WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

JANUARY 1979/$1.25

POPULAR Electronics®

Build a Car Electric System Analyzer
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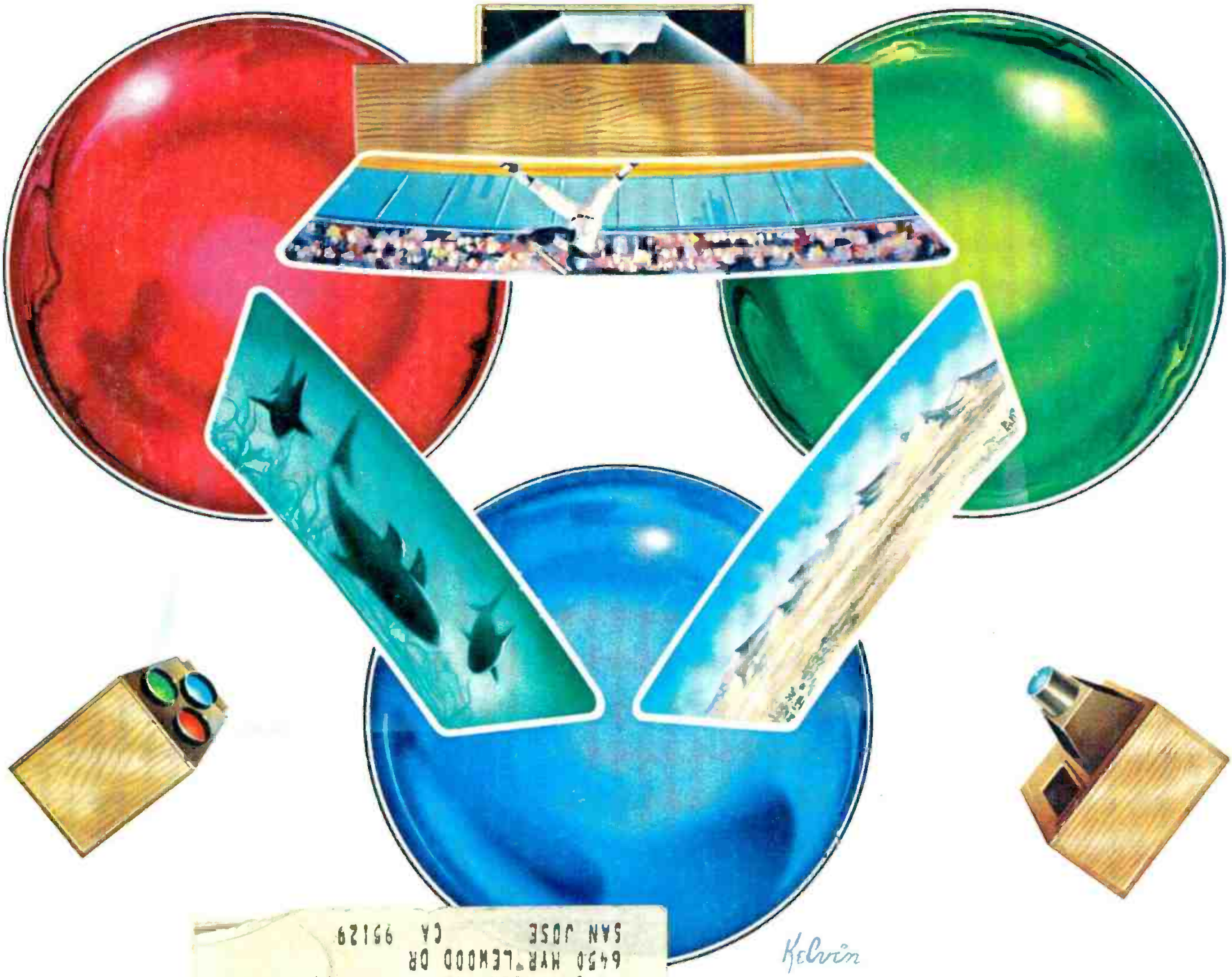
Computer ROM Board Buying Directory

Home Projection TV — The Big Picture is Here!

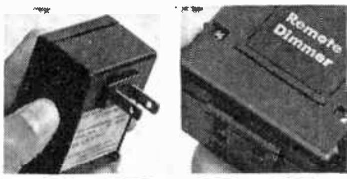
HOW THEY WORK □ BUYING GUIDE TO 58 MODELS



In This Issue

...2 Two-Speed Cassette Deck
SAE Two Integrated Amplifier & Tuner
Advent "Powered" Speaker System

This $20 pager can control 16 of either your appliances or your lights. There's no installation required and the complete story is explained below.



Space Pagers

Control your entire home from your pocket with the world's first micro electronic remote space pager.

You're in bed. It's late at night and you're watching TV. It's time to shut off your TV, so you reach for a remote control device, press a button, and off it goes.

That's not unusual. But what is about to invade the typical American home will be.

AMERICA WILL NEVER BE THE SAME

Scientists have developed the technology to individually page any light or electrical appliance in your home and command it to go on or off from a device that fits in your pocket.

Remote paging requires no special home installation since it utilizes your existing household wiring system and small inexpensive modules that plug into your wall outlets.

The system is also very inexpensive. It costs only $13.95 per module to control any light, only $14.95 for any appliance, and less than $100 for a complete paging system.

WHAT IT WILL DO

Remote space paging will perform many useful functions that will pay for your modest investment.

Security From your bed, you can turn on all the interior lights, your exterior lights, and sound an alarm to warn your neighbors.

Savings You can turn on your air conditioning system or turn up your heat just before you arrive home. The savings in energy will practically pay for the system itself.

Convenience Wake up in the morning to a hot cup of coffee, the TV, and a car that's ready to go as you tie space paging in with a computerized timing system.

HERE'S HOW IT WORKS

Space paging is easy to understand. You hold a pager in your hand and press a number on a calculator-type keyboard. When you press that number, your keyboard sends out a digital signal that is picked up by the electrical wiring system in your home.

The digital signal pages only those wall modules set to the number you keyed. If you page a light, for example, you can also page it to turn on, off, or you can even dim it (just like the dimmer switch you have on your wall). You can page an appliance such as your coffee maker or toaster to turn either on or off. There are up to 16 different electrical devices you can control with your pager.

A PERSONAL SYSTEM

Because it is so easy to use and so inexpensive, you can start with just a few modules and expand later. There are modules that plug into your outlets, and modules that replace your present wall switches. The system can be set for hundreds of different codes, so even if your entire neighborhood has space pagers, you will be able to privately use yours without any interference from your neighbors.

To make space paging work, you need a device to generate the digital code and another device to receive and transfer the signal to your household wiring. There are two systems available to do this – all adding a degree of versatility to the concept.

Direct-Controlled The direct system consists of a control unit at $39.95. The control unit is plugged into the wall and placed by your bed or at any location you select. To open, close, or dim a light, you press the appropriate number and press the function you want to perform. You also have the option of using the system with a remote ultrasonic pager. You point the pager at the control unit and enter the command. The remote pager lets you move about a room or area and is an optional accessory of the direct system at only $19.95.

Timer-Controlled The timer-controlled unit costs $49.95 and consists of a digital clock and a memory. You can program the exact time you want each light or appliance to turn on or off. You also have a "dynamic living pattern" switch which controls the lights randomly and automatically to make it look like you are home while you are away or on vacation. You can now have your TV wake you up, your coffee started, and even your car warmed up in a set sequence every morning. It's like having your own invisible robot.

TRY THE SYSTEM NOW

We recommend that you purchase a series of modules, wall switches, and the direct system as these components are available right now. A good starter package consists of one plug-in module for a plug-in light at **$13.95** (Order Nr. **3011**), two modules for appliances at **$14.95** each (Order Nr. **3012**), one wall switch for **$14.95** (Order Nr. **3013**), and the control unit for **$39.95** (Order Nr. **3010**). The total cost for the package is **$98.75** complete. If you wish to order the remote pager, it costs **$19.95** (Order Nr. **3014**). If you wish to order just the starter package, use Order Nr. **3015**. Postage and handling will be $2.50 for each order no matter how many modules or receiving control units you purchase.

When you receive the package, set the plug-in wall modules to specific numbers. Plug in a light. See how you can turn on and off or even dim the light. Connect your outdoor lights to the wall switch.

Then plug your TV and your coffee maker into one of the appliance modules. Plug your control unit into the outlet by your bed. When you're ready to go to sleep, turn off the outdoor and indoor lights, the TV, and go to sleep.

The next morning, turn on the lights, the TV, and the coffee maker from your bedside. Get dressed, and when you arrive at the kitchen table, sit down to a hot cup of fresh coffee.

Let's say you're in the living room and the lights are plugged into the modules and the control unit is in the bedroom. No problem. You can override the system by turning the lights on or off manually at your lamp switch.

After you experience the convenience of space paging, think of how you can expand the system inexpensively, adding modules to more of your lights and to your wall switches so that you can control your remaining exterior and interior lights. Visualize the security that can be yours once you can control all your lighting and electrical appliances from one central location. Then order more wall switches and light and appliance modules. If you want to control your lighting from two locations, order another control unit or order the entire system you want with your first order.

Once you've turned your bedroom into a paging command center, there is one more expansion possibility: the timer-controlled system which will be available early in 1979. JS&A customers will be advised first of its availability.

JS&A is America's largest single source of space-age products. We back the system with a prompt service-by-mail facility, a one year limited warranty and a 30-day trial period. If you're not completely satisfied, simply return the system for a prompt and courteous refund.

Space paging will bring you freedom, security, convenience, and peace of mind. It will save you steps, time, and money. Finally, right from your bed, you can control your entire home's electronics – something that only a thousand dollar home computer could have done until the space pager was developed.

To order your space pagers, simply send your check for the correct amount (Illinois residents please add 5% sales tax) or credit card buyers may call our toll-free number below. Please also specify the order numbers.

Let space-age technology turn your house into a home of the future. Order your space pager system at no obligation, today.

JS&A NATIONAL SALES GROUP ®

Dept. PE One JS&A Plaza
Northbrook, Ill. 60062 (312) 564-7000
Call TOLL-FREE 800 323-6400
In Illinois Call .... (312) 564-7000

Color. VP-590 add-on Color Board allows program control of 8 brilliant colors for graphics, color games. Plus 4 selectable background colors. Includes sockets for 2 auxiliary keypads (VP-580). $69.*

Sound. VP-595 Simple Sound Board provides 256 tone frequencies. Great for supplementing graphics with sound effects or music. Set tone and duration with easy instructions. $24.*

Music. VP-550 Super Sound Board turns your VIP into a music synthesizer. 2 sound channels. Program control of frequency, time and amplitude envelope (voice) independently in each channel. Program directly from sheet music! Sync provision for controlling multiple VIPs, multitrack recording or other synthesizers. $49.*

Memory. VP-570 RAM Expansion Board adds 4K bytes of memory. Jumper locates RAM in any 4K block of up to 32K of memory. On-board memory protects switch. $95.*

EPROM Programmer. VP-565 EPROM Programmer Board comes complete with software to program, copy and verify 5-volt 2716 EPROMs—comparable to units costing much more than the VP-565 and VIP put together! Programming voltages generated on board. ZIF PROM socket included. $99.*

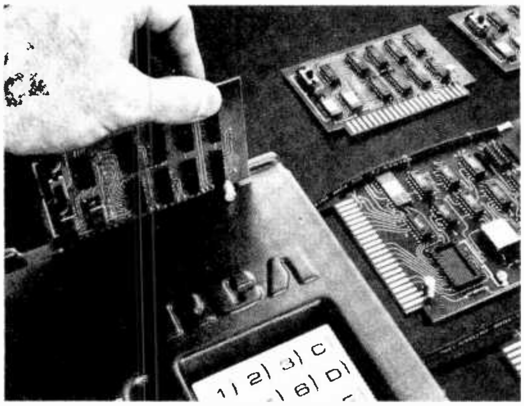
EPROM Interface. VP-560 EPROM Interface Board locates two 5-volt 2716 EPROMs (4K bytes total) anywhere in 32K of memory. VIP RAM can be re-allocated. $34.*

ASCII Keyboard.** Fully encoded, 128-character ASCII encoded alpha-numeric keyboard. 58 light touch keys including 2 user defined keys! Selectable upper and lower case. Handsomely styled. Under $50.*

Tiny BASIC.** VP-700 Expanded Tiny BASIC Board puts this high-level language on your VIP. BASIC stored in 4K of ROM. Ready for immediate use—no loading necessary. This expanded BASIC includes the standard Tiny BASIC commands plus 12 additional—including color and sound control! Requires external ASCII encoded alpha-numeric keyboard. $39.*

Auxiliary Keypads. Program your VIP for 2-player interaction games! 16-key keypad VP-580 with cable ($15*) connects to sockets provided on VP-590 Color Board or VP 585 Keyboard Interface Card ($10*).

COSMAC VIP lets you add computer power a board at a time.



With these new easy-to-buy options, the versatile RCA COSMAC VIP (CDP18S711) means even more excitement. More challenges in graphics, games and control functions. For everyone, from youngster to serious hobbyist. And the basic VIP computer system starts at just $249* assembled and ready to operate.

Simple but powerful—not just a toy.

Built around an RCA COSMAC microprocessor, the VIP includes 2K of RAM. ROM monitor. Audio tone with a built-in speaker. Plus 8-bit input and 8-bit output port to interface relays, sensors or other peripherals. It's easy to program and operate. Powerful CHIP-8 interpretive language gets you into programming the first evening. Complete documentation provided.

Take the first step now.

Check your local computer store or electronics parts house. Or contact RCA VIP Marketing, New Holland Avenue, Lancaster, PA 17604. Phone (717) 291-5848.

*Suggested retail price. CDP18S711 does not include video monitor or cassette recorder.
**Available 1st Quarter, 1979.

The fun way into computers.

RCA

CIRCLE NO 46 ON FREE INFORMATION CARD

JANUARY 1979

POPULAR Electronics®

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

VOLUME 15, NUMBER 1

Coming Next Month

- COMPARING AUDIO TIME-DELAY MODELS
- BUILD A 55-MPH CAR "CRUISEALERT"
- BUILD A MULTIPLE-CHOICE DMM
- AUDIO REPORTS:
  Hitachi HMA-7500
  Power Amplifier
  Akai Pro-1000
  Open-Reel Tape Deck

Cover Art by George Kelvin

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Feature Articles

Construction Articles

Columns

Julian Hirsch Audio Reports

Departments

Editorial

FCC POWER AND CHALLENGES

The pressures of new developments, the economy, and the legislative climate combine to determine what will likely change in some areas of the consumer electronics field. Among the "movers and shakers" is a handful of people that comprise the Federal Communications Commission. What will they do next?

For example, now that Canada established a "No-Code" Amateur Radio license at the end of '78, will the U.S. soon follow in its footsteps? I hope that the FCC will act on this quickly, maintaining the Canadian operating restrictions that promise to motivate such licensees to upgrade with a traditional code exam. Also, what ever happened to the reputed restrictions set by international agreement that Morse Code proficiency is a prerequisite to amateur radio operation on high-frequency bands? Simple. It was never true above 144 MHz!

In truth, the FCC has not been idle the past year. For starters, the agency rewrote its CB rules in "plain English." One's first reaction could well be, "It's about time!" But as it happens, the FCC is the first Federal Government agency to rewrite its rules in this manner. (For a copy of the new rules, send a $1.25 check or money order made out to the Superintendent of Documents to CB Handbook, Consumer Information Center, Department 109F, Pueblo, CO 81009.)

CB radio, which celebrated its 20th anniversary in '78, might eventually be the beneficiary of a recent FCC action—an order to draft a notice of inquiry on carving out additional frequencies for CB in the 900-MHz band. This, of course, will not be finalized for some time to come since public comments are invited which have to be weighed, proposals made, etc. Hams can rejoice, naturally, since the 220-MHz band has been left alone. Canada's new no-code license, in fact, permits "packet radio transmissions"—computer data bursts—on 220.1-220.5 MHz, which are shared with other modes of modulation.

The FCC is also a factor in congressional legislation that seeks to pass a radio frequency interference (RFI) bill that will authorize the FCC to establish minimum standards for reducing r-f interference to audio equipment. Such bills died in committee on adjournment of the 94th Congress. But continued efforts to pass an RFI bill are expected. The Institute of High Fidelity (IHF) expressed concern on this issue, observing that there are no simple solutions to solving the problem, legislators and/or administrators are not qualified to dictate design details unrelated to product performance, and that specific harm to proper functioning of high-fidelity equipment could occur by implementing "easy solutions" to RFI problems as suggested by legislators. (It'll increase the price of audio gear, too.)

On other fronts, the FCC was attacked by the Electronics Industries Association, which disputes its uhf conclusions that a 7-to-10-fold improvement is achievable in land mobile spectrum efficiency with current technology. The agency was on the offense in another arena. FCC Commissioner Tyrone Brown charged that the U.S. Court of Appeals is seeking to be a "super FCC" by making communications policy. He allowed, however, that this is being done by FCC default and by the FCC saying one thing and doing another. The upshot of the latter—inconsistent statements and actions—creates industry uncertainty among the public, Brown declared. All too true!!

The FCC was formed by the Communications Act of 1934, of course, replacing the Federal Radio Commission. Now it's expected that the Communications Act of 1978 will displace the FCC with a new Communication Regulatory Commission. A first draft of the new Act reduces the agency's functions and the number of Commissioners from seven to five members. It will be most interesting to see what impact this impending change will have on future audio and radio rules.

Art Salsberg

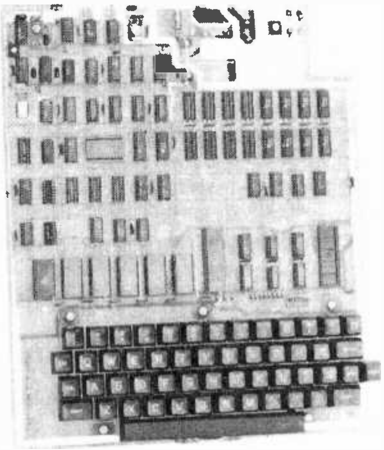
The Age of Affordable Personal Computing Has Finally Arrived.

Ohio Scientific has made a major breakthrough in small computer technology which dramatically reduces the cost of personal computers. By use of custom LSI micro circuits, we have managed to put a complete ultra high performance computer and all necessary interfaces, including the keyboard and power supply, on a single printed circuit board. This new computer actually has more features and higher performance than some home or personal computers that are selling today for up to $2000. It is more powerful than computer systems which cost over $20,000 in the early 1970's.

This new machine can entertain your whole family with spectacular video games and cartoons, made possible by its ultra high resolution graphics and super fast BASIC. It can help you with your personal finances and budget planning, made possible by its decimal arithmetic ability and cassette data storage capabilities. It can assist you in school or industry as an ultra powerful scientific calculator, made possible by its advanced scientific math functions and built-in "immediate" mode which allows complex problem solving without programming! This computer can actually entertain your children while it educates them in topics ranging from naming the Presidents of the United States to tutoring trigonometry all possible by its fast extended BASIC, graphics and data storage ability.

The machine can be economically expanded to assist in your business, remotely control your home, communicate with other computers and perform many other tasks via the broadest line of expansion accessories in the microcomputer industry.

This machine is super easy to use because it communicates naturally in BASIC, an English-like programming language. So you can easily instruct it or program it to do whatever you want, *but you don't have to.* You don't because it comes with a complete software library on cassette including programs for each application stated above. Ohio Scientific also offers you hundreds of inexpensive programs on ready-to-run cassettes. Program it yourself or just enjoy it; the choice is yours.



Ohio Scientific offers you this remarkable new computer two ways.

Challenger 1P $349
Fully packaged with power supply. Just plug in a video monitor or TV through an RF converter to be up and running.

Superboard II $279
For electronic buffs. Fully assembled and tested. Requires +5V. at 3 Amps and a video monitor or TV with RF converter to be up and running.

Standard Features

- Uses the ultra powerful 6502 microprocessor
- 8K Microsoft BASIC-in-ROM
  Full feature BASIC runs faster than currently available personal computers and all 8080-based business computers.
- 4K static RAM on board expandable to 8K
- Full 53-key keyboard with upper/lower case and user programmability
- Kansas City standard audio cassette interface for high reliability
- Full machine code monitor and I/O utilities in ROM
- Direct access video display has 1K of dedicated memory (besides 4K user memory), features upper case, lower case, graphics and gaming characters for an effective screen resolution of up to 256 by 256 points. Normal TV's with overscan display about 24 rows of 24 characters; without overscan up to 30 X 30 characters.

Extras

- Available expander board features 24K static RAM (additional), dual mini-floppy interface, port adapter for printer and modem and an OSI 48 line expansion interface.
- Assembler/editor and extended machine code monitor available.

ORDER FORM

Order direct or from your local Ohio Scientific dealer.

☐ I'm interested. Send me information on your:
☐ Personal Computers ☐ Business Systems
☐ Send me a Superboard II $279 enclosed
☐ Send me a Challenger 1P $349 enclosed
☐ Include 4 more K of RAM (8K Total) $69 more enclosed

Name ______________________

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TOTAL CHARGED OR ENCLOSED ____________
All orders shipped insured UPS unless otherwise requested. FOB Aurora, OH

Interested in a bigger system? Ohio Scientific offers 15 other models of microcomputer systems ranging from single board units to 74 million byte hard disk systems.

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America's Largest Full Line Microcomputer Company
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CIRCLE NO 36 ON FREE INFORMATION CARD

Letters

MORE ON CAR SOUND

In "How to Get Hi-Fi Sound in Any Auto" (July 1978), it is stated that "Doors are not the very best choice [for mounting speakers] for mechanical and acoustic reasons." There is another reason—water leakage. Water running down the window glass into the interior of the door may drip onto the paper cone of the speaker and ruin it. Such water leakage is usual and is the reason why car manufacturers put drain holes into the bottom edges of doors. —*Sherman A. Baker, Arlington, VA.*

NO "FREEBIE"

An incorrect statement was made in the May 1978 Product Test Reports section for the Heathkit Model HW-2036 2-meter transceiver. A properly assembled transceiver kit is *not* aligned free of charge by one's local Heathkit service center. There is a nominal charge for this service.—*James Maher, Oregon, OH.*

Sorry. We checked with Heath in Benton Harbor, MI and had it confirmed that there is indeed a nominal charge for aligning the transceiver.—Ed.

IDEAS ON MUSIC MIXING

I enjoyed greatly "A Practical Guide to Multitrack Tape Recording" in the March 1978 issue. Here are some more ideas. Since it is difficult for one person to mix a previously recorded track with new material while supplying that new material (I only have two hands!) this technique might prove helpful. Record the first three instruments one at a time on tracks 1, 2, and 3. (Be sure they are synchronized!) When you are satisfied with these performances and recording levels, etc., mix them down onto track four. Repeat this mix until satisfied before reusing tracks one through three. Note track four is out of sync with the other tracks.

The next two sources are recorded on tracks one and two in synchronization with track four. Mix these down onto track three and re-record track four onto track one after this mix to keep things synchronized.

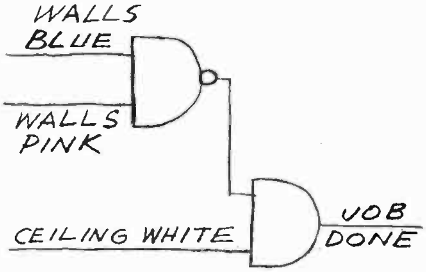
The next two sources are recorded on tracks two and four in sync with one and three. We now have seven performances recorded. However, three of them are third-generation recordings (copied twice), two are second generation and only two are first generation. But I believe that, if noise reduction were used throughout the procedure to mini-

mize degradation of sound by re-recording, the loss of quality is offset by the gain in concentration when mixing was done for the sake of a better balance of sound.

Using the above procedure, add a new source while mixing (loss of balance again). Then, when two tracks are all that remains, use the method of sound-with-sound as described in your article to get three vocals onto one track leaving the last for solo instrument or voice.—*Bill Fox, Columbus, OH.*

DATA PROCESSING QUIZ

The answer given for question three of Robert P. Balin's "Data Processing Quiz" (p. 70, September 1978) is incorrect. The question sets the conditions, "You can paint the walls blue or pink, but paint the ceiling white, even if you don't do the walls." However, the logic network given as the answer indicates the paint job is completed under the following conditions: an unpainted ceiling with walls painted pink; an unpainted ceiling with walls painted blue; painted ceiling with walls unpainted, painted blue, painted pink or painted



both blue and pink (stripes). A logic network that will indicate a completed paint job (output at logic 1) is shown here. —*Tony Banks, Cambridge, MA*

Out of Tune

In "A Cassette Control System for Computers" (November 1978): change the two lines numbered 240 and 330 in the Graphic Star Program to read as follows:

```
240 IF 20+X/B = 47 THEN 310
330 IF 20+(127−X)/B = 47 THEN 410
```

In "Solid State" (August 1978): Ranges E and F of the Capacitance Meter should have CK equal to 0.01 μF (not 0.001 μF).

In "An Infrared Intrusion System" (December, 1978), in Fig. 1 insert a 20-ohm resistor in series with LED1; in Fig. 2, make C2 .22 μF and C5 a 50-V Mylar; in Fig. 3A, T1 center-tap should be yellow; in Fig. 3B the T1 primary should be B/Y instead of B/G; and in Fig. 4, D3 should be a 1N4002.

In the September "Experimenter's Corner," Fig. A of the Project of the Month, the value of current limiting resistor *R3* should be 470 ohms, not 470,000 ohms.

the $988 Surprise . . .

If you haven't looked carefully at the Level-II 16K TRS-80, you're in for a big surprise! Level-II BASIC gives TRS-80 advanced features like comprehensive string handling, multi-dimension arrays, multi-letter variable names, named cassette files, full editing, integer arithmetic, single (6-digit) and double (16-digit) precision arithmetic, formatted printing, memory-mapped video (print directly at any of 1024 screen positions), 128x48 video graphics (may be intermixed with text), error trapping, auto line numbering, TRACE, PEEK and POKE . . . to name just a few. Because Level-II is in ROM, TRS-80 powers-up ready to go with the full 16K RAM available for your use.

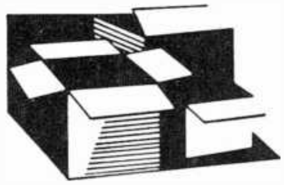
This means TRS-80's memory is equivalent to a 28K RAM-based system.

New for 1979—TRS-80's numeric (calculator) keypad included on every 16K computer, and available as an add-on for present owners.

TRS-80's modular design allows easy expansion. Add up to 48K RAM, Expansion Interface, printers, 1 to 4 Mini-Disks, RS232C, telephone acoustic couplers, Voice Synthesizer, dual cassette recorders, our System Desk and Printer Stand. Surprisingly, these are not promises of things to come, but real products being delivered right now. Software from games to General Ledger are available, with more cassette and disk software being added monthly.

Radio Shack's 58 years of consumer electronics leadership, our 50 regional repair centers (growing to 100 this year), our new Radio Shack computer centers, and our NYSE-listed billion-dollar parent, Tandy Corporation, insure that customer support is always available right where it should be—locally.

So if you haven't seriously looked at TRS-80 yet, ask your local Radio Shack for our new 20-page fact-filled catalog and be prepared for a $988 surprise. Surprising power—features—price—support! Level-II 16K systems include everything pictured, plus the manual. Better to be surprised now . . . before you choose the wrong microcomputer system.



New Products

Additional information on new products covered in this section is available from the manufacturers. Either circle the item's code number on the Free Information Card or write to the manufacturer at the address given.

BSR Quanta Direct-Drive Turntable

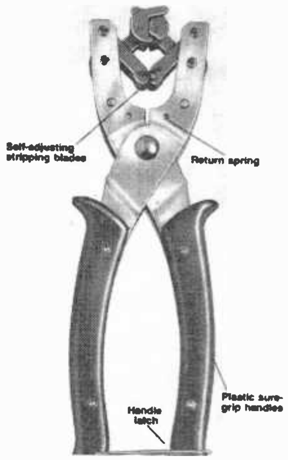
The Quanta 800 is the top of a series of three new BSR single-play, two-speed turntables whose base cabinets utilize a special sandwich construction of dissimilar materials, plus energy-absorbing, resonance-tuned feet, to absorb noise reso-

nances. The 800 has a quartz-locked, direct-drive servometer with illuminated digital speed display and digital speed selection and adjustment. The die-cast aluminum platter is covered with an anti-static mat. The semi-automatic turntable's tone arm is an S-shaped, tubular aluminum low-mass type with viscuous-damped cueing and automatic return. $230.00. Address: BSR (USA) Ltd., Route 303, Blauvelt, NY 10913.

CIRCLE NO. 92 ON READER SERVICE CARD

Vaco Wire Stripper

The No. 70358C is a new self-adjusting wire stripper from Vaco Products. The simple-to-use stripper automatically adjusts itself to the diameter of the wire being stripped. This eliminates the need to look for specific hole sizes. Its blades cut through the insulation but never touch the inner conductors. Spring action returns the



wire stripper to its ready-to-use position. A latch at the bottom of the handles keeps them together when the stripper is not being used. Address: Vaco Products Co., 1510 Skokie Blvd., Northbrook, IL 60062.

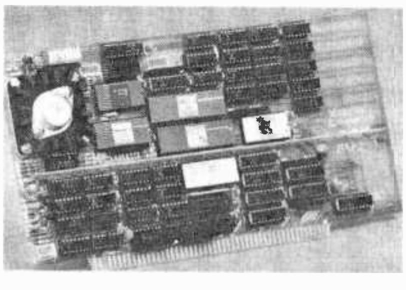
CIRCLE NO. 93 ON READER SERVICE CARD

Electronic Deadbolt Combination Lock

"Electrolock EL-S" is a combination-plus-key electronic deadbolt lock from Electronic Security Systems. Solid-state electronics control an electromechanically operated 1"-throw deadbolt. Before the lock can be opened using a key, the proper combination must be entered on a 12-key keypad. Up to three combinations of four to seven digits can be programmed. During a power failure only the key is required to retract the deadbolt. The lock is powered by 120 V ac. Available options include weatherproofing, custom-programmed combinations, three-level master keying, and timer-controlled locking. $89.50. Address: Electronic Security Systems, Inc., Box 61403, Sunnyvale, CA 94088.

Xitan Z80 CPU Board

The ZPU-2, an S-100 board with a Z80 microprocessor and two unique options, has been announced by Xitan. The System Support option includes multi-tasking reg-



isters, allowing up to four tasks to run concurrently, plus memory-mapping for up to one megabyte of memory to be addressed. This option also provides four Direct Memory Access (DMA) channels, permitting data transfer rates between I/O devices at 2 megabytes per second, as well as three 1-μ sec to 1-sec intervals, and interrupt control for eight input lines. The Floating Point option provides mathematical processing capabilities at up to 10 times normal software speed while the main processor handles other tasks. The ZPU-2 will operate at either 2 or 4 MHz (switch-selectable); wait state generation is provided separately for memory, DMA and input/output operations. Address: Xitan, Inc., 1101-H State Road, Princeton, NJ 08540.

CIRCLE NO. 94 ON READER SERVICE CARD

Fisher Receiver with Equalizer

The RS2004 is the lead entry among four new Fisher AM/FM-stereo receivers in its RS2000 Studio Standard series. Incorporating five-band graphic equalizers with detented controls in place of the usual tone

controls, it also features dual tuning meters, two speaker outputs, tape monitor switch, loudness contour, plus FM-muting and equalizer defeat. In addition, it has an illuminated function indicator, and a rear-panel 25-microsecond Dolby deemphasis switch. Power is rated at 45 watts continuous into 8 ohms from 20 to 20,000 Hz at 0.1% THD or less. Fm mono usable sensitivity is 10.3 dBf (1.9μV). $450.00. Address: Fisher Corp., 21314 Lassen St., Chatsworth, CA 91311.

