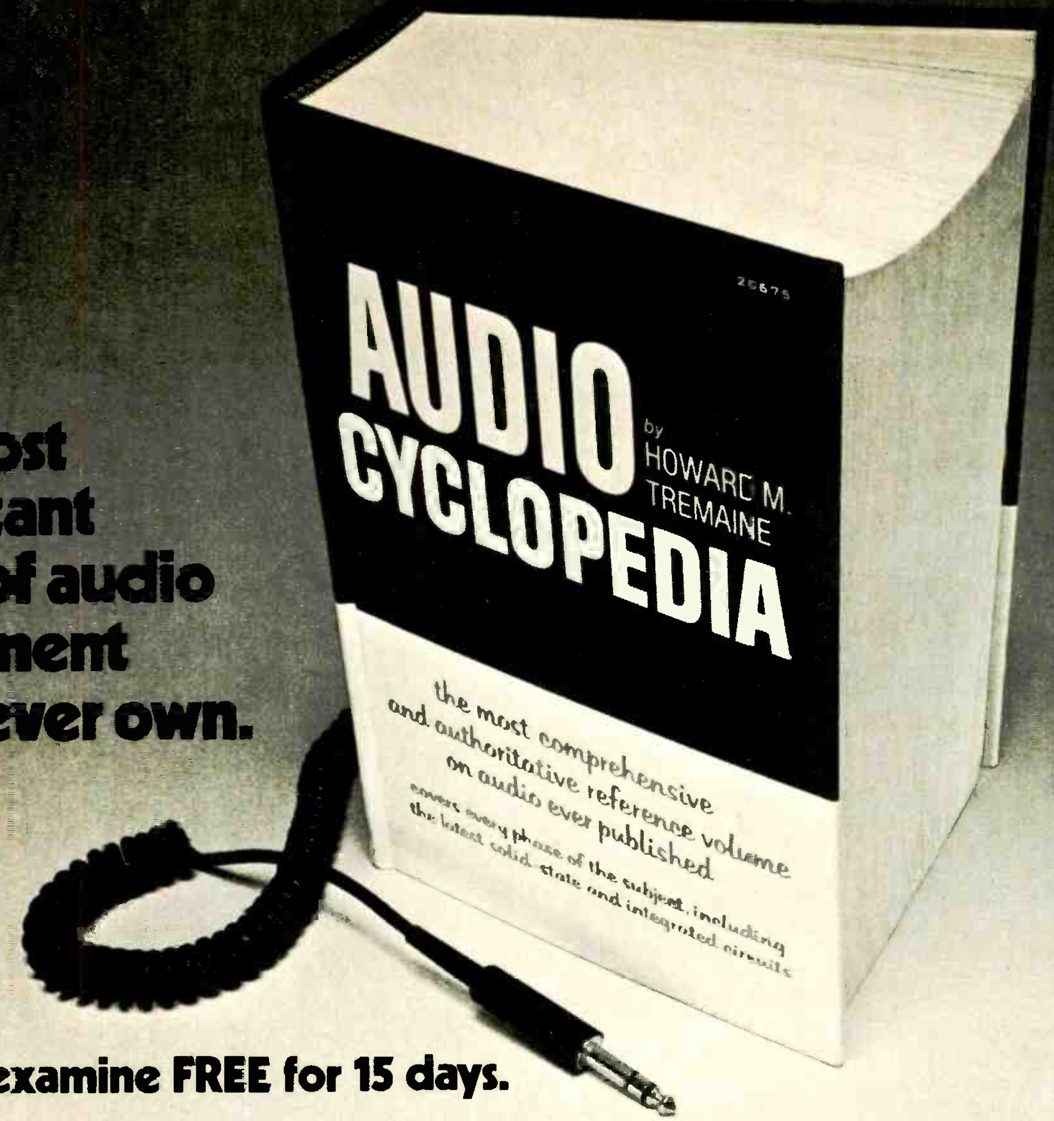

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editorial

It's A Great Little Library

If you've ever been stuck for service data on an old TV or radio that you are trying to revitalize. If you need data on any electronic part or test instrument and you can't seem to locate the information you need; try the ISCET/TECH. That's the Technical Electronic Clearing House, the technical library of the International Society of Certified Electronics Technicians.

What's in the library? Any and almost all electronics manuals, diagrams and magazines . . . antique radios, test equipment, antique tubes. If you haven't been able to find it elsewhere, Henry V. Golden, CET, the official librarian can probably locate it for you.

The library is a two-way street. If you've got old service literature and materials, don't throw them out . . . ship them to the Library instead. Henry Golden has no budget to pay for anything, but he can supply you with a tax-deductible receipt for the material and freight. It's a great way to dispose of materials that are outdated for your shop but still of value to other technicians.

The services of the library are available to members at no cost and to non-members at a very nominal cost. Membership is $25 per year, and entitles you to unlimited free use of the library's facilities. The only additional expense would be shipping or duplication costs.

If you have materials to send to the library, ship them prepaid to, ISCET Technical Clearing House, Henry V. Golden, CET, Librarian, 8015 Paseo, Kansas City, MO 64131. You'll be doing every technician in the world a service.

If you want information on becoming a member of the library, write Henry today. Membership in the Library is a great investment.

Larry Steckler

LARRY STECKLER
Editor

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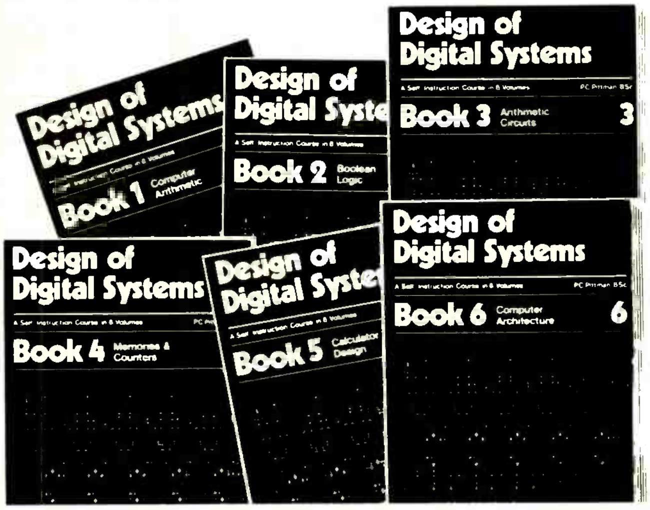
Understanding Digital Electronics

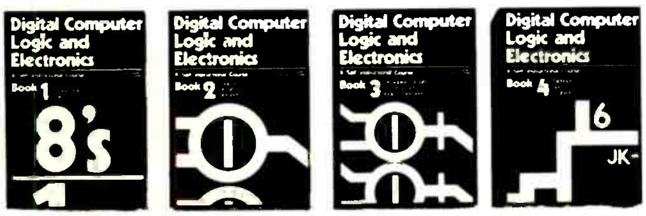
New teach-yourself courses



Design of Digital Systems is written for the engineer seeking to learn more about digital electronics. Its six volumes — each 11-1/2" x 8-1/4" are packed with information, diagrams and questions designed to lead you step-by-step through number systems and Boolean algebra to memories, counters and simple arithmetic circuits, and finally to a complete understanding of the design and operation of calculators and computers.

The contents of Design of Digital Systems include:

Book 1 Octal, hexadecimal and binary number systems; conversion between number systems; representation of negative numbers; complementary systems; binary multiplication and division.
Book 2 OR and AND functions; logic gates; NOT, exclusive-OR, NAND, NOR and exclusive-NOR functions; multiple input gates; truth tables; De Morgans Laws; canonical forms; logic conventions; Karnaugh mapping; three-state and wired logic.
Book 3 Half adders and full adders; subtractors; serial and parallel adders; processors and arithmetic logic units (ALUs); multiplication and division systems.
Book 4 Flip flops; shift registers; asynchronous and synchronous counters; ring, Johnson and exclusive-OR feedback counters; random access memories (RAMs) and read only memories (ROMs).
Book 5 Structure of calculators; keyboard encoding; decoding display data; register systems; control unit; program ROM; address decoding; instruction sets; instruction decoding; control program structure.
Book 6 Central processing unit (CPU); memory organization; character representation; program storage; address modes; input/output systems; program interrupts; interrupt priorities; programming; assemblers; computers; executive programs; operating systems and time sharing.



Digital Computer Logic and Electronics is designed for the beginner. No mathematical knowledge other than simple arithmetic is assumed, though the student should have an aptitude for logical thought. It consists of four volumes — each 11-1/2" x 8-1/4" — and serves as an introduction to the subject of digital electronics. Everyone can learn from it — designer, executive, scientist, student, engineer.

Contents include: Binary, octal and decimal number systems; conversion between number systems; AND, OR, NOR and NAND gates and inverters; Boolean algebra and truth tables; De Morgans Laws; design of logic circuits using NOR gates; R-S and J-K flip flops; binary counters, shift registers and half adders.

In the years ahead the products of digital electronics technology will play an important part in your life. Calculators and digital watches are already commonplace. Tomorrow a digital display could show your automobile speed and gas consumption; you could be calling people by entering their name into a telephone which would automatically look up their number and dial it for you.

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letters

2650 KEYBOARD

This letter is in reference to the Radio Shack keyboard (No. 277-177) and to Mike Herbach's letter in the February 1978 issue.

It is quite easy to make the conversion from a "7E" code to a "1B" code as needed for the 2650, provided that you don't mind unsoldering the board from the keyboard. The information on how to do this is available from Jerry Heep, Project Engineer, Tandy Systems Design, 1800 One Tandy Center, Fort Worth, TX 76102.

I have already modified my board and it works perfectly.

KEITH LITTLE
The Computer People
Webster Groves, MO

EMERGENCY CB RADIO PATROL

Some of your readers might be interested to know that we have formed an Emergency Citizens Band Radio Patrol (E.C.B.R.P.). The aims of the patrol are to maintain a community of alert citizens to watch out for and report on crime, vandalism, accidents, hazardous drivers and dangerous road conditions, etc., and to render assistance whenever necessary to fire, police and civil defense departments and to local and federal agencies in case of emergency.

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The $5.00 membership fee entitles you to a membership card, personal E.C.B.R.P. unit number, CB slang dictionary, copy of emergency procedures and official 10-code. For more information, send stamped, self-addressed envelope to E.C.B.R.P., Main P.O. Box 240, Yonkers, NY 10703.

B. MANDEL
Yonkers, NY

SOLDERING/DESOLDERING TRICKS

The article entitled "Tricks of Soldering/Desoldering" (January 1978 issue) contains a couple of errors of omission.

Table I lists manufacturers of soldering equipment, but fails to include American Beauty, a company that has manufactured soldering equipment and accessories for many years. Their products include irons from 20 watts to 550 watts, temperature-controlled irons and replacement tips.

Although various brands of fluxed braids for desoldering are listed in Table II, no mention is made in the article of their applications. The author writes that a DIP device can be removed with a special flat block tip but that this leaves old solder in the board. Why not use fluxed braid and a regular soldering iron to free the DIP, since the braid soaks up the solder and at the same time removes the old solder from the PC board pads.

MARVIN SMITH
Harbor City, CA

I read the article in the January 1978 issue on "Tricks of Soldering/Desoldering," and found it very interesting.

I have built many Heathkits, and I work for Quasar, where I do occasional repair work on production equipment.

The heat dissipation from a soldering iron tip is proportional to surface contact. When soldering or desoldering, touch a little solder to the iron tip first. This gives the iron tip a liquid surface that adheres to the surface of the terminal, increasing heat conduction by increasing surface contact. When the terminal is heated fast, less heat is conducted into the component.

JAMES R. GRANDSTAFF
Oak Park, IL

HAS TV IMPROVED?

In "Looking Ahead", December, 1974, page 4, you mentioned that AT&T promised to improve the audio quality of network TV broadcasting links in two years. However, three years have passed and I see little improvement. Although both TV sets in my home have been modified to reproduce sound through large, wide-range speaker systems, I still hear little sound outside the range of 100 Hz–5 kHz on any network TV show. Sometimes one of our local independent stations comes across with wide-range sound and the results are at times breathtaking. On the other hand, the orchestra on the NBC Tonight Show sounds so thin and miserable they might as well settle for a small combo.

Second, in "New and Timely" (January 1978 issue, page 12) it was mentioned that a NESDA Service Conference predicted a "throw-away" TV set, and also said, "Equipment will last for about five years before obsolescence." I am appalled by these statements, because with the shift from tubes to solid-state, along with the improved dielectric and encapsulating materials in use today, modern electronic equipment should last 20 or more years with proper care. I have seen 10- and 15-year-old transistorized equipment still in use and working as well as it did when it was installed.

Additionally, I was intrigued by Mr. Kubilus' letter ("Letters", January 1978 issue, page 16) regarding the superior serviceability of European radio and TV sets. I suspect one reason for this is that Europeans value their possessions more dearly and therefore expect them to last much longer and be more conducive to repair. American products are often made as cheaply and expediently as possible and are thrown away after only a few years' use.

MICHAEL KILEY
Palos Heights, IL

CLEANER DISSOLVES POLYSTYRENE

I feel that a few words of common sense are in order concerning GC's *Liqui-Cleen* silicone contact cleaner featured in the Equipment Report in the February 1978 issue.

Having worked in electronics parts sales in Honolulu, let me say that GC chemicals are popular with the military, industry, technicians and myself.

The article identifies the cleaner as 1,1,1, trichloroethane, which I have used in its pure state. I can tell you right now is definitely *will* dissolve polystyrene-type foam and plastics into solution (a particular need of mine), so it isn't entirely harmless to all plastics. Even in GC's popular *Spray-*

continued on page 22

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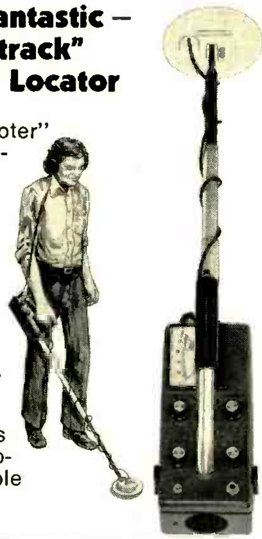

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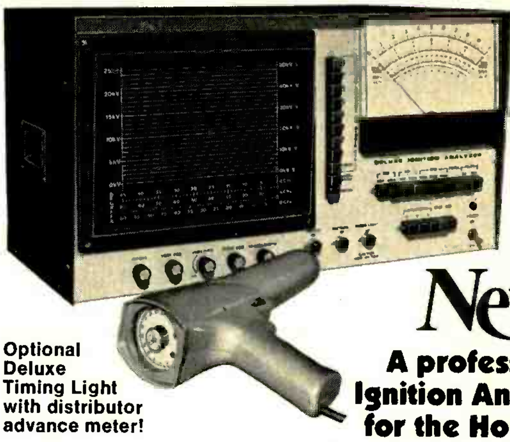

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LETTERS
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Kleen, 1,1,1 trichloroethane is found in weaker solution, yet GC cautions that it shouldn't be used on polystyrenes, e.g., cheap switches, some plastic cases and, especially, clear plastic dial covers for transistor radios. For truly component-safe, clean-and-be-gone work, I use GC's audio/video tape head cleaner spray on my bench.
GARY S. VIVEIROS
Honolulu, HI

AMERICAN VS. EUROPEAN TV's

Having just spent three years in West Berlin, I can say Edward M. Kubilus' seven points on European TV's are quite accurate (see "Letters," January, 1978).

However, I would like to continue the discussion a bit further. For those of you who have had the opportunity to view German color television, did you ever stop and make an objective comparison between a "typical" color TV presentation in Germany and one in the U.S.? If you did, I'm sure you noticed quite a difference. The colors all seemed brighter. The picture had better contrast and focus and was, overall, just sharper.

After a little research, you found that the German overall signal bandwidth is 5.5 MHz as opposed to our 4.5 MHz bandwidth. They have 625 lines per frame, we have 525 lines per frame. One might ask, what does this do for me? Compare the pictures again and the answer becomes immediately obvious.

And the differences did not stop with the picture. Did you look at the TV's physical appearance? What happened to all the external color controls? Didn't find any, did you? The Germans use a color TV transmission system called PAL. Through this system, the TV station controls the color on each and every TV set. This is done by transmitting a color control signal in addition to the normal video and sound information. And it works!

I guess the point to this discussion is to make the American public aware of the way things really are. I wholeheartedly agree with the editorial response to Mr. Kubilus' letter. I believe the TV industry is taking the American consumer for a long and profitable ride, and Mr. American Consumer doesn't know or doesn't care!
GERALD W. GLAVE
San Jose, CA

MAGNETIC SEMICONDUCTOR

If we ever find a "magnetic semiconductor" such as the one suggested by Andrew Fraser in his October 1977 letter, we can replace his iron block with an inductor and use another screen and magnet on the opposite side. By alternately screening magnets of opposite polarity from a centered coil we then have a solid-state AC generator.
SCOTT C. COBAIN
Woodbridge, VA

CHANGE IN FORMULA

With respect to the article, "10-Function Digital Clock," by Jeffrey G. Mazur in the August 1977 issue, I would like to suggest a small change in the formula for calculating R_L in the relay circuit of Fig. 4.

In this circuit, R_L in series with the relay is calculated in the following manner:

$$R_L = \frac{12}{I_{RELAY}} - R_{RELAY}$$

This value of R_L gives just enough current in the circuit for which the relay is designed. Hence, the relay is used without any safety margin—to cover the variations in relay performance due to handling and usage as well as variations of circuit current due to voltage and resistance variations (both relay and external resistances). Therefore, the working of the relay is unreliable.

Normally, in relay circuits, circuit current is taken as one and a half to two times the operating or pickup current of the relay, providing adequate safety margin between the pickup and circuit currents. In view of this, I have altered the formula for calculating R_L as

$$R_L = \frac{12}{1.5 \text{ to } 2 \times I_{RELAY}} - R_{RELAY}$$

This reduces the value of R_L, making the working of the relay in the circuit reliable. If the value of R_L turns out to be very small or negative, then it is not required in the circuit. In such a case, a relay having a pickup current of approximately one-half of the circuit current must be selected.
R. GOPALA RAO
Bangalore, India R-E

equipment report

Triplett Model 100-T Maintenance Kit

CIRCLE 103 ON FREE INFORMATION CARD

TRIPLETT'S *MODEL 310* "SHIRT-POCKET" VOM has been around for a long time. I've had one for many years that's still going strong. They even made a FETVM version, and now they have released the *model 100-T* maintenance kit that includes the *model 390* VOM, a thermistor probe, the *model 10* clamp-on AC Current Adapter, the *model 101* Line Separator, the *model 311* extension cord set, batteries and instructions. The *model 100-T* is manufactured by the Triplett Corp., Bluffton, OH 45817 and sells for $120.

The *model 390* VOM has all the ranges of the *model 310*: DC voltages on a 0–3-volt scale up to 1200 volts, at 20,000 ohms-per-volt, AC voltages on the same scales at 5000 ohms-per-volt, DC current up to 600 mA and four ohmmeter ranges. Two temperature ranges, one from −50 to +150° F and the other from +50 to +300° F, are included.

The *model 100-T* contains a small thermistor probe with an aluminum shield to protect the thermistor. This shield can be removed for readings requiring surface contact; for example, to read the case temperature of power transistors, the temperature of bearing housings, etc. The probe is calibrated by pressing a button on the probe body and setting the ohms adjust control for zero. This control is a thumbwheel type, mounted on the left side of the case, right under your left thumb. You can use the probe to check air conditioners, refrigerators, furnaces, and ovens, and it can also be used for free air, surface and liquid measurements.

One of the handiest items included in the *model 100-T* is the *model 10* clamp-on AC Current Adapter, which can be plugged into the top end of the VOM case and locked. The whole unit then becomes a clamp-on AC adapter. The VOM is set to the 0–3 VAC range. The selector switch of the *model 10* adapter can be set to read AC current in six ranges, from 0–6 amp up to 0–300 amp. The *model 10* must be clamped around only one wire to read accurately. For times when you can't get at a single wire, the plug-in *model 101* Line Separator, also included, can be used. The clamp is hooked through the ring. It has three ranges—direct, divide-by-10 (giving full-scale reading of 0–600 mA AC) or divide-by-20 for a low range of 0–300 mA AC. For tight spots in breaker-boxes where even the little VOM can't go, an extension cord, the *model 311*, also included, may be used. This is 42 inches long. Then only the *model 10* is pushed into place to read the current.

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Simulated TV Reception

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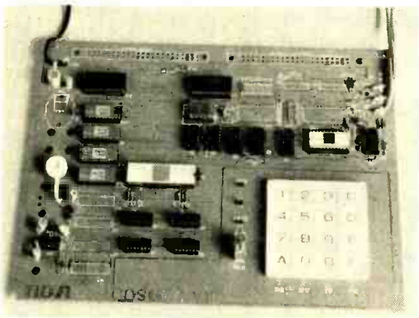
The *model 390* VOM uses two batteries, a 1.5-volt unit for all ohms ranges except the 1K range, which uses a 15-volt battery. The low ohms ranges are protected by a 1/16-amp fuse located under the 1.5-volt battery. The batteries are easily accessible by removing a small plate on the back of the case.

A leather carrying case, *model 379*, is available. **R-E**

RCA VIP Computer Kit



CIRCLE 104 ON FREE INFORMATION CARD

THE RCA *V*IDEO *I*NTERFACE *P*ROCESSOR IS A hobbyist microcomputer with a graphic video output. As soon as it is assembled and operational, you become acquainted with the system by loading and running an assortment of video games, including "Kaleidoscope" and (my favorite) "Armored Vehicle Clash." After you gain this initial familiarity and have some fun, you can graduate to writing 1802 machine language and CHIP-8 programs.

The VIP is constructed on a single 8½ × 11-inch PC board that holds the CDP1802 microprocessor, 2048 words of user RAM, a 512-word ROM-based operating system, a 3.521280-MHz crystal oscillator, a video display generator IC, a cassette recorder interface and various system related IC's. A 5-volt, 600-mA power-supply module is part of the package. On-board memory can be increased to 4096 words (a higher current supply may be needed), and parallel I/O ports can be added by filling wired, empty IC positions. Standard 44-pin connectors can be used to expand up to 32,000 memory bytes, and beyond the 19-line on-board I/O limitation.

Programs, data and system control commands are entered through a 16-key hexadecimal keypad. Depressing a key switch on the keyboard operates the Q light, affects the on-screen display and generates an audio tone (the speaker is not included). The uppermost 256-byte portion of memory is displayed in a format that is 64 bits horizontal by 32 bits vertical. The video output is monochrome and noninterlaced, and must be connected to a video monitor, the video circuits of a TV receiver, or an external RF modulator for hookup to a TV antenna terminals. User programs are started at address 0000 by flipping the reset toggle switch from RES to RUN. To access the 512-word operating system at address 8000, key C is held while the reset switch is flipped.

The operating system has four functions—memory write, memory read, tape write and tape read. When memory contents are entered and checked, the address and contents are displayed simultaneously at the bottom of the TV screen, so you can keep track of what you are doing. The video format can be expanded to 64 × 64 bits or 64 × 128 bits for higher resolution by writing your own video refresh interrupt routine in machine language. Video format expansion uses more memory for the display (512 bytes or 1024 bytes). Using the video display slows down the processor because of the time it spends translating memory contents into a video display pattern. The operating system saves the processor registers on the last page of memory for debugging programs.

The CHIP-8 interpreter is a 512-byte program that you must load manually, or from tape, into locations 0–01FF. CHIP-8 user programs, such as games, are then loaded starting at 0200. The language is a series of 31 two-byte instructions that let you control up to 15 variables, run a timer, display patterns, generate a variable-duration audio-output tone, convert binary to decimal, obtain random numbers and perform skips and subroutine jumps. You can create all kinds of static and moving displays with relatively few instructions. The CHIP-8 interpreter should be stored on cassette tape to save reloading and checking each time you want to use it.

A VIP operating manual, the MPM-201 1802 microprocessor manual, and data sheets describing the ROM, video display IC and 1802 microprocessor are included. The VIP manual includes all the details, but a beginning computer hobbyist will find a reference book or two helpful. Twenty video games are listed, plus some short "getting-started" programs.

Kit assembly requires good soldering technique since a single short between the necessarily close PC traces keeps the unit from creating its pretty pictures. While the VIP is basically designed to be used for fun, it can be expanded to perform useful control and calculation work.

After I resolved a couple of self-inflicted assembly errors, the system performed flawlessly. Programing mistakes did have the annoying habit of wiping out CHIP-8, but shifting to the tape cassette mode of operation made recovery easy. I used both an inexpensive time-worn audio cassette recorder and a better-grade Heathkit tape deck. The tape deck loaded programs successively nine times out of 10, but the less expensive recorder performed only once out of every three times.

The *model CDP18S022 VIP Kit* is priced at $275. An order form is available from RCA Solid State Division, Box 3200, Somerville, NJ 08876. **R-E**

Redco Model FM-30 Frequency Monitor

CIRCLE 105 ON FREE INFORMATION CARD

THE RELIABLE ELECTRONICS DESIGN COMPANY, 11823 Slauson, Santa Fe Springs, CA 90670, manufacturers of frequency counters for communications and amateur work, as well as CB accessories, such as preamps and speech processors, has developed the *model FM-30* frequency-monitor counter with a range of 1.0 MHz to 40 MHz. This low-cost unit (sug-

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EQUIPMENT REPORT
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gested retail price, $99.95) uses a through-line circuit for continuous monitoring of any low-band frequency, especially CB frequencies. It measures only 4 inches wide, 1.25 inches high and 6 inches deep, making it easy for top-of-dash or console mounting.

The 5-digit readout has ½-inch-high, easy-to-read LED digits. A selector switch on the panel lets you read the CB channel frequency in MHz, and three places to the right in the 1-kHz position. Setting the switch to the 0.1-kHz position allows you to read to 100 Hz. The placement of the decimal point is automatic. The meter sensitivity is less than 1.0 watt, and is rated as being able to handle up to 1000 watts PEP without damage.

The all solid-state circuitry uses standard TTL logic, with a crystal-controlled clock oscillator for greater stability. The basic *model FM-30* operates at any DC voltage between 10.5 and 16. It has built-in reverse-polarity protection and can be used with either positive or negative ground electrical systems. A cigarette-lighter plug is provided for quick installation or removal.

The display reacts quickly, almost instantaneously, when changing channels. It is used in a through-line hookup. Two SO-239 connectors on the rear panel are provided so the unit can be hooked up quickly. The *model FM-30* can be used with base stations, using the optional AC/DC power supply available.

We checked the unit out on a couple of CB sets, and the results agreed with those of our lab standards. Instrument stability is good, and the display is steady. Two-way radio technicians, or the dedicated CB'er who likes to know whether he's right on-channel or not, will find the *model FM-30* a useful item for troubleshooting sets using frequency synthesizers! **R-E**

B&K-Precision Model 2810 Digital Multimeter

THE B&K-PRECISION COMPANY HAS DEVELOPED a new 3.5-digit DMM, the *model 2810*. This instrument is a true multimeter that reads AC and DC voltage, current and resistance. It has all the handy features: automatic zeroing, automatic polarity indication, as well as some special features that make it even more useful in a variety of electronic measurement applications.

The *model 2810* has a 10-megohm input impedance on all voltage ranges. AC and DC voltages are read on the same 1–10 scales. Both voltage scales start at 0–100 mV and go up to 1000 volts in five ranges. There is 100% overrange capability on all ranges except for the 1000-volt ranges. This means that you can set the meter to the 10-volt range and read any voltage up to 19.99 before changing ranges. Voltages greater than 19.99 will show a blinking LED readout of 1999. This blinking readout also represents the infinity or open-circuit readout for all ohms ranges.

AC and DC currents share the basic ranges—from 1.0 mA full-scale to 1000 mA or 1.0 amp. For DC readings, the polarity indicator shows which way the current flows. Once again, there is 100% overrange capability for all but the top range.

There are seven resistance ranges, one of which is special. First, there is a 0–10-ohm
continued on page 30

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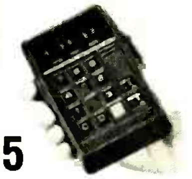

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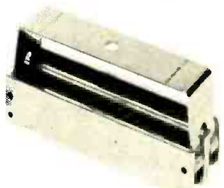

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EQUIPMENT REPORT
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range (that's the special one), then there are ranges of 0–100, 1K, 10K, 100K, 1000K and 10 megohms. To use the 0–10-ohm range, set both controls to the 10-ohm position. A special zero-adjust control works on this range only.

The 0–10-ohm range is useful for resistance measurements of flyback windings, deflection yoke windings, etc. The normal resistance is shown on many schematics and on all Sams Photofacts schematics. If a winding resistance is given as 7.8 ohms, and you see a reading of only 3 or 4 ohms, there's a good chance that the winding has some shorted turns in it. We ran this test on several flybacks, both good and bad, and it gave us the right answer every time. When you take readings in this area, even the normal slight resistance of the test leads is important. Therefore, just short the test prods and adjust the readout for 0000. This removes the lead resistance, which will be about 0.4 ohm, or so.

The ohmmeter is dual voltage. The 0–10-ohm range is always low ohms and transmits less than 0.2 volt across semiconductor junctions so that they won't turn on. The highest range (10 megohms) is always high ohms, which delivers a higher voltage. The middle ranges can be switched to either high or low ohms as needed.

The low ohms range is also useful for checking those tiny resistors (3.3 ohms, etc.) found in solid-state circuits. These resistors are critical, since they're generally used in bias circuits and it takes only one-tenth of an ohm or so to throw some circuits way out. Nulling out the contact resistance will let you read the resistors accurately.

The *model 2810* has the accuracy typical of digital meters. It's rated at ±0.5% of reading, or 0.1% of full scale on DC voltages. Similar accuracy is obtained on AC voltages, resistance and current. This feature comes in handy when reading the fractional voltages so common in solid-state sets, especially those using IC's. If a schematic states 5.4 volts is necessary at a given point, this is really meant! Quite often a schematic will show DC voltages that come from *inside* the IC for each pin. This can be a valuable clue to the proper voltage. If these voltages are within a small percentage of normal, the chances are that particular IC is good. If they're off, or missing entirely, and the supply voltage is normal, the IC is apt to be bad. A great many IC voltages such as this will be in the 0–10 range, which is where precision readings are useful.

The *model 2810* is powered by four C-cell dry batteries. Stock dry-cells, alkaline batteries or NiCads can be used. A NiCad recharging unit is available. The jack for the battery charger is already on the case. You can test the battery condition quickly by simply setting the *model 2810* to the 0–10 VDC range, then touching the hot test prod to the charging socket terminal and to a battery-test jack on the other side of the instrument.

All voltage current and resistance ranges are overload-protected. A 2-amp, 3AG fast-blow fuse is conveniently mounted right on the front panel next to the test-lead jacks. A spare fuse and holder come with the instrument. Diode protection against overload is also provided on the current ranges.

The following accessories are available that extend the range of the *model 2810*: A high-voltage probe (*model PR-28*) extends the range to 40 kV DC, and also extends the AC voltage ranges to 20 kV at 60 Hz. There is also a 10-amp current shunt (*model ES-28*). The demodulator probe (*model PR-23*) can read from 15 kHz to 250 MHz, and an isolation-direct probe (*model PR-21*) takes DC voltage readings in circuits with high RF signals.

The 3.5-digit LED readout has 0.3-inch-high, bright red 7-segment digits. The circuitry uses dual-slope integration for greater accuracy and stability. Precision IC-type resistor

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CIRCLE 106 ON FREE INFORMATION CARD

BLURRED PICTURE

I've had the same problem three times in this Heathkit GR-180. The picture is perfect at turn-on, then 5 seconds later it slowly goes out of focus to a huge smear! I checked and changed the tubes . . . no help.—K. F., Miami, FL.

I *think* you'll find the basic cause of this problem is a drop in the focus voltage. The drop is not to zero, but to about 1 to 2 kV. Read the focus voltage right at the base pin of the picture tube. Also, pull the socket and check this pin; if the color is light green, check the socket contact!

(Feedback: "I followed your advice. Everything in that focus circuit was messed up. I cleaned the socket; the 4.7-megohm resistor in series was about 6 megohms and the 1V2 socket was bad. That stopped the original trouble.

"The set played for a short time, then it went completely black. What now? I found that the boost voltage was dropping to about +380. So, I changed the boost rectifiers, D701 and D702. This got it!")

HORIZONTAL DRIFT

The original complaint on this GE SB chassis was an intermittent loss of high voltage. I changed the 0.0027- and 0.0068-μF capacitors across the horizontal-hold coil and corrected this problem. Now I had a new problem: In about 15 minutes, the picture would fall out of horizontal sync. It could be brought back by adjusting the hold control. However, the next time the set was turned on, the picture was out of horizontal sync again. I've changed numerous parts, but have not solved the problem. Please enlighten me.—C. H., Alplaus, NY.

I hate to make positive statements, for I'm wrong so often! However, this has all the symptoms of thermal drift. *Something* in that oscillator circuit is changing the value as it warms up. Kill the automatic frequency control (AFC) and see if the oscillator runs on-frequency after the problem appears. If it is quite a way off, the AFC may be OK and the problem is in the oscillator resonant circuit.

(Feedback: "I monitored the AFC voltage and found that it changed about 7 volts between turn-on and sync failure. I changed the 6.8-megohm AFC plate load resistor, but this didn't help. So, I went back and tried another capacitor in place of the 0.0027-μF capacitor I had just inserted. This helped! The picture slid sideways a bit but did not fall out of sync. Then, I tried all four of the 0.0027-μF capacitors I had, and all showed some instability in this circuit. Finally, I tried a 0.0033-μF 10% capacitor which was all I had in stock, and this one worked!")

(Comment: Your capacitor stock wasn't in very good shape! I've run into this at times. Evidently, you did find one that had a zero temperature coefficient. This was enough so that the circuit could be tuned.) **R-E**

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E—MODERN VIDEO SERVICING—The television servicing business has NOT gone downhill, except for technicians who fail to keep up with the advances. Transistors, integrated circuits, digital technology, automatic tuning and color correction, video games, home video players/recorders—all respond easily to modern methods in this group of MONOGRAPHS. You'll discover that many of today's best techniques are faster, simpler, and more easily understood than those used so long for older TV receivers.

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continued from page 30

networks are used for the attenuators.

All in all, the *model 2810* is quite a fine piece of test equipment that should give long service. It is obtainable for $119.95 from B&K-Precision/Div. of Dynascan, 6460 West Cortland, Chicago, IL 60635. **R-E**

RCA Model VBT200 SelectaVision Videocassette Recorder

CIRCLE 125 ON FREE INFORMATION CARD

THIS PAST HOLIDAY SEASON SAW MANY MANUfacturers scurrying to market VCR's (*v*ideo*c*assette *r*ecorders), whose public acceptance has been proven by the over 100,000 Sony *Betamax* VCR's sold in the U.S. even *before* the last holiday season.

One of the most highly advertised recorders is RCA's *model VBT200 SelectaVision*, which was offered initially for $1000, but is available for as little as $850 at some outlets. This unit uses the VHS (*V*ideo *H*ome *S*ystem) format, as contrasted with the Beta format used by Sony and other manufacturers. The *model VBT200*, however, offers two speeds for up to four hours of recording or playback time on a single cassette, while most other machines offer only two hours. The *model VBT200* also has two other *exclusive* features—a built-in fluorescent digital clock and a remote-wired pause control, plus a "dew" light, lighted tuner dials, switchable output channels and an auto-set indicator.

The *model VBT200* is *not* designed to be portable; it has no carrying handle, weighs over 38 pounds, and measures 19 inches wide, 7 inches high and 15½ inches deep! Power consumption is 45 watts from a 110-to-130-volt 60-Hz power supply; no portable power source is offered or recommended.

If you've never used a videocassette recorder before, it will take a little getting used to, since there are some controls and terminology that may puzzle you at first. Also, installing the recorder, while no problem in most cases, is a little confusing until you figure out what's happening.

Basically, the regular TV antenna is connected to the VCR, which has its own VHF/UHF tuners. Another cable goes from the VCR output to the TV antenna input. The antenna signals *always* go to the VCR tuners, but may *also* be directed to the TV. This way you can record on one TV channel (using the VCR tuner) while watching another channel (using the TV tuner). It is not necessary to monitor the VCR while recording—so you can even record with the TV off, while you're asleep or away from home. When you *do* have the TV set on, you can choose whether to watch the signal going to the VCR unit or TV by using the VCR/TV SELECT switch. If you choose the VCR switch setting, just set the TV to Channel 3 or 4 (whichever channel is not used in your viewing area) and tune with the VCR tuners. Selecting the TV setting lets you operate the TV in the regular way, whether the VCR is recording or turned off altogether!

To playback a recording, the VCR-TV SELECT switch must be set to VCR, with the TV set tuned to Channel 3 (or 4).

An eight-pushbutton color-coded keyboard controls the tape functions: EJECT (which lifts the entire tape cassette compartment), REWIND, STOP, FAST FORWARD, PLAY, RECORD, AUDIO DUB and PAUSE. As in most recorders, the PLAY and RECORD pushbuttons must be pressed together to record. The AUDIO DUB pushbutton allows you to record your *own* sound track on a prerecorded tape by using an external microphone plugged into the front-panel MIC jack; it erases the original sound track but does not affect the TV picture. The PAUSE pushbutton stops the tape and allows you to edit out commercials, for example, when recording; it also erases the screen on playback when you want to interrupt your viewing for short periods. One of the special features of the *SelectaVision* recorder is a 20-foot remote PAUSE-CONTROL switch that plugs into a jack on the rear of the unit.

The built-in digital clock is another plus. Other VCR's either use external add-on clocks, or have LED displays that are not visible in bright lighting. The *model VBT200* uses bright, blue-green ½-inch-high fluorescent digits, with AM-PM indicators and a flashing dot to indicate seconds. The time-display setting and command controls are located under a flip-up panel. Three two-position toggle switches allow you to advance the

continued on page 35

CIRCLE 59 ON FREE INFORMATION CARD

EQUIPMENT REPORT

continued from page 34

time either at a fast or slow speed (1 hour-per-second or 1 minute-per-second), to display the time-of-day or the auto-set time, and to turn the built-in auto-set on or off. When the auto-set is on, the VCR will turn on at the auto-set time if the power is on, and a red LED indicates that the unit is in the auto-set mode. When the VCR is operated this way, it shuts off automatically at the end of the tape.

A mechanical pushbutton-reset digital tape counter with a MEMORY switch is provided. When rewinding, the tape stops at "000" (actually "999" to allow for system backlash) when the MEMORY switch is on. This allows you to "zero" the tape at any point other than just the beginning. A two-speed switch lets you select either the SP (two-hour *S*tandard *P*lay) mode or LP (four-hour *L*ong *P*lay) mode for recording. On playback, the unit senses the correct speed automatically.

The *model VBT200* contains six other lights: a red LED on-off light located next to the power switch; a yellow LED DEW light that indicates when excessive moisture has triggered a disable switch. The *VBT200* remains disabled until the excessive moisture evaporates. There are lights inside each of the VHF and UHF tuner drum dials to show channel tuning in green digits; and a green LED indicator to show that the AFT (*a*utomatic *f*ine *t*uning) switch on the front panel is on.

One other control on the front panel is the TUNER/CAMERA input switch. When you record from the VHF input or the UHF input, you use the TUNER switch position; when you record from a video camera or from a video output of another VCR for dubbing, this input switch must be set to the CAMERA position.

The back panel contains the UHF, VHF, video and audio inputs and outputs, with screw terminals for UHF inputs and RCA phono jacks for the rest. A miniature phone jack is included for the PAUSE control. Another handy switch is the CHANNEL 3/4 output selector. Some VCR's require separate converters for each channel, whereas the *SelectaVision* VCR only requires a flick of a switch.

Two manuals come with the *SelectaVision*: the *Operating Instructions* and spiral-bound *Simplified Instruction Cards*. The instruction booklet contains adequate installation information, except it does not cover camera use or dubbing. The *Simplified Instruction Cards* show the switch positions and operations for each use, except again for camera use or dubbing. **R-E**

Belar, Motorola lead AM stereo field tests

The National AM Stereophonic Radio Committee recently presented to the Federal Communications Commission a 455-page report assessing field tests on AM stereophonic systems. This report (containing data only, with no specific recommendations) indicated that Belar Electronics Laboratory, Inc. and Motorola Inc. have emerged as leaders in developing AM stereo systems capable of competing with FM stereo systems on an overall performance level.

The Belar system was cited for its overall simplicity, most easily demodulated signal and compatability with existing monophonic receivers. The Motorola entry, called C-QUAM (*C*ompatible *QU*adrature *A*mplitude *M*odulation) performed best in a high noise environment (including skywave transmissions), but its signal-demodulation technique is highly complex. Magnavox has also developed an AM stereo system, less sophisticated than Motorola's but more complex than the Belar system.

Copies of the report can be obtained for $20 from the Electronics Industries Association, 2001 Eye Street, NW, Washington, DC 20006.

Although the Radio Committee (and many AM radio broadcasters and receiver manufacturers) would like the FCC to render an early decision regarding AM stereo broadcasting, it does not seem likely that an answer is forthcoming right away. And, if the ruling does come about, manufacturers say the success of the system will depend on the development of an IC demodulator that will allow the AM stereo system to be truly competitive with FM stereo systems. Additionally, the FCC and national AM committee privately express fear that since so far the most interest shown in the system comes from Japan, this will again mean U.S. manufacturers may miss the boat as far as being the first to get their products on dealers' shelves, as was the case with CB radios.

NEXT MONTH

A special section on personal computers in the June issue is something special you won't want to miss. Fundamentals, languages, accessories and a detailed directory. Don't miss it.

CIRCLE 59 ON FREE INFORMATION CARD

BUILD

Graphic Equalizer For Your Stereo System

This versatile audio accessory lets you obtain maximum enjoyment from your stereo system by compensating for bumps in the response of your speakers and listening room.

JOE GORIN

NO AUDIO SYSTEM HAS PERFECTLY FLAT frequency response. Although cartridges and amplifiers can be made very close to perfect, even the best speakers have major bumps and dips in their frequency response. Rooms affect the response of a speaker in a myriad of ways. Even the records played on an audio system are not flat. Alltogether, an audiophile can spend thousands of dollars on a system and end up with a jumbled mess for a frequency-response curve. Traditional bass and treble controls are not adequate to overcome the problems in the overall response of an audio system.

Enter the graphic equalizer. With individual controls for frequency spans narrower than an octave, an equalizer can be used to compensate for response deficiencies in the system. It is called an equalizer because it can make the system response to all frequencies roughly equal; it is graphic because the position of the slide controls forms a graphic representation of the response of the unit.

Applications

In an average room, 90% of the sound you hear has been reflected from the room's surfaces. The amount of reflected sound varies greatly with frequency. Thus, a speaker that sounds dull and bassy in a room with heavy draperies and soft furniture can sound sizzling and harsh in a room full of sliding glass doors and tiled floors. The response can even change with the number of people in the room! Furthermore, a room with parallel walls resonates at the frequency for which the wall-to-wall spacing is a half wavelength. A speaker placed away from the walls and floor of a room will have only one-eighth the bass response of the same speaker placed in a corner, due to wall reflections. A graphic equalizer can correct many of these problems, and even make the sound of a good speaker even better.

Many recording studios use a graphic equalizers. A recording engineer can use the equalizer to bring out various instruments or change the character of the sound. It is common practice in the recording industry to add treble boost to compensate for the rolloff in inexpensive radios and record players. The graphic equalizer can undo what the recording engineer did and make the recording sound more realistic.

In reinforced sound systems, acoustic feedback causes ringing or oscillation at various frequencies. By reducing the gain at these frequencies, a flatter response and higher volume can be maintained. The frequency response of the human ear is far from flat at low levels. Weighting filters used in laboratory testing have a very irregular frequency response. All these applications can be enhanced by the use of a graphic equalizer.

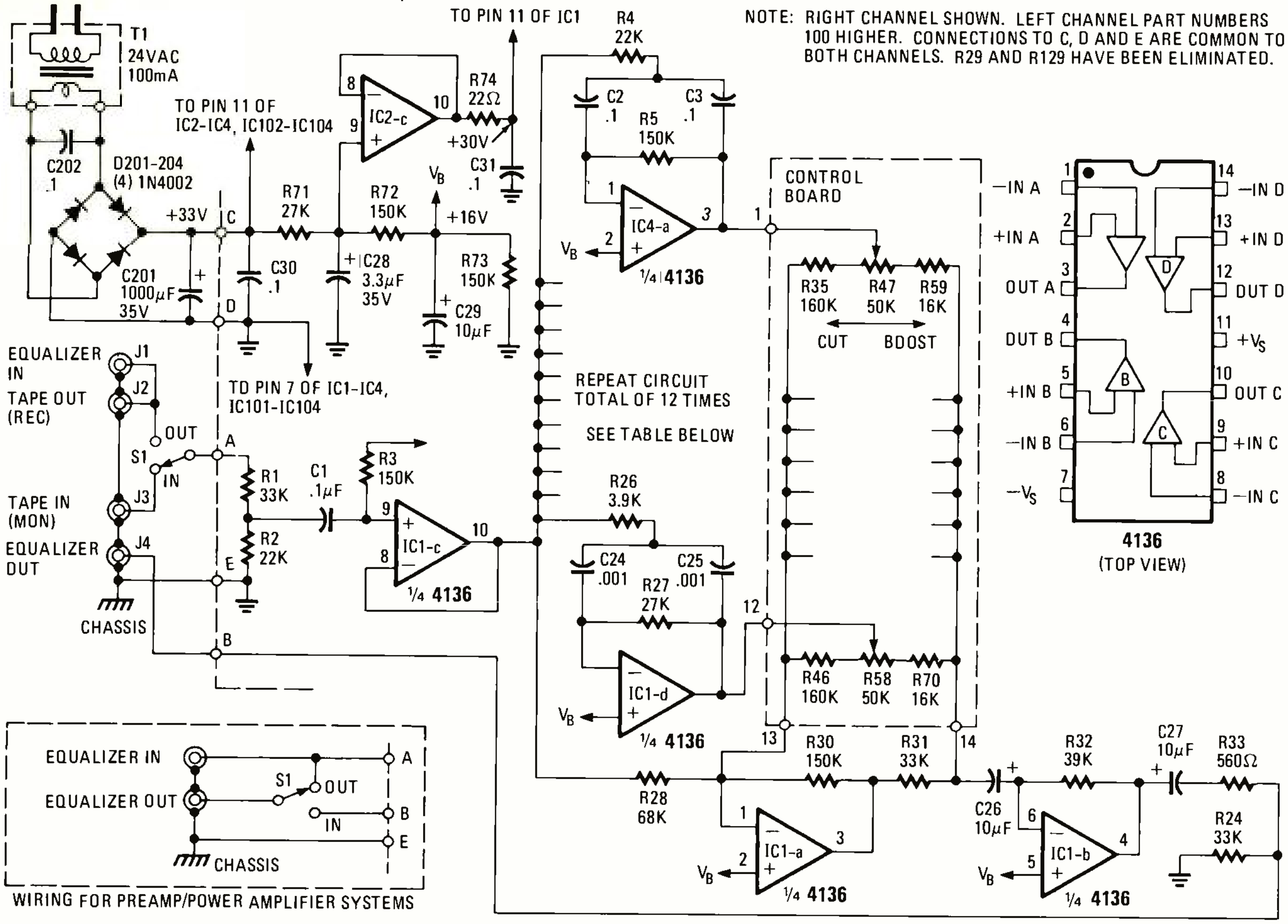
The suboctave equalizer described here solves the two biggest problems with commercialy assembled units. The price range for 10-band equalizers is about \$200–\$600. Since this unit was designed specifically for the hobbyist, it can be sold

SPECIFICATIONS

Frequency Response	10 Hz—100 kHz ±3 dB
Nominal Control Range	± 10 dB
Nominal Gain	0 dB
Rated Output	2 volts RMS
S/N Ratio @ Rated Output	92 dB—100 dB*
Distortion @ 1 kHz @ Rated Output	.02%
Input Impedance	50,000 ohms—150,000 ohms*
Output Impedance	600 ohms
Input Overload	8.5 volts RMS—3 volts RMS*

Note: All controls centered

*For alternate wiring and component changes listed in text.



CONTROL BAND TABLE

BAND NO.	CENTER FREQ.	RESISTOR INPUT	RESISTOR FEEDBACK	CAPACITORS	BAND NO.	CENTER FREQ.	RESISTOR INPUT	RESISTOR FEEDBACK	CAPACITORS
1	28	R4 = 22K	R5 = 150K	C2 = C3 = .1μF	7	890	R16 = 6.8K	R17 = 47K	C14 = C15 = .01μF
2	51	R6 = 12K	R7 = 82K	C4 = C5 = .1μF	8	1.6K	R18 = 3.9K	R19 = 27K	C16 = C17 = .01μF
3	89	R8 = 6.8K	R9 = 47K	C6 = C7 = .1μF	9	2.8K	R20 = 22K	R21 = 150K	C18 = C19 = .001μF
4	160	R10 = 3.9K	R11 = 27K	C8 = C9 = .1μF	10	5.1K	R22 = 12K	R23 = 82K	C20 = C21 = .001μF
5	280	R12 = 22K	R13 = 150K	C10 = C11 = .01μF	11	8.9K	R24 = 6.8K	R25 = 47K	C22 = C23 = .001μF
6	510	R14 = 12K	R15 = 82K	C12 = C13 = .01μF	12	1.6K	R26 = 3.9K	R27 = 27K	C24 = C25 = .001μF

FIG. 1—SCHEMATIC OF ONE CHANNEL of the equalizer. The remaining eleven channels use filter components listed in the table.

PARTS LIST

All resistors ¼ watt, 10% or better.

R1, R31, R34, R101, R131, R134—33,000 ohms
R2, R4, R12, R20, R102, R104, R112, R120—22,000 ohms
R3, R5, R13, R21, R30, R72, R73, R103, R105, R113, R121, R130, R172, R173—150,000 ohms
R6, R14, R22, R106, R114, R122—12,000 ohms
R7, R15, R23, R107, R115, R123—82,000 ohms
R8, R16, R24, R108, R116, R124—6800 ohms
R9, R17, R25, R109, R117, R125—47,000 ohms
R10, R18, R26, R110, R118, R126—3900 ohms
R11, R19, R27, R71, R111, R119, R127, R171—27,000 ohms
R28, R128—68,000 ohms
R32, R132—39,000 ohms
R33, R133—560 ohms
R35–R46, R136–R146—160,000 ohms
R47–R58, R147–R158—50,000 ohms, 10% linear slide potentiometer
R59–R70, R159–R170—16,000 ohms
R74—22 ohms
C1, C30, C31, C101, C130, C131—0.1 μF, disc +80% -20%
C2–C9, C102–C109—0.1 μF, 100 volts, 10%
C10–C17, C110–C117—.01 μF, 100 volts, 10%
C18–C25, C118–C125—.001 μF, 100 volts, 10%
C26, C27, C29, C126, C127, C129—10 μF, 25 volts, electrolytic
C28, C128—3.3μF, 35 volts, electrolytic
C202—1000 μF, 35 volts, electrolytic
D201–D204—1N4002 rectifier diode
IC1–IC4, IC101–IC104—RC4136 (Raytheon), XR4136 (XR) μA4136 (Fairchild) or equal quad op-amp
S1—double-pole, double-throw miniature toggle switch
T1—24-VAC, 100-mA, wall-mount transformer
Misc.: J1–J4, J101–J104—phone jacks, PC boards, wire, chassis, knobs.

The following parts are available from Synergistic Sound Systems, 1608 S. Douglas Ave., Loveland, CO 80537:

Amplifier and control PC boards, $7.00 each. Both boards are ³⁄₃₂ inch G-10, tin-plated. Complete kit of parts without cover, $90.00. Solid walnut assembled, unfinished cover $10.00 (available only with complete kit). All prices postpaid in U.S. Colorado residents add sales tax.

in kit form for under $100. Although commercial units are generally designed to be rack-mount compatible, and thus about 18 inches wide, this compact unit is only 9 inches wide. It is even available with a professional-looking walnut case! The design uses no inductors and a minimum of different values of capacitors to make it insensitive to magnetic fields and saturation problems. Also, it is easier and cheaper for the hobbyist to acquire the parts. With 12 bands-per-channel, a slightly more accurate response can be formed than with a 10-band unit, and, of course, the suboctave equalizer is more flexible than bass/treble controls or even 5-band units. Another benefit of the build-your-own equalizer is that it can be specifically wired for either tape-monitor or preamp/power amplifier connections. Thus, the overload characteristics and signal-to-noise ratio can be optimized for the application.

How it works

The schematic of one channel of the

Radio-Electronics Lab Test

LEN FELDMAN

A COMPLETED VERSION OF THE GORIN 12-band dual channel graphic equalizer was put through its paces in our laboratories to verify the specifications of this ultra compact add-on component. Since the unit is so compact, we feel that the designer of this equalizer was wise to keep the power supply step-down transformer removed from the equalizer package itself. This arrangement contributed to the excellent signal-to-hum-and-noise readings we obtained, which measured 85-dB below a 1-volt input reference level.

Insertion loss of the equalizer, with all slide controls set to their mid-position, was approximately 1.5 dB. Figure 1 is a scope photo of our spectrum analyzer, in which successive frequency sweeps from 20 Hz to 20 kHz were taken with maximum and minimum settings of each of the twelve slide controls on the equalizer. Approximately 12-dB of boost or cut is available at each of the twelve center frequencies. The response plots disclose an interesting characteristic of the equalizer. While boost settings affect a fairly wide band of frequencies for each control (relatively low Q response), the maximum attenuation settings of each lever result in frequency dips that are quite a bit narrower in terms of the frequencies that they affect. Most commercially made equalizers that we have tested in the past exhibit completely symmetrical boost and cut characteristics as opposed to the asymmetrical results obtained with this home-built unit.

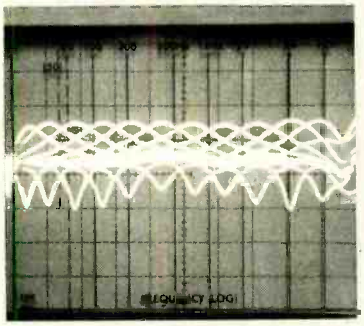


FIG. 1

In one sense, the asymmetry turns out to be a desirable feature for the user. In attempting to compensate for deficient speaker characteristics of a high-fidelity component system, one often wishes to provide a very gradual rise in response at specific frequency regions in the audio spectrum, and the boost characteristics of this equalizer makes this possible. On the other hand, when one is faced with problems of standing waves in a given listening room, it is desirable to be able to attenuate or cut a very *narrow* band of frequencies so that the audible affects of standing waves are minimized without seriously affecting overall musical balance. The narrowband attenuation characteristics of the equalizer (when the slide controls are used to *cut* response at a given center frequency) are suited for this application as well.