Sinclair Pocket DMM

Sinclair Radionics' Model PDM35 is a pocket-size digital multimeter designed for measuring ac and dc voltages, dc current, and resistance. LSI circuitry employs BI-FET technology rather than the more costly A/D converter to keep prices down. The DMM measures dc voltages in four ranges to 1000 volts and ac voltages to 500 volts at an accuracy of 1% full-scale. Resistance is measured in five ranges at an accuracy of 1.5%. The instrument features automat-

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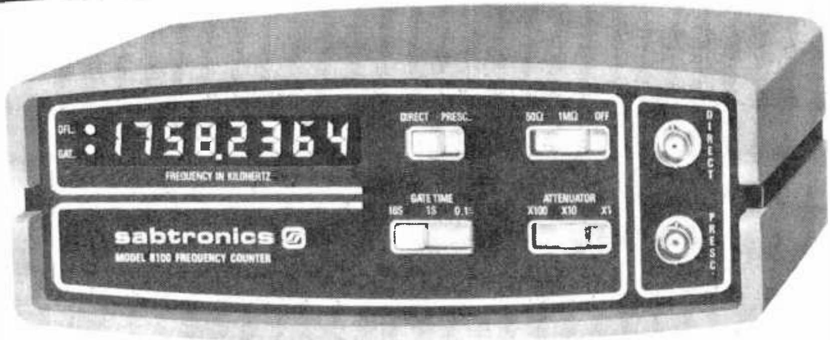

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ic polarity indication and a magnified seven-segment LED display with a high-contrast-ratio filter. Optional accessories include a deluxe carrying case, ac adapter, and 30-kV probes. $59.95, including test leads and vinyl slip case. Address: Sinclair Radionics, Inc., 115 E 57 St., New York, NY 10022.

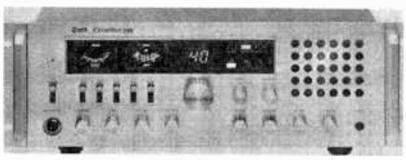
CIRCLE NO. 95 ON READER SERVICE CARD

Amphenol Mini-Uhf Connectors

Miniature uhf plugs and jacks with five times greater frequency range (to 2.5 GHz) than standard-size connectors have been introduced by Amphenol. The new connectors feature instant-on FPC-type terminations and are designed to replace standard-size connectors used with RG-58/U coaxial cable. About half as large as their conventional counterparts, mini-uhf connectors can easily be used in miniaturized circuits and simplify installation of base-station and mobile Amateur radio and CB transceivers. The connectors are rated at a nominal 50 ohms impedance, 1.25:1 typical VSWR, and 350 volts maximum. Prices are $1.10 for the plug and $1.36 for the jack. Address: Bunker Ramo/Amphenol RF Operations, 33 E. Franklin St., Danbury, CT 06810.

Colt AM-SSB Base Station

The new 40-channel Colt "Excalibur SSB" model 1200 CB transceiver base station features single-sideband and AM operation, and digital LED channel display. Front-panel controls include r.f. gain, mic

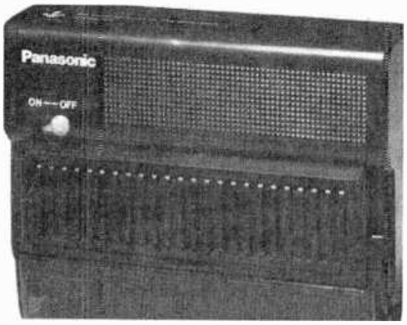


gain, PA gain, and tone. Among control swtich provisions are: high-frequency filter, r.f. noise blanker ANL, CB-PA, and SWR-calibrate. There are also two large meters for signal strength and SWR/r.f. indications, headphone jack, and mode lamps on the front panel. Other features include an external speaker jack, a.c.-d.c. operation, and an optional walnut-grain cabinet. The unit can also be mounted in any standard EIA 19" rack. Address: Colt Communications, 5424 W. Touhy Ave., Skokie, IL 60077.

CIRCLE NO. 96 ON READER SERVICE CARD

Panasonic Cordless Record Cleaner

The Panasonic BH-651E is a battery-operated, hand-held LP record cleaning device recently unveiled by Panasonic. A rotary brush with 0.05mm bristles made of



PVC collects dust from the record surface and deposits it in a built-in dust-box. The brush turns at 3000 rpm. The cleaner operates on two AA batteries (not included). Address: Panasonic, One Panasonic Way, Secaucus, NJ 07094.

CIRCLE NO. 97 ON READER SERVICE CARD

E&L Video Terminal

Used with a TV receiver or optional video monitor, E&L Instruments' Model VTE-1 video terminal electronics system provides a full ASCII keyboard, reprogrammable character generator, cursor, and flicker-free refresh. The one-piece molded cabinet is designed to support a CRT monitor at a comfortable viewing angle. Full duplex and local operation are possible with RS-232C and 20-mA current-loop interfaces operating at speeds up to 9600 baud. The standard character set contains 64 uppercase alphanumeric ASCII characters (lower-case optional), and the character generator is user-reprogrammable to provide any user-defined 5 × 7 dot matrix characters. The 128-character ASCII decoder supplied is also user-reprogramma-

ble to accommodate alternate character codes or code sets. The blinking cursor can be positioned anywhere on-screen or switched off. Other features include clear screen, bell code, and wrap-around. $600 assembled, $450 kit. Address: E&L Instruments, Inc., 61 First St., Derby, CT 06418.

CIRCLE NO. 98 ON READER SERVICE CARD

Fujitsu Ten In-dash AM-FM-Cassette with Dolby

The Fujitsu Ten GP-7881 in-dash car stereo combines AM and stereo FM reception plus an auto-reverse cassette player with Dolby noise reduction. The AM-FM section has preset push-button selection of five AM and five FM stations, interstation muting, and a built-in noise blanker. The stereo cassette section features locking re-

wind and fast-forward. The unit also has separate bass and treble controls, and a four-way fader control to adjust front/back and left/right sound distribution. Tape-section ratings are 0.3% wow and flutter; 48 dB S/N. Power output is rated at 5 watts for each of the four speaker outputs, or 20 watts total, into a 4-ohm load. Current drain is 1.6 amps max. $239.95. Address: Fujitsu Ten, Dept. P, 1135 East Janis St., Carson, CA 90746.

CIRCLE NO. 99 ON READER SERVICE CARD

Yamaha "Disc Mode" Amplifier

Yamaha's Model A-1 integrated amplifier has a built-in head amplifier for moving-coil cartridges and is used in a "disc-mode ori-

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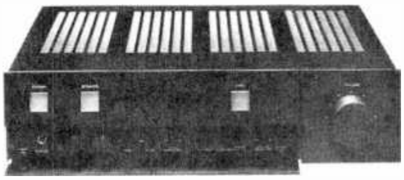


ented" operation that couples the phono input almost directly to the output power amplifier. A unique DISC switch overrides all secondary controls and achieves a circuit configuration that is claimed as close to the straight wire with gain concept as is technologically possible. This amplifier also uses a direct-current equalizer to achieve significant improvement in transient response. The equalizer is direct-coupled to a high-gain (41.5 dB) power amplifier whose full-rated output power can be achieved with only a 200-mV output from the preamplifier. Specifications: 70 watts/channel into 8 ohms at 0.02% THD; 20 to 20,000 Hz +0/−0.2 dB frequency response; 230 mV rms moving-magnet, 6 mV rms moving-coil phono overload; more than 70 dB channel separation; 82 to 105 dB S/N. $595. Address: Box 6600, Buena Park, CA 90620.

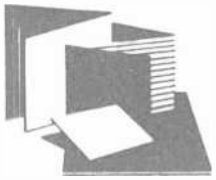
CIRCLE NO. 100 ON READER SERVICE CARD

Heathkit Computerized Weather Station

Heath's new ID-4001 weather station has digital readouts for indoor and outdoor temperatures, wind speed and direction, barometric pressure and time. As a result of a built-in microprocessor, it can also calculate and display average wind speed and wind chill factor. In addition, a built-in memory allows it to instantly recall the

dates and times of maximum and minimum temperatures, barometric pressure, wind gusts, barometric pressure's rate of change per hour, and whether pressure is rising or falling. Wind speed can be read in mph, kph or knots, temperature in Fahrenheit or Celsius, and barometric pressure in inches of mercury or millibars. $369.95, kit; $595.00, assembled. Address: Heath Company, Dept. 350-730, Benton Harbor, MI 49022.

CIRCLE NO. 90 ON READER SERVICE CARD



New Literature

STURDILITE "IDEA BOOKLET"

Sturdilite has announced availability of its "Idea Booklet" describing its line of modular lab and work stations for electronic, R&D, quality control, technical production and assembly applications. Over a dozen typical installations are shown, and the brochure demonstrates how the Sturdilite "building-block" design concept can simplify planning lab or work station areas. Address: Sturdilite Lab & Work Stations, Angle Steel Div., 323 Acorn St., Dept. 32, Plainwell, MI 49080.

PHILMORE CATALOG SUPPLEMENT

An eight-page catalog supplement (#771) is available from Philmore describing additions to their line of communications, hi-fi, consumer, and OEM products. Among the 47 new items listed are a four-way car speaker system, five-channel disco/broadcast mixer, and all-purpose portable PA amplifier. Address: Philmore Mfg. Co., Inc., 40 Inip Dr., Inwood, NY 11696.

COMPUTER SERVICES DIRECTORY

A new version of "Directory of Computer Based Services" is available from Telenet, listing organizations offering interactive computing and information retrieval services. These include data banks, commercial service bureaus, educational institutions, and other companies, all categorized by application specialty, programming language, and data base offerings. Also listed is information on financial and economic data bases, FCC tariffs for communications common carriers, school guidance, advertising media and market research, energy and pollution, and engineering. Cost is $2.00. Address: Telenet Communications Corp., Publications Dept., 1050 17th St. NW, Washington, DC 20036.

HIGH-VOLTAGE TRANSIENT TIPS

Tech Tips 1-7 from Westinghouse describes an ac switch voltage transient protection circuit. The two-page bulletin includes a schematic of the circuit described. Address: Westinghouse Electric Corp., Semiconductor Div., Youngwood, PA 15697.

SWITCHCRAFT CONNECTOR BULLETIN

Switchcraft's New Product Bulletin No. 328 describes "Silent-Plug." This connector eliminates loudspeaker noises when amplifier cables are connected and disconnected from amplified musical instruments. Also discussed are special features that protect cable and plug from damage associated with transporting and setting up equipment. Address: Switchcraft, Inc., Sales Dept., 5555 N. Elston Ave., Chicago, IL 60630.

NEWMAN COMPUTER CATALOG

Newman Computer Exchange has a new 72-page catalog listing its most popular new and used mini- and microcomputer products. Personal computers, books, accessories, and other computer-related items appear in the micro section of the catalog, while the mini section features mostly DEC and Data General products. Mailing list members receive catalogs twice each year plus supplements and special sale announcements. Address: Newman Computer Exchange, Dept. R48, Box 8610, Ann Arbor, MI 48107.

VIZ TEST INSTRUMENTS

The VIZ 1978 full-line catalog describes over 55 test instruments and accessories, many of them new. Full specifications and technical details are contained in its 44-page publication. Also available is an eight-page short-form catalog listing 36 popular VIZ instruments. Address: Robert Liska, VIZ Test Instruments Group, VIZ Mfg. Co., 335 E. Price St., Philadelphia, PA 19144.

NANMAC THERMOCOUPLE BOOKLET

"Temperature-EMF Tables for Thermocouples" (Booklet No. 9000) is a 20-page publication available free from Nanmac. It contains American National Standards Institute thermocouple calibration tables, designated ANSI MC96.1-1975. Information is presented in Celcius and Farenheit format. Also included is information on calibration graphs, wire codes, extension and compensating wire codes, and limits of error. Address: J. Nanigian, Nanmac Corp., 9-11 Mayhew St., Framingham Centre, MA 01701.

REI RENTAL CATALOG

The 1978 catalog of electronic instrumentation and equipment available for short-term rental from Rental Electronics, Inc. describes almost 13,000 items, including products from companies such as Brush, Digitec, Fluke, Hewlett-Packard, Honeywell, Intel, Tektronix, etc. Product categories include: amplifiers, analyzers, calibrators, counters, function generators, signal sources, digital meters, oscilloscopes, power supplies, probes, chart recorders, etc. Address: Rental Electronics, Inc., 19347 Londelius St., Northridge, CA 91324.

NATIONAL BI-FET BROCHURE

A 16-page brochure on BI-FET™ and BI-FET II™ op amps, available from National Semiconductor, is a guide to circuits using these devices, including op amps, sample and holds, analog switches, MUXs and others. Data sheets and selection guides are included. Address: National Semiconductor, 2900 Semiconductor Dr., Santa Clara, CA 95051.

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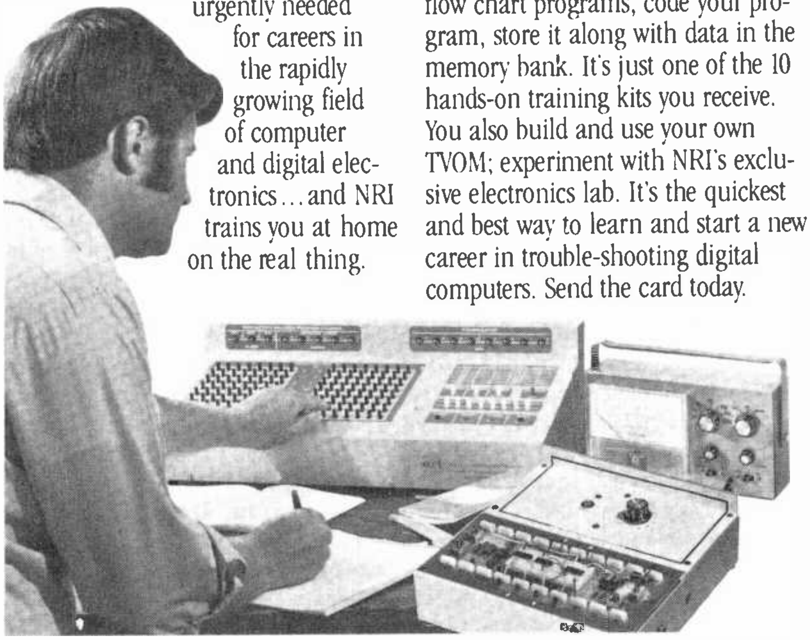

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Stereo Scene

By Ralph Hodges

A NEW TONEARM

IN THE PAST, this column has been outspoken about the desirability of controlling—and reducing as much as possible—the tonearm/cartridge resonances that are an inevitable part of playing a record. The major such resonance, of course, results from the total effective mass of the arm and the compliance of the stylus suspension in the cartridge (compliances, actually, because many cartridges exhibit different static compliances for vertical and lateral stylus movements). There are secondary resonances as well. They generally result from nonrigidity of the tonearm structure (nobody knows how to make a perfectly rigid tonearm), so that it behaves as an assemblage of lesser masses rather than as a unitized whole. These resonances frequently turn up in the audio-frequency range, while the fundamental resonant frequency is well below 20 Hz with most tonearm/cartridge combinations.

I have always considered secondary resonances in the audio range to be the lesser of the two evils. When audible (and as a rule they are extremely subtle if the tonearm is at all decent), they introduce colorations that are usually of much less magnitude than similar-sounding colorations contributed by loudspeakers and listening rooms. Therefore, they are psychoacoustically masked out of the sonic picture. But the fundamental arm-cartridge resonance is often a high-amplitude affair that, while being too low in frequency to be audible as a coloration per se, brings about significant arm motion relative to the record surface. The cartridge cantilever is deflected, rapidly changing the effective length of the tonearm and introducing flutter effects in the reproduced sound. Strict tracking geometry is upset and becomes ever-varying. Tracking force oscillates, and mistracking is prone to occur. And the high-amplitude infrasonic frequencies, if passed by the amplification chain, have been demonstrated as capable of producing audible Doppler distortion in loudspeakers.

Tonearm Philosophies. As you might suspect, not everyone agrees with the way I order tonearm priorities. For example, I tend to favor a tonearm with suitably low effective mass, so that the fundamental resonance can be raised sufficiently above the frequency where most warps statistically occur (around 4 Hz, according to studies by Shure Brothers). Of course, secondary resonances are more likely to occur in an arm of very light structure. However, using a suitably inert arm material, keeping the arm shaft as homogenous as possible (for example, no removable head shells, alas), and exercising some care in the design and adjustment of pivots can do much to keep such resonances below the audible threshold.

Another school of thought, especially popular in Japan, espouses an exceptionally sturdy—and therefore rather massy—arm shaft to banish secondary resonances. Fundamental resonances are kept somewhat in check by various damping schemes or by admonitions not to expect the best results unless unwarped records are used. The Japanese have developed sophisticated means of detecting and measuring secondary resonances, and their concern about them has been aroused proportionately. But the unwarped record that works best with a relatively massy arm is still a hard item to find—at least outside of Japan.

The Servo-Assisted Arm. A few years ago, Finnegan and Klunis of 3M reported on experiments with a tonearm having a built-in linear electric motor—not really much more than a loudspeaker drive assembly—that could be directed by a servomechanism to resist undue vertical "bobbing" of the tonearm caused by record warps. The results seemed promising, and it soon came to light that at least one other U.S. company was engaged in work on a similar design, with intent to introduce it as a consumer product. Very recently, however, Sony in Japan beat everyone to the punch by announcing the development of an "electronic" tonearm somewhat more complex than any of the other proposed designs. That there are no immediate plans for export of the arm makes any interest in it purely academic; but the test results achieved so far make the interest considerable.

According to Sony's Satoshi Kusaka, writing in the August, 1978 issue of the *Japan Electronics Industries* journal, the motion sensors and servo motors in the arm perform several functions. They lift and lower the arm and swing it to and from the record surface, thus providing the essential operation of an automatic turntable. They apply tracking force, skating compensation, and static balance. And through servo feedback they introduce electromechanical damping that greatly reduces the fundamental arm-cartridge resonance and other vibrations. With the fundamental arm resonance under control through electronic means, the arm structure can theoretically then be made rigid and massy enough to suppress secondary resonances with no detriment to overall performance.

The complexity of the Sony design takes it a step beyond other proposals of the same fundamental nature. Not only does it have a vertical sensor and motor, assigned the tasks of establishing zero balance, tracking force, and vertical damping. It also has a similar configuration for lateral movement, which applies anti-skating and keeps the arm in lateral balance. The automatic functions—tonearm lift and transit—are easily included side benefits. An optical system at the very base of the arm triggers the end-of-record cycle and also regulates the cueing of the tonearm so that it can accomodate various record diameters.

An obviously essential external unit contains the servo amplifiers and the controls for operating and adjusting the arm. Kasuka's paper gives virtually no details on the nature of the control systems, so it is necessary to speculate. Unlike some of the other electronic-ser-

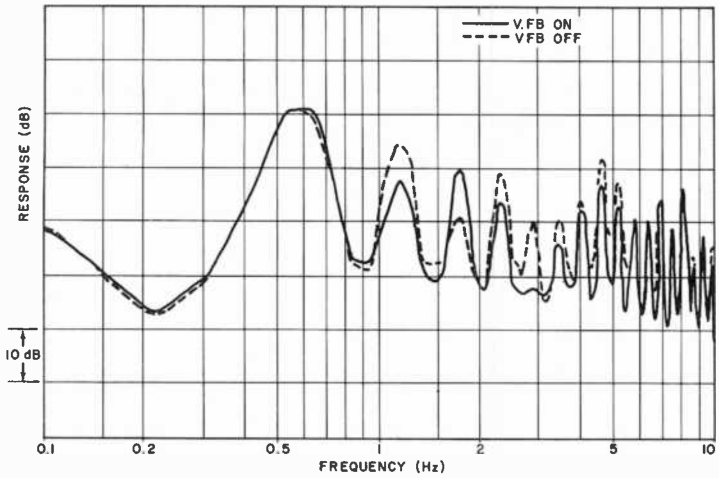


Fig. 1. Tests of the Sony arm with electronics "on" (solid line) and "off" (dotted line) demonstrate wow and flutter values up to 10Hz.

vo designs, which feed the control systems by means of signals derived from the cartridge through a low-pass (infrasonic) filter, the Sony arm evidently pays no attention to the cartridge output and instead relies on built-in motion sensors. Sony's curves, reproduced in Fig. 1, suggest that the motion-sensor outputs are processed by a high-pass filter that restricts their influence to frequencies above about 1 Hz, which is an octave away from the approximately 0.5-Hz rotational rate of an LP record. This makes perfect sense if we want (as we do) the arm to be able to follow the eccentricities of an off-center record freely. What the servo system is supposed to do when confronted with a 45- or 78-rpm record is not indicated.

Other Performance Characteristics. The curves of Fig. 2 show the considerable effectiveness of the Sony arm in reducing the amplitude of the fundamental arm-cartridge resonance. They also show a dramatic reduction in interchannel crosstalk, which indicates the fallacy of some tonearm manufacturers in believing that arm resonances activated by record warps involve only vertical perturbations. Experience shows that there are significant lateral components of motion involved as well.

Fig. 1 shows measured values of wow and flutter for frequencies up to 10 Hz, with and without the servomechanisms in the arm engaged. You'll note how much more subject the arm is to frequency-modulation effects without the servo, particularly near the critical region of 4 Hz where record warps are concentrated. I suspect that this is where the greatest benefits of the arm are to be realized. In the region above 5 Hz, which is where the curves of Fig. 1 show the fundamental arm-cartridge resonance to be located, the results are less clear-cut, but they certainly show no significant detriment to performance.

Fig. 3 shows the output of the cartridge with the arm playing an unmodulated record groove, without and with servo regulation. The "without" signal exhibits a sort of envelope suggesting low-frequency modulation of the record noise that serves to increase its peak values. The "with" signal is well controlled by comparison. In similar experiments, I have observed a sort of tonearm "shimmy" that can crop up even without any groove modulation; this shimmy can be audible as a sort of stylus "chatter."

Finally, Fig. 4, another "without" and "with" display, exhibits the damping provided by the servomechanism. In this case the tonearm has had a 0.5-gram object dropped on its head shell from a height of 10 centimeters. The interpretation of the results is obvious.

How Good an Idea? Evidently it will be some time before the U.S. consumer gets a chance to sample the performance of the Sony arm at first hand, and even then the price (I cannot even quote a projected figure in Japanese Yen) may get the better of his curiosity. The data, as supplied by Sony, definitely seem to be moving in the right direction, and they certainly reveal the possibilities for significant improvement in record-player performance. The conquest of the effective-mass problem seems quite decisive, and it is hard to see how any significant trouble could be encountered unless the fundamental arm-cartridge resonance fell low enough to approach 1 Hz, which is unlikely even with the most compliant of today's cartridges. In this sense the arm should be truly universal. It is also universal in requiring no complex readjustment when cartridges are changed. Zero-balance, tracking force, and anti-skating are established electronically through the servos. If the new cartridge requires a different tracking force and skating compensation, these are simply dialed in on the control module. The whole business becomes a simple plug-in and a few deft twists.

On the other hand, had Sony chosen to offer its own cartridge—a strain-gauge or photoelectric type, for example—as an option for the arm, new possibilities could have been opened up. These types of cartridge have an output down to dc when stylus deflection exists.

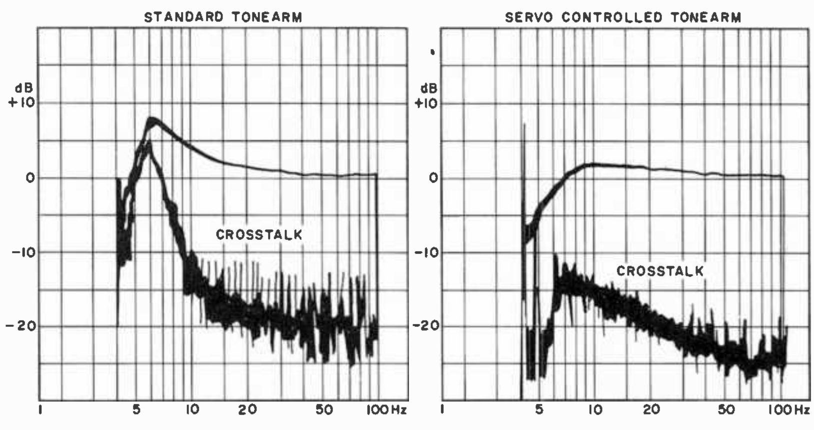


Fig. 2. Damping action of Sony servos significantly reduces amplitude of the fundamental arm-cartridge resonance and the crosstalk.

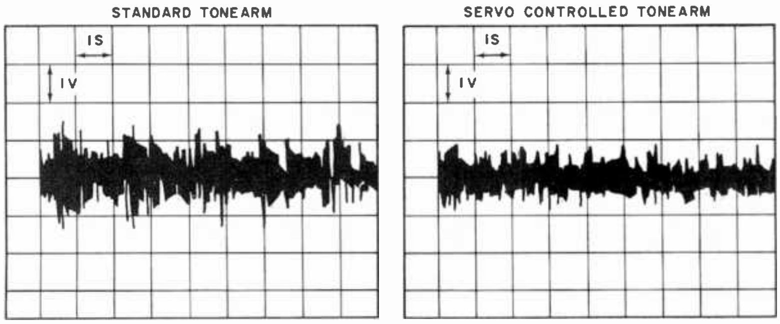


Fig. 3. A stable tonearm can markedly reduce noise output from a cartridge over a broad band of frequencies.

Monitoring that output would make possible dynamic anti-skating compensation that could to a degree adjust itself to the constantly changing drag exerted on the stylus by different record materials and modulation velocities. (At the time of his direct involvement with radial-tracking tone arms, inventor Jacob Rabinow became convinced that their elegant solution to the skating problem was a great contribution to their audible merit.) Tracking force could be referred directly to stylus-cantilever deflection, which might prove to be a bit more realistic approach than to assume that every sample of a particular cartridge model is identical to its brethren and requires exactly the same tracking force. But let us not quibble here. Sony has chosen to build a completely universal tonearm designed to work with any high-quality cartridge, and this attitude probably serves the interests of the market best.

Now, what I would like to do is pirate the whole assembly containing the vertical sensor mechanism and motor, mount it to a carriage that would enable it to transit along an overhead track, shorten the support shaft so that the lateral sensor and motor could be brought right up underneath the carriage, convert the optical record-size/end sensor mechanism into a system that could control an advance motor, straighten the arm shaft, and. . . . Well, you get the idea. Maybe next year.

The pity of it all is that a miniscule number of people ever gets to work with a record-playing system sophisticated enough to do credit to the disc medium, and therefore the *audible* improvements possible are just not realized by the majority of sound enthusiasts. Pursuing the ideal speaker is certainly no waste of time, and trying to get a line on the best-sounding amplifier and preamplifier is probably not complete folly. But the program sources available to the average consumer today are grossly imperfect, and although digital techniques suggest an answer, it is not an answer readily at hand. So I recommend you consider looking to improvements on your record-playing system. The improvements will not be easy to effect and in many cases they will not be cheap. But they can be a revelation.

We'll keep you posted. ◇

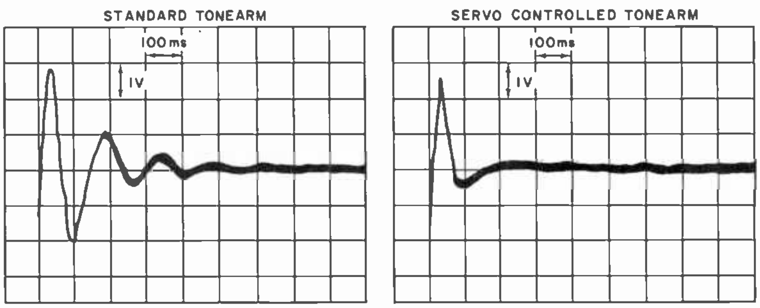
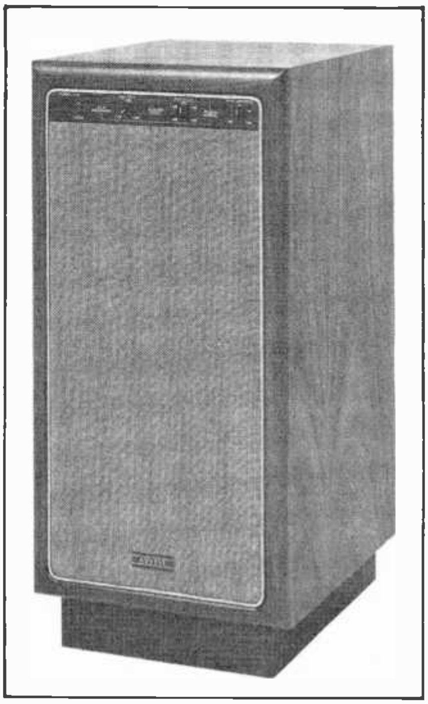


Fig. 4. In a shock-response test, the servo-controlled arm's superiority is immediately apparent from the quick damping of oscillation.

Julian Hirsch Audio Reports

two amplifiers are in "Powered Advent" speaker system

separate amps for woofer and tweeter plus electronic crossover network



HIRSCH-HOUCK LABS REPORT

Advent Corporation's "Powered Advent" is a biamplified speaker system that employs the same drivers developed for the company's "New Advent" system. The enclosures for the two systems are approximately the same size. The Powered Advent, however, contains built-in separate power amplifiers for its woofer and tweeter plus an electronic crossover network and elaborate safeguards to protect both amplifiers and drivers against damage.

The cabinet for the system is finished in oiled walnut veneer, with rounded solid walnut edge moldings. Except for a control panel at the top of each enclosure, these speaker systems appear conventionally designed. The system, including a black pedestal base that comes with it, measures 28 ⅜"H × 14 ⅛"W × 13"D (72.1 × 35.9 × 33 cm) and weighs 66.5 lb (30.2 kg). Each system is supplied with a 30' (9.1-m) cable fitted with phono plugs at both ends. Suggested retail price is $499.50 per system.

General Description. The Powered Advent is a two-way system, as are all Advent speaker systems. Its 10" (25.4-cm) acoustic suspension woofer is driven by an amplifier rated to deliver 80 watts from 20 to 20,000 Hz (it operates up to only about 2000 Hz) with less than 0.1% distortion. Beyond the 1500-Hz crossover frequency, a 1⅜" (3.50-cm) dome tweeter takes over. It is driven by a separate identical amplifier which operates from about 1000 to 20,000 Hz. The power transistors for both amplifiers are mounted on the enclosure's metal rear plate, which serves as a heat sink.

The speaker system's input is through a conventional phono jack on the rear panel. Near this jack is a small toggle switch that can be used to switch in and out an internal subsonic filter whose response is down 1 dB at 30 Hz and 24 dB at 5 Hz. A small panel on top of the enclosure contains a number of operating controls, including a pushbutton POWER switch, low- and high-frequency EQUALIZER CIRCUIT controls, and an INPUT SENSITIVITY control.

Equalization controls affect only the frequency extremes and are intended to compensate for room acoustics (and for some program material at high frequencies). The BELOW 100-Hz control provides up to 6 dB of boost at 30 Hz, and its action is confined to a frequency range of less than 100 Hz. The ABOVE 3000-Hz control affects only those frequencies beyond 3000 Hz and has a range of ±4 dB at 10,000 Hz. The INPUT SENSITIVITY control can be adjusted from 0.3-volt maximum input for full speaker system output to fully off.

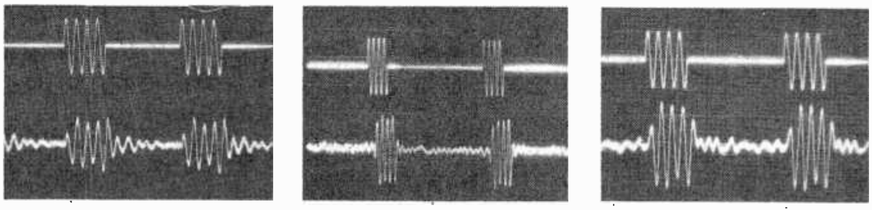
A green LED on the panel comes on when power is switched on, while a red LED flashes when one of the system's internal protective systems has been tripped. The system's input impedance of 100,000 ohms permits the Powered Advent to be driven from any line-level source, such as a preamplifier, tuner, or tape deck.

There are four separate protective circuits in the Powered Advent system. The tweeter is protected by an analog circuit that integrates the energy in the tweeter's frequency range and shuts off the driver if thermal overload is imminent. It does not react to short bursts of high-frequency energy. Thus, it protects the tweeter against voice-coil burnout from lower-level signals of relatively long duration.