Additional measurements

For a 1-volt input signal, total harmonic distortion measured 0.005% with a 1-kHz input signal. At the frequency extremes of 20 Hz and 20 kHz, harmonic distortion measured 0.09% and 0.027%, respectively. Even with all the controls set to their maximum boost settings, distortion remained quite low. These extreme settings resulted in an output voltage of approximately 4 volts (for a constant 1.0-volt input), a gain of approximately 12 dB, and distortion measured 0.0035% at 1 kHz, 0.14% at 20 Hz and 0.14% at the 20-kHz high-frequency extreme. Intermodulation distortion measured 0.009% with all the controls set to flat and actually decreased to 0.006% with all the controls in their maximum boost positions.

Figure 2 illustrates the overall response of the equalizer with controls all set to maximum boost (upper trace) and to maximum cut (lower trace). With controls centered, response was flat from 20 Hz to 20 kHz, within 0.5 dB.

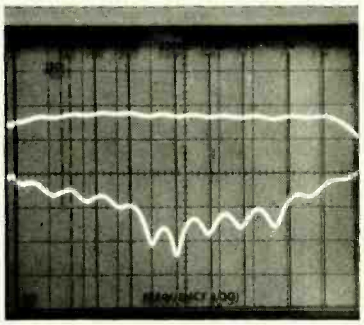


FIG. 2

Summary

In our opinion, this home-built equalizer offers graphic equalization capabilities of more expensive, commercially built units at just a fraction of the cost of such units. Examination of the layout of the equalizer suggests that it would be relatively easy to assemble.

unit is shown in Fig. 1. For a simplified diagram of one band, see Fig. 2. Op-amp IC3-d, with R14, R15, C12 and C13

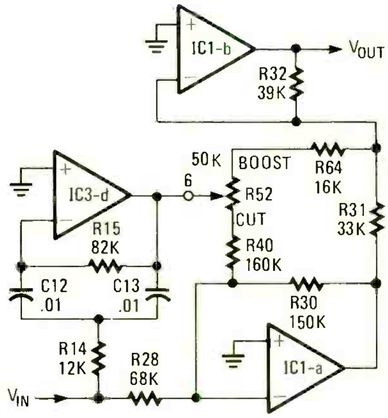


FIG. 2—SIMPLIFIED CIRCUIT of one channel. Cut or boost depends on setting of R52.

form a bridged-T bandpass filter. Capacitors C12, C13 and resistor R14 are the "T" that is bridged by resistor R15. At low frequencies, the high impedance of the capacitors blocks the signal. At high frequencies, C12 and C13 short IC3-d's output to its negative input. The resulting negative feedback keeps the output at the same voltage level as the positive input, thus preventing a signal from passing through.

Near the center frequency of the filter, the signal flows through R14 to the center of the "T." From there, it is phase-shifted by passing through C12, inverted by the op-amp and then phase-shifted again by C13. The two phase shifts and the phase inversion cause the signal coming through C13 to be nearly in phase with the input signal, thus adding to it and resulting in signal gain. Resistor R15 damps the "T' to control Q and filter gain. Figure 3 shows the frequency re-

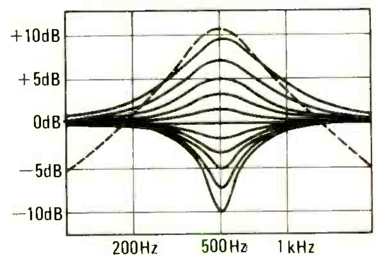


FIG. 3—FREQUENCY RESPONSE of Band 6 as control pot is varied through 11 positions.

sponse of the filter at eleven evenly spaced settings of control R52. The dashed line represents the output of IC3-d.

For frequencies outside the passband of IC3-d, the signal is amplified by IC1-a and IC1-b with gains of R30/R28 and R32/R31, respectively. When the wiper of R52 is set to the CUT position, frequencies in the passband of IC3-d are partially cancelled because the signal fed to the top end of R40 has been inverted by IC3-d. When R52's wiper is moved toward the

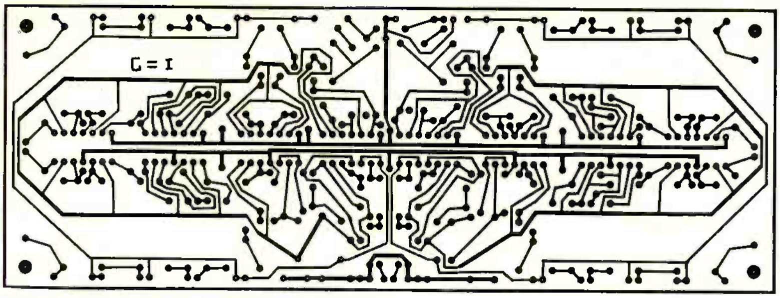


FIG. 5—PATTERN FOR AMPLIFIER BOARD is half-size. Enlarge to exactly 8 inches across.

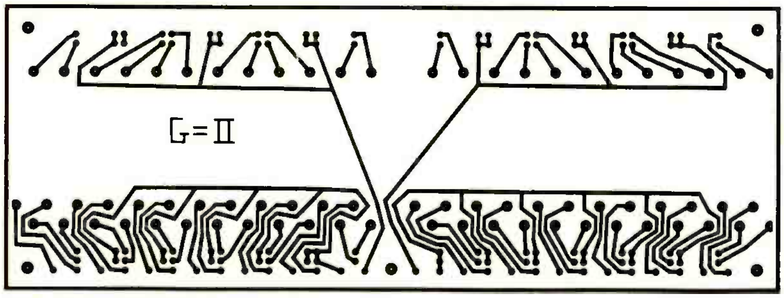


FIG. 6—HALF-SIZE pattern for control board that holds the slide pots.

BOOST end, the signal from IC3-d adds to the output. When the wiper is centered, signal additions and cancellations are equal and the response is flat. The resistors are selected for a nominal range of ± 10 dB at the center frequency of the bridged-T. With a linear-taper potentiometer, the boost or cut versus position is shown in Fig. 4. It is close enough to linear on a dB scale so as not to require specially tapered potentiometers.

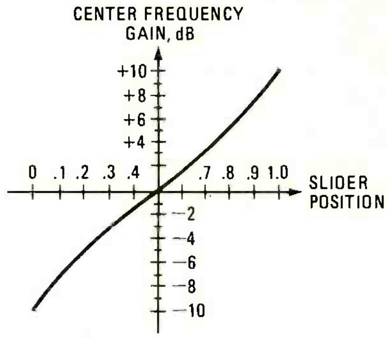


FIG. 4—HOW RESPONSE VARIES with the position of slider on a linear-taper potentiometer.

Next month we will conclude this article with a further discussion of circuit operation followed by construction, installation and operating details. Included in construction details will be several interior photographs and step-by-step instructions that you will need to successfully complete this stereo graphic equalizer with the minimum of effort and a maximum of pleasure. **R-E**

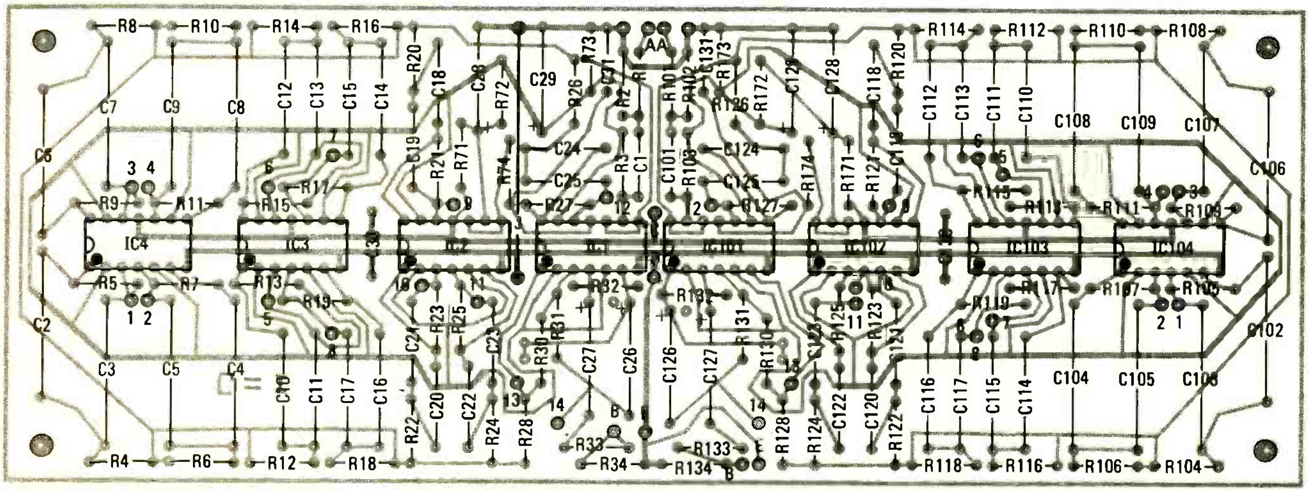
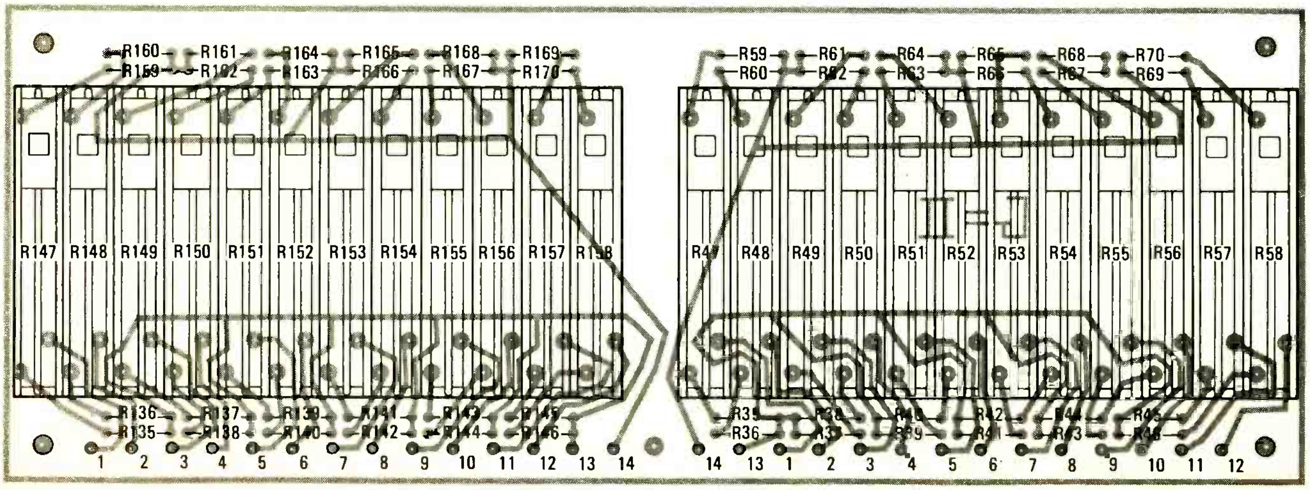


FIG. 7—HOW PARTS ARE POSITIONED on the amplifier board. Right and left halves of board are almost mirror images.

FIG. 8—THE SLIDE POTS and their associated fixed resistors are mounted on control board as shown here.



Protect Your Home—

Build Autodialer And Cassette Interface

A fire, intruder or other emergency in your unattended home can result in serious losses. Use this autodialer to alert neighbors or authorities.

JULES H. GILDER

A BURGLAR BREAKS INTO YOUR HOME, tripping an alarm in the process, but nothing seems to happen. Minutes later he is caught in the act by the police. They were called automatically by the cassette autodialer. Activated by switches in the intruder or fire alarm systems or by a panic button, the autodialer dials a preprogrammed number and plays a prepared message. The device attaches to your telephone and a cassette recorder.

> **WARNING**
> Current FCC rules (Part 68) forbid direct connection of customer-owned equipment that is not FCC type approved to telephone company lines. To use unapproved equipment, an approved protective coupler must be installed. Check with your local phone company for details.

If you desire, several different numbers, each with a different message, may be dialed in sequence. This comes in handy when local laws prohibit burglar alarm dialers from calling the police directly. In this case, several friends or relatives can be dialed in turn, to make sure that at least one is alerted and will call the police.

Dialing can be done in two ways: Either by pulsing a relay that has contacts in series with one of the leads to the telephone or by pulsing a solenoid that presses and releases the cradle button. This version is shown in a photograph. The first method is easiest and does not require a mechanical linkage to the phone. However, telephone company tariff regulations may require you to use a special coupling device between the dialer and telephone. If you don't want the expense of the coupler and want to avoid the possibility of trouble with the phone company, use the solenoid approach.

With the solenoid actuator the cradle button, which is depressed when you hang up the phone, is released and pressed a number of times corresponding to the numbers dialed. This action accomplishes the same results as the contacts on the telephone dial; it opens and closes the telephone circuit each time a pulse is applied.

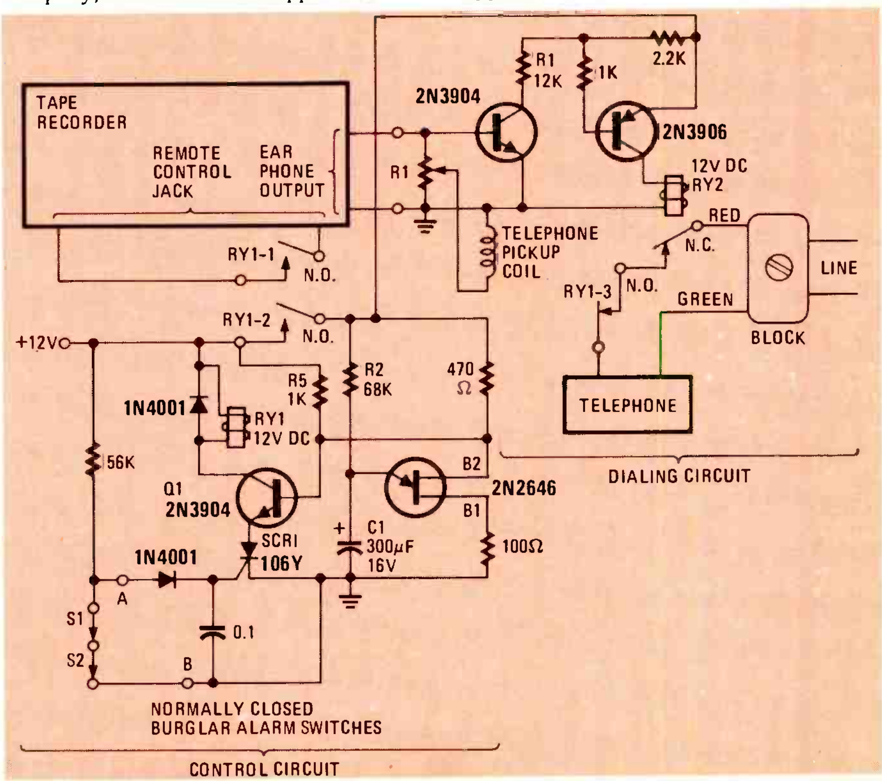


FIG. 1—THE AUTODIALER consists of an ordinary cassette recorder and a few simple components. Pulses recorded on tape dial a selected phone and then a pre-recorded message is played.

The autodialer circuit

The automatic cassette dialer circuit (Fig. 1) consists of the recorder, the control circuit and the dialing circuit. You can use any cassette recorder that has a remote control jack and a jack for an external microphone. Information that is recorded and played back is well within the frequency response of even the least expensive units.

The control circuitry couples the unit to any existing intruder alarm system that has a series of normally closed switches. When a switch is opened, the gate of the SCR is disconnected from ground and a positive pulse is applied to it. The SCR turns on and locks in. Once the SCR is triggered, its gate loses control. The device continues to conduct even when the gate is returned to ground.

When SCR1 is triggered, it completes the emitter-to-ground circuit of Q1. The transistor conducts and energizes relay RY1. This applies power to the recorder and to the dialer's disconnect timer circuit through contacts RY1-1 and RY1-2. At the same time, normally open contacts RY1-3—in series with the red line—are closed to complete the circuit to the telephone.

The recorder starts and plays back the programmed tape. The recorder output is fed through control R1 to a ring-type telephone pickup coil and fed directly to the pulse-detection circuit that opens and closes RY2. The coil induces the audio signals from the recorder into the telephone line. Relay RY2 has normally closed contacts in series with the normally open contacts of RY1 and the telephone. When RY2 opens and closes in accordance with the prerecorded pulses, it is dialing the telephone.

(If the solenoid method of dialing is used, the RY1 and RY2 series contacts are placed in the power lead to the solenoid so it pulls in and then releases with each dialing pulse.)

The audio message follows the dialing pulses. It will not key RY2 because its level is much lower than that of the pulses.

If more than one phone call is to be made each message, except the last, must be followed by a tone that is 5 to 10 seconds long. This tone causes RY2 to open the telephone line long enough for it to disconnect and prepare the telephone for the next call.

After the disconnect tone, the next number is dialed and message transmitted in the same way as the first. After the last message, the autodialer is turned off by a timer built around a 2N2646 unijunction transistor. When the delay determined by $T = R2 \times C1$ has elapsed, the timer produces a pulse that turns off Q1. This interrupts the current path through the SCR and releases RY1, disconnecting power from the autodialer and opening the phone-line circuit.

Construction

The construction of the autodialer will be largely determined by the method of dialing used. If the series relay is used, the whole unit may be enclosed in a small Bakelite case. If the solenoid dialing scheme is chosen, then a 5 × 9 × 2-inch chassis is suggested. This allows the phone to sit on top of it and provides a firm foundation for the vertical arm that will hold the pulsing solenoid, as shown in Fig. 2.

FIG. 2—AUTODIALER WITH SOLENOID that pulses the cradle button. The two toggle switches in the base are not used.

The vertical arm should be 10 inches high and is easily constructed from a piece of wood 2 inches wide and 1 inch thick. To position the supporting arm, place the telephone on the chassis the way it normally will be placed. Then mark the spot where the arm is parallel with the receiver cradle. Fasten the vertical support with two screws.

Next, place the solenoid against the support and let the plunger hang down. Lower the solenoid until the plunger depresses the cradle button, mark the spot on the support and fasten.

With the mechanical work out of the way, the rest of the device is relatively simple to fabricate. The circuit can be built on perforated board or on a PC board of your own design. The autodialer can work from a pair of 6-volt lantern batteries that are generally used in alarm systems, but a regulated 12-volt DC power supply can be used.

Installation and operation

If the solenoid dialing method is used, installation simply means placing the telephone on the chassis, taking the receiver off the hook, and allowing the solenoid plunger to hold the cradle button down.

If the series-relay dialing method is used, one of the leads from the telephone, preferably the red one, is connected in series with the contacts of RY1 and RY2. In both cases, the telephone pickup coil is then placed on the earpiece of the handset of the telephone. Before placing the unit into operation, play the entire message tape and time it. Add 5 seconds on to this time and then set the unijunction oscillator so that it will produce a pulse after that period of time has elapsed. This is done by adjusting the value of R1 until the desired delay is obtained.

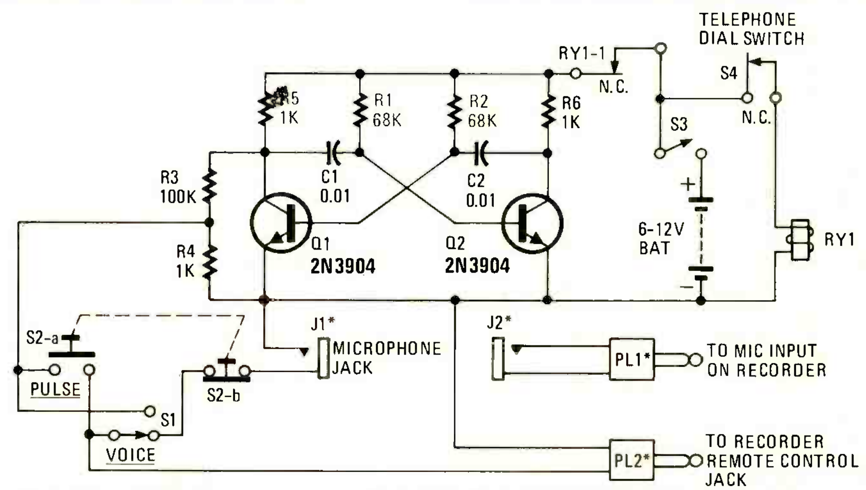
You are now ready to test the cassette autodialer. Connect the unit to your burglar alarm system so that in the untriggered position A and B are normally shorted. Now momentarily depress the alarm TEST switch or open one of the switches in the alarm circuit.

If the dial pulses recorded on the tape do not cause the relay to operate, the volume is too low. It may be necessary to rerecord them at a higher volume.

If the voice message causes the relay to kick in and out, the volume is too high. Lower the volume or rerecord.

The pulse programmer

The pulse programmer in Fig. 3 is primarily intended to be used with the cassette autodialer alarm system. It is



*PL1-MINIATURE PHONE PLUG
PL2-SUBMINIATURE PHONE PLUG
J1 AND J2-MINIATURE AND SUBMINIATURE JACKS TO MATCH PLUGS ON RECORDER MIKE

FIG. 3—PULSE PROGRAMMER uses a multivibrator to develop the audio tone pulses that dial the phone or perform other operations. Mike signal feeds through programmer to recorder.

used to program tapes, which can then dial a telephone or control some other circuitry. However, a little bit of imaginative thinking will quickly make you realize that there are many other applications. For example, you can combine the programmed tapes with the recorder and dialer portions of the autodialer and produce an automatic telephone dialer. A C-60 cassette used for this application could easily store one hundred phone numbers. Another use for the pulse programmer is in synchronizing tape/slide presentations. Tones recorded on the tape are used to short out the remote-control contacts of the projector and thus cause the slide mechanism to advance.

The pulse programmer can also be used to prepare tapes that will control a sequence of events, such as turning lights on and off in your house while you are away. If endless cassettes are used, things can periodically be turned on and off.

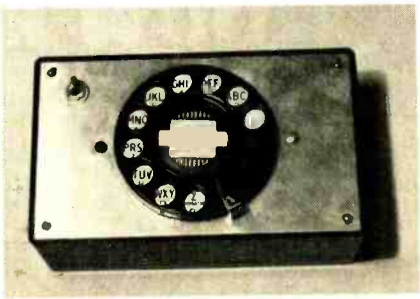
The heart of the pulse programmer is a two-transistor astable multivibrator. The frequency of oscillation of the multivibrator is determined by R1, R2, C1, and C2. By setting R1 = R2 and C1 = C2 the frequency of oscillation is $f = 1/T$ where $T = 1.38 \times R1 \times C1$. For the components shown, the oscillation frequency is about 1 kHz.

The oscillator provides the tones that will be recorded onto the tape for controlling the relay at the output of the recorder.

Not all tape recorders have a high-impedance microphone input, so the voltage-divider network R3/R4 provides the desired high resistance load to the oscillator. The voltage divider also prevents any damage to the recorder from excessively high oscillator voltages.

To get the multivibrator to produce tone pulses that correspond to the digit pulses produced by a telephone, its output circuitry is controlled by relay RY1, which itself is controlled by the telephone dial. The telephone dial may be removed from any old telephone or purchased surplus.

The relay is needed because the pulsing contacts of the phone dial are normally closed, and normally open contacts are needed to control the output of the multivibrator. The relay is connected so that when the dial is operated it produces a series of tone pulses for each number dialed. If, for example, a 3 is dialed, the relay will close and open three times producing three pulses. The pulse rate of the dial is about 10 pulses-per-second.



PULSE PROGRAMMER with its electronics (Fig. 3) and telephone dial are built into a small plastic utility box or similar housing.

Building the programmer

The pulse programmer is built into a plastic utility box that measures $6\frac{1}{4} \times 3\frac{5}{8} \times 2$ inches. This size box will accommodate the standard telephone dial as well as the multivibrator circuit, relay and battery.

The $3\frac{1}{4}$-inch hole in the cover plate required for the dial can easily be cut with a hole saw. It is best to use a variable speed drill on low, if one is available. If not, pump the trigger switch on and off so that the hole saw only makes a few revolutions at a time. By working slowly and carefully you will get a perfect hole. The dial can be mounted to the cover plate with two screws and Z brackets. (For PL2, any wire can be connected to the plug's tip or body.)

Installation

To connect the pulse programmer for use, a four-conductor shielded cable is needed. This cable should have a miniature and subminiature plug on both ends. The miniature plug (PL1) goes to the tape recorder's microphone input, while the subminiature one goes to the remote control jack so the recorder can still be controlled by the push-to-talk switch on the microphone.

To program a series of pulses from the telephone dial, turn on S3 and place S1 in the PULSE position and operate the telephone dial. This feeds a train of tone pulses to the recorder input. When you are finished recording pulses, flip the switch to the VOICE position and record your message. Additional pulses of longer duration, such as those used to separate messages in the autodialer, can be made by operating pushbutton S2. This will produce an output pulse for as long as it is held down, regardless of what position S1 is in.

(Material for this story and for the articles, "Amplifier for Hands-Off Telephone" and "Turn-On Appliances Via Long Distance" in the March and April 1977 issues was taken from the author's book, Telephone Accessories You Can Build. *Published by Hayden Book Co., Rochelle Park, NJ 07662, Price $3.95.—* Editor) **R-E**

Matsushita develops new video disc system

Matsushita of Japan recently announced the development of its *Visc II* video disc system that uses the same material (polyvinylchloride) and techniques used in manufacturing LP records. A further similarity to LP techniques is provided by the system's diamond stylus, which drives a piezoelectric transducer to reproduce the information contained in the hills and valleys of the disc. The disc is uncoated, it revolves at 450 RPM and plays up to one hour per side.

Groove depth is about 1 μm, with the undulations at the bottom of the grooves about 0.1 μm high. Spacing between hills on the Matsushita disc is about 0.5 μm at a maximum recording frequency of 10 MHz. The video luminance signal is recorded as an FM carrier signal with a tip frequency of 4.3 MHz and a white peak frequency of 6.3 MHz. The cartridge installed on a radial trolley with zero tracking error is kept synchronized with the spiral groove.

Matsushita claims that all components for the system are easily available, and the *Visc II* can be produced for between $480 and $600. No actual production plans have been released yet; the company says it has to line up disc manufacturers as well as program material.

"Feedback TV" entertains cable subscribers

Warner Cable Corporation, a subsidiary of Warner Communications, Inc., has made a new "feedback TV" system available to its 30,000 subscribers in the Columbus, OH, area. Viewers participate in TV shows in progress by merely pushing a button to register an opinion or answer program questions.

How the system works: A box of electronic equipment is installed next to the TV set, plus a control box that looks like a pocket calculator. There are 30 channels on the control box, two of which are "participatory." These two channels let the viewer "talk back" to the TV.

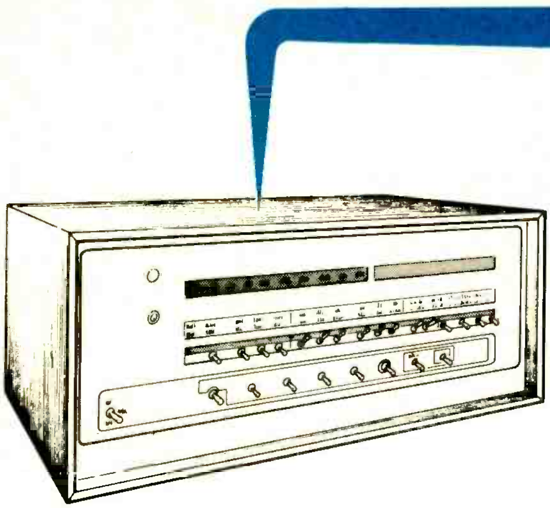
One of the two participatory channels features a morning "Sesame Street" type of program; the other splits the programming between "Columbus Alive" (resembling the "Today Show") and a game program. On these shows, subscribers press the buttons to inform program officials how they feel about the program material, to suggest topics for discussion, or to answer game show questions.

Another type of programming is envisioned. Merchants would display their merchandise (such as electronic equipment); the viewers can then order what they want by pushing the appropriate button. The computer has the viewer's address, phone number and account number, so that the product and bill can then be sent to him.

The remaining channels in the Warner cable system present traditional programs, premium or pay-TV and community service programs. The company presently has a franchise to serve 30,000 homes in Columbus and expects this number to increase as "feedback TV" catches on.

Microcomputer convention to be held in Dallas, TX

The International Microcomputer Exposition will be held in Dallas, from September 29 through October 1, 1978. Several groups, including the American Association of Microprocessor Engineers, will be sponsoring the event, which will be geared to every level from professional engineers to beginning computer hobbyists. A panel of experts will be present to answer questions. Write International Microcomputer Exposition, 413 Carillion Plaza, 13601 Preston Rd., Dallas, TX 75240.



Digital Data How A Computer

The value of a computer is greatly enhanced when the peripheral devices, such as a CRT terminal, transmission methods, transmission rates and

THERE ARE MANY WAYS TO TRANSMIT BINARY DATA FROM ONE location to another. With the advent of the personal computer, it is important that we understand these different ways so that we can understand how a computer communicates with a peripheral device.

Transmitting digital data

Digital devices communicate with other digital devices on a direct current (DC) basis. Within this DC signaling there are two transmission modes—bit-serial and bit-parallel.

In the bit-serial mode each bit is transmitted sequentially. Figure 1 shows a DC circuit in which a receiving device is

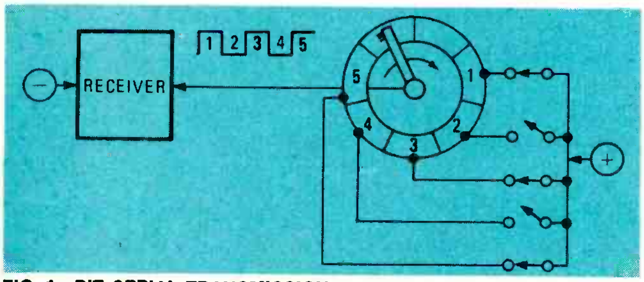


FIG. 1—BIT-SERIAL TRANSMISSION. For illustrative purposes only, the transmitter is shown as an electromechanical device. The transmitted character consists of five data bits.

connected to a bit-serial transmission mechanism. This hypothetical mechanism consists of a plate that has seven electrically isolated segments. One segment for each of the five bits required to transmit a character, plus two additional segments that serve to transmit a space in between each transmitted character. A wiper arm makes contact with each segment individually and completes one revolution for each character transmitted.

Each segment is wired to a sensing contact, which, in turn, can be operated by a mechanical component of the transmitter such as a paper-tape sensing pin. Current flows in the circuit connecting this transmitter to the receiver when the wiper arm crosses a segment whose associated sensing contact is closed. Because the wiper arm tests each segment sequentially, the circuit responds accordingly, and the generated code bits are presented serially to the receiver.

Bit-parallel transmission is performed by preparing all the character bits simultaneously and then issuing a clock signal to indicate to the receiver that a character is ready (see Fig. 2).

From this you can see that bit-serial transmission requires only one circuit to send a complete character whereas in bit-parallel transmission, a separate circuit is required for each character bit (plus the clocking information). The advantage of bit-parallel transmission is that data can be transmitted faster because all bits within a character are made available simultaneously. This is why bit-parallel interfaces are normally used to connect up to a high-speed printer whereas the slower teletypewriter circuits use bit-serial transmission.

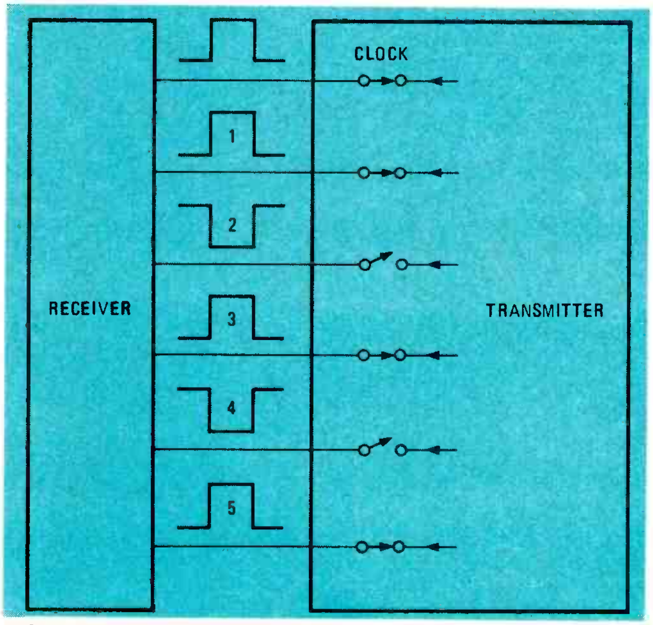
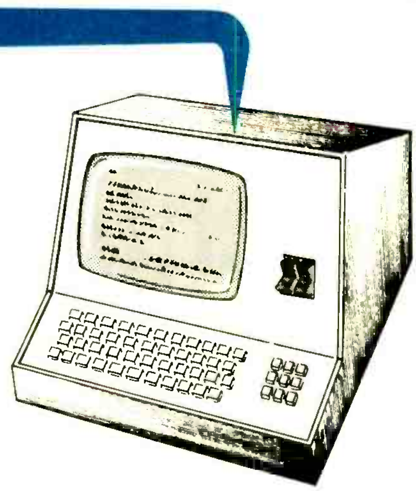


FIG. 2—BIT-PARALLEL TRANSMISSION. All data bits are transmitted simultaneously over five individual circuits.

Transmission method

A communications receiver accepts and acts upon the information contained within the transmitted signal. If the circuit operates in the bit-serial mode, the receiver must know when the first bit of a character is available and the time interval separating each sequential bit. In the bit-parallel mode the receiver must distinguish between the idle condition of the circuit and the occurrence of a character. The transmitter and the receiver must be synchronized, and, because there is no mechanical linkage between them, the timing information must be conveyed on the circuit connecting them. This synchronization is estab-

Transmission—Communicates



computer has the capability to communicate with printer or floppy disc. Here's a look at the various interface schemes that are available for use.

PHIL HUGHES

lished by one of two methods: *asynchronous* or *synchronous*.

In asynchronous transmission the timing information is derived from each character transmitted. The normal idle condition of an asynchronous circuit is current-on (called *mark*). To initiate operation, the transmitter precedes each character with a *start* (current-off) bit. This current-off condition (called *space*) advises the receiver that a character will follow and that it should start looking at the predetermined intervals for the character bits. The transmitter follows the last data bit with a return to the normal idle condition by adding a *stop* (current-on) interval. The length of this interval is determined by when the next character is available for transmission. The term asynchronous is synonymous with *start/stop* and implies that the receiver comes to rest between each character. The start bit provides the synchronization with each incoming character.

The bit-serial transmission mechanism shown in Fig. 3 is

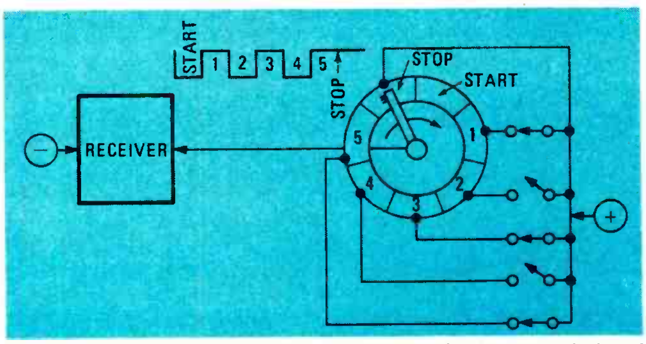


FIG. 3—ASYNCHRONOUS SERIAL TRANSMISSION includes start and stop bits in addition to the data bits.

similar to that shown in Fig. 1, but with the addition of start and stop bits. Note that the stop bit has a fixed length, but this is meaningful only when there is a continuous flow of characters, otherwise the stop bit is indistinguishable from the idle (mark) condition of the line. This, according to old Western Union operators, is where the expression 'just marking time' comes from.

In a bit-parallel circuit the receiver uses a timing or clock pulse to signal the arrival of data. The clock contact shown in Fig. 2 is operated whenever a character is available.

The synchronous transmission method is more sophisticated than the asynchronous mode. It assumes that the transmitter and receiver are being driven at identical clock rates and that the corresponding functions of each (bit generation by the transmitter and the detection of that bit by the receiver) occur at the same time. The clock rates of the transmitter and receiver are matched by the transmission of a timing pattern. These timing patterns are called synchronization (or sync) characters.

In some systems during idle line time (when no data is ready for transmission), a continuous stream of sync characters is transmitted. In other systems, a fixed number of sync characters are sent immediately preceding the data characters. In all systems, the receiver does a bit-by-bit comparison of the incoming bit stream to the bit configuration of the sync character. When a match is detected, the receiver is said to be *locked-on*, and the data characters can be sent without additional timing information. The receiver can then distinguish between the individual bits of a data character because the position of the sync character has been established.

In asynchronous transmission, timing information is included with each character. This timing overhead represents from 20% to almost 50% of the character time, depending on what code is being transmitted. Synchronous transmission has the advantage of handling its timing overhead with a few sync characters at the beginning of a message. This significantly reduces transmission overhead attributable to timing information.

Transmission rates

Digital data can be transmitted at many different speeds, and individual devices can frequently operate at two or more rates. These rates can be expressed as characters-per-second (CPS), words-per-minute (WPM) and *baud* or bits-per-second, the term baud is used interchangeably with bits-per-second. For bit-serial transmission, the meaning of characters-per-second is clear. For bit-parallel transmission, bits-per-second and characters-per-second are equivalent because each bit requires a separate circuit. Bit-serial devices have a varying number of bits in each character, and transmission facilities are concerned with the maximum number of electrical transitions they are required to handle. Therefore, bit-serial devices and transmission limitations are expressed in terms of bits-per-second.

To determine the transmission rate, we must first determine the number of bits contained in a transmitted character. This number is generally not equal to the number of bits that are required to define the character because transmission-overhead bits must be added. For example, the ASCII code requires only seven bits to define a character, but the synchronous transmitter adds a parity bit for error checking. Thus, transmitting the ASCII code over a synchronous data link requires eight bits-per-character. The following formula can be used to compute the data rate on a synchronous link:

Bits-per-second = characters-per-second × bits-per-character (data bits + parity bit).

For asynchronous transmission, add the start and stop bits as well as a parity bit. If the start and stop bit times are equal to the character bit times, then 10 bit times (seven data bits + parity + stop + start) are required to transmit an ASCII character. Actually, in asynchronous transmission the stop bit is frequently longer than the data bits. For example, an ASCII teletypewriter requires a stop bit that is equal to twice the length of a data bit, thus requiring 11 bit times to transmit a character. The Baudot (an older five-bit level code) teletypewriters generally require a stop bit that is equal in length to 1.42 bit times. Because of this difference between various asynchronous transmitters, the character is expressed in terms of bit-lengths. This bit-length-per-character is called the *unit code*. For example, an ASCII code with a parity bit, a start bit and a stop bit equal in length to one data bit is a 10 unit code. A Baudot device with five data bits, a start bit, and a 1.42 unit stop bit form a 7.42 unit code. Table 1 shows some common devices and representative code lengths.

TABLE 1–UNIT CODE FOR COMMON DEVICES

	Bell System Baudot TTY	Western Union TTY	10 characters per second ASCII TTY	30 characters per second ASCII terminal
Start	1	1	1	1
Data bits	5	5	7	7
Parity bits	Not used	Not used	1	1
Stop	1.42	1	2	1
Total unit code	7.42	7	11	10

Using the unit code concept, the following formula determines the data rate for asynchronous circuits:

Bits-per-second = characters-per-second × unit code.

Communications interface

The communications interface is the electrical connection between the computer and the communications equipment. The latter is generally a data set or modem. (A modem is a device that converts DC signals into AC signals suitable for transmission over telephone circuits and then converts them back to DC signals for reception.) The computer equipment is either an I/O port or a terminal.

It is fairly common for two pieces of computer equipment to be connected together. Although this does not fit into the strict definition of a communications interface, the definition can be stretched a little. The two pieces of connected equipment are generally called the *data terminal equipment* and the *data communications equipment*. Since the data terminal equipment will exist whether the terminal is connected to a communications interface or to a computer, the terminal itself can be defined as the data terminal equipment. Data communications equipment refers to either the data equipment or the computer. In other words the data communications equipment will always refer to whatever it is that you are connecting to a terminal. Now that we have the hardest definition out of the way let's look at a couple of common interfaces. We'll see what they are, how they differ and how they are applied.

Figure 4 shows a 20 mA (20-mil) current-loop interface. The circuit has only two wires, with the earth commonly used in place of one wire. A mark condition or logic 1 is defined as a complete circuit; a space or logic 0 is an open circuit; and information is transmitted as is shown in Fig. 3. This circuit is the standard interface for teletypewriter devices.

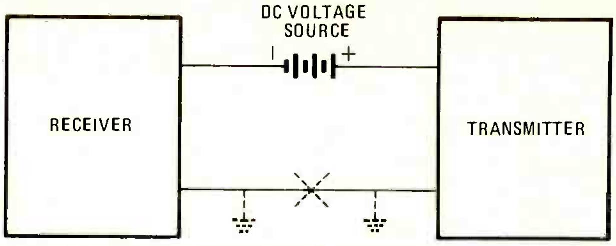


FIG. 4—20-MIL CURRENT LOOP for serial data transmission. Some systems replace the return path with a common ground. This reduces the number of wires running between the transmitter and receiver to one.

The other common interface is the Electronic Industries Association (EIA) No. RS-232-C. This interface is the most popular even though it predates integrated circuits and is therefore not tailored to IC levels. The telephone companies use this standard as the interface with which their data sets are designed to operate.

The RS-232-C standard is defined in terms of voltage levels. A voltage from +3 to +15 is defined as a space or logic 0, and a voltage from −3 to −15 is defined as a mark or logic 1. The transmitter specifications are from +5 to +15 volts for a space, and −5 to −15 volts for a mark. This allows for noise and a loss of up to 2 volts in the circuit.

A standard RS-232-C communications circuit consists of a data path in both directions, a ground return and status and control lines. Table 2 shows the standard pin assignments for the most common signals and the direction of data flow. Note that if a computer is directly connected to a terminal, it is necessary to alter some connections such as attaching the receive-data lead from the terminal to the transmit-data lead of the computer and vice versa.

TABLE 2–STANDARD RS-232-C PIN ASSIGNMENTS

Pin No.	Description	Data direction
1	Protective (chassis) ground	
2	Transmitted data	From terminal
3	Received data	To terminal
4	Request to send	From terminal
5	Clear to send	To terminal
6	Data set ready	To terminal
7	Signal ground	
8	Data carrier detect	To terminal
20	Data terminal ready	From terminal

The protective ground is equivalent to the third pin on a standard household electrical outlet. It insures that the chassis potential of all the equipment is equal, which should result in a longer equipment life. It also eliminates possibly hazardous potential differences between chassis. Signal ground is used as the reference for all the interface levels.

Transmitted data is the data that comes from the transmitter and is sent to a receiver; receive data is transmitted in the other direction, with the information to be displayed.

All other RS-232-C interface signals are for supervisory or control purposes. Some send information to the terminal, and others request information from the terminal. *Data set ready* signals the terminal that the communications equipment is powered up and ready. *Data terminal ready* indicates that the terminal is powered up and ready.

The *request to send* and *clear to send* lines are used for handshaking between the terminal and data set. When the terminal wants to send data, it activates the *request to send* line and then waits for the communications equipment to activate the *clear to send* line before data is actually sent. This gives the data set time to turn on the transmit signal. The delay between *request to send* and *clear to send* is called *line turnaround time* and can vary between 0 and 200 ms. The actual delay is selected based on circuit characteristics and then set by the circuitry within the data set. **R-E**

Noise Interference In Mobile Rigs

How To Get Rid Of It

Eliminating interference in mobile radios can be simple when you find the source. Here's how to find and get rid of most noise.

JOSEPH J. CARR

NOISE INTERFERENCE IS PERHAPS ONE OF THE MOST IRRITATING problems encountered when installing a mobile rig. Some noise problems seem so difficult to eliminate that many simply put up with the irritation, and accept it. However, most noise problems are relatively easy to solve, and are amenable to almost simplistic solutions.

The first step in troubleshooting any mobile noise problem is to identify the *types* (notice the use of the plural form!) of noise present. Generally, noises come in bunches, each of which must be solved by a slightly different approach. Is it, for example, spark plug/ignition noise? Is it alternator whine? Or is it the sloshy-sounding tick of the gasoline level sensor in the fuel tank? You should not fall prey to the trap of assuming that only one form of noise is present, even when they sound enough alike to mask each other.

Suppression methods

Table 1 shows the most common types of noise in mobile broadcast and communications receivers, along with their recommended cures. Be aware, though, that many transceivers may not be able to use all of these techniques because of the high current demands of the transmitter. For example, if the L-section filter is used to suppress alternator whine, the recommended choke will have too high a resistance for a 100-watt transmitter. In these cases, you could open the transceiver and insert the filter in the power-supply line feeding the receiver and thus leave the power-supply line feeding the transmitter circuits intact. If this is possible, it will also allow you to fuse the power-supply line feeding the receiver at a much lower current than the rating of the primary fuse for the transmitter. It has been known to happen, especially where solid-state receivers are used, that the receiver power supply could burn up rather spectacularly, yet the power-supply current would not blow the 25- to 50-ampere fuse needed to sustain the normal transmitter supply current.

Also, be aware that some automobile manufacturers will have installed some suppression techniques that could be superior to those given in this article for specific automobile models. This is especially true for alternator whine or where a grounding or shielding problem in the vehicle has been detected. A call to the local automobile dealership or to the field-service department of the auto maker often yields rich information.

The capacitor method of suppressing ignition noises works well on the old-fashioned Kettering coil/breaker-points type of ignition that is standard on almost all cars, but it may not work

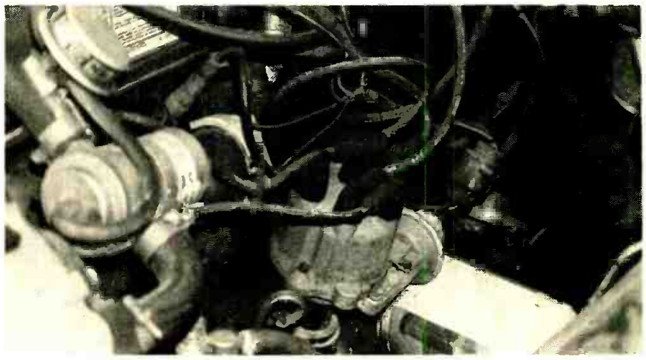


FIG. 1—IGNITION SYSTEM is the most dominant source of RF interference in automotive installations. Early amateur radio operators often used ignition coils from Model-T cars as transmitters.

or may cause damage to the newer solid-state ignition systems. In this case, contact the car manufacturer (either the car maker if it is O.E.M. equipment or the ignition manufacturer if it is an after-market product).

The ignition system (shown in Fig. 1) is not the only source of spark-like interference. There are numerous small DC motors in your car that are often overlooked. One of the prime offenders is the motor (see Fig. 2) that drives the blower in the heating/air-conditioning system.

Standard suppressors

Some of the suppression techniques recommended (see Table

TABLE I

SYMPTOM	CAUSE	CURE	COMMENTS
Popping static at a regular rate. Varies with engine RPM.	Ignition system	Check for deteriorated resistance ignition wire. Bypass capacitor from battery terminal of ignition coil to ground (0.5-μF).	Check antenna ground.
High-pitched ragged howl.	Generator	0.1 to 0.5-μF from armature terminal to ground and/or L-section filter at radio power lead. Do *not* bypass field terminal.	Applicable only to older U.S. and some imported cars.
High-pitched, nearly "pure" whistle. Varies with engine RPM.	Alternator	Check car manufacturer's service manual. Install a 0.1 to 0.5-μF capacitor at alternator and/or L-section filter at radio power lead.	
"Frying eggs" sound.	Regulator	Bypass input and output terminals of regulator to ground with 0.1-μF capacitors.	May also indicate a defective regulator.
Popping (slow). Does not vary as engine RPM varies.	Gas gauge sender unit.	Bypass lead-in wire as close to tank as possible. (0.5-μF).	Usually found under carpet in trunk. Consult manufacturer's service manual.
Popping sound as brake is depressed.	Brake-light switch.	0.5-μF across switch.	
Horn noise.	Horn	0.5-μF across horn winding.	May be masked by sound of horn.
Electrical motor whine. Does not vary with engine RPM.	Motors	0.5-μF across winding.	

Capacitor types: For AM radios, use only automotive-type bypass capacitors or coaxial types. For FM or CB radios, use only coaxial automotive bypass capacitors.

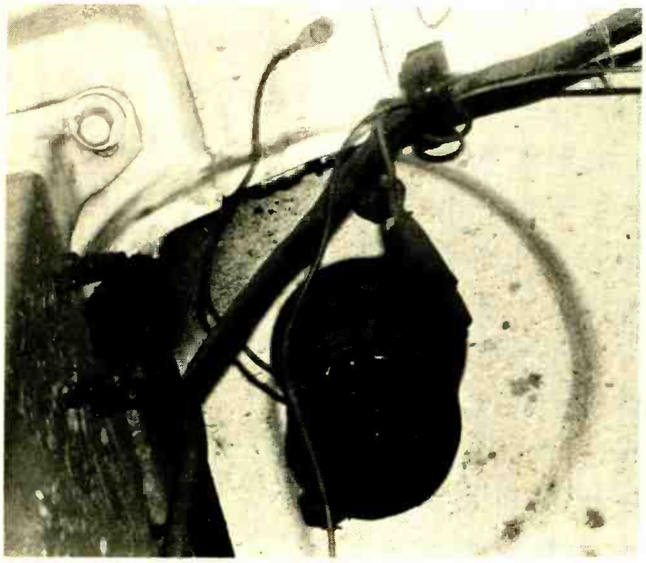


FIG. 2—HEATER/AIR CONDITIONER BLOWERS and other DC motors are often overlooked as sources of noise.

1) may already be installed in the car by the auto manufacturer, while you must add the others yourself. Note that vehicles equipped with only an AM radio may not have adequate bypass capacitors for high-frequency suppression, but many cars having AM/FM radios will have the correct capacitors. What is needed are *coaxial* bypass capacitors, such as those manufactured for amateur and CB use by Mallory and others.

Ignition system suppression uses a 0.1- to 0.5-μf capacitor across the primary side of the ignition coil and some resistance (approximately 10,000 ohms) in series with the spark plugs. Be absolutely sure to connect the capacitor to the battery terminal of the ignition coil (see Fig. 3) and not to the distributor terminal. (The distributor terminal of the coil is identified by the wire that runs to a grommet or connector on the side of the distributor, while the wire on the battery terminal of the ignition coil seems to disappear into the car's main wiring harness.) Use a coaxial bypass capacitor, then disconnect and discard the existing AM suppression capacitor.

The series resistance can take any of several forms. You could, for example, use copper ignition wires and then insert one

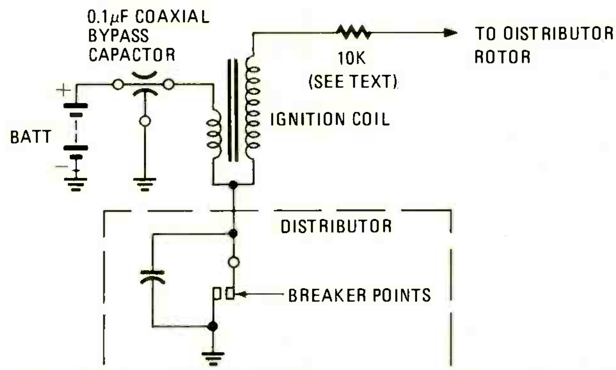


FIG. 3—KETTERING IGNITION SYSTEM was the most common before the electronic ignition system was introduced. Noise suppression involves addding a 0.1-μF capacitor on the primary side of the ignition coil and some resistance in series with the spark plugs if the engine does not already have this resistance present. The series resistance can take the form of resistance-type ignition wires or barrel-type resistors that are inserted in the spark plug wires.

of those little black barrel-shaped noise-suppression resistors in the line. I do not recommend this method, however, because the resistor could work loose and leave you stranded in the middle of nowhere. The car manufacturers usually supply the vehicle with either radio resistance wires or resistor spark plugs. In the case of some imported cars, resistor inserts or caps that attach to the spark plug electrodes are installed. The resistance wire, used on most American cars, works well in suppressing spark plug noise, but has the habit of deteriorating every couple of years. It does, however, provide very credible suppression of spark plug noises!

Figure 4 shows how to mount the coaxial bypass capacitor to the alternator frame to reduce the high-pitched whistle-type interference. As in *all* noise suppression capacitor installations, it is critical to keep the leads between the capacitor and the alternator as short as possible.

The *correct* terminal on the alternator (or generator if your car is older or imported) is the larger of the two terminals. This high-current terminal carries the charge to the battery. Do not

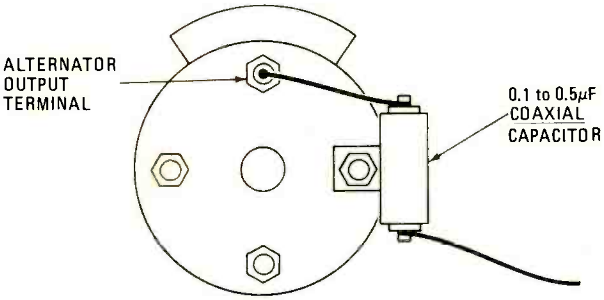


FIG. 4—ALTERNATOR WHINE is reduced by adding 0.1 to 0.5-µF coaxial capacitor to alternator as shown. Check with auto manufacturer for correct value or damage may result. To further reduce noise, an L-section filter can also be added at the input power line feeding the radio.

attach a capacitor to the smaller terminal, or damage may result.

Also, check with the automobile manufacturer about the correct capacitor value for your particular car model. A value between 0.1 to 0.5 μF is usually recommended. However, there have been several cases reported where certain alternators have resonated with the added capacitance, and this resonant condition resulted in alternator damage. It is better to check it out than not!

In the "old days" when generators were used and the voltage regulator was a chattering bank of three high-current relays in a little black box, the recommended cure was a 0.1-μf capacitor connected to both the battery and generator terminals of the regulator and a series R–C network with a short (less than 1 μs) time constant from the field terminal to ground. But this is no

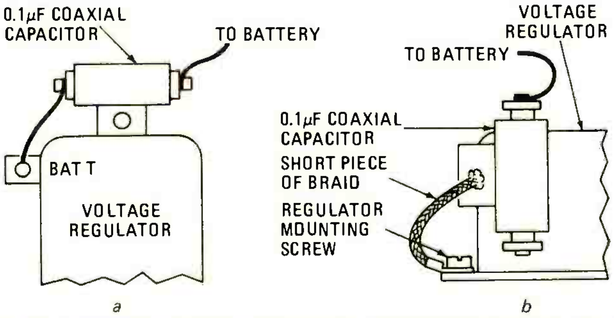


FIG. 5—REGULATOR CAUSED NOISE is reduced by adding a 0.1-µF coaxial capacitor in series with the battery terminal. Two possible methods for mounting the capacitor is shown in *a* and *b*.

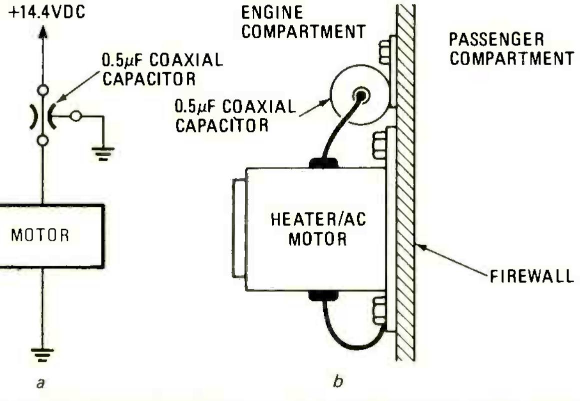


FIG. 6—DC MOTOR NOISE is reduced by adding 0.5-µF coaxial capacitor across motor winding as shown in *a*. Possible mounting location is shown in *b*.

longer the best advice. In modern cars, the regulator is either all solid-state or partially solid-state (the high-current pass element is a relay), so only a 0.1-μF coaxial capacitor from the battery terminal to ground is required.

Figure 5 shows two alternate methods for mounting the coaxial capacitor. Note that any existing AM suppression capacitors must be removed prior to installing the coaxial capacitors. Figure 5-a shows what can be termed the "common-sense" mounting method, while Fig. 5-b shows a little more clever method if the mechanical construction of the regulator allows it. Most regulator terminals are threaded to accept a No. 10-32 machine screw to hold the wire, so use a Mallory bypass capacitor that is similarly threaded. If only the female version is available, cut a No. 10-32 stud from a machine screw. Be absolutely sure that the connection between the capacitor and the terminal is tight or problems will occur at high charging currents. Use a piece of battery grounding braid or the tinned shield from a RG-8 or RG-11 coaxial cable to ground the capacitor body. Solder the end of the ground strap to the capacitor.

Figure 6 shows the method for suppressing the noise from a small DC motor such as the heater/air-conditioner blower. The 0.1-μf coaxial capacitor must be mounted as close as possible to the motor, a feat that is a lot easier to write about than actually do in most cases! Also, be sure that the motor housing is well grounded; the antirattle compounds that are sometimes used often provide a good DC ground but a poor RF ground.

Receiver defects

Component failures can create a noise problem in a vehicle that is otherwise free of excessive interference. The most common problem is the failure of certain noise-suppression components in the power-input circuit to the receiver.

Figure 7 shows a typical (well almost typical) power-input

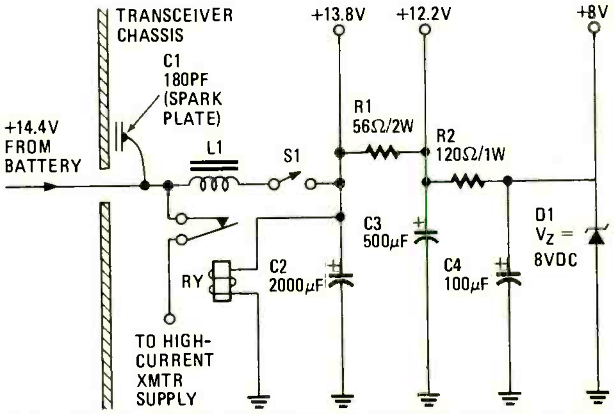


FIG. 7—TYPICAL POWER-INPUT CIRCUIT to mobile radio. If capacitors C1-C4 open up or if L1 should short, noise will enter the radio through the power supply line.

circuit to the receiver portion of a transceiver. Capacitor C1 rarely opens up (if it is used at all) because it is a spark-plate capacitor that consists of two pieces of copper foil sandwiched across a small square of fishpaper insulator. But if capacitors C1–C4 (especially capacitor C2) should open up, or if coil L1 should short out without shorting to the chassis (in which case it would burn out the fuse), then noise will result.

If the antenna input choke, or the lead from the antenna terminal on the transmit/receive relay, is placed parallel and beside the power-supply line from the battery, then there is a good chance that noise pulses will be picked up and cause interference in the RF amplifier. This type of noise problem, which incidentally is seen fairly often, is best corrected by either repositioning the antenna line or by placing it inside a shielded enclosure.

The best way to determine whether the problem is in the radio is by substitution, although this is not the most practical way where amateur mobile installations are concerned. But if it is possible to temporarily install some other rig then try it. If there is *reduction* in noise with the new rig (or, very rarely, the elimination of noise), then the problem is in the rig.

Antenna and radio grounding

Do not overlook the grounding connections for the antenna and the transceiver chassis as a possible cause of noise problems. The antenna should be checked by substituting it with a known good antenna. Although it is not resonant at the HF or VHF ham bands, you may use for test purposes only, an ordinary low-cost AM car-radio antenna. Attach the correct cable adapter and plug it into the transceiver antenna connector. Ground the base of the test antenna to a conductive chrome or bare steel fixture on the car—it is not usually necessary to mount the antenna.

When checking ground connections, it is advisable not to rely on an ohmmeter because the readings can be highly misleading. Like the tube tester, if the reading indicates it is bad, then you better believe it, but if it indicates it is good, then it may *still* be bad. In the case of the antenna, if an ohmmeter indicates that the coaxial cable shield is open, then you have found the source of your trouble—not to mention transmitter tune-up problems. However, if the ohmmeter reads some low resistance, then you must make the substitution test to verify that the ground is the cause of the problem.

Similarly, the radio chassis may look grounded to the DC power supply but to RF it actually might be at a sufficiently high impedance to produce a noise voltage high enough to interfere with reception.

Modern automobiles frequently use a clay- or putty-like anti-rattle compound between the dashboard and the firewall. Noise may result if the dashboard and the firewall are used as the ground return for the transceiver's DC power supply. The solution is to connect a heavy conductor between the radio chassis, the major dashboard braces *and* the firewall. Use either battery braid or an outer shield from a length of heavy coaxial cable.

The problem of noise caused by poor chassis grounding has been compounded in recent years by the use of lock-mount brackets and antitheft consoles over the transmission hump. This type of mounting is particularly popular with CB'ers, but is also used in low-power HF and two-meter amateur rigs.

Many less experienced mobile installers will use the coaxial cable shield as the DC ground return wire. This will not cause any DC-related problems unless the transmitter is a high-power unit that requires a large current from the supply circuit. It does, however, create potential noise problems because the RF impedance is quite high! If the radio has a ground wire, use it; if not, make one.

If you use a slide mount, you should take special care of the copper-finger connectors that bring power to the set. As long as they are not corroded and have not lost their spring tension, they work well, but let them deteriorate and you will hear it in the loudspeaker! The best solution is to route the ground wire directly to the firewall, but if theft is a problem in your area, then be sure to maintain the connections on the slide mount.

Antenna or power-line noise

Once the radio chassis and antenna grounding have been attended to and eliminated as possible sources of the noise, the next consideration is whether the noise is entering via the antenna or the power line. To determine this, disconnect the antenna and note whether or not the noise level is reduced. Some amateurs seem to believe (erroneously) that the type of noise indicates how it enters the set. Ignition noise, especially, can enter the set by either the antenna or power line, and the proper corrective action for each is different.

Antenna-related noise, for example, is often caused by the inadequate shielding action of the hood or body panels, or it can be caused by RF reradiation from the tailpipe of some other vehicle. Noise that enters on the power line, on the other hand, is often caused by the incorrect placement of the power cable itself, or by induction from another cable.

It is good practice to take note of whether the car has recently been serviced, or has recently been returned from the body shop following accident repairs. Sometimes, the fiberglass and plastic components materials used to repair body damage, or an incorrectly reinstalled antenna ground, can cause noise that did not exist before. For instance, in an actual case of a car with an all fiber glass body, the AM/FM radio has a great deal of motor noise that had not been there prior to repairs on the right rear-quarter panel. It turned out that the antenna ground to the tailpipe had not been reconnected, which was causing the interference.

After the tune-up

Another possible cause of a flare-up in motor noise is an improper motor tune-up job. If the noise occurs for the first time right after a tune-up, then suspect that something was wrong with the job.

In some cases, I have discovered that the mechanic substituted straight copper high-voltage wires for the resistance wires specified by the manufacturer. Use an ohmmeter to check whether the mechanic substituted the incorrect wire. First, check the wire from the high-voltage terminal on the coil to the center terminal on the distributor. If this wire does not have a resistance of several thousand ohms, then get back to that garage and have the mechanic install the correct spark-plug wires.

It is equally important to check the wires if the noise has appeared gradually, and it has been 25,000 miles or two years since the high-voltage wires were last replaced. The carbon-wire filament used in these cables deteriorates after a while and to a point where internal arcing occurs. Besides causing rough engine idle, this will also cause radio-frequency interference in the radio receiver.

A sure sign of deteriorated ignition cables is a low-speed popping noise that is most noticeable when the car is idling. This condition is caused by having one open-circuited spark plug. If you have ever observed the ignition waveforms of a multicylinder engine with such a problem on an automotive oscilloscope, then you probably saw the pulse amplitude on the offending cylinder go so high that it passed right off the top of the screen!

Some amateurs operating in the low-frequency (75-meters, mostly) bands use a low-value RF choke in series with the receiver antenna line inside the transceiver cabinet. This RF choke is usually placed in the receiver side of the transmit/receive relay circuit. Figure 8 shows an RF choke made up of a

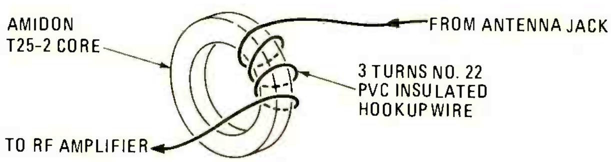


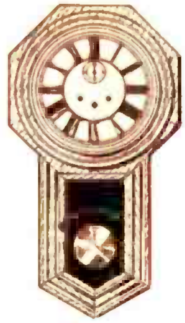
FIG. 8—NOISE CAN ALSO BE REDUCED by placing an RF choke in series with the antenna line inside of the receiver.

few turns of No. 22 enameled wire wrapped around a red-core toroid. This technique can work as high as the 20-meter band, and a colleague on mine claims that it works even into the 27-MHz Citizens band. However, inductance at the high end of the HF spectrum becomes appreciably reactive at those frequencies and will not only dull the noise-pulse spike but also impede the RF signal!

Alternator whine is one of the most annoying forms of interference to mobile rigs. It usually enters through the power line and is difficult to suppress. It even affects two-meter rigs, (normally immune because of the remoteness of 144-MHz from the stronger noise-pulse harmonics) because the whine penetrates the audio stages.

Figure 9 shows an L-section filter, long popular in the auto entertainment electronics market. The problem with using this filter is that the choke's high DC resistance will cause appreciable voltage drop when the transmitter is keyed. The choke is

continued on page 114



Unusual Electronic Clocks

Pendulums

Part 2—Conclusion of the roundup covering electronic clocks designed for installation in wall and mantel cabinets.

Displays Chimes

FRED BLECHMAN, K6UGT

LAST MONTH WE INTRODUCED YOU TO the world of unusual electronic clocks—those electronic clocks housed in the more traditional cabinets and having such features as chimes and pendulums. Now let's complete the roundup.

Heath

The *Electronic Clock Chimes* is an accessory that fits into the cabinets of the Heath *model GC-1195* floor and *model GC-1197* shelf *Super Clocks*. It electronically synthesizes a natural, mechanical chime sound and reproduces the Westminster Chimes melody of London's Big Ben clock. The notes are the same as those first used on the clock in the University Church tower of St. Mary, Cambridge, England, and selected for the Victoria Clock Tower in the House of Parliament in 1859. There, the hour is still struck on the old bell, Big Ben, after the four famous musical phrases have been played on the smaller bells. The music (Fig. 6) was inspired by a phrase from Handel's symphony "I Know That my Redeemer Liveth," and the words and music were arranged by William Crotch in 1793.

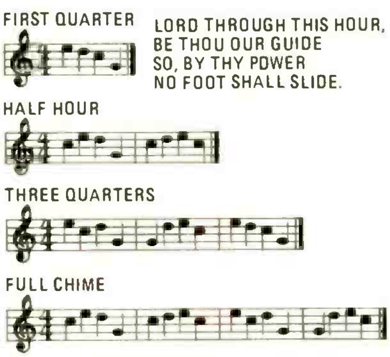


FIG. 6—WESTMINSTER CHIMES MELODY is struck by several of these clocks.

Synthesization is the production and control of sound, including music, by duplicating the pitch, timbre and loudness contour. The pitch is the sound's dominant frequency, the timbre is its time-varying frequency spectrum and the loudness contour is its amplitude or modulation envelope. Synthesis of the chime notes uses this principle.

HEATH GC-1197 Digital Shelf Clock may be used with Heath electronic clock chimes.

Each note frequency that is used in chime-note synthesis is generated by the note synthesizer and related to the other note frequencies by a multiple of $12\sqrt{2}$. Therefore, there is a constant frequency change between each successive note, just as in a piano scale. This note-frequency relationship establishes what is known as an even-tempered scale. In this unit, the entire scale can be adjusted approximately 1½ octaves with the pitch control, to transpose the tune into various musical keys. The pitch of these notes falls within the range of most clock chimes.

Four notes sound on the quarter-hour, eight on the half-hour, twelve on the three-quarter hour, and the full 16-note passage is sounded on the hour, followed by a monotone striking the number of hours. Actually, only five notes are used—four for the melody and one for the striking hour. A tick-tock sounds continuously, and controls are provided for volume, pitch and sound decay.

It's easy to build

Construction is straightforward and the Heath assembly manual, as usual, is excellent. Twenty-two IC's, 24 diodes, 7 transistors, a speaker and many other components fit onto a single 4¾-inch × 10-inch PC board. Power and display segment signals are provided by the clock

DO-IT-YOURSELF case made from balsa wood. "Clock module" is LCD wristwatch.

in which this unit is installed via a 9-pin connector and two clip leads. The display segments are decoded by the chimes electronics to program the times, the tune and the hour-tone sound. Heath will *not* give you information on how to mate these chimes to any other clocks but their *Super Clocks*, and to use these chimes with any other clocks voids the chime warranty.

The circuitry used in this unit involves advanced digital and musical theory, well beyond the scope of this article. If you're interested in specific details, write Heath for the price of the *Electronic Clock Chimes Manual* (Part No. 595-1896-02). Heath Company, Benton Harbor, MI 49022.

Sankyo

The Sankyo *model 803 AL* is a digital alarm clock in a wooden case, and it features Westminster Chimes. Although the digits are driven electromechanically, electronics control the number of times the tune, which is played on a motor-driven music box, is repeated. The full 16-note Westminster Chimes tune, shown in Fig. 6, plus chords, takes 13 seconds to play, and is switch-selectable at the beginning of every hour or at alarm-set time. It plays only once on the hour, but when the unit is set in the alarm

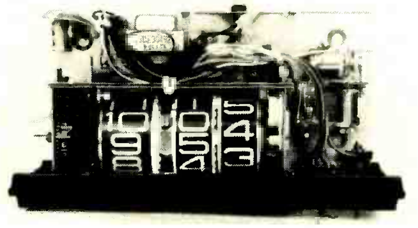
SANKYO 803AL Digital 24-hour alarm Westminster Chimes clock.

mode, the tune repeats five times. The control circuit uses an R–C time constant to bypass a cam on the music-box drum that operates the cutoff switch. The time constant is set to complete its cycle during the fifth playing of the tune, after which the cam switch shuts off the circuit. A small motor drives the music box through a set of high-quality plastic gears.

The digital display consists of four silk-screened translucent orange plastic drums on a common shaft, driven by a small 60-Hz synchronous clock motor and the associated gears. A single 0- to 60-second wheel turns once per minute. A 24-hour alarm drum, which can be set in 10-minute intervals, trips a microswitch to sound the chimes at the selected time.

To set the time display, place an index finger in a depression in a knob on the side and turn the knob with your fingertip to activate the unit-minutes drum. You can go forward or backward; the other digits change sequence by means of molded tabs on their drums. A low-high switch sets the level of a single incandescent bulb that is used to light the display from within.

A three-position switch selects chime operation—hourly, off or alarm. There is



SANKYO 803AL. The digits are printed on translucent drums, driven by a clock motor. A single incandescent bulb lights the number drums from inside. The "chimes" are played by motor-driven music box.

no sound on the quarter-hour, half-hour, or three-quarter hour.

This unique and beautifully styled clock is ruggedly made and can be obtained from any Sankyo dealer. However, it is *not* available in kit form. Sankyo Seiki (America) Inc., 149 Fifth Avenue, New York, NY 10010.

Solid-State Time

This Fosket-designed *Electronic Pendulum Clock* is intended as a mantelpiece

SOLID-STATE TIME. Completed elegant maple mantel-style digital clock with swinging electronic pendulum. Time exposure shows all pendulum LED's lighted.

clock; it is over 10 inches wide and almost 11 inches long. It comes complete with an early-American maple case, four lathe-turned spindles, a crown and two ruby lenses—a large one for viewing the time and a smaller one for viewing the pendulum. The pendulum electronics are sophisticated but assembly is simple. In fact, the entire assembly of this clock is simple enough for a beginner.

A completely preassembled *Liton model LT-701* 12-hour clock module, with four large 0.7-inch-high bright digits and a blinking colon handles the timekeeping and display functions. A wall-plug transformer is used to supply power and the 60-Hz input from the 117-VAC line. The module processes the 60-Hz input to perform timekeeping with long-term accuracy. Pushbutton and toggle switches set the alarm and display times. An alarm buzzer was included in the kit we built, but it was necessary to add the circuitry shown in Fig. 7 to make

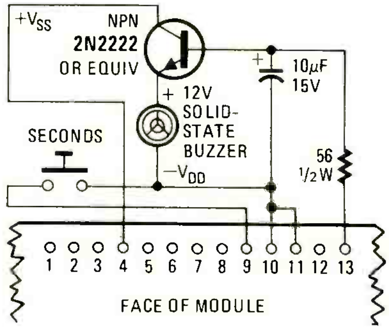
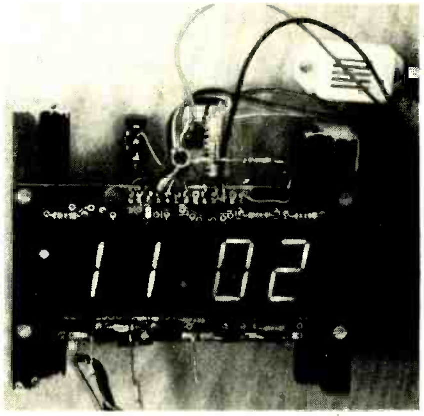


FIG. 7—ALARM DRIVER and seconds display switch added to Solid-State Time's clock.



SOLID-STATE TIME alarm buzzer is driven by a simple transistor circuit wired directly to clock module.

the sound louder. (The components for this extra circuitry may be included in the kits being shipped by the time you read this article.) In addition, it was necessary to add a switch for displaying seconds, as shown in Fig. 7.

The module and the switches are mounted on the back panel, with lots of room and accessibility.

The pendulum

The pendulum assembly is built onto a separate PC board that mounts on the inside front of the case and is connected to the clock module with only three wires. Figure 8 shows the physical layout of the

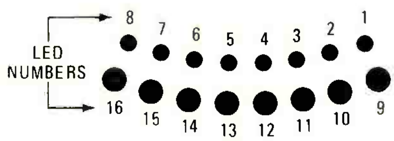
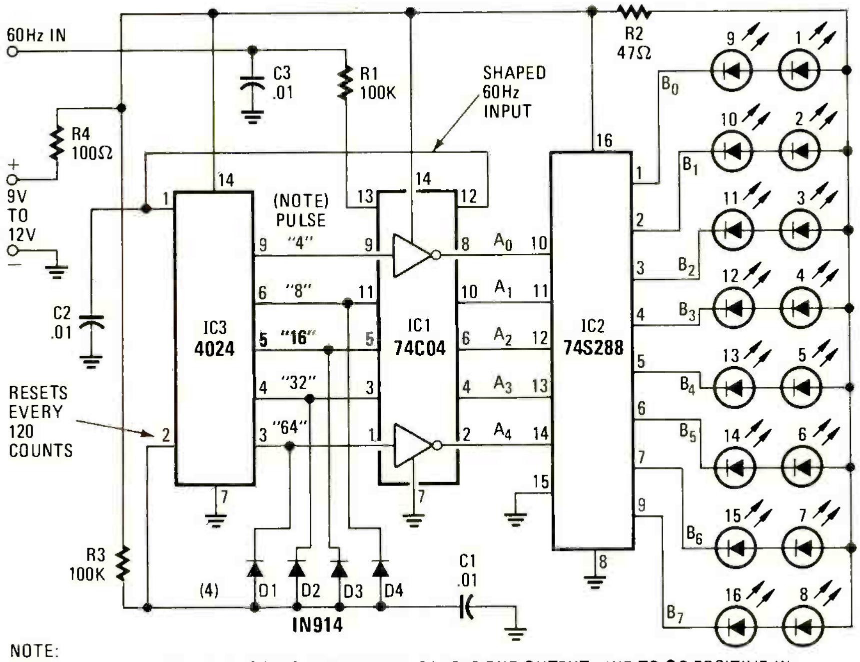


FIG. 8—SOLID-STATE PENDULUM has miniature and jumbo LED's.

pendulum, which consists of eight small LED's, wired so that both a small LED and a jumbo LED light simultaneously. A unique feature of this pendulum is that its rate of travel varies throughout its swing, the action closely simulating that of a real pendulum. This is accomplished by using a PROM (*P*rogrammable *R*ead-*O*nly *M*emory) furnished already programmed for this specific design.

Pendulum electronics

Figure 9 shows the complete pendulum circuitry. The 60-Hz signal coming from the AC line is slightly squared by resistor R1 and capacitor C3 and further squared by one inverter section of hex inverter output pin of IC3 is affected by the incoming pulses. Note that pin 9 changes state every four pulses, creating a new address for the PROM. Also, note that diodes D1, D2, D3 and D4 (Fig. 9) hold the IC3 reset line low (until the 120th



NOTE:
EACH FOURTH NEGATIVE-GOING INPUT PULSE CAUSES ONE OUTPUT LINE TO GO POSITIVE IN BINARY SEQUENCE. SEE FIGURE 10.

FIG. 9—COMPLETE PENDULUM CIRCUITRY. The 60-Hz line waveform is processed by binary counter and a PROM to light the LED pairs in a realistic sequence.

IC1. This 60 pulse-per-second signal is fed into IC3, a binary ripple counter. Each time the pulse at the input changes from positive to ground (negative-going pulse) the counter advances one count, and the output pins count up in binary code. All the output pins are not used; in this application, pin 9, which counts every fourth pulse, has the lowest count. Output pins 9, 6, 5, 4 and 3 are fed through inverters to address PROM IC2 to determine which pair of LED's will be turned on at any instant. A 74S288 PROM is used, although a properly programmed 8223 or 74188 might also work.

Figure 10 shows how the state of each pulse, at which time output pins 3, 4, 5 and 6 are all high (64 + 32 + 16 + 8 = 120). At that instant, since all the diodes are now blocked, the reset line goes high through resistors R3 and R4, and the counter starts back at 0. Now, since the output lines change state every fourth pulse, and it takes 120 pulses to reach reset, that means that 120 ÷ 4 = 30 "words" are formed in 120 pulses, or 2 seconds. These words are different combinations of highs and lows fed through five IC1 inverters to address the PROM.

Although no tick-tock or chimes are available with this unit, its construction, beautiful cabinet, alarm, seconds display and unique "programmed" pendulum make this a real conversation piece for the inexperienced builder. Solid-State Time, Box 2159, Dublin, CA 94566.

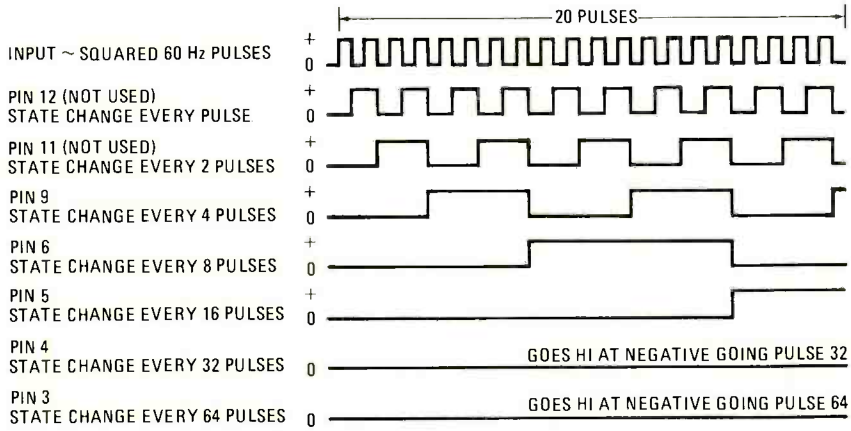


FIG. 10—OUTPUT PULSES as related to input to binary counter IC3. For example, output signal at pin 9 changes state for every four input pulses on pin 1.

Do-it-yourself digital wall clock

Here's a simple idea that will cost you almost nothing (if you own a spare LCD wrist watch) and will create an unusual conversation piece or addition to your dollhouse!

Figure 11 shows the front view (shown

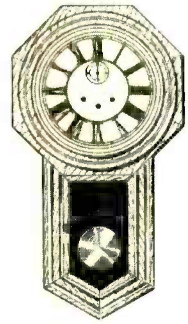


FIG. 11—CLOCK PHOTO or drawing from catalog is basis for home-made cabinet.

slightly smaller than half-size) of the *Micro-Regulator*, a microversion of the *Regulator* wall clock. You can use Fig. 11 as a model or find a mail-order or clock-catalog color photograph that you prefer. Make sure the face is larger than your own watch. Mount the clock drawing or photo on a thin piece of cardboard, and make a rectangular cutout in the clock face to match the display portion of

DO-IT-YOURSELF WALL CLOCK, actual clock fits easily into the palm of your hand.

the watch you'll use. An LCD readout is best; since it's on all the time, there are no buttons to push. Make the "cabinet" from balsa wood and glue, using wood strips to hold the watch snugly in position against the inside of the watch face. Cover the sides and back of the cabinet with maple- or walnut-colored self-adhering vinyl, trim the vinyl with a razor blade and then hang it on the wall for all to see!

No winding or time-setting is required, except when battery-changing time comes around once a year or so. You can carry this idea a little farther—with larger conventional or digital watches, digital clocks, and finally full-size *Regulator* designs with chimes, pendulums and tick-tock, but isn't that how this article began? **R-E**

You Can

Qualifying is easy. Correct answers to a

About the CET Program

In 1965, the National Electronics Service Dealers Association Incorporated (NESDA) developed the Certified Electricians Program. Since that time, it has become a highly accepted, widely publicized accomplishment. Manufacturers have acknowledged and approved the program. The U.S. Department of Labor has recognized the importance of the CET plan. International Correspondence Schools, Division of In-Text, offers the CET test as a goal for their graduate electronic service/repair course students. Today, dozens of schools are using the CET exam as a standard by which to judge their curriculum content. The list of registered CET's includes radio station engineers, college professors, trade school instructors, military officers, electronic writers, electronics parts distributors, personnel, manufacturers, representatives and top service technicians from every state, plus several foreign countries.

The CET test is a multiple-choice examination, offered to electronics technicians. Technicians who pass and show proof of four years' experience and/or schooling are awarded an internationally recognized certificate suitable for framing.

A technician or student in electronics with less than four years' experience and/or schooling may apply for the associate level exam, which may be administered by the Certification Administrator in his area or, under special circumstances, at his school. The exam is the basic electronics portion of the full CET exam and must be passed with a score of 75% or better. A successful Associate CET receives a wall certificate valid for four years or until the time he is eligible to take and pass the journeyman-level exam.

A fully certified technician must pass an entire CET exam, which consists of the basic electronic portion plus any one or more of several journeyman exams. He must also have four or more years' experience in electronics. The exams are available or are being prepared in the areas of: Radio-TV (Consumer Electronics), Industrial Electronics, Communications, Audio, MATV and Medical Electronics.

SINCE THE CET (*C*ERTIFIED *E*LECTRONICS *T*echnicians) program was started in 1966 by the National Electronic Associations, Inc. (NEA), over 10,000 CET certificates have been issued to electronics technicians.

The purpose of the CET tests is to give qualified technicians international recognition and to upgrade the profession. All 50 states and 16 foreign countries now have registered CET's.

While the CET exam committee of ISCET (*I*nternational *S*ociety of *C*ertified *E*lectronics *T*echnicians) is composed of instructors from colleges, vocational schools, high schools, and commercial educational institutions, it also includes practicing service technicians. Thus, the exam is practical and valid for anyone in the electronic technology field.

By far the largest number of CET's come from the service end of consumer electronics, which is appropriate since the most critical need for recognition of competency and achievement is in the consumer area.

How to become a CET

Four years of experience and/or schooling, plus passage (by 75% or better) of the written exam, are required of every prospective CET. Any combination of experience and schooling is acceptable. For instance, a technician could qualify by having had two years of vocational electronics study, plus one year of military electronics experience, plus one year of working for a TV-radio repair shop. Or, he could have had four years of on-the-job experience as a technician in industrial, communications, or any other area of electronics work. Correspondence courses count, and any time spent in work, such as in parts supply companies, the phone company, or electrical jobs, can help fulfill the time requirement.

The written test consists of two sections: The Associate Level section, which contains seventy-five questions, *and* any one of several Journeyman Options (another seventy-five questions). The associate level contains questions that are basic for any phase of electronics work; the journeyman option questions are more specifically slanted toward a particular field of electronics. The option categories you may take in addition to the associate-level section are: Consumer Electronics, Biomedical, Industrial, Audio, MATV and Communications.

A technician with less than the required four years of schooling and/or experience may take the associate-level part of the test only. Passing the associate level qualifies you for the associate CET certificate and wallet card, and allows you membership in ISCET. Once you have a total of four years' experience, you may take the remainder of the CET exam (an option of your choice) and can become a full CET.

Preparing for the exam

Since everyone has to take the associate-level portion of the CET exam, let's take a look at some questions similar to those found in that portion. The Associate Level sections are:

- Section 1. Basic mathematics
- Section 2. DC circuits
- Section 3. AC circuits
- Section 4. Transistors and semiconductors
- Section 5. Electronic components and circuits
- Section 6. Test instruments
- Section 7. Tests and measurements
- Section 8. Troubleshooting and network analysis

Section 1 questions, basic mathematics

Here are 10 questions similar to those you will find in Section 1 of the Associate Level test. In the next article in this series, we will give the answers to these questions and provide 10 n ore questions

Be A CET

hundred or so questions in your specialty and you are in.

DICK GLASS

for Section 2. Analyze each question carefully and take your time. Simply place a check mark next to the correct answer.

1. Which statement is true regarding Fig. 1.

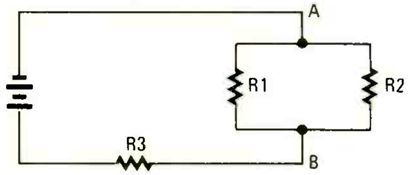


FIG. 1

( ) a. the total resistance between A and B is equal to $\sqrt{R3^2 + (R1 - R2)^2}$

( ) b. total current flow is through R3

( ) c. $R_T = \dfrac{R1 + R2}{R1 \times R2}$

( ) d. if R1 is smaller than either R2 or R3, the current flow through R1 will be larger than through either R2 or R3

2. Figure 2

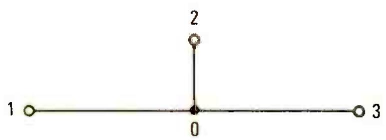


FIG. 2

( ) a. could be a vector display of an electronic circuit's inductive, capacitive, and resistive impedances

( ) b. is equivalent to the formula, $Z = \sqrt{L^2 + C^2}$

( ) c. is equivalent to the formula, $Z = \sqrt{R^2 + L^2 + C^2}$

( ) d. will mathematically equal zero if each leg (01, 02 and 03) is equal in impedance

3. A resistor dissipating 5 watts of power with 1 mA of current flowing through it would be what value?

( ) a. 5 ohms
( ) b. 5000 ohms
( ) c. 500,000 ohms
( ) d. 5 megohms

4. A resistor color-coded green, blue, red and another resistor coded yellow, violet, red are connected in parallel. What is the equivalent resistance?

( ) a. 2553 ohms
( ) b. 2555 ohms
( ) c. 25,533 ohms
( ) d. 2,555,330 ohms

5. Which statement is true regarding Fig. 3?

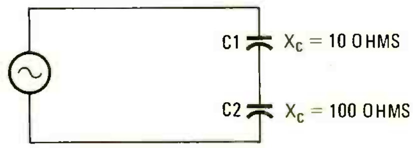


FIG. 3

( ) a. total capacitance equals 110 ohms

( ) b. C2 is the smaller-value capacitor

( ) c. total capacitive reactance is less than 10 ohms

( ) d. increasing the frequency will increase the reactance

6. A transformer has a turns ratio of 5:1. With 10 amps flowing in the primary, which of the following is true?

( ) a. 5 amps is flowing in the secondary
( ) b. 10 amps is flowing in the secondary
( ) c. 2 amps is flowing in the secondary
( ) d. 50 amps is flowing in the secondary

7. Two resistors dissipate 5 watts of power each and are connected in parallel. The same resistors connected in series and dissipating 5 watts each would give a combined equivalent dissipation of:

( ) a. 10 watts
( ) b. 5 watts
( ) c. 2.5 watts
( ) d. 7.5 watts

8. What is the wavelength (in meters) of a 300-kHz radio wave?

( ) a. 32.8
( ) b. 3.28
( ) c. 10
( ) d. 1000

9. Increasing the wire size in a coil will have what effect?

( ) a. decreases the inductance
( ) b. increases the "Q"
( ) c. increases the inductive reactance
( ) d. increases the impedance

10. In a series-resonant circuit, increasing the series resistance (R) will:

( ) a. lower the resonant frequency
( ) b. raise the resonant frequency
( ) c. sharpen the frequency response curve
( ) d. broaden the frequency response curve

The next article in this series will review the correct and incorrect answers to the Section 1 questions and present Section 2 questions. Once you feel you are ready to take the Associate or Journeyman CET exam, write to ISCET, Ron Crow, CET, Executive Director, 310½ Main St., Ames, IA 50010 (515-232-4720). ISCET will send a listing of Certification Administrators you can contact to take the test. CET study guides are also available from ISCET. **R-E**

hobby corner

Part II—A look at the various breadboarding and prototyping systems available (including a brand-new one) for building your own circuits from scratch.

EARL "DOC" SAVAGE, K4SDS, HOBBY EDITOR

LAST MONTH, WE LOOKED AT VARIOUS breadboards that are used to build and test your circuit after you've designed it. This month, we'll look at various prototyping systems that are used to build the prototype.

Prototyping boards

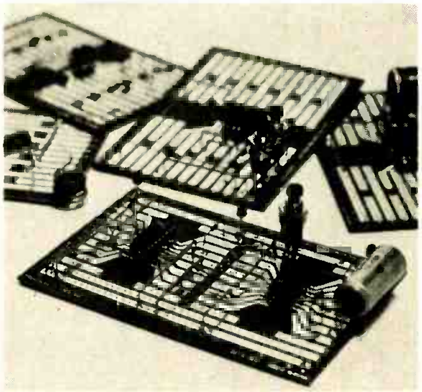
After your circuit has been thoroughly developed and tested on your breadboard, the next step is usually to hard-wire it. Even if you plan to build the circuit on a dedicated PC board ultimately, it is often advisable to construct a prototype for immediate use and further testing. There are a number of prototype systems you can use. Table 2 summarizes the characteristics of several prototyping systems. In this table the column marked "Density" indicates how closely components can be packed on the boards. Some universal PC boards have the highest potential density (can hold more components in a small area). Note that, as in the case of breadboarding systems, some of these system components are also interchangeable.

The *DeC* system has introduced two innovations to prototyping: The first is the manner in which components are attached to the boards, which are called *Blob-Boards*. These boards are *not* drilled but the copper strips are heavily "roller-tinned." To attach a component, you simply hold a lead on the strip where it is to be fastened and use your soldering iron to deposit a blob of solder at that point. When the solder blob cools and hardens, the lead is electrically and mechanically attached. For best results, follow the recommended procedure of tinning each lead before soldering it to the board. The speed of the *DeC* system is shown in Table 2 and is classified as Medium because of the time required to tin the leads, but this system does make for a more dependable connection.

Note that it is equally easy to *remove* a component from a *Blob-Board*. Just touch the blob with a hot iron and pull the lead away. It is so easy to change components, in fact, that the manufacturer recommends that they be used in circuit design and development. And, indeed, they can be used in this manner with the advantage of having a prototype immediately when you finish. However, this method is more time-consuming than using a breadboard, and the overall construction time will be greater unless the circuit is relatively simple and few changes have to be made.

TABLE II—PROTOTYPING CHARACTERISTICS

					Circuit Element		Component Socket		
Manufacturer	**Pattern**	**Index**	**Density**	**Method of Wiring**	**Stability**	**Ease of Change**	**Required**	**Can Be Used**	**Speed of Use**
OK Machine & Tool Corp. 3455 Conner St. Bronx, NY 10475	.1 X .1-in. Universal PC boards	No	Medium to high	Wire-wrap	Good to fair	Good to fair	Yes	●	Medium to high
Saxton Products, Inc. 215 N. Rte. 303 Congers, NY 10920	Several types	Yes	Low to medium	Solder	Good	Good	No	Yes	Medium
Vector Electronic Co., Inc. 12460 Gladstone Ave. Sylmar, CA 91342	.1 X .1-in. Plain & Universal PC boards	Some	Low to high	Trad. solder	Good	Poor	No	Yes	Slow
				Wire-wrap	Good to fair	Good to fair	Yes	●	Medium to high
Vero Electronics, Inc. 171 Bridge Rd. Hauppauge, NY 11787	.1 X .1-in. Universal PC boards	No	Low to high	Pen-wire	Good to fair	Fair	No	Yes	High



BLOB-BOARDS with prototype circuits built on them.

The second *DeC* system innovation involves the foil patterns of the *Blob-Boards*. These foil patterns are exactly like the bus structure of the various types of breadboarding DeC's. In addition, they are indexed identically! This makes it simple to transfer a circuit from DeC to *Blob-Board*—a lead is brought out from tie point D10 on the DeC and attached to D10 on the *Blob-Board*. The price you pay for this simplicity, however, is that you cannot have a high-density board.

Blob-Boards are available in various sizes, capacities and in configurations other than those that match the DeC's. There is a straight matrix board. Of special interest is the *BCB2*, which has a configuration and index identical to that of the Continental Specialties *Experimentor* breadboard sockets. The *BCB2* also matches some of the AP Products and E & L sockets, although these sockets are not indexed.

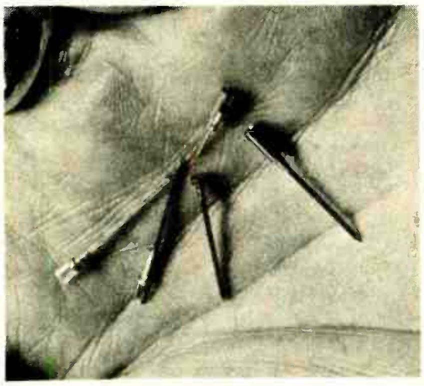
The remaining prototyping systems

(OK, Vector and Vero) are based on perforated .1 × .1-inch boards. Each system contains universal PC boards in various sizes, shapes and foil patterns. Vector also makes a plain perforated board without copper.

Wiring methods

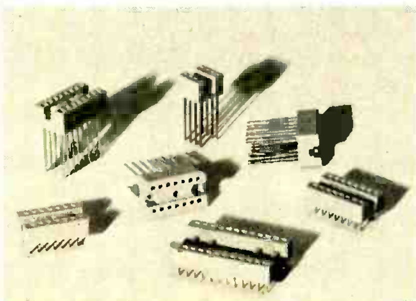
In using any of these systems, the hobbyist must choose the best wiring method for each project. This should be given careful thought so we'll look at them in some detail. The methods are *traditional wiring, wire-wrapping* and *pen-wiring*.

Traditional wiring hardly needs explaining. For years we have been using this technique: Cut the wire, strip and bend the ends, squeeze them around the connections using needle-nose pliers, then solder. This old tried-and-true method, however, makes inefficient use of space, time and effort. There are better and more efficient methods for most modern circuits. However, some circuits require a heavier gauge wire than is normally available to the hobbyist in pen-wiring and wire-wrapping. Therefore, you should continue using traditional wiring for those circuits that carry a larger current, such as power supplies and buses, tube circuits and the like.



VERO WIRE-WRAP TERMINALS.

In the wire-wrapping technique, connections are made by simply wrapping wire ends around rectangular pins or terminals. An inexpensive special wire-wrapping tool insures a tight wrap and a good electrical and physical bond.The actual wrapping is very fast, but the speed is rated as medium to high because pins with rectangular cross-sections *must* be provided



VERO IC SOCKETS; wire-wrap and solder versions.

TABLE III—PROTOTYPE WIRING SELECTION

Wiring Method	When To Use
Traditional: cut, strip and solder	Circuits carrying heavy currents; except for power supplies and buses, AF and RF final amplifiers, tube circuits.
Wire-wrap	Absolute maximum density required. Circuit element(s) that are especially heat sensitive. Wrap terminals can be provided for all (or most) connections. Many circuit changes are anticipated.
Pen-wire	Minimum board or component thickness required. Use of sockets is impractical. All other cases.

Of course, sockets and the like are readily available with wrap-pins (tails), but capacitors, resistors, etc., are not. You *cannot* wire-wrap on round pins or leads because there are no sharp corners to bite into the wire to produce a dependable low-resistance connection. There are three ways to provide wrap terminals: using wire-wrap sockets for the direct insertion of DIP's, transistors, etc.; wire-wrap sockets for the direct insertion of DIP "headers" (these have solder terminals on one side and pins on the other side that are inserted into a DIP socket) to which components have been soldered; and board feed-through pins with wrap-tails on one end and solder terminals on the other.

Every connection that does not have a proper terminal must be soldered. If there are a great many connections, the primary benefit of wire-wrapping is defeated, and you should probably use the pen-wiring method.

For old timers (like me) with an innate mistrust of anything that is not nailed down and well soldered, here are a few facts about wire-wrapping. First, you can inspect a wire-wrap connection visually for quality; if it looks all right, it is good. Second, a good wire-wrap connection is more dependable electrically than a good-looking solder joint; its resistance is as low and usually lower than that afforded by soldering. Finally and most surprising, a good wire-wrap connection is more stable mechanically than a good solder joint, especially in the case of a modified wrap in which the first turn or so is made with the insulated part of the wire. And you may be interested to know that wire-wrapping is not new — it was developed by Bell Laboratories some 30 years ago and has been time-tested. Now, we old hands can use wire-wrapping without that nagging worry that it just couldn't possibly hold up!

Because wrapped connections are readily *un*wrapped, they can be changed more easily than solder joints. In most cases, the same tool can be used for both wrapping operations. The price of wire-wrap tools manufactured by OK Machine and Tool Corporation ranges from about $6 for a simple manual model with a built-in stripper to $35 for an electrically driven unit.

Most wire-wrap systems require that you cut wire to length and end-strip it *before* wrapping. Furthermore, one individual wire is required between each two connections. Vector's *Slit-N-Wrap* wire-wrap tool automatically overcomes both of these problems.

The *Slit-N-Wrap* has a built-in device that slits the insulation *as the wrap is being made*. In addition, the tool holds a roll of wire and feeds it out as you move from one connection to another. This can save a great deal of time because the wire does not have to be cut and stripped and because you can make daisy-chain connections; you can start at one joint, move to a second and, *using the same continuous piece of wire*, proceed to a third connection, and so on.

Vector's *Slit-N-Wrap* manual tool is available in a kit with wire, an accessory knife for about $25. An electrically driven model costs $75.

If you use the cut-and-strip method of wire-wrapping, you can save some time and effort two ways. First, there are kits available containing precut and prestripped wires of many lengths and colors. Second, OK Machine and Tool Corp. produces a good wire dispenser with a built-in cutter and stripper ($3.50 with wire). Not to be overlooked is the advantage that the dispenser retains the wire on the spool until *you* are ready for it.

Pen-wiring, the third wiring process, is especially useful in prototyping, and maybe one the hobbyist will prefer. It is quick and easy, and no special posts or terminals are needed, although you can obtain some handy ones for board feed-through and the like. The pen-wiring process uses a pen-like device that holds a small spool of wire on the upper end. The wire is fed down through the body of the tool and out the pointed tip.

In using the pen-wiring technique, just move the point around a terminal or lead (round, square or whatever) to make two or three turns of the wire. Trail the wire out to the next joint, make two or three turns and, then, proceed on to the next joint in daisy-chain fashion. In the process, the insulation is not removed from the wire. In fact, the insulation *should* not be removed because it is made of a special composition that causes it to be

continued on page 105

Compact Pro Speakers

HISTORICALLY, HIGH-POWERED SOUND REinforcement loudspeaker systems have been heavy and large. Not only are these speakers difficult to transport, they also require special skills for permanent mounting. Lately, however, smaller, more compact systems are displacing these giant systems. The smaller speakers can handle reasonable amounts of power while being easy for one person to operate and transport.

How can you recognize a compact sound reinforcement speaker system? Certain characteristics are self-evident. First, you should be able to carry the speaker yourself. This places upper limits for size and weight in the vicinity of 0.1 cubic meters (3.5 cubic feet) and 20 kilograms (44 pounds), although I'm sure most readers can carry more than this. Second, the speaker should deliver high sound-pressure levels, i.e., 105 dB to 110 dB at 3 meters (10 feet). Finally, you should be able to plug the speaker into a medium-size power amplifier (100 watts into 8 ohms) without sending woofer-cone fragments into the front row. In short, the compact sound reinforcement speaker system closes the gap between the home hi-fi speaker and the big sound reinforcement speaker.

Now that you know some of the system's basic characteristics, you may ask why they are gaining in popularity. Traveling musicians find the portability a genuine asset. Small speaker systems eliminate having to wrestle big boxes through narrow doorways and up and down stairs. And when it's time to go home, compact speakers do not need to be transported by a van or station wagon.

Sound installers find the speakers' compact size very convenient for mounting in small auditoriums, churches and lounges. Even in large auditoriums, the compact speaker works well in a distributed system. The small size also works well in a discotheque system, although a low-frequency equalizer should be used to provide more thump in the low end. In total, the compact system provides added flexibility when you must tailor the sound to a particular room.

The flexibility of compact systems becomes apparent again if stacking is desired. Stacking—placing one speaker on top of another—increases the horizontal penetration and spread of a sound system while reducing vertical radiation. Column speaker systems have used this principle effectively for years.

* The following article was written while the author was a Senior Development Engineer at Shure Brothers Inc., Evanston, IL.

Frequency response

The first consideration when you buy a speaker, whether it be for hi-fi or sound reinforcement, is the system's frequency response. Flat-amplitude response over the entire audio range is usually the goal. However, in a compact system, response to the extreme lows and highs at high power levels does not come inexpensively. So, let's take a look at the first tradeoff.

For low frequencies, the speaker-system designer reaches a compromise by juggling amplitude, efficiency, box volume and cost factors. Often distortion and power handling play a role in this compromise. Figure 1 shows the results

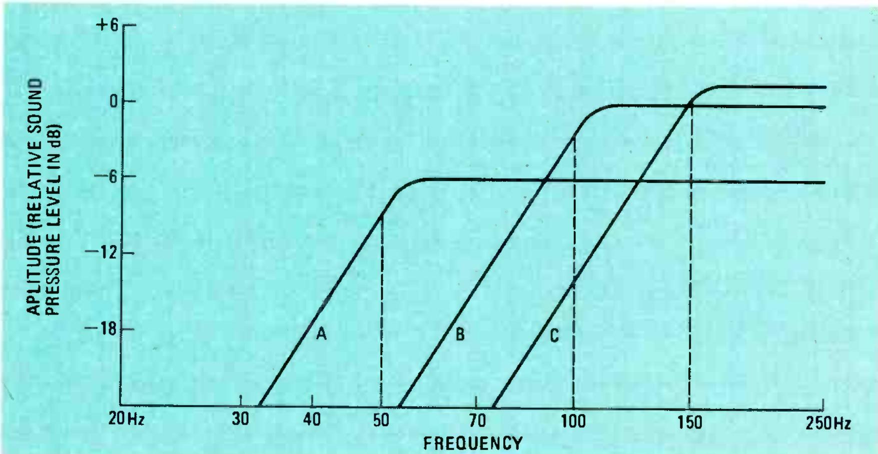


FIG. 1—FREQUENCY RESPONSE can be tailored to different needs. Speaker system A has the best bass response but provides a lower overall output. Speaker system C has a much higher overall output but at a sacrifice in bass response.

If these features are attractive to the speaker buyer, how does he choose the compact system best for him? The answer, quite logically, depends on an honest appraisal of his needs and budget. Every feature, or the quality of every feature, has its cost, which may be in dollars and cents or in performance tradeoffs. The following discussion will examine how all these factors interrelate.

of three design approaches, each using the same enclosure volume. The examples are intended to be general, but it should be noted that a ported cabinet gives the designer extra flexibility over a closed cabinet. A port allows the cabinet to be tuned for more low-end response, given a particular driver.

The designer of system "A" chose a 3-dB-down (half-power) frequency at 50

Compact professional speakers fill the gap between hi-fi speakers and cumbersome full-size pro speakers. Here's what you should know before you buy.

RONALD J. BREY*

Hz. However, since a compact system was designed, he could not use a large cabinet to achieve the desired response; instead he used a woofer with a low resonance frequency. Unfortunately (and here is the tradeoff), to achieve that low resonance frequency, some potential woofer efficiency was sacrificed.

The designer of system "B" has taken the opposite approach to system "A." Instead of 50 Hz, the 3-dB-down frequency is 100 Hz, the result of this sacrifice being a 6-dB higher level at 200 Hz.

The designer of system "C" has taken a completely different approach. Many woofers are used to achieve good power handling. However, with many woofers in the same box, each one adds less volume and, consequently, the low-frequency response suffers. However, with good power handling, an equalizer for boosting the bass plus a higher-powered amplifier can restore the low end.

Once the speaker is on the market, you must consider the tradeoffs. If you like a deep low end and possess a good-size amplifier, system "A" will probably fit the bill. On the other hand, if amplifier power is at a premium or high sound-pressure level is needed, system "B" will be a better choice. And if small cabinet size is a must, while amplifier power comes easy, system "C" is the best option.

A number of factors go into the low-frequency melting pot. You should pick the product that has the best mix of factors for your needs and budget. And when you look at the budget, don't forget that extra amplifier watts cost more money.

What should you look for next in high-frequency performance? Should it be flat response and high efficiency? The answer is a qualified "yes."

Flat-amplitude response at the high end is usually desirable. However, a room that is acoustically bright (with hard floors and walls) requires a reduced high end for listener comfort. A compact system should have some means of attenuating the high frequencies, whether it be a potentiometer, a switch, or an equalizer. And if a speaker has a high-frequency level control, don't be afraid to move it from the flat position.

Tweeter efficiency for compact sound reinforcement systems is usually no problem. Woofer efficiency is usually harder to achieve, so tweeters are often padded down to the level of the woofer.

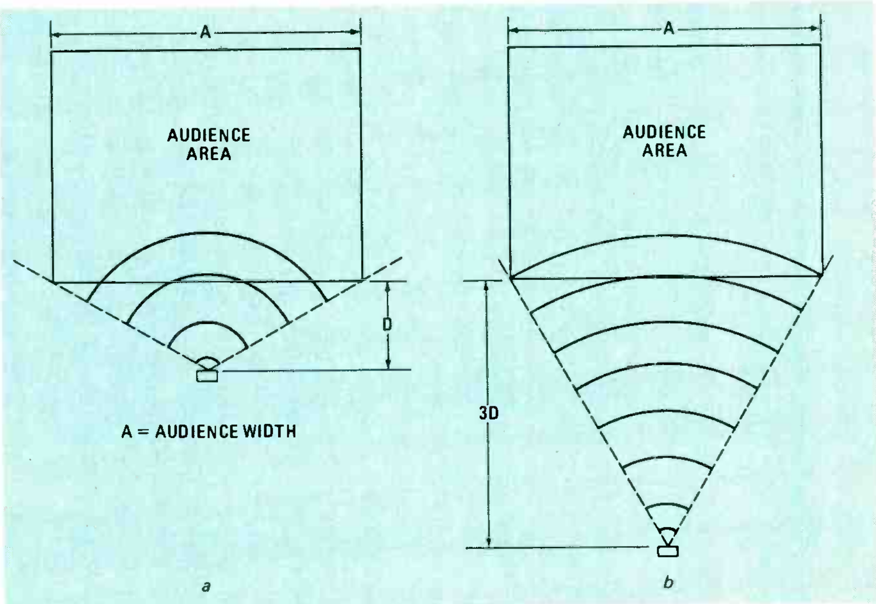


FIG. 2—WIDE POLAR RESPONSE enables speaker to cover greater area from a shorter distance as shown in *a*. Narrow polar response requires greater distance between speaker and audience to cover same area as shown in *b*.

Polar response

One important difference between the compact sound reinforcement speaker and the larger speakers is in polar response. A big sound reinforcement speaker is often designed to project long distances in a narrow arc, while the compact speaker is usually designed to cover shorter distances in a wider arc. The reason for the difference is shown in Fig. 2. To cover the same width at a closer distance, the speaker shown in Fig. 2-a has to have a wider high-frequency coverage angle than the speaker shown in Fig. 2-b.