Another circuit protects against excessive excursion of the woofer's cone, which could be caused by a failure in the amplifier that places the dc supply voltage across the woofer's voice coil or by certain overload signals (such as dropping the phono pickup onto a record with the volume set high) with the subsonic filter bypassed.

two-way system has 10-inch woofer and 13/8-inch dome tweeter

A third circuit protects the amplifiers' output transistors. This circuit continu-



Toneburst responses for (left to right) 100, 1000, and 10,000 Hz.

The Powered Advent is one of the few self-powered biamplified speaker systems on the market today. Several advantages have been claimed for this design approach. Some are obvious, such as the elimination of bulky power amplifiers that can at times pose installation problems. Most, however, relate to the interface between amplifier and speaker-system drivers.

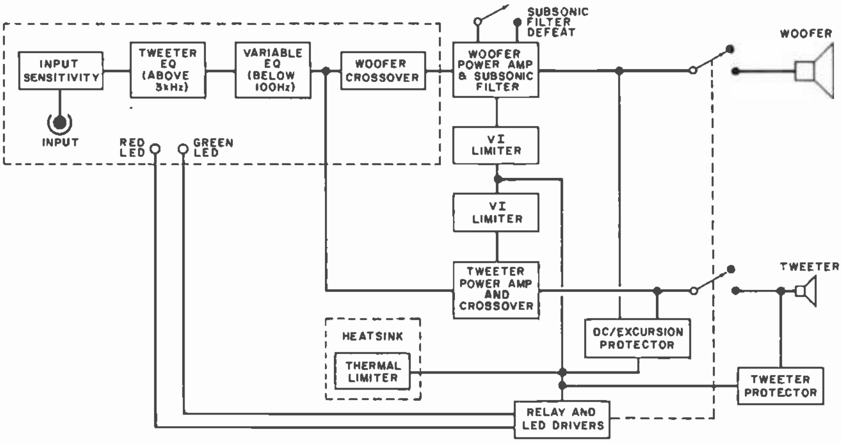
It has been claimed that the inductance (or capacitance or resistance or a combination of the three) of ordinary speaker cables leads to a subtle loss of definition or other degradation of sound quality, usually by virtue of its effect on the system's response in the ultrasonic range. Although the reality of these effects is debatable, there can be no argument that reducing the length of speaker cables or eliminating them entirely can be beneficial. Building the amplifier into the speaker enclosure represents the ultimate in elimination of cable effects.

The impedance of most speaker systems varies widely over the audio frequency range. Part of this is due to the drivers' mechanical resonances and part to the reactive crossover network components. As a result, the amplifier is almost never terminated in a load that in any way resembles the ideal resistor load used for laboratory testing of amplifier performance. Some combinations of speaker systems and amplifiers are particularly unfortunate because they lead to distortion and instability. In a biamplified system, however, the crossover components are ahead of the amplifiers. Thus, each amplifier "sees" only the impedance variation of the drivers themselves. Even if these are substantial or unusual, the integrated speaker-system designer has the opportunity to compensate for them in the overall design of the amplifier and speaker system.

There can be no doubt that the crossover design has a considerable effect on the overall sound of a speaker system, and many people feel that eliminating the usual crossover (by going to a biamplified system) results in a clearer, better defined sound quality.

Anyone who has had the misfortune to blow out a speaker system or an amplifier by careless or over-enthusiastic use of the volume control, will appreciate the advantage of having foolproof protection in his music system. It is difficult to make an amplifier that is absolutely blowout-proof under any load and drive conditions, and it is impossible to make a speaker system that cannot be damaged by some amplifier. However, if the amplifier and speaker system are designed as an integrated unit, as in the Powered Advent system, their characteristics can be made complementary. In addition, the protective circuits can be integrated with the total design, making burn-outs almost impossible.

The above are some of the advantages of the integrated biamplified design used in the Powered Advent. There are certainly many more, but the ones enumerated here are, in our view, the principal "plusses" of this type of product. The most obvious minus in such a system is the cost, although when one compares it to the combined cost of a 200-watt/channel amplifier and a pair of conventional speaker systems of similar performance, such as the New Advents, with due allowance for the more effective protection in the powered version, the cost differential does not seem great.



ously monitors the output-transistor current and voltage. And overload from an excessive input level or from a short-circuited driver causes this circuit to immediately shut down the system.

Finally, there is thermal protection for the entire amplifier system. This circuit continuously monitors the temperature of the heat sink. Should the temperature increase to too great a degree, the thermal-protection system shuts down the amplifier.

Laboratory Measurements. As is our custom, we measured the semireverberant-field response of the Powered Advent system with its equalizer controls set to their nominally flat 0-dB settings. We then measured the frequency response with the high-frequency equalization control set to its limit of ±4 dB.

> four circuits protect tweeter, woofer, output transistors, and amplifier system from overload

The low-frequency response was measured separately with close microphone spacing and the bass equalizer control set first to 0 and then to +6 dB. When we spliced together the two curves, we obtained a frequency response that rose beyond 5000 Hz.

The lowest setting of the high-frequency equalizer control (−4 dB) produced an extremely flat response out to 13,000 Hz, after which the response fell off rapidly. The dispersion of the new tweeter used in the Powered Advent system was outstanding. Our on-axis and 30° off-axis measurements for the tweeter were essentially identical.

The woofer's response reached its maximum in the range between 60 and 100 Hz. It sloped down gradually at higher frequencies and at the expected 12-dB/octave rate at lower frequencies (in the 0-dB bass equalization condition). The equalizer had a 6-dB maximum effect at 30 Hz, as rated, and had essentially no effect on frequencies beyond 60 Hz. The spliced composite curve revealed a broad dip in the midrange, amounting to about 5 dB between 600 and 1000 Hz. Using the

Manufacturer's Specifications

Specification	**Rating**
Power output (cont. both amps. driven, 6-ohm load)	
Woofer	80 W min., 20-20,000 Hz at less than 0.1% THD
Tweeter	80 W min., 20-20,000 Hz at less than 0.1% THD
Intemodulation distortion	60/7000 Hz, 4:1 Less than 0.1% at rated output
Input sensitivity	Adjustable from 0.3 V to infinity
Input impedance	100,000 ohms
Crossover frequency	1500 Hz
Subsonic filter	−1 dB at 30 Hz −24 dB at 5 Hz
Equalizer controls	Variable below 100 Hz from flat to +6 dB at 30 Hz. Variable above 3000 Hz ±4 dB at 10,000 Hz.

equalization that yielded flattest overall response (−4 dB at high frequencies and +6 dB at low frequencies), we obtained a very good ±3-dB overall response variation from 26 to 15,000 Hz,

flattest setting of equalization controls yielded very good +3-dB overall response from 26 to 15,000 Hz

although it showed signs of rising again above 20,000 Hz. The Powered Advent had a uniformly good tone-burst response at any frequency in its operating range. Even in the crossover region, there were no serious modifications of the burst shape. Since an appreciable amount of tone-burst distortion arises in the conventional LC passive crossover networks of speaker systems, it is possible that the active networks used in this system are responsible in part for its tone-burst performance.

In measuring bass distortion of the speaker system, we could not follow our usual practice of driving the system with a constant voltage corresponding to 1 watt into its rated impedance. Instead, we drove it to a sound pressure level (SPL) of 90 dB at a 1-meter distance with a 100-Hz sine wave and maintained that input level as we reduced the frequency. The output of the close-spaced microphone was connected directly to our Hewlett-Packard Model 3580A spectrum analyzer; the levels of all significant harmonics were combined to obtain a THD reading. The second harmonic was predominant, while the total distortion was 1% to 2% from 100 to 50 Hz. Notably, the distortion did not rise sharply at lower frequencies. It was only 5% at 30 Hz, as an example.

Although the sensitivity of the system also cannot be readily compared to that of any conventional speaker system, we discovered that an input of 0.3 volt of random noise in an octave centered at 1000 Hz, with the system's input control set to 0.3 volt (maximum), produced a very high 112-dB SPL at 1 meter from the grille. Since the sensitivity can be reduced to any lower value, and the 112-

the dispersion of the new tweeter is outstanding

dB SPL is exceptionally high for any home speaker system, it would appear that the Powered Advent can be driven adequately from *any* high-level or line-level signal source.

User Comment. The Powered Advent sounded distinctly "bright" when we used its 0-dB equalizer settings. We soon determined that other settings were preferable in our listening room: −4 dB for HF and +6 dB for LF settings. This also gave us the flattest measured response and illustrated what a creditable electronic tone-control system the speaker/amplifier has.

To our ears the speakers exhibited a clean, crisp, and very slightly bright character with program material that did not contain much bass. We confirmed that the speaker system can indeed be played at prodigious volume levels without equipment damage or obvious distortion. When pushed too far, the protective circuits momentarily silenced the speakers, accompanied by lighting of front panel red LEDs. The level required to cause this condition was unbearably high in our normal-size room.

From both our listening tests and measurements, the Powered Advent is clearly a very fine system. That is, a combined speaker and power amp system. We would recommend it highly for anyone with a top-quality separate preamp who does not intend to buy a separate power amp (remember, each of these systems contains 160 watts of high-quality amplification). One would therefore reduce space requirements, and gain the attributes of biamplification, virtually fail-safe equipment protective systems, and so on.

can be played at prodigious volume levels without equipment damage

The only drawback we could find was the minor one that requires plugging the systems into an ac line and switching them on and off separately at the beginning and end of each listening session. Since they draw considerable power (up to 450 watts per speaker/amplifier), Advent does not recommend plugging them into the switched outlets of a preamplifier unless they are rated to handle the 900-watt load.

(Reports continued on page 28)

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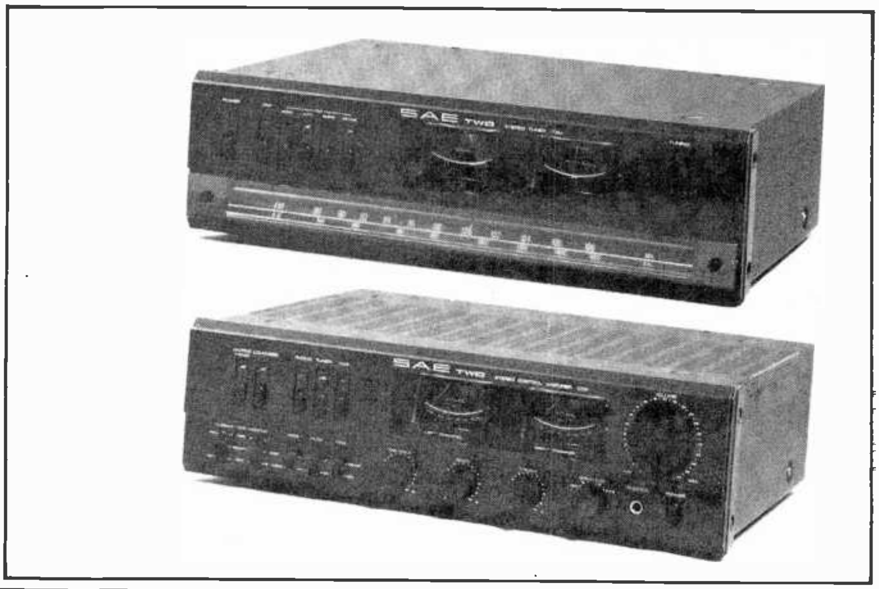


popularly priced components from a "high-end" manufacturer: the SAE TWO stereo tuner and integrated amplifier

new audio line is introduced

HIRSCH-HOUCK LABS REPORT

Scientific Audio Electronics' new "SAE TWO" product line brings the company's products into a more popular price range than its typical "high end" models. Initially, the SAE TWO line consists of an AM/FM-stereo tuner, an integrated amplifier, a receiver, and cassette deck. All are built in Japan to SAE designs and specifications.

We tested the SAE TWO Models T3U tuner and C3A integrated amplifier, which together form the nucleus of a modestly priced audio system of outstanding quality. Both units are identical in size and style. They're finished in black throughout, with accents of white panel legends and red LED status indicators. The cabinet tops are dimpled to accept feet on the bottom of each unit, allowing them to be stacked if desired.

The SAE TWO units measure 17¼" W × 12⅜" D × 5" H (43.8 × 31.4 × 12.7 cm), excluding the knobs and rear connectors. The amplifier weighs 19 pounds (8.6 kg) and the tuner weighs 12½ pounds (4.9 kg). The suggested retail prices are $325 for the amplifier and $275 for the tuner.

General Description. The Model T3U tuner has a long dial scale that occupies most of the width of the bottom half of the front panel. The dial is calibrated only at 2-MHz intervals. Above the dial are two large meters that indicate relative signal strength and FM center-channel tuning. To the right of the meter is a large TUNING knob, the only knob control on the tuner.

To the left of the meters is a group of control pushbuttons, with red status LEDs above them. They include BLEND (mixing of two channels at high frequencies to reduce hiss on weak stereo signals) and MUTING. On the rear is a hinged ferrite-rod AM antenna.

The FM "front end" has a conventional dual-gate MOSFET r-f amplifier. Bipolar transistors are used in the mixer and local oscillator; active circuits of the AM tuner are contained in a single IC, which provides all the functions from r-f input to the audio output. The FM i-f output goes through two pairs of ceramic filters that are separated by a single transistor stage and then to a multipurpose IC that provides gain, limiting, quadrature detection, and FM interstation muting. Audio output, including multiplexed stereo information, goes to a phase-locked loop multiplex IC, whose outputs are the two stereo channels. After filtering to remove ultrasonic pilot carrier components, the audio goes through discrete component low-level audio amplifiers and through relay contacts to the output jacks. The relay disconnects the tuner's audio outputs the moment any of the selector buttons is pressed and restores the audio about a second after the button is released. This prevents any switching transients from reaching the amplifier and speakers.

The front panel of the amplifier has its two output meters in the same position occupied by the tuner's tuning meters, giving the two units a highly unified appearance when they are stacked. Meter scales are calibrated approximately logarithmically from 1 to 50 watts. Like the tuner's meters, their white pointers and legends contrast well with the black meter face and panel, resulting in excellent readability.

To the right of the meters is a large VOLUME knob matching the tuner's TUNING knob in size and placement. One side of the VOLUME knob is flattened and has an engraved index line, and the control is lightly detented in about 40 steps. The other knobs on the amplifier, though smaller than that on the VOLUME control, are similar in shape. To the left of the meters are pushbutton switches that are identical in appearance to those on the tuner. Three are for selecting inputs,

provide uniform appearance when stacked

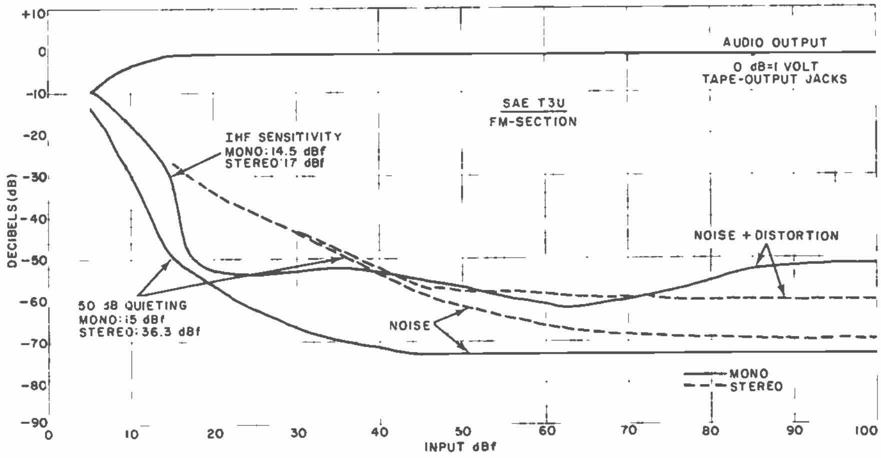
while the others are for switching in and out the LOUDNESS compensation and audio MUTING. (The latter provides a nominal 20-dB volume reduction.)

Along the bottom of the panel are a number of other controls. Two three-position toggle switches are assigned to tape-monitoring and dubbing functions for two tape decks that can be connected to the amplifier. The other two-position switches are for stereo/mono MODE switching, FILTER (a low-cut filter, although this is not so indicated on the panel), and TONE DEFEAT. The BASS and

TREBLE controls are continuous types, detented at their center settings. The SPEAKERS switch connects either or both of two pairs of speaker systems to the amplifier's outputs or silences the speaker systems for headphone listening through a jack near the switch.

On the rear apron are the various input and outpout phono jacks, plus three ac outlets, one of which is unswitched. The speaker connectors are insulated and spring loaded, with a hole into which the speaker wire is inserted.

The amplifier uses IC op amps for its tone-control amplifiers and phono preamplifier stages. The power amplifier section uses discrete transistors and components. The output stages use plastic cased complementary-symmetry transistors that are clamped to a finned heat sink that occupies the center of the amplifier below the ventilating grille on its top cover. A relay, operated by electronic sensing circuits, disconnects the speakers instantly in the event of a severe overload, short-circuited output, or other malfunction. It also provides a few seconds of turn-on delay.



Noise and sensitivity curves for FM section of tuner.

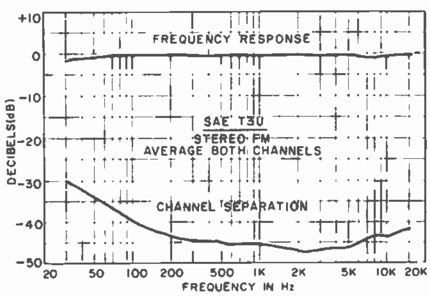
Laboratory Measurements. The SAE T3U tuner had an IHF sensitivity of 14.5 dBf in mono and 17 dBf in stereo. For 50-dB quieting sensitivity—which is the truly important tuner sensitivity rating—was a very good 15 dBf in mono at 2.6% THD. In stereo, the figures were 36.3 dBf at 0.4%. Stereo and muting thresholds were identical at 14.8 dBf. Distortion at a 65-dBf input measured 0.083% in mono and 0.115% in stereo. In mono, distortion reached its minimum at 65 dBf and rose slightly higher at higher inputs. It was typically 0.2% to 0.25% at most signal levels. Stereo distortion, on the other hand, decreased steadily with increasing signal level, reaching a minimum of only 0.1% above 85 dBf. The ultimate S/N, at a 65-dBf input, was a very good 76.5 dB in mono and 70.5 dB in stereo.

capture ratio was exceptionally good at 1.12 dB

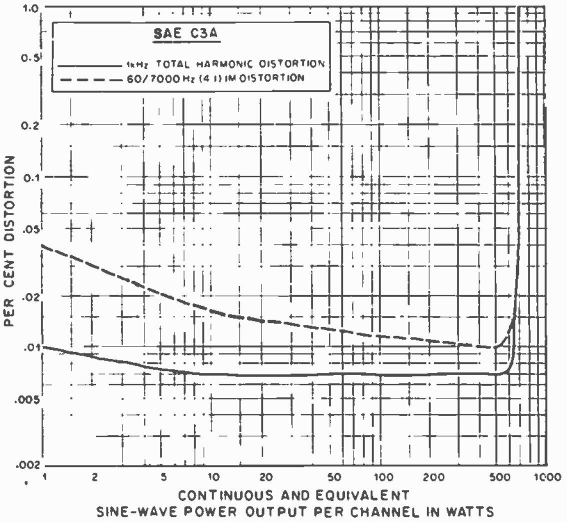
The tuner's stereo distortion with L – R modulation, at a 65-dBf input, was 0.45% at 100 Hz, 0.12% at 1000 Hz, and 0.16% at 6000 Hz. The audio output lev-

Performance Specifications

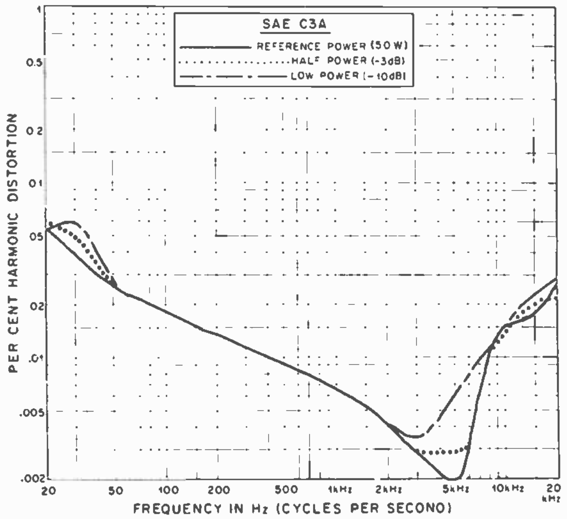
Specification	Rating	Measured
Model C3A Amplifier:		
Power (8 ohms 20-20,000 Hz)	50 watts/channel	65 watts/channel (1000 Hz)
Total harmonic distortion	0.05%	0.01% (1000 Hz)
IM distortion	0.05%	0.015% (1-65 watts)
S/N ratio		
Phono (A wtd., 100-mV reference)	85 dB	70-75 dB (A wtd., 1-watt out.)
Aux (A wtd.)	97 dB	70-75 dB (A wtd., 1-watt out.)
Phono overload	150 mV	160 mV at 1000 Hz
Sensitivity Phono	2.5 mV	0.31 mV (1-watt output)
Aux	150 mV	22 mV (1-watt output)
Frequency response (20-20,000 Hz)	±0.25 dB	Verified
RIAA equalization accuracy	N/A	20-20,000 Hz ±0.5 dB
Model T3U Tuner:		
FM section:		
50-dB quieting		
Mono	14.7 dBf (3 μV)	15 dBf
Stereo	27.3 dBf (40 μV)	36.3 dBf
Frequency response	N/A	30-15,000 Hz +0.2/−0.8 dB
THD Mono	0.1%	0.083%
Stereo	0.2%	0.115%
Capture ratio	N/A	0.95 dB at 65 dBf
Separation	40 dB (1000 Hz)	40-46 dB (120-15,000 Hz)
	35 dB (10,000 Hz)	30 dB (30 Hz)
S/N ratio	N/A	76.5 dB (mono)
		70.5 dB (stereo)
Alternate-channel rejection	N/A	50.6 dB
Image rejection	N/A	85.6 dB
AM rejection	N/A	55 dB at 65 dBf
AM Section:		
Frequency response	N/A	−6 dB at 33 and 2900 Hz



Averaged response and crosstalk.



THD and IM distortion at 8 ohms.



Percent harmonic distortion.

el, which is fixed, was 0.86 volt at 100% modulation. Frequency response was +0.2/−0.8 dB from 30 to 15,000 Hz. Channel separation differed in the two channels, but was uniform with frequency. The average of the two readings was between 40 and 46 dB from 120 to 15,000 Hz and a good 30 dB at 30 Hz.

The capture ratio was exceptionally good at 1.12 dB at 45 dBf and 0.95 dB at 65 dBf. AM rejection was average, measuring 55 dB at 65 dBf and 65 dB at 45 dBf. (It is unusual for the AM rejection to decrease with increasing signal strength.) Image rejection of 85.6 dB represents good performance. The i-f bandpass of the tuner was highly asymmetrical, however, which made measurement of its alternate-channel selectivity rather difficult. The best average reading we could get of this characteristic was 50.6 dB, an acceptable but not distinguished rating. Adjacent-channel selectivity was 5.5 dB.

Although the tuner's high-frequency response showed no signs of a drop-off from the low-pass filter (it was actually *up* at 15,000 Hz), the filter was highly effective. The 19-kHz pilot carrier signal in the audio output was −73 dB, referred to 100% modulation. No sign of the 38-kHz component could be detected. There was a small amount of power-line hum in the tuner's output, measuring −62 dB at 60 Hz. The AM-tuner section had a restricted frequency response, down 6 dB at 33 and 2900 Hz.

The SAE C3A amplifier became only moderately warm during its one-hour preconditioning period at one-third rated power, after which its outputs clipped at 68 watts/channel when both channels were driven at 1000 Hz into 8-ohm loads. This corresponds to an IHF clipping headroom rating of 1.33 dB. The IHF dynamic headroom, a measure of the amplifier's short term power capability, was 1.85 dB.

Harmonic distortion at 1000 Hz was 0.007% at most power levels. It rose to 0.01% at 0.1 watt and 65-watts output. Thus, its 65-watts/channel at 0.01% distortion performance was substantially better than its rating of 50 watts/channel with 0.5% distortion. IM distortion was less than 0.015% at most power outputs from 1 to 65 watts, although it rose appreciably at very low powers in the milliwatt range. In contrast, harmonic distortion was nearly constant with power at outputs from rated power to −10 dB. Beginning at a maximum of less than 0.06% at 20 Hz (which includes the approximately 0.02% residual of our signal generator), distortion decreased smoothly to a minimum of 0.002% to 0.004% at about 5000 Hz. It then rose to about 0.025% at 20,000 Hz. To drive the amplifier to a reference power of 1 watt, an AUX input of 22 mV or a PHONO input of 0.31 mV was needed. The A-weighted S/N was roughly the same through both inputs under IHF standard test conditions, measuring 70 to 70.5 dB referred to 1 watt. The phono input overloaded at 160 mV. Phono input impedance was 50,000 ohms in parallel with 50 pF of capacitance.

The tone controls had conventional curves, with a sliding bass turnover frequency and treble curves hinged at about 1500 Hz. The LOUDNESS compensation boosted both low and high frequencies as volume was reduced. The response of the FILTER was down 3 dB at 45 Hz. We could not determine its ultimate slope, which was below our 20-Hz lower measurement limit. The RIAA equalization accuracy was well within ±0.5 dB from 20 to 20,000 Hz and was hardly affected by cartridge inductance. (The output at 20,000 Hz rose less than 0.5 dB when measured through the coil of a cartridge).

User Comment. Our initial impression of the SAE TWO components was highly favorable. They are, to our eyes, quite attractive. The measurements speak for themselves. These compo-

FM tuner was positive and noise free

nents are excellent performers, though not quite up to the stellar standards set by SAE's costlier regular line.

We did not find any operating "bugs" in the SAE TWO tuner and amplifier, and they were as quiet and free from thumps and switching noises as any tuner and amplifier we have used. FM tuning was positive and noisefree. Furthermore, the momentary muting action when an input button was pressed was totally effective in eliminating noise.

There were a few minor criticisms, though. Lack of separate preamplifer outputs and power amplifier inputs in the amplifier would have been a nicety in an otherwise very up-to-date design. Their inclusion would certainly simplify connecting certain signal-processing accessories, including some made by SAE, into the system without sacrificing a tape recorder circuit.

(Continued on page 32)

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The calibration marks on the FM tuning dial are much too limited to permit unambiguous station identification. They appear to be reasonably accurate (though interpolating to 200 kHz accuracy between markings spaced at 2-MHz intervals calls for a combination of skill and luck).

Aside from the foregoing, we must say that the SAE TWO components performed very well. Also, we appreciated that the FM tuner was noncritical in its setting for minimum distortion and maximum channel separation. At most signal levels, the center-channel tuning meter really did show the optimum tuning point for lowest distortion.

Although the Model C3A is not by any means a "super-power" amplifier, it has more than enough power for most installations. We operated the tuner and amplifier stacked, with the tuner on top, and the amplifier hardly became warm, let alone hot. This is a positive benefit of a design that does not seek to cram every possible watt into a small package. The versatility in installation afforded by this combination, plus their strikingly handsome appearance and excellent sound, combine with a surprisingly modest price to make the Models C3A and T3U a fine SAE entry into the medium-cost component market. ◇

two operating speeds are available in the new B. I. C. Model T-2 cassette deck

single-motor, two-head deck runs at 1 7/8 or 3 3/4 ips

HIRSCH-HOUCK LABS REPORT

In the more than ten years since Philips introduced the "Compact Cassette," it has been exclusively a 1⅞-ips tape format for audio recording and playback. Philips licensing agreements have, until now, prevented any manufacturer from entering the consumer market with cassette machines operating at other than 1⅞ ips. Philips' purpose has been to maintain full compatibility between all cassette recorders and tapes. Now, however, the situation has changed with the introduction of three new cassette decks from B.I.C. In addition to the usual 1⅞-ips speed, the "T" series decks can be operated at 3¾ ips. Just as with open-reel tape, doubling the tape speed makes possible a substantial improvement in frequency as well as dynamic ranges as well as flutter.

The B.I.C. Model T-2 examined here is a single-motor, two-head, two-speed cassette deck with distinctive styling and unique operating features. Its black panel, with clearly legible white markings, contrasts with a rosewood-finished wooden cabinet. The overall dimensions are 16¾"W × 6"H × 9¼"D (42.6 × 15.2 × 23.5 cm), while its weight is 12.8 lb (5.8 kg). Suggested retail price is $329.95.

General Description. At first glance, the Model T-2 appears to be quite conventional, though unusually handsome. The front-loading tape transport, with its bottom-hinged door, is at the left of the front panel. Piano-key controls are below it and include a combined STOP/EJECT key. (Initial operation of this key stops the tape motion, and the second opens the cassette compartment.) The tape must be at a stop before the PLAY, FAST FORWARD, or REWIND controls can be operated. The cassette compartment's window is retained by two thumbscrews and can be removed easily for cleaning, demagnetizing, and adjusting the heads.

Just to the right of the cassette compartment is an index counter with a MEMORY button that can be set to stop the tape in REWIND when the counter registers 000. Two large, well-lit meters have black faces with back-lit white scale markings and white pointers that are exceptionally easy to read. Above 0 dB, the markings are in red. The meter scales are logarithmic and cover a range from −40 to + 5 dB, with the Dolby level calibration (corresponds to a 200 nW/m flux level) at 0 dB.

Below the meters are two large concentric knobs for setting recording levels for the two channels. A single indicator between the meters glows green when the deck is recording and instantly changes to red if the peak level exceeds 0 dB. A small OUTPUT LEVEL knob is located to the right of the meters, while below it is a separate PHONES LEVEL control that affects only headphone outputs.

doubling tape speed improves frequency and dynamic range

The remaining controls form a single row across the bottom of the panel, including a switch for selecting either 1⅞- or 3¾-ips tape speed. The dc motor that drives the transport features tachometer feedback for speed

(Continued on page 38)

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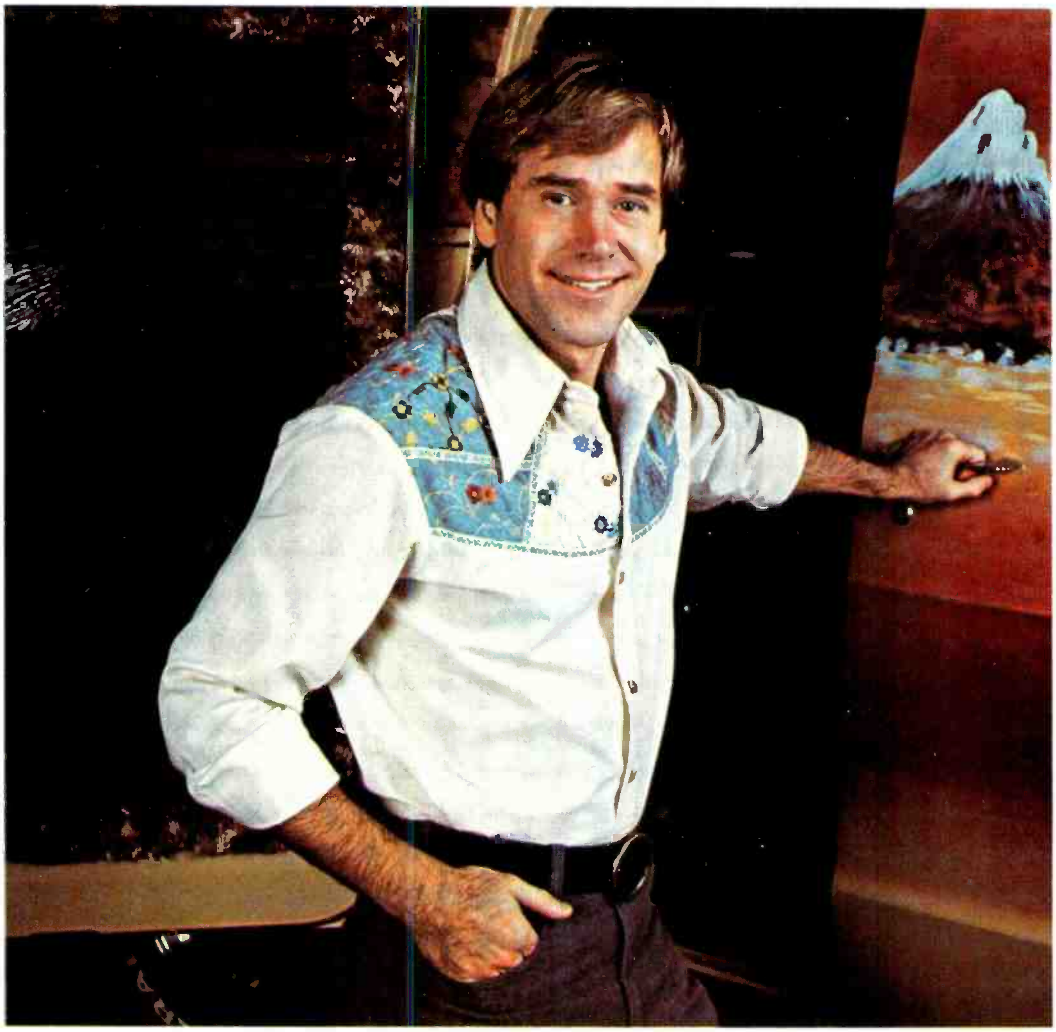

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(Continued from page 32)

regulation. A RECORD SAFETY switch has three positions, labelled SAFE, READY, and MUTE. This switch operates in addition to the mechanical RECORD switch associated with the transport keys and the recording safety tabs on the cassette, which prevent the RECORD key from being engaged when they are removed. In the SAFE position, the deck will not record or erase, no matter how the other controls are set. In READY, the recorder operates in a conventional manner, under the control of its RECORD and PLAY keys. MUTE is spring-loaded and can be used to blank out unwanted material (such as commercial announcements) while making a recording. Holding it down allows the deck to continuously erase the tape, with no signal being recorded. Releasing it restores normal recording. A DOLBY/MPX switch is also provided. In its bottom position, the Dolby system is off. Setting it to the center position, turns on the Dolby system and a green LED above the switch. In the top position, a multiplex (MPX) filter is inserted in the signal path to prevent an FM tuner's pilot carrier leakage from influencing the operation of the Dolby system.