Such a wide polar response also works well in stage monitoring in case a performer wishes to move around during a performance. Although monitors with a narrow coverage angle are sometimes needed, they require the performer to stay in one location in order to hear himself properly.

The wide polar response for a compact system is easily achieved at low frequencies because of the long wavelengths. As a rule of thumb, a direct radiator (cone) loudspeaker is essentially nondirectional until the wavelength becomes shorter than three times its diameter.[1] This, in turn, means that special methods are often needed to achieve wide polar response at high frequencies.

Two such methods for broadening high-frequency polar response are by using an acoustic lens or multiple drivers facing different directions. The acoustic lens, which can take many shapes, slows wave propagation near the edges of a tweeter opening to obtain a circular wavefront with wider polar response.[2] The multiple-driver method takes narrow-beam tweeters and, through careful placement, collectively achieves a wider polar response. If the tweeters are not carefully positioned, the collective polar response may be narrower rather than broader than a single speaker.

A straightforward method of achieving wide high-frequency polar response is by using a horn. A few designs use a sectoral horn (see Fig. 3). The side walls of the horn define the horizontal pattern, so a

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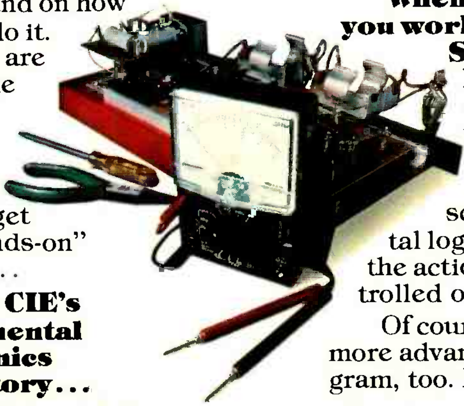

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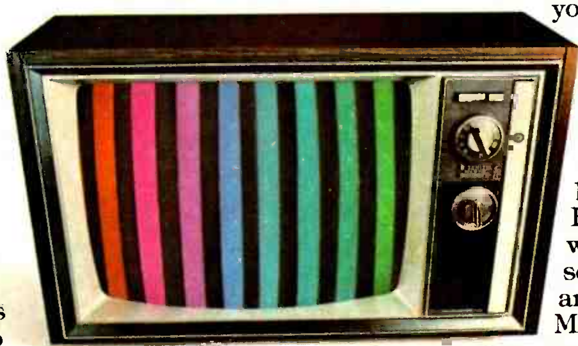

Pattern simulated.

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120° angle between the side walls will create a 120° horizontal pattern. This horizontal pattern will generally hold until the very high frequency range, depending on the horn dimensions. A few words of caution—the vertical pattern of the sectoral horn varies with the frequency and decreases with increasing frequency, so that a horizontal orientation of the horn is generally preferred. Such horns should not, however, be confused with many presently on the market that have a marked flare in the side, top and bottom walls. At high frequencies, these horns show a definite narrowing of both the horizontal and vertical polar patterns.

FIG. 3—SIDE WALLS OF HORN define horizontal radiation pattern while top and bottom walls define vertical radiation pattern.

Power handling

Power handling for compact systems is usually more of a problem for the tweeters than the woofers. Although most manufacturers supply a high-frequency or system power-handling specification, you should be aware that no standard exists for power handling. Manufacturers differ in their power-handling measurement philosophies. For example, some believe that a good power test is a 100-hour speaker system performance test without failure or degradation. The test signal consists of a tape recording of various representative live performances in conjunction with a power amplifier driven into peak clipping typical of the loudspeaker application.[3] The nominal impedance of the speaker system and the amplifier output voltage at clipping determines the power rating. It is felt that this test simulates actual use better than sinewaves, swept sinewaves or pink noise, and that it is important to know the power rating of the largest power amplifier that can be used with the loudspeaker system. Other manufacturers prefer the latter measurement signals, and can make a good case for using them. Depending on the measurement method, the results can vary significantly.

Where does this leave you as a potential customer? You can either accept the manufacturer's rating or rely on word-of-mouth from other users. In any case, you should not exceed the manufacturer's suggested maximum amplifier power rating (if it is given) for the speaker, even though precautions such as fuses may prevent speaker damage. Then, if a power-handling catastrophe occurs, you can approach the manufacturer with a legitimate complaint. But, if you hook up a speaker rated at 100 watts to a 200-watt amplifier, don't expect much sympathy from the manufacturer (although you may get some anyway)!

Sensitivity

Since high sound-pressure levels (SPL's) are one goal of compact sound reinforcement speaker systems, you may be concerned with how large an amplifier is needed to achieve those levels. The answer is provided by the speaker system efficiency, which is the acoustical power output of the system versus electrical power input into the system. Because efficiency is usually difficult and time-consuming to measure, on-axis sensitivity is specified instead.

TABLE 1—CONVERSION FACTORS to change other sensitivity ratings to EIA.

DISTANCE CONVERSION VALUES		POWER CONVERSION VALUES	
Distance	**Subtract** dB	**Power** (watts)	**Subtract** dB
3 feet	20.0	0.01	10.0
1 meter	19.2	0.1	20.0
4 feet	17.5	0.5	27.0
6 feet	14.0	1.0	30.0
2 meters	13.2	1.5	31.8
3 meters	9.7	2.0	33.0
10 feet	9.5	4.0	36.0
15 feet	6.0	10.0	40.0
5 meters	5.2	25.0	44.0
20 feet	3.5	50.0	47.0

Example: Given 95.5-dB SPL at 4 feet, 1-watt input.
EIA equivalent = 95.5 − 17.5 (distance conversion) − 30 (power conversion) = 48-dB SPL.

On-axis sensitivity relates the SPL produced at a certain distance by a speaker system to electrical power input. Many manufacturers specify EIA (*E*lectronic *I*ndustries *A*ssociation) sensitivity, which is measured at 9.2 meters (30 feet) with an electrical input of 1 mW. Although the driving signal and speaker impedance rating can vary with each manufacturer (which moderately affects results), you can use the rating to compare similar speaker systems.

Some manufacturers specify on-axis sensitivity at distances less than 30 feet and at powers greater than 1 mW. Unless some unusual test conditions are used, the numbers can be converted to EIA sensitivities. Table 1 shows how many dB should be subtracted to convert other ratings to EIA sensitivity.

Home high-fidelity loudspeakers generally have EIA sensitivities in the SPL range of 30 dB to 45 dB. Comparing a popular hi-fi speaker to a popular compact sound reinforcement system, their EIA sensitivities are 42 dB and 48 dB, respectively, a 6-dB difference. For every 3-dB decrease in sensitivity, twice the power is needed to obtain the same SPL. So the 6-dB difference means the speaker with the lower sensitivity requires four times the amplifier power to achieve the same SPL. Four times the amplifier power (for instance, going from a 50-watt amplifier to a 200-watt amplifier) translates into quite a few dollars and a lot of weight.

Speaker enclosures

When you have narrowed your choice of compact speakers down to a few on the basis of their acoustic properties, you should look at their construction. You probably want the speaker to look good and at the same time provide reliable service. Additionally, you may want some convenience items for mounting and carrying.

The first item to check, and probably the most difficult to find information on, is the speaker's construction material. Generally, two kinds of wood are used for cabinet construction: particleboard (sometimes referred to as flakeboard or pressboard) and plywood. Particleboard keeps cabinet costs down, but it weighs more and deteriorates more rapidly if it gets wet. Plywood, on the other hand, because it contains long wood fibers and is of a laminated construction, is stronger and less affected by temperature and humidity.

The wood thickness should be at least ½ inch for strength; ⅝-inch or ¾-inch material is generally preferred. However, here's another tradeoff: the thicker the wood, the more it will weigh and cost.

Certain manufacturers use thermoplastic structural foam as a basic cabinet material. Some cabinets use thermoplastic extensively, while others use it in special areas, such as in the baffle board

continued on page 100

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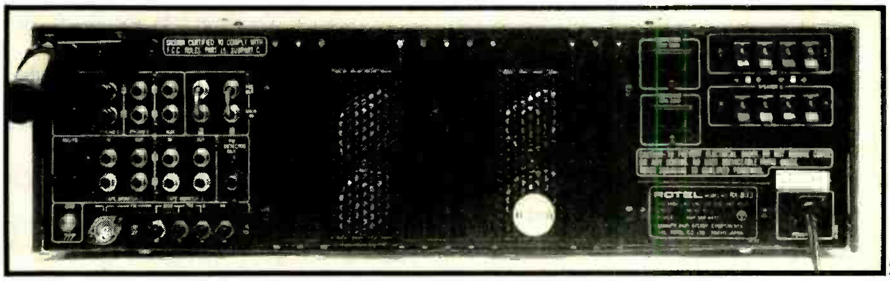
1

Radio-Electronics Tests Rotel Model RX-803 FM/AM Receiver

LEN FELDMAN
CONTRIBUTING HI-FI EDITOR

THE MODEL RX-803 RECEIVER (SEE FIG. 1) IS Rotel of America, Inc.'s third most powerful all-in-one stereo component. The three-dimensional gold-colored front panel has the unusual dial-area opening that is characteristic of other Rotel receivers. This odd-shaped opening permits the signal-strength and center-of-channel tuning meters to appear below the linearly calibrated FM frequency scale and the AM frequency scale. A stereo indicator light is placed between the two meters, while program source indicator lights are evenly spaced below the right-hand section of the frequency dials. A large tuning knob to the right is coupled to an effective flywheel/dial-pointer combination. Five small pushbuttons below the dial opening take care of FM muting, the selection of either 75- or 25-μs FM de-emphasis (the latter used for FM Dolby reception, in combination with a separate external Dolby decoder not provided), mono/stereo selection, loudness and -15-dB audio muting.

Additional pushbuttons along the bottom of the panel are used for POWER turn-on, SPEAKER selection (either or both sets of speakers can be connected), TONE DEFEAT, low- and high-cut filters, tape monitoring and tape dubbing of up to two connected tape decks. A headphone jack is located near the POWER on-off pushbutton. Rotary controls include dual concentrically mounted BASS and TREBLE knobs, a program selector (including positions for PHONO 1 and PHONO 2, AM, FM and AUX), a calibrated BALANCE control and a step-type calibrated master VOLUME control that attenuates signals in 2-dB steps down to -24 dB (from maximum setting), and in larger dB increments from that level downward.



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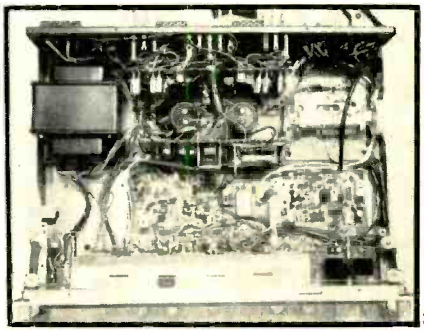
The rear panel of the *model RX-803* contains low-level, high-level and antenna input jacks; preamplifier-out/main amplifier-in jacks (interconnected by wire jumpers); and a ground terminal and FM detector (multiplex) output jack. This array of connections is located on the left-hand side of the rear panel, far removed from the twin sets of spring-loaded speaker terminals and the two convenience AC receptacles at the far right. The antenna terminals permit using either 300-ohm or 75-ohm coaxial transmission lines, and, in addition to the external AM antenna terminal, there is a built-in pivotable ferrite-bar AM antenna. European-type DIN multiple-pin connectors are also provided for one of the tape circuits and one of the two phono circuits.

Output transistors, covered with protective screening and mounted on vertically finned heat-sink structures, occupy the center of the rear panel (Fig. 2).

An internal view of the chassis is shown in the photo of Fig. 3. The large PC board in the



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front contains the entire FM-IF, stereo multiplex, AM and tone-control amplifier circuits. Two identical vertically mounted power-amplifier modules are located near the rear of the chassis, with the power transformer on one side and the separate RF front-end on the other side. A pair of 10,000-μF filter capacitors (for the B+ and B$-$ output-transistor power supplies) are nestled between the two power amplifiers.

The FM front-end uses a dual-gate FET RF stage and a four-gang tuning capacitor. Extensive use is made of IC's in the FM-IF section,

MANUFACTURER'S PUBLISHED SPECIFICATIONS:

FM TUNER:
Usable Sensitivity: mono, 1.8 μV (10.4 dBf). **50-dB Quieting:** mono, 3.2 μV (15.2 dBf). **S/N Ratio:** mono, 70 dB; stereo, 65 dB. **Harmonic Distortion:** mono, 0.1% at 100 Hz and 1 kHz, 0.3% at 6 kHz; stereo, 0.3% at 100 Hz and 1 kHz, 0.5% at 6 kHz. **Frequency Response:** 30 Hz to 15 kHz, +0.3, -1.0 dB. **Capture Ratio:** 1.5 dB. **Selectivity:** 75 dB. **Spurious Rejection:** 90 dB. **Image Rejection:** 85 dB. **IF Rejection:** 95 dB. **AM Suppression:** 60 dB. **Stereo Separation:** 43 dB at 1 kHz; 30 dB at 30 Hz to 15 kHz.

AM TUNER:
Sensitivity: 250 μV/M (internal antenna); 12.5 μV (external antenna).

AMPLIFIER:
Power Output: 70 continuous watts-per-channel into 8 ohms, 20 Hz to 20 kHz. **Rated Harmonic Distortion:** 0.2% (0.08% at 1 watt). **IM Distortion:** 0.2% (0.1% at 1 watt). **Damping Factor:** 50 into 8 ohms. **Input Sensitivity:** phono 1 & 2, 2.5 mV; high level, 150 mV. **Phono Overload:** 200 mV. **Frequency Response:** phono, RIAA ±0.3 dB. **Bass and Treble Control Range:** ±10 dB at 100 Hz and 10 kHz. **Low- and High-Filter Cutoff:** 40 Hz and 12 kHz (12 dB-per-octave). **S/N Ratio:** phono, 75 dB, IHF "A"-weighted; high level, 90 dB, IHF "A"-weighted. **Audio Muting:** -15 dB.

GENERAL SPECIFICATIONS:
Power Consumption: 520 watts maximum, 120 volts, 60 Hz. **Dimensions:** 19¼ W × 5.7 H × 16⅛ inches D. **Net Weight:** 30.9 lbs. **Suggested Retail Price:** $480.

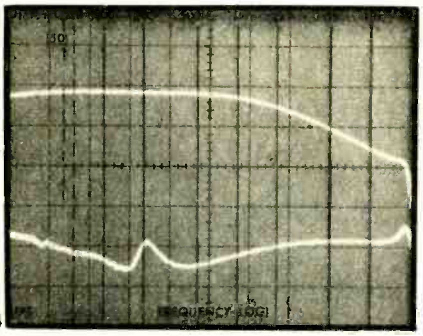
the AM circuitry and the stereo-decoder section. Fixed ceramic-type filters are used in the FM-IF section, and a wideband quadrature-detector circuit recovers composite FM audio signals that are then fed to a phase-locked-loop stereo decoder requiring no tuning coils or capacitors.

Tone control is handled by the familiar Baxandall negative-feedback circuit, while cutoff filters each use dual R–C filter networks to approach 12-dB-per-octave slopes. Each power output module uses a differential amplifier input stage and complementary pairs of NPN-PNP direct-coupled output transistors. An electronic protection circuit combined with a relay guards against speaker damage or amplifier overload. As further protection, there are fuses in series with all secondary windings of the power transformer. Positive and negative output voltages are just over 47 each, while the lower voltages required by the tuner and low-level amplifier sections are all electronically regulated. You can place a simple strapping plug inside the chassis for U.S. or European and other foreign voltages.

FM measurements

Table 1 summarizes measurements made for the FM tuner section. The results can be compared with the manufacturer's published specifications shown elsewhere in this report. Usable sensitivity was an impressively low 1.6 μV (9.3 dBf) in mono and 4.5 μV (18.3 dBf) in stereo. More important, 50-dB quieting was reached with signal inputs of only 2.5 μV (13.1 dBf) in mono and 32 μV (35.3 dBf) in stereo. Signal-to-noise ratio was a bit better than claimed in both mono and stereo, as were most of the other secondary measurements. While most of the mono and stereo distortion measurements were lower than claimed, this was not the case for our 100-Hz stereo measurements, which resulted in a 0.4% reading.

Figure 4 is a spectrum analysis showing the desired and crosstalk output signals for one channel, including the standard 75-μs de-emphasis. The unusual crosstalk peak at around 200 Hz was thought at first to be a result of a defect in our sweep system; however, repeated static measurements showed that this slight reduction in separation at the 200-Hz frequency does occur. At its worst, however, there is still nearly 40 dB of stereo separation. So whatever the cause of this phenomenon, it can be ignored for all practical purposes. Note, too, the excellent 19-kHz filtering that occurs at the end of the sweep to remove unwanted subcarrier output signals.



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Amplifier measurements

The amplifier of the *model RX-803* delivered 77-watts-per-channel into 8-ohm loads with a 1-kHz test frequency before the THD reached its rated 0.2% value. There was some

TABLE 1
RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Rotel of America, Inc.** Model: **RX-803**

FM PERFORMANCE MEASUREMENTS

SENSITIVITY, NOISE AND FREEDOM FROM INTERFERENCE	**R-E Measurement**	**R-E Evaluation**
IHF sensitivity, mono: (μV) (dBf)	1.6 (9.3)	Superb
Sensitivity, stereo (μV) (dBf)	4.5 (18.3)	Very good
50-dB quieting signal, mono (μV) (dBf)	2.5 (13.1)	Excellent
50-dB quieting signal, stereo (μV)	32 (35.3)	Excellent
Maximum S/N ratio, mono (dB)	71	Very good
Maximum S/N ratio, stereo (dB)	68	Very good
Capture ratio (dB)	1.1	Excellent
AM suppression (dB)	60	Excellent
Image rejection (dB)	86	Very good
IF rejection (dB)	95	Excellent
Spurious rejection (dB)	93	Very good
Alternate channel selectivity (dB)	77	Very Good
FIDELITY AND DISTORTION MEASUREMENTS		
Frequency response, 50 Hz to 15 kHz ($\pm$dB)	+0, −1.3	Good
Harmonic distortion, 1 kHz, mono (%)	0.11	Excellent
Harmonic distortion, 1 kHz, stereo (%)	0.19	Excellent
Harmonic distortion, 100 Hz, mono (%)	0.19	Very good
Harmonic distortion, 100 Hz, stereo (%)	0.40	Fair
Harmonic distortion, 6 kHz, mono (%)	0.13	Excellent
Harmonic distortion, 6 kHz, stereo (%)	0.20	Excellent
Distortion at 50-dB quieting, mono (%)	0.38	Excellent
Distortion at 50-dB quieting, stereo (%)	0.35	Very good
STEREO PERFORMANCE MEASUREMENTS		
Stereo threshold (μV) (dBf)	5.0 (19.2)	Very good
Separation, 1 kHz (dB)	42	Excellent
Separation, 100 Hz (dB)	40	Excellent
Separation, 10 kHz (dB)	26	Good
MISCELLANEOUS MEASUREMENTS		
Muting threshold (μV) (dBf)	2.0 (11.2)	Excellent
Dial calibration accuracy ($\pm$kHz at MHz)	100 at 98	Very good
OVERALL FM PERFORMANCE RATING		Excellent

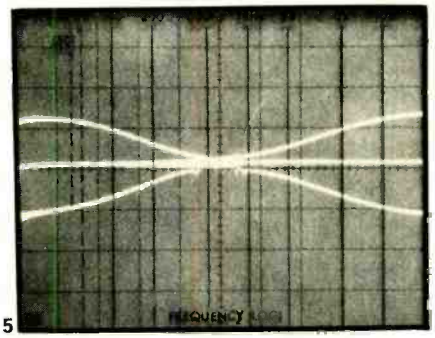
TABLE 2
AMPLIFIER PERFORMANCE MEASUREMENTS

POWER OUTPUT CAPABILITY	**R-E Measurement**	**R-E Evaluation**
RMS power/channel, 8-ohms, 1 kHz (watts)	77.0	Very good
RMS power/channel, 8-ohms, 20 Hz (watts)	74.0	Very good
RMS power/channel, 8-ohms, 20 kHz (watts)	70.0	Good
RMS power/channel, 4-ohms, 1 kHz (watts)	100	Very good
RMS power/channel, 4-ohms, 20 Hz (watts)	87	Good
RMS power/channel, 4-ohms, 20 kHz (watts)	85	Good
Frequency limits for rated output (Hz-kHz)	15-20	Good
DISTORTION MEASUREMENTS		
Harmonic distortion at rated output, 1 kHz (%)	0.065	Very good
Intermodulation distortion, rated output (%)	0.15	Good
Harmonic distortion at 1-watt output, 1 kHz (%)	0.025	Excellent
Intermodulation distortion at 1-watt output (%)	0.03	Excellent
DAMPING FACTOR, AT 8 OHMS	35	Very good
PHONO PREAMPLIFIER MEASUREMENTS		
Frequency response (RIAA $\pm$dB)	0.3	Very good
Maximum input before overload (mV)	230	Excellent
Hum/noise referred to full output (dB) (at rated input sensitivity)	72 (77 wt'd)	Excellent
HIGH LEVEL INPUT MEASUREMENTS		
Frequency response (Hz-kHz, $\pm$dB)	8-40, 1.0	Excellent
Hum/noise referred to full output (dB)	90	Excellent
Residual hum/noise (minimum volume) (dB)	100	Excellent
TONAL COMPENSATION MEASUREMENTS		
Action of bass and treble controls	See Fig. 5	Very good
Action of secondary tone controls		N/A
Action of low-frequency filter(s)		Excellent
Action of high-frequency filter(s)		Good
COMPONENT MATCHING MEASUREMENTS		
Input sensitivity, phono 1/phono 2 (mV)	2.5/2.5	
Input sensitivity, auxiliary input(s) (mV)	150	
Input sensitivity, tape input(s) (mV)	150	
Output level, tape output(s) (mV)	150	
Output level, headphone jack(s) (V or mW)	563 mV (8 ohms)	
OVERALL AMPLIFIER PERFORMANCE RATING		Very good

power margin at the low-frequency end of the spectrum, too, but at 20 kHz, the amplifier was able to deliver only its rated 70-watts-per-channel. Intermodulation distortion came close to its rated 0.2% value, but decreased significantly at all lower power levels, well below the 0.08% claimed for a 1-watt output.

As for the preamplifier, all input sensitivities were precisely as claimed by the manufacturer. Phono overload was even higher than the rated 200 mV. RIAA equalization accuracy was within 0.3 dB from 30 Hz to 15 kHz, and even unweighted phono hum and noise was an impressive 72 dB referred to an input sensitivity of 2.5 mV.

Tone control range of BASS and TREBLE is shown in Fig. 5; the pivot point of these controls is set at around 700 Hz. The flat



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response curve in Fig. 5 was achieved with the tone controls defeated, and in a separate point-by-point sweep, was found to extend from 8 Hz to 40 kHz for the −1-dB rolloff points.

Summary

Table 2 contains a summary of all amplifier measurements made on the *model RX-803*. Table 3 contains an overall product analysis as well as our summary comments regarding the listening qualities of the receiver. We found that the controls performed smoothly and up to expectations. FM calibration was accurate to within 100 kHz or better across the entire FM dial. Although the Rotel of America line of hi-fi equipment is perhaps not as familiar to most readers as some other more popular items, the *model RX-803* deserves high marks for quality. **R-E**

TABLE 3

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Rotel of America, Inc.** Model: **RX-803**

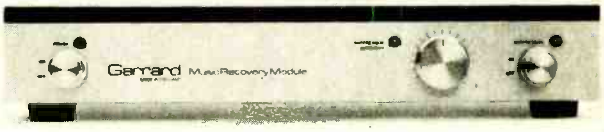
OVERALL PRODUCT ANALYSIS

Retail price	**$480**
Price category	**Medium**
Price/performance ratio	**Excellent**
Styling and appearance	**Very good**
Sound quality	**Excellent**
Mechanical performance	**Excellent**

Comments: **Rotel not only maintains a family resemblance between its higher-, medium- and lower-powered sets, but also provides a great degree of control and switching facility even in their more moderately powered, modestly priced sets. Of course, 70-watts-per-channel is not a low amount of power, but in view of the power race which seems to be going on in receivers one tends to lose sight of that fact. The power output of the *model RX-803* was great enough to drive our standard low-efficiency air-suspension lab speaker systems to well over 100-dB sound-pressure levels in a 14 × 22-foot listening room. The sound quality was quite transparent, with little transient distortion or even occasional clipping. The tuner section actually outperforms the amplifier section by a small margin. The front-panel de-emphasis switch makes conversion to FM Dolby reception simple, particularly if you aleady own a cassette deck with a built-in Dolby decoder. Just about every published FM performance specification was met or exceeded. AM performance, on the other hand, is average and typical of many high-fidelity receivers. Phono performance was excellent, and there was no evidence of phono overload even when relatively high output cartridges were used. Residual hum and noise in phono, under actual listening conditions, was extremely low—almost inaudible. From an aesthetic standpoint, we would have preferred it if Rotel had omitted those protruding handles on the front panel; they really serve no purpose whatever.**

On a straight power-versus-price comparison, the *model Rotel RX-803* offers extremely good value when compared with similarly rated, better-known receivers.

Garrard MRM-101 Noise Supressor Phono Preamp



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GARRARD's *MODEL MRM-101* IS *NOT* ANOTHER record player, despite the company's acknowledged reputation in the turntable field. Rather, the *model MRM-101* (the initials stand for *M*usic *R*ecovery *M*odule) is intended to remove the objectionable popping and clicking noises that are heard when a phono pickup meets a scratch in the groove of a record being played. Unlike an earlier impulse noise suppressor manufactured by SAE (the *model 5000*), the Garrard device, shown in Fig. 1, also contains a complete preamplifier-equalizer circuit so that the outputs from the *model MRM-101* can connect to a high-level pair of inputs on your amplifier or receiver, such as the auxiliary inputs.

The front panel of the *model MRM-101* has only a few easy-to-use controls. At the left is a power on-off switch with an associated indicator light. A symmetrically positioned control knob at the extreme right turns the suppressor circuitry on and off, and an indicator light near this control illuminates when the suppression circuit is introduced. The remaining larger knob at the right adjusts the sensitivity at which the scratch suppression operates. Turning this control to the right causes the unit to be triggered by relatively smaller scratches in the record, while turning the knob counterclockwise increases the scratch amplitude required to trigger the suppression circuitry. Triggering of the suppressor is indicated by a third indicator that flashes only when a scratch is being detected and suppressed.

The rear panel contains both phono-tip and DIN input and output terminals, as well as a grounding terminal to which the turntable ground wire must be connected.

MANUFACTURER'S PUBLISHED SPECIFICATIONS:

Input: suitable for cartridges having outputs of 0.7 to 2.0 mV-per-cm-per-sec. **Input Impedance:** 47,000 ohms. **Frequency Response:** 20 Hz to 20 kHz, ± 1.5 dB (including RIAA equalization). **Dynamic Range Via Suppressor:** greater than 80 dB. **Nominal Output:** 300 mV. **THD at Nominal Output, 1 kHz:** (direct) less than 0.01%; (via suppressor) less than 0.1%. **Channel Balance:** better than 2.0 dB at 1 kHz. **Output for 1.0% THD at 1 kHz:** (suppressor out) 8.0 volts; (suppressor in) 2.5 volts. **Output Impedance:** 3300 ohms. **Rated Load Impedance:** greater than 10,000 ohms. **Power Requirements:** 120 volts AC, 50 to 60 Hz, 7 VA. **Dimensions:** 14⅞ W × 2.8 H × 11¾ inches D. **Weight:** 8.16 lbs. **Suggested Price:** $200.

How it works

The *model MRM-101*, in addition to containing a preamplifier/equalizer circuit, has a scratch-detection circuit that recognizes the waveform of a scratch and distinguishes it from the peaks of recorded music. In order to allow the scratch-detection circuit sufficient time to remove the scratch, both audio channels are individually delayed by a few milliseconds without limiting the audio frequency range of the signal path. After the scratch is recognized, a specially designed network isolates the signal for a sufficient length of time to enable the scratch noise to pass out of the channel delay lines, after which the signal paths to the output terminals are restored. The duration of the signal interruption is so slight that the listener does not have time to detect the absence of music. An internal view of the *model MRM-101* is shown in Fig. 2.

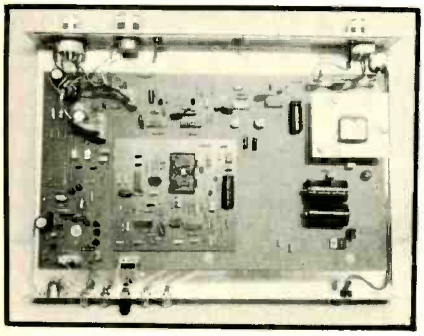

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TABLE 1

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Garrard** — Model: **MRM-101**

PREAMPLIFIER/NOISE SUPPRESSOR PERFORMANCE MEASUREMENTS

SPECIFICATIONS	R-E Measurement	R-E Evaluation
Frequency response (including equalization) (Hz-kHz)	20-20, ±1 dB	Excellent
Suppressor in	20-20, ±3 dB	Good
Voltage gain, 1 kHz (dB)	35.5	Good
Nominal output (mV)	300	(Reference value)
Output for 1% THD (V)		
Suppressor out	10.0	Excellent
Suppressor in	2.0	Fair
Distortion at nominal output (%)		
Suppressor out	0.015	Excellent
Suppressor in	0.10	Good
S/N ratio (dB, unweighted)		
Suppressor out	77	Excellent
Suppressor in	70	Excellent
EVALUATION OF CONTROLS, CONSTRUCTION AND DESIGN		
Ease of installation		Excellent
Arrangement of controls		Excellent
Action of controls and switches		Very good
Design and construction		Excellent
Ease of servicing		Very good
OVERALL PREAMPLIFIER PERFORMANCE RATING		Good

TABLE 2

RADIO-ELECTRONICS PRODUCT TEST REPORT

Manufacturer: **Garrard** — Model: **MRM-101**

OVERALL PRODUCT ANALYSIS

Retail price	$200
Price category	Medium
Price/performance ratio	Very good
Styling and appearance	Excellent
Sound quality	Very good
Mechanical performance	Very good

Comments: To date, we have tested only two products (SAE's *model 5000* and Garrard's *model MRM-101*) that claim to remove (at least audibly) those annoying pops and ticks from records damaged by scratches and dirt. Neither of these products claim to remove or reduce random surface noise, for which other forms of filtering are required. Both are effective in reducing the audible impulse noises such as those caused by scratched records. The chief difference between the SAE *model 5000* and the Garrard *model MRM-101* lies in that the latter unit is a full preamplifier-equalizer and therefore provides the necessary RIAA equalization and voltage gain so that its output signals can be connected directly to a high-level pair of inputs. This has advantages and disadvantages. The disadvantage is that since the preamplifier-equalizer is connected only in the phono circuitry, ticks and pops from other program sources (an FM station playing a scratched record) will not be reduced by the *model MRM-101*. The advantage is that by retaining total control of the cartridge signal from its introduction into the preamp/equalizer circuitry through the time-delay and impulse-noise elimination circuitry, an optimum interface is provided between the phono signal and all subsequent required circuitry. We believe that the Garrard unit is a bit more effective than the SAE unit in eliminating or reducing the effects of less severe scratches; while both seemed equally effective in reducing the impact of really severe gouges and scratches. If you own many severely damaged or scratched records, the Garrard *model MRM-101* offers what amounts to new life for them. It is easy to use and install and did not seem to materially change musical coloration when the suppressor circuitry was introduced.

Preamp-equalizer tests

Since the *model MRM-101* is a full preamplifier-equalizer, our first tests concerned this primary function. Test results are summarized in Table 1.

An input signal of 5 mV (at 1 kHz) was required to produce the nominal output of 300 mV; this was equivalent to a gain of just under 36 dB. With the suppressor out of the circuit, overload occurred at a 10-volt output, which translates to an input overload capability of around 166 mV. This is more than adequate to handle high-output cartridges even when they track heavily modulated grooves. With the suppressor turned on, however, the maximum output before a THD of 1.0% is reached was considerably lower—2.0 volts. This translates to an input capacity (at 1 kHz) of around 33 mV—a rather low figure in terms of some of today's dynamically recorded discs and one that indicates choosing lower-output cartridges. Since Garrard lists an input range of 0.7 mV to 2.0 mV-per-centimeter-per-second, we recommend a cartridge whose output is at the lower end of that range. (Most cartridge manufacturers state a nominal output for a velocity of 3.54 centimeters-per-second, which works out to approximately a 2.5-mV nominal output for the 0.7 mV-per-centimeter-per-second extreme of the recommended range.)

The unweighted S/N ratio of the *model MRM-101* is high enough so that when such lower-output cartridges are used there is still plenty of dynamic range available between the lower noise-and-hum floor and the upper distortion-level ceiling of this preamplifier.

Testing the suppressor

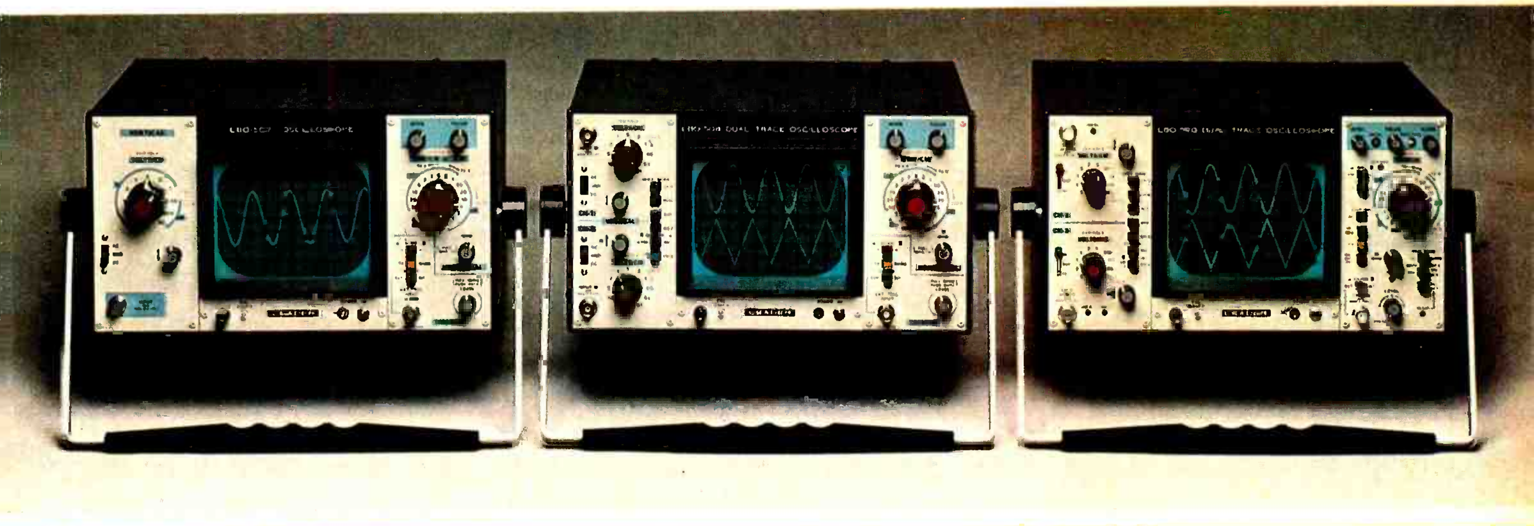
The most effective way to test the ability of the *model MRM-101* to reduce or remove audible pops and ticks caused by scratches in discs is to play a variety of scratched records. Our record collection has no shortage of such damaged records and we spent several hours listening to the way in which this amazing device was able to improve the reproduction. To be perfectly fair, not every type of scratch was totally inaudible, but most of our damaged discs became quite listenable when played through the *model MRM-101*. It is important to set the device's sensitivity control to its optimum point (this can be done only by careful listening and switching back and forth between the suppressed and unsuppressed modes). The results are extremely effective, and, in nearly all cases, our tests revealed there was no audible change in musical content with the suppression feature turned on—only a complete or substantial reduction of the audible pops and clicks.

Demonstrating the effects of the suppressor feature graphically while playing a disc was beyond the capability of our laboratory equipment because of the random quality and brevity of the scratches and pops produced by a typically damaged disc. We therefore attempted to create our own repetitive signal to approximate the waveform generated when a pop is reproduced or picked up by a stylus in a groove. After much experimentation, we managed to create a signal resembling such a waveform. It consisted of an upper mid-frequency

continued on page 104

Forest Belt tells...

What You Need To Know About Oscilloscopes



OSCILLOSCOPES ARE COMING INTO THEIR OWN. INDUSTRIAL and broadcast technicians have known for years how indispensable a scope is. However, in many home-electronics service shops, the scope has often been an instrument that gathered dust on a shelf under the bench. A technician set it up only as a last resort. Even then, he could seldom convince himself that what he saw on the scope face could really help him fix anything.

Today's successful repair expert knows better. No single instrument has been proved more versatile and useful in the hands of a skilled technician.

Three factors have contributed to its spectacular rise in popularity:

1. Test equipment you buy today is easier to use than ever before. Manufacturers have invested both money and effort in designing oscilloscopes that are simpler to operate, just as the instruments themselves have grown more sophisticated.
2. Technology in home-electronic devices leaves no room for "cut-and-try" troubleshooting. An oscilloscope is the only instrument that lets you see complex, sensitive signals the way they really are.
3. You have available, as never before, the means for learning how to use unfamiliar equipment. There is no excuse not to learn. Conscientious technicians rise to the challenge of high-technology diagnosis and repair, and incorporate the oscilloscope smoothly into their troubleshooting procedures.

This Special Section reviews maintenance-type and service-type oscilloscopes; featured are the state of the art—what instruments you can buy and use—hints to speed scope-trace analysis—familiarization with modern features. Whether you are a beginning technician or an old maintenance hand, this discussion should help dispel any apprehension you may have about modern oscilloscopes.

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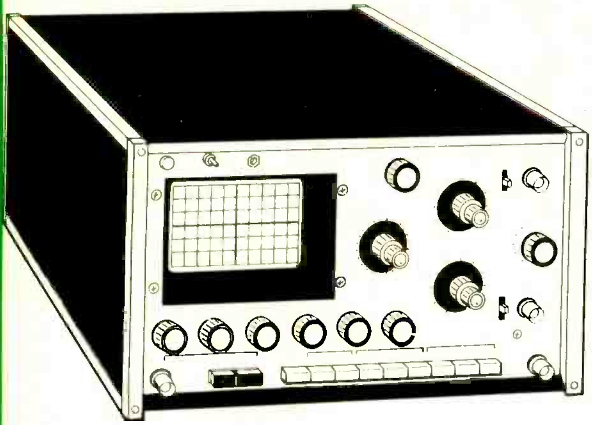


Why Are Triggered Scopes So Popular?

There's more than one reason, and you should know them all

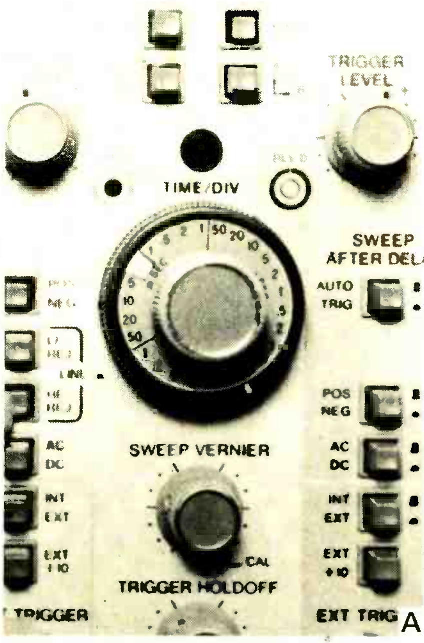
YOU DON'T HAVE TO THINK BACK very far to remember when a triggered-sweep oscilloscope was rarely seen in a service shop. Only "egghead" technicians had them, or tried to use them for troubleshooting, especially around TV sets. You generally thought of triggered-sweep scopes in relation to a Tektronix, Hewlett-Packard, Marconi or some other exotic brand of TV set. They were called lab scopes; and you were considered special if you knew how to use one.

For TV and home-electronics servicing, the only scope used in those days was a recurrent-sweep type. The sweep ran continuously, pulling the beam across the CRT face to form a baseline, then quickly returning for another trip across. You set the sweep at some frequency that would synchronize a few cycles of a desired signal and hold the display steady enough for viewing. Recurrent-sweep scopes did a sufficiently accurate job, and they were easy to understand and use. At least they seemed that way.

VIZ Model WO555

Today, as you know if you've looked around your distributor's shelves or thumbed through any test-equipment catalogs, you can hardly find a new recurrent-sweep scope to buy. There are a few models (see Table 1), but they are an exception now rather than the rule. Why is this so?

A dozen technicians would give you twelve different answers. However, only a couple of reasons need concern you as they apply to servicing.



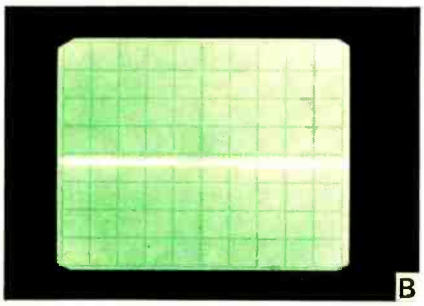


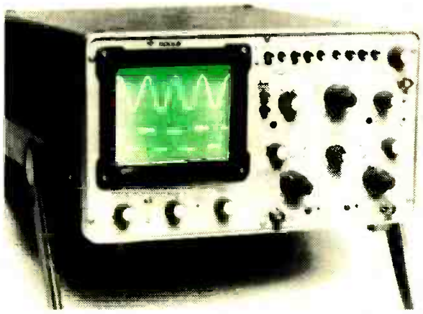
FIG. 1—TIMEBASE KNOB MAY BE LAbeled Time/Cm or Time/Div. At sweep settings longer than 1 ms, the trace (here auto-triggered) flickers or becomes a mere scanning spot.

For one thing, a triggered scope gives you more information about a waveform than a recurrent-sweep scope. You will see why, as you read further.

And, believe it or not, despite the awe with which older technicians regard a triggered-sweep scope, it actually is easier to use—or to learn to use—than a recurrent-sweep type. Usually, the difficulty lies with technicians who have been taught to view waveforms mainly in terms of *frequency*, as is necessary with a recurrent-sweep scope. When you think of waveforms in terms of *time*, most of the mystery about a triggered scope disappears. In fact, any waveform, except perhaps a sinewave, can be analyzed more easily in terms of time than by its frequency.

On a timebase

Consider how a triggered-sweep scope draws its trace: The scope *sweep* moves the CRT beam from left to right across the CRT face. The Sweep control has *time* markings (Fig. 1-a) that indicate *how long it takes the sweep* to move from the exact left of the graticule to the rightmost position (usually out of sight).



Gould Model OS 1100

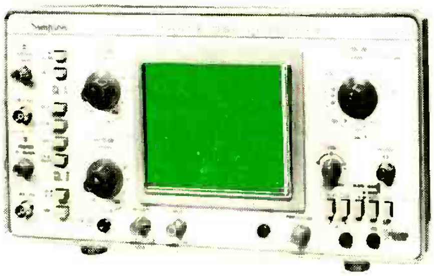
This is easy to observe if you have a triggered scope that runs with a sweep time as slow as, say, 50 milliseconds per-division (expressed as 50 ms-per-division). This means the beam takes 50 ms to traverse each marked square (usually 1 centimeter) of the graticule. Since most scopes have 10 divisions from left to right, the scope sweep swings the beam all the way across in 500 ms, or one-half second. Try it, with the scope set for automatic triggering, and you can watch the spot move from left to right.

As you turn the sweep's Time/Division knob to shorter and shorter times, the beam is swept faster and faster. At 20 ms-per-division and 10 ms-per-division, you can still see the spot move across the screen, but very rapidly. At 5 ms-per-division, the trace line appears to flicker.

At 2 ms-per-division and shorter time periods, the beam sweeps across the 10 divisions so rapidly that the eye sees a fairly steady trace. At 1 ms-per-division, the spot moves across the screen in only a hundredth of a second (one-thousandth of a second for each division). At this and faster speeds, the beam moves fast enough and phosphor tube persistence is long enough that the moving spot appears as a solid trace line (Fig. 1-b).

Looking at signals

Now, what can you deduce from this timebased sweep? For a few moments, ignore whatever you remember of waveform frequencies, and just examine one complex TV signal: the *composite video*. A useful way to analyze this signal is by observing how the oscilloscope (in this instance, a triggered-sweep model) displays this familiar signal.



Simpson Model 452

A scope test probe connected to the video-detector output of a TV receiver feeds a composite video signal into the scope's vertical amplifier. As it sweeps across the screen, the CRT beam, instead of forming a straight trace line, also deflects upward and downward in accordance with the instantaneous voltages in the video signal. The patterns thus traced are called the *waveshape*. The spacing of these patterns across the screen corresponds to respective time positions of each point in the waveform.

For example, let's assume the sweep is triggered (or begun) at the tip of the vertical-sync pulse, as shown in Fig. 2-a. (Later on in this article, you'll learn exactly how to control this pulse.)

With the sweep set for 2 ms-per-division, 10 graticule divisions represent a total timebase of 20 ms. Next, count the graticule divisions. The tip of the next vertical pulse *after triggering* falls about 8.4 divisions beyond the first division. At 2 ms-per-division, this represents a time duration of 16.8 ms, or the time occupied by one field of video in the composite video signal. It represents the time distance between

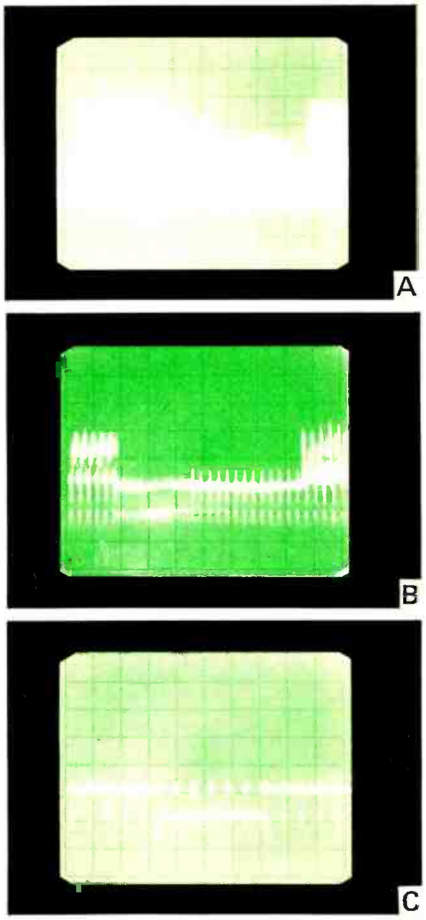


FIG. 2—TELEVISION VERTICAL FIELD can be spread and delay-triggered to show vertical interval in detail or expanded to reveal serrated sync pulse.

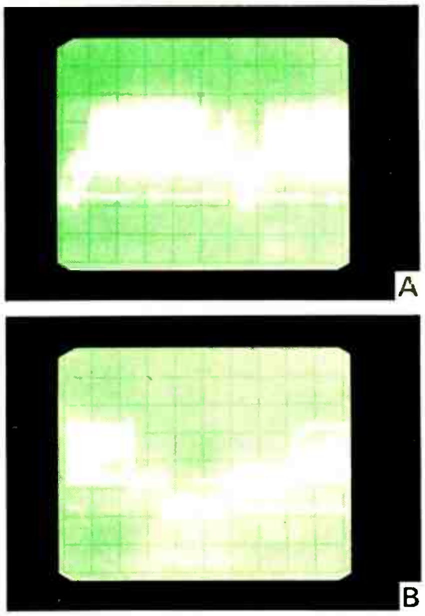


FIG. 3—TELEVISION HORIZONTAL LINE, with horizontal-sync pulses and burst, can also be widened for measuring and examination.

two vertical-sync intervals (blanking and pulse).

Analyzing the waveform shape is one crucial reason for viewing the signal in the first place. If you know the timing between the high spots of any waveform, you can choose a timebase that spreads out any portion of the signal you wish to examine.

For example, suppose you want to take a closer look at the exact makeup of the vertical-sync interval shown in Fig. 2-a. With a setting at 2 ms-per-division, you cannot accurately determine the time duration of the vertical-sync pulse and blanking. Nor can you examine the waveform in any detail.

The solution, of course, is to shorten the sweep's timebase. Setting the switch to 1 ms-per-division makes the interval between video fields occupy twice as much graticule space. Shortening the time to 0.2 ms-per-division (Fig. 2-b) displays the makeup of the pulse more thoroughly. This setting spreads the whole interval–blanking, vertical pulse, equalizing pulses and inactive (blanked) lines–over about 6.8 divisions. The duration, therefore, is about 1.36 ms. It is almost possible to distinguish the horizontal-sync serrations in the vertical pulse. And you can easily see the equalizing pulses that ride the blanking pedestal.

By the time you shorten the timebase to 50 μs-per-division, the sync pulse itself is spread over 3.7 graticule divisions. The duration of the pulse alone is 185 μs. Figure 2-c shows the serrations and equalizing pulses clearly.

Close detail

It is evident by now that you can view a complicated waveform much more clearly with a triggered-sweep scope than with a recurrent-sweep type. You can spread out a signal on virtually any timebase within the range of the scope sweep. Triggering also allows you to observe a waveform, pulse train, or an individual pulse of almost any shape or duration. You merely select a timebase and triggering point that shows whatever detail you desire.

To clarify this even further, consider a single horizontal line of the video composite signal. You will probably recall, from your studies of TV fundamentals, that a complete horizontal line–pedestal, sync pulse and video–occurs every 63.5 μs. If you want to examine one line closely, you must make it cover a wide portion of the scope graticule. A 10-μs-per-division setting of the sweep spreads the 63.5-μs line over more than six divisions (see Fig. 3-a). The video, the front and back porches of the pedestal, the color burst on the back porch and the pulse tip itself are clearly visible. You can verify the proportions of the sync pulse, make sure the burst is normal and assess whether some fault in the TV receiver is compressing the video, smearing it, or degrading the sync pulse.

TABLE 2—TRIGGERED-SWEEP OSCILLOSCOPES

Brand	Model	Bandwidth (MHz)	Sensitivity (mV/div)	Dual-Trace modes: Chop	Dual-Trace modes: Add	Signal Delay ②	CRT: Rectangular	CRT: PDA	CRT: Graticule Illum.	Sweep Range: from (μsec)	Sweep Range: to (sec)	Magnifier	Trigger: TV	Trigger: HF Rej (kHz)	Trigger: Variable Delay	Probes: Model	Probes: Included	Prices: Under $600	Prices: $600-$1300	Prices: Over $1300
B & K Precision	1432	15	2	①	√					0.5	0.5	5X	√			PR-37	√		√	
	1461	10	10							1.0	0.5	5X	√			PR-31	√	√		
	1471B	10	10	①	No					1.0	0.5	5X	√			PR-34	√	√		
	1472C	15	10	①	√				edge	0.5	0.5	5X	√			PR-36	√		√	
	1474	30	5	①	√	√		√	edge	0.2	0.5	5X		30+		PR-36	√		√	
Conar	255	6	10							1.0	0.5							NA		
Eico	480	10	10							0.1	0.5		√			LCD-10	√	√		
	482	10	10	No	No					0.1	0.5		√			LCD-10	√	√		
Gould	OS245A	10	5	①	No		√			1.0	0.5	③	√			PB13	√	√		
	OS260	15	5	④	No		√	√	edge	0.5	0.2	10X				PB13	√		√	
	OS1100	30	2	√	√	√	√	√	int	0.2	2.0	10X		10+	Yes	PB13	√		√	
	OS3300B	50	5 ⑤	√	√	√	√	√	int	⑥	⑥	10X		10+	⑦	PB13	√			√
Heath	104510	15	1	√	No	√	√	√	edge	0.1	0.2	5X				PKW-105			⑧	
	104541	5	20							0.2	0.2							⑧		
	104550	10	10	No	No					0.2	0.2	5X						⑧		
	104555	10	10							0.2	0.2	5X						⑨		
	104560	5	100							0.2	0.2							⑨		
Hewlett-Packard	182C (180 series)	35 ⑩	10	√	√	√	√	√	FG	.05 ⑩	1.0	10X		15+	⑪					√
	1740A (1700 series)	100	5 ⑤	√	√	√	√	√	FG	.05	2.0	10X		4+	⑦					√
Hickok	515	15	10							0.5	0.2	5X	√			SP-6	√	√		
	517	15	10	①	√					0.5	0.2	5X	√			SP-6, 7	√		√	
	532	30	10	√	√	√				.05	2.0	4X		10+	Yes	SP-7	√		√	
Leader	LBO502	15	10						edge	NA	NA	5X					√	√		
	LBO507	20	10							0.5	0.2	5X	√					√		
	LBO508	20	10	①	√					0.5	0.2	5X	√						√	
	LBO515	25	5	√	√		√		int	⑫	⑫	10X	√	10+						√
	LBO520	30	5	√	√	√	√	√	edge	0.2	0.5	10X	√						√	
Lectrotech	TO-55	10	10						edge	0.5	0.2	5X	√			PR-10		√		
	TO-60	15	10	√	√				edge	0.5	0.2	5X	√			PR-10		√		
Philips	PM3211	15	2	√	√		√	√	NA	0.5	0.2	5X				NA			√	
	PM3212	25	2	√	√	√	√	√	int	0.2	0.5	10X	√			PM-9336	√		NA	
	PM3214	25	2	√	√	√	√	√	int	⑫	⑫	10X	√		⑦	PM-9336	√		NA	
	PM3226 ⑬	15	2	√	No		√	√	NA	0.5	0.2	5X				PM-9337			√	
	PM3233	10	2	④	No	√	√	√	edge	0.2	0.5	5X	√			PM-9337			√	
Sencore	PS29	8	10						edge	0.2	0.1	5X	√			39G80	√	√		
	PS163	8	5	√	√				edge	0.1	0.1	5X	√			39G80	√		√	
Simpson	452	15	5	①	No				edge	0.2	0.5 ⑭	5X	⑭		⑮	√				
	455T	12	10							0.5	0.5 ⑭	5X	⑭		⑮	√				
Tektronix	SC502 (500 series)	15	5	√	⑯	√	√	√	int	0.2	0.5	10X							√	
	T935 (900 series)	35	2	①		√	√	√	int	0.1	0.5	Var	√		Yes	P6062A	√			√
	7704A (7000 series)	75 ⑰	5	√	√	√	√	√	int	.005	5.0 ⑰	10X	√	50+	⑦					√
Telequipment	D32 ⑱	10	10	①	No		√			0.5	0.5	5X	√			10:1	√		√	
	D61A	10	10	No	No					0.5	0.5	5X	√					√		
	S61	5	5							1.0	0.5							√		
Viz	WO-527A	15	10							0.5	0.5	10X	⑭			WG-478		√		
	WO-555	15	10	√	√	√				0.5	0.5	10X	⑭			WG-478	√		√	

NOTES (see copy)

NOTES

NA — Information not made available by mfr.
FG — Floodgun Illumination
Opt — Optional extra
Int — Internal
Var — Variable
1 — Switches automatically to Chop mode at sweep times slower than 0.5 msec.
2 — Delay line in vertical amplifier(s) to allow viewing leading edge of displayed waveform.
3 — Has both 5x and 10x magnification.
4 — Dual beam, not dual trace. Beam switching not necessary.
5 — Vertical 5x magnifier raises sensitivity by that factor.
6 — Two time bases: A is 0.1 usec to 1.0 sec/div.
B is 0.1 usec to 0.5 sec/div.
7 — Incorporates both intensified and delayed trigger, using multiple time bases; has 10-turn delay multiplier.
8 — Kit version priced substantially less.
9 — Kit only.
10 — With models 1807A vertical amp and 1820C time base plug-ins.
11 — Only in models 1821A and 1825A time base plug-ins.
12 — Two time bases: A is 0.2 usec to 0.5 sec/div.
B is 0.2 usec to 0.1 sec/div.
13 — Single-trace version is model PM3225.
14 — Plus TVV and TVH sweep positions, usually with matched triggering.
15 — Fixed trigger delay for VITS display at special VITS setting of time base.
16 — Has A minus B mode, but no flipover for A plus B.
17 — With models 7A18 vertical amp and 7B53A-05 time base plug-ins.
18 — Battery-operated portable; AC-operated too.

You can look even closer at the pulse itself. Just spread the signal some more. Try a sweep setting of 2 μs-per-division, as shown in Fig. 3-b. On a live scope, you can even count burst cycles. More significantly, you can verify that the burst is not being attenuated by either poor alignment or some other defect preceding (or in) the video detector.

A triggered scope with certain extra features can even let you select and study the VITS and VIR signals when they come through the network linkage. These signals occupy lines 17, 18 and 19 of each vertical field, yet they're not always transmitted. The VITS signals also differ with each network. A scope with a variable delay on the trigger can single out those lines and examine the signals in detail. How you manipulate these extra features brings up the question: Exactly how does a triggered scope trigger? And the answer will be given later on in this article.

Meanwhile, you should now be fairly insulated against thinking any more about waveform *frequencies*. Using a triggered scope, you'll fare much more successfully if you think of waveforms in terms of length or duration.

TIMEBASE CHART

A guide to the handiest Time/Div setting at which to start viewing common signals.[1]

Signal	Suggested Time/Div
Low-end audio	0.2 ms
High-end audio	50 μs
TV fields	2 ms
TV lines	10 μs
TV vertical sync only	5 ms
TV horizontal sync only	20 μs
CB xmtr output modulated 1000 Hz	0.2 ms
EIA noise signal (for CB noise blankers)	0.5 μs

1. Synchronizing stable displays of the above signals depends, sometimes, on critical trigger settings.

Scope Features

They might determine which one you will buy

PRICE SHOULD NOT BE THE CHIEF criterion in purchasing one oscilloscope instead of another. Just as with other products, you may not get a bargain by saving money. Yet, the opposite side to this coin is that spending more money does not automatically assure greater value.

Shopping for an oscilloscope entails a panorama of choices. I am not going to suggest what kind of scope you should buy, but rather offer some shopping hints.

The next several paragraphs will acquaint you with key features found in various triggered oscilloscopes. On the basis of this knowledge, you can then select a scope best suited to the kind of servicing or maintenance you provide. You will recognize conveniences that add confidence and accuracy to your analyses and diagnoses.

I assume you are already familiar with recurrent-sweep scopes and know whether they satisfy your purposes. Therefore, this article will confine itself to a discussion of triggered scopes, from the least expensive to large, elaborate and costly models.

First, shop for the features that you need, and only then explore the prices of the models that interest you.

Second, expect and ask for a demonstration of any and all features. Do not settle for a quick verbal run-through of what the scope will do. *See* the scope display the waveforms you want to inspect. For that much money, a test-instrument salesman can take the time this requires. If he can't, find one that will.

Third, insist on a week's trial in your shop. Introduce the instrument to your workaday problems and make sure it will do everything you want done. If it won't, perhaps you need a more elaborate instrument—or perhaps you just need a lesson or two in operating it. Understand the instrument. Ask your salesman to come and explain anything that confuses you. *Do not* play know-it-all. You're paying too much money to buy something you can't use.

Heath IO-4550

Finally, examine more than one brand and model of scope. It is not a waste of time, you will be living with your purchase a long time. Be sure you like its appearance, its smoothness of operation and its capabilities. If the controls are hard to find or manipulate; if the probes do not fit the instrument or your hand well, or do not clip on easily for tests; if the panel size and arrangement do not fit your bench or your working habits—you will never be truly satisfied. Since dissatisfaction inevitably leads to avoiding using the instrument, that's no way to make it a profitable investment.

So, shop around; you'll be glad you did.

Simple (but important) features

Some minor features that are common, yet not all-pervasive, should be mentioned right away.

Examples abound in the cathode-ray tube (CRT). A P31 phosphor tube is generally used in triggered scopes because of its medium persistence. Almost no one uses the shorter-persistence P1 phosphor tube in a triggered scope. A P31 phosphor tube can be aluminized, which allows slightly more brilliance; this tube is labeled P31A. A P31 tube delivers a green trace; a P11 tube delivers a blue trace. Some scopes offer an optional longer-persistence P7 phosphor tube, but it is doubtful you would need it for servicing. A storage-type CRT actually holds a selected pattern for an hour or more, but it's expensive and not needed for ordinary service work.

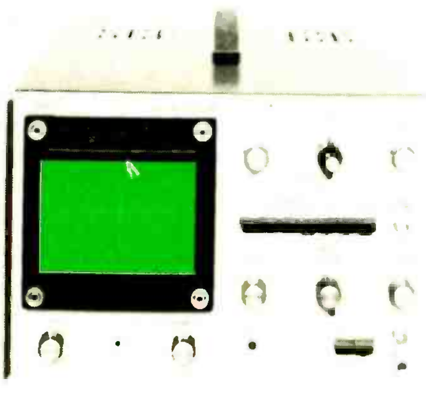
Today's scopes have both round and rectangular CRT screens, and most are flat-face. The vertical viewing size (called the Y-axis) of a rectangular CRT runs 8 centimeters (8 cm), typically; the horizontal viewing size (the X-axis) is 10 cm.

Some graticule divisions are as small as 0.79 cm; a few as large as 1.29 cm, most are 1.0 cm exactly. Round CRT screens generally are covered by a mask with a rectangular graticule grid. A standard size for the grid on a 4-inch-round tube is 8 by 8 cm; for a 5-inch-round tube, 8 by 10 cm or 10 by 10 cm. A very few are marked in inches. And an occasional graticule sports vector markings for B–Y/R–Y displays from color TV.

How or if the graticule is lighted may matter to you. An external graticule with sidelighting (Fig. 1-a) achieves one effect; usually some areas are brighter than others. Internal graticule lighting (Fig. 1-b) provides much more even lighting but is also more expensive.

Some Hewlett Packard models use a CRT that incorporates a technique called *floodgun* graticule lighting. A set of special elements inside the CRT flood the phosphor tube with electrons and produce a glow over the whole CRT screen. Black graticule lines etched on the CRT face show in strong contrast to the glowing phosphor. Figure 1-c shows this effect. The intensity of this backlighting effect can be varied to increase the visibility of the etched graticule grid.

A characteristic called *post-deflection acceleration* (PDA), sometimes known just as *post acceleration*, turns up in some sales pitches. The term refers to applying high voltage to an accelerator anode *beyond* the deflection plates. (An ordinary electron gun accelerates the beam before deflection.) Acceleration after deflection improves the linearity of the sweep across the screen and produces a brighter and, usually, a sharper trace than usual.



EICO Model 480

Do not overlook the importance of a sharp trace. A scope for triggered applications should have an *astigmatism* adjustment in addition to the usual focus knob. The Astigmatism Adjust control (typically, a tiny screwdriver pot) may be located on the front panel, perhaps at the rear, but it must be accessible.

In examining the fine detail possible with a wideband triggered scope, a thick trace line can hide significant flaws, such as ringing or overshoot. The astigmatism adjustment helps re-

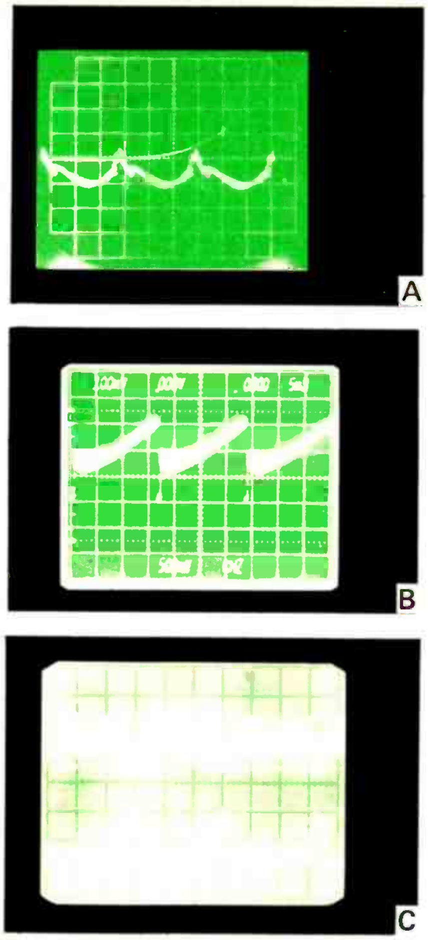


FIG. 1—SIMPLER FEATURES OF SCOPES, such as graticule lighting, often bring more convenience to operation. Shown here are (*a*) edge lighting, (*b*) internal graticule, and (*c*) unique floodgun lighting.

fine the beam to a tiny round pinpoint. You adjust it in conjunction with the focus knob to obtain a trace that is thin and sharp on both the Y-axis (rising or falling lines) and the X-axis (horizontal trace lines). Hickok, in their *model 532* triggered 30-MHz dual-trace scope, claims a beam thickness no more than 0.006 inch.

Many triggered oscilloscopes include what manufacturers term a built-in delay line. This feature is located in the vertical amplifier section to delay the signal a few nanoseconds. If there are two channels, as in a dual-trace instrument, each channel has this *signal delay* line.

The purpose of this feature is to slow down the arrival time at the CRT of the signal that will be viewed. During internal triggering, the sweep does not begin until the trigger amplifier perceives a slope of whatever polarity and amplitude have been chosen by the triggering-control settings. However, the same signal, coming through the vertical amplifiers, causes a vertical deflection of the CRT beam. The sweep doesn't start until part of that signal has occurred. Therefore, you do not see the leading edge of the viewed waveform because of the trigger setting. This is especially a problem for waveforms that have leading edges with a very fast risetime.

A short delay holds the vertical signal back until several nanoseconds after the sweep triggers. Thus, you see *all* the waveform, including some trace line ahead of the leading edge.

Do not confuse this *signal delay* with delayed trigger, which is entirely different. You find the delayed-trigger feature in expensive scopes; you will learn what it is and how it performs later on in the article.

A trace expander, usually called a magnifier, comes in handy for examining complex waveshapes in detail.

Non Linear Systems MS-15

Pressing this button simply spreads the trace out to five or ten times the normal scan.

If you activate the magnifier, you must consider the multiplier in any timebase measurements. Some scopes expand the trace X5, some X10, and a few expand it to both. Imagine a timebase setting of 10 μs-per-division, for example. Turn on a X10 magnifier, and what originally occupied one division on the screen now covers all 10 divisions. Hence, the *effective* timebase has become 1 μs-per-division.

Make sure the Horizontal Position knob moves the trace far enough left and right to let you see all the expanded trace. Normally, the magnifier spreads out what is at the centerline of the graticule. To see other portions of the display, use the Position knob.

Examine the reduction of beam brightness when you use the magnifier feature. In a few scope sweeps, with sweep times in microsecond ranges, you may be almost unable to view the trace when it is expanded—even after turning up the beam intensity. If this sort of operation is important, find a model that develops a trace display that is bright enough to view even a 1-μs pulse spread out to five graticule divisions. The brightest scope models incorporate a CRT with PDA or apply a high (above 5-kV) accelerating potential to the CRT.

An occasional scope includes a vertical expander, but, generally, flipping the VOLTS/DIV switch accomplishes the same effect.

The range of the sweep times may be of concern in some instances. For ordinary service measurements and testing, a 50-ms-per-division sweep time should be quite slow; and 0.5-μs-per-division should be satisfactory at the fast end. If you expect to work on personal computers, digital process control, or other similar gear, you sometimes may need a faster sweep—perhaps as fast as 0.1 μs-per-division. This faster sweep, supplemented by a X5 magnifier, would let you examine and/or count pulses no more than 10 ns apart. Sweep ranges beyond these ranges would be a bonus, unless they are necessary for some specific servicing use. A trial period in your shop will tell.

These are a few of the small but crucial features you might overlook in selecting a scope. An alert salesperson will point out and explain the significance of many other features. You, the customer, must also be aware. It's your money being spent; you hope to spend it wisely.

Scope Bandwidth

How much is enough? And exactly what is it?

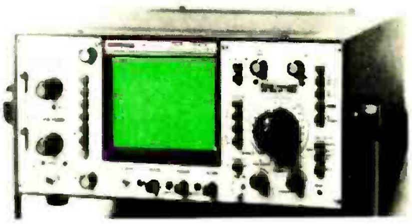
YOU NEED TO UNDERSTAND what is meant when scope specifications refer to the bandwidth. Some manufacturers state the bandwidth in a nonstandard way, making a scope seem more wideband than it really is (compared with others).

It is not simple to compensate the vertical amplifiers of an oscilloscope to pass a band of frequencies all the way from 0 volts DC to many, many megahertz. This is why wideband scopes cost more. And not even the the best vertical amplifier can come out perfectly flat; it is likely to favor some frequencies. However, careful design can hold the variances in frequency response within a relatively narrow range. The standard tolerance is 3 dB.

To meet this standard tolerance, an oscilloscope must neither attenuate nor peak any signals, within its rated bandwidth, more than 3 dB. In other words, the vertical amplifier could boost signal voltages as much as 1.4 times the normal voltage at certain frequencies, and diminish them by 0.7 times at others, and still remain within accepted specifications.

Most significant is the bandwidth over which the scope's vertical amplifiers will meet this 3-dB standard. Since rolloff is more pronounced at higher frequencies, bandwidth is often expressed in terms of the highest frequency. That is, a 15-MHz scope displays signals up to that frequency with no more than 3-dB loss (sometimes stated as −3 dB) or peaking.

However, be sure the scope you buy meets this 3-dB standard across its whole bandwidth. A specification that claims the scope response is "down 3 dB at 15 MHz" could be peaked at that frequency and have a severe dip at various frequencies below 15 MHz. What you should expect is response *within* 3 dB across the entire bandwidth—from DC to 15 MHz. If the specification states exactly that, you can trust it; dependable manufacturers are careful of their claims. But read specifications closely; 3.5 dB or 4 dB is not the same—and, even though accurate, is difficult to compare with standard bandwidth figures.



Leader LBO-520

If you have any doubts, have your new instrument checked and calibrated by an instrument lab. (Don't go by your signal generator; it may peak more erratically than any scope.)

So, how much bandwidth is necessary? A recent popular use for oscilloscopes is in viewing the output of CB transceivers. Citizens band RF signal output is usually about 27 MHz. To measure the signals accurately, you need a scope with a bandwidth to 30 MHz.

You can *see* the 27-MHz RF output on a 15-MHz scope. If all you're interested in is the shape of the modulation, this lesser bandwidth is acceptable and usable. However, the display will be small and calibrations inaccurate. What is worse, weak signals, such as those generated by oscillators and mixers inside the CB transceiver, may be so attenuated that they cannot even trigger a sweep. Therefore, if you expect to work regularly with 27-MHz signals, consider a 30-, 40-, or 50-MHz oscilloscope bandwidth.

In digital pulse work, whether in a microcomputer or a modern TV receiver tuning system, wide bandwidth becomes important from another standpoint. To examine short-duration pulses, you need a scope with a *risetime* that is adequate to reveal the pulse shapes without distortion.

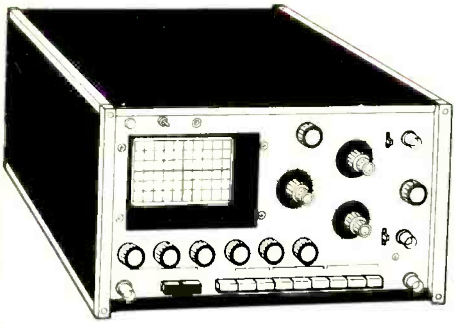
Technically, *risetime* is the period required for the leading edge of a pulse to rise from 10% to 90% of its final amplitude. Risetime relates closely to bandwidth. If you need a particular risetime to view and measure certain pulses accurately, you can divide 0.35 by the risetime (in seconds) and find the 3-dB bandwidth required (in Hertz).

For example: Suppose you need a 10-ns risetime—that's 0.00000001 second. You can use your scientific calculator to solve this risetime/bandwidth computation. Enter 0.35 and press the divide pushbutton. Using scientific notation, it's easier to express nanoseconds as (10^{-9}) seconds. So, enter 10 (for 10 ns); press the exponent button and enter a negative 9. Press the equal sign pushbutton, and the answer appears (in Hertz): 35,000,000. Therefore, you need a 35-MHz scope.

Another example: You need a 2-ns risetime for extremely quick pulses. Divide 0.35 by 2 (10^{-9}). You need a scope with a bandwidth to at least 175 MHz.

Typically, a 10-ns risetime will suffice, except in fast microprocessors. If you know enough about computer equipment to be able to service it, you know what risetimes are involved in the pulse trains. Use the $0.35/T_R$ formula to find what bandwidth you need in an oscilloscope.

An interesting sidelight on this: If a manufacturer has stated the bandwidth specification in some nonstandard fashion, you can compute the actual 3-dB bandwidth from the specified risetime. So far, no scope maker I know uses any standard specification for risetime except the usual 10% to 90% method.



Scope Sensitivity

A most important scope characteristic

THERE IS A SPECIFICATION THAT might be crucial in some types of servicing. The term *sensitivity* (occasionally called *minimum deflection ratio*) refers to how much signal voltage is required to produce a usable display. On most scope screens, a display that occupies at least two of the vertical (Y-axis) divisions gives a fairly good view of the waveform. Four divisions are more than enough.

However, vertical amplifier sensitivity is rated as the signal voltage that is required to deflect the trace vertically by one division, which usually is one centimeter (1 cm). Thus, an instrument that takes 5 mV to display a waveform one division high is not as sensitive as one that needs only 2 mV for the same size trace. An oscilloscope rated at 5 mV-per-division sensitivity can satisfactorily display smaller signals than one rated at 10 mV-per-division.

Watch out for the difference between peak-to-peak (P-P) and RMS-sensitivity ratings. If sensitivity is listed with RMS voltage, and this is not uncommon, you must multiply by 2.8 to obtain a peak-to-peak sensitivity figure. Thus, a scope that is rated for sensitivity at 2 mV RMS (it is acceptable to omit *per-division* or *per-centimeter*), is not as sensitive as a scope rated at 5 mV P-P.

Sencore Model PS163

What sensitivity value is needed to show a three-division display from a 10-mV signal? Obviously, a value of 3.3-mV (or better) sensitivity will manage nicely—providing the bandwidth is sufficient to accommodate the signal.

Using this three-division criterion, a scope with sensitivity of 2 mV-per-division displays well any 6-mV P-P signal. A scope with a sensitivity of 5 m-V-per-division needs a 15-mV P-P signal to show a sizeable display. Of course, you can *see* a 5-mV signal, or even a 2-mV signal, but only as a much smaller trace. You also may have difficulty getting such a small signal to trigger.

You can spot the rated sensitivity of a scope by examining its vertical amplifier input knob (Fig. 2-a). It can be labeled in volts-per-division (Volts/Div) or per-centimeter (Volts/Cm or V/Cm). The smallest voltage listed on the settings is the per-division sensitivity of the scope. (If the instrument has a vertical expander, divide the lowest voltage-per-division setting by the expander multiplier. Thus, a scope with 5 mV-per-division as the bottom setting, and with a ×5 vertical magnifier, has an *effective* sensitivity of 1 mV-per-division.)

FIG. 2—INPUT ATTENUATOR KNOB calibrates vertical amplifier(s) to measure amplitude of input signal. Low-cap test probe introduces ×10 multiplier that must be taken into consideration.

The maximum calibrated peak-to-peak voltage may also be important to you. It is the highest voltage on the vertical-input switch. For example: At 20 volts-per-division, an 8- by 10-cm graticule lets you view a waveform of 160-volts P-P amplitude.

When you service TV receivers, you encounter signals as low as 10 mV P-P or 15 mV P-P. In CB radios, at least in the transmitter and synthesizer, signals as weak as 20-mV P-P are usual, Hence, a scope with a sensitivity less than 5 mV-per-division P-P may not let you view, comfortably, some of the desired signals.

Measuring signal amplitudes with today's oscilloscopes is simple enough. You merely count the divisions occupied by the display and multiply by the voltage indicated at the setting of the input switch. For example, with the input switch set to 0.1 volts-per-division and a display that is about 3.4 divisions high, you are viewing a waveform that is 0.34 volt (or 340 mV) in amplitude. The same simple arithmetic works for any setting of the volts-per-division switch.

There are three things to remember: (1) Voltages are peak-to-peak. (2) Voltages measured by the scope are accurate to 3 dB only within the bandwidth of the scope. (3) The CAL/VAR knob with the input switch must be set at its calibrated (CAL) position. Fancier scopes include a light—in addition to the switch knob shown in Fig. 2-a—that warns you if you have left the variable knob at an uncalibrated spot. You use this knob only when you want to set the display at some specific size for whatever reason.

One other factor could mislead your peak-to-peak amplitude measurements: the test probe. Most tests should be performed with a low-capacitance probe such as shown in Fig. 2-b. So, when using the probe in the low-capacitance position, don't forget to multiply by 10 whatever voltage the graticule and switch indicate. Or, if loading is not a worry, turn the probe to its direct or 1:1 position.

Dual Trace Scopes

Two are often better than one

PROBABLY NO TEST INSTRUMENT has caught on so fast lately as the dual-trace triggered oscilloscope. Its primary advantage lies in letting you view more than one signal waveform at a time. However, that's not its only capability, nor even its most useful. Once you're truly familiar with a dual-trace instrument, you can make it perform a whole string of unusual and versatile functions. First, you need to know exactly how a dual-trace scope works. Otherwise, some of its operations will confuse you more than help you.

Simple dual-trace scope models operate in what is known as an *alternate mode*. A switcher inside the instrument alternately activates two traces and two vertical-input channels. You may be able to visualize this sequence easier by following through on your own or on a borrowed scope.

Conar Model 225

Imagine a video signal fed into vertical amplifier Channel A and nothing being fed into Channel B. With the triggering set for Channel A internally, the incoming signal fires the sweep. The TIME/DIV knob is set at 10 μs-per-division to display the horizontal video lines and, of course, the sync pulses. The sweep completes trace A and its display, then it blanks the beam and snaps it back to the left side.

The switcher instantly does three things: (1) It applies a DC vertical-deflection voltage that moves the beam down to a position where it can form another trace, which will be trace B. (2) It triggers the beam again, similar to the trace A triggering, and the sweep pulls the beam across at the same time/division rate as for trace A. (3) It switches the vertical deflection to the output of vertical amplifier Channel B. With no input, trace B remains flat, just a baseline. But trace B would display any signal that you feed into the Channel B input jack.

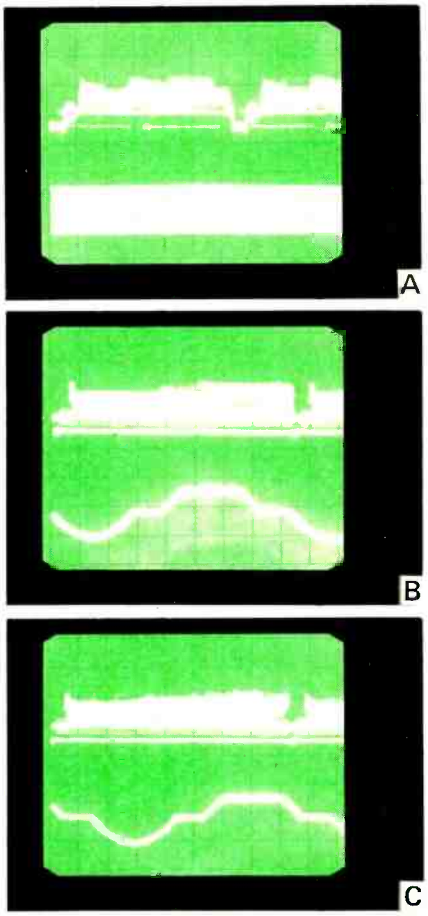


FIG. 3—DUAL-TRACE DISPLAY LOCKS on one signal or the other, unless both are in phases. (*a*) Horizontal line on trace A, supply ripple on trace B and triggering from trace A; also, timebase is too fast for ripple. (*b*) Timebase set to accommodate 16.7-ms duration of both TV field and ripple waveform; but slight phase variance lets one crawl. (*c*) Composite triggering locks both displays despite minor phase difference.

At the end of trace B, the sweep shuts off and the switcher lets the position deflection move the beam back up to trace A. The beam then waits for another trigger in Channel A. This alternating action between Channels A and B accounts for the term, *alternate mode*.

Now, imagine feeding a TV horizontal-sweep signal into Channel B. (Drape a test lead near the TV yoke.) Set the Channel B VOLTS/DIV switch for a comfortable display. Since both the Channels A and B input signals run at the same repetition rate, the timebase need not be changed. The switcher alternates displaying trace A and then trace B, with their respective signal displays.

But remember that the triggering is coming only from Channel A, internally. You can, in most dual-trace scopes, switch the triggering to Channel B. In that case, the sweep doesn't start until the Channel B signal reaches the chosen triggering amplitude (and slope direction). Trace B is completed and the switcher moves the beam up so the sweep can run trace A. Then, the sweep stops and waits for another trigger from the Channel B signal.

The single trigger and timebase limit a dual-trace scope in one way. Suppose you feed a power-supply ripple signal into Channel B. Leave the video signal fed into Channel A. You adjust the VOLTS/DIV switch on the Channel B side to accommodate the small signal amplitude. Set the trigger back to Channel A.

Once the sweep displays the video waveform on trace A, the switcher pulls the beam down to form trace B. However, the trigger comes from Channel A and the timebase is still set at a 10-μs-per-division speed that displays horizontal TV pulses.

This sweep rate is far too fast for a signal that has a per-cycle duration of almost 17 ms. The waveform on trace B just blurs, since it cannot synchronize. Figure 3-a shows the dual-trace result.

Thus, you discover one significant limitation of a dual-trace scope: You cannot view widely divergent waveforms simultaneously (unless they bear a harmonic relationship—but that's another story).

Now, to carry this demonstration one additional step, make two changes in the scope settings. Move the TIME/DIV switch to a position more suited for the ripple signal—say, 2 ms-per-division. Then, switch the trigger source to Channel B internal.

The trace B signal, if you place the trigger level correctly, locks in solidly (Fig. 3-b). Note that, with this new timebase, you can now see vertical-field video on trace A. If the AC power at your bench differs in phase from that at the TV station, the display on trace A may crawl slowly, because the ripple signal is not in phase with the video. Switch the trigger source back to Channel A internally; the vertical fields lock in and the ripple signal crawls.

This exercise proves that a dual-trace scope can accommodate different-shaped waveforms just as long as their time durations are similar.

Now, here's one more little trick. A few scopes allow you to obtain a composite trigger—from both Channels A *and* B. When you do this, triggering in the alternate mode jumps from one channel to the other as the channels alternate, and, lo and behold, *both* signals lock in solidly. Each display is triggered internally by its own waveform. That slight phase difference between AC power and video-field rate no longer upsets the triggering.

Philips Model 3211

Dual traces set the stage for many servicing simplifications. Here are some examples: Imagine an audio generator output to Channel A and to an audio amplifier under test, with the output of the amplifier to Channel B. You can compare any change in waveshape, particularly if you use squarewaves. You can measure input-to-output voltage gain directly, using the VOLTS/DIV switches and graticule. Channel B lets you calculate the power output easily across the amplifier dummy load: just square the voltage measured and divide by the load resistance.

For stereo amplifiers: Feed the same squarewave generator signal to both left and right channels. Connect the left amplifier output to scope Channel A and the right output to Channel B. Compare the waveshape and phase differences between channels. You can check balance accuracy. Look for distortion in either channel. Take one probe and trace any distortion you see. A dozen other possibilities will suggest themselves to you when you're familiar with the instrument.

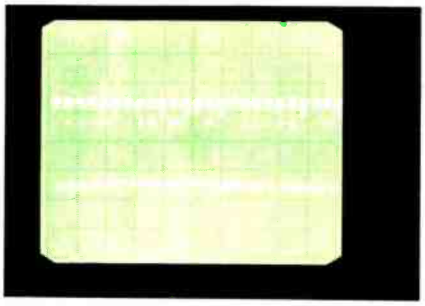


FIG. 4—CHOPPED-MODE DUAL TRACE appears like this at faster sweep speeds (shorter sweep times). Alternate mode is better when sweep time-per-division is 0.1 ms or less; chopped mode at 0.2 ms or more.

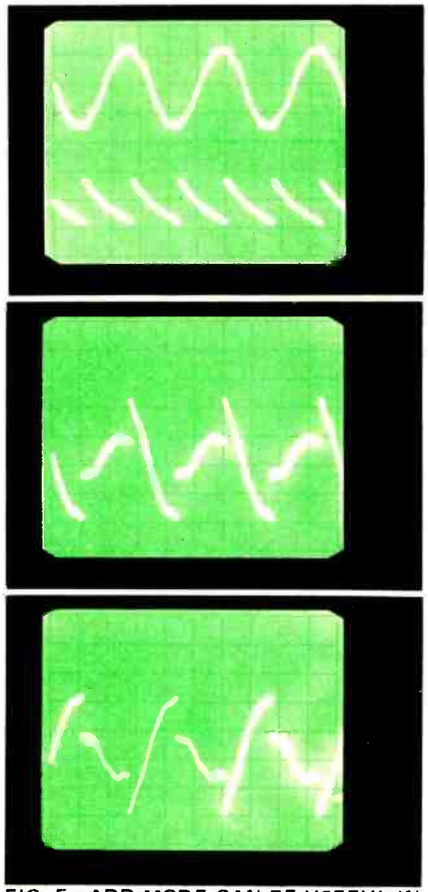


FIG. 5—ADD MODE CAN BE USEFUL IN costlier scopes, although most prevalent use is for subtracting—a function often called ***common-mode rejection.***

In CB radios: Feed a 1000-Hz audio signal to the scope's Channel A and to the mike input of the transmitter. Feed the transmitter RF output to Channel B. Modulate the transmitter; then, compare the waveform of trace A with the modulation envelope on trace B.

Leave Channel B connected as a monitor for RF output. Use Channel A to troubleshoot the circuits inside the unit. If the scope has sufficient bandwidth, you can check RF right down in the synthesizer or phase-locked loop, or any other oscillator. Don't bother changing the timebase from 0.2 ms; unmodulated RF shows up as a thick display, its size depending on amplitude and the setting of the Channel A VOLTS/DIV switch.

Alternating the sweep to form two traces works fine as long as the sweep times are short. However, some flickering appears (even with one trace) when the sweep time reaches 1 ms-per-division or 2 ms-per-division. Switch to the dual trace, alternate mode, and you can observe flicker at 0.5 ms-per-division and 1 ms-per-division. It can become quite distracting; at 2 ms or 5 ms, such flickering makes the traces hard to watch.

Therefore, high-priced scopes that can afford such refinements have what is called a *chopped* mode. Instead of the timebase determining when the internal switcher goes from trace A to trace B, a chop oscillator operates the switcher. This chop oscillator runs at 200 kHz–500 kHz (250 kHz is usual). It causes the switcher to flip back and forth between Channels A and B too rapidly for the eye to follow. Thus, even at slow sweep times, there is absolutely no appearance of switching from one trace to another.

At a 250-kHz chop rate, each trace is chopped up into tiny 2 μs bits. Channel A displays for 2 μs, then Channel B displays for 2 μs. Intervals of 2 μs exist between each visible segment, but they are too small to observe at slow sweeps. In fact, only two seemingly continuous displays can be seen until sweep timing becomes as short as 50 or 20 μs-per-division. At that point, you begin to detect segment patterns in the traces.

Figure 4 shows this effect. However, in the alternate mode, switching happens so fast at these sweep speeds, you would not use the chopped mode.

This explains how you select which dual-trace mode to use. At sweep settings between 20 ms-per-division and 0.2 ms-per-division, you select the *chopped* mode—unless there's some other good reason to stay in the alternate mode. At sweep settings from 0.2 ms-per-division to the shortest time setting on the knob, select the *alternate* mode. Some dual-trace models select the best mode automatically, as you set the TIME/DIV switch.

An *add* mode, common among dual-trace scope designs, adds the two displays together algebraically and displays them as one signal on one trace. Figure 5 shows an example. Channel A has a 17-ms sinewave; Channel B displays an 8.5-ms sawtooth waveshape. They are visible separately in Fig. 5-a. In Fig. 5-b, they are shown added together. Where phases coincide, the amplitude is greater; where phases are opposed, the amplitude is smaller.

A *rejection* or *subtract* mode is possible if the scope has a capability for reversing the polarity of the Channel B signal. When the signal in Channel B is normal, the add mode gives you signals A + B. Reverse the polarity of signal in Channel B, and the same mode gives you A − B. In some circumstances, you can use this capability to eliminate unwanted portions of certain waveforms.

X−Y mode

Technicians sometimes ask, "With a triggered scope, how can I use sweep alignment equipment?" They realize that feeding the generator baseline signal to the trigger input does not work. Nor do most triggered scopes have a horizontal input jack—at least, not labeled as such, although a few do.

The answer lies in a feature that is now part of virtually all triggered scopes: the *X−Y mode*. (One scope manufacturer calls it "A-vs.-B" mode.) This feature is not complicated. When you switch a dual-trace, dual-channel scope to the X−Y mode, one channel (usually Channel B) serves as a horizontal input channel. In single-trace scopes, the trigger amplifier becomes an X-axis amplifier; the X-input then is through the external trigger jack.

To the X-input arranged in this fashion, you connect the horizontal signal from a sweep generator. If one Y-channel has been converted to an X-channel, adjust its VOLTS/DIV switch for a baseline trace that fills the graticule from side to side. The scope's sweep no longer functions at all, nor does the trigger. Only the signal from the sweep generator forms the horizontal or X-axis trace.

Channel A, or whichever channel remains the Y-axis amplifier, accepts the response-curve signal from the video detector or demodulator probe. Otherwise, operation is similar to that for alignment with a recurrent-sweep scope.

You can use the X−Y mode for any purpose that suits the horizontal and vertical inputs of an older scope: Lissajous figures, phase comparisons, vectorscope displays, curve-tracer hookups, and the like.

Delayed Sweep

You won't find it on inexpensive instruments

YOU DON'T FIND DELAYED TRIGgering on an inexpensive triggered scope. Delayed triggering has long been considered a feature reserved for lab scopes used for broadcast-station monitoring. Typically, a service technician worked his entire career without ever seeing or even learning how to operate such a sophisticated device.

Scopes within the price reach of a serious technician now have delayed triggering. As you troubleshoot the digital systems of TV receivers, video games and personal computers, you may find this feature virtually indispensable. Not only does it help you pin down faults, delayed triggering can help you understand digital operations better than any teaching device I can think of.

Hickok Model 532

Delayed triggering allows you to select precisely any portion of a waveform or pulse train you want to examine closely. For example, suppose you want to observe only the vertical interval reference (VIR) signal. (Why? To make sure it reaches the video detector unattenuated by the IF's.)

You simply delay the trigger until the signal fed into the oscilloscope reaches line 19 (or the preceding line). To view the VITS signal on lines 17 and 18, you delay the trigger slightly less.

Figuring out delays sounds a bit complicated but it's not. You do not have to calculate delay times. In fact, you manage the whole operation visually. Elaborate scopes are designed for easy manipulation.

To simplify delayed-trigger operation, you will find a *sweep intensifier* system built into today's sophisticated oscilloscopes. With the Hewlett-Packard and Tektronix models that include this feature, you determine how much sweep is to be intensified by setting a

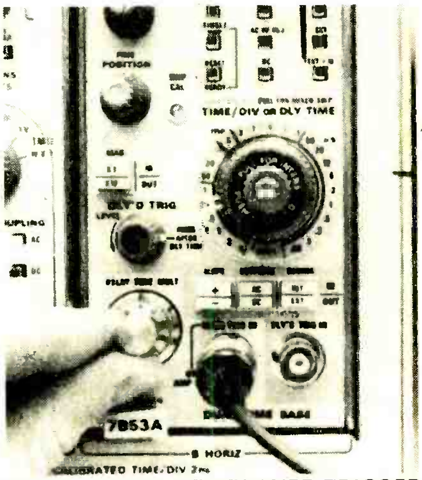


FIG. 6—VARIABLE DELAYED TRIGGER is a feature of more costly triggered scopes. Basically, a timebase determines how much of a waveform is to be viewed and a delay multiplier sets the time allowed to elapse before triggering fires the sweep.

knob that is concentric with the timebase switch knob. This Delay Time knob follows the same calibration marks (TIME/DIV) as for sweep time. Here's how you use the delay facility. Follow these steps using the photos of Fig. 6 and Fig. 7 as a guide, or go through them with your own scope.

1. Turn the Delay Time knob (Fig. 6-a) until you can see a portion of the display being brightened. Generally, this is at the start (left end) of the display. In Fig. 7-a, the brigher segment has been moved to the right of center, so you can see it better. If you can't see the intensified portion plainly, reduce the overall sweep intensity.

Ordinarily, try an approximate delay-

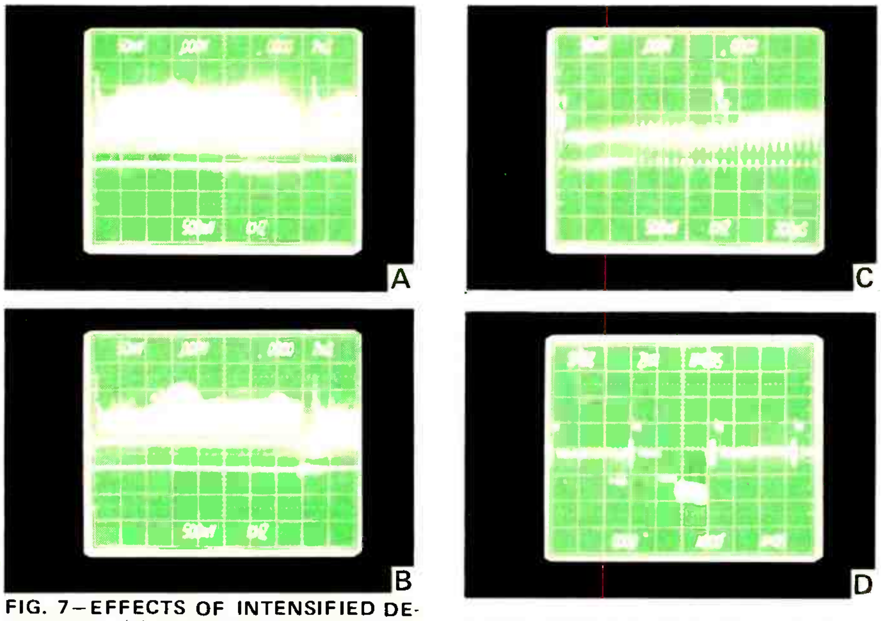
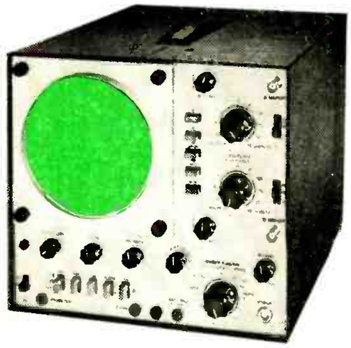


FIG. 7—EFFECTS OF INTENSIFIED DElay system. (*a*) Brighter bit of display indicates *where* delay will affect triggering. (*b*) Delay time set to encompass vertical-sync interval in video. (*c*) Delay system activated, displaying period selected by Delay Time knob and Trigger Delay multiplier. (*d*) X 10 magnifier expands trace to make VIR signal easy to examine.



Lectrotech dual trace unit.

time setting at one-tenth of the main sweep time. For example, Fig. 7-a shows the result of an intensifier setting of 0.2 ms with a main sweep time of 2.0 ms. You can refine the setting later. Although it's called delay time, you are setting the *duration* of intensified display that will presently be spread out for examination.

2. Find the Delay Multiplier knob (see Fig. 6-b). This is a decimal counter, connected inside to a precision multipotentiometer. This multiplier lets you choose exactly how much delay time you want between the *start* of the waveform and the portion you want to observe closely. The dial is tightly calibrated. But with this system, you don't usually have to concern yourself with the delay time itself. Just turn the potentiometer and observe the intensified portion of the sweep slide along the display. Superimpose the intensified portion of the sweep over the display segment you want to examine. In Fig. 7-b, the delay time has been moved over to intensify the vertical-sync interval.

3. Now, refine the Delay TIME/DIV setting so that it *includes* all the display segment you want to examine close-up but no more than that. If necessary, also refine precisely the *position* of the intensified segment by readjusting the Delay Multiplier knob.

4. Activate the trigger-delay feature. The Hewlett-Packard *model 1740A* has a pushbutton labeled DELAYED. On the Tektronix *model 7704*, you pull outward on the same knob (Fig. 6-a) you use to set the delay time/division. In either instance, and in other scopes with this arrangement, the display opens up precisely that portion of the waveform you marked with the intensifier.

B&K Model 1432

In case you do want to know the amount of delay time, in ms or μs, multiply the Delay TIME/DIV setting by the delay multiplier digits; the main dial shows 10's, the subdial shows units.

For example, in Figs. 6 and 7, the delay time was set for 0.2 ms-per-division. The delay multiplier has been set to 81 on its dial. Multiplying 0.2 by 81 gives 16.2 ms. The delayed trigger lets 16.2 ms of the original waveform go by without being seen. Then, upon triggering the sweep moves at a speed determined by the Delay TIME/DIV setting—in this case, 0.2 ms-per-division. At this point, across the 10 divisions of the scope graticule, you are looking at a 2-ms waveform that includes one vertical-sync interval of composite video, beginning 16.2 ms after the triggering point that was set initially for the main sweep.

5. You can carry this procedure one step further with the x 5 or x 10 magnifier. If you center exactly a portion of the delayed-sweep display, the magnifier spreads it out. Figure 7-d shows refined detail of a VIR signal on line 19 of the vertical interval.

"ANYONE WHO EXPECTS TO STAY in electronics beyond 1980 had better know how to operate a top-grade oscilloscope." So insisted Forest Belt at an interview shortly after completing preparation of this Special Section of **Radio-Electronics**.

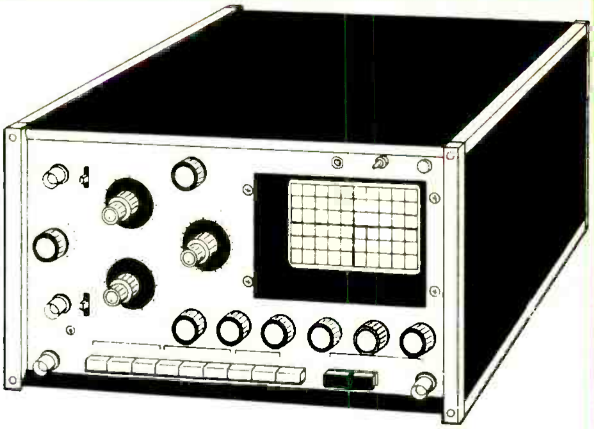
"Not that they shouldn't understand scopes already," he went on. "Any good technician or engineer should. But, let's face it, plenty of them don't. They waste an hour or two every day sweating over repair and maintenance problems that would not be tough if they only had a good oscilloscope and kept it dusted off."

As Forest writes in the introduction to this section, there is no excuse not to learn. One new item aimed at making the learning easy is a Forest Belt *Service Training Monograph* just out this month. Its title: "Triggered Oscilloscopes—Four Hours to Familiarity." It is the first of two *Monographs* about triggered scopes in his Electronic Basics series. This illustrated *Monograph* No. 48A0202-24 takes its reader smoothly through a sequence of hands-on exercises that show exactly how triggered scopes work inside and out. Step by step, any student, engineer, or technician discovers what waveforms mean, how to display and analyze them, and what to do when they look wrong.

A companion *Monograph*, entitled "Triggered Oscilloscopes—More Hours to Advanced Understanding," (No. 58A0305-24) will be published next month.

Each *Monograph* sells for \$8. Add \$3 to your check for postage and handling. (That's \$11 for one, \$19 for both.) Order from Forest Belt's *Service Training Monographs*, Box 68120, Indianapolis, IN 46268.

So...Shop Around



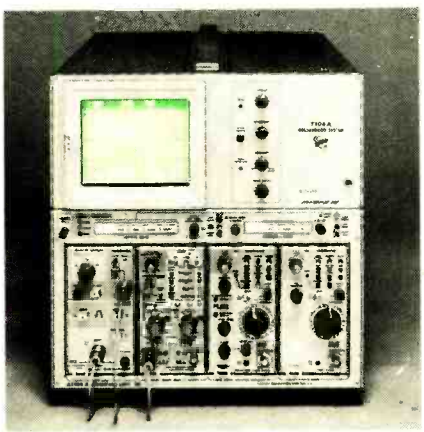
Find exactly what you need. . . .
then buy your scope.

In very high-priced oscilloscopes, you encounter the "mainframe and plug-in" concept. For example, the Tektronix *model 7704* scope has a whole list of plug-ins.

In shopping for this kind of scope, you must first decide what kind of mainframe you want. What kind of CRT, which plug-in capability, whether you want on-screen readouts (see the Fig. 7 photos), and several other considerations come into play in choosing a mainframe.

Next, you have to decide which vertical amplifier module you need. You can obtain modules with four or more traces instead of just one or two. Bandwidth size is an important consideration here. Some modules have greater sensitivity than others. What you need determines your selection.

Then, you choose the timebase and the triggering system. Do you want plain or delayed triggering? HF rejection or not? How about TV triggering (usually an extra)? The Tektronix *Series 7000* scopes offer at least seven alternative modes just in timebase modules.



Tektronix Model 7704A.

Overall, you have a large number of options; check catalogs thoroughly and ask a sales engineer to go over your entire requirements. (*Note*—you may become frustrated in this attempt if you're a service technician. Few salespeople for sophisticated scopes have had servicing experience. They may not really know what your needs are. They are accustomed to selling to engineering, industrial maintenance and laboratory customers. So go slowly. Determine that any scope you buy will do exactly what you need it for.)

Table 1—Recurrent-Sweep Oscilloscopes

Brand	Model	Bandwidth (MHz)	Sensitivity (mV/cm)	CRT Inches	CRT Shape	CRT Phos-phor	Graticule Size (in)	Graticule Illum	Sweep Range from (Hz)	Sweep Range to (kHz)	Price $
B & K Precision	1403A	5	10	3	Rnd	P31	10 cm		10	110	230
Conar	250	4①	250①		Rnd	NA			10	500	NA
Eico③	427	0.5	10	5	Rnd	NA			10	100	220
	435	4.5	50	3	Rnd	NA	2x3"	√	10	100②	240
	460	4.5	35	5	Rnd	NA	4x4"	√	10	100②	210
	462	10	10	5		P31	3x6cm		10	1000	NA
	465	6①	35①	5	Rnd	NA	6x10cm	√	10	100②	330
Leader	LBO310A	4	NA	3	Rnd	NA	8x10 div		10	100	210
	LBO511	10	20	5	Rnd	NA	8x10 div	√			300

NA Information not made available by mfr.
① Approximate mfr specification not standard
② Plus TVV and TVH sweep positions.
③ Available in kit form at less cost.

You find there are two more openings to fill on the *model 7704* mainframe. A digital voltmeter, itself containing three or four options, fits into one plug-in slot. Submodules include a digital VOM, an AC voltmeter, a thermometer probe (finds TTL IC's that are bad or becoming bad) and others. A frequency counter could fit into the other opening.

More modules are available for various specific purposes. Catalogs and alert salespeople can show you endless ways to make your expensive scope more versatile than you might have dreamed possible.

Telequipment Model D32.

And that's the name of this game. If you are a technician with an eye to a long and profitable career, soon you will take the step toward a really top-notch oscilloscope. I do not recommend buying a fancy triggered instrument just to say you have one. Instead, buy it to make your job easier, faster, more certain and more professional.

To accomplish that, take your time shopping. Find absolutely what you *need*. Be sure you are taught how to use that particular model to the best advantage. The oscilloscope you buy must save you time and make you more money. That's why a great scope is worth its cost.

R-E

computer corner

6502

An in-depth look at the widely used 6502 microprocessor.

WILLIAM BARDEN, JR.

THE MOS TECHNOLOGY MCS6502 MICROprocessor is one of the most widely used microprocessors today, especially in hobby computers where it is second only to the 8080. The Commodore PET, Apple, KIM-1 and Ohio scientific microcomputers are a few that use the 6502. Let's look at some of the hardware and software characteristics of the 6502.

6502 signals

The 6502's chief selling point is that it is an easy IC to interface, more so than the 8080. Only one power supply is required, +5 volts. Rather than a cumbersome two-phase clock, the 6502 uses an internal clock that requires only an external R–C network or crystal. Like the 8080, up to 64K (65,536) bytes of external memory can be used directly. Unlike the 8080, I/O devices are *memory-mapped*, meaning that I/O devices must share the 64K address with memory. All inputs and outputs are TTL-compatible.

Figure 1 shows the pinout of the 6502.

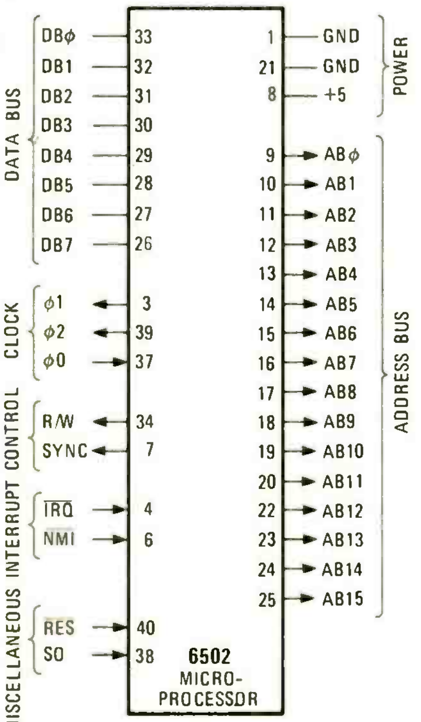


FIG. 1

There are 16 address lines, designated AB15 through AB0, and eight data lines designated DB7 through DB0; these data lines are bidirectional. (Here, as in many other microprocessors, AB0 and DB0 represent the least-significant bits.)

The clock lines are $\phi 0$, $\phi 1$ and $\phi 2$. Figure 2 shows the connections for the

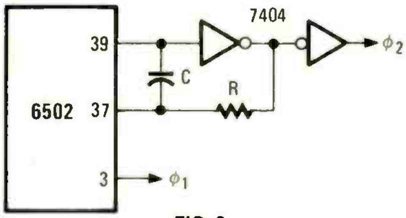


FIG. 2

R–C network providing 1 percent accuracy for the clock frequency. Lines $\phi 1$ and $\phi 2$ are system clock outputs, defining a two-phase clock.

Like other microprocessors, the 6502 can execute a variety of instructions. Instruction lengths are one, two, or three bytes, and execution times range from two *cycle* times (2 μs) to seven cycle times (7 μs). During the course of each instruction, the one to three bytes of the instruction is *fetched* from memory by a memory read for each byte. After the CPU has fetched the instruction, the *execution* portion of the instruction is implemented. The execution portion may require additional memory reads or

TABLE 1—6502 INSTRUCTIONS

Instruction Mnemonic	Explanation	Instruction Mnemonic	Explanation
ADC	Adds 8-bit operand to accumulator with carry	LDX	Loads 8-bit operand to X index
AND	ANDs 8-bit operand to accumulator	LDY	Loads 8-bit operand to Y index
ASL	Shifts operand one bit left	LSR	Shifts operand one bit right
BCC	Branches on no carry	NOP	No operation
BCS	Branches on carry	ORA	Performs OR on 8-bit operand and accumulator
BEQ	Branch on equal		
BIT	Tests operand bits		
BMI	Branches on minus	PHA	Pushes accumulator into stack
BNE	Branches on not equal		
BPL	Branches on plus	PHP	Pushes program counter into stack
BRK	Software interrupt		
BVC	Branches on no overflow	PLA	Pulls accumulator from stack
BVS	Branches on overflow	PLP	Pulls program counter from stack
CLC	Clears carry		
CLD	Clears decimal mode	ROL	Rotates operand one bit left
CLI	Enables interrupt		
CLV	Clears overflow	ROR	Rotates operand one bit right
CMP	Compares 8-bit operand with accumulator	RTI	Return from interrupt
CPX	Compares 8-bit operand with X index	RTS	Return from subroutine
		SBC	Subtracts 8-bit operand from accumulator with carry
CPY	Compares 8-bit operand with Y index		
DEC	Decrements 8-bit operand	SEC	Sets carry
		SED	Sets decimal mode
DEX	Decrements X index	SEI	Disables interrupt
DEY	Decrements Y index	STA	Stores accumulator into memory
EOR	Performs exclusive OR on 8-bit operand and accumulator	STX	Stores X index into memory
INC	Increments 8-bit operand	STY	Stores Y index into memory
INX	Increments X index	TAX	Transfers A to X
INY	Increments Y index	TAY	Transfers A to Y
JMP	Jump to new location	TSX	Transfers S(tack) to X
JSR	Jump to subroutine	TXA	Transfers X to A
LDA	Loads 8-bit operand to accumulator	TXS	Transfers X to S
		TYA	Transfers Y to A

writes, reads or writes to an I/O device, or simply perform internal processing, such as incrementing a register.