Separate switches control bias and equalization. The three BIAS positions are labelled HI, NORM, and LO, while the EQ settings are marked in terms of their time constants (70 and 120 μs). In general, HI bias is for chromium-dioxide or equivalent tapes, while good ferric-oxide tapes will require NORM bias. LO bias is presumably for relatively inexpensive, low-performance tapes.

To the right of the recording level knobs is a pushbutton switch that permits selection of either the LINE or the MIC inputs for recording. (The two cannot be mixed.) Next in line to the right is the PHONES jack.

Laboratory Measurements. The recorder had been factory adjusted for TDK AD and SA tapes (NORM BIAS and 120-μs EQ; HI BIAS and 70μs EQ). Hence, we used these tapes for all our tests. Insofar as possible, all measurements were made at both tape speeds. Following the information supplied with the recorder, we used HI bias for both tapes at 3¾ ips, although the EQ time constants were the same at both speeds.

The line inputs at the rear apron required only 31 mV at 1000 Hz for a 0-dB meter indication. The corresponding maximum playback level was about 1.8 volts. MIC sensitivity was 0.165 mV, and the microphone preamplifier overloaded with a 21-mV input. This indicates the need for caution when recording from microphones, any of which can deliver over 21 mV at reasonably high sound levels. The maximum headphone output was 1.5 volts into 200 ohms, which gave a very comfortable listening level with medium-impedance phones.

red indicator is most informative display for overload seen

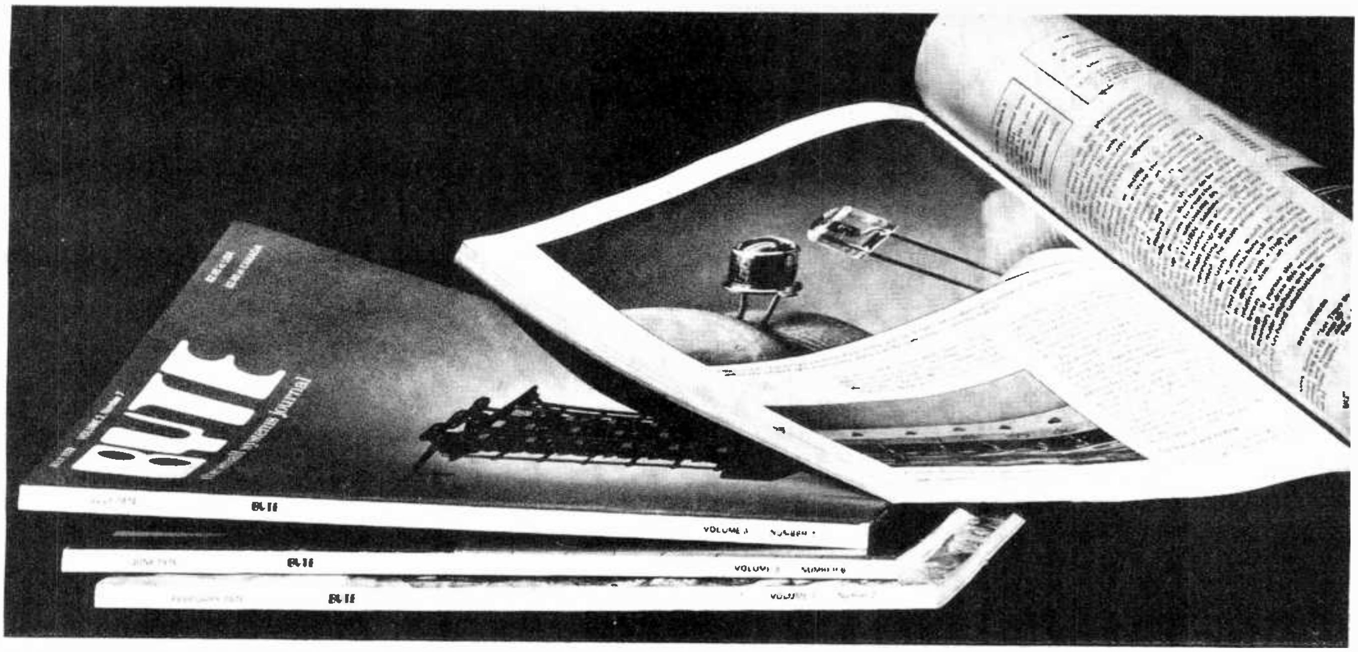
The 1000-Hz playback distortion with a 0-dB recording signal level was well below the specified limits with SA tape and extremely low (0.25% to 0.5%) with AD tape. The reference recording level for AD tape, corresponding to 3% playback distortion, was +5 dB at 1⅞ ips and +7 dB (well above the meter scales) at 3¾ ips. As expected, the SA 70-μs tape saturated at a lower level, +3 dB at 1⅞ ips and +4 dB at 3¾ ips. The red OVERLOAD indicator came on at +1 dB, well before the onset of significant distortion with either tape.

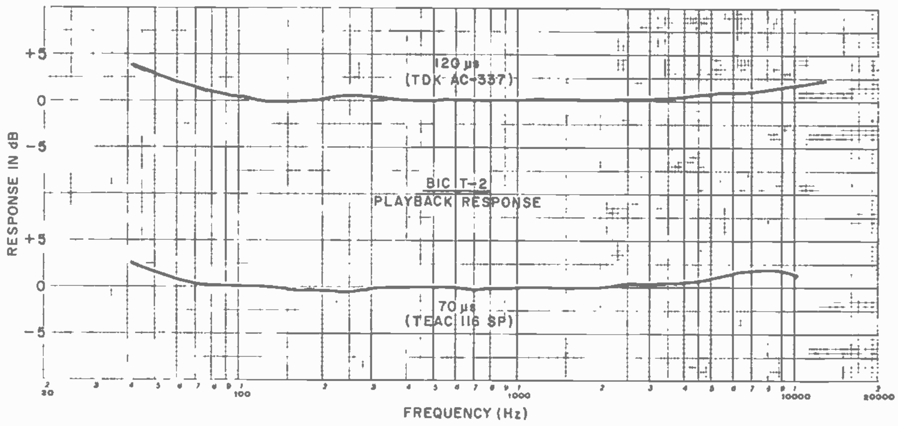
The unweighted S/N, referred to the 3% distortion signal level, was about 48 dB at the lower speed and 51 dB at the higher speed with both tapes. With A weighting, it was 57 to 57.5 dB at 1⅞ ips. At 3¾ ips, the difference between the two tapes was revealed, with AD measuring 61.2 dB and SA 62.4 dB. When we used the Dolby system with CCIR/ARM noise weighting, the S/N performance was very good. It was 64.2 dB with AD tape and 63.6 dB with SA tape, both at 1⅞ ips. At 3¾ ips, S/N was 66.8 dB for AD and 69 dB for SA tape.

The 120-μs playback equalization was measured with a TDK AC-337 test tape. It was flat within ±0.5 dB from 90 to 4000 Hz, and rose to +3.4 dB at 40 Hz and +2.2 dB at 12,500 Hz. The 70-μs response from a Teac 116SP tape was within ±0.5 dB from

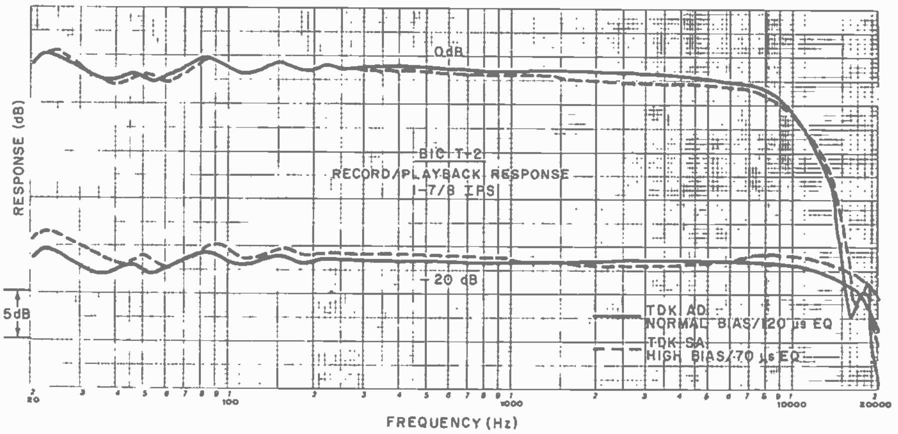
Performance Specifications

Specification	Rating	Measured
Speeds	1⅞ ips (4.75 cm/s) 3¾ ips (9.5 cm/s)	
Frequency Response		
70 μs: 1⅞:	30-18,000 Hz ±3 dB	20-15,500 Hz ±2 dB
3¾:	30-21,000 Hz ±3 dB	20-25,000 Hz ±3.5 dB
120 μs: 1⅞:	NA	20-15,000 Hz ±1.5 dB
3¾:	NA	20-24,400 Hz ±3.5 dB
S/N (A weighted, ref. 3% THD, 70 μs)		
1⅞:	54 dB	57.5 dB
3¾:	57 dB	62.4 dB
1⅞ (Dolby):	62 dB	63.6 dB (CCIR)
3¾ (Dolby):	66 dB	69.0 dB (CCIR)
Wow and Flutter		
1⅞ (wrms):	0.06%	0.06% avg.
3¾ (wrms):	0.04%	0.04% (R/P)
1⅞ (wpk/DIN):	0.12%	0.10%
3¾ (wpk/DIN):	0.10%	0.06% (R/P)
THD (0 dB, 70 μs): 1⅞:	1.9%	1.1%
3¾:	1.6%	0.8%
(0 dB, 120 μs): 1⅞:	NA	0.56%
3¾:		0.25%
Fast Forward/Rewind	Approx. 48 seconds	51 seconds
Meter Type	Peak indicating	Confirmed
Meter Range	−40 to +5 dB	Confirmed
Output (line)	2.0 V rms into 10,000 ohms	1.8 V
Input (line)	200 mV for 0-dB indication	31 mV line 0.165 mV mic.
Microphone Overload	NA	21 mV

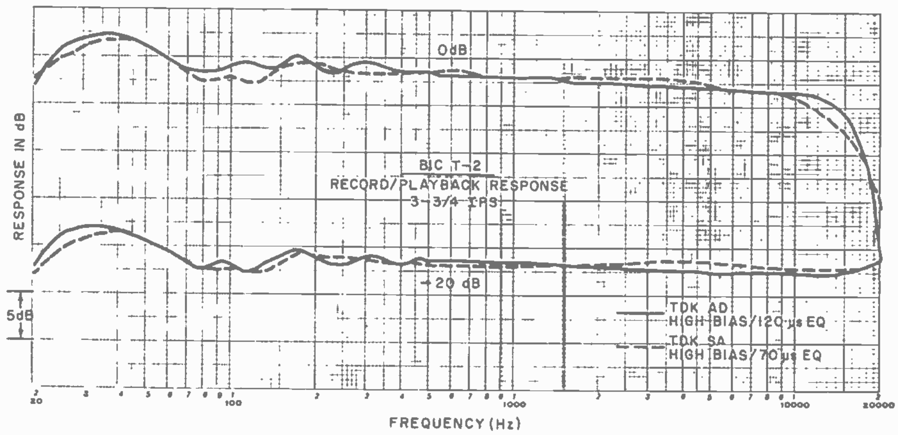




Playback response on test tapes with 120 and 70 microsecond equalization.



Record/playback response for TDK AD and SA tapes at 1⅞ ips.



Record/playback response for TDK AD and SA tapes at 3¾ ips.

63 to 4000 Hz and rose to +2.4 dB at 40 Hz and +1.7 dB at 10,000 Hz.

Record/playback frequency response with TDK AD tape at 1⅞ ips (measured at a −20-dB level) was ±1.5 dB from 20 to 15,000 Hz. The response "ripples" at low frequencies, though present, were much less noticeable than on most cassette recorders. B.I.C's T-2 was unusual in maintaining its full performance down to 20 Hz. High frequencies rolled off fairly gently above 15,000 Hz, to −7.5 dB at 20,000 Hz. At a 0-dB recording level, the effects of tape saturation were hardly detectable below about 7000 Hz, and the 0-dB response curve intersected the −20-dB curve at 15,000 Hz. (This intersection usually occurs around 11,000 to 12,000 Hz.)

Performance with TDK SA tape was generally similar, although there was a slight response rise at 10,000 Hz and slightly better output at the highest frequencies. The overall response was ±3 dB from 20 to 19,000 Hz. The 0-dB curve intersected the −20-dB curve at 15,500 Hz.

When we measured the record/playback response at 3¾ ips with AD tape, we found a substantial improvement. (Although it was predictable and expected, it was nonetheless highly impressive.) The response was within ±3.5 dB from 20 to 24,400 Hz at −20 dB, and the 0-dB curve was virtually flat up to 13,000 or 14,000 Hz, intersecting the −20-dB curve at 20,000 Hz. With SA tape, the response was fairly similar, and was within ±3.5 dB from 20 to 25,000 Hz at −20 dB. The 0-dB response saturated earlier than that of the AD tape. The curve began to drop at 10,000 Hz, but it intersected the −20-dB curve somewhere above 20,000 Hz.

Dolby tracking was unusually close. The change in frequency response, when the Dolby system was switched in and out, was less than 1 dB up to about 12,000 Hz and less than 2 dB at 15,000 Hz, at recording levels of −20 and −40 dB. The meters indicated exactly 0 dB (the Dolby level) when we played a standard Dolby level calibration cassette. Unlike many low-priced recorders, the meter calibrations here were exceptionally accurate (an input change of "X" dB produced a closely corresponding change in the meter indications). With 0.3-second tone bursts used to check VU-meter ballistics, the Model T-2's meters indicated the same as with a steady-state signal. On program input, we could see that the meters had a fast rise time, followed by a much slower decay, so that they tended to follow the peak program level.

The 1⅞-ips speed drifted slightly, from 0.5% fast at one end of a cassette to 0.15% fast at the other end. (We made no speed measurements at 3¾ ips.) Using a TDK AC-342 flutter test tape, we measured the CCIR (weighted peak) flutter at a very good ±0.1%. The JIS (weighted rms) flutter varied from 0.05% to 0.07% at the two ends of the cassette. In a combined record/playback flutter measurement, the CCIR and JIS flutter readings were respectively ±0.12% and 0.09% at 1⅞ ips. At 3¾ ips, they measured ±0.06% and 0.04%. These figures would do justice to a good open-reel recorder! In fast forward and rewind modes, the transport moved a C-60 cassette from end to end in 51 seconds, which is considerably above average for a cassette deck.

User Comment. The B.I.C. Model T-2 demonstrated superb performance at 3¾ ips. But we were equally impressed by what it did at 1⅞ ips! After all, the limitations of the cassette medium begin to decrease rapidly when the speed is doubled. Hence, we were not so surprised by what we measured at 3¾ ips (although the prospect of frequency response, S/N, and flutter levels approaching or matching those of a costly three-head cassette deck is certainly attractive).

Considering the T-2 solely as a conventional 1⅞-ips cassette deck, it is one of the better values we have seen in some time. In many ways, it is a "no frills" machine, with a single motor, combination record/playback head, completely mechanical transport controls, and no input mixing capability. On the other hand, it has superb meters, whose dynamic range and response characteristics give the user a much clearer idea of what the program is doing than run-of-the-mill recorder meters. The manner in which the green RECORD indicator instantaneously changes to red at a +1-dB level might seem to be a rather minor "gimmick," but we found it to be by far the most visible and informative overload indicator we have seen on a tape deck. It simply cannot be ignored or confused with any other indication. Perhaps its only weakness is that it flashes far below the true overload level of AD tape, but it is nearly ideal for use with SA tape.

When we recorded interstation FM tuner hiss at −20 dB on AD tape, the playback was almost indistinguishable from the input signal. (There were minute differences, but one must listen very closely to detect them.) By increasing the speed to 3¾ ips, we could record at meter readings of −2 dB, with the red overload indicator flashing regularly, and hear only about the same small amount of degradation in the high-frequency response. At −10 dB, the reproduction was perfect. In our experience, this is uniquely fine performance for a two-head cassette deck. In practical terms, this means that the Model T-2 is much less likely to compress the high-level peaks and produce a dull or "mushy" sound, especially when recording from a live source, than almost any other comparably priced cassette recorder.

Unfortunately, one must also consider the limitations of a cassette operating at 3¾ ips. Operating times are halved, so that even a C-90 cassette plays only about 23 minutes on a side. One would think that a C-120 would be an ideal solution to this problem, since it would be the equivalent in recording time of a C-60 operating at 1⅞ ips. However, B.I.C. specifically and categorically states that the Model T-2 should *not* be used with C-120 tapes, both because of their magnetic and physical properties and because the high-speed rewind and fast forward of the transport could damage very thin tapes.

Even if one finds C-90 tapes satisfactory, there is the question of compatibility. At this time, B.I.C. is the only company making a 3¾-ips cassette recorder. This means that tapes made on a B.I.C. machine at 3¾ ips can be played only on a B.I.C. machine, at least for the immediate future. Furthermore, even if other companies go to the higher speed, there is no assurance that they will adhere to the equalization standards chosen by B.I.C. Finally, there is the imminent commercial introduction of metal particle tapes and recorders capable of using them. Although they are expensive—at least for the present—these tapes have the potential of giving much of the performance at 1⅞ ips that B.I.C. achieves at 3¾ ips, without sacrificing any playback compatibility with existing cassette decks.

Thus, we prefer to consider the B.I.C. Model T-2 as an especially good cassette recorder, with performance well above the normal for its price range. It also has a higher speed operating mode that may well give it the best cassette performance capability at this moment in time.

CIRCLE NO. 103 ON READER SERVICE CARD

Correction: In the report on the Signet Model TK7E stereo phono cartridge, in the November issue, the channel separation at 1 kHz should be 30 dB, as shown in the graph, rather than 20 dB, as given in the Performance Specification chart.

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Home Projection Color TV
The Big Picture is Here!

A buyer's guide to projection TV receiver systems

The BIG television picture is bigger than ever now as a result of technological advances in video projection systems. Projection TV is not new, of course. In the late Forties, when TV picture tubes were still rather small, all-in-one TV projection systems were introduced in the hope of displacing direct-view receivers. Low brightness and the development of larger TV CRTs, however, dampened the projection concept for home use.

Two decades later, the Advent Corporation resurrected the projection-TV concept with a newly developed very-large-screen system that dwarfed present-day TV picture tube viewing areas without noticeable loss of brightness or resolution. Local bars and well-to-do people were among the first buyers in 1973 of the large-screen (7′ diagonal), two-piece, Model 1000 color projection

TV system. A smaller, lower-cost, 5′ diagonal screen model is now also being marketed by Advent, competing with some 50 other manufacturers of home projection-TV systems. These companies—including GE, Panasonic, and Quasar—produce a variety of projection-TV models at prices ranging from $400 to more than $3000. Clearly, giant-size color TV for the home has arrived!

Projection-TV systems receive standard off-the-air TV signals, but they differ enormously from the standard 25″ (63.5-cm) console receiver. The fundamental difference is that the video image you see is not produced directly on a conventional picture tube. Instead, the image is magnified, projected onto a giant 45″ to 120″ (diagonal measurement) viewing screen. This projection scheme gives you a movie-house effect right in your living room.

Just how the picture is produced by each of the many projection-TV systems available varies. Physically, these new home-entertainment devices can range from two-piece systems in which the projector hangs from the ceiling to all-in-one compacts that close up into a wall unit when not in use. The optical techniques employed give picture qualities that range from fair to excellent.

In spite of the differences in system design, there are only three main categories in projection-TV schemes: refraction, Schmidt, and light-valve. Each renders a projected image with its own particular tradeoffs.

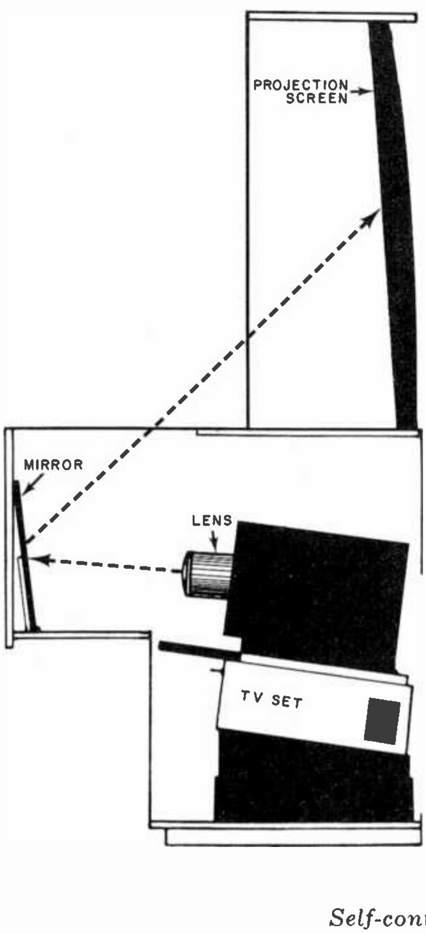
Refraction Systems. If you hold a magnifying glass up to the face of your TV receiver, you can focus the magnified image on a nearby wall. In doing so, you create a basic refraction, or all-lens, projection-TV system. Light from the picture tube passes through the lens and is bent (refracted) outward to provide the magnification. This is the simplest and most commonly employed technique for projection. There are, however, two types of refraction projectors. The first is the single-tube-system, which uses an "almost" conventional TV receiver as the image source and a separate magnifying lens.

In some single-tube projection systems, the lens is merely bolted directly to the face of the receiver. For others, some type of enclosure is used to house the TV receiver and support the lens. In any event, the results are the same. Light from the image on the TV screen is gathered at the back of the lens, refracted, and sent out the front of the lens. This light is then focused on a reflective screen for viewing some 5′ to 8′ (1.5 to 2.4 m) away.

Light passing through the lens from the TV receiver is inverted in the refraction process. To correct for this inversion, a minor modification must be made to the TV receiver. Wires on the receiver's yoke are transposed to invert the original picture on the face of the tube. (The yoke is a coil of wire on the neck of the picture tube that causes the electron beam to scan across the face of the tube.) A switch is usually provided to flip the picture back for normal viewing. Once the inverted image in the projection mode passes through the lens, it is inverted so that it appears right-side up for normal viewing on the screen.

Brightness deficiency is a major consideration for many refraction-lens systems. As a result, you must watch the screen in virtual darkness in order to obtain a good picture.

There are two major reasons for the lower light level in refraction systems. The first is the optics themselves. Lenses are nowhere near perfect in efficiency. Not all the light that enters them passes out again. Some of the light is scattered into useless heat energy with-



Self-contained type of projection TV, such as the Sony Corp. model above right, uses mirror to reflect enlarged TV image to face of viewing screen.

in the lens. Too, a part of the light spectrum may never get through the lens. Also, the light-gathering efficiency of a lens is determined by the lens' F rating. Like the F-stops of a camera, the lower the F number of a projection-TV lens, the more light that passes through. The type of lens used in a single-tube projector often accounts for price. Typically, the lower the cost, the higher the F number (and the lower the light level available for imaging on the viewing screen).

The second and by far the greater problem is the TV receiver itself. For each degree of magnification you gain, you pay a price in light loss. If you project a magnified picture twice its normal size, for instance, you may require 10 times the amount of light coming from the picture-tube source to compensate for the loss of brightness on the screen.

Some manufacturers increase drive voltage on the picture tube of a conventional TV receiver in an attempt to achieve a brighter picture. Although this can certainly be done, it can have detrimental effects on picture quality. Since the total picture is brightened, blacks become shades of grey, causing a loss in contrast and, depending on the receiver, image blooming that can render the picture out of focus.

Naturally, there are exceptions to the foregoing. Some projection-TV receivers are specifically designed for projection use. A good example of this is the 13" (33-cm) in-line picture tube in GE's 45" diagonal Widescreen 1000, which is driven by 32,000 volts.

To combat the problems inherent in single-tube systems, some manufacturers have gone to multiple-tube designs and better optics. The idea here is to substantially increase the available light level without degrading picture quality. These systems employ three projection CRTs (cathode-ray tubes), each of which consists of an electron gun that scans a small phosphor-coated screen. The image produced on the screen is then magnified by a front lens and projected onto the viewing screen. While it is easy to see why three tubes give off more light than one, the reason for a much brighter picture goes far beyond simple light multiplication.

In a normal color picture tube, the *total* color picture is produced on the face of the screen. To accomplish this, triads of red, green, and blue phosphors must be kept close together to form a particular color. To prevent one gun from exciting all three colors simultaneously, a shadow mask is used. The mask allows only the correct color-generating gun to strike the appropriate phosphor. Though the mask serves its purpose for conventional viewing, it poses a problem for projection-TV applications. It cuts down the energy from the electron guns by as much as 80%. Only 20% of the available energy is converted into usable light.

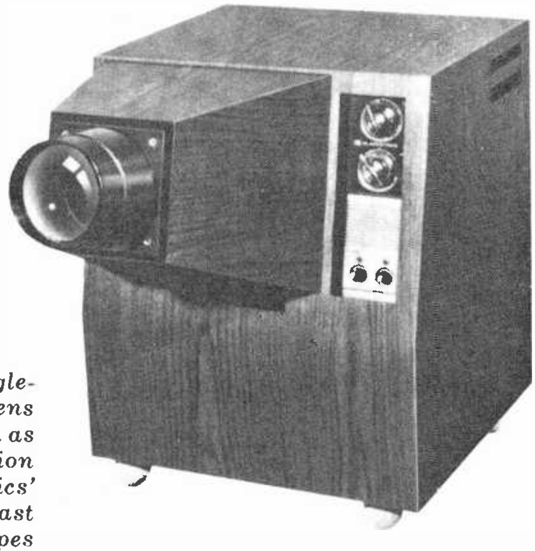
In a three-tube projection system, each tube produces just one color. The "mixing" occurs on the screen so that no shadow mask is required in the tubes. The result is a picture with four or five times the brightness obtainable from most conventional single-tube systems.

In addition to increased brightness, picture quality is usually enhanced in three-tube systems. Convergence, where the three color dots are exactly mixed to form the desired color, is also less of a problem. In contrast, *any* misconvergence in a single-tube system is exaggerated by magnifying the total picture. Sharp, clear outlines of images become lost, and in extreme cases multiple different color images can appear superimposed on but slightly offset from each other.

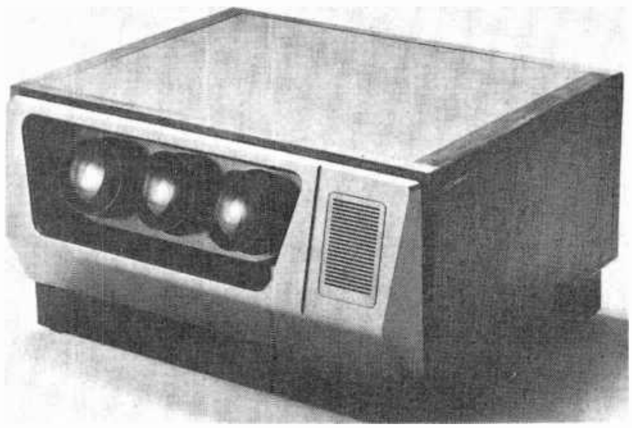
With respect to selling prices, single-tube systems are by far the least expensive. If you choose a three-tube system, though, you can expect to pay two to three times the cost of a single-tube system. Sony, however, is attempting to capitalize on both worlds. The newest Sony system is a three-tube, two-lens design. Three 9" (22.9-cm) CRTs produce the picture, but the red and blue images are combined in a diacrylic mirror that transmits all but one color, to be projected through a single lens. This eliminates one-third of the optics required in a multiple-lens system.

Schmidt System. Although the refractive concept appears an obvious beginning for home projection TV, it did not come along until after development of Advent's "LightGuide" tube. It employed Schmidt optics for a brighter picture. (One of the first demonstrations of a Schmidt projection-TV system was done by RCA in 1939.)

The Schmidt system used consisted of multiple tubes for projection of a video image. Three tubes produce separate red, green, and blue images, which are then converged on the viewing screen. The image is produced by an electron gun that scans the face of a phosphor-coated target screen. The target is specially designed for high illumination levels. Its 5" (12.7-cm) average screen size, operating at 25 to 30 kV, is heavily heat sinked and heat-conductive to prevent burnout. The key to the system, however, is in the optical technique employed.



Two-piece, single-refraction-lens models, such as Projection Electronics' here, are least costly types



Front view of Advent projection TV, shown on opening page, uses three refractive lenses.

Home Projection TV *continued*

A spherical mirror magnifies an image with very good efficiency, but the reflected image is distorted along the edges due to the mirror's shape. A round spot appears comet-shaped when projected onto a screen. The solution to this problem has been used in Schmidt telescopes for years. A corrector lens located in front of the mirror compensates for the optical error to assure a normally magnified image. This combination of reflective and refractive techniques is known as Schmidt optics.

The image produced on the target is reflected from a rear-mounted spherical mirror. It then passes back beyond the target, out of the focal point, through a corrector lens, and onto the remote screen. The result is a picture with a brightness two to three times greater than that obtained with a multiple-tube refraction system.

Because of the $3000 to $6000 price of the Schmidt systems, original home systems were sold mostly to well-to-do customers. As other companies entered the field, the market became more industrially oriented. Since the newest Schmidt systems, from Quasar, Matsushita, and Panasonic, appear to be designed for the home, this picture may be changing again.

Light-Valve System. If money is no object and a big screen TV is what you really want, a light-valve system may be your best choice. In the light-valve system, a high-intensity light source is directed through a thin layer of oil If the oil is smooth, no picture information exists and the light is diverted away from the projection lens. Above the oil is an electron gun. As the electron beam scans in a conventional manner, it deposits a charge that creates a groove in the oil that is proportional to the video information. The light passing through the oil is then refracted to the projection lens and onto the screen.

The light-valve system is not dependent on the amount of light available from a phosphor screen. Any light source will work, though a xenon lamp is the type usually used. In GE's latest light-valve system, three grooves are created simultaneously, one for each color. With this system, a 20′ (6.1-m) wide color picture can be created from as far away as 120′ (36.6m).