The R/W output is low for memory or I/O writes and high for reads. Transfer of data occurs during clock $\phi 2$. The direction of data transfer is determined by the state of the R/W line. As the 6502 always places known addresses on the address lines, the address, clock, and R/W signals are sufficient to control all memory and I/O reads and writes. The SYNC output identifies which cycles are fetch cycles in the instruction.The primary use of SYNC is to allow single instruction execution by using the RDY line.

The RDY line is an input used by a slow memory or I/O device to halt the microprocessor until the device can respond. Bringing down RDY during clock $\phi 1$ will halt the CPU until the signal is disabled. Lines RDY and SYNC can be used in control-panel microcomputers to execute a single instruction at a time.

There are two direct interrupts available for the 6502: $\overline{\text{IRQ}}$ and $\overline{\text{NMI}}$. $\overline{\text{NMI}}$ is a nonmaskable interrupt that can never be disabled. A negative-going edge on $\overline{\text{NMI}}$ causes the CPU to transfer control to an $\overline{\text{NMI}}$ interrupt routine in memory. Interrupt $\overline{\text{IRQ}}$ is a maskable interrupt that can be enabled or disabled by the software program. If $\overline{\text{IRQ}}$ is not disabled, an external interrupt on this line causes a

continued on page 114

state of solid state

A TV modulator IC from National that produces a composite video modulated RF signal.

KARL SAVON, SEMICONDUCTOR EDITOR

DESIGNERS OF TV GAMES, TV TYPEWRITERS and microcomputer accessories must have digital know-how, yet be proficient in video and RF techniques. They sometimes borrow oscillator-modulator circuits that use coils that have to be wound, tapped and tuned, calling for time-consuming analog skills. The designers dream of putting color and sound into their systems, but more often than not are discouraged by the complications entailed. Now, National Semiconductor's LM1889 TV video modulator circuit generates a VHF signal complete with audio and color, with little more trouble than adding another integrated circuit to the schematic.

Figure 1 shows the circuit block diagram of the LM1889, which includes two RF oscillators that operate to 100 MHz. The oscillators are usually tuned to VHF low-band Channels 3 and 4. Either oscillator is selected by applying a voltage to the external R–L–C tank circuit. The sound oscillator is isolated from the rest of the IC, and can be externally frequency-modulated with a varactor diode or by switching a capacitor across the tank. External components add the sound.

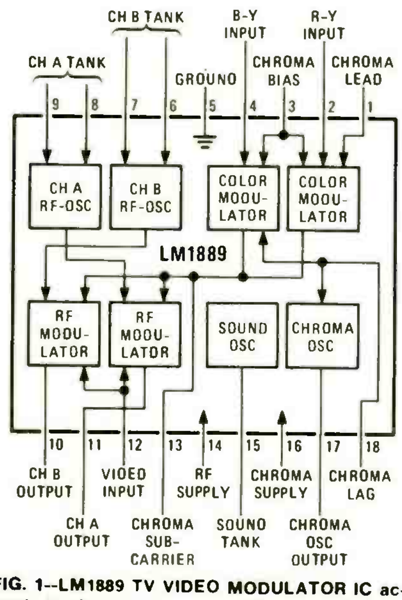


FIG. 1--LM1889 TV VIDEO MODULATOR IC accepts luminance, sync, chrominance and audio inputs and produces an RF modulated composite video signal.

The crystal-controlled color oscillator feeds two chroma modulators with quadrature signals (90° out-of-phase with each other). Chroma is generated using the R–Y and B–Y color-difference inputs to control the phase of the color-output signal. Burst-keying of the B–Y input inserts the reference burst during horizontal blanking. Two RF modulators add video, chroma and sound to the selected carrier frequency.

The internal sound oscillator uses a positive feedback differential amplifier. Difference amplifiers make good oscillators because the oscillations are amplitude-limited by the transistor cutoff that unloads the tank circuit. Oscillators that limit by shorting or otherwise loading the tank circuit reduce the oscillator stability and the waveform purity. The tank circuit for the sound oscillator is connected between pin 15 and the pin 16 power-supply input.

The two RF oscillators are positive feedback difference amplifiers similar to the sound oscillator. Voltage regulators are provided that hold the output of the RF oscillator to within about ±2 kHz of the tuned frequency over a 12- to 16-volt supply range. Each modulator is powered from the corresponding oscillator so that an oscillator-modulator combination is enabled as a block.

The RF modulators are double-balanced circuits that are fed from the chroma subcarrier on pin 13 and the video input on pin 12. If pin 12 and pin 13 are

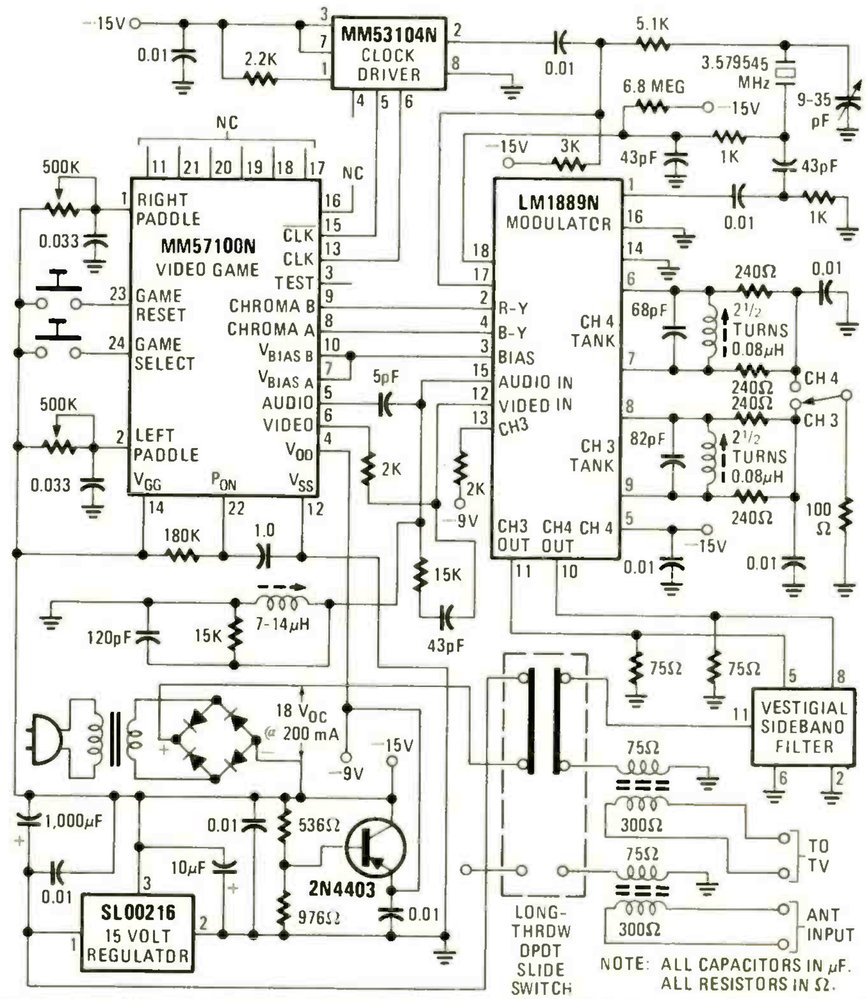


FIG. 2--TV GAME CIRCUIT uses the LM1889 modulator and MM57100 video game IC.

biased at the same DC voltage, the modulator would be perfectly balanced and there would be no RF output. A DC offset between pin 12 and pin 13 unbalances the modulator and determines the unmodulated RF-carrier level.

The 3.58-MHz chroma oscillator also uses a difference amplifier. This oscillator requires an external R–C circuit and crystal. Oscillator-output terminal pin 17 drives the external 3.58-MHz crystal circuit. The crystal network has two 90° out-of-phase outputs that are the chroma-modulator inputs.

The color modulators are double-balanced circuits. As with the RF modulators, these stages must be biased with a DC offset between pin 2 and pin 3 and between pin 4 and pin 3 to set the subcarrier level.

Figure 2 is the schematic of a complete game circuit, in which the National Semiconductor MM57100N game IC is used to generate the video, chroma and sound inputs for the LM1889. Note that the 2N4403 power-supply regulator is the only discrete transistor. Figure 3 is a monochrome character generator display circuit that demonstrates how simple it is to use the LM1889.

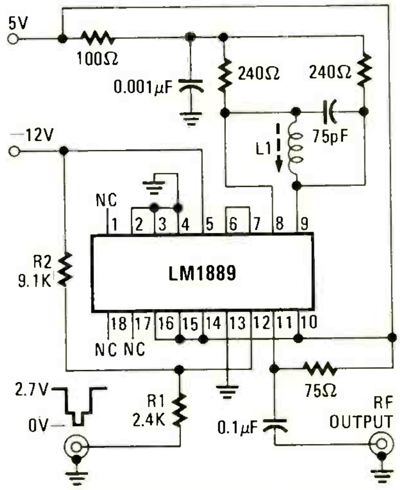


FIG. 3--MONOCHROME MODULATOR for character generator display.

The LM1889 TV video modulator has a maximum current drain of 45 mA. The minimum chroma-oscillator output is 4 volts P-P with up to 20-pF loading, and the minimum sound-oscillator output is 2 volts P-P. The minimum RF-oscillator level is 200 mV P-P. For more information, write to National Semiconductor Corporation, 2900 Semiconductor Drive, Santa Clara, CA 95051. **R-E**

NEXT MONTH

Great special section on personal computers. Everything from what they are to who makes what. Don't miss it. Reserve your copy of the June issue of **Radio-Electronics** today.

Should your career in electronics go beyond TV repair?

CREI prepares you at home for broader and more advanced opportunities in electronics— plus offers you special arrangements for engineering degrees

There is no doubt television repair can be an interesting and profitable career field. TV repair, however, is only one of the many career areas in the fast growing field of electronics.

As an indication of how career areas compare, the consumer area of electronics (of which TV is a part) makes up less than one-fourth of all electronic equipment manufactured today. Nearly twice as much equipment is manufactured for the communications and industrial fields. Still another area larger than consumer electronics is the government area. That is the uses of electronics in such areas as research and development, the space program, and others.

Just as television is only one part of the consumer field, these other fields of electronics are made up of many career areas. For example, there are computer electronics, microwave and satellite communications, cable television, even the broadcast systems that bring programs to home television sets.

As you may realize, career opportunities in these other areas of electronics are mostly for advanced technical personnel. To qualify for these higher level positions, you need college-level training in electronics. Of course, while it takes extra preparation to qualify for these career areas, the rewards are greater both in the interesting nature of the work and in higher pay. Furthermore, there is a growing demand for personnel in these areas.

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service clinic

How to ruin horizontal output transistors.

JACK DARR, SERVICE EDITOR

THERE ARE QUITE A FEW WAYS TO DEstroy a brand-new horizontal output transistor, after finding the original transistor is shorted. Probably the best (and most common) method is to insert the new transistor and then apply full power to the set. Make sure that you do not check the flyback, low-voltage DC power supply or anything else. Following these principles can easily lead to what a British friend once called "a benchful of dead output transistors lying on their backs with their little legs sticking up in the air."

There are many other ways, none original. If I haven't tried them, someone else has. If you don't like the results, there are a few simple tests that will help hold transistor mortality down to a minimum. First, before inserting the new horizontal output transistor, check the DC supply voltage, which is regulated in the majority of sets. Make sure that this voltage is not *too high*.

If the DC voltage is high, then the voltage regulator isn't working. It should hold the voltage down to normal even under no-load conditions. The horizontal output stage is really a *voltage multiplier:* If you feed in, say, 125 volts, the output will be 25,000 volts. In other words, the output is directly proportional to the input voltage; hence, the use of the regulators. What happens is that the input voltage is multiplied by 200. Every 1-volt rise in the DC input means a 200-volt rise in the output! These excessively high voltages can break down perfectly good horizontal output transistors, as well as many other components.

Auxiliary circuits

The modern TV set may have quite a few auxiliary circuits driven from the flyback. These are low-voltage DC power supplies, or boost voltages, each one has its own rectifier and filter circuits. If the diodes in these circuits short, this overloads the flyback and output transistor. Therefore, check all the diodes for shorts. I cannot emphasize enough that these diodes must be fast-recovery diodes. Stock silicon types will not work in such circuits.

One of the best and safest tests is to use a variable-voltage line transformer, which costs about the same as a large horizontal output transistor. Don't insert the horizontal output transistor. Connect a current meter across the DC-output fuse holder, and connect a DC voltmeter to the output voltage. Then bring the line voltage up slowly. Both meters will indicate whether the DC voltage is too high; vary the voltage adjustment and see if it shows the right reaction.

If this checks out so far and you can find no obvious shorts in the flyback loads, then insert the transistor and bring the voltage up slowly. The size of the DC-output fuse will indicate approximately what the normal current should be. For example, if the fuse is a 1.5-amp unit, the current should be around 900 to 1000 mA maximum. If you see more than 1.2 amp and the line voltage is only about 75, back out of there *fast!* You've still got a problem. (Warning: this variable-voltage test will *not* work with the saturated-core (resonant) power transformers, such as those used in Zenith sets and others. These transformers hold the output at zero until about 45 volts, and then they rise suddenly to full output. The only way to use this test in such circuits would be to disconnect the set's low-voltage DC supply and use a bench power supply plugged into the variable-voltage transformer. The clue to the use of these transformers is the 2- to 3-μF nonpolarized electrolytic capacitor, connected across the entire secondary.)

High-voltage shutdown

Another common circuit used in these sets is the high-voltage shutdown. There may be more than one of these circuits, all used for the same purpose. If these circuits are working, they do not damage anything, just turn them off. However, if the high-voltage shutdown itself is faulty, it can cause overloading. By slowly advancing the line voltage, you can check these circuits for normal operation. Many use SCR's (*S*ilicon-*C*ontrolled *R*ectifiers), that kill the horizontal oscillator, etc. In some early versions, the SCR used to shut down on normal brightness changes, program changes, etc. There are factory fixes for most of these, usually involving changing to a different SCR, or making adjustments to the gate circuit to eliminate premature tripping. (Although the temptation is great in many instances, it isn't a good idea to disable the shutdown circuit. They can save a lot of trouble.)

Now, a few words about derating. If the horizontal output transistor fails repeatedly, even though exact replacements were used, it's possible that the original transistor didn't have a high enough rating. Cross-check the type number of the original shown in any of the better transistor guides to see what substitute is recommended. For example, if the substitute transistor is rated at 800 volts V_{cbo} (collector breakdown voltage) and it's not holding up, try another one of the same type and case, having a much higher V_{cbo}. There are some transistors available that are rated up to 1200 and even 1500 volts. They also usually have higher collector-current ratings, which helps keep the junction running cooler and should increase the life of the transistor.

Capacitors

Finally and most important, problems can occur in sets using collector-shunt capacitors in the horizontal output stage. These capacitors are actually *tuning* capacitors for the retrace pulse. The worst aspect about this problem is the fault condition that can damage the new transistor is not a shorted capacitor, but an *open* one! If a capacitor opens, the retrace frequency changes, the pulse goes to tremendous heights and something pops. It is therefore advisable always to check these collector-shunt capacitors for opens. In fact, if you can't find any obvious cause for the failure of the original horizontal output transistor, it is a good idea to replace these capacitors.

You will have to use factory replacement parts because the capacitors are special types and there is currently no available data on general-purpose replacements.

With a little extra care in checking and some luck, you will be able to avoid the embarrassment and expense of having to "replace the replacement transistor" that you just finished installing! **R-E**

service questions

LOSES VERTICAL SWEEP

This GE solid-state set loses both its vertical sync and its sweep right after it warms up. I found that the Q204 collector voltage drops to only 3. I'm not too familiar with solid state. Can you help?—L. M., Pettus, WV.

I'll try. This sounds a lot like a thermal transistor. Use freeze spray on all the transistors in the vertical stage after you lose the sweep. Transistors are often extremely thermal.

(Feedback: "Right! A couple of squirts of freeze spray showed that the vertical-output transistor was bad.")

VOLTAGE TROUBLE

Here's a cute one. In a Sylvania DO-J, there was excess cathode current in the 42KN6. The grid voltage was going down to only −25 volts. After you suggested checking the 42KN6, I discovered that the +135-volt source was low. I disconnected this from several circuits; no help. Finally, I lifted the screen voltage feed to the 42KN6, and it went up. I tried a new 42KN6 tube, and this fixed it! Thanks.—Vito Shimkus, Dalton, PA.

We have run into this kind of problem in quite a few different horizontal-output tube sets. The screen seems to be taking too much current, dropping the voltage. I haven't found out the exact failure mechanism yet, but I do know that if the screen voltage drops with no apparent cause, you should try a new tube.

BURNT OHMMETER RESISTOR

Resistor R15 has burned up in the ×10 range in this Kyoritsu KEW-33 VOM. Can you tell me what the value is?—H. P., Brasilia, Brazil.

Since I've never heard of this make of VOM, I can't tell you what the value of the resistor is. However, if you want to find out, just read the resistor value in the ×100 range. The circuit diagram you sent shows this VOM is a stock ohmmeter; the ×10 resistor should be one-tenth the value of the resistor in the ×100 range. You can check this with a precision variable resistor that gives you exactly half-scale on the ×10 range, and read this.

HORIZONTAL DRIFT

This Olympic 6C124 set loses its horizontal sync after about 10 to 15 minutes. The horizontal-hold control brings it back. The horizontal oscillator coil doesn't seem to have much effect. You can give the coil several turns without doing much.—H. S., Cambridge, MD.

The horizontal oscillator coil should have a very *definite* effect on the frequency. Several things can cause this problem: The .0039 μF capacitor across the coil could be leaky. (Or perhaps it was replaced with one having the wrong value; this has happened!) Finally, this is rare but possible—run the core out of the coil and see if half of it has broken off. If so, this will upset the tuning rather badly.

turn page

WEAK INTERCOMS

Two wireless intercoms built from kits are weak. The voice comes through clearly, but there's not enough volume. All voltages seem to check out OK. Any ideas?—R. A., Brooklyn, NY.

Two of them. First, check the *tuning* on both units. Each receiver must be tuned to the other transmitter. Feed an audio signal into the mike on one, and tune the other receiver; then repeat the process.

Second, this is a carrier-current system, and low-frequency RF signals travel on the AC lines between the units. If you plug one unit in on one side of your home AC line, and the other on the other side, the chances are the signals will be weak. Add a bypass capacitor from one side to the other, insulating it carefully. Check them out in the same room and same outlet. If they work then, the problem lies in the transformer.

INTERMITTENT RASTER

This Magnavox T989 comes on with 25 kV . . . momentarily. It plays for a minute or two. Pushing in the circuit breaker sometimes creates a raster for a second. I've checked or replaced everything I can think of except the flyback. Would you replace that? What ails this critter?—T. D., Bellevue, OH.

Frankly, I don't know! I've always waited until the very last to change a flyback. However, there are a couple of other things you didn't mention. First, check Zener diode Z301 in the high-voltage shutdown. There is a silicon controlled rectifier (SCR) and the Zener voltage goes to its gate, at which point it kills the horizontal *drive*. Scope the drive signal and see if it pops in then disappears. (Also check the SCR.)

(Feedback: "Zener Z301 was shorted and that fixed it. How did you know?") I'll never tell—I just guessed!—*Service Editor*

DUPLICATE FLYBACK NEEDED

I need a flyback for a Bradford BATV-60525A chassis. I can't find this chassis number listed anywhere, nor do I know of a source for a replacement part. Help!—P. L., Red Hook, NJ.

Believe it or not, the Bradford chassis was manufactured by no less than 16 different companies! However, according to the part number you indicate, the chassis *you* have was manufactured by Westinghouse. *Thordarson's Guide* doesn't show a substitute part number under Bradford but it does show an exact duplicate part number for Westinghouse—493V023D01, and FLY-445 is listed as a substitute.

PALE VIDEO, SHORT SCAN

The picture on this Zenith 16Z7C50 was pale and weak. The plate voltage on the video output tube read only +190 (270 normal). Checks showed that the

4700-ohm shunt-feed resistor was open. There are two paths for this plate voltage, one through the peaking transformer in the picture tube cathodes and another through this 4700-ohm resistor. This fixed the video problem.

Now, the raster was short. Adjusting the vertical controls lengthened it, but it was badly nonlinear. Checking around in the large resistors in the height control circuit showed a 4.7-megohm resistor that read more than 7.0 megohms. This fixed the linearity problem.

NO RASTER

The raster is dark on this Magnavox T-950. I've got plenty of high voltage and the picture tube is good. What is this?—E. C., Napanoch, NY.

Check the focus voltage. If this is down to zero, the raster won't light.

(Feedback: "That's it. They never told me in school that this would cause a no-raster condition! How did you know?")

The same way you did, the hard way! After spending a good deal of time checking everything out, I said "Well, there's no high voltage." I reached into the set; there was a loud ZAP and a scream, which told me I had *plenty* of high voltage. Some time later, I read the focus voltage, which was zero, just like yours; it was caused by a dead focus rectifier. I highly recommend using a high-voltage meter. Much less painful than the way I did it then.

VERTICAL HOLD

This GE LX chassis has a vertical hold problem. I can't get the picture to stop, with the hold control all the way to the end.—J. G., Flushing, NY.

You've got a time-constant problem, apparently. The oscillator cannot be brought close enough to the right frequency to lock. Check all the resistors in the control grid circuit, including the height control and R205, the 150K fixed resistor to ground. If these resistors are OK, then check capacitors C203 and C204 very carefully for leakage; same result.

(Feedback: "You're 100% right. I changed capacitor C203 and fixed it. Thanks!")

TAPE-SPEED CHECK

I have two questions: One, how much variation can there be in a tape player running at each of the three standard speeds? Second question: Are there test tapes available that can be used to check speed?—J. B., Landis, NC.

First, that's a good question and I'm sorry you asked! I don't know the exact tolerance in speed. However, it is pretty darn small. You can usually tell by listen-

turn page

ing to musical selections. At slow speed, the music will be flat; at fast speeds it will be sharp (excluding rock music and synthesizers).

Second, yes, there are quite a few test tapes available. The Audiotex Division of General Cement (Rockford, IL 61101), for one, has test tapes for 8-track cartridges, cassettes and reel-to-reel units. These tapes have standard-frequency runs, single-tone sequences, etc. You can connect a scope on the output, run the 1000-Hz band and check its frequency. A frequency counter is also very good for this kind of test.

NO SERVICE DATA

I can't find the service data on this RCA stereo. There are several numbers on the chassis, including the serial number RC1223C, and some others. Can you help me find this data?—W. T., Fremont, CA.

I've been looking for an easy question all day and this is it! You have already found the data you need. The "RC-1223C" serial number is RCA's *chassis* number for radio components. You can find this number listed in the back part of the RCA section in the Sams *Photofact Index*. It is in 930-7, in fact.

WATCH FOR KEY CLUE!

I had just gotten through chewing out a friend for walking right over a key clue when a technician in Longmont, CO wrote me about a set of waveform readings, P-P voltages, etc., in a vertical sync problem. I told him to check the integrator, etc. He wrote me back saying that didn't help.

To my horror, I then saw that I had walked right over the key clue in his first letter that had been right there in the schematic. His composite-sync waveform at the sync-separator output read only *1.5 volts* P-P! Of course, this should have been 50 volts P-P. So, I apologized and told him to check that sound-sync amplifier stage, which was definitely close to the cause of the problem.

SEVERE HEIGHT LOSS

I wrote about a severe loss of height in a Sylvania DO-2. You told me to check several places, including the cathode circuit. This checked out OK, so I started checking capacitors. I found that C336, 0.0056 μF, 2-kV, was shorted. I can't quite see how this caused such a loss in height; most of the bias upsets I've found have caused a severe foldover! Thanks for the lift, anyhow.—R. C., Toledo, OH.

You're welcome even if I didn't do so well! Capacitor C336, by the way, is actually in the feedback loop. It seems to be the lower part of a saw-forming network from the feedback loop back to the input-section control grid. The capacitor probably reduced the feedback pulse so that the oscillator couldn't deliver enough amplitude! (From the crystal-ball department.) R-E

new products

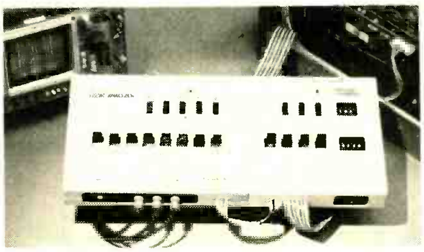
More information on new products is available from manufacturers of items identified by a Free Information number. Free Information Card is inside back cover.

FREQUENCY COUNTER, *model LDC-822*, features 8-digit LED display and operation to 80 MHz; variable sensitivity to 20-mV to eliminate stray RF signals; and a 10-MHz timebase with 5-

ppm accuracy. Comes with test leads, and is suitable for both industrial and field/bench applications. Price: $299.95.—**Leader Instruments Corp.,** 151 Dupont St., Plainview, NY 11803.

CIRCLE 107 ON FREE INFORMATION CARD

TRIGGER EXPANDER, *model 10*, is a 16-bit add-on to the 8-bit *model 100A Logic Analyzer*, forming an integrated 24-bit logic analyzer package for microprocessor troubleshooting, training and system development.



The *model 10* captures and displays the instruction and data flow on the microprocessors data bus at the occurrence of a particular 16-bit address. The combination *model 10/model 100A* package can display a 16-word deep data-domain truth table of both lower and upper address bytes and the date byte, which can be viewed via a three-position switch. A 25th input called a "qualifier" permits selected machine states, such as read, store, etc., to be collected for display. A clock delay feature allows up to 1000 steps of a program without changing the reference trigger word. The *model 10* can also be used to display the state of the machine after "n" passes through the loop.

Both the *model 10* and the *model 100A* are available as kits or assembled and come with buffered data probes terminated with gold-plated "universal" pin connectors. Optional baseplate locks both units together. Each unit contains both owners manual and 100-page applications manual. Prices: *model 10* kit, $229; assembled, $295. *Model 100A* kit, $198.50; assembled, $272. Optional baseplate, $12.—**Paratronics, Inc.,** 800 Charcot Ave., San Jose, CA 95131.

CIRCLE 108 ON FREE INFORMATION CARD

ELECTROLYTIC ALUMINUM CAPACITORS, *Series TDA*, is a complete line of axial-lead devices

having values to 22,000 µF. Designed to operate in temperatures from −40°C to +85°C, the

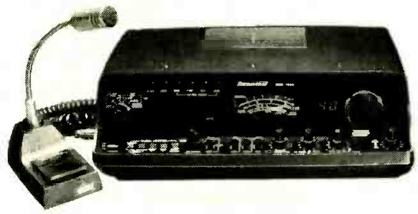
Series TDA devices have a capacitance range of 0.47 μF–22,000 μF, with a DC voltage range from 6.3 to 50. A 10,000-μF capacitor (shown) measures less than 1 × 2-in., and costs $29.50 per 5000.—**International Components Corp.**, 105 Maxess Rd., Melville, NY 11746.

CIRCLE 109 ON FREE INFORMATION CARD

SELF-STUDY COURSE in photographic electronics—eight lessons and supplements in looseleaf form. Course features electricity and electronics fundamentals and their application to camera repair, as well as special circuit coverages. Comes with step-by-step illustrations, self-test quizzes and optional final exam.—**National Camera, Inc.**, Larry Lyells, 2000 W. Union Ave., Englewood, CO 80110.

CIRCLE 110 ON FREE INFORMATION CARD

40-CHANNEL CB BASE TRANSCEIVER, *model CBB-1040*, is base-station version of *model CB-640 Aircommand* mobile unit. Base transceiver



features power mike, dual-conversion superheterodyne receiver, Channel-9 priority scanner, LED readout (with automatic power switch), Mod/Power/Cal/SWR meter, automatic noise limiter and blanker, and delta fine tune control. Price: $389.95.—**Superscope, Inc.**, 20525 Nordhoff St., Chatsworth, CA 91311.

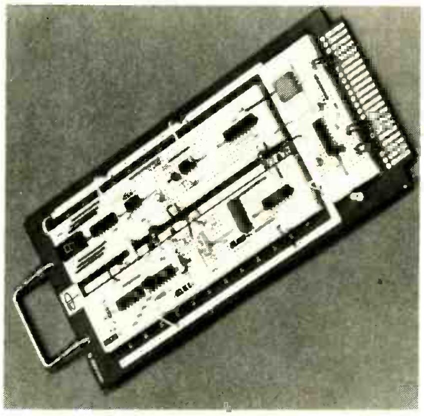
CIRCLE 111 ON FREE INFORMATION CARD

CB FREQUENCY COUNTER/CLOCK, *model FT-76*, has a 10-Hz resolution with 0.0003% accuracy. It is used to measure the transmitted signal from a CB transceiver. An optional receiver frequency adapter, *model FA-70*, enables the unit to measure received frequencies with same degree of accuracy. Clock can be used either for 12- or 24-hour operation and contains crystal-controlled oscillator accurate to 10 sec/year. Has built-in AC/DC power supplies with quick-discon-

nect cables for mobile or base-station operation, plus high-impedance input. Prices: *model FT-76*, $199.95; *model FA-70*, $49.95.—**Communications Power, Inc.**, 1280 Reamwood Ave., Sunnyvale, CA 94086.

CIRCLE 112 ON FREE INFORMATION CARD

SOLDERLESS BREADBOARDS, *Unicard I, II*, contain double rows of terminals, each with 5 tie points; *Unicard I* has 960 tie points, *Unicard II* offers 1620 tie points. Tie points (made of nickel-silver) require no patch cord and can be plugged into standard 5¼-in. card racks. Unit accommodates all DIP's, TO-5's or other discrete compo-



nents having lead diameters to 0.032 in. Also featured are protective rubber feet and extractor handle; predrilled buses, tin-plated copper printed circuits and glass-epoxy bases. Prices start at $31.50 for *Unicard I*.—**A P Products, Inc.**, Box 110, 72 Corwin Dr., Painesville, OH 44077.

CIRCLE 113 ON FREE INFORMATION CARD

IC TEST CLIP, *model 4140*, 40-pin DIP test clip

for attaching test probes permits handfree testing. Has nontarnishable nickel-silver contacts; lower contacts measure 1.022 mm wide and mate with DIP contacts, square, serrated upper-end test points measure 0.63 mm and are designed for mini test clips. Nylon casing can withstand temperatures to 240°C. Price: $19.95.—**ITT Pomona Electronics**, 1500 E. Ninth St., Pomona, CA 91766.

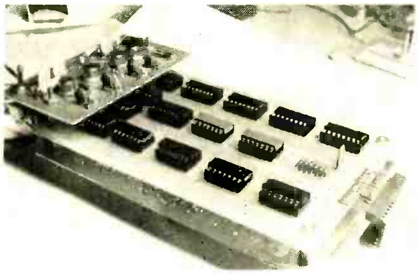
CIRCLE 114 ON FREE INFORMATION CARD

MICROCALCULATOR, *model 85*, interfaces with 8-bit microprocessors and with most 8-bit interface devices, such as Intel's 8255, via a bidi-

rectional 8-bit port. Operation requires less than 256 bytes of memory. Control and interface circuitry permit the microprocessor to enter instructions and display the answer on 14-digit LED readout. The *model 85* contains a four-register stack and nine memory addresses. Problem-solving capabilities include logarithms, sines and tangents; polar/rectangular coordinate conversions; multiple storage registers; four U.S. metric unit constants for metric conversions; plus mean and standard deviations. Unit comes with handbook and 1-year membership in manufacturer's users group. Price: $189.—**Artisan Electronics Corp.**, 5 Eastmans Rd., Parsippany, NJ 07054.

CIRCLE 115 ON FREE INFORMATION CARD

VIDEO CAMERA KIT, *model 202*, features 100-bit by 100-bit self-scanning charge-coupled device and CCD 202C image sensor for both visible and infrared viewing. Camera can be used under many atmospheric conditions, including underwater. All clock voltages operate at 6 volts, with a higher video output signal. Comes with power board and two-level TTL output for interfacing. Also included are semiconductors, PC boards, data sheets, diagrams, resistors, capacitors and



an 8-mm lens. Price: $349.—**Solid State Sales,** Box 74D, Somerville, MA 02143.

CIRCLE 116 ON FREE INFORMATION CARD

CASSETTE TAPE DECK, *model SC-3100*, comes in simulated walnut-grain finish. *Directo-O-Matic* front-loading system lets you make fast checks of tape status and permits easy accessibility. *Tape-Lead-In* feature allows leader bypass, beginning portion of tape can be omitted. Separate three-position bias and equalization switches handle three different types of tape.

Model SC-3100 specifications: wow and flutter, 0.06%; S/N ratio, 57 dB (before Dolby); frequency

response (normal tape) 25 Hz–14 kHz (30 Hz–13 kHz ± 3 dB) and (CrO_2 tape) 25 Hz–16 kHz (30 Hz–14 kHz ± 3 dB).

Other features include automatic memory and playback (with timer); Dolby system; mike/line-mixing capability; and large VU meters. Instrument measures 17$^{15}/_{16}$ H × 7$^{13}/_{16}$ H × 12$^{3}/_{4}$-in. D and weighs 18.3 lbs. Price: approximately $430.—**Sansui Electronics Corp.**, 55–11 Queens Blvd., Woodside, NY 11377.

CIRCLE 117 ON FREE INFORMATION CARD

POWER/SWR METER, *model WM-7000*, uses a 30-dB directional coupler to read a 1.8 MHz–30 MHz frequency to a 1.1:1 ratio. Meter reads peak or average power on three scales (20, 200 and

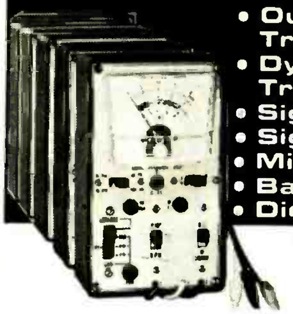
1000 watts). Useful for SSB measurements and for adjusting mike and speech compressor controls. Price: $69.95.—**Communications Power, Inc.**, 1280 Reamwood Ave., Sunnyvale, CA 94086.

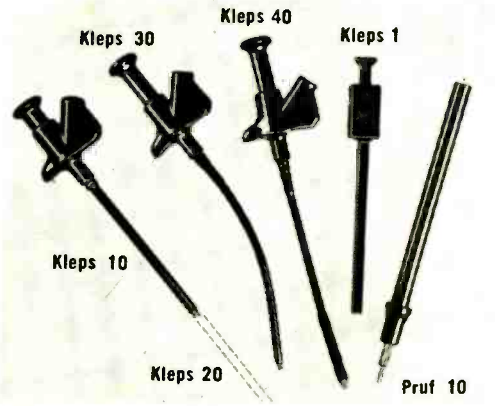
CIRCLE 118 ON FREE INFORMATION CARD

PHONE VOICE SCRAMBLER, *Privacom M13*, insures complete telephone privacy. You notify caller you are scrambling, specify one of 25 codes (from Alpha to Yankee), turn code-phone switch on and turn code dials to desired setting. Remove

telephone from *Privacom* unit and place conventional handset into unit and talk. Unit measures 3½ × 4½ × 9 in. and contains 4-volt mercury battery. Price per unit, $325 (two units needed for operation).—**Mountain West Alarm Supply Co.**, Box 10780, Phoenix, AZ 85064.

CIRCLE 119 ON FREE INFORMATION CARD





new lit

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

BINARY BIT WEIGHTS AND RESOLUTION. Pocket card provides a quick reference for determining the necessary resolution for a particular A/D or D/A application. Contains % resolution and ppm resolution for 1 to 20 bits. Also included is a quick selection guide covering manufacturer's products for data acquisition systems, A/D and D/A converters, instrument amplifiers, gain-programmable and sample-hold amplifiers, and voltage references.—**Micro Networks,** 324 Clark St., Worcester, MA 01606.

CIRCLE 120 ON FREE INFORMATION CARD

SEMICONDUCTOR REPLACEMENT GUIDE, *SPG-202W*, was prepared to aid service technicians, engineers and all those who work with solid-state devices. The guide contains 240 pages of the RCA SK-series replacement transistors, rectifiers, thyristors, IC's and high-voltage triplers—more than 750 devices, replacing over 141,000 domestic and foreign components. Also included are an Index of SK-series semiconductors, necessary mounting hardware and schematics. The guide sells for $1.50, and is available from RCA distributors and the manufacturer.—**RCA Distributor and Special Products Div.,** Box 85, Runnemede, NJ 08078.

CIRCLE 121 ON FREE INFORMATION CARD

COMPUTER HARDWARE/SOFTWARE CATALOG, 13 pages, contains many hardware and software packages, including a text editing package, a complete FORTRAN IV package, a video display board, disc software in two formats, five XITAN-alpha packages, plus basic ZPU card and system monitor board. Complete specifications on all system components are given. Separate price list.—**Technical Design Labs,** Research Park, Bldg. H, 1101 State Rd., Princeton, NJ 08540.

CIRCLE 122 ON FREE INFORMATION CARD

COMPONENTS CATALOG, 12-page folder listing many different varieties of IC's, diodes, power transformers, LED's. Also featured are prototyping boards and sockets.—**Albia Hobbies,** 24 Albia St., Box 1833, New Haven, CT 06508.

CIRCLE 123 ON FREE INFORMATION CARD

SPEAKER SPECIFICATIONS, *Form 77-1*, describes 11 8-inch speakers, covering a wide price/installation/performance spectrum. Included are single-cone PA models, single and dual-cone background music formats, flame-retardant models, and standard intercom and outdoor units. Speakers feature precision-centered voice coils, heavy-gauge metal baskets and rugged construction. Spec sheet and other informative literature available free on request.—**Quam-Nichols Co.,** 234 E. Marquette Rd., Chicago, IL 60637.

CIRCLE 124 ON FREE INFORMATION CARD

PRO SPEAKERS
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shown in Fig. 4. The foam can be molded into shapes that are difficult to manufacture with wood. In addition, the structural foam is extremely rugged and impervious to temperature and humidity extremes.

The second construction item to check is the external covering. If the speaker system is visible, the cabinet should look good and remain that way.

For permanent installations, durability is usually not a problem. In this case, a wood veneer or painted cabinet is sufficient. These materials will be satisfactory as long as they are not given much abuse.

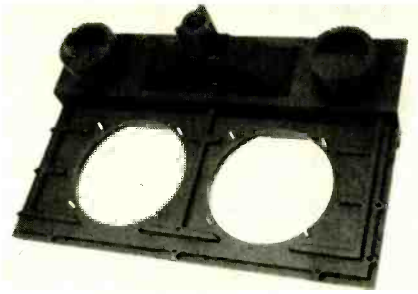

FIG. 4—THERMOPLASTIC is being used as a basic cabinet material instead of wood as shown in the above thermoplastic baffle.

Recessed baffle boards or rear panels can protect painted or veneered surfaces, as well as connectors and knobs. But, for portable use, durable surface finishes are required.

For extensive portable use, the surface should be covered with vinyl or an equally rugged material. The vinyl material is the same as or similar to that used on automobile roofs. It is scuff- and tear-resistant, which is what you need for a portable cabinet covering.

FIG. 5—REMOVABLE FRONT COVER protects speaker during transport.

You might also want a removable shipping cover. Since most damage usually occurs during transport, the cover is useful . . . either a full cover or a baffle-board cover (Fig. 5), depending on the system.

A corner protector also shields speaker systems from damage. Usually made from steel, corner protectors fit over all exposed corners. Since corners are extremely vulnerable, the protectors can keep them from getting crushed.

If you want a permanent mounting, you should look for mounting provisions that will add to convenience. Wall-mount swivel brackets, similiar to those shown in Figs. 6 and 7, add greatly to positioning flexibility. The bracket shown in Fig. 6 allows vertical positioning. If a wall or ceiling is not handy for mounting, stands are available that can raise a speaker more than six feet off the floor.

If you are handy, you can install your own hardware. Eyebolts are useful be-

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PRO SPEAKERS
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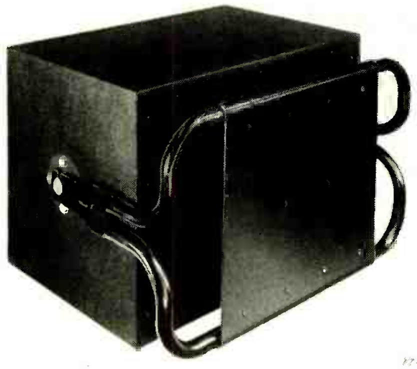

FIG. 6—MOUNTING BRACKET fastens to the sides of the speaker cabinet and permits vertical positioning.

cause they are easy to install and allow flexible positioning, especially if you hang the speaker from a ceiling. When installing eyebolts, make sure the cabinet is sturdy; if it isn't, you must add bracing. Mount the eyebolts to the cabinet sides, not the top of the cabinet. Otherwise, the stress may cause the top to pull loose.

Finally, if you plan to do your own repairs, you should check out driver accessibility. Is the access through the front or rear of the cabinet? It can make a difference with permanently mounted speakers. Do all the drivers remove easily? Is the crossover network buried under layers of glass fiber material? The right answer to these questions can save much time and frustration.

Selecting a compact sound reinforcement speaker system has never been easy because of the many variables involved. It is important to select as many features as you can for the money you want to spend. You have to consider the tradeoffs of efficiency and frequency response. You must compare specifications to make sure the speaker you buy has the desired polar response, enough power handling and enough sensitivity. You should select a well-constructed cabinet with suitable surface and corner protection for your needs. You have to select covers, handles and mounting gear to facilitate transporting the speakers or installing them permanently. And, finally, you must check on parts accessibility if repairs should ever become necessary. **R-E**

References

1. Beranek, L. L., *Acoustics*, McGraw-Hill, New York, NY, 1954, p. 112.
2. Olson, H. F., *Acoustical Engineering*, Van Nostrand, Princeton, NJ, 1957, pp. 19–20.
3. Schulein, R. B., "Power Ratings for Sound Reinforcement Loudspeaker Systems," *Audio Engineering Society*, Preprint No. 1066, 1975.

HI-FI LAB TEST REPORT

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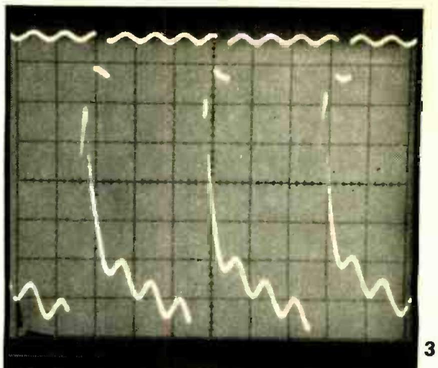
continuous sinewave, onto which is superimposed a brief high-frequency tone burst that is present for approximately 1 ms and repeated at about 10-ms intervals. This waveform is shown as the upper trace in Figs. 3 and 4. In Fig. 3, the suppressor switch is turned off, and the lower trace shows an extremely sharp spike appearing in the output every time the tone burst is present at the input.

Without changing the composition of the input signal, the *model MRM-101*'s suppressor switch was turned on in Fig. 4 to show that the sharp spike noted in Fig. 3 has been "tamed" or reduced substantially (see lower trace of Fig. 4). We must emphasize that the reason the spike was not completely suppressed is probably because we were not totally successful in reproducing a waveform corresponding exactly to the kind of impulse noise that is transmitted to the input when an actual record scratch is encountered.

An overall product evaluation of the Garrard *model MRM-101* is found in Table II, together with our summary comments. We believe that besides making scratched records useful once more, placing a preamplifier-equalizer right next to a record player in the *model MRM-101* is very sensible. Conceivably, Garrard might well go one step further and actually include this circuitry as an integral part of some of their better turntable systems. Admittedly, this arrangement would cause a redundancy in most hi-fi systems (since you would have an unused preamplifier-equalizer in the receiver or integrated amplifier), but this seems like a small price to pay for being able to listen to those precious old records you thought were ready for the scrap heap. **R-E**



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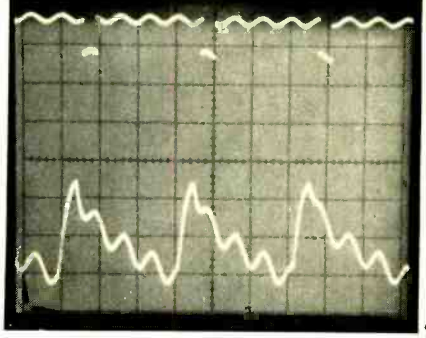
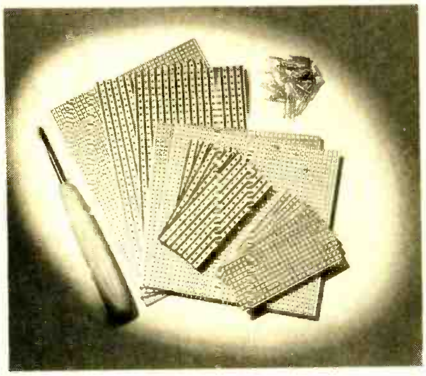


4

vaporized by heat from a hot iron.

After wiring the entire board (although you don't really *have* to wait that long!), simply touch each joint with your soldering iron. Since the insulation vaporizes immediately, apply solder for a good electrical and physical connection. If the insulation does not vaporize, your iron is not hot enough; its minimum temperature should be about 400° F.



A SELECTION OF VEROBOARDS with various hole sizes, a spot face cutter used to break foil strips and discrete terminals.

This wiring process is so direct and quick that even a large board can be completed in a short time. Because of its

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HOBBY CORNER

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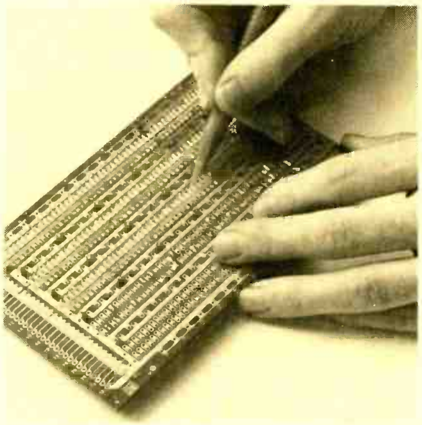
simplicity, it is recommended for all except specialized and production boards. The pen-wiring process is hard to beat for prototyping and one-of-a-kind production of electronic projects.

Vero Electronics, Inc. manufactures the *Verowire* prototyping kit *(model 79-1738K)*. The kit contains a wiring pen, several spools of wire with the special self-fluxing polyurethane insulation, terminals, a 10X magnifying loupe, a terminal tool, a universal PC board (No. 06-0128J, 4.5 by 6.5 inches) with 44-pin edge connector and a wire cutter, all for about $29.



A VEROWIRE PEN being used to route heat strippable wire on a DIP board.

Vero also produces a spot face cutter ($2.20 Part No. 22-0239G) that neatly and painlessly cuts breaks in copper traces on PC boards. No longer will you have to wrestle with a knife and its potential problems when you want to alter the printed circuit on a board.

Table 3 (on page 57) should help you select the best wiring process for a given prototype. These processes also apply to projects from articles in **Radio-Electronics** since the principles of selection are the same.

Putting it all together

Sometimes we get so involved in a project that we don't stop to look at the whole circuit development/construction process to see if there is a better way to do it. It is not enough simply to select the right wiring procedure; you must make other choices.

For instance, how do you decide whether or not to use a breadboard? Perhaps you *always* use one—or you never do. And what about all the different ways to construct a circuit? Do you use the same construction method every time without questioning if it is the best one *this* time?

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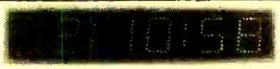

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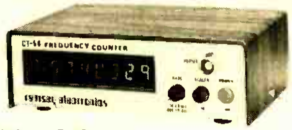

This counter is such a great seller because people like you have found that, feature for feature, the CT-50 gives you more for your money. Advanced LSI and CMOS circuitry has; lowered power consumption, increased performance, and reduced cost. Complete push button operation makes using the CT-50 a snap, and automatic decimal point positioning gives you quick, reliable readings. Battery operation is also possible becuase the CT-50 runs equally as well on 12VDC as it does on 110VAC. For ultra-accuracy we offer the CB-1 color burst adapter, it locks the CT-50's internal crystal to the television networks color standard for .001 ppm accuracy! Why sacrifice performance by using another counter when you can get professional quality at the unheard of price of $79.95? Order yours today!

SPECIFICATIONS
Sensitivity: less than 10 mv.
Frequency range: 5 Hz to 60 MHz, typically 65 MHz
Gatetime: 1 second, 1/10 second, with automatic decimal point positioning on both direct and presacle
Display: 8 digit red LED .4" height
Accuracy: 2 ppm, internal TCXO standard
Input: BNC, 1 megohm direct, 50 Ohm with prescale, option
Power: 110 V ac 5 Watts or 12 V dc @ 300-400 ma
Size: Approx. 6" x 4" x 2", high quality aluminum case

CT-50, 60 MHz Counter Kit $79.95
CT-50 wt 60 MHz Counter Wired & Tested $159.95
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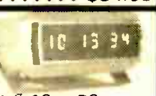

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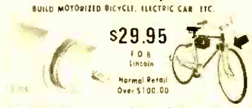

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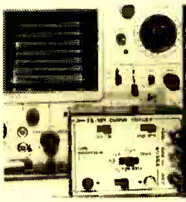

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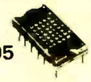

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All parts completed on a PC Board
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Supply voltage 4.5V ~ 9V D.C.
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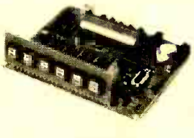

Model 250-30A

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!

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* Resolution: 1 Hz at 1 sec. 10 Hz at 1/10 sec.
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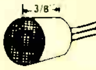

3/8"

$2.50 each
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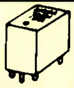

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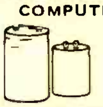

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Not a Kit!

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(15W X 2)

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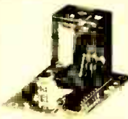

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use 7473 I.C. and 12V relay
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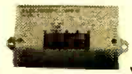

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* ABCDEF
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* ← → Key

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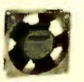

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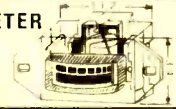

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MOBILE NOISE

continued from page 50

the same kind of choke shown as L1 in Fig. 7. The choke is a common stock item available in car radio repair shops or in stereo sales outlets. Those made by Delco seem to have a lower DC resistance for a given inductance. A DC resistance of 0.20 ohms may not seem like much, until you key the transmitter and draw 30 amperes through the coil. Even if it didn't burn up (it will!), the voltage drop by Ohm's law would be 6 volts. This technique can be used successfully with a low-powered 2-meter

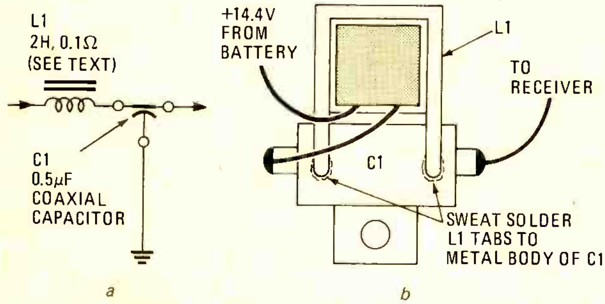


FIG. 9—L-SECTION FILTER shown in *a* is added to power supply line feeding radio. L-section filter is constructed as shown in *b*.

mobile rig, but if you have a high-powered transmitter, it is advisable to separate the DC lines from the receiver section, if possible, and bring them out on their own connectors.

Inductive and capacitive pickup

Up to this point we have discussed almost every type of noise encountered in automotive installations. The sources that remain are often very difficult to locate, although most are easy to fix once found.

Figure 10 shows one example. The exhaust pipe on your car may reradiate noise, and if it is of the correct length, it may also resonate the noise components inside the RF band. This problem is particularly prevalent in 10-meter and 11-meter CB installations. The solution is to ground the tailpipe. It is generally assumed that the tailpipe is already grounded at the engine, but three other factors can contribute to interference: gaskets, rust and the tailpipe length being close to a one-quarter wavelength. Install ground clamps every few feet to reduce the severity of this problem.

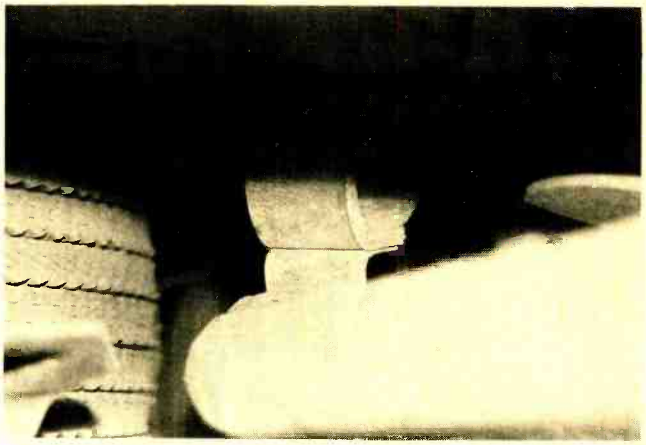


FIG. 10—INSULATED TAILPIPE HANGERS can make tailpipe RF source.

The chrome strips on some cars can also cause motor noise in mobile rigs. If the strips are an appreciable fraction of a wavelength on the band of interest, then it could reradiate if the grounding action of the holding clamps is reduced by corrosion or loss of the clamps. This was the cause of a very tiring and most perplexing source of noise that I had to troubleshoot once many years ago. I still get a backache just thinking about it!

Noise detector

Channel Master has developed a device that is probably the first tool specifically designed to track down sources of motor noise. This is the *model 5270* RF noise detector, also called the *Sleuth* and shown in the head photo.