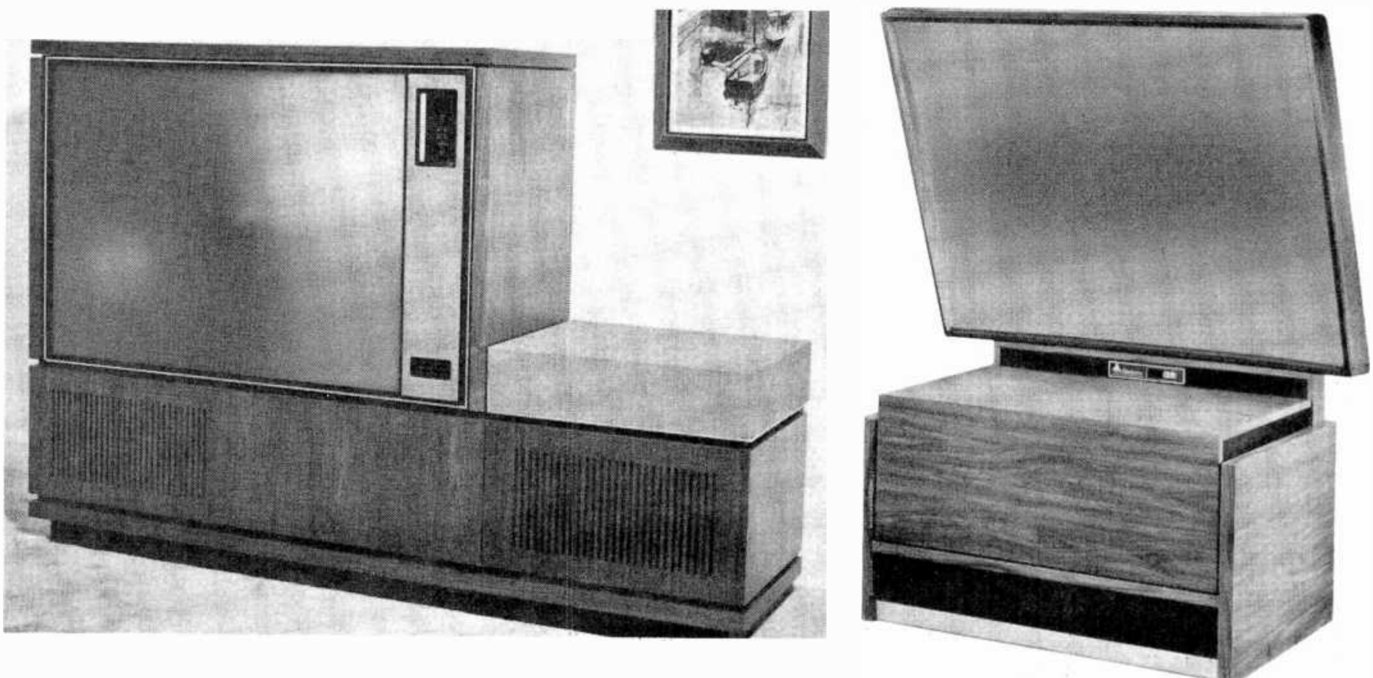
Given these facts, it is obvious that light-valve projection systems were not designed for the home. Not only are they much too large, but their selling prices *start* at $50,000.

Screens and Brightness. It is only natural to concentrate on the light-producing aspect of a projection-TV system. In reality, however, the screen on which the picture is imaged plays an equally important role. The total brightness of the picture you see depends on three important factors—brightness of the original source, size of the projected picture, and *gain* of the viewing screen.

Conventional matte screens have a gain of one, which is simply used as a base by which other screens are compared. Light directed onto a matte screen is partially absorbed, as well as reflected in all directions. In comparison, beaded and lenticular screens are designed to reflect more light and even concentrate light rays for a brighter picture. While a standard beaded screen has a gain factor of two or three, others, such as Kodak's Ektalite screen, have gains of 10 to 16. The Ektalite screen reportedly returns 10 times more light than a matte-surface screen.

Many projection-TV screens have uniform surface particles that act like tiny lenses. Each "lens" receives and redirects the light toward the center of the viewing area. Often, the screen is bent at the sides to direct more light to the center, toward the viewer.

The higher the gain factor of a screen, the greater the concentration of light and thus the brighter the picture. Unfortunately, a price must be paid for the increased brightness: the viewing angle narrows as brightness increases. Ac-



General Electric's "Widescreen 1000," Quasar's Model PR6800QW, and Panasonic's Model 4000 (next page) projection color TV systems are one piece types.

cordingly, if you move 20° to 30° left or right from center-screen, you may no longer see a picture. The same holds true in the vertical plane. Most projection-TV systems are designed to direct the light to a seated audience. If you stand up, the picture's brightness is significantly diminished.

Matching the proper screen to a particular projector is already done for you by the manufacturer of the projection-TV system you choose. If done properly, the screen supplied with a projection-TV system generally offers the best ratio of brightness and viewing angle for that particular system. However, because of all the variables involved, brightness measurements that are often used to rate the system can be very misleading.

Many specifications sheets state brightness as lumens of projected light. This specification may refer to an average "TV" level, or it might be a maximum level without regard to the quality of the projected image. If the latter, it may refer to a picture that exhibits "blooming," which produces a brighter picture than normal.

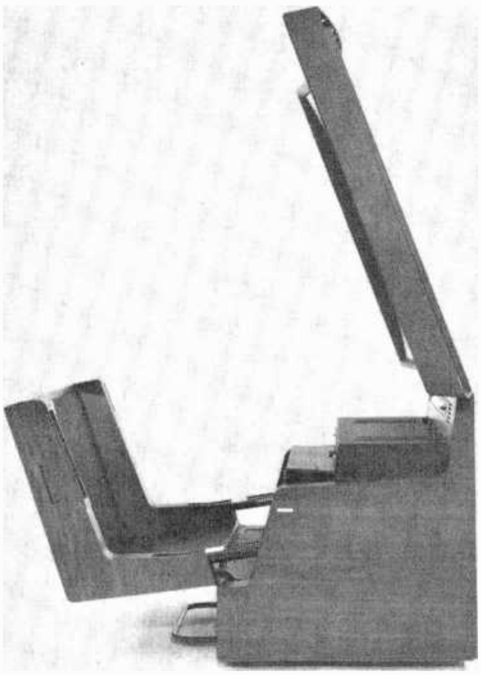
Another question is what the specified lumens means in terms of actual picture brightness once the image is reflected from the screen. The reflected brightness may or may not be listed in the specifications. If not, you can convert into foot lamberts of reflected light by dividing the lumens by the screen's area in square feet and multiplying the result by the screen's gain. This gives you the amount of light coming from the screen when viewed head-on. (Of course, the picture will be less bright if you view from a position slightly off-center.) Too, there may be "hot spots" in the picture, where a portion of the screen may be brighter than the rest of the screen.

The light levels given in specifications sheets should be used merely as a rough guide. Typically, a single-tube refraction system produces 4 to 10 foot lamberts, while multiple-tube systems yield 20 to 30 foot lamberts and Schmidt systems can range from 40 to 60 foot lamberts of light at the screen. As a point of reference, the projector in a typical movie theater usually generates about 16 foot lamberts of light on the screen with no picture projected. A typical movie averages a tenth of this figure, or 1.6 foot lamberts.

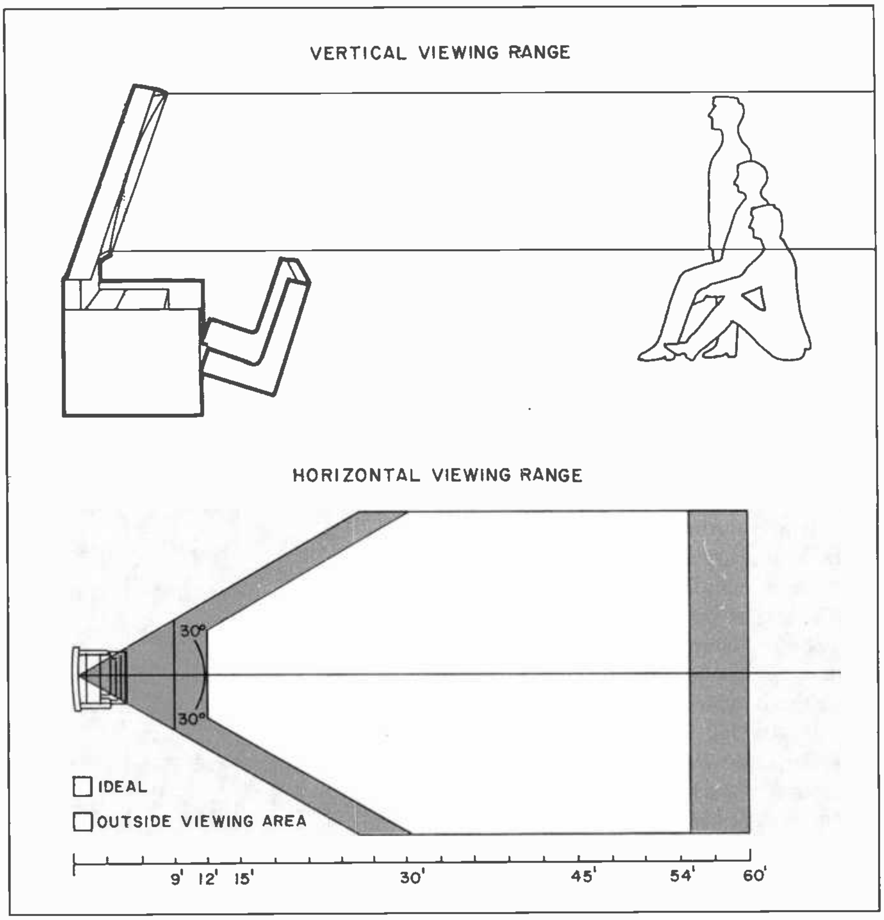
If you are considering buying a projection-TV system, get a demonstration of the system you plan to buy. Better yet, A-B test two or more systems of comparable price against each other. Bear in mind, of course, that the final picture quality will depend on the picture source, the optics, and the type of screen used in the system.

In Your Home. From the outset, projection-TV systems offered good potential for home use. Systems could be built to easily trade off picture quality against cost to meet almost any budget. Naturally, early versions had some physical drawbacks in most home viewing areas. Typical systems consisted of two pieces: a cumbersome TV receiver/projector box and a separate screen. The projector box usually occupied valuable space in the center of the viewing room. As the market developed, however, manufacturers found various means by which to overcome this problem.

The separate two-piece configuration still exists, but the companies that produce them generally put the projector box on casters so that it can be rolled out of the way when the system is not in use. Moreover, the "box" is smaller than earlier versions. Other companies make



Side view of Panasonic model open for use.



To enjoy bright video, seating arrangements for viewing projection TV screen must be in the proper vertical and horizontal area.

Home Projection TV *continued*

ceiling mounts for the projector and screen, which permit the two to be permanently hung overhead and operated by remote control. (Needless to say, be sure your ceiling is 10′ or higher when shopping for one of these systems.) A third approach was to simply let the projector blend in with the room and its furnishings. Here, the projector is disguised as an end or coffee table.

With few exceptions, most of the newest systems are built into a single stand-alone cabinet that contains both projector and screen. In a single-tube system, the receiver lies on its back at the bottom of the cabinet. The picture image passes through a lens/prism box, where it is focused onto a mirror and reflected onto the top-mounted screen. The mirror is generally mounted on a movable "drawer" that opens out 3′ to 4′ (0.9 to 1.2 m) in use and closes into the cabinet when not in use.

The newer multiple-tube and Schmidt systems employ a similar technique to that used in single-tube systems. A variation on this arrangement is used in GE's "Widescreen" projection system. Here, the originating image comes from projection tubes just below the screen, however. The projected picture is sent to the side of the cabinet in which the system is housed and imaged on a rear-projection screen that makes up much of the front of the cabinet. This keeps the height to a minimum (4′ as opposed to the nearly 6′ for other systems), making the system appear like an oversized conventional TV receiver with a 50″ viewing screen.

The Quality Is There. Many projection-TV systems are deluxe items in the manufacturers' lineups. They have top-of-the-line features throughout. For example, many feature video input jacks; some even include a place to mount a video cassette or disc system in or on the cabinet. Remote control is often standard. Automatic color and brightness circuits adjust the picture for you, and VIR (vertical interval reference) is now being used in some models.

Because of the high-fidelity sound capability of the new video cassette decks and the advancements made in TV broadcast network sound, many manufacturers have improved the audio section of their systems. Some systems have separate hi-fi quality speakers built in or as external systems. Other models "project" the sound toward the screen, where it is reflected back to make it appear as though the screen itself is the originating source. This latter approach visually and audibly supports the "moving-picture theater" effect.

The video portion of some TV receivers used in projection systems has high sensitivity and selectivity, and very good resolution and contrast ratio. (Panasonic, as an example, claims 320 lines of resolution off the air, 450 lines through the video input, and a 60:1 contrast ratio.)

The cost of operating projection TV systems is very reasonable. Power consumption is typically 130 to 170 watts, which is about average for a conventional console color TV receiver.

Projection TV Buying Directory

Manufacturer	Price $	Screen Diag. (in.)	Type	Pieces	Remarks
Advent Corp.	4495-up 2595-2995	84 60-72	Schmidt 3-ref	2 2	Conv. & coffee tbl. mod.
American Video	1794-1949	50-80	1-ref	2	Screens opt. $146 to $396
Amtron Video	1995	51	1-ref	2	Ceiling mt. avail.
Automazing Corp.	1695-2195	53-80	1-ref	2	Ceiling/floor cabinets
Avanti Corp.	1495-1995	48	1-ref	2	72″ & 96″ opt. screens avail.
Belmont Proj. Sys.	2195-2795	66-84	1-ref	2	
Century Proj. Sys.	2495 2995-2800	60 72-84	1-ref 1-ref	2 2	Rear projection Conv. & overhead
Cinema IV	1995-2195 995-1300 2195	50-65 60-65 45	1-ref 1-ref 1-ref	2 2 1	Overhead projector Floor models Floor model
Cooper Video	2895-3295	68-84	1-ref	2	Ceiling mounted
Cygnus Video Sys.	1399-1899	50-63	1-ref	2	
Electrohome Ltd.	3495	84-120	3-ref	2	Canadian Advent version
Electronic Sys.	2495	84	1-ref	2	Coffee table design
Extron	995 1199	50 50	1-ref 1-ref	2 1	Excl. TV Excl. TV
Future-Vision	1995 1395-2250	60 60-96	1-ref 1-ref	1 2	
Futurevision	1695-1895	54-66	1-ref	2	
Gemini Sys.	1595	52	1-ref	1	
General Equip.	1995-2895 995-1595	48-72 48-72	1-ref 1-ref	2 2	Ceiling system Floor models
General Electric	2800	45	1-ref	1	Rear projection
Giant Screen TV	1495-1795	50	1-ref	2	13″ or 15″ TV
Global Video Ind.	1995-2295	50	1-ref	1	
Holophonics	895	72	1-ref	2	Proj/TV mode
Kalart Video	4820	var	Schmidt	2	B/W only
Keyser Video Inc.	1495-1595	51-67	1-ref	2	Ceiling or console
Lin-Video	1095	50	1-ref	2	
Magnavision	1695-2195	53-80	1-ref	2	Ceiling or floor
Magna-Vu	499	52	1-ref	2	Kit: screen, lens, cab.
Miami Flock	425	84	1-ref	2	Kit, excl. TV
Mitsubishi	3400-4000	72-84	Schmidt	1	

Selecting a System. Projection-TV systems are not appliances you just "pick up," plug in, and turn on. You must plan your system and make provisions for its installation to take full advantage of its capabilities.

The thing you must keep foremost in mind is that a projection-TV system demands lots of space. Separate two-piece systems require 6' to 8' minimum of clear floor space between projector and screen. Then you must figure another 2' to 3' for the projector and some space behind the projector for viewers. All-in-one systems require about the same amount of space, except that the area required is proportioned differently. You need approximately 20 to 25 square feet of floor space, depending on the system. As a general rule, the closest seating for a viewer should be no nearer than two times the screen's width.

M&M Video	700-800	52	1-ref	1	
Muntz	995-1895 1395-2195	50 50-67	1-ref 1-ref	2 1	Ceiling or console
New Products	1595-2295	53-72	1-ref	2	Ceiling or floor
Panasonic	4000	60	Schmidt	1	
Pro Audio/Video	1695-1995	50-84	1-ref	2	
Projectapix Ltd.	1495-2790	48	1-ref	2	
Projecta-Vision	1495-2495	53-68	1-ref	1	No mirror used
Projection Elec. Corp.	795-1695 1296-1495	50-65 50-65	1-ref 1-ref	2 1	Lens variations
Projection Elec. Inc.	1495	52	1-ref	2	
Projection Sys.	5000-6500 6000	90-120 120	Schmidt Schmidt	2 1	Floor/ceiling, mt. fr./r. proj.
Projection TV	1300	52	1-ref	2	
Quasar	4500	60	Schmidt	1	
Sega Entr.	995-2295 1595-2595	44-66 44-50	1-ref 1-ref	2 1	
Sony Corp.	2295 3500-4000	40 50-72	1-ref 3/2-ref	1 1	 See Text
Spectra VU	2860-4950	50-100	1-ref	2	Ceiling or console
Steck Mfg.	895-1031	52-72	1-ref	2	
Sunyet Co.	2349	54	1-ref	1-2	Model variations
Super Screen TV	1195-3395	52-90	1-ref	2	Ceiling mount avail.
Tandom Ent.	1395-1895	53-68	1-ref	2	Variety of lenses
Tape Head Co.	600-1100	56	1-ref	2	Kit versions
Titan	1645	48	1-ref	2	
Theatre Vision	995-up	50	1-ref	1	
Tradiovision	1795-2495	53-100	1-ref		
Unique Pro. Sys.	399-499	50-67	1-ref	2	Kit, excl. TV
Video Connection	1395-2995	60	1-ref	2	Floor, ceiling, table versions
Video Industries	1595-1995 1995	52-68 83	1-ref 1-ref	1 2	
Videorama	995-1200 1295-2500	48-72 48-72	1-ref 1-ref	2 1	Fr./r. proj. avail. Custom cabinets
Viewpoint Inc.	599-949	52	1-ref	2	With or without TV
Voorhies Entr.	999-1599	52-68	1-ref	2	Hex table model
Worldwide Entr.	1195-2695 1995	52-68 52	1-ref 1-ref	2 1	

Another very important consideration is room lighting. Since the screen that accompanies a projection-TV system is specifically designed to reflect any and all light, standard room lighting can easily wash out an otherwise good TV picture if it is not placed properly. Indirect or recessed lighting fixtures usually work well. Table and floor lamps, however, must be carefully placed. It is also a good idea to replace your wall switches with dimmer controls because even the more elaborate systems are best viewed in dimly lighted rooms.

When making a performance buying judgement, be sure to be seated and in the center of the screen viewing area. You'll lose considerable picture brightness if you are standing or located at an angle outside the width of the screen. Moreover, the room should be dimly lighted for best viewing results.

After viewing the projected TV picture in this optimum situation, do your viewing under worst-case conditions—increase room light, move to the side of the screen, etc.

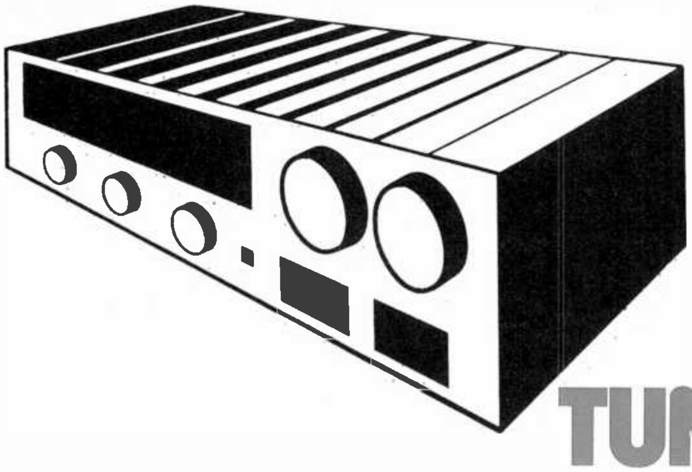
You'll doubtlessly find that the difference between the best optics and just plain good optics isn't really that noticeable under the best viewing conditions unless one is simultaneously comparing the systems. What separates the men from the boys is when conditions aren't optimum. Thus it will be your decision as to whether you wish to save a lot of money as a tradeoff for compelling you and your family to watch projection TV under very good conditions only.

Also, most viewing screens used today are washable. But some earlier projection TV viewing screens were not.

There's also a choice to be made between one and two-piece systems. Bear in mind that one-piece systems take up a lot of room; cabinets are huge. Two-piece systems have their drawbacks, too. Unless ceiling mounted, a "box" has to be moved into the proper projection location. Futhermore, the picture will be obliterated if someone walks in front of the projector.

Interestingly there are some "kit" manufacturers that offer a projection lens and plans for fabricating a cabinet that you can build around a home TV receiver for a few hundred dollars. (Edmund Scientific Co., Barrington, NJ, as an example, offers a 5" f/2.6 projection lens and focusing mount for $267.50.)

Projection TV's future appears to be excellent, given the size limitations of CRT's and the dramatic effect proffered by a large picture. ◇



By Daniel R. von Recklinghausen

HOW ACCURATE ARE FM TUNING METHODS?

A major cause of distortion in FM tuners and receivers is explored

Modern FM tuners and receivers often have distortion specifications much lower than 1%. Yet when listening to them, high distortion may be apparent. Of the many possible causes for this—faulty program material, multipath signals, interference, or even faulty receiving equipment—the most probable one is that the receiver has not been precisely tuned to the signal. Usually, slight retuning will elimate the problem.

The IHF/IEEE standard on testing of FM broadcast receivers specifies that it is accurately tuned when minimum distortion is measured with a weak signal. After tuning, all other measurements are performed. No such tuning verification is possible, however, when listening to broadcasts. It is difficult to attenuate a local signal sufficiently to make it "weak," and it is practically impossible to measure distortion of music.

In the Early Days. "Tuning by ear" has been used to tune more or less accurately ever since FM stations first began to broadcast. The early FM receivers of all-vacuum-tube design required considerable frequency retuning. Unsophisticated listeners thought that the dial pointer was physically slipping.

Many manufacturers tried to combat the drift with a reactance tube circuit (Fig. 1) in which the capacitance of a small grid-plate feedback capacitor caused the plate capacitance to change as the grid voltage was changed by the filtered output of the FM detector. Automatic variation of the plate capacitance then retuned the tuner's local oscillator. This is automatic frequency control (afc), of course. This was an excellent idea when it worked properly. But in practice, a number of faults remained.

The early FM receivers had a warm-up drift of more than 100 kHz, which was almost doubled when a reactance tube was connected. Consequently, the afc pull-in range had to be at least as large as the drift to allow the same local station to be heard day after day. (See Fig. 2.) As a result, the tuners could have only moderate-to-poor selectivity in order to provide sufficient detector output while off-tune.

To permit tuning to another signal, the afc circuit must not hold the oscillator frequency constant regardless of tuning setting. There must be a hold-in range to permit tuning to at least the next local station, or 800 kHz or more away from the station previously tuned. This was accomplished by only providing partial tuning correction.

In the early FM receivers with afc, drift correction was the same as the ratio of hold-in range to pull-in range, or about 3 to 1. The effective drift was reduced only to about half that of an uncompensated receiver. Many functions, features, and construction details of these tuner sections are found today in low-cost FM radios. They all include afc, though using a tuning diode. The tuning "feel" is "rubbery." What's more, fairly high distortion is evident owing to difficulty in consistently and reliably aligning a detector for simultaneous zero dc output voltage and minimum distortion with varying signal strengths. Fading of a weak signal can cause such a tuner to tune itself to the nearest local station.

In the mid 1950s the first "high fidelity" FM tuners and receivers became available. Here, good-quality tuners were designed to operate without afc, using temperature compensation of the local oscillator to keep warmup drift to as low as 20 kHz (or 0.02%). This is still a state-of-the-art figure for an FM oscillator without afc!

Additionally, these tuners had meters to permit more accurate tuning than is possible by ear alone. With more careful design, the tuners would, indeed, produce low-distortion audio signals when correctly tuned with a zero-center tuning meter. Such tuners are still produced today. Unfortunately, they are the ones that may distort when not accurately tuned to the exact channel center with the tuning meter. The meter itself contributes to this problem.

Its sensitivity is often designed so that when the tuner is grossly mistuned to a local station, maximum meter indication will be near full-scale or about ±250 kHz. Furthermore, the meter center often has a "good" tuning bandwidth of ±25 kHz to ±35 kHz.

The width of this band is such that tuner distortion can be as much as twice the rated distortion when tuned "accurately" by eye. Accordingly, the local oscillator may drift during warmup without the meter displaying an obvious off-center indication. If initial mistuning and local oscillator drift combine in the same direction, the meter's pointer will naturally move outside the "good" area.

Modern Tuner. Circuits in the latest class of tuners and receivers are designed to correct the foregoing mistuning problems. One of the solutions is afc. Today's top-quality FM tuners and receiver tuner sections have some form of control logic to ensure accurate tuning. With the exception of a few tuners, the actual tuning of the local oscillator is accomplished with the aid of a Varactor diode that is coupled to the tuning capa-

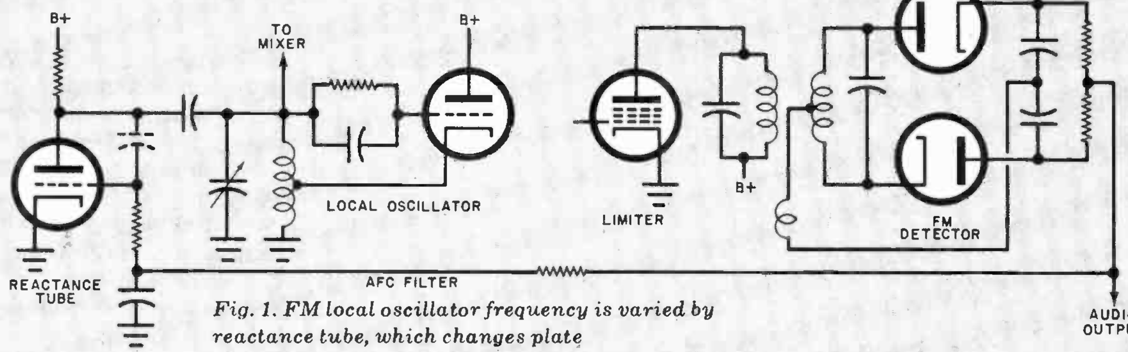


Fig. 1. FM local oscillator frequency is varied by reactance tube, which changes plate capacitance. Afc filter removes audio signals that would frequency modulate oscillator.

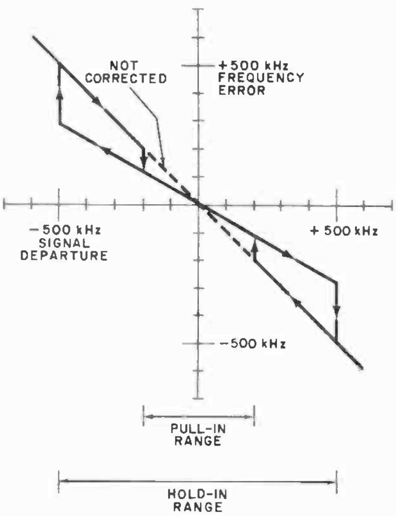


Fig. 2. Characteristics of FM pull-in versus hold-in ranges.

citor. (See Fig. 3.) Any variation in the diode's bias voltage, which is normally at 0 volt, changes the diode's capacitance and, therefore, the oscillator frequency.

To prevent excessive frequency correction, peak control voltage is restricted with diode limiters. And to prevent detected audio frequencies and hum from varying the local oscillator's frequency, the control voltage is filtered with a low-pass filter that has a cutoff frequency of about 0.2 Hz. A higher cutoff frequency would introduce a low-frequency audio phase shift that could degrade low-frequency stereo separation; a lower cutoff frequency would cause slower, more sluggish frequency correction.

One manufacturer, Nakamichi, uses an alternative method to achieve accurate tuning. The company uses a tuning capacitor with a small dc servo motor in its Model 730 to drive the tuning capacitor. However, since such a motor can be positioned only in discrete steps, rather than continuously, a Varactor diode in a low-gain circuit is used to "fill in" between these steps.

Each tuner that has afc circuits must have a way to measure frequency. The resultant dc output from this system is amplified and may be inhibited by control logic before becoming the frequency control voltage. High amplification ensures that the resultant tuned frequency remains as accurate as the measurement of frequency. These are the areas where the designs reveal considerable variation, each of which has its own advantages and disadvantages.

The simplest frequency measuring circuit is the ratio detector (discriminator) that has a nominal 0-volt output at its center frequency. Coincidence detectors, used in such integrated circuits as the ULN 2111 or CA3089 families, also produce a 0-volt output with respect to a reference voltage. This output is then used as reference for the control voltage amplifier. The majority of the new tuners employ this type of measuring circuit in their designs.

The tuning stability of such a tuner with afc is now as stable as the tuning of the detector circuit, ±5 to ±10 kHz, or better by four to one than a well-designed local oscillator in a tuner. The actual improvement in reception is even more since inaccurate manual tuning is also corrected.

FM detectors typically operate at an intermediate frequency (i-f) of 10.7 MHz, which is the beat frequency between the

(Continued on page 56)

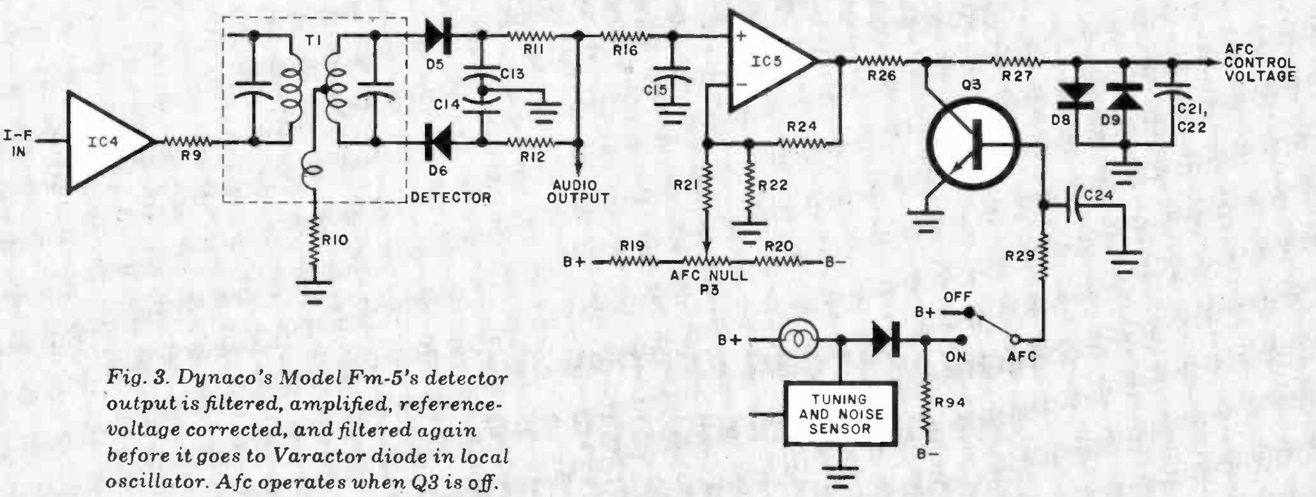


Fig. 3. Dynaco's Model Fm-5's detector output is filtered, amplified, reference-voltage corrected, and filtered again before it goes to Varactor diode in local oscillator. Afc operates when Q3 is off.