The *Sleuth*, which sells for about $17, is approximately 25 inches long, and 1 inch in diameter. It has a 17-foot coaxial cable fitted at the free end with a PL-259 coaxial connector. This connector is attached to the radio's antenna connector, so that the receiver can be used as a noise indicator. **Do not key the transmitter with the *Sleuth* connected!**

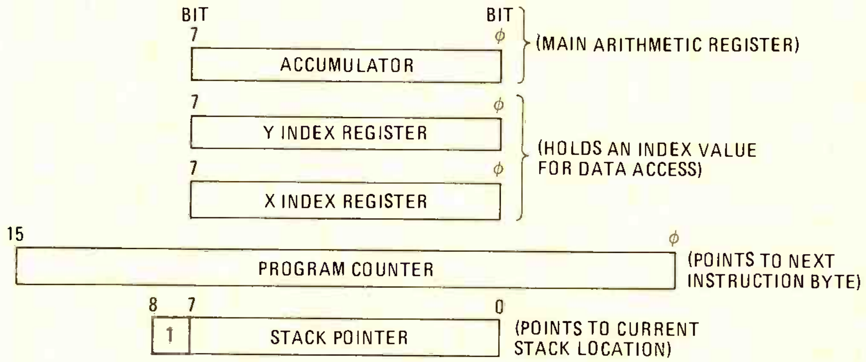
When the *Sleuth*, which is nothing more than a directional RF detector, comes in close contact with the offending noise source, it lets you know through the radio speaker. The device will pinpoint noise sources wherever they are located, even most reradiation sources; such as the tailpipe, the emergency brake cable, a wire or cable bundle or the various rods and linkages passing through the firewall. Most reradiation problems can be then cured by grounding, bypassing or shielding. **R-E**

COMPUTER CORNER

continued from page 83

similar action to $\overline{\text{NMI}}$. The locations for the two interrupt processing routines for $\overline{\text{NMI}}$ and $\overline{\text{IRQ}}$ are held in memory locations FFFA/FFFB$_{16}$ and FFFE/FFFF$_{16}$, respectively. They, of course, must be initialized by the program before any interrupt can occur. (This also means that if interrupts are used in the system, there *must* be a small segment of memory in address area FFFX$_{16}$).

The remaining two lines are $\overline{\text{RES}}$ and SO. $\overline{\text{RES}}$ is an input whose action is similar to that of an interrupt. When the line is brought from low to high, the reset sequence is entered. The CPU loads the CPU *program counter* with the contents of memory locations FFFC/FFFD$_{16}$ to start program execution at a meaningful place. Signal SO is an input signal that allows external logic to set an *overflow* flip-flop in the CPU and is normally not used.



CPU registers

Figure 3 shows the CPU registers that are accessible to the user. The primary arithmetic register is an 8-bit *accumulator*. Arithmetic and logic operations, such as adds or exclusive OR's, are performed between the contents of the accumulator and other operands.

The *program counter* register is 16 bits wide and controls memory addressing for program instructions. As each instruction is executed, the program counter is incremented by one to point to the next byte of the instruction or to the next instruction, operating identically with other microprocessors such as the 6800 or the 8080.

An 8-bit *stack pointer* register points to the *memory stack*, an area of RAM set

continued on page 116

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2102 1	[illegible]	[illegible]	[illegible]
91L02APC	[illegible]	[illegible]	[illegible]
21L11	[illegible]	[illegible]	[illegible]
2111 1	[illegible]	[illegible]	[illegible]
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COMPUTER CORNER

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aside to hold data temporarily and to store the program-counter contents during interrupts and program subroutines. Unlike the 8080, this stack area is predefined in a *page* of memory located from 0100 to $01FF_{16}$. As in the interrupt/reset cases, this memory area must be available and dedicated in the system.

The remaining two CPU registers are two 8-bit index registers. One of the great advantages of the 6502 is that it has a variety of addressing modes, or ways to access memory data. Indexing is a common access method on larger computers; here, the 6502 makes two registers available for indexing, making it easy for the program to acquire contiguous data.

6502 instructions

There are 55 basic instructions in the 6502, but since there are 13 addressing modes there are many more unique instructions than the 55. (See Table I.)

Arithmetic instructions include an add, compare, subtract, AND, OR and exclusive OR. There are several instructions that are devoted to transferring data between CPU registers and memory, or other CPU registers. The remaining instructions are concerned with conditional branching, stack operations and subroutines. Although the 6502 does not contain any spectacular instructions (such as the Z-80 block instructions), the overall instruction repertoire, especially when you consider the 6502's powerful addressing capability, makes for a well-designed versatile microprocessor.

The 6502 is by no means *over*designed. It is an efficient microprocessor IC, easy to program at an assembly-language level and much simpler to interface than the 8080. Since there are many microcomputers built around the 6502 with much software available, you should consider it if you're buying or designing a new system. **R-E**

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7437	.25
7438	.25
7439	.50
7440	.21
7442	.53
7445	.70
7446	.70
7447	.70
7448	.70
7450	.21
7451	.21
7453	.21
7454	.21
7460	.21
7470	.30
7472	.30
7473	.30
7474	.30
7475	.49
7476	.32
7480	.70
7483	.70
7485	.89
7486	.28
7489	2.19
7490	.44
7491	.70
7492	.44
7493	.44
7494	.70
7495	.70
7496	.70
74100	1.28
74107	.30
74109	.33
74116	1.26
74121	.35
74122	.44
74123	.61
74125	.40
74126	.40
74128	.48
74132	.70
74141	.88
74145	.70
74147	1.63
74148	1.30
74150	1.16
74151	.70
74153	.65
74154	1.03
74155	.70
74156	.70
74157	.70
74160	.88
74161	.88
74162	.88
74163	.88
74164	.96
74165	1.15
74166	1.15
74170	2.64
74174	.98
74175	.93
74176	.79
74177	.79
74180	.70
74181	2.15
74182	.79
74184	2.15
74185	2.19
74189	3.50
74190	1.23
74191	1.23
74192	.88
74193	.88
74194	.88
74195	.88
74196	.88
74197	.88
74198	1.49
74199	1.49
74221	.86
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74365	.67
74366	.67
74367	.67
74368	.67

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74LS03	.28
74LS04	.29
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74LS08	.29
74LS09	.29
74LS10	.28
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74LS85	.49
74LS86	.39
74LS90	.57
74LS92	.57
74LS93	.57
74LS95	.88
74LS96	.88
74LS107	.39
74LS109	.39
74LS112	.39
74LS113	.39
74LS114	.39
74LS125	.49
74LS126	.49
74LS132	.81
74LS136	.39
74LS138	.73
74LS139	.73
74LS151	.75
74LS153	.75
74LS154	1.10
74LS155	.75
74LS156	.75
74LS157	.75
74LS158	.75
74LS160	1.02
74LS161	1.02
74LS163	1.02
74LS164	1.02
74LS168	1.14
74LS169	1.14
74LS170	1.73
74LS173	1.34
74LS174	1.06
74LS175	.84
74LS181	2.50
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74LS191	1.18
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74LS194	.88
74LS195	.86
74LS196	.86
74LS197	.86
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74LS243	1.70
74LS244	1.70
74LS247	.79
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74LS251	.84
74LS253	.84
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74LS260	.34
74LS261	2.00
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74LS290	.65
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4010	.44
4011	.23
4012	.23
4013	.40
4014	.96
4015	.96
4016	.40
4017	1.05
4018	1.05
4019	.23
4020	1.14
4021	1.14
4022	.96
4023	.23
4024	.84
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4026	1.68
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4029	1.14
4030	.23
4033	1.51
4034	3.50
4035	1.14
4040	1.14
4041	.79
4042	.79
4043	.70
4044	.70
4046	1.86
4049	.40
4050	.40
4051	1.26
4052	1.26
4053	1.26
4060	1.58
4066	.79
4070	.23
4071	.23
4072	.23
4073	.23
4075	.23
4081	.23
4082	.23
4502	.79
4510	1.14
4511	1.05
4514	2.80
4515	2.80
4516	1.23
4518	1.14
4520	1.14
4527	1.68
4528	.88
4585	1.23
74C00	.23

LINEAR

CA3046	.75
CA3086	.50
LF351N	.76
LF356N	1.20
LF357N	1.20
LF13741	.76
LM301AN	.44
LM307N	.64
LM308N	1.00
LM309K	1.80
LM311N	.90
LM317T	3.00
LM317MP	1.90
LM318N	2.70
LM320MP-5	1.30
LM320MP-6	1.30
LM320MP-8	1.30
LM320MP-9	1.30
LM320MP-12	1.30
LM320MP-15	1.30
LM320MP-18	1.30
LM320MP-24	1.30
LM323K	7.50
LM324N	.72
LM325N	2.70
LM326N	2.70
LM327N	2.70
LM339N	1.15
LM340T-5	1.25
LM340T-6	1.25
LM340T-8	1.25
LM340T-10	1.25
LM340T-12	1.25
LM340T-15	1.25
LM340T-18	1.25
LM340T-24	1.25
LM341P-5	.98
LM341P-6	.98
LM341P-8	.98
LM341P-10	.98
LM341P-12	.98
LM341P-15	.98
LM341P-18	.98
LM341P-24	.98
LM348N	1.60
LM349N	1.60
LM358N	.72
LM1310N	.84
LM1800N	.94
LM1801N	1.70
LM1812N	4.80
LM1830N	1.30
LM1889N	2.00
LM2111N	1.25
LM2907N	1.50
LM2917N	1.50
LM3089N	1.30
LM3900N	.88
LM3900N	.88
LM3905N	1.40
LM3909N	.69
LM3911N	1.50
MC1456V	1.00
MC1458V	.53
MC1496N	.70
MC3302P	1.15
NE536T	2.50
NE540L	2.04
NE555V	.48
NE556A	.88
NE558N	2.40
NE559N	2.40
NE560B	2.50
NE561B	2.50
NE562B	2.50
NE565A	1.25
NE566V	1.28
NE567V	1.36
UA709CV	.44
UA710CA	.44
UA711CA	.53
UA723CA	.60
UA733CA	.75
UA741CV	.44
UA747CA	.70
UA748CV	.49
UA7805CU	1.25
UA7806CU	1.25
UA7808CU	1.25
UA7812CU	1.25
UA7815CU	1.25
UA7818CU	1.25
UA7824CU	1.25
UA78L05ACZ	.40
UA78L06ACZ	.40
UA78L08ACZ	.40
UA78L10ACZ	.40
UA78L12ACZ	.40
UA78L15ACZ	.40
UA78L18ACZ	.40
UA78L24ACZ	.40
UA7905CU	1.70
UA7906CU	1.70
UA7908CU	1.70
UA7909CU	1.70
UA7912CU	1.70
UA7915CU	1.70
UA7918CU	1.70
UA7924CU	1.70

MISC IC

MM5314N	3.75

MICROPROCESSORS

8080A	8-BIT CPU, 2 USEC CYCLE	$12.95
8212	8-BIT I/O PORT	$ 3.95
8216	BI-DIRECTIONAL BUS DRIVER	$ 4.25
8224	CLOCK GENERATOR	$ 3.95
8228	SYSTEM CONTROLLER	$ 6.95
8251	COMMUNICATIONS INTERFACE	$12.95
8255	PERIPHERAL INTERFACE	$11.95
1702A	2K EPROM (256x8)	$ 6.95
2708	8K EPROM (1Kx8)	$29.50
2102-1	1K RAM 500 NS	$ 1.79
SC MP	5 VOLT SC/MP CPU	$ 9.95
2650	MICROPROCESSOR 1.25 MH-2 CLOCK 40 DIL	$24.95

I.C. SOCKETS

8 PIN SOLDER	.17	1.60/10	14.50/C
14 PIN SOLDER	.20	1.90/10	17.00/C
16 PIN SOLDER	.22	2.10/10	18.75/C
18 PIN SOLDER	.29	2.75/10	24.50/C
20 PIN SOLDER	.30	2.85/10	25.25/C
22 PIN SOLDER	.33	3.15/10	27.75/C
24 PIN SOLDER	.38	3.60/10	32.25/C
28 PIN SOLDER	.45	4.25/10	38.25/C
40 PIN SOLDER	.63	6.00/10	53.50/C
8 PIN W-W	.24	2.30/10	20.50/C
14 PIN W-W	.26	2.50/10	22.00/C
16 PIN W-W	.30	2.85/10	25.50/C
18 PIN W-W	.60	5.70/10	51.00/C
20 PIN W-W	.70	6.65/10	59.50/C
22 PIN W-W	.84	8.00/10	71.50/C
24 PIN W-W	.96	9.10/10	81.50/C
28 PIN W-W	1.12	10.00/10	95.20/C
40 PIN W-W	1.36	12.50/10	115.00/C

8080A CHIP SET

ONE EACH 8080A, 8212, 8224 and 8228 PLUS SIXTEEN 2102-1's

ALL FOR — **$49.95**

MOLEX I.C. SOCKET PINS

.85/C 8.20/M 38.20/5M 275.00/50M

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AN ASSORTMENT OF METALIZED POLYESTER CAPACITORS

300 CAPS 18 VALUES $26.00

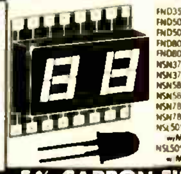
MINIBOX METALIZED POLYESTER CAPACITORS

.001	.14	1.15/10	9.00/C	.033	.15	1.25/10	10.00/C
.0022	.14	1.15/10	9.00/C	.047	.15	1.25/10	10.00/C
.0033	.14	1.15/10	9.00/C	.068	.15	1.25/10	10.00/C
.0047	.14	1.15/10	9.00/C	.1	.17	1.35/10	11.00/C
.0068	.14	1.15/10	9.00/C	.22	.23	1.85/10	15.00/C
.01	.14	1.15/10	9.00/C	.33	.30	2.50/10	20.00/C
.022	.15	1.25/10	10.00/C	.47	.36	3.00/10	24.00/C

ELECTROLYTIC CAPACITORS

VALUE	RADIAL LEADS			AXIAL LEADS		
.47/50V	.08	.65/10	5.41/C	.11	.90/10	7.65/C
1/50V	.08	.65/10	5.41/C	.11	.90/10	7.65/C
2.2/50V	.08	.65/10	5.41/C	.12	.90/10	7.82/C
3.3/50V	.08	.65/10	5.41/C	.12	1.00/10	8.31/C
4.7/35V	.08	.65/10	5.41/C	.12	.95/10	7.91/C
4.7/50V	.08	.68/10	5.75/C	.12	1.00/10	8.31/C
10/16V	.08	.65/10	5.41/C	.11	.90/10	7.65/C
10/25V	.08	.65/10	5.66/C	.12	1.00/10	8.31/C
10/35V	.09	.70/10	6.12/C	.13	1.10/10	8.94/C
10/50V	.10	.75/10	6.58/C	.14	1.15/10	9.56/C
22/16V	.08	.67/10	5.66/C	.12	1.00/10	8.31/C
22/25V	.09	.70/10	6.09/C	.13	1.05/10	8.74/C
22/35V	.11	.85/10	7.29/C	.15	1.19/10	9.98/C
22/50V	.12	1.00/10	8.48/C	.17	1.32/10	11.22/C
33/16V	.09	.75/10	6.90/C	.12	1.00/10	8.48/C
33/25V	.10	.81/10	7.50/C	.14	1.15/10	9.56/C
33/35V	.13	1.05/10	9.65/C	.17	1.34/10	11.23/C
33/50V	.14	1.13/10	10.41/C	.19	1.52/10	12.89/C
47/10V	.09	.71/10	6.52/C	.13	1.04/10	9.50/C
47/16V	.10	.81/10	7.47/C	.14	1.15/10	9.56/C
47/25V	.13	1.05/10	9.65/C	.17	1.30/10	11.22/C
47/35V	.14	1.13/10	10.41/C	.19	1.51/10	12.89/C
47/50V	.15	1.21/10	11.16/C	.21	1.71/10	14.55/C
100/10V	.10	.77/10	6.58/C	.14	1.13/10	9.56/C
100/16V	.11	.85/10	7.28/C	.17	1.30/10	11.22/C
100/25V	.13	1.10/10	9.15/C	.20	1.55/10	13.30/C
100/35V	.17	1.41/10	11.85/C	.25	1.93/10	16.50/C
100/50V	.21	1.71/10	14.55/C	.29	2.30/10	19.70/C
220/10V	.13	1.08/10	9.15/C	.18	1.42/10	12.05/C
220/16V	.15	1.16/10	9.86/C	.20	1.55/10	13.[illegible]/C
220/25V	.21	1.71/10	14.55/C	.29	2.35/10	19.96/C
220/35V	.25	2.03/10	17.26/C	.35	2.79/10	23.70/C
220/50V	.29	2.35/10	19.96/C	.40	3.23/10	27.44/C
330/6V	.14	1.12/10	9.50/C	.19	1.48/10	13.71/C
330/10V	.15	1.16/10	9.83/C	.21	1.64/10	15.13/C
330/16V	.21	1.66/10	14.14/C	.31	2.45/10	22.70/C
330/25V	.23	1.86/10	15.79/C	.38	3.07/10	28.38/C
330/35V	.33	2.66/10	24.59/C	.43	3.43/10	31.68/C
330/50V	.54	4.30/10	39.73/C	.60	4.81/10	44.45/C
470/6V	.15	1.21/10	11.16/C	.20	1.64/10	15.13/C
470/10V	.21	1.71/10	14.55/C	.31	2.45/10	22.70/C
470/16V	.23	1.81/10	15.39/C	.33	2.66/10	24.59/C
470/25V	.29	2.35/10	19.96/C	.43	3.43/10	31.68/C
470/35V	.41	3.27/10	30.26/C	.47	3.78/10	34.99/C
470/50V	.54	4.30/10	39.73/C	.75	6.03/10	55.80/C
1000/6V	.22	1.90/10	16.50/C	.35	2.76/10	25.54/C
1000/10V	.24	1.96/10	16.62/C	.38	3.07/100	28.38/C
1000/16V	.29	2.35/10	19.96/C	.43	3.43/10	31.68/C
1000/25V	.42	3.33/10	28.27/C	.68	5.42/10	50.13/C
1000/35V	.60	4.81/10	44.45/C	.75	6.03/10	55.81/C
2200/6V	.36	2.86/10	26.48/C	.43	3.43/10	31.68/C
2200/10V	.42	3.33/10	28.27/C	.60	4.81/10	44.45/C
2200/16V	.54	4.30/10	36.58/C	.68	5.42/10	50.13/C

LED DIGITS AND LAMPS



FND357	.375" Single Digit, CC, Red	$1.35
FND500	.5" Single Digit, CC, Red	1.35
FND507	.5" Single Digit, CC, Red	1.35
FND800	.8" Single Digit, CC, Red	2.50
FND807	.8" Single Digit, CA, Red	2.50
NSN373	.3" Dual Digits, CC, Red	2.20
NSN374	.3" Dual Digits, CA, Red	2.20
NSN583	.5" Dual Digits, CC, Red	2.60
NSN584	.5" Dual Digits, CA, Red	2.60
NSN783	.7" Dual Digits, CC, Red	3.00
NSN784	.7" Dual Digits, CA, Red	3.00

NSL5053 D4 Red T-1¾ Lamp w/Mtg. Hdwe $1.80/10 $16.00/100
NSL5056 D4 Narrow Angle Red T-1¾ Lamp w/Mtg. Hdwe $1.80/10 $16.00/100

5% CARBON FILM RESISTORS

¼ WATT RESISTOR ASSORTMENTS

Catalog Number	Description	PRICE
RS125	Set of 5 each of the 73 standard 5% ¼ watt carbon film resistors in the series 1.0, 1.2, 1.5, 1.8, 2.2 etc. through 1.0 megohm (365 total pcs.)	$9.90
RS225	Set of 5 each of the 72 standard 5% ¼ watt carbon film resistors in the series 1.1, 1.3, 1.6, 2.0, 2.4 etc. through 910 kilohm (360 total pcs.)	$9.90

½ WATT RESISTOR ASSORTMENTS

Catalog Number	Description	PRICE
RS150	Set of 5 each of the 73 standard 5% ½ watt carbon film resistors in the series 1.0, 1.2, 1.5, 1.8, 2.2 etc. through 1.0 megohm (365 total pcs.)	$9.90
RS250	Set of 5 each of the 72 standard 5% ½ watt carbon film resistors in the series 1.1, 1.3, 1.6, 2.0, 2.4 etc. through 910 kilohm (360 total pcs.)	$9.90

Bishop Graphics 5"x6"

The Digi-Key Catalog features many more quality Bishop Graphics products.

3365-ND 12.50

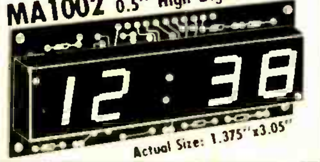
CLOCK MODULES

The MA1002 and MA1010 series clock modules by National Semiconductor are fully assembled and tested clocks using a 4 digit LED display and an MOS integrated circuit on the same board. Simply connect switches and our special transformer and you have a fully functioning clock.

The MA1003 clock module is a fully assembled and tested 12 hour clock using a high brilliance green flourescent display and crystal time base making it perfect for car, boat or other portable use. It operates directly from 12 volts DC so no transformer is needed. Our price includes three push button switches for setting the time.

MA1002A	.5" LED 12 Hour AM-PM Clock Module	$10.50
MA1002A SET	Module with Transformer & Switches	$13.95
MA1002C	.5" LED 24 Hour Clock Module	$10.50
MA1002C SET	Module w/Transformer & Switches	$13.95
MA1003	12 Volt Car Clock with Switches	$24.95
MA1010A	.84" LED 12 Hour AM-PM Clock Module	$13.00
MA1010A SET	Module w/Transformer & Switches	$16.45
MA1010C	.84" LED 24 Hour Clock Module	$13.00
MA1010C SET	Module w/Transformer & Switches	$16.45

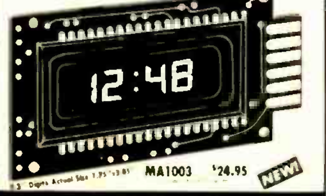
MA1002 0.5" High Digits



Actual Size: 1.375" x 3.05"

MA1010 0.84" High Digits

Actual size: 1.75" x 3.75"



.3" Digits Actual Size 1.75" x 3.85" **MA1003** $24.95 NEW!

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CMOS DATA BK. 77 EDIT. 555 P. NAT. SEMI.	9012B	$3.00
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LIN. APPLIC. BK. VOL. 1, 432 P. NAT. SEMI.	9018B	$4.00
LIN. APPLIC. BK. VOL. 2, 246 P. NAT. SEMI.	9019B	$4.00
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SC/MP MICRO. APP. HANDBK. NAT. SEMI.	9022B	$5.00
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½ WATT ZENER DIODES

.15 1.30/10 11.00/C

1N5226B	3.3V	1N5242B	12V
1N5227B	3.6V	1N5243B	13V
1N5228B	3.9V	1N5244B	14V
1N5229B	4.3V	1N5245B	15V
1N5230B	4.7V	1N5246B	16V
1N5231B	5.1V	1N5247B	17V
1N5232B	5.6V	1N5248B	18V
1N5233B	6.0V	1N5249B	19V
1N5234B	6.2V	1N5250B	20V
1N5235B	6.8V	1N5251B	22V
1N5236B	7.5V	1N5252B	24V
1N5237B	8.2V	1N5253B	25V
1N5238B	8.7V	1N5254B	27V
1N5239B	9.1V	1N5255B	28V
1N5240B	10V	1N5256B	30V
1N5241B	11V	1N5257B	33V

HARDWARE

2-56 1/4 SCREW	.99/C
2-56 1/2 SCREW	.99/C
4-40 1/4 SCREW	.55/C
4-40 1/2 SCREW	.60/C
6-32 1/4 SCREW	.65/C
6-32 1/2 SCREW	.75/C
8-32 3/8 SCREW	.90/C
8-32 5/8 SCREW	.99/C
2-56 HEX NUT	.55/C
4-40 HEX NUT	.55/C
6-32 HEX NUT	.60/C
8-32 HEX NUT	.60/C
NO 2 LOCKWASHER	.85/C
NO 4 LOCKWASHER	.45/C
NO 6 LOCKWASHER	.45/C
NO 8 LOCKWASHER	.45/C

FREE CATALOG

SILICON TRANSISTORS

MPS918	.16	1.55/10	13.60/C	130.00/M
MPS930	.16	1.55/10	13.60/C	130.00/M
MPS2222A	.16	1.55/10	13.60/C	130.00/M
MPS2369A	.16	1.55/10	13.60/C	130.00/M
MPS2907A	.16	1.55/10	13.60/C	130.00/M
MPS3393	.16	1.55/10	13.60/C	130.00/M
MPS3393	.16	1.55/10	13.60/C	130.00/M
MPS3394	.16	1.55/10	13.60/C	130.00/M
MPS3395	.16	1.55/10	13.60/C	130.00/M
MPS3563	.16	1.55/10	13.60/C	130.00/M
MPS3565	.16	1.55/10	13.60/C	130.00/M
MPS3638A	.16	1.55/10	13.60/C	130.00/M
MPS3640	.16	1.55/10	13.60/C	130.00/M
MPS3641	.16	1.55/10	13.60/C	130.00/M
MPS3643	.16	1.55/10	13.60/C	130.00/M
2N3904	.16	1.55/10	13.60/C	130.00/M
2N3906	.16	1.55/10	13.60/C	130.00/M
2N4124	.16	1.55/10	13.60/C	130.00/M
2N4126	.16	1.55/10	13.60/C	130.00/M
2N4401	.16	1.55/10	13.60/C	130.00/M
2N4403	.16	1.55/10	13.60/C	130.00/M
2N4410	.16	1.55/10	13.60/C	130.00/M
2N5087	.16	1.55/10	13.60/C	130.00/M
2N5089	.16	1.55/10	13.60/C	130.00/M
2N5210	.16	1.55/10	13.60/C	130.00/M
2N3055	.99	9.20/10	85.00/C	800.00/M
MPF102	.36	3.35/10	30.60/C	300.00/M
2N5457	.48	4.50/10	41.00/C	400.00/M
MPSA13	.28	2.60/10	24.00/C	230.00/M
MJ2955	.99	9.20/10	85.00/C	800.00/M
TIP120	.99	9.20/10	85.00/C	800.00/M

NEW! 74C SUPER QUALITY SUPER PRICES

74C00

74C00N	.25	74C154N	2.90
74C02N	.25	74C157N	1.90
74C04N	.27	74C160N	1.18
74C08N	.25	74C161N	1.18
74C10N	.25	74C162N	1.18
74C14N	.90	74C163N	1.18
74C20N	.25	74C164N	1.10
74C30N	.25	74C165N	1.10
74C32N	.25	74C173N	1.30
74C42N	.98	74C174N	1.16
74C48N	1.28	74C175N	1.16
74C73N	.72	74C192N	1.38
74C74N	.48	74C193N	1.38
74C76N	.72	74C195N	1.10
74C83N	1.38	74C221N	1.90
74C85N	1.38	80C95N	.48
74C86N	.40	80C96N	.48
74C90N	.98	80C97N	.48
74C93N	.98	80C98N	.48
74C95N	1.10	74C901N	.48
74C107N	.70	74C902N	.48
74C150N	2.90	74C909N	1.78
74C151N	1.90	74C926N	7.80

STRANDED HOOK UP WIRE

20 ga PVC	2.50/100'	10.00/500'
22 ga PVC	2.80/100'	11.25/500'
24 ga PVC	2.10/100'	8.50/500'
26 ga PVC	2.10/100'	8.50/500'

Digi-Key Stocks the Entire AP Line

SILICON DIODES

1N4001	.64/10	5.50/C
1N4002	.66/10	5.60/C
1N4003	.68/10	5.80/C
1N4004	.70/10	5.95/C
1N4005	.82/10	7.05/C
1N4006	.90/10	7.75/C
1N4007	.99/10	8.60/C
1N4148	.40/10	3.50/C

FREE CATALOG

SLIDE SWITCHES

SPST	.15	1.25/10	10.00/C
SPDT	.19	1.70/10	13.00/C
DPDT	.23	2.00/10	19.00/C

50 VOLT DISCS

100 PF	.40/10	3.50/C
220 PF	.40/10	3.50/C
470 PF	.40/10	3.50/C
.001 UF	.40/10	3.50/C
.0022 UF	.40/10	3.50/C
.0047 UF	.40/10	3.50/C
.01 UF	.45/10	3.65/C
.022 UF	.50/10	4.00/C
.047 UF	.70/10	5.60/C
.1 UF	1.35/10	11.50/C

DOUBLE DIGIT DISCOUNTS SAVE YOU EVEN MORE!

HANDLING CHARGES

$ 0.00-$ 4.99 ... Add $2.00
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$ 25.00-$49.99 ... Add $0.50
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$100.00 & Up ... No Charge

VOLUME DISCOUNT & HANDLING CHARGE

All items except those with catalog numbers ending with the suffix-ND may be combined for discount. First—total all discountable items and apply the volume discount. Then add to this sub-total the nondiscountable items. Add the handling charge. This is your total cost. We pay all shipping and insurance to addresses in the U.S.A. and Canada.

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DIGI-KEY CORPORATION

Quality Electronic Components

P.O. Box 677 Thief River Falls, MN 56701 (218) 681-6674

CIRCLE 91 ON FREE INFORMATION CARD

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IC, LED SALE

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7404	$.14
7410	.13
7430	.15
7437	.15
7447	.49
7474	.23
7485	.69
7493	.28
7495	.49
74123	.23
74141	.65
74151	.49

CMOS

4002	.19
4006	.95
4007	.19
4009	.39
4011	.16
4014	.79
4019	.25
4021	.87
4022	.89
4023	.18
4051	.89

LINEAR

301m	Prec. Op Amp	$.19
302H	Volt Follower	.39
308H	Prec Op Amp	.49
311N	Hi Perf V Comp.	.59
340T6v	Pos. V Req.	.59
540H	Power Amp	1.59
565N	Genl Purp PLL	.99
723N	Volt Reg	.45
733H	Diff Video Amp	.49
739N	Dual Audio Preamp	.69
1414N	Dual Diff Comp.	.99

MAN 1	.27" Red CA LHD	.99
MAN 2	.30" Red 5x7 LHD	3.95
MAN 5	.27" Green CA LHD	.99
MAN 7	.27" Yellow CA LHD	.49
MAN 54	.30" Green CC RHD	1.19
MAN 66	.60" Red CA LHD	1.19
MAN 72	.30" Red CA LHD	.59
MAN 82	.30" Red CA LHD	.99
MAN 3610	.30" Orange CA RHD	.69
MAN 3640	.30" Orange CC RHD	.69
MAN 4610	.40" Orange CC RHD	.59
MAN 6660	.56" Orange CA RHD	.59
DL 10A	.27" Red CA LHD	.99
DL 702	.30" Red CC LHD	.79
DL 707	.30" Red CA RHD	.79
DL 747	.60" Red CA LHD	1.19
FND 359	.375" Red CC RHD	.59
FND 500	.50" Red CC RHD	.69
FND 507/510	.50" Red CA RHD	.69
NSN 74R	.30" Red CC RHD	.69

MAN 6610	2 Dig .56" Orng CA RHD	.69
MAN 6630	1-1/2 Dig .56" Orng CA RHD	.59
MAN 6640	2 Dig .56" Orng CC RHD	.69
MAN 6650	1-1/2 Dig .56" Orng CC RHD	.59
MAN 6710	2 Dig .56" Red CA RHD	.69
MAN 6730	1-1/2 Dig .56" Red CA RHD	.59
MAN 6740	2 Dig .56" Red CA RHD	.69
MAN 6750	1-1/2 Dig .56" Red CC RHD	.59
DL 338	3 Dig .17" Red CC	.29
DL 338	2 Dig .17" Red CC	.49
NSN 33	3 Dig .17" Red CC	.39
HP 5082	4 Dig .11" Mag. RHD	.39
HP 5082	5 Dig .11" Mag. RHD	.49
SP425-09	9 Dig Gas Discharge	.69
Calc Disp	9 MAN 3s on board Red	.79
TI 434	9 Dig Red	.49

ELECTRONIC DOOR CHIME KIT

WITH TI TMS 1000 MICROPROCESSOR CHIP PROGRAMMED TO PLAY 24 DIFFERENT TUNES

$39.50 SHIPPING $1.00

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2511	Dual 100 bit Shift Reg.	.95
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MM5016	500/512 bit Shift Reg.	.95
SL-5-4025	Quad 25 bit Shift Req.	.59

MV108 TO-18 clear 15/$1.00

2513(caps)	Char. Gen.	2.95
2513(L.C.)	Char. Gen.	2.95
MM1101	256 bit RAM	.65
MM1103	1K RAM	.75
1702A	EROM	4.75
MM5261	1K RAM	.55
MM5262	1K RAM	.95
F93410	256 bit RAM	.95
2708	8K EROM	$8.95

EXAR

320	1.19
2206	3.90
2207	1.49
2567	1.49
4136	.69
4202	.69
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KEYBOARD
20 Keys - 2 slide switches
3" x 3-3/4" $1.00/3

BUGBOOKS

I & II - Logic, memory text & experiments $17.00 /set
Instructors Manual (for 1 & 2) $ 3.00 ea.
IIA - Introduction, use of UART $ 5.00 ea.
V & VI - Experiments in Digital 8080A programming & interfacing $ 9.50 ea. 19.00 /set
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CMOS - Designers primer and handbook $ 6.00 ea.
SK10 - E & L Solderless Breadboard $16.50 ea.

IC SOCKETS TT

Low Profile Solder Tail

8 pin	$.16	24 pin	$.36
14 pin	.19	28 pin	.44
16 pin	.21	40 pin	.61
18 pin	.28		

Wire Wrap

8 pin	.45
14 pin	.49
16 pin	.55

LINEAR ASSORTMENT
1 each of following - all functional
301M, 302H, 307M, 311N, 340T-5, 340T-6, 340T-15, 380-8, 385K, 723N, 739N, 741M, 748M, 75453M
$4.75

5 BACK ISSUES OF ELEKTOR MAGAZINE containing a variety of electronic projects, with schematics, PC lay-outs, parts list. PC boards are available. Regular $1.50/copy
$4.00/5 issues
25 26 29 30 31

METAL FILM RESISTORS
± 1%, 1/4w, ± 50 PPM/oC
Standard Decade Values 10.5 - 464K

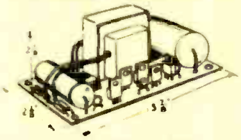
Qty.	Ea.	Min 10/value	Min 100/value
1-99	$.20	$.15	
100-999	.20	.10	$9.00/100
1000-			8.00/100

CERAMIC DISC CAPACITORS - 50V

1pf	22pf	56pf	120pf	270pf	820pf	.022uf
5pf	27pf	68pf	150pf	390pf	.001uf	.030uf
7pf	33pf	82pf	180pf	470pf	.0047uf	.050uf
10pf	47pf	100pf	220pf	600pf	.01uf	

0-10 per value..$.10ea 10-up per value $.05ea
10-up per value $.05ea

REGULATED POWER SUPPLY



Plus & minus 5V, 12V and 15V.
Uses 3 LM340T and 3 LM320T regulators, 115V/29V CT transformer plus PC board capacitors & diodes.
All parts, schematic, instructions
PS-29.........$12.95 + $1.00 Shppng.

PLASTIC CASES

VERO - dark and light gray nominal O.D.

2514F	2"x4"x1"	$4.34
2516G	2"x4"x1.6"	4.90
2518H	2.6"x 4.7"x1.6"	5.48
2520J	3.2"x6"x2"	6.24
2522K	4.3"x7.4"x2.4"	8.28
2755G	2.6"x4.7"x2.6"	6.74
27600	4.3"x7.4"x2.4" (w/ handle/stand)	10.78
2525F	2.8"x5.4"x2.4" (ventilated)	5.40
HAMMOND - blue		
1591C	2.6"x4.8"x1.6"	2.65

PRECISION RESISTOR PACKAGE
Metal Film ± 1% 1/4 watt
Starter Kit - 2ea. 60 values
120 Resistors 10.5 ohm- 464K
$14.95
Supplied in 15 Drawer 60 Comp. Cabinet - $26.50 + $2.00 Sh.

CAPACITOR KIT - ceramic disc
50V, 24 values, 10 capacitors each

1pf	33pf	82pf	220pf	820pf	.022uf
5pf	47pf	100pf	270pf	.001uf	.030uf
10pf	56pf	150pf	470pf	.0047uf	.050uf
22pf	68pf	180pf	600pf	.01uf	.1uf

capacitors only...$11.95
Packaged in 15 drawer, 60 compartment cabinet....$19.95 plus $2.00 shipping

BEZELS - with red filters

140-2	cut-out 1.125" x 2.375" max .062" panel thickness	$1.75
140-4	cut-out 1.160" x 4.375" max .125" panel thickness	$2.75

DIODES

Silicon SW diode assorted 400 mw	$.05ea
1N4148 (1N914) Silicon diode 400 mw	.10
1N3064 Silicon SW diode 400 mw	.10
1N4006 Silicon rect. diode 600V 400mw	.10
Zener diode 400 mw - 2.4V, 3.6V, 5.1V, 6.5V, 6.8V, 10V, 12V, 14.5, 15V, 120V	.15
Germanium diode 400 mw	.08

PC BOARDS - for use with ELEKTOR MAGAZINE PROJECTS
MAGAZINE PROJECTS

ELEKTOR #32 Dec 77........................		$ 1.50
music synthesiser (E25-31)	9724-1	7.45
CPU - SC/MP	9851a	18.80
UHF TV modulator	9864	2.95
microphone preamp	9866	1.30
ANALOG FREQ. METER	9869	2.40
heating controller	9877	7.05
MW reflex receiver	9880	1.85
sensitive lightmeter	9886	1.30
stylus balance (E12)	9343	1.05
signal generator (E24)	9765	1.10
knotted handkerchief (E27/28)	9830	.45
ELEKTOR #31 Nov 77........................		1.50
music synthesiser	9723-1	18.35
CCIR TV pattern generator	9800-3	5.65
video biofeed back		
display generator	9825-1	5.60
alpha amplifier	9825-2	4.60
electrometer	9826-1	1.50
sensors for electometer	9826-2	1.40
magnetiser	9827	1.45
CPU-SC/MP		
RAM-I/O	9846-1	12.70
SC/MP Board	9846-2	3.95
model car track (E24-E30)		
transmitter power supply	9218	2.20
chassis	9850	6.35
ELEKTOR #20 Oct 77........................		1.50
CCIR TV pattern generator (E29)	9800-2	7.35
infrared transmitter	9822	5.55
ioniser	9823	6.60
Kirlian camera (set) 4523,	9831	5.00
model car track (E24-26,29)		
infrared receiver	9848-1	1.80
multiplex decoder	9848-2	1.90
ELEKTOR #29 Sept 77		1.50
FM intercom	9359	10.75
music synthesiser (E25,26)		
interface receiver	9721-2	2.80
power supply	9721-3	9.15
keyboard divider(1 ocatave)	9721-4	1.70
logarithmic timer	9797	3.35
CCIR TV test pattern generator	9800-1	13.10
model car track (E24-26)		
motor speed control	9829-1	1.20
proptester	9829-2	3.45

UNIVERSAL BREADBOARD

Silver plated copper circuits fits any IC and related components. 2 triple rows of 27 holes for DIP. 3-3/16" x5-1/16" $1.00

ELECTRONIC BUZZER

Miniature, Solid State
6V 15ma (4-9V oper.) $1.69 ea.
12V 15ma (8-20V oper.) $1.69 ea.

TANTALUM CAPACITORS - solid dipped

.1u/35V	$.20	6.8/6	$.25	15/50	$.40
.22/35	.20	6.8/16	.25	22/16	.40
.33/35	.20	6.8/50	.30	33/10	.50
1/35	.20	10/16	.30	47/6	.50
2.2/20	.25	10/25	.35	47/25	.55
2.2/35	.25	10/50	.35	56/6	.65
3.3/35	.25	15/10	.35	150/15	1.25
4.7/16	.25	15/20	.35		

Carbon Film Resistors ± 5% 1/4w, 1/2w

Qty.	Ea.	Min 10/value	Min 100/value
1-99	$.10	$.05	
100-999	.10	.04	$3.00/100
1000-			2.50/100

I C BREADBOARD

Silver plated copper circuits holds 5 - 16 pin DIP IC's and interconnection holes. $1.00

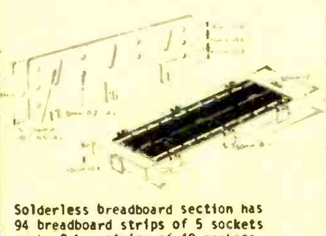
RESISTOR PACKAGE
Carbon Film ± 5% 1/4w or 1/2w
Usage Evaluated Assortment
5 to 20 ea of 44 values.
$12.95
Supplied in 15 Drawer 60 Comp. Cabinet. $22.95 + $2.00 Sh.

TANTALUM CAPACITOR KIT
solid dipped, 12 values, 5 each

.1uf/35V	2.2/35	10/25	33/10
.33/35	4.7/16	15/20	47/25
1/35	6.8/16	22/16	56/6

capacitors only......$14.95
supplied in styrene utility box.... ....$19.95

BIMBOARD - BREADBOARD KIT



Solderless breadboard section has 94 breadboard strips of 5 sockets each. 2 bus strips of 40 sockets each. Component bracket for switches lamps etc., accepts leads .01" to .035" diameter. $11.95 ea.

RESISTOR PACKAGE
Carbon Film ± 5% 1/4 w or 1/2 w
15 ea. of 12 values:
100, 220, 470, 1K, 1.5K, 3.3K 4.7K 6.8K, 10K, 33K, 100K, 1M.
$5.45

TRANSISTORS

2N1132	PNP Gen Purp. Ampl TO-5	$ .69
2N2218A	NPN Low Power Trans TO-5	.69
2N2222A	NPN Low Power Trans TO-18	.29
2N2223	NPN Low Power Trans. TO-5	.69
2N2369	NPN Low Power Trans TO-5	.29
2N2904	PNP Low Power Trans TO-5	.49
2N2905A	PNP Low Power Trans TO-5	.76
2N3227	NPN Low Power Trans TO-18	.69
2N3904	NPN Low Power Trans TO-92	.17
2N3906	PNP Low Power Trans TO-92	.17
SCA 13572	NPN Pwr Trans - 200V TO-5	1.75

CLOCK KIT - Mark I
6 digit clock kit with one PC board. Accommodates MM5314 clock chip and 6 FND 359 displays contains all components except transformer. Includes 3 switches. Board has terminals for remote displays. $10.95

with 12V/300 ma transformer $13.95

TRIMPOT - 25 turn
Bourns - Cermet 3299W
PC Mount, vert. adj.
2K, 10K, 20K $1.75 ea

VECTOR BOARD - Phenolic
169P44-D62 (.1"spacing .42" dia.)
4-1/4" x 4-1/2" x .0625"...$1.15 ea.

TRIMPOT - Single Turn
Mepco - Cermet 8014
.5w, ± 100 PPM/°C ± 20%
500 ohm, 2K, 10K, 25K, 50K, 100K, 500K, 1M. $.75 ea.
.69/10-

COMPLETE SATISFACTION GUARANTEED. SHIPMENT TO US AND CANADA PREPAID UNLESS INDICATED OTHERWISE. OTHER COUNTRIES ADD 10% - EXCESS REFUNDED. ORDERS SHIPPED IN 3 WORKING DAYS FROM RECEIPT. MINIMUM ORDER $10.00 CALIFORNIA RESIDENTS ADD SALES TAX. MINIMUM COD OR CHARGE ORDER $15.00

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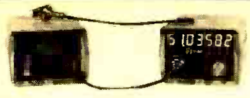
CIRCLE 12 ON FREE INFORMATION CARD



SC-5 With Rechargeable Batteries & Charger Unit **$89**

FM-7 With Rechargeable Batteries & Charger Unit **$195**

Features Include: • By using the new NLS SC-5 Prescaler, the range of the FM-7 Frequency Meter, which is 10 Hz to 60 MHz, may be extended to 512 MHz (the upper VHF & UHF frequency bands). • The FM-7 utilizes an LED readout, providing 7-digit resolution. • The FM-7 can be calibrated to an accuracy of 0.00001%. • The SC-5 is accurate to one part per million. • Each unit has 30 millivolts sensitivity, is battery powered and has a charger unit included. • Dimensions of each are 1.9" H x 2.7" W x 3.9" D. • The units may be obtained separately or as a "Frequency Duo." • Parts & Labor guaranteed 1 year.

Tilt stand option .... $ 3.50
Leather case $16.00

LEDU MG 10A List $72.00

Perfectly balanced, fluorescent lighting with precision magnifier lens. For prof'l, techn'l & hobbist. Has die cast protective shade, inst. start 3 diopter lens 42" reach.

$44^{95}

with 1-9 fluorescent lamp (required) $49.95
colors Gray or Black Chocolate Brown
2 choices please

$44^{95} SPECIAL

MS-15 MINISCOPE $289

With Rechargeable Batteries & Charger Unit

- 15 megahertz bandwidth.
- External and internal trigger.
- Time base — .1 microsec. to 0.5 Sec/div - 21 settings. ± 3%.
- Battery or line operation.
- Automatic & line sync modes.
- Power consumption < 15 watts.
- Vertical Gain — .01 to 50 V/div - 12 settings ± 3%.
- Viewing area 1.1" x 1.35".
- Case size 2.7"H x 6.4"W x 7.5"D, 3 pounds.
- Parts & labor guaranteed 1 year
- 10 to 1, 10 meg probe $24.50
- Leather carrying case $30.00

PROBE 1¢ with the purchase of SCOPE and the MENTION of this MAGAZINE

NEW VOLKSMETERS!

With LCD Display— Excellent Readability in Direct Sunlight!

1% LM-300 Full three digits $99.50*

0.5% LM-350 3½ digits $125.00*

FEATURES

- Measures DC volts, AC volts, ohms and current.
- Automatic polarity, decimal and overload indication.
- No zero adjustment and no full scale ohms adjust.
- Large LCD display for easy reading without interpolation.
- Size 1.9" H x 2.7" W x 4.0" D.
- Parts and labor guaranteed for one year.

SPECIFICATIONS

MODE	RANGE	ACCURACY LM-300	ACCURACY LM-350	RESOLUTION	INPUT RESISTANCE	TEST CURRENT
VOLTS DC*	1 10 100 1000	±1% Reading†	±0.5% Reading†	1 mV 10 mV 100 mV 1 V	10 MΩ	
VOLTS AC*	1 10 100 1000	±1% Reading† 50-400 Hz	±0.75% Reading† 50-400 Hz	1 mV 10 mV 100 mV 1 V	10 MΩ, 30 pF	
KILOHMS**	1 10 100 1000 10000	±1% Reading†	±0.5% Reading†	1 Ω 10 Ω 100 Ω 1 kΩ 10 kΩ		1 mA 100 µA 10 µA 1 µA 100 nA
CURRENT	1 mA 10 mA 100 mA 1 A	±2% Reading†	±2% Reading†	1 µA 10 µA 100 µA 1 mA	1 kΩ 100 Ω 10 Ω 1 Ω	

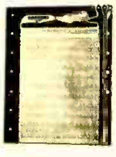
* 1000 vdc or peak ac maximum any range. † ±2 digits
** Test Voltage (Ohms) 1 vdc Full Scale - LM-300, 2 vdc Full Scale - LM-350
• LM-350 has 100% over-range - full scale readings are 1.999, 19.99, etc.

Tilt Stand Option, add $ 3.50
Leather Case $ 16.00
3AA NiCad Batts. & Charger $ 12.00

Standard AA-size batteries provide up to 20 hours of operation. Rechargeable NiCad batteries and charger unit available as optional equipment. *Batteries not included.

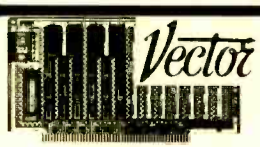
8803 MOTHER BOARD FOR S100 BUS MICRO-COMPUTERS — Vector

- Kit includes 12 tantalum capacitors for +5, +12, —12 buses and insulated mounting spacers
- Wiring side shown. Component side bare epoxy glass with white markings for component locations
- G10 epoxy glass board with 2 ounce copper, solder plated and .038 diameter holes for leads
- Solder mask with solder windows on etched circuits to avoid accidental short circuits
- Mounts 11 receptacles with 100 contacts (2 rows) on .125 centers with .250 row spacing. Vector part number R681-2, or mounts 10 receptacles plus interconnections to smaller mother board for expansion
- Includes etched circuits and instructions for option of active, pull up, or floating terminations
- Large buses: +5V and GND (10 AMPS), ± 12V or 16V (7 AMPS). Current ratings are per MIL-STD-275 with 10°C rise
- Fits in Vector pak enclosures
- Fits in IMSAI 8080 microcomputer as expander board



Price: $29.50

Vector Plugboards



8800V

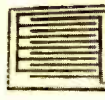
Universal Microcomputer/processor plugboard, use with S-100 bus. Complete with heat sink & hardware 5.3" x 10" x 1/16

1-4	5-9	10-24
$19.95	$17.95	$15.96

8801-1

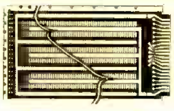
Same as 8800V except plain; less power buses & heat sink.

1-4	5-9	10-24
$14.95	$13.46	$11.96



3682 9.6" x 4.5" **$10.97**
3682-2 6.5" x 4.5" **$9.81**

Hi-Density Dual-In-Line Plugboard for Wire Wrap with Power & Grd. Bus Epoxy Glass 1/16" 44 pin con. spaced .156



3677 9.6" x 4.5" **$10.90**
3677-2 6.5" x 4.5" **$9.74**

Gen. Purpose D.I.P. Boards with Bus Pattern for Solder or Wire Wrap. Epoxy Glass 1/16" 44 pin con. spaced .156

3662 6.5" x 4.5" **$7.65**
3662-2 9.6" x 4.5" **$11.45**

P pattern plugboards for IC's Epoxy Glass 1/16" 44 pin con. spaced .156

R644 P.C. recepticle 22/44 cont .156 ctrs. pierced solder eyelets tails gold $3.45
R644-3 P.C. recepticle 22/44 cont .156 ctrs. Wire Wrap tails gold $4.49

S-100 Bus P.C. Edge Connectors

R681 DIP solder tails on .140 spaced rows for ALTAIR mother boards. Fits .042" dia. holes, gold $7.35
R681-1 .025" sq., 3 wrap lengths posts (.62 long) on .250 spaced rows, gold $5.00
R681-2 .025" sq., 1 wrap length posts (.22 long) on .250 spaced rows for wrapping or DIP solder for IMSAI mother boards, gold $5.85
R681-3 pierced solder eyelet tails, gold $7.35

1/16 Vector BOARD

.042 dia holes on 0.1 spacing for IC's

Phenolic

PART NO.	SIZE	PRICE
64P44-062XXP	4.5 x 6.5"	$ 1.49
169P44-062XXP	4.5 x 17"	$ 3.51

Epoxy Glass

PART NO.	SIZE	PRICE
64P44-062	4.5 x 6.5"	$ 1.70
84P44-062	4.5 x 8.5"	$ 2.10
169P44-062	4.5 x 17"	$ 4.30
169P84-062	8.5 x 17"	$ 6.39

SLIT-N-WRAP

Wraps insulated wire on .025" square posts
FOUR TIMES FASTER
than regular manual wrap post tools

P180 with two 100' spools of 28 ga wire **$24.50**

P160-4T includes charger, wire **$75.00**

Vector

NO PRE-STRIPPING*
NO PRE-CUTTING*
SPOOL-FED WIRE*

*The spooled wire passes through the tool past a slitting edge next to the wrap post. A narrow longitudinal cut is made in the insulation where it presses the square post corner. The bared copper is indented by the sharp edge (7 turns = 28 contacts).
Insulation is slit where wrapped but not between terminal posts when fed straight out of the tool.

"Daisy chain" runs. Reliable and easy to use. Manual or power operation.

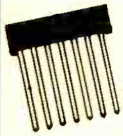
SLIT-N-WRAP WIRE $2^{75} Package
NO. 28 GAGE INSULATED WIRE, 100' SPOOLS
W28-2-A Pkg. 3 Green W28-2-C Pkg. 3 Clear
W28-2-B Pkg. 3 Red W28-2-D Pkg. 3 Blue

2708 8K 450 ns EPROM FACTORY PRIME

1-9	$12.00
10-24	$11.50

25 + Call for Price

14 & 16 PIN 3 LEVEL WIRE WRAP SOCKETS



14-T3 100 for $30.00
16-T3 100 for $30.00
50 of ea. for $32.00

ACE • All-Circuit Evaluator — for fast, solderless, plug-in circuit building and testing

Model 236

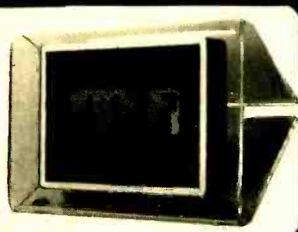
Just plug in any components with leads to .032" dia. Interconnect with solid wire up to 20 ga. Assembled models too!

ACE Model No.	Tie Points	DIP Capacity	No. Buses	No. Posts	Board Size (Inches)	Price Each
200-K (kit)	728	8 (16's)	2	2	4-9/16 x 5-9/16	$18.95
208 (assem.)	872	8 (16's)	8	2	4-9/16 x 5-9/16	28.95
201-K (kit)	1032	12 (14's)	2	2	16 x 7	24.95
212 (assem.)	1224	12 (14's)	8	2	4-9/16 x 7	34.95
218 (assem.)	1760	18 (14's)	10	2	6-1/2 x 7-1/8	46.95
227 (assem.)	2712	27 (14's)	28	4	8 x 9-1/4	59.95
236 (assem.)	3648	36 (14's)	36	4	10-1/4 x 9-1/4	79.95

SALE

LIQUID CRYSTAL DIGITAL CLOCK-CALENDAR

- For Auto, Home, Office
- Small in size (2x2½x½)
- Push button for seconds release for date.
- Clocks mount anywhere with either 3M double-sided tape or VELCRO. Included.
- 2 MODELS AVAILABLE:
  LCD-101, portable model runs on self-contained batteries for better than a year.
  LCD-102, runs on 12 Volt system and is back-lighted.
- LCD-101 or LCD-102 your choice **$34.95 ea.**
- Clear desk stand for **$2.00**



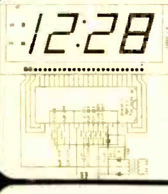
3 LEVEL GOLD WIRE WRAP SOCKETS

	1-24	25-49	50-99
8 pin	.47	.42	.37
10 pin	.45	.41	.37
14 pin	.39	.38	.37
16 pin	.43	.42	.40
18 pin	.75	.68	.62
22 pin	1.00	.97	.95
24 pin	1.00	.94	.75
28 pin	1.09	.98	.84
36 pin	1.59	1.45	1.30
40 pin	1.49	1.39	1.29

Vector MICRO-KLIP

for .042 dia. holes (all boards on this page)
T42-1 pkg. 100 .... $ 1.50
T42-1 pkg. 1000 .... $11.00
P-149 hand installing tool .... $ 2.03

.8" LED ALARM CLOCK



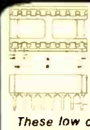
12 hr. LED Alarm Clock uses 3½ digit .8" LED Display with AM/PM indicators and colons. Direct drive. PIN to PIN interface with S1998A I.C. Just add switches, AC Supply, Alarm, Display and I.C. only.