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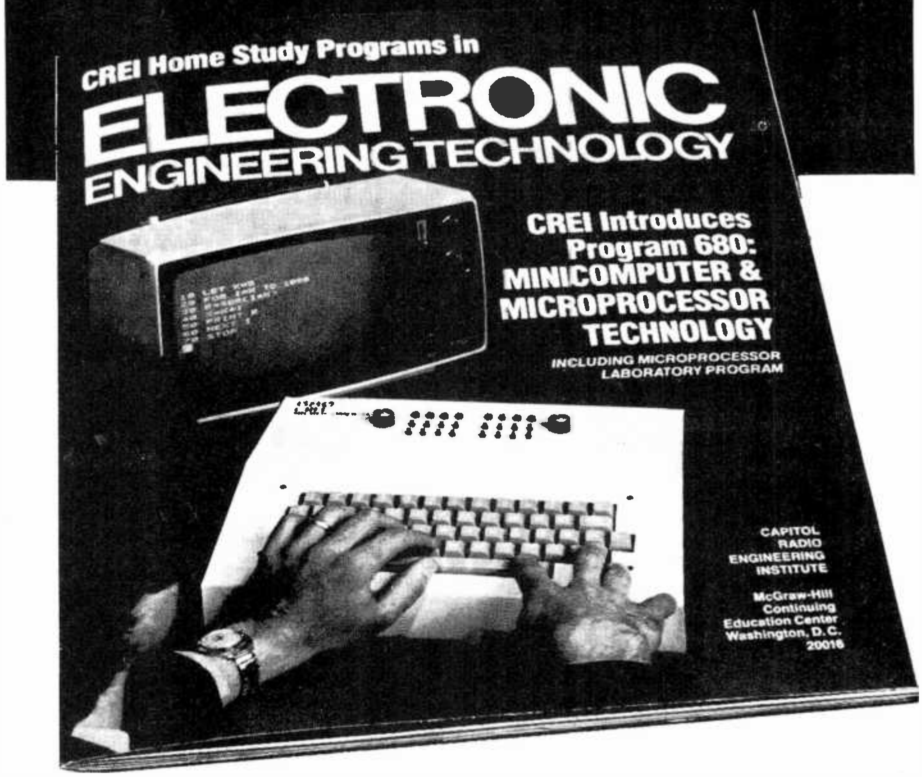

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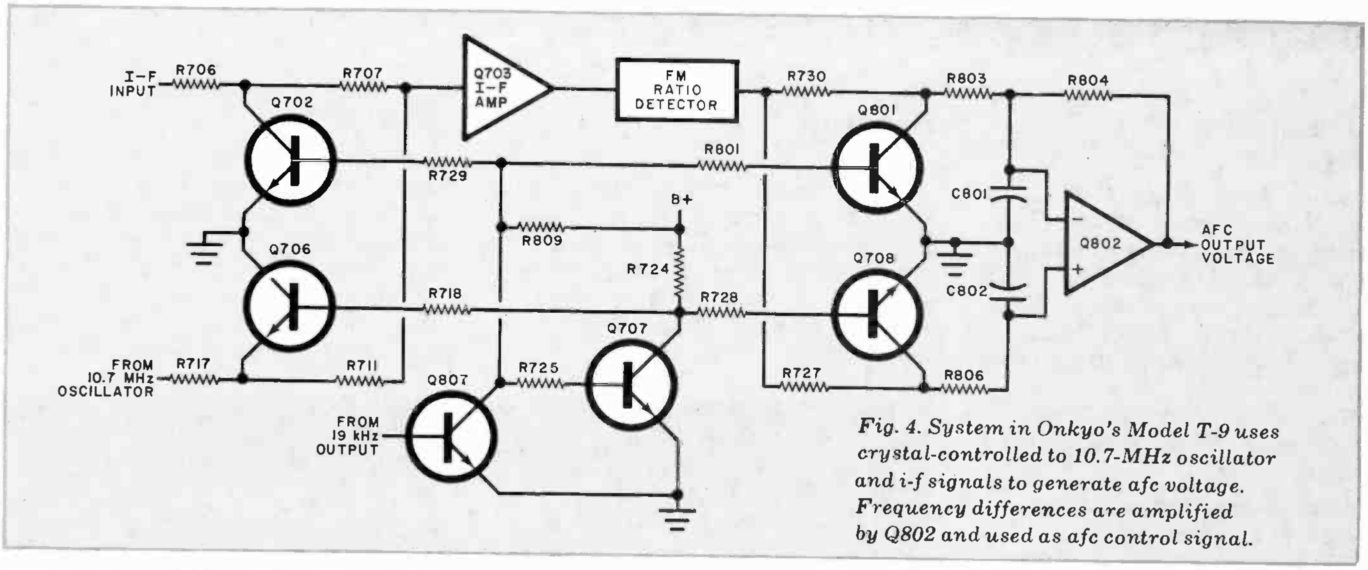


Fig. 4. System in Onkyo's Model T-9 uses crystal-controlled to 10.7-MHz oscillator and i-f signals to generate afc voltage. Frequency differences are amplified by Q802 and used as afc control signal.

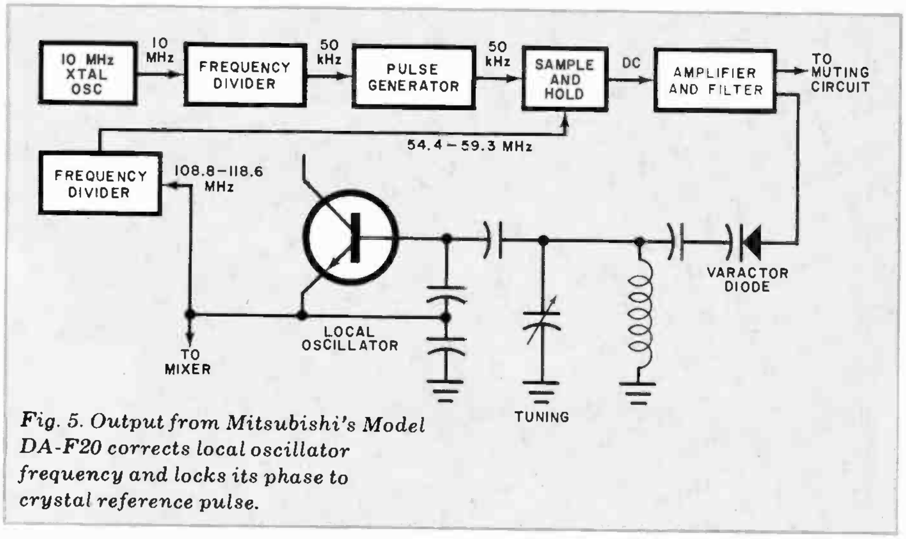


Fig. 5. Output from Mitsubishi's Model DA-F20 corrects local oscillator frequency and locks its phase to crystal reference pulse.

(Continued from page 51)

local oscillator and the received signal. As long as the received signal originates from a broadcast station, its frequency is quite accurate. (No error greater than ±2 kHz is allowed by law in the U.S.) However, a signal that has faded out or is obscured by broad-band interference, such as severe ignition noise, has only the average tuned frequency of the receiver without any correction. Such a condition may cause severe mistuning. Consequently, the control logic circuits prevent use of automatic frequency control with poor signals.

Quartz Tuning. Quartz-crystal control has been used for many years to ensure accurate frequencies and accurate tuning. The simplest crystal-controlled receivers capable of receiving all FM channels, such as Onkyo's Models T-9 (Fig. 4) and TX-4500, employ an FM detector to alternately measure the actual i-f (near 10.7 MHz) using the normal received signal and then the frequency of a 10.7-MHz crystal oscillator. A 19-kHz switching voltage, derived from the stereo multiplex decoder, drives a synchronous switch between the crystal frequency and the i-f signal to become the reference voltage for the control-signal amplifier and the error voltage, respectively. The corrected i-f signal remains locked to the crystal frequency when afc is enabled.

FM broadcast stations in North America are assigned to the band between 88 and 108 MHz, with the channel carriers occuring in 200-kHz steps on odd channels between 88.1 and 107.9 MHz. The customary use of a local oscillator tuned 10.7 MHz higher results in frequency steps starting at 108.8 MHz. (In Europe, 300-kHz channel separation and differing frequency assignments require that a receiver be capable of being tuned in multiples of 100 kHz.) This is precisely the concept used in the most sophisticated tuners.

Design differences exist here, too. A simple method is to sample the local oscillator voltage every 10 μs and to use the resultant voltage to correct local oscillator tuning. If the sampling period is accurately derived as a reference frequency from a crystal, the local oscillator will lock in frequency and phase to the nearest harmonic of the reference frequency. Then the receiver will tune in steps equal to the reference frequency. The Mitsubishi Model DA-F20 (Fig.5) operates in such a fashion, deriving its reference frequency by division from a 10-MHz crystal oscillator, which is also used as a reference frequency for the digital frequency counter that indicates the tuned frequency. This ensures accurate tuning that's independent of the received frequency.

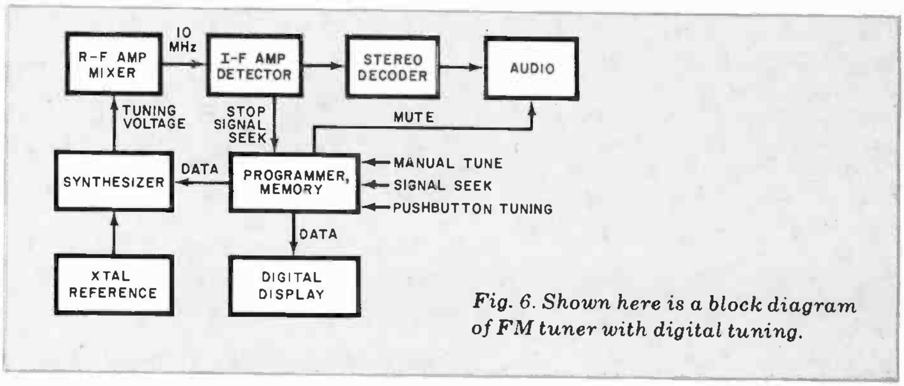


Fig. 6. Shown here is a block diagram of FM tuner with digital tuning.

More complex is the method by which the local oscillator frequency is divided by a programmable frequency divider. The resultant output is detected by an electronic switch that opens and closes at a frequency determined by a quartz-crystal reference oscillator. Only one local-oscillator frequency will cause a dc tuning voltage to lock the phase and frequency of the oscillator to the programmed harmonic of the reference frequency. This is the principle of a frequency synthesizer. Instead of using the traditional pointer dial to indicate the tuned frequency, these new tuners display the frequency with a direct-read numeric display. Digital circuits control the offset frequency and division ratio, remember the last station tuned, and control the number displayed.

Frequency synthesizers have been used for several years, as exemplified by the H.H. Scott Model 433 and the later Heath Model AR-15 tuners. (See Fig.6.) Synthesizer tuner designs are possible today with substantially reduced circuit complexity. Digital frequency displays are standard with all synthesizer-type tuners, of course.

Essential to the success of all forms of automatic frequency control is the use of control logic. The early FM tuners had no control logic; the afc was active all the time. This caused marginal performance at times.

Afc in Modern Tuners. New tuners that have afc circuits employ large amounts of feedback to correct tuning-error signals. All these tuners also have logic circuits that control tuner operation.

All tuners with frequency synthesizer circuits or digital tuning mute the audio output until the tuning system has locked onto the tuned frequency. Only then are the other tuner circuits allowed to function, such as detecting the presence of a mono or stereo signal or the absence of noise. After this, the tuner unmutes and functions normally unless it is programmed to examine the next tuned frequency step.

All other tuners and receivers with afc circuits operate during manual tuning with the afc circuit disabled. To enable the afc circuit, the control logic circuit must detect the presence of a signal that is strong enough to cause unmuting if the muting switch were turned on. Also, the control logic circuit must detect if the signal is tuned sufficiently well (say, ±50 kHz or better) so that only minor frequency correction is needed.

If these conditions are satisfied for a second or so, the afc control voltage is generally applied to a Varactor diode. This logic system permits tuning to a signal with as much finger-tip feel as tuning a receiver without afc. An indicator usually tells when the afc circuit operates.

Manually tuning off-signal while the afc circuit attempts to hold onto the signal was the major cause for the old complaint of "rubbery" tuning. The new breed of tuners and receivers has overcome this problem as well.

Though afc control voltage is applied slowly, it's removed relatively fast (in about 0.02 second) when the tuning error exceeds ±50 kHz or less by discharging all afc filter capacitors. Since the afc control has a long time constant of about one second and manual detuning to the 50-kHz limit usually takes much less time, the automatic frequency control can be temporarily disabled by just retuning the tuner.

To further simplify tuning, some tuners, such as Dynaco's Model FM-5, permit switching off the afc. Other tuners, such as those made by Onkyo, detect whenever the tuning knob is touched by measuring hum pickup or the change in oscillation voltage of a medium-frequency oscillator connected to the tuning knob. Here, afc is disabled whenever the tuning knob is touched.

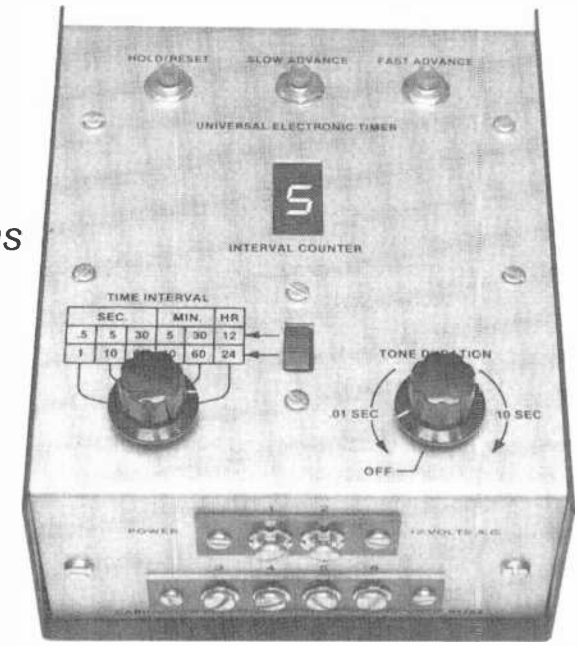
Have afc and the new logic circuits solved all the tuning problems and are frequency synthesizers the ultimate answer? No. There are tuning problems still remaining. One is how to solve the tuning problem automatically when there is strong interference adjacent to the desired signal. Here the manual solution is to mistune for minimum audible annoyance. Another problem is how to stay tuned to a weak signal that might fade out, while a strong local signal is near in frequency.

A third problem is how to make Varactor tuners (used in synthesizers) as high in selectivity, overload handling capability, noise figure, and residual noise as other tuners that utilize conventional components.

Perhaps more important is the need to make the new tuner designs less complex so that if trouble does occur, it can be easily determined and corrected.

The new afc circuits used to help the listener tune accurately to a signal have their counterpart in multiplex demodulator circuits, since FM-stereo reception requires locking the 38-kHz stereo demodulator in frequency and phase to the 19-kHz pilot signal broadcast by the radio station. ◇

BUILD A UNIVERSAL ELECTRONIC TIMER



By Michael S. Robbins

Time any event occurring in a 24 hour period in seconds, minutes or hours. Includes audible alert and automatic on/off.

Timing is becoming increasingly more important around the home, in the workshop, and in the lab. For example, we routinely time such diverse things as cooking, watering the lawn, long-distance telephone calls, photographic film processing, etc. Hence, there is an increasing need for an accurate timer to help us. The "Universal Electronic Timer" described here was designed to fill virtually any timing need

The basic function of the Universal Electronic Timer is to turn on and off an electrical or electrically operated device or to generate a tone for a predetermined period of time at regular programmed intervals. An interval-selection switch gives you a choice of 0.5, 1, 5, 10, 30, or 60 seconds; 5, 10, 30, or 60 minutes; or 12 or 24 hours. The "on" time can be adjusted over a 10-ms to 10-second range and can be expanded to more than 30 minutes by a simple change in component values. The "thing" that gets turned on or off can be external to the timer (as mentioned above) or it can be the self-contained tone generator. The latter is a gated 1000-Hz oscillator driving a speaker. If the gate control is short enough, the output will be a sharp "tick." By setting the interval switch to 1 second and the period control to 0.01 second, one tick per second will be generated. A one-second beep every 10 minutes, with the indicator displaying the minutes, can be obtained with an interval setting of 10 minutes and a period control of 1 second.

This timer project is built around a 5309 six-digit clock chip that features both seven-segment and BCD outputs. The feature that distinguishes the 5309 from the 5311 through 5314 chips is a reset function that sets all digits to zero. (The 5315 will work, but it has a different pin configuration.)

The seven-segment and BCD outputs of the 5309 IC are multiplexed. Digit-enable outputs indicate which digit is present at the outputs at any instant. By sensing the desired digit-enable output, the internal multiplex oscillator can be stopped while the desired digit is present. Hence, the IC can be made to output only one of its six digits.

The 5309 IC can directly drive a common-cathode LED display to indicate the state of the seven-segment outputs.

About the Circuit. Transistor *Q1* in Fig. 1 controls clock chip *IC1*'s multiplex oscillator. Switch *S1B* is used to select the digit at which the oscillator stops.

Since a zero will appear in the units-seconds digit only once every 10 seconds and in the tens-seconds digit only once every minute, the circuit must be speeded up. By connecting the slow-set input of the 5309 to ground through *S1A*, the clock chip operates 60 times its normal speed. Thus, instead of the tens-seconds zero appearing once a minute, it now appears once a second.

The zero is detected by testing the states of segments *f* and *g* in the display. The only digit for which the *f* segment is on and the *g* segment is off is the zero. Hence, each time the zero occurs, the voltage at the collector of *Q2* drops. This generates a negative-going pulse that toggles one-shot multivibrator *IC2*, which generates a signal whose duration is determined by the values chosen for *C5*, *R3*, and *R5*. The values specified

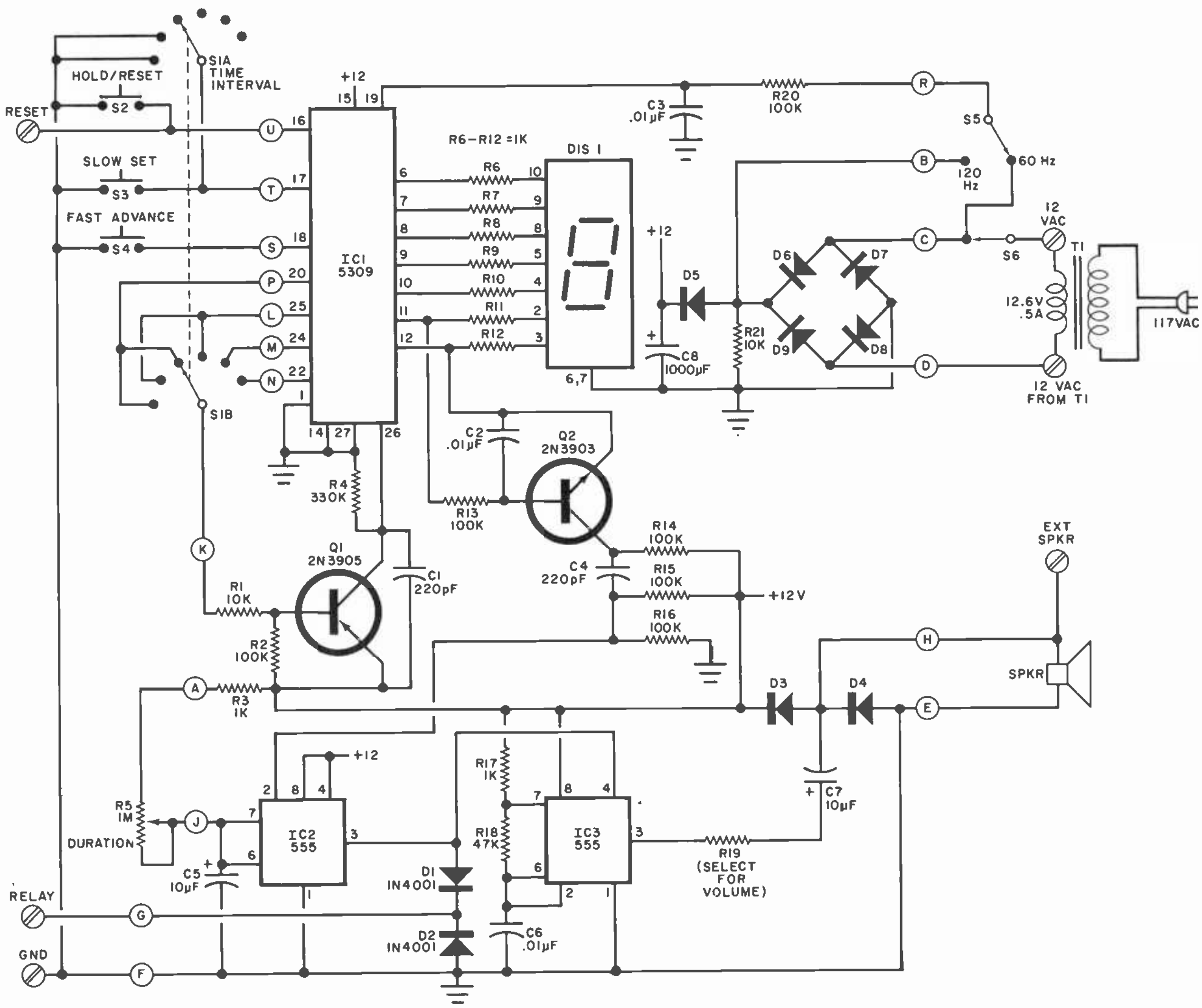


Fig. 1. A conventional digital clock chip forms a 0.5-s to 24-h timer. Gated tone generator creates desired "beep." Timer also activates relay for external control.

PARTS LIST

C1, C4—220-pF disc capacitor
C2, C3, C6—0.01-μF, 16-volt disc capacitor
C5—10-μF, 10-volt tantalum capacitor
C7—10-μF, 16-volt electrolytic capacitor
C8—1000-μF, 25-volt electrolytic capacitor
D1 thru D9—1N4001 rectifier diode
DIS1—Seven-segment display (common-cathode) TIL313 or HP5082-7740
IC1—MM5309 clock IC (National)
IC2, IC3—555 timer IC
Q1—2N3905 or 2N3906 transistor
Q2—2N3903 or 2N3904 transistor
All resistors ¼ watt, 10% tolerance:
R1, R21—10,000 ohms
R2, R13, R14, R15, R16, R20—100,000 ohms
R3, R6 thru R12, R17—1000 ohms
R4—330,000 ohms
R18—47,000 ohms
R19—10 ohms minimum (select for desired volume)
R5—1-megohm audio-taper potentiometer with switch
S1—Two-pole, six-position nonshorting rotary switch
S2, S3, S4—Normally-open spst pushbutton switch
S5—Spdt slide switch
S6—Spst switch (part of R5)
SPKR—45-ohm loudspeaker
T1—12.6-volt, 500-mA power transformer
Misc.—Two-screw terminal strip or barrier block; four-screw terminal strip or barrier block; Molex Soldercons® (for DIS1); sockets for ICs (or substitute Soldercons); suitable enclosure; 1" (2.54-cm) threaded spacers (4); red acrylic filter; control knobs (2); dry-transfer lettering kit; machine hardware; hookup wire; solder; etc.
Note: The following items are available from Caringella Electronics, Inc., P.O. Box 727, Upland, CA 91786: Complete kit of parts, including cabinet, No. UET-1K, for $34.95 plus $2.00 shipping and handling; etched and drilled pc board No. UET-1PC for $6.95 postpaid in USA. California residents, please add 6% sales tax.

in the schematic diagram and Parts List will produce a range of from approximately 10 ms to 10 seconds. If you require a longer period, you can increase the value of *C5*. For example, a 100-μF capacitor will yield a range from 100 ms to 100 seconds. If a 10-M potentiometer is used for *R5*, the range becomes 100 ms to 18 minutes. If a 10-megohm resistor is connected in series with the 10-megohm potentiometer, the range will be from 18 to 36 minutes.

The output of *IC2* is used to drive an external relay and tone generator *IC3*. Any 12-volt dc relay whose coil resistance is at least 120 ohms can be used. If a visual output is desired, connect a LED in series with a 240-ohm resistor to this point.

To increase the frequency of the 1000-Hz audio tone generated by *IC3*, decrease the value of *R18*. You can decrease the frequency by increasing the value of *R18*.

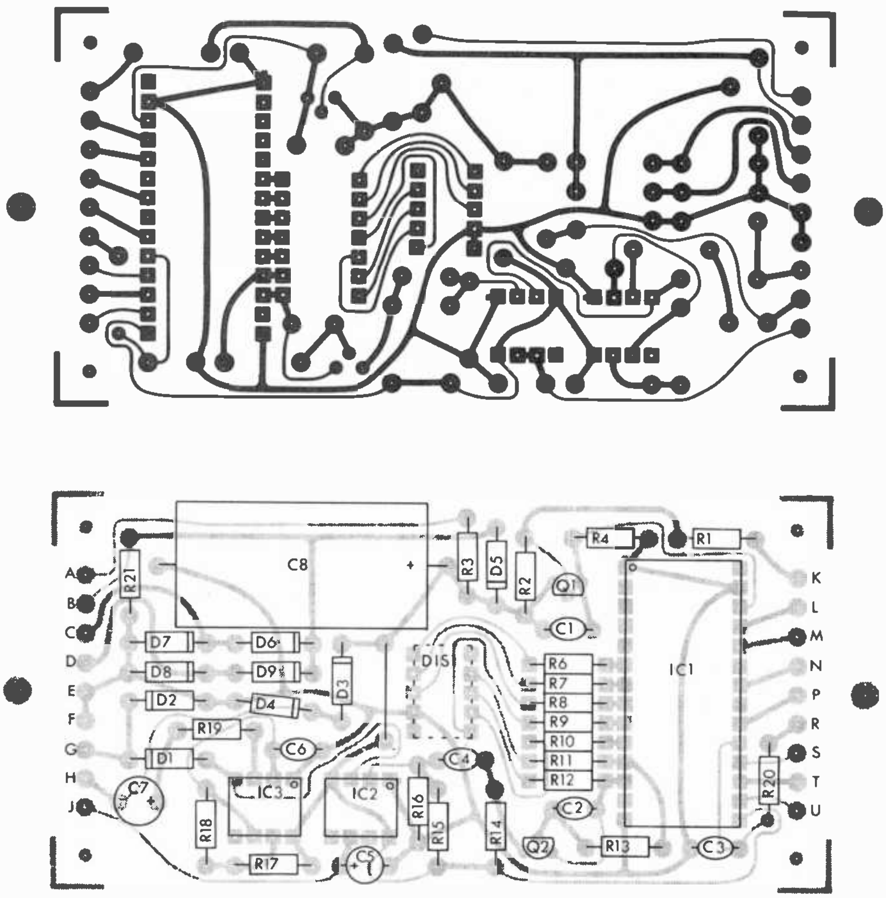


Fig. 2. Actual-size etching and drilling guide for printed circuit board is shown at top. Component placement diagram is directly above.

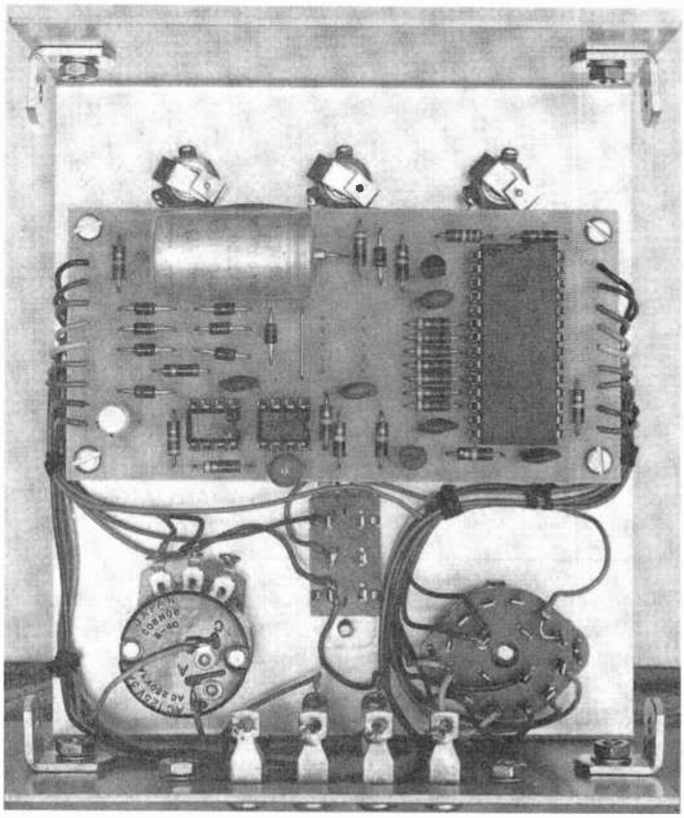


Fig. 3. Photo shows interior construction details of author's prototype.

Construction. The timer circuit is best assembled on a printed-circuit board. The actual-size etching-and-drilling guide and separate components-placement diagram for the pc board are shown in Fig. 2.

Before you proceed to wire the pc board, place it *foil* side up on a hard, flat surface. Slip a strip of five Molex Soldercons® onto the pins on each side of *DIS1*. (Do *not* remove the connecting strips of metal on the Soldercons until directed to do so.) Lower the display onto the pc board, guiding the pins of the Soldercons into the appropriate holes on the board. Because of the hard surface under the board, the pins will not go in as far as they might otherwise. Do not try to push them in all the way. Simply solder them to their respective traces on the board, using only as much heat and solder as necessary to assure a good electrical and mechanical connection in each case. Leave the display in place and cover its top surface with a piece of masking tape.

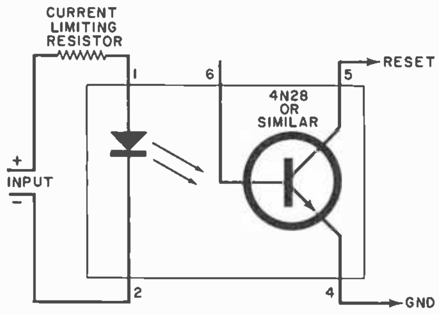


Fig. 4. An optoisolator can be used to interconnect two timers for extremely long timing durations.

Flip over the pc board and install the resistors, capacitors, diodes, and transistors. Refer to the components-placement diagram in Fig. 2 for proper component location and orientation. Install sockets in the locations for the integrated circuits. Then install *IC2* and *IC3* in their sockets. Do *not* install *IC1* until last and, when you do so, be sure to practice safe handling procedures for MOS devices. (This clock chip is a PMOS device that can be damaged by static fields if it is not handled properly.) Flip over the board assembly and carefully flex the connecting strips on the display's Soldercons until they break away. Three or four flexes will generally do the trick. Temporarily set the board assembly aside.

Next, referring to Fig. 3 and the lead

photo, machine the top half of the enclosure in which the project is to be housed. (If you plan to build the power supply into the project, select a large enough enclosure to accommodate it without interference to the other elements in the circuit.) Drill the holes for the various switches, control, and circuit board standoffs; cut a window for the display; and make a pair of slots (or drill ½" holes) for the screw-type terminal strips or barrier blocks. Use a dry-transfer lettering kit to label the various switches, control, and terminal strip points, as shown in the lead photo. Then mount each item, except the circuit board assembly, in its respective location.

Solder an 8" (20.3-cm) length of hookup wire to pads A through U on the circuit board assembly. Flip over the board and peel away the tape from the display. Then mount the circuit board assembly, with *DIS1* centered in the window in the top half of the box, with threaded spacers and machine hardware. If you wish to protect the display and enhance its contrast for easier reading, cement a piece of red acrylic plastic over the window on the inside of the box before mounting the circuit board assembly on its spacers.

Drill a series of ¼" holes in the bottom half of the enclosure to perforate it for the loudspeaker. Then mount the speaker, with a protective screen between it and the enclosure wall. Refer back to Fig. 1 and interconnect the circuit board assembly with the control, switches, terminal strips, and speaker, using the wires connected to holes A through U on the board. Trim the wires as necessary as you connect them. Finally, arrange the wires neatly and lace them together and assemble the case.

Using the Timer. RESET pushbutton switch *S2* or the RESET input on the four-lug terminal strip returns the interval timer and display to zero. The display remains at zero as long as the RESET switch is closed or the RESET input is grounded. Releasing either initiates the timing cycle. If you desire remote operation of the reset feature, you can use the optoisolator circuit shown in Fig. 4.

The SLOW SET and FAST SET pushbuttons are used to preset the interval timer. The SLOW SET button is not operational in the two shortest interval positions of *S1* (1 second and 10 seconds).

The divide-by-two switch (*S5* in Fig. 1 but not labelled in Fig. 3) effectively cuts all of the timing intervals that are selected by *S1* in half. ◇

BY TONY CARISTI

Electronic diagnostic instrument for locating and identifying problems in battery or charging systems

TROUBLE-SHOOTING ANALYZER FOR AUTOMOTIVE ELECTRIC SYSTEMS

THE AUTOMOTIVE industry has taken advantage of the latest techniques in modern electronics technology. As a result, many of the components in late-model automobiles have become more difficult to diagnose when trouble occurs. An example of this is in the automotive battery and charging system, where the old-style battery, dc generator, and electro-mechanical voltage regulator have given way to the sealed battery, alternator, and solid-state voltage regulator. These new components are superior to the ones they replaced, but they also require more sophisticated test procedures to analyze and isolate faults.

It seems only natural that electronics technology should provide the means to check these components. The automotive battery and charging system monitor described in this article, provides such a check. It can be constructed at low cost, yet gives the accuracy and dependability suitable for a professional as well as an amateur. The monitor uses four LED's to provide an indication if a fault arises and also indicates possible sources of trouble. This feature will eliminate unnecessary replacement of properly operating components.

Circuit Operation. The analysis of an automotive battery and charging system can be accomplished by monitoring the battery voltage under several operational conditions, then comparing the measured value to a known standard.

PARTS LIST

C1,C2 — 10-μF, 15-volt electrolytic
D1 — 1N2069 or similar
D2 — 1N4148 or similar
IC1 — μA 78GU adjustable regulator (Fairchild)
IC2 — LM339 quad comparator
LED1 through LED4 — Red LED
R1,R2,R4 — 1000-ohm, 1% resistor
R3 — 1000-ohm potentiometer, pc mount
R5 — 39,200-ohm, 1% resistor
R6,R11,R14,R18 — 100,000-ohm, 1% resistor
R7,R9,R15,R19 — 10,000-ohm, 10% resistor
R8,R12,R16,R20 — 1000-ohm, 10% resistor
R10 — 5900-ohm, 1% resistor
R13 — 25,500-ohm, 1% resistor
R17 — 19,600-ohm, 1% resistor
Misc. — Suitable enclosure, interconnecting leads, optional spst switch, mounting hardware, etc

Note: The following are available from: A.Caristi, 69 White Pond Rd., Waldwick, NJ 07463: etched and drilled pc board at $2.50; a set of 11 precision resistors at $2.50.

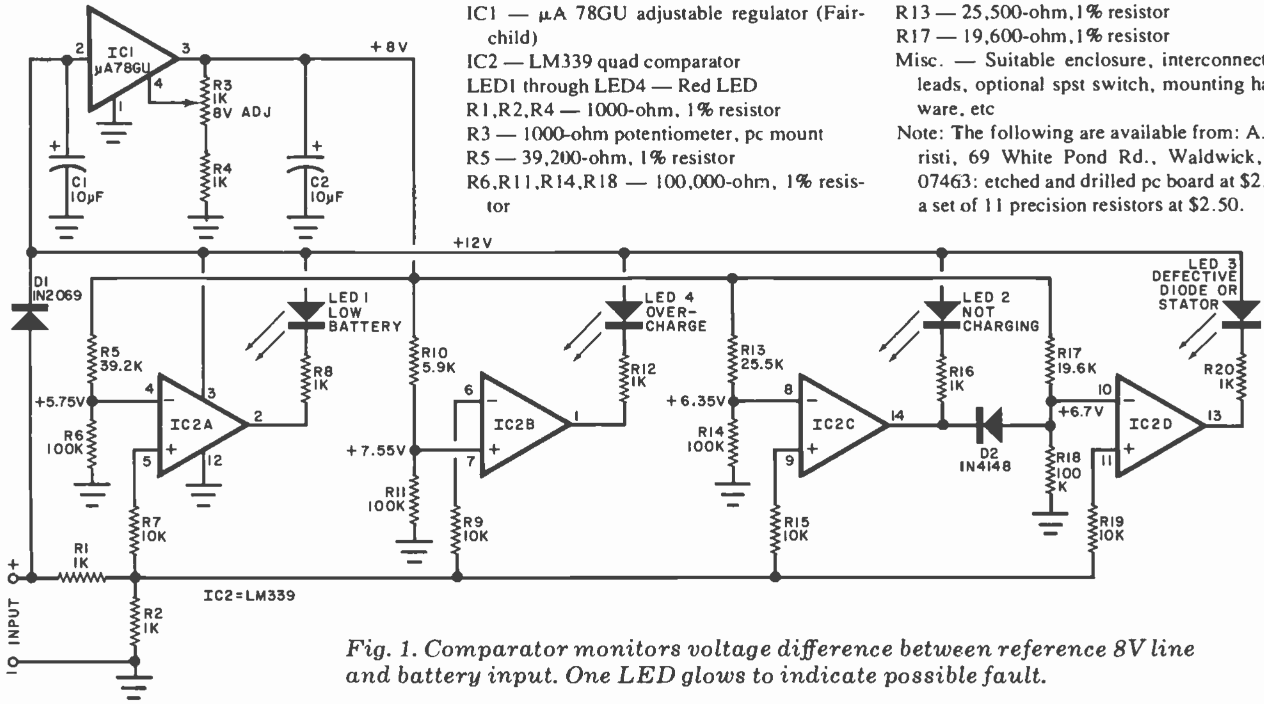


Fig. 1. Comparator monitors voltage difference between reference 8V line and battery input. One LED glows to indicate possible fault.

A properly operating battery and charging system will have a battery terminal voltage of about 12.6 volts when the engine has been turned off for some time, and between 13.5 and 15.0 volts when the engine is running and the battery is being charged.

If the battery voltage is below 11.5 volts with the engine not running, the battery is either in a very low state of charge or has a damaged cell. If the battery voltage is less than 12.7 volts with the engine running, the charging system is inoperative. If the voltage is less than 13.4 volts, then there is insufficient charging; if there is more than 15.1 volts across the battery terminals, overcharging is occuring.

The circuit shown in Fig. 1 constantly monitors the battery voltage, while LED displays indicate any improper electrical condition. The basic reference voltage for the monitor is formed by *IC1* which is an adjustable voltage regulator that is set to a precise 8-volt output.

This voltage reference is fed to four precision voltage-divider networks (*R5/R6, R10/R11, R13/R14* and *R17/R18*) that provide levels of 5.75, 7.55, 6.35 and 6.7 volts respectively), to individual sections of *IC2*. By feeding half the battery voltage to the noninverting input, the corresponding voltages then become 11.5, 15.1, 12.7 and 13.4 volts.

In *IC2A, C* and *D*, the precision reference voltage is fed to the inverting input (-) of the comparator, while half the system's battery voltage (via divider *R1, R2*) is coupled to the noninverting (+) input. As long as the voltage at the noninverting input is greater than the voltage applied to the inverting input, the output of the comparator is high. The associated LED is thus extinguished, indicating that the system is normal for that particular voltage level.

Should the battery voltage drop below the reference level, the comparator output drops to zero, causing the associated LED to indicate a malfunction.

Note that *IC2B* has its input terminals reversed; that is, the reference voltage is applied to the noninverting input while the battery voltage is applied to the inverting input. This causes its associated LED to glow if the battery voltage exceeds the reference level. This condition is also caused by a fault in the charging system. Diode *D2* is connected between the output of *IC2C* and the inverting input of *IC2D* to prevent *LED3* from lighting if *LED2* is glowing. This not only prevents the two indicators from lighting at the same time, but also provides a positive indication of a particular type of fault in the charging system.

Diode *D1* is connected in series with the positive input lead to protect the circuit against damage caused by an accidental reversal of the input leads.

Construction. The circuit can be assembled on a small pc board such as that shown in Fig. 2. Observe the polarities of the two diodes and two polarized capacitors. A 14-pin socket can be used for *IC2*. Pin 1 of *IC2* can be identified by a small dot or mark on the plastic case.

The four LEDs can be mounted where they are easily observed, and then connected to their respective pads on the pc board. Each LED must be clearly identified as to indicated fault.

A long length of insulated wire can be connected between the monitor positive input and the battery positive terminal The monitor's negative input may be connected to a chassis ground.

Test and adjustment. A 0- to 16-volt dc power supply and an accurate dc voltmeter are used to test the monitor.

Observing the correct polarity, connect the two monitor input leads to the power supply, and set the power supply for a 12-volt output.

Connect the voltmeter positive lead to *IC1* pin 3, and the negative lead to ground. Adjust *R3* until the voltmeter indicates precisely 8 volts.

Connect the voltmeter across the

power supply, then reduce the supply down to 11 volts. Both *LED1* (Low Battery) and *LED2* (Not Charging) indicators should be glowing. The other two LED's should be dark.

Slowly increase the power supply voltage until *LED1* is extinguished. This should occur between 11.4 and 11.6 volts. As the power supply output is increased, note that *LED2* should extinguish between 12.6 and 12.8 volts, and *LED3* (Defective Diode or Stator) should light when *LED2* goes out.

As the power supply output is further increased, *LED3* should go out when the voltage is between 13.3 and 13.5 volts. *LED4* (Overcharge) should glow when the supply voltage exceeds 15.1 volts. *Do not raise the power supply output above 16 volts!*

If any of the LEDs do not operate properly, check the 8-volt line, then make sure that the correct precision resistors are used at the proper comparator inputs.

Using the Monitor. The following steps should be performed in sequence when checking an automotive battery and charging system. Connect the monitor to the vehicle's battery terminals, being sure to observe correct polarity for each terminal.

An spst switch can be connected between the monitor positive input lead and the battery so that the monitor can be disabled when not in use. Make sure that the alternator drive belt has the proper tension.

Before the engine is started, the Not Charging (*LED2*) or Defective Diode or Stator (*LED3*) will be lighted since the battery is not yet being charged. If the Low Battery (*LED1*) glows, the battery voltage is less than 11.5 volts. This can be caused by a state of deep discharge or a faulty cell. If this LED is glowing, investigate the battery before proceeding.

When the engine is started and everything is normal, all the LEDs should be dark. If there is an electrical malfunction, then one of the LEDs will glow.

If the Not Charging LED glows, the terminal voltage of the battery is less than 12.7. Thus, the alternator is not delivering any current to the battery. This can be caused by an open regulator circuit or open alternator field.

If the Defective Diode or Stator LED glows, the terminal voltage of the battery is less than 13.4 volts. This can be caused by a shorted diode or stator in the alternator, or an improperly adjusted regulator.

If the Overcharging LED glows, the terminal voltage of the battery is greater than 15.1 volts. This can be caused by a shorted or misadjusted regulator.

If no LEDs glow with the engine running, load the alternator by turning on the headlights' high beams, the air conditioner, the high-speed blower, the high-speed windshield wipers and the radio. Then moderately race the engine. All LEDSs should be extinguished.

If the Defective Diode or Stator LED is now lighted, but was extinguished with no load on the alternator, the most likely cause of the problem is an open diode in the alternator.

This low-cost, easy-to-use automotive instrument can save the builder many dollars of repair costs, making it a worthwhile investment in parts and labor. ◇

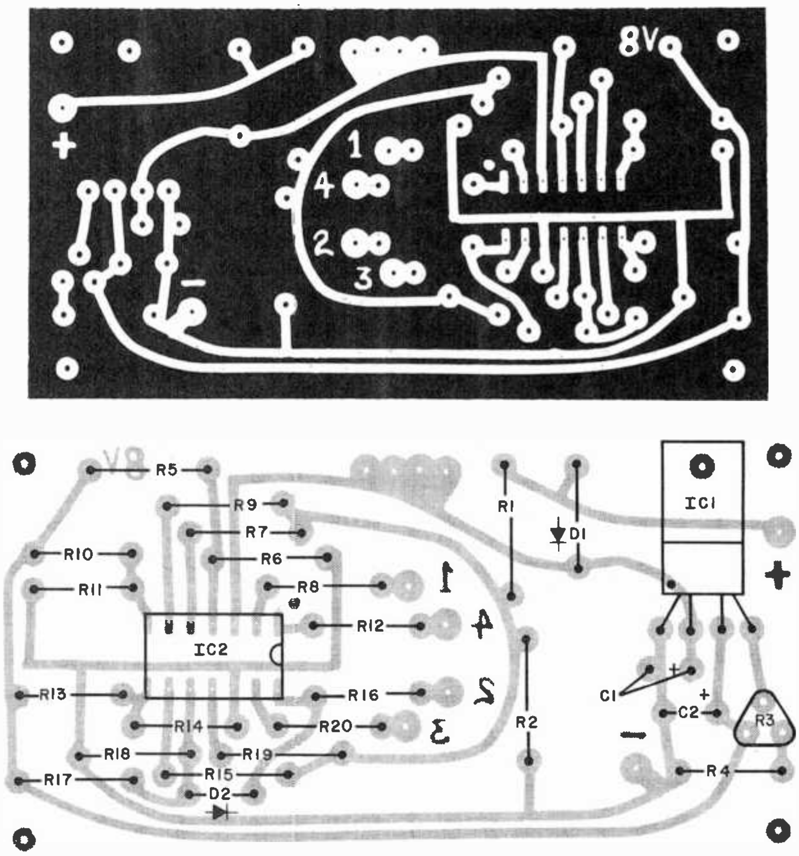


Fig. 2. Actual size etching and drilling guide for pc board is at top; component layout diagram below.

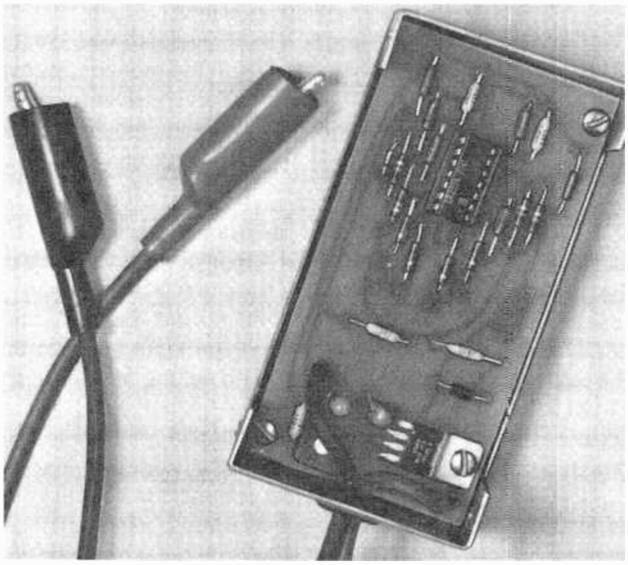


Photo of interior of author's prototype shows components mounted on printed circuit board and connections to enclosure.

BY BUD WEISBERG, K2YOF

BUILD A REMOTE ANTENNA SELECTOR SWITCH

Low-cost, reliable switch permits selecting from among six antennas

Erecting multiple antenna systems offers the communications buff increased operating flexibility and frequency coverage. Unfortunately, it can also add appreciably to station cost and complexity—especially when the antennas require separate feedlines. Presented here is an alternative to a large investment in coaxial cable—a low-cost, remotely controlled coaxial switch.

The Remote Antenna Selector Switch enables the user to quickly select one of six antennas. Equally important, it provides a silent, reliable indication of the selection without any need for relay-holding current or the imposition of dc or a-f control signals on the feedline. The project can be assembled from inexpen-

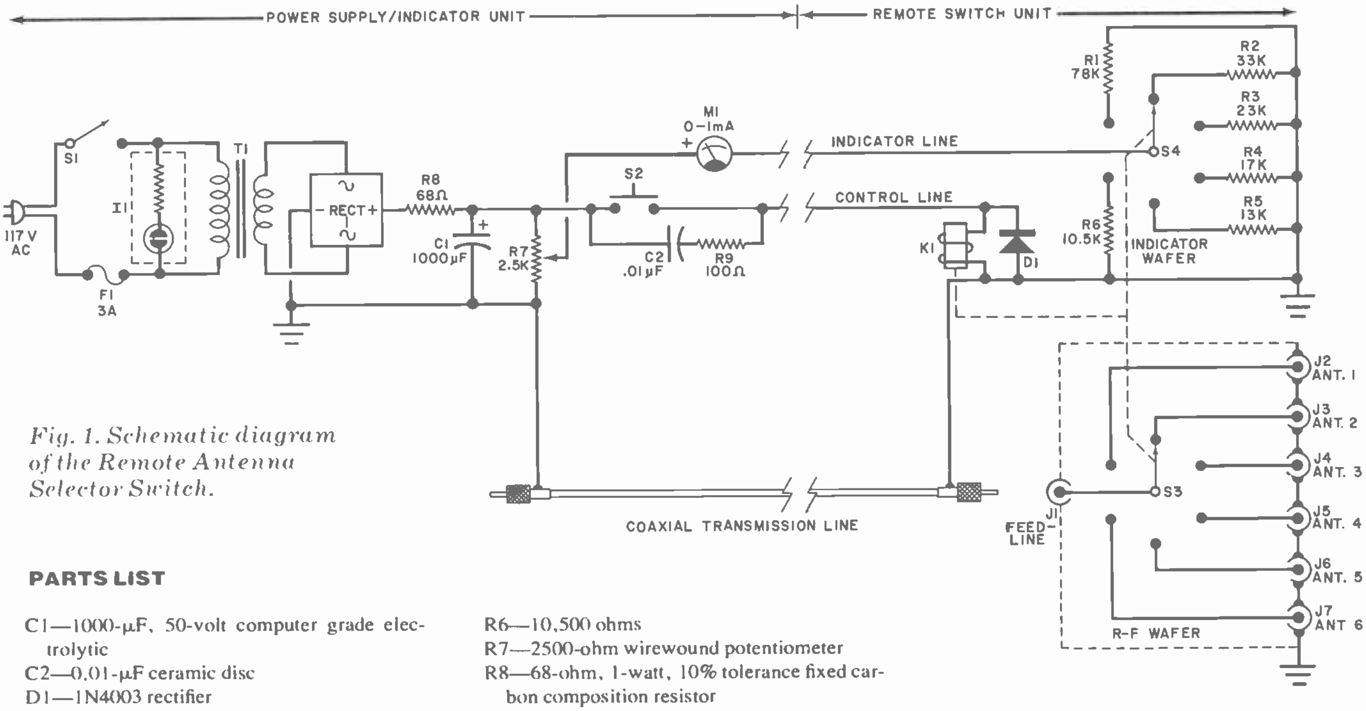


Fig. 1. Schematic diagram of the Remote Antenna Selector Switch.

PARTS LIST

C1—1000-µF, 50-volt computer grade electrolytic
C2—0.01-µF ceramic disc
D1—1N4003 rectifier
F1—3-ampere fast-blow fuse
I1—110-volt neon pilot light assembly
J1 through J7—SO-239 coaxial connector
K1—12-position rotary stepping solenoid with 24-to-28-volt dc coil (Ledex Series 5 or equivalent)
M1—0-to-1mA meter movement
The following are ½-watt, 5% tolerance carbon composition fixed resistors:
R1—78,000 ohms
R2—33,000 ohms
R3—23,000 ohms
R4—17,000 ohms
R5—13,000 ohms
R6—10,500 ohms
R7—2500-ohm wirewound potentiometer
R8—68-ohm, 1-watt, 10% tolerance fixed carbon composition resistor
R9—100-ohm, ½-watt, 10% tolerance fixed carbon composition resistor
RECT1—100-PIV, 4-ampere modular bridge rectifier
S1—5-ampere spst switch
S2—5-ampere, normally-open, momentary contact pushbutton switch
S3—11-position, 1-pole ceramic rotary switch (Centralab No. 2503 or equivalent)
S4—11-position, 1-pole phenolic switch wafer (Centralab No. JD or wafer from No. 1403 switch)
T1—24-to-28-volt ac, 2-ampere transformer (Radio Shack No. 273-1512 or equivalent)
Misc.—Suitable enclosures, 4" × 4" × 2" (10.2 × 10.2 × 5.1 cm) aluminum utility box, coaxial cable and PL-259 connectors, ¼" (6.4-mm) flexible shaft coupling, 2- or 3-conductor cable, machine and self-tapping hardware, silicone cement, PVC tape, No. 14 copper wire, solder, etc.
Note—Suitable surplus stepping solenoids are available from several sources, including Poly Paks, Box 942, South Lynnfield, MA 01940 (Cat. No. 92CU3493) and Fair Radio Sales, 1016 East Eureka, Lima, OH 45802 (Cat. No. MX167869G1).

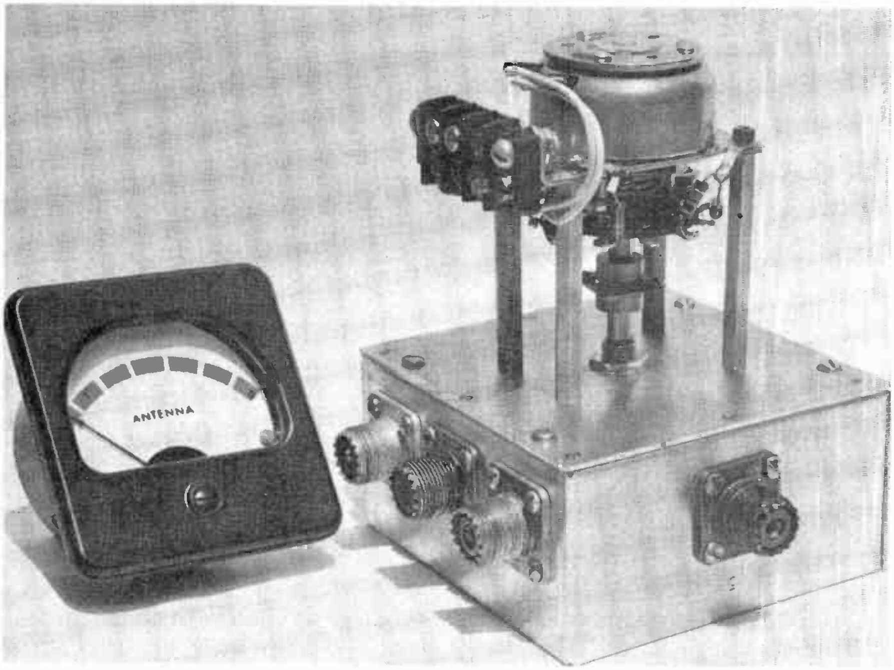


Fig. 2. Photo of the remote switch unit and antenna selection indicator.

sive surplus and junk-box parts and gives a level of performance rivalling that of commercial products costing much more.

About the Circuit. A schematic diagram of the Remote Antenna Selector Switch appears in Fig. 1. Upon the application of line power, electrolytic capacitor *C1* draws charge from stepdown transformer *T1* through bridge rectifier *RECT1* and resistor *R1*. When momentary pushbutton *S2* is depressed, *C1* discharges via the coil of *K1*, a 12-position rotary stepping solenoid. Eleven-position rotary switches *S3* and *S4* are driven by the shaft of *K1*, so the switches advance one position when the solenoid is energized.

In this project, only alternate switch contacts are employed. The solenoid must therefore be stepped *twice* to advance the switches to the next position. Wafer *S3* performs the antenna switching function. The other wafer, *S4*, is part of the indicator circuit, as are fixed resistors *R1* through *R6*, potentiometer *R7*, and milliammeter *M1*. As *K1* rotates the switch shafts, the effective series resistance between the negative side of *M1* and ground varies. This causes the meter movement to deflect and indicate the antenna selection on a modified meter scale. If the solenoid is stepped only once, the meter will read OFF, indicating that *S2* must be closed once more to advance the mechanism to the next antenna position.

Construction. The Remote Antenna Selector Switch comprises two units, the switch proper, shown in Fig. 2, and the power supply which appears in Fig. 3. Also shown in Fig. 2 is the position indicating meter, which can be built into an enclosure with the power supply or mounted on a separate panel.

The power supply is relatively simple and is most easily constructed using point-to-point wiring techniques. A barrier terminal strip such as that mounted on the prototype power supply's chassis will facilitate interconnections with the power line, switches and solenoid. Due to the amount of charge it must hold, capacitor *C1* must be a high-grade component such as a computer-grade electrolytic. Similarly, the pushbutton switch employed as *S2* must be able to handle the substantial current flowing when *C1* discharges through *K1*.

The meter scale will have to be relabelled. The zero line should be labelled the OFF position, the full-scale mark labelled position 6, and the remaining five numerals spaced equally between these two extremes. A more or less sensitive meter movement can be used, but in the former case larger values will be required for *R1* through *R6* and in the latter case smaller values. Non-standard resistor values can be obtained by combining standard ones in series or parallel.

The remote unit shown in Fig. 2 consists of a solenoid driving two rotary switches. In the author's prototype, the solenoid is a Ledex Series 5 type with a 1-7⁄8-inch (4.8-cm) diameter case. It is available from most industrial suppliers. Surplus solenoids can be obtained from several sources, two of which are given

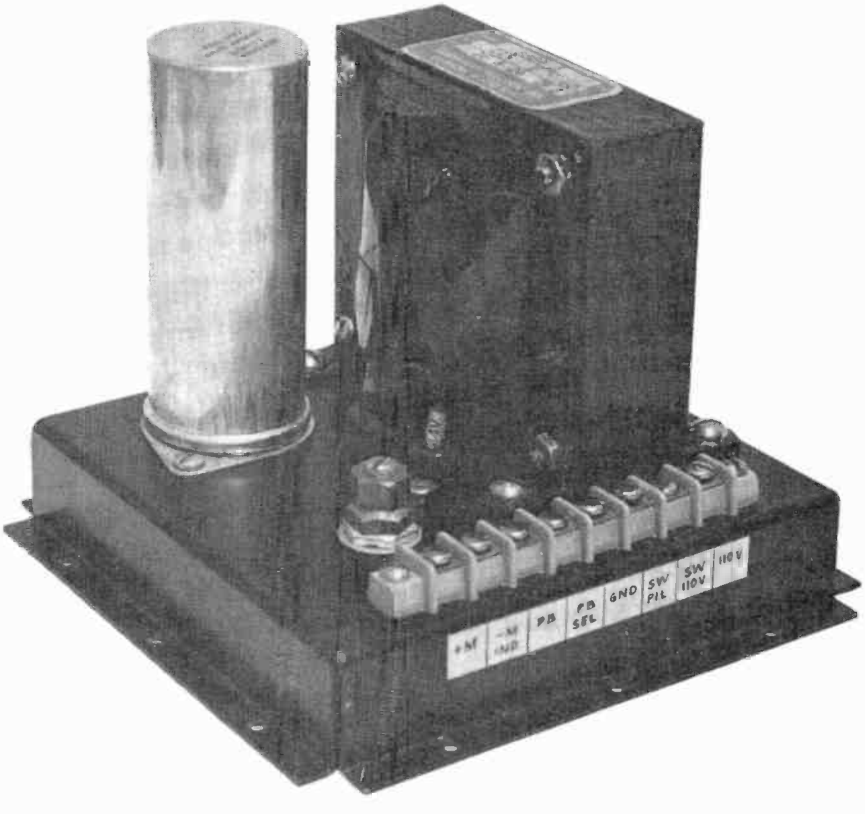


Fig. 3. Photo of the power supply unit.

at the end of the parts list of Fig. 1.

Solenoid *K1* and phenolic switch wafer *S4* are mounted in the center of the utility box's top cover using four 2¼-inch (5.7-cm) tapped metal standoffs, as shown in Fig. 2. Ceramic wafer switch *S3* is mounted inside the utility box and its shaft is coupled to that of the solenoid by an all-metal flexible coupling with dual setscrews on each hub. (These are required to withstand the high torque generated by the solenoid.)

Because the solenoid provides positive indexing, the detent and stop on *S3* must be carefully broken off to reduce drag and allow continuous rotation. Also, alternate contacts on the switch's ceramic wafer should be removed by *very gentle* prying or filing to leave six contacts plus the wiper contact.

The wiring of this switch is shown in Fig. 4. To minimize impedance mismatch, two low-inductance rings are mounted on opposite sides of the ceramic wafer. Form two 2½" (6.4-cm) inner diameter rings from 8" (30.3-cm) lengths of soft-drawn copper wire and hammer the rings flat. Again adjust the inner diameter to 2½", and trim away the excess at the overlap. Butt-join and solder the rings closed.

Partially hidden in Fig. 4, the front ring is soldered to the lug of *S3*'s wiper and to a short length of tinned No. 14 copper wire. The other end of this wire should be soldered to the inner conductor pin of *J1*, the FEEDLINE SO-239 coaxial jack. The rear copper ring is soldered to lugs held in place by the switch assembly screws. A ¼-inch (6.4-mm) insulated spacer should be placed under each of these solder lugs to position the two rings about 7/16 inch (11.1 mm) apart. This might require the substitution of longer screws for those used by the switch manufacturer.

The inner conductor pins of the remaining SO-239 jacks (*J2* through *J7*) can now be connected to the appropriate contact lugs of *S3* via short lengths of tinned No. 14 copper wire. Install a solder lug at each jack location, securing it to the aluminum utility box with one of the four pairs of screws and nuts holding each jack in place. Next, connect one end of a short length of tinned No. 14 copper wire to the solder lug at *J1*. Solder the other end of the wire to the rear copper ring. Repeat this procedure for the remaining jacks (*J2* through *J7*).

Note that the switch shown in Fig. 4 has a metallic ring which shorts out all unselected switch contacts. The author's original intention was to utilize this ring to ground all unselected antennas. This idea was discarded, however, because of the possibility of flashover during transmissions at medium amateur power levels (several hundred watts). In CB, QRP amateur, and SWL applications, however, there is no danger of flashover. Accordingly, those readers whose use of the antenna switch falls into one of the three categories mentioned might want to incorporate this feature for lightning protection. Those who want to do so should not procure the switch type specified in the parts list because it lacks a shorting ring. Rather, they should obtain a switch having such a ring.

Before tightening the shaft coupling's setscrews, make sure that the wiper of *S3* is properly aligned with that of *S4*. Each wiper should be touching the corresponding contact on each switch wafer. A drop of Loctite or nail polish on each screw head and nut will keep the mechanical assembly of the Remote Antenna Selector Switch secure.

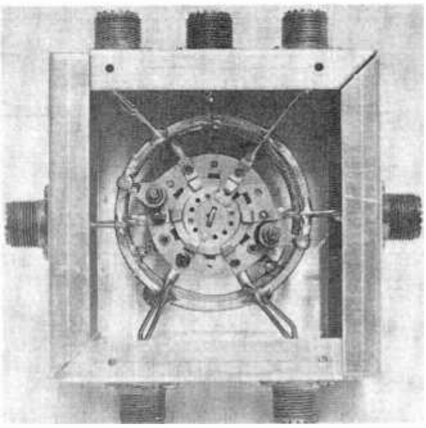


Fig. 4. Photo of the r-f wafer switch shows how two copper rings are used to minimize impedance mismatch.

Adjustment. Interconnect the power supply and switch units with a length of two- or three-conductor cable. The cable should have the same length as that required to run from the remote switch unit to the power supply in the finished installation. It can, in fact, be the same cable. Note that the circuit shown in Fig. 1 employs the braid of the coaxial feedline as a return path for the solenoid and position indicator circuits. This allows the use of a two-conductor control cable. If a separate return path is preferred, a three-conductor control cable must be used. For cable lengths up to 50 feet, No. 20 conductors can be used. Longer control cable lengths necessitate the use of No. 18 or 16 conductors.

Close power switch *S1* and wait a few seconds so that *C1* can acquire a full charge. Then momentarily close *S2*. The solenoid should step and advance one position. Note, however, that *S2* must be closed again to advance the switch to the next antenna position. With the component values specified in the schematic and parts list, you should be able to step *K1* once every two seconds or so. If a faster stepping rate is desired, reduce the value of *R8*.

Adjust potentiometer *R7* so that +10 volts appears between its wiper and ground. The meter will then correctly indicate the position of the antenna position switch. If *K1* is stepped only once, the meter will read OFF, indicating that the switch is between antenna positions.

Installation and Use. The location of the remote switch unit depends on the particular application. If directly exposed to the elements, the remote unit should be housed in a plastic enclosure of a suitable size. All joints, holes and screw heads should be treated with silicone cement to weatherproof the assembly. Coaxial connectors soldered to the antenna and main downlead cables should be thoroughly taped with PVC tape and/or liberally treated with silicone cement because these PL-259 plugs are not weatherproof. Failure to do this will result in premature deterioration of the coaxial feedlines.

As mentioned earlier, the Remote Antenna Selector Switch does not ground unselected antennas. Therefore, it is advisable to insert lightning arrestors in the main downlead and the switch-to-antenna feedlines of any antennas which are not by virtue of their construction at dc ground.