$7.95 or 2/$15.00

Price Breakthrough! $17^{95} MA1003 CAR CLOCK

Bright Green Fluorescent Display Crystal Time Base Assembled, just add switches and 12 VDC.

SPECIAL



14CS2 100 for $14^{00}
16CS2 100 for $16^{00}
14 pin CS2 10 for $2^{00}
16 pin CS2 8 for $2^{00}

These low cost DIP sockets will accept both standard width plugs and chips.
For use with chips, the sockets offer a low profile height of only .125" above the board. These sockets are end stackable.

WRAP POST

for .042 dia. holes (all boards on this page)
T-44 pkg. 100 .... $ 2.28
T-44 pkg. 1000 .... $14.00
A-13 hand installing tool .... $ 2.80

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OEM and Institutional inquiries invited

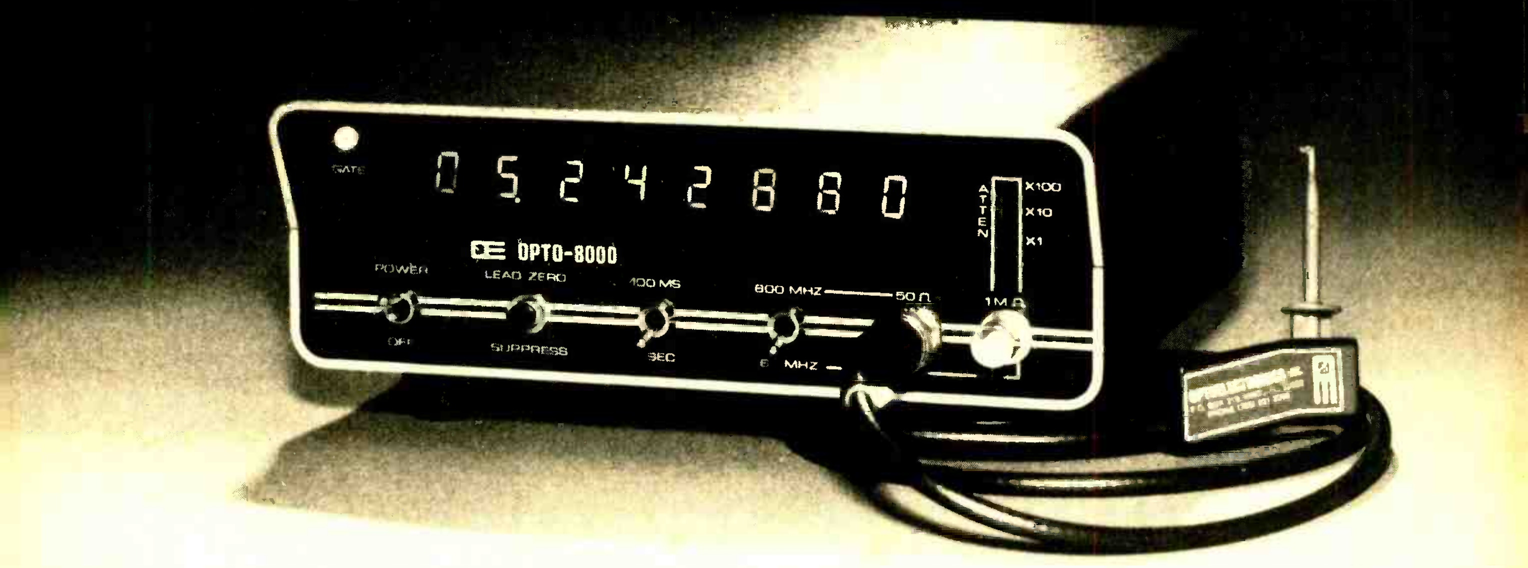
24 PIN DIP PLUGS WITH COVERS

3 / $1.00
40 / $10.00

CIRCLE 2 ON FREE INFORMATION CARD

600 MHZ. FREQUENCY COUNTER
±0.1 PPM TCXO

OPTO-8000.1



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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5821 NE 14 Avenue
Ft. Lauderdale, FL 33334
Phones: (305) 771-2050 771-2051
Phone orders accepted 6 days, until 7 p.m.

SPECIFICATIONS:
Time Base—TCXO ±0.1 PPM GUARANTEED!
Frequency Range—10 Hz to 600 MHz
Resolution—1 Hz to 60 MHz; 10 Hz to 600 MHz
Decimal Point—Automatic
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**

ACCESSORIES:

Battery-Pack Option—Internal Ni-Cad Batteries and charging unit	**$19.95**
Probes: P-100—DC Probe, may also be used with scope	**$13.95**
P-101—LO-Pass Probe, very useful at audio frequencies	**$16.95**
P-102—High Impedence Probe, ideal general purpose usage	**$16.95**
VHF RF Pick-Up Antenna-Rubber Duck w/BNC #Duck-4H	**$12.50**
Right Angle BNC adapter #RA-BNC	**$ 2.95**

FC-50 — Opto-8000 Conversion Kits:
Owners of FC-50 counters with #PSL-650 Prescaler can use this kit to convert their units to the Opto-8000 style case, including most of the features.

FC-50 — Opto-8000	**Kit $59.95**
*FC-50 — Opto-8000F	**Factory Update $99.95**
FC-50 — Opto-8000.1 (w/TCXO)	**Kit $109.95**
*FC-50 — Opto-8000.1F	**Factory Update $149.95**

*Units returned for factory update must be completely assembled and operational

master charge
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TERMS: Orders to U.S. and Canada, add 5% to maximum of $10.00 per order for shipping, handling and insurance. To all other countries, add 10% of total order. Florida residents add 4% state tax. C.O.D. fee: $1.00. Personal checks must clear before merchandise is shipped.

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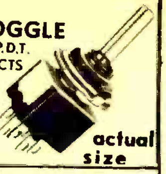
MINI MINI TOGGLE

EXTRA SMALL D.P.D.T.
3A 125VAC CONTACTS
each $1.50
8 – 10.
100 – $105.



actual size

ACTUAL SIZE

$1.35 10·$12

C & K #7103
Single pole double throw center off (3 position) toggle switch..........

LOOK new

RCA 40374
250V - 2A NPN TO66

POWER TRANSISTOR MOUNTED ON A FACTORY ASSEMBLED HEAT SINK – 5.8 WATTS @ AMBIENT OF 25C

$.75 ea. 10 for $6

1/8 WATT RESISTORS

10 ea. - 390, 1.8k, 3.9k, 6.8k, 11k 43k, 68k, 240k - 5 percent tol.

80 FOR $4

BISTABLE RELAY

SPDT 6VDC 200 OHM COILS
1 AMP 20 WATT DC CONTACTS
LONG LIFE (1 X 10^9) OPER.
HIGH SPEED (500 HZ)
HERMETICALLY SEALED 3/8X3/8X3/4"

$2.95 ea.

2A, 50V bridge 39¢ ea

ultra sensitive relay

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

$2.95 ea.

ELEC-TROL REED RELAY

12 vdc
440 Ω coil
dpst
n.o.

.3 1.1" .4

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

$1.75 ea. - ten $15

-SUPER SPECIALS-

DIAC 27 TRIGGER DIODE . . .	.20
PULSE XFMR. 1/1 TOROID-ENCASED	.25
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SP425 SPERRY 9 digit 1/4" HV multiplexed 7 seg.	1.25
MM5369 time base osc. chip	1.75
T.V. crystal for above.....	1.75
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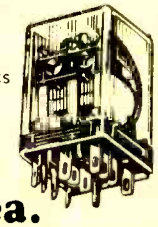
93410 256 x 1 45NS RAM . . .	.85
75451 peripheral driver . .	.40
7402 TTL nor gate	.16
7430 TTL nand gate	.14
CERAMIC FILTER 10.7 MHz. . .	1.20
MM5058 1024 bit static SR . .	1.50
UA715 60MHz. op-amp	1.20
74S206 256 x 1 45NS RAM . . .	.90
78L2.6 2.6V TO92 .1A +regul.	.29
78L05 5.0V " " "	.29
78L6.2 6.2V " " "	.29
78L12 12V " " "	.29
78L15 15V " " "	.29
78M05 5V tab .5A + regul.	.59
78MG 4 term. adj. .5A + reg.	1.29
79MG " " " " - reg.	1.39
7805T tab 1A 5v regul	.89
7812 to-3 1A +12V regul.	.59

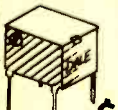
POTTER BRUMFIELD

Type KHP Relay
4 PDT 3A Contacts
24VDC COIL
650 ohms
120VAC
10.5MA



$1.60 ea.

DIP TRIMMER



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5K or 200K only
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$.50 TEN FOR $4

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DM8880 IC DRIVER FOR "NIXIE" ABOVE DISPLAYS 0123456789AbCdEF WITH 0-15 BINARY INPUT.............

DISPLAY or IC $1.50 BOTH $2.75

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FACTORY ASSEMBLED ON HEAT SINK READY TO PUT IN YOUR CIRCUIT BD.

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WIREWRAP

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Why buy wire on rolls?

PRECUT & STRIPPED WIRE IS:

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100 pcs of 3" at $.82 = 3 1/4¢/ft.	50 ft. roll at $1.99 = 4¢/ft.
100 pcs of 6" at 1.06 = 2¢/ft.	100 ft. roll at 2.95 = 3¢/ft.
Wire Kit 1 at $6.95 = 2 1/3¢/ft.	

#30 Kynar stripped 1" on each end. Lengths are overall
Colors Red, Blue, Green, Yellow, Black, Orange, White
Wire packaged in plastic bags. Add 25¢/length for tubes.

	100	500	1000	5000
2 1/2 in.	.78	2.40	4.30/K	3.89/K
3 in.	.82	2.60	4.71/K	4.22/K
3 1/2 in.	.86	2.80	5.12/K	4.55/K
4 in.	.90	3.00	5.52/K	4.88/K
4 1/2 in.	.94	3.21	5.93/K	5.21/K
5 in.	.98	3.42	6.34/K	5.52/K
5 1/2 in.	1.02	3.65	6.75/K	5.86/K
6 in.	1.06	3.85	7.16/K	6.19/K
6 1/2 in.	1.15	4.05	7.57/K	6.52/K
7 in.	1.20	4.25	7.98/K	6.85/K
7 1/2 in.	1.25	4.45	8.39/K	7.18/K
8 in.	1.29	4.65	8.80/K	7.53/K
8 1/2 in.	1.32	4.85	9.21/K	7.84/K
9 in.	1.36	5.05	9.62/K	8.17/K
9 1/2 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

WIRE WRAP SOCKETS

	1-9	10-24	25-99	100-249	250-999	1K-5K
8 pin*	.41	.38	.35	.31	.29	.27
14 pin*	.42	.39	.36	.32	.29	.27
16 pin*	.46	.43	.39	.35	.32	.30
18 pin*	.63	.58	.54	.47	.44	.41
20 pin	.84	.78	.71	.63	.59	.54
22 pin*	1.30	1.20	1.10	.95	.90	.84
24 pin	.91	.84	.78	.68	.64	.59
28 pin	1.25	1.15	1.08	.95	.89	.82
40 pin	1.65	1.55	1.42	1.25	1.15	1.09

Gold 3-level Closed Entry Sockets
End & Side Stackable All prices include gold
Tin sockets and 2-level sockets available

WIRE WRAP TOOLS

$34.95

HOBBY WRAP
Model BW 630
With Free Wire Kit 1
($6.95 Value)

Batteries & Charger	$11.00
WSU 30 Hand Wrap-Unwrap Strip Tool	5.95
WSU 30M, for Modified Wrap	6.95
BT 30 Extra Bit	2.95

WIRE KITS

#1	$6.95			#2	$19.95				
250	3"	100	4 1/2"	250	2 1/2"	250	4 1/2"	250	6"
250	3 1/2"	100	5"	500	3"	250	5"	100	6 1/2"
100	4"	100	6"	500	3 1/2"	100	5 1/2"	100	7"
				500	4"	1 250 ft. Roll Bulk			

Choose One Color or Assortment

INTERCONNECT CABLES

Ribbon cable connectors for connecting boards to front panels, or board to board.

	SINGLE ENDED			DOUBLE ENDED		
	14 pin	16 pin	24 pin	14 pin	16 pin	24 pin
6"	1.24	1.34	2.05	2.24	2.45	3.37
12"	1.33	1.44	2.24	2.33	2.55	3.92
24"	1.52	1.65	2.63	2.52	2.76	4.31
48"	1.91	2.06	3.40	2.91	3.17	5.08

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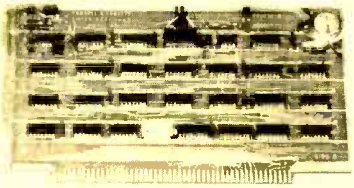
Why Wait?



The Tarbell Cassette Interface

- Plugs directly into your IMSAI or ALTAIR*
- Fastest transfer rate: 187 (standard) to 540 bytes/second
- Extremely Reliable — Phase encoded (self-clocking)
- 4 Extra Status Lines, 4 Extra Control Lines
- 37-page manual included
- Device Code Selectable by DIP-switch
- Capable of Generating Kansas City tapes also
- No modification required on audio cassette recorder
- Complete kit $120, Assembled $175, Manual $4

TARBELL ELECTRONICS

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California residents please add 6% sales tax
*ALTAIR is a trademark/tradename of MITS, INC.

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VARIABLE POWER SUPPLY KIT NO. 1 ONLY $10.95

- Continuously variable from 5V to 20V
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- Kit includes all components
- Drilled fiberglass P.C. Board
- Case Included
- 4400 Mfd of filtering
- One hour assembly

VARIABLE POWER SUPPLY KIT NO. 2

Same as above but with a 1 Amp output, also with case
ONLY $13.95

This model will power a 5 watt transistorized CB Radio

LOOK AT THIS SPECIAL FROM RADIO HUT

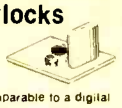
- Power Supply Kit: 5V1 amp reg.
- Line regulation .005%
- Load regulation 50mV

Kit includes components. PC board, transformer, fuse and pilot light. Line cord not included.

Only $6.50

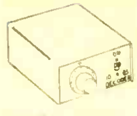
60 Hz. Crystal Time Base for Digital Clocks

$4.50 Buy 2 for $8.



A 60 Hz output with accuracy comparable to a digital watch
B Directly interfaces with all MOS clock chips.
C Super low power consumption (1.5 ma type.)
D Uses latest MOS 17 stage divider IC
E Eliminates forever the problem of AC line glitches.
F Perfect for cars, boats, campers, or even for portable clocks at ham field days
G Small size, can be used in existing enclosures.
KIT INCLUDES CRYSTAL, DIVIDER IC, P.C. BOARD PLUS ALL NECESSARY PARTS & SPECS.

UNSCRAMBLER $19.95



Plugs into earphone of external speaker of any Scanner or Monitor. Guaranteed to unscramble any 1085 call.

- Easily tuned
- Full instruction included
- Drilled fiberglass P.C. Board
- One Hour Assembly
- Punched Case

7400 TTL DIGITAL CIRCUITS

7400	.11	7430	.13	7480	.31	74153	61
7401	.13	7432	.23	7481	.55	74154	.98
7402	.13	7433	.26	7482	.57	74155	.89
7403	.13	7437	.23	7483	67	74156	.89
7404	15	7438	.23	7485	.89	74157	.55
74L04	29	7440	.13	7489	1.25	74160	.55
74S04	.44	7441	.76	7490	65	74161	.65
7405	.13	7442	.47	7491	.61	74163	.65
7406	16	7443	.59	7492	.43	74164	.85
7407	16	7444	.59	7493	.43	74165	.89
7408	19	7446	.68	7494	.67	74174	.85
7409	19	7447	.68	7495	.67	74175	.85
7410	13	7448	.71	7496	.67	74180	.67
7411	18	7450	.13	74100	.30	74181	1 93
7412	.26	7451	.13	74104	.49	74182	68
7413	.37	7453	.13	74107	.28	74191	.98
7416	15	7454	13	74109	.31	74192	.79
7420	.13	7460	19	74121	.29	74193	.81
7421	.13	7470	.27	74123	.48	74194	.81
7423	.25	7472	.25	74132	.99	74195	.69
7425	.29	7473	.29	74136	.99	9316	.85
7426	.24	7474	.29	745138	1 95	9601	3/$1
7427	.19	7475	.47	74141	.75	9L04	.35
7428	.26	7476	.31	74151	.61		

74LS00 LOW POWER SCHOTTKY

74LS00	.21	74LS47	.73	74LS136	.37	74LS258	71
74LS02	.21	74LS51	.26	74LS138	.71	74LS260	.26
74LS03	.21	74LS54	.26	74LS139	.71	74LS266	.26
74LS04	.28	74LS55	.26	74LS145	1.00	74LS279	.55
74LS05	28	74LS73	35	74LS151	.70	74LS290	.75
74LS08	.21	74LS74	.35	74LS153	.70	74LS293	.61
74LS09	.28	74LS76	.49	74LS155	.69	74LS295	.95
74LS10	.21	74LS83	.73	74LS156	.70	74LS298	.95
74LS11	.21	74LS85	1.35	74LS157	.75	74LS365	55
74LS13	.45	74LS86	.36	74LS158	.71	74LS366	.55
74LS14	99	74LS90	.55	74LS160	.85	74LS367	.55
74LS15	.26	74LS92	.55	74LS161	.85	74LS368	.55
74LS20	24	74LS93	.55	74LS162	.85	74LS390	1.75
74LS21	.28	74LS109	.38	74LS163	.85	74LS393	1.45
74LS22	.28	74LS112	.38	74LS164	1.49	74LS670	2.30
74LS26	.32	74LS113	.38	74LS168	.85	74LS192	95
74LS27	.32	74LS114	38	74LS169	.85	74LS193	95
74LS30	.26	74LS122	.49	74LS170	1.69	74LS194	95
74LS32	.32	74LS124	.99	74LS173	1.10	74LS195	.85
74LS37	.32	74LS125	.47	74LS174	1 00	74LS196	.85
74LS38	32	74LS126	.47	74LS175	.81	74LS197	.85
74LS40	.26	74LS132	.79	74LS190	.95	74LS251	.85
74LS42	.65	74LS133	.35	74LS191	.95	74LS253	.81
						74LS257	.71

74H SERIES TTL

74H00	.18	74H21	.29	74H53	.29	74H73	.39
74H05	.29	74H40	.29	74H61	.25	74H74	.39
74H20	.29	74H50	.20	74H72	.45		

CMOS

CD400	.19	CD4017	.95	CD4040	1.00	CD4071	19
CD4001	.19	CD4018	95	CD4041	.69	CD4081	19
CD4002	.19	CD4019	.19	CD4042	.69	CD4507	.35
CD4006	1.20	CD4020	97	CD4043	.60	CD4508	2.80
CD4007	19	CD4021	97	CD4044	60	CD4510	1.00
CD4009	.47	CD4022	.97	CD4046	1 39	CD4512	1.10
CD4010	.39	CD4023	.19	CD4047	1.50	CD4516	79
CD4011	19	CD4024	.75	CD4049	.35	CD4518	1.10
CD4012	29	CD4025	19	CD4050	.39	CD4520	.69
CD4013	32	CD4027	.39	CD4051	1 19	CD4528	.85
CD4014	.78	CD4028	.85	CD4053	1.19	74C02	.45
CD4015	78	CD4029	.99	CD4056	1.15	74C04	.32
CD4016	32	CD4030	.35	CD4066	.78	74C107	79

TTL SPECIAL!

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9003/7410	10/1 00
9004/7420	10/1.00
9006/7460	6/1.00
9007/7430	10/1.00
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9024/74109	3/1.00
9300/74195	3/1.00

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934 Dual 5 Input NAND Gate	10/$1
941 One Shot Multivibrator	5/$1
945 JK F/F	8/$1
946 Quad 11 Input Gate NAND/NOR	8/$1
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950 F/F	10/$1
951 One Shot Multivibrator	5/$1
1800 (see 934 above)	10/$1
1806 Quad 2 Input NAND Gate	10/$1
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9094 Dual JK F/F	8/$1
9097 Dual JK F/F	8/$1
9099 Dual JK F/F	8/$1
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9110 Hex Inverter	7/$1
9112 Hex Inverter	7/$1
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9949 Quad 2 Input NAND	8/$1
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302	Quad 2 Input Buffer open collector	.18
303	Quad 2 Input NAND Buffer	.15
311	Master Slave F/F	.18
312	Dual JK Flip Flop	.18
321	Quad 2 Input NAND Gate	.18
322	Dual 5 Input NAND Gate	.15
323	Quad 2 Input NAND Gate	.18
324	Quad 2 Input NAND Gate	.18
325	Dual 2 Dual 3 Input NAND Gate	.13
326	Dual 2 Dual 3 Input NAND Gate	.13
331	Dual 5 Input Expander	.13
332	Hex Inverter	.18
333	Hex Inverter	.18
334	Hex Inverter	.18
335	Hex Inverter	.18
342	Dual One Shot Multivibrator	.25
343	Dual 4 Bit Comparator	.22
370	Quad D Flip Flop	.22
371	Decode Counter	.30
372	Quad Ripple Counter	39
380	BCE to Decimal Decoder	.39
381	BCD to Decimal Decoder	.39

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ITT 501 Quad Seg. Dr.	.35
ITT 502 Hex Digit Dr.	.49
ITT 503 Quad Seg. Dr.	.49
ITT 506 Hex Digit Dr	49
ITT 508 8 Digit Dr.	.49
ITT 509 8 Seg Dr	.49
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ITT 514 8 Digit Dr	.59

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10 Amp	50V	1.25
25 Amp	50V	1.39

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14 Pin Low Profile	22
16 Pin Low Profile	25
18 Pin Low Profile	30
28 Pin Low Profile	69
40 Pin Low profile	89

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7404	10/1 00	7438	6/1.00
7408	10/1 00	74141	3/1 00
7420	10/1 00	74153	3/1.00

Please specify that you are ordering House Number TTL

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100 PFd	100V	.001 Fd	
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330 PFd	50V	.02 MFd	200V
001 UFd	500V	3 3 PF	500V
.0015 UFd	500V	4 7 PF	500V
005 UFd	500V	8.2 PF	500V
		100 PF	500V

PC Leads 25/89 cents No Mix

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UL923	JK FLIP FLOP	$1 19

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7812 Pos	12V 1 Amp	.99	7912 Neg.	12V 1 Amp	1 10
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IN5339	5.6	IN5348	11	IN5357	20
IN5340	6.0	IN5349	12	IN5358	22
IN5341	6.2	IN5350	13	IN5359	24
IN5342	6.8	IN5351	14	IN5360	25
IN5343	7.5	IN5352	15	IN5361	27
IN5344	8.2	IN5353	16	IN5362	28
IN5345	8.7	IN5354	17	IN5363	30
IN5346	9.1	IN5355	18	IN5364	33

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74S04	.12	DM8880	.50
7432	.10	uA709	.19
7442	.25	LM301	.18
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NE-2 NEON BULB .08

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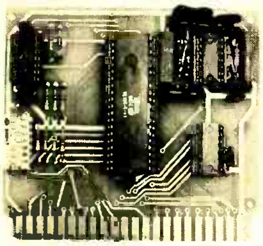


UART & BAUD RATE GENERATOR

Part no. 101

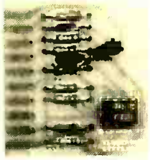
- Converts serial to parallel and parallel to serial
- Low cost on board baud rate generator
- Baud rates: 110, 150, 300, 600, 1200, and 2400
- Low power drain +5 volts and -12 volts required
- TTL compatible
- All characters contain a start bit, 5 to 8 data bits, 1 or 2 stop bits, and either odd or even parity.
- All connections go to a 44 pin gold plated edge connector
- Board only $12.00; with parts $35.00

8K STATIC RAM

Part no. 300

- 8K Altair bus memory
- Uses 2102 Static memory chips
- Memory protect
- Gold contacts
- Wait states
- On board regulator
- S-100 bus compatible
- Vector input option
- TRI state buffered
- Board only $22.50; with parts $160.00

RS-232/TTL INTERFACE



Part no. 232

- Converts TTL to RS-232, and converts RS-232 to TTL
- Two separate circuits
- Requires -12 and +12 volts
- All connections go to a 10 pin gold plated edge connector
- Board only $4.50; with parts $7.00

DC POWER SUPPLY

Part no. 6085

- Board supplies a regulated +5 volts at 3 amps., +12,-12, and -5 volts at 1 amp.
- Board has filters, rectifiers, and regulators
- Power required is 8 volts AC at 3 amps., and 24 volts AC C.T. at 1.5 amps.
- Board only $12.50

TIDMA

Part no. 112

- Tape Interface Direct Memory Access
- Record and play programs without bootstrap loader (no prom) has FSK encoder/decoder for direct connections to low cost recorder at 625 baud rate, and direct connections for inputs and outputs to a digital recorder at any baud rate.
- S-100 bus compatible
- Comes assembled and tested for $160.00

TAPE INTERFACE Part no. 111

- Play and record Kansas City Standard tapes
- Converts a low cost tape recorder to a digital recorder
- Works up to 1200 baud
- Digital in and out are TTL-serial
- Output of board connects to mic. in of recorder
- Earphone of recorder connects to input on board
- Requires +5 volts, low power drain
- Board $7.60; with parts $27.50
- No coils

Part no. 107

RF MODULATOR

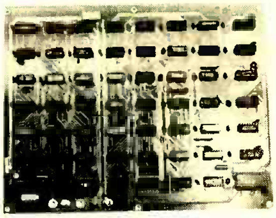
- Converts video to AM modulated RF, Channels 2 or 3
- Power required is 12 volts AC C.T., or +5 volts DC
- Board $4.50; with parts $13.50

APPLE I MOTHER BOARD

Part no. 102

- 10 slots – 44 pin (.156) connectors spaced ¾" apart
- Connects to edge connector of computer
- Pin 20 and 22 connects to X & Z for power and ground
- Board has provisions for by-pass capacitors
- Board cost $15.00

TELEVISION TYPEWRITER



Part no. 106

- Stand alone TVT
- 32 char/line, 16 lines, modifications for 64 char/line included
- Parallel ASCII (TTL) input
- Video output
- 1K on board memory
- Output for computer controlled curser
- Auto scroll
- Non-distructive curser
- Curser inputs: up, down, left, right, home, EOL, EOS
- Scroll up, down
- Requires +5 volts at 1.5 amps, and -12 volts at 30 mA
- Board only $39.00; with parts $145.00

MODEM

Part no. 109

- Type 103
- Full or half duplex
- Works up to 300 baud
- Originate or Answer
- No coils, only low cost components
- TTL input and output-serial
- Connect 8 ohm speaker and crystal mic. directly to board
- Uses XR FSK demodulator
- Requires +5 volts
- Board $7.60; with parts $27.50

To Order:

VISA master charge

Mention part number and description. For parts kits add "A" to part number. Shipping paid for orders accompanied by check, money order, or Master Charge, BankAmericard, or VISA number, expiration date and signature. Shipping charges added to C.O.D. orders. California residents add 6.5% for tax. Parts kits include sockets for all ICs, components, and circuit board. Documentation is included with all products. Dealer inquiries invited. 24 Hour Order Line: (408) 374-5984. E21

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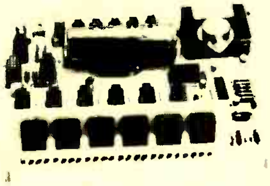
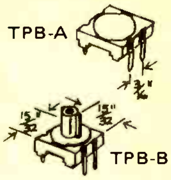
- Easy to Operate—No switches to flip
- Tin Plated & Screened Board—For easy assembly



COMPARE and SAVE!
$54.95
KIT # T-250-30A

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

P.C. MOUNT PUSH BUTTON SWITCHES



45¢ ea.
10/$4.00

PUT YOUR HAM GEAR OR CB IN YOUR HOUSE WITH THIS SPECIALLY DESIGNED POWER SUPPLY KIT!

A lot of companies offered you this kind of power supply with very poor quality. Either the ripple is too high or the output voltage is not stable. Some of them even made their power supply with a zener diode and a resistor! Nobody has ever considered the safety of your equipment. With our kit, you can be sure of high quality and your equipment is protected against any failure of your power supply by a built in OVP circuit.

KIT INCLUDES: Transformer, PC Board, Large heat sink, Large filtering capacitor and all the parts with detailed instruction.

Features:
- Output Voltage = 13.5V
- Output Current = 3.5A Min.
- Load Regulation = 0.01%
- Line Regulation = 0.02%
- Internal Current Limiting
- Over-voltage Protected

ONLY $16.95
KIT # T-700

WOW! LOOK AT THIS!

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 **$11.95**

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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
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D. Detailed Instructions

THIS IS A BIG ONE!
$19.50

MINIATURE SLIDE SWITCH

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10 for $1.75
100 for $15.00

PUSH BUTTON SWITCH

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

60 Hz Time Base IC

MM5369
$1.95

WIRE-WRAP TOOLS from OK

Hobby Wrap - 30 $5.45
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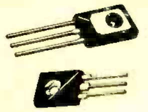
POWER TRANSISTORS



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MOTOROLA MJE2955 PNP
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$2.25 PER PAIR

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1MHz	$4.50
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INTER–COM BOARD

Fully assembled.
Works on 9~15V D.C.
2 speakers make it work.
With Schematic
ONLY $3.00

TANTALUM CAPACITORS

1µ 35V	.15
1µ 10V	.15
3.3µ 35V	.20
10µ 50V	.35
22µ 35V	.25

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AM/FM CASSETTE TAPE RECORDER with AC/DC POWER and ON/OFF MONITOR SWITCH**

NEW!

- ☐ On/Off Monitor Switch
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Reg. $54.95
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**M8000
AM/FM 8-TRACK TAPE PLAYER**

- ☐ Jumbo Size with Durable Shoulder Strap
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- ☐ 2000mW Amplifier
- ☐ Automatic or Manual Program Change
- ☐ AM/FM Radio

Reg. $44.95
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Please add $3.00 for postage and handling.

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Commercial Single Turn 2K 3305P
$1.25 ea. 10/$10.00
Cermet Mil. Spec. Multi-Turn 1K & 2K RJ24CX
$3.00 ea. 10/$25.00

COMPUTER GRADE CAPACITORS

6,000 µF	75V	4.50
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27,000 µF	50V	4.50
30,000 µF	15V	3.50
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100,000 µF	5V	2.00

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SOCKET JUMPERS

Mates with two rows of .025" sq. or dia. posts on patterns of .100" centers and shielded receptacles. Probe access holes in back. Choice of 6" or 18" length.

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924003-06R	26	6"	4.78 ea.
924005-18R	40	18"	8.27 ea.
924005-06R	40	6"	7.33 ea.
924006-18R	50	18"	10.31 ea.
924006-06R	50	6"	9.15 ea.

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Solder to PC boards for instant plug-in access via socket-connector jumpers. .025" sq. posts. Choice of straight or right angle.

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923865-R	40	straight	1.94 ea.
923875-R	40	right angle	2.30 ea.
923866-R	50	straight	2.36 ea.
923876-R	50	right angle	2.82 ea.

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Part No.: 922576-26 No. of contacts: 26 Price $6.90 ea.

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25 PIN-D SUBMINATURE (RS232)

DB25P	PLUG	$3.25
DB25S	SOCKET	$4.95
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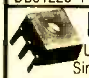
LOTS OF POTS



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1/4" mounting holes

				1-9	10+
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	JMT123	SPDT	on-none-on	1.65	1.21
	JMT221	DPDT	on-off-on	2.55	1.87
	JMT223	DPDT	on-none-on	2.15	1.58
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	MPC123	SPDT	on-none-on	1.75	1.31
	MPC221	DPDT	on-off-on	2.65	1.97
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	PB126	SPDT	momentary	1.95	1.47
PUSH BUTTON Minature	MS102	DPST	momentary open	.35	.30
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DIPSWITCH SPST	206-4	8 pin dip	4 switch	1.75	1.65
	206-7	14 pin dip	7 switch	1.95	1.85
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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 GLASS	64P44 062WE	4.50	6.50	2.07	1.86
	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

INSTRUMENT/ CLOCK CASE

Injection molded unit.
Complete with red bezel.
4½" x 4" x 1-9/16".

$3.49

MICROPROCESSOR COMPONENTS

8080A	CPU	$10.95
8212	8 Bit Input/Output	4.95
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MC6800	8 Bit MPU	19.95
MC6810AP1	128 x 8 Static RAM	5.95
MC6820	Periph. Interface Adapter	7.95
MC6830L8	1024 x 8 Bit ROM	14.95

CPU'S

8080A	Super 8008	$10.95
2650	8 Bit MPU	26.50
P8085	CPU	29.95

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2504	1024 Dynamic	$ 3.95
2518	Hex 32 BIT	4.95
2519	Hex 40 BIT	4.00
2522	Dual 132 Bit SSR	2.95
2524	512 Dynamic	.99
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2528	Dual 250 Bit Static	4.00
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2533	1024 Static	2.95
3341	Fifo	6.95
74LS670	16 x 4 Reg	1.95

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AY-5-1013	30K Baud	$ 5.95

ROM'S

2513(2140)	Char. Gen.-upper case	$ 9.95
2513(3021)	Char. Gen.-lower case	9.95
2516	Char. Gen.	10.95
MM5230	2048 BIT (512 x 4 on 256 x 8)	1.95

MM5262	2K x 1	Dynamic RAM	3 for 1.00

RAM'S

1101	256 x 1	Static	$ 1.49
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
TMS4044-45NL	4K	Static	14.95
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
21L02/91L02	1024 x 1	Static	1.95
74200	256 x 1	Static	6.95
93421	256 x 1	Static	2.95
MK4116(UPD416)	4K	Dynamic 16 Pin	5.95
MK4027(UPD414)	16K	Dynamic 16 Pin	29.95

PROMS

1702A	2048	Famos	$ 5.95
5203	2048	Famos	14.95
82S23	32 x 8	Open C	5.00
82S123	32 x 8	Tristate	5.00
74S287	1024	Static	7.95
3601	256 x 4	Fast	3.95
2708	8K	Eprom	10.95
2716 T.I.	16K	Eprom	29.95
2716 Intel	16K	Eprom	59.95
6301-1	1024	Tri-State Bipolar	3.49
6330-1	256	Open Collector Bipolar	2.95

SPECIAL REQUESTED ITEMS

FCM3817	$5.00	11C90	19.95	7205	19.95	9368	3.95
AY-3-8500-1	7.50	4N33	3.95	ICM7045	24.95	LD110/111	25.00/set
AY-5-9100	14.95	8T20	7.50	ICM7207	7.50	95H90	11.95
AY-5-9200	14.95	8T97	1.50	ICM7208	19.95	MC3061P	3.50
AY-5-9500	4.95	HD0165	7.95	ICM7209	7.50	MC4016 (74416)	7.50
AY-5-2376	14.95	MCM6571	13.50	MK50240	17.50	MC1408L7	4.95
9374	1.50	MCM6574	13.50	DS0026CH	3.75	MC1408L8	5.75
82S115	19.95	MCM6575	13.50	TIL308	10.50	74C922	9.95

CLOCK CHIPS

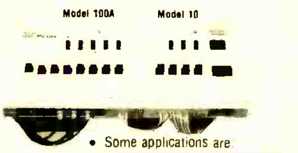
MM5309	$9.95
MM5311	4.95
MM5312	4.95
MM5314	4.95
MM5316	6.95
MM5318	9.95
MM5369	2.95
MM5841	9.95
CT7001	5.95

PARATRONICS

Featured on February's Front Cover of Popular Electronics

Logic Analyzer Kit Model 100A

$229.00/kit



Model 100A Model 10

- 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:

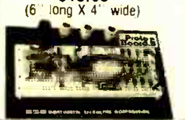
Mobile Charger Eliminator use power from car battery — Model 100 — CLA $3.95

Charger/Eliminator use 110 V AC — Model 100 — CAI $9.95

CONTINENTAL SPECIALTIES

PROTO BOARD 6

$15.95
(6" long X 4" wide)



Other CS Proto Boards

PB100 - 4.5" x 6"	$ 19.95
PB101 - 5.8" x 4.5"	29.95
PB102 - 7" x 4.5"	39.95
PB103 - 9" x 6"	59.95
PB104 - 9.5" x 8"	79.95
PB203 - 9.75 x 6½ x 2¾	80.00
PB203A - 9.75 x 6½ x 2¾ (includes power supply)	129.95

PROTO CLIPS

14 PIN	$4.50
16 PIN	4.75
24 PIN	8.50
40 PIN	13.75

DESIGN MATES

DM1 - Circuit Designer $69.95
DM2 - Function Generator $74.95
DM3 - RC Bridge $74.95

LOGIC MONITOR for DTL, HTL, TTL or CMOS Devices **$74.95**

CSC QT PROTO STRIPS

QT type	# holes	price
QT-59S	590	12.50
QT-59B	bus strip	2.50
QT-47S	470	10.00
QT-47B	bus strip	2.25
QT-35S	350	8.50
QT-35B	bus strip	2.00
QT-18S	180	4.75
QT-12S	120	3.75
QT-8S	80	3.25
QT-7S	70	3.00

Experimentor 300	$ 9.95
Experimentor 600	$10.95

The Incredible "Pennywhistle 103"

$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 deaf. In addition, it is free of critical adjustments and is built with non-precision, readily available parts.

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

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

The Original the 3rd Hand

$9.95 each

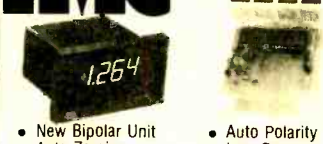
- Leaves two hands free for working
- Clamps on edge of bench, table or work bench
- Position board on angle or flat position for soldering or clipping
- Sturdy, aluminum construction for hobbyist, manufacturer or school rooms

DIGITAL STOPWATCH

- Bright 6 Digit LED Display
- Times to 59 minutes 59.59 seconds
- Crystal Controlled Time Base
- Three Stopwatches in One: Times Single Event — Split & Taylor
- Size 4.5 x 2.15 x .90 (4½ ounces)
- Uses 3 Penlite Cells

Kit —	$39.95
Assembled —	$49.95
Heavy Duty Carry Case	$5.95
Stop Watch Chip Only (7205)	$19.95

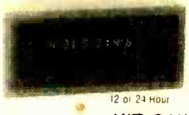
IMC 3½ DIGIT DPM KIT



- New Bipolar Unit
- Auto Zeroing
- .5" LED
- Auto Polarity
- Low Power
- Single IC Unit

Model KB500 DPM Kit	$49.00
Model KB503 5V Power Kit	$17.50

JE700 CLOCK



The JE700 is a low cost digital clock but is a very high quality unit. The unit features a simulated walnut case with dimensions of 6" x 2½" x 1". It utilizes a MAN72 high brightness readout, and the MM5314 clock chip.

12 or 24 Hour
115 VAC

KIT ONLY **$16.95**

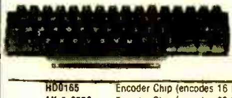
HEXADECIMAL ENCODER 19-KEY PAD

- 1 - 0
- ABCDEF
- Shift Key
- 2 Optional Keys

$10.95 each

New 63 KEY KEYBOARD

$29.95
IN STOCK



This keyboard features 63 unencoded SPST keys, unattached to any kind of P.C.B. A very solid molded plastic 13" x 4" base suits most applications.

HD0165	Encoder Chip (encodes 16 Keys)	$7.95 ea.
AY-5-2376	Encoder Chip (encodes 88 Keys)	$14.95 ea.

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**

$5.00 Minimum Order — U.S. Funds Only
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Spec Sheets - 25¢ — Send 35¢ Stamp for 1978 Catalog
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SN7413N	.40	SN7491N	.59	SN74176N	.79
SN7414N	.70	SN7492N	.43	SN74177N	.79
SN7416N	.25	SN7493N	.43	SN74179N	1.95
SN7417N	.25	SN7494N	.65	SN74180N	.79
SN7420N	.20	SN7495N	.65	SN74181N	1.95
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SN7430N	.20	SN74122N	.39	SN74192N	.79
SN7432N	.25	SN74123N	.49	SN74193N	.79
SN7437N	.25	SN74125N	.49	SN74194N	.89
SN7438N	.25	SN74126N	.49	SN74195N	.69
SN7439N	.25	SN74132N	.75	SN74196N	.89
SN7440N	.20	SN74136N	.75	SN74197N	.89
SN7441N	.89	SN74141N	.79	SN74198N	1.49
SN7442N	.49	SN74142N	2.95	SN74199N	1.49
SN7443N	.75	SN74143N	2.95	SN74200N	5.59
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20% Discount for 100 Combined 7400's

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LM320T-5.2	1.25	NE555V	.39	LM3900N(3401)	.49
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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
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74LS00 TTL

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74LS02	.23			74LS157	.69
74LS03	.23	74LS74	.35	74LS160	.89
74LS04	.29	74LS75	.49	74LS161	.89
74LS05	.29	74LS76	.35	74LS162	.89
74LS08	.23	74LS83	.75	74LS163	.89
74LS10	.23	74LS85	.99	74LS164	.99
74LS13	.49	74LS86	.35	74LS175	.79
74LS14	.99	74LS90	.49	74LS181	2.49
74LS20	.23	74LS92	.59	74LS190	.89
74LS26	.29	74LS93	.59	74LS191	.89
74LS27	.29	74LS95	.79	74LS192	.89
74LS28	.29	74LS96	.89	74LS193	.89
74LS30	.23	74LS107	.35	74LS194	.89
74LS32	.29	74LS109	.35	74LS195	.89
74LS40	.29	74LS112	.35	74LS253	.79
74LS42	.69	74LS123	.99	74LS257	.69
74LS47	.69	74LS132	.79	74LS260	.55
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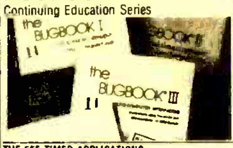

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Starts at basic structure of CMOS devices through integration into MSI.

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8080 interpretive debugger. A program for entering, debugging and storing assembly language programs.

COMPLETE MANUAL FOR DIGITAL CLOCKS by John Weiss and John Brooks — $3.95
Familiarizes technician or hobbyist with basic theories behind digital clocks. Includes trouble shooting guides, basic characteristics of clocks, soldering techniques, clock component data sheets and construction tips.

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XC209	Yellow	4/$1	XC22	Orange	4/$1	XC526	Yellow	4/$1
			SSL-22	RT	4/$1	XC526	Clear	4/$1

.190" dia.			.200" dia.		
XC111	Red	10/$1	XC556	Red	5/$1
XC111	Green	4/$1	XC556	Red	100/$8
XC111	Yellow	4/$1	XC556	Green	4/$1
XC111	Orange	4/$1	XC556	Yellow	4/$1
			XC556	Orange	4/$1
			XC556	Clear	7/$1

.085" dia. MV50 Red 6/$1

INFRA RED LED — 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	4/$1	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	.400	.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	CA3083	1.60
CA3023	2.56	CA3086	.85
CA3035	2.48	CA3089	3.75
CA3039	1.35	CA3091	3.50
CA3046	1.30	CA3102	2.95
CA3053	1.50	CA3123	2.15
CA3059	3.25	CA3130	1.39
CA3060	3.25	CA3140	1.25
CA3080	.85	CA3160	1.25
CA3081	2.00	CA3401	.49
CA3082	2.00	CA3600	1.75

EXAR

XR-2206KB Kit $19.95 — XR-2206KA Kit $14.95

WAVEFORM GENERATORS		MISCELLANEOUS		TIMERS	
XR-205	$8.40	XR-2211CP	$6.70	XR-555CP	$.39
XR-2206CP	5.50	XR-4136	2.00	XR-320P	1.55
XR-2207CP	3.85	XR-1468	3.85	XR-556CP	.99
STEREO DECODERS		XR-1488	1.95	XR-2556CP	3.20
XR-1310CP	$3.20	XR-1489	1.95	XR-2240CP	4.80
XR-1800P	3.20	XR-2208	5.20	**PHASE LOCKED LOOPS**	
XR-2567	2.99			XR-210	5.20
				XR-215	6.60
				XR-567CP	.99
				XR-567CT	1.25

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	1.55	1.40

50 PCS. RESISTOR ASSORTMENTS $1.75 PER ASST.

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

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

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SPECIFY COLOR — White - Yellow - Red - Green - Blue - Black

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Prime Stock Inventory Clearance — STEWART WARNER — Special Offer

P/N	10(min.)	100	1000	P/N	10(min.)	100	1000
SW7401	$1.20/lot	$9.00/lot	$80.00/lot	SW7482	$4.90/lot	44.00/lot	430.00/lot
SW7407	2.20	19.00	180.00	SW7483	3.50	31.00	300.00
SW7416	2.20	19.00	180.00	SW7486	2.20	19.00	180.00
SW7417	2.20	19.00	180.00	SW7491	3.50	31.00	300.00
SW7420	1.30	11.00	100.00	SW7494	3.50	31.00	300.00
SW7423	2.20	19.00	180.00	SW7495	3.50	31.00	300.00
SW7425	1.70	14.00	130.00	SW7496	3.50	31.00	300.00
SW7427	1.50	12.00	110.00	SW74100	6.90	66.00	650.00
SW7430	1.50	12.00	110.00	SW74104	2.20	19.00	180.00
SW7432	1.50	12.00	110.00	SW74105	2.20	19.00	180.00
SW7437	1.50	12.00	110.00	SW74107	2.20	19.00	180.00
SW7438	1.50	12.00	110.00	SW74121	2.20	19.00	180.00
SW7440	1.20	9.00	80.00	SW74123	2.50	22.00	200.00
SW7443	3.50	31.00	300.00	SW74145	5.50	51.00	500.00
SW7444	3.50	31.00	300.00	SW74150	6.90	66.00	650.00
SW7445	3.50	31.00	300.00	SW74151	3.50	31.00	300.00
SW7446	4.00	36.00	350.00	SW74153	4.00	36.00	350.00
SW7450	1.20	9.00	80.00	SW74156	4.00	36.00	350.00
SW7453	1.20	9.00	80.00	SW74180	4.50	41.00	400.00
SW7454	1.20	9.00	80.00	SW74181	9.90	96.00	950.00
SW7460	1.20	9.00	80.00	SW74182	4.50	41.00	400.00
SW7472	2.20	19.00	180.00	SW9601	2.50	22.00	200.00
SW7475	3.50	31.00	300.00	SW9602	4.90	44.00	430.00
SW7480	2.90	26.00	250.00				

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TV GAME CHIP SET — $7.95

Includes AY-3-8500-1 Chip and 2.010 mhz crystal
(2.010 crystal — $.99 ea/AY-3-8500-1 Chip — $7.50 ea.)

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	8/1.00	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	6/1.00	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	1.50
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	$1.95
C38M	35A @ 600V	SCR	1.95
2N2328	1.6A @ 200V	SCR	.50
MDA 980-1	12A @ 50V	FW BRIDGE REC	1.95
MDA 980-3	12A @ 200V	FW BRIDGE REC	1.95

TRANSISTORS

MPS A05	.30			PN4250	4/$1.00
MPS A06	5/$1.00			2N4400	4/$1.00
2N918	4/$1.00			2N4401	4/$1.00
2N2219A	3/$1.00	2N3638	5/$1.00	2N4402	4/$1.00
2N2221	4/$1.00	2N3702	5/$1.00	2N4403	4/$1.00
2N2222A	5/$1.00	2N3704	5/$1.00	2N4409	5/$1.00
2N2369	5/$1.00	2N3705	5/$1.00	2N5086	4/$1.00
2N2369A	4/$1.00	2N3706	5/$1.00	2N5087	4/$1.00
2N2484	4/$1.00	2N3707	5/$1.00	2N5088	4/$1.00
2N2906A	4/$1.00	2N3711	5/$1.00	2N5089	4/$1.00
2N2907A	5/$1.00	2N3724	$.65	2N5129	5/$1.00
2N2925	5/$1.00	2N3725	$1.00	2N5138	5/$1.00
2N3035	2/$1.00	2N3772	$2.25	2N5139	5/$1.00
2N3055	$.89	2N3903	5/$1.00	2N5209	5/$1.00
MJE2955	$1.25	2N3904	4/$1.00	2N5210	5/$1.00
MJE3055	$1.00	2N3905	4/$1.00	2N5432	$2.00
2N3392	5/$1.00	2N3906	4/$1.00	2N5449	3/$1.00
2N3398	5/$1.00	2N4013	3/$1.00	2N5951	5/$1.00
PN3567	3/$1.00	2N4014	3/$1.00	C106B1SCR	2/$1.00
PN3568	4/$1.00	2N4123	6/$1.00	40409	$1.75
PN3569	4/$1.00	PN4249	4/$1.00	40410	$1.75

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-49	50-100		1-9	10-49	50-100
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	.13	.10	1.0/16V	.15	.13	.10
4.7/25V	.16	.14	.12	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

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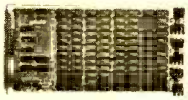
(See the 1/77 issue of Kilobaud magazine for a product profile that tells just about everything you'd ever want to know about Econoram II . . . or send a self-addressed. stamped envelope to "Kilobaud Article" c/o our address and we'll send you a reprint. But if you really want to be convinced . . . talk to somebody who owns one!)

Kit form: $135.00
3 kits: $375.00
Assembled, tested: $155.00



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Kit form: $235.00

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We'll be ready to ship these soon, so we thought you'd like a sneak preview. The price? Under $400. The performance? All that you've come to expect from the Econoram line. along with impressively low power consumption and a couple of other tricks we have up our sleeve. If you've been waiting for a 16K board. you'll be happy you waited for us.

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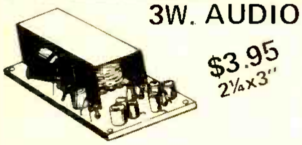

Assembled & tested. Not a kit. Has tapped output for either 4, 8 or 16 OHMS. With schematic.

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Ten each of the following values:
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24PF 150PF 1000PF
39PF 180PF 1800PF
68PF 280PF
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All New!
WOW! A $40.00 VALUE
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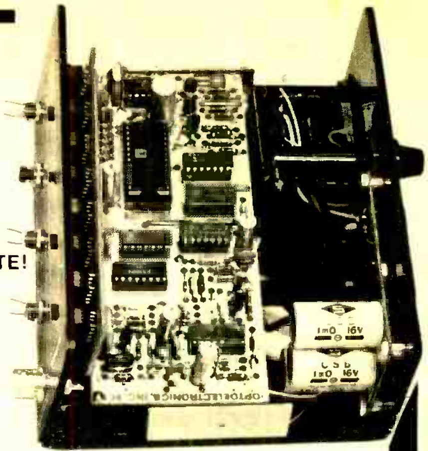

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MODEL #FC-50WT	60 MHZ	COUNTER WIRED, TESTED & CAL.	165.95
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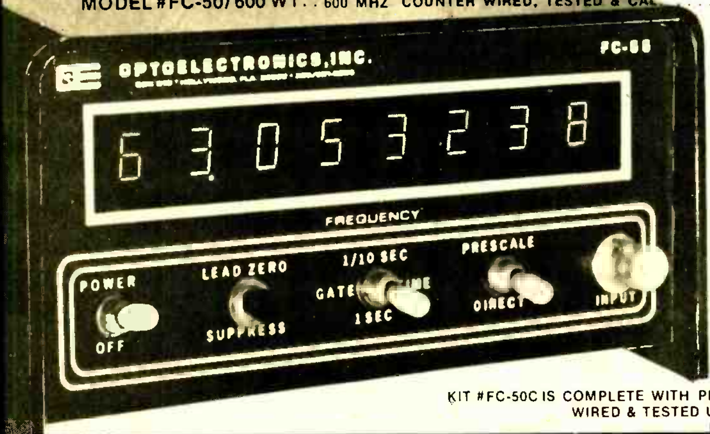

SIZE:
3" High
6" Wide
5½" Deep

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
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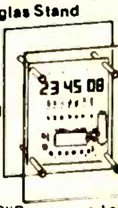
Black, White or Clear Cover
\$6.50 ea.

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
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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.

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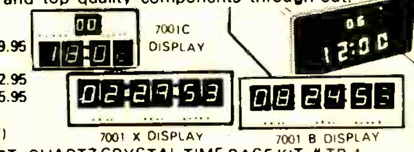

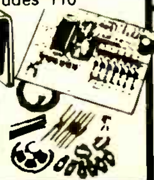

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ALL 7001 KITS FIT CABINET I AND ACCEPT QUARTZ CRYSTAL TIME BASE KIT # TB-1

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.

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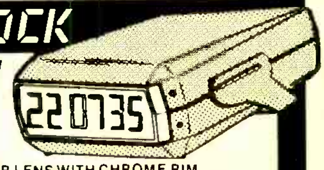
Convert small digit LED clock to large .5" displays. Kit includes 6 - LED's, Multiplex PC Board & Hook up info.
Kit #JD-1CC For Common Cathode
Kit #JD-1CA For Common Anode

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!



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12 VOLT AC or DC POWERED

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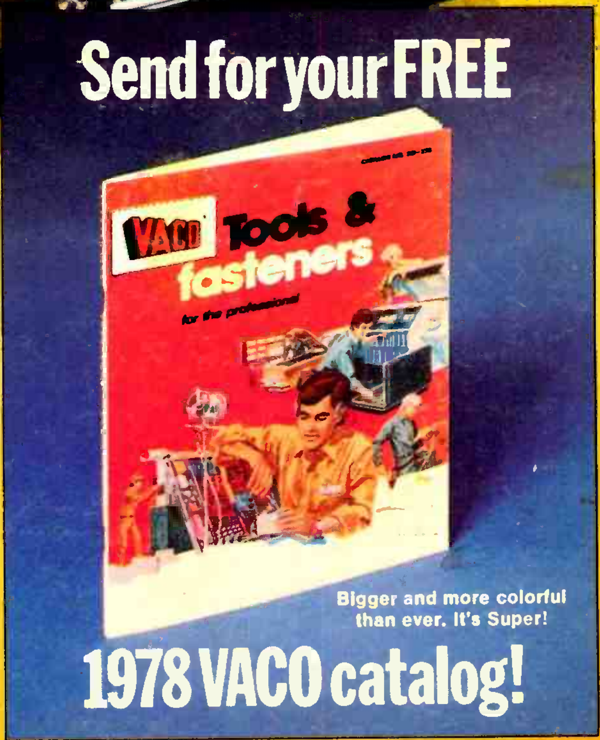

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