This project was designed to provide reliable remote antenna selection without introducing a significant impedance "bump" and consequent standing wave ratio on the coaxial line running to the radio shack. If switch *S3* and the coaxial jacks have been wired as suggested in this article, the switch can be used through vhf with good results. Remember that the solenoid must be stepped twice to advance the switch to the next antenna position. (Even if you forget, the meter will remind you by displaying an OFF indication.) During idle periods (the bulk of the time), the supply unit can be used to power other intermittent control projects formed around inexpensive surplus or industrial 24-volt relays and stepping solenoids. ◇

Microcomputer ROM Board Buying Directory

Make & Model		Power required (mA)²			PROM cap.	PROM type	Can Program	Firmware	Remarks
		+8V	+16V	−16V					
FOR S-100 BUS:									
Advanced Computer Prods.									
A-8KK	24 (b) 60 (k) 90 (w)	X	X	X	8K	2708	no		Power-on jump; reset jump; user breadboard area.
Byte									
4K PROM	100	X		X	4K	1702A			Powers only ROM being accessed.
PROM Boot	120	X		X	8K	2708			Auto-start option; 2704 option.
CGRS Microtech									
16K ROM	60 (k) 100 (w)				16K	2708	no	opt.	Tiny BASIC, various operating systems, dissassembler/trace/editor firmware optional.
Computerware, Inc.									
EPROM Board	125 (w)				16K 32K	2708 2716	no	no	
Cromemco									
Bytesaver	145 (k) 245 (w)	500			8K	2708	yes	programmer	
16PR	145 (k)	400	800	500	16K	2708	no		Bank select; "address anticipation."
32KBS	195 (k) 295 (w)	2.1A			32K	2716	yes		RAM can overlay ROM address space, bank select; DMA compatible.
D.C. Hayes									
80-708	163 (w)				8K	2708	no		
Ibex									
16KPB	85 (k) 110 (w)				16K	2708	no		Blocks can be disabled to save power and allow RAM to overlay address space.
IMSAI									
PROM 4-512	165 (k) 247 (w)				4K	1702A			Includes 512-byte EPROM.
PROM 4-4	399 (k) 579 (w)				4K	1702A			Includes 4K EPROMs.
Ithaca Audio									
EP16K	25 (b)	320	750	500	16K 32K	2708 2716	no	no	Enables ROMs individually, allowing overlay by RAM.
EPPRO6	85					3*	yes	yes	*One 2708, one 2716, one 2732; up to 4 wait states if desired.
Jade Computer									
MR8	100 (k) 121 (w)	1A			8K	2708	no	$90 mon.	Can alternate RAM and ROM; external RAM disable.
MR16T	100 (k) 121 (w)	1A			16K	2716	no	$90 mon.	As above.
JG RNR	105 (k) 168 (w)	1A			4 to 32K*	*	no	no	*Can use 1702, 2704, 2708, 2716, 5204, 6834.
JG 8/16	30 (b) 60 (k)	1A			8 or 16K	2708, 2716	no	no	Unused locations free for RAM.
PROM SETTER	210 (k) 375 (w)	1A			0	*	yes	no	*Programmer only for 1702, 2704, 2708, 2716, 5204, 6834. With software listing.
Mountain Hardware									
ProROM	164 (k) 214 (w)	500			7.5K	AMI-6834	yes	monitor	Can program 1 byte at a time; includes 512 bytes RAM.
Objective Design									
Databank	200 (k)				16K	2716/ 2708	yes	yes	
Piiceon									
PS-K-OK	167 (k)	X	X	X	8K	2708	yes	mon.	Reset-jump capability.
PS-W-OK	220 (w)	X	X	X	8K	2708	yes	mon.	Same, wired.
PS-W-4K	257 (w)	X	X	X	8K	2708	yes	mon.	Same, w. 4 EPROMs.
PS-W-8K	296 (w)	X	X	X	8K	2708	yes	mon.	Same, w. 8 EPROMs.
Processor Tech.									
GPM	149 (k) 189 (w)				8K	2708	no	2K CUTER	1K RAM; ALS-8 firmware optional.

Make & Model	[illegible]	Power required (mA)[2]			PROM cap.	PROM type	Can Program	Firmware	Remarks
		+8V	+16V	−16V					
GPM-SOL	99 (k) 123 (w)				10K	2708	no	none	Same, less RAM and firmware.
2KRO	65 (k)	600		350	2K	1702			
Solid State Music									
MB-3	65 (k)	250		40	4K	1702	no		Switch-selectable address and wait (0-4) cycles.
MB 8A	95 (k)	160	10	10	16K	2708	no		Similar, but 0-8 wait states, power-on vector jump, allows disabling any 1K block for RAM address overlay.
MB 9	80 (k)	X			4K		no		Can intermix RAM or PROM in 256-byte increments; jump on reset or power-up.
Szerlip									
R N-R	117 (k) 168 (w)				64K	any 24-pin	no		For any 24-pin PROM; also has 1K RAM, parallel I/O.
PROM Setter	210 (k) 375 (w)	700	200	200	64K	same	yes	yes	Similar, but can program.
Teletek									
System Central Interface	385 (w)	X	X	X	3-12	27*	yes	2K mon.	*For 2708, 2716, 2732; has 256 bytes RAM, I/O, reset-jump
Vector Graphics									
PR1	129 (w)				2K	1702A	no	$75*	*Includes 1K RAM; 1K monitor extra; jump-on-reset; MWRITE.
PR2	175 (w)				12K	2708	no	$75*	*As above, but addressable in two 8K blocks; 3K unused space allows RAM overlay.
Wameco									
EPM 1	30 (b) 200 (k) 230 (w)				4K	1702	no	no	Phantom disable.
EPM 2	30 (b)						no	no	Phantom disable & bank sel.
	455 (w)				16K	2708	no	no	2708 version.
	1225 (w)				32K	2716	no	no	2716 version.
Western Data Systems									
PRO/EX 1	296 (k)	2A	125	125	8K	2716	no	yes*	*MICROBUG OS; also contains Video RAM, on-board r-f modulator.
Xybek									
Prammer I	259 (w)				2K	1702	yes	opt.*	*1.8K EPROM, 256 bytes RAM; programming firmware $32, external program socket $17.
Prammer III	370 (w)				31K	2708 T2716 PD458	yes	opt.*	*Similar, but firmware $32, zero-insertion-force ext socket $19; 1K RAM, 30K PROM.

Make & Model	Price[1] ($)	Power required (mA)[2]			PROM cap.	PROM type	Can Program	Firmware	Remarks
		+8V	+12V	−12V					
FOR SS 50 BUS:									
Gimix									
8KP	90 (w)	X			8K	2708	no		
4KPPD	198 (w)	X			4K	2708	yes	yes	PROMs can be inserted & removed from programming sockets with power on, can program 4 at once.
Midwest Sci.									
EPR 8	95 (k)* 150 (w)*	X	X		8K	2708			*Sockets, $15 extra.
PRR 68	95 (k)* 150 (w)*				4K*	1702A			*Sockets, $25 extra. 4K includes 256 bytes RAM.
SDS Technical									
MCM6830	145 (k)	800			2K	2716	8K	yes	
Smoke Signal									
P38	129 (w)				8K	2708	no	optional	Interfaces to POP-1 EPROM programmer, Oliver paper tape reader.
P38-1	129 (w)				8K	2708	yes	optional	

Notes:
[1] (b)=bare board, (k)=kit, (w)=wired. Prices usually do not include PROMs.
[2] In amperes where indicated by "A." Power consumption may vary with number of PROMs.
*See "Remarks" column

BY ROBERT B. COOPER, JR., W5KHT, AND S. K. RICHEY

PART 3

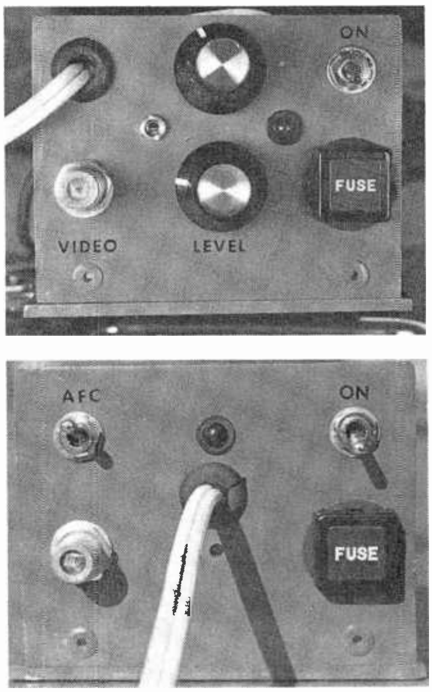
A PERSONAL MICROWAVE COMMUNICATIONS SYSTEM THE MINI-WAVE

Antennas, range and licensing information

Antennas and Range. Microwave Associates' Gunnplexers are shipped equipped with UG-39/U waveguide flanges and must be used with antennas having compatible flanges. The company offers several antennas that will function well with its Gunnplexer units.

The least expensive antenna available is a small horn with 17 dB of gain and a half-power beamwidth of approximately 30 degrees. A small (2-foot or 0.6-m) parabolic dish can be used if more gain is desired. The Microwave Associates Model MA-86555 dish has 32 dB of gain, a 4-degree half-power beamwidth, and mounts on a 2-inch (5.1-cm) pipe. Even more gain can be achieved by installing the Model MA-86556 antenna. This 4-foot (1.2-m) dish has 38 dB of gain and a 2-degree half-power beamwidth. It mounts to a 2-inch (5.1-cm) pipe. Ordering information for these antennas can be found in Part 1 of this article.

Exactly which antenna is right for your installation depends on the desired communications range. Antenna gain must be used to overcome path loss, which increases with frequency. At 10.250 GHz, signal loss over the first mile (1.6 km) is 116.8 dB. That's very high, but when the path is doubled to 2 miles (3.2 km), path loss increases "only" 6 dB to 122.8 dB. Each time the path is doubled again, say, from 2 to 4 miles (3.2 to 6.4 km), the signal drops another 6 dB. Obviously, getting a signal to travel the first mile (1.6 km) while retaining a usable signal level is the biggest hurdle. Once that distance is achieved, extending the range should be relatively easy.



Controls for transmitter (top) and receiver (bottom) are on enclosures ends. Hole below ac line on receiver is for audio.

Every calculation of microwave communications range includes one immutable assumption and several variable factors. The fixed assumption is that the path extends over the *line of sight*. That is, if a powerful enough pair of binoculars were available, the receiving antenna could be seen by an observer at the transmitting antenna. No obstructions by hills, buildings, or plants are permitted.

In the real world, microwaves will penetrate objects to varying degrees and over short paths (0.5 to 1 mile or 0.8 to 1.6 km) intervening objects can be tolerated if necessary. The authors have used Mini-Wave gear to communicate through one to several walls with good results. Quality of the link depends upon the composition of the intervening structures. (Wood doesn't attenuate microwaves too severely; solid steel blocks them completely!)

The reflective properties of solid objects can be employed to advantage in situations where a line-of-sight path cannot be obtained. For example, if both ends of a proposed microwave link can "see" a metal water tower but no direct line of sight exists between them, communications might well be established by aiming both antennas at the tower. Metallic objects such as the water tower

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CIRCLE NO. 5 ON FREE INFORMATION CARD

(Continued from page 70)
in this hypothetical situation usually reflect microwave energy very efficiently. In some instances, a large building or mountain will reflect enough signal to make communications possible.

Other factors that govern range are transmitter output power, the method of modulation employed, receiver sensitivity and noise figure, path loss, the required signal-to-noise ratio, etc. In FM systems such as the Mini-Wave communications link, range is affected by the "FM improvement factor," which is the advantage gained by more fully modulating the carrier (increasing the frequency deviation and modulation index), the "FM threshold," the point at which limiting improves intelligibility, the design and operating characteristics of the limiter and discriminator, and other factors too complex for adequate treatment here.

The curves in Fig. 11 show the line-of-sight ranges for Mini-Wave transmitters and receivers employing 17-dB horns (A), 32-dB parabolic dishes (B), and 38-dB dishes (C), plotted against signal-to-noise ratio. Intermediate ranges will result if different antennas are used at the transmitter and receiver. If the goal of flawless video reception is established, an S/N ratio of 48 dB is required.

These range plots show what a powerful tool antenna gain is! In the Mini-Wave system, transmitter output power is fixed at a nominal value of 20 milliwatts. Receiver noise figure, discriminator and limiter characteristics and the transmitter modulation index are established by circuit design and component parameters. Accordingly, increasing antenna gain is the simplest and most effective way to increase range.

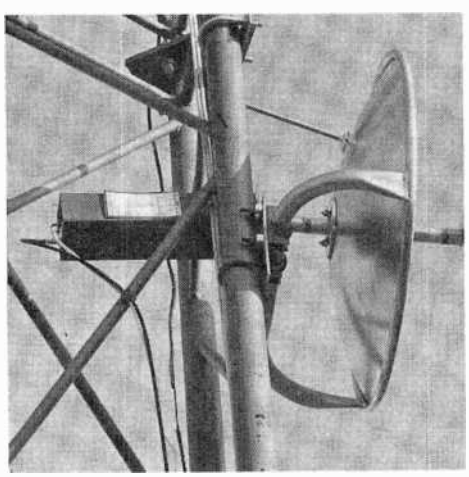
The dramatic increase in signal-to-noise ratio that can be obtained by replacing the stock 17-dB horns supplied by Microwave Associates in its MA-87141-1 package is illustrated by both Fig. 11 and the following example. Assume that 17-dB horn antennas are used at each end of a 2.5-mile (4.0-km) path and that the baseband signal at the receiver's video output has an (unacceptable) signal-to-noise ratio of 20 dB. If one of the horns is replaced with a 2-foot (0.6-m) parabolic dish, system gain increases 15 dB. Thus, the video signal-to-noise ratio becomes 35 dB.

The quality of the received picture can be further improved by replacing the other horn antenna with a 2-foot (0.6-m) dish. Adding the second dish increases the signal-to-noise ratio at the receiver output by an additional 15 dB to an excellent 50 dB, 2 dB above the requirement for flawless video reception. Employing 4-foot (1.2-m) dishes at both ends of a Mini-Wave System makes possible excellent video reception over 13-mile (20.8-km) paths, very good picture quality at 32 miles (51.2 km), and usable video reception over distances greater than 64 miles (102.4 km)—assuming that the terrain permits such long line-of-sight paths!

A final word about the range plots shown in Fig. 11. They were derived without any allowance for a *fade margin*. Commercial microwave links are designed to provide more signal at the receiving antenna than is necessary for proper reception. This extra margin of signal strength is included in the link to compensate for equipment aging, increases in path loss which can occur during heavy rain, etc. Typical commercial systems made by Bell Telephone and others provide the receiver with 40 dB more signal than is needed under optimum conditions.

Such a margin adds considerably to the cost of a communications system. Commercial users are willing to pay the price for high reliability. Otherwise, their ability to forward information (and to collect revenue for the service) would be dependent on the exact amount of atmospheric attenuation at any given instant, as well as other factors beyond their control.

Those employing Mini-Wave equipment can usually tolerate brief signal outages during extremely heavy rainstorms. They therefore do not have to invest the large sums required for substantial fade margins. However, if a particular Mini-Wave application calls for a fade margin, it can be obtained simply by installing an antenna with more gain than is needed for clear reception. For example, if a horn providing satisfactory results is replaced with a 4-foot (1.2-m) dish, a fade margin of 21 dB or more will be obtained—at a cost of $265.



Range of several miles can be obtained with 2' parabolic dish.

Set-up. Place the transmitter and receiver relatively close together, say, 50 to 100 yards (47.7 to 95.4 m) apart. Connect a video source to the transmitter input jack and a video monitor to the receiver's output jack. If the audio circuits have been built, connect a high-impedance signal source to the transmitter's audio input jack and a pair of headphones or an external audio amplifier to the demodulator's output jack. Optically align the antennas and apply power to both units.

If the Gunnplexers have been ordered for compatible transmit and receive frequencies and the Varactor bias levels have been set at +4 volts, contact should be established almost instantaneously. Next, place receiver switch *S1* in the AFC ON position if you have not already done so, and adjust the transmitter's video level control (*R30*) for optimum picture quality if it was not set earlier with the aid of an oscilloscope. Similarly, audio level control *R7* should be adjusted for best-sounding audio if it was not previously adjusted for the proper ±25-kHz subcarrier deviation.

After you have gained some experience operating the Mini-Wave system over short distances, you can begin to extend the signal path. If horn antennas are employed, aiming them becomes relatively noncritical as the path length increases because the antennas have −3-dB beamwidths of approximately 30 degrees. Parabolic dishes, however, are extremely directional and demand very precise positioning—a change in antenna alignment of only a few degrees will mean the difference between no signal at all and perfect video reception!

The following procedure is recommended for the installation of parabolic dish antennas. If possible, establish communications over the path with horn antennas. Picture quality need not be good, but the presence of a video signal (even one that is just detectable) will simplify matters greatly. Next, replace the horn on the receiving Gunnplexer with a 2-foot (0.6-m) or larger parabolic dish antenna. Leave the transmitting horn fixed and adjust the position of the receiving dish for optimum reception. Then, if necessary, replace the transmitting horn with a parabolic antenna and

A Band Plan for the 10.0-to-10.5-GHz Amateur Allocation

This plan has been developed so that the 10-GHz amateur band can accommodate the largest possible number of simultaneous, interference-free video (or video plus audio subcarrier) transmissions in a given area. Placing the receiver's Gunn local oscillator 45 MHz above the transmitter frequency and taking advantage of antenna polarization (horizontal or vertical) characteristics results in 33 one-way channels. For two-way communications, receiver and transmitter are reversed, generating 33 reply channels.

The "national calling frequency" for general use is channel B4, 10.2 GHz transmit and 10.245 GHz receive. Note that channel C5's transmit frequency coincides with the receive frequency of the national calling channel. This has been done deliberately to allow frequency netting and calibration of equipment against a local CW (A) beacon operating on channel C5.

Channel group	A (horizontal)		B (horizontal)		C (vertical)		D (vertical)	
	T	R	T	R	T	R	T	R
1	10.010	10.055	10.035	10.080	10.025	10.070	10.050	10.095
2	10.065	10.110	10.090	10.135	10.080	10.125	10.105	10.150
3	10.120	10.165	10.145	10.190	10.135	10.180	10.160	10.205
4	10.175	10.220	10.200	10.245	10.190	10.235	10.215	10.260
5	10.230	10.275	10.255	10.300	10.245	10.290	10.270	10.315
6	10.285	10.330	10.310	10.355	10.300	10.345	10.325	10.370
7	10.340	10.395	10.365	10.410	10.355	10.400	10.380	10.425
8	10.395	10.440	10.420	10.465	10.410	10.455	10.435	10.490
9	10.450	10.495						

*Antenna polarization is given in parentheses.

aim it for best picture quality on the receiving monitor. A radio or land-line voice link will make this task easier.

Never move or attempt to align *both* antennas *simultaneously*! Always leave the transmitting antenna undisturbed (pointed in the direction you believe it should be) when aligning the receiving antenna. Conversely, when adjusting the transmitting antenna leave the receiving horn or dish fixed in position. Both the extreme directionality of parabolic dishes and the relatively abrupt quieting characteristics of the FM i-f make antenna alignment very critical, but the increase in range and improvement in picture quality make the task well worth the effort.

Licensing Your Gunnplexer System. If you are a Technician or higher class radio amateur, your ticket authorizes you to operate Gunnplexers on the 10.0-to-10.5-GHz amateur band. The author has drawn up a band plan for the 10.0-to-10.5-GHz allocation so that as many amateurs as possible can place Mini-Wave systems on this 500-MHz-wide band. (See box above for information on band plan.)

Readers who are not licensed amateurs can either obtain a ham ticket or apply to the FCC for authorization to operate Gunnplexers on nearby frequency allocations.

Satisfying the requirements for a Technician Class amateur license is relatively easy. Moreover, Technicians have extensive operating privileges on vhf, uhf, and other microwave bands, and can access repeaters and orbital satellites carrying transponders.

Two microwave allocations are available to persons not holding valid amateur radio licenses. The 10.5-to-10.55-GHz allocation is a "developmental" band for which the Commission grants "Experimental" licenses. Just above this, from 10.55 to 10.68 GHz, is a "mobile" band for which "Research" licenses are granted. At last check, less than 50 Research licenses had been granted in the United States for operations on the mobile band. Gunnplexers for these bands are available on special-order from Microwave Associates.

The Research license is intended primarily for persons developing communications "projects," while the Experimental license is granted to facilitate the development of new equipment which might ultimately be placed on the communications market. If you are interested in simply placing the Mini-Wave system as described in this article on the air for microwave experimentation, the Experimental license is appropriate. Those wishing to expand on this concept and create new microwave communications systems are suitable candidates for a Research license. Both licenses are granted and licensees' operations regulated pursuant to Part 5 of the FCC's Rules and Regulations, which governs Experimental Radio Services (Other Than Broadcast).

To obtain either license, write to the nearest field office at the FCC, requesting Form 442. Upon receipt of this form, fill it out and return it to the Commission's office in Washington, D.C. The form requires that you submit details of the system you propose to construct, its intended application, and how and where you will use it. Both licenses have terms of one year and are renewable.

Safety and RFI Considerations. The negative effects of microwave radiation upon living tissue are well docu-

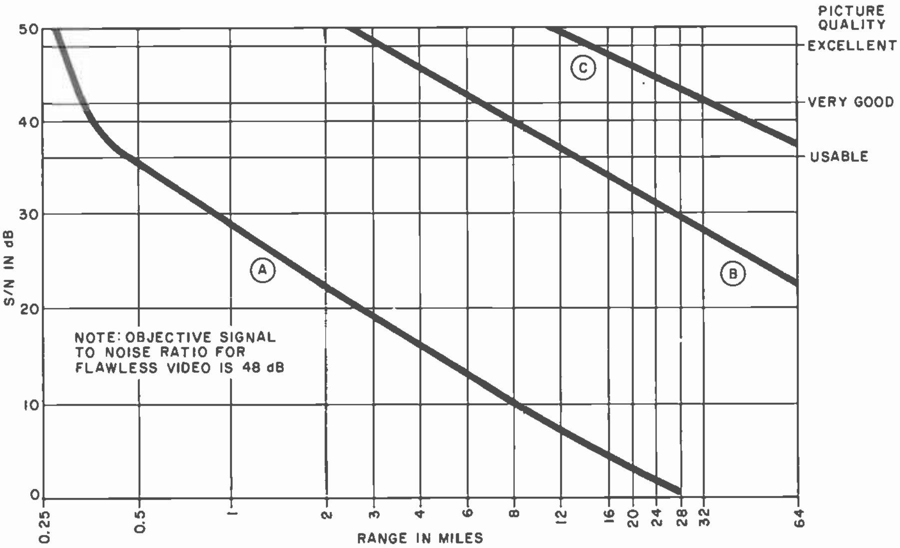


Fig. 11. Range plot for horn (A), 2-foot parabolic (B) and 4-foot parabolic (C) dish antennas when used with the Mini-Wave microwave communications system.

mented, with the eyes being especially vulnerable. Exactly what level of intensity is hazardous to human beings has been and continues to be the subject of a worldwide debate. The Federal government's Occupational Safety and Health Administration (OSHA) has set a safety limit of 1 milliwatt per square centimeter (1 mW/cm^2).

Microwave Associates Gunnplexers are low-power devices, having a nominal power output of 20 mW. However, the microwave radiation is concentrated in a relatively small area. The power density at the open (antenna) end of the waveguide is approximately 6.2 mW/cm^2, considerably greater than OSHA's maximum permissible value. Fortunately, r-f power density decreases dramatically with distance, and the intensity of microwave radiation is at safe levels 6 inches (15.2 cm) from the mouth of the waveguide.

To adhere to the most conservative radiation exposure limits, no one should place himself directly in front of the horn (or parabolic dish) antenna for a distance of several feet. *Never* look into the open end of a Gunnplexer while it is oscillating or place any portion of your body inside the waveguide, horn, or dish antenna. If you follow these simple rules, you can operate your Mini-Wave system in complete safety.

The 10.0-to-10.5-GHz amateur band and the 10.55-to-10.68-GHz "mobile" band are on either side of the 10.525-GHz frequency commonly used by "X-band" police radar. This frequency is actually inside the 10.5-to-10.55-GHz "developmental" band. During hundreds of hours of operating car Mini-Wave system, the authors have never suffered interference from the low-power police radar transmitters.

On several occasions, however, our 10.25-GHz transmitters have driven police radar receivers and motorists' X-band radar detectors "absolutely nuts." We therefore offer these words of advice—operating a Gunnplexer near X-band police radar units is unwise. The police radar receiver will experience interference at a far greater distance (several miles) than that at which a motorist's radar detector will be triggered by the police radar transmitter.

In Conclusion. We have presented here the first low-cost, compact microwave audio/video communications link project. The world of microwaves is waiting for you, and the Mini-Wave system will enable you to explore it. ◇

Solid State

By Lou Garner

THOSE VERSATILE MULTIS

GENERALLY, the simpler a semiconductor device, the greater its versatility—that is, the more circuits in which it can be used. Transistors and diodes, for instance, are the most versatile of all devices, and are used in virtually all types of circuits. As increasingly complex devices such as ICs are considered, however, versatility drops and some LSI devices, a calculator IC, for example, may be so specialized as to have a relatively small number of potential applications. But there are exceptions: the multifunction ICs, devices designed specifically for maximum versatility. TI's SN76477 complex sound generator, is one example. The ubiquitous 555 timer is another and there are more, including Intersil's (10900 N. Tantau Ave., Cupertino, CA 95014) powerful 8038 waveform generator and National Semiconductor's (2900 Semiconductor Drive, Santa Clara, CA 95051) intriguing LH0094 multifunction converter.

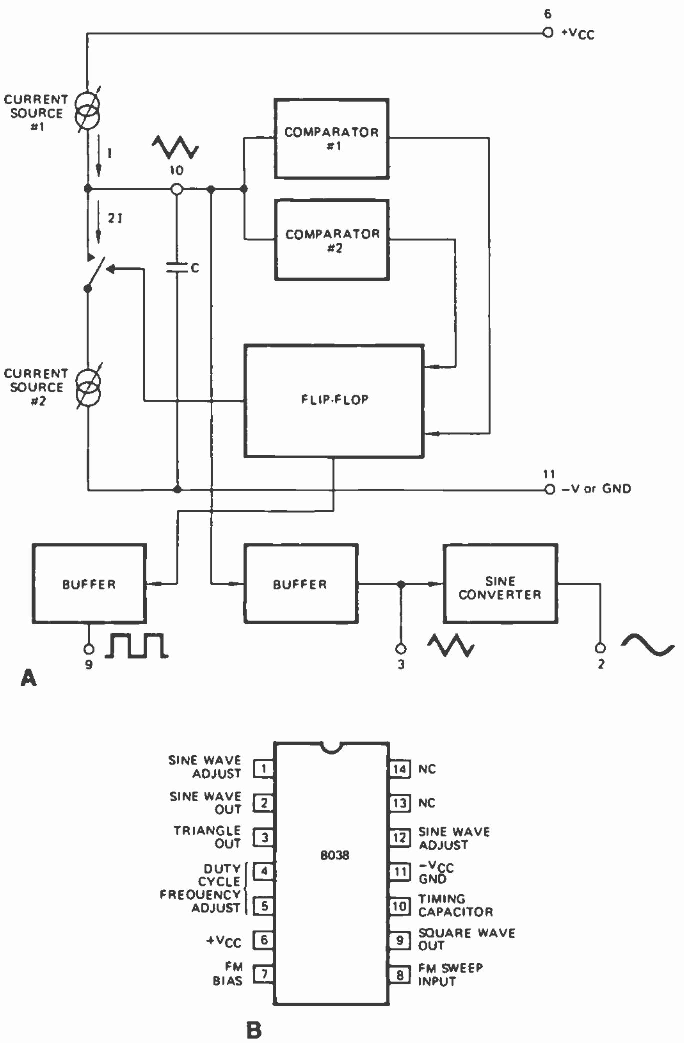


Fig. 1. Intersil's 8038 waveform generator: (A) functional block diagram; (B) pin connections.

Functionally, the 8038 comprises two externally adjustable constant-current sources, a pair of comparators, a flip-flop, buffer amplifiers, and a sine converter, as shown in Fig. 1A. A monolithic IC assembled in a standard 14-pin DIP, the device is capable of producing sine, square, triangular, sawtooth and pulse waveforms over a frequency range from less than 0.001 Hz to more than 1.0 MHz. The output frequency is independent of the supply voltage and generally depends only on the values chosen for the external resistive and capacitive timing components. If desired, however, the 8038's output can be either frequency modulated or swept over a wide range simply by applying a control voltage to its appropriate terminals (Fig 1B). Quite stable, the unit has a maximum rated frequency drift of only 50 ppm/°C. Its other features include low distortion (typically, 1.0% or less), good linearity (0.1% or better), a variable duty cycle from 2% to 98%, and the capability of driving TTL devices. Adaptable to a variety of power supplies, the 8038 may be operated on either single-ended or dual dc power sources from 10 to 30 V or from ±5 to ±15 V, at less than 20 mA.

In operation, the IC's nominal output frequency depends upon the values of the two external current-source (or timing) resistors connecting pins 4 and 5 to $+V_{CC}$ as well as upon the value of the timing capacitor between pin 10 and $-V_{CC}$ (or circuit ground). The *symmetry* of the waveforms varies with the *duty cycle* and this depends upon the relative values of the two timing resistors. Three different configurations for the timing resistors are given in Fig. 2. Of these, the arrangement shown in Fig. 2A is the most versatile, permitting the greatest degree of operator control over both the frequency and waveform symmetry through the two timing potentiometers (R_A and R_B). A 50% duty cycle, delivering symmetrical waveforms, is achieved when R_A equals R_B.

Requiring a single potentiometer, the arrangement shown in Fig. 2B permits a relatively small variation of the duty cycle on either side of the 50% point and may be preferred for some applications. In the last circuit, Fig. 2C, the timing resistor pins are shorted together and a single potentiometer is used for control. While this arrangement does not permit an independent adjustment of duty cycle, it is the simplest and least expensive of the three designs.

Typical variations in output waveform symmetry with square-wave duty cycles of 50% and 80% are shown in Figs. 3A and 3B, respectively. With a 50% duty cycle, the outputs are a triangular wave, sine wave and square wave. As the duty cycle is increased or decreased, the triangular wave changes into a sawtooth and the square wave into a rectangular wave, approaching a narrow pulse as the duty cycle is increased or decreased to near its extreme limits. The sine wave becomes highly distorted, for the wave-shaping circuit

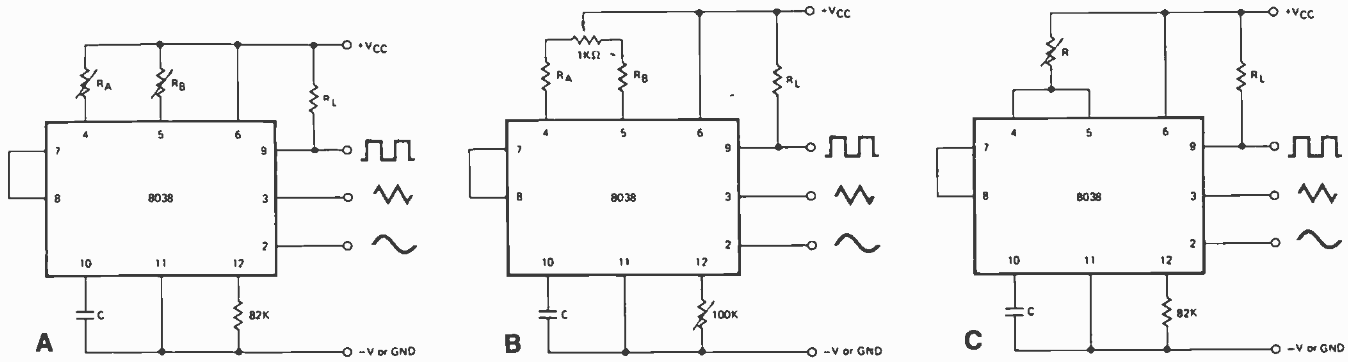


Fig. 2. Timing resistor connections for the 8038 as explained in text.

used on the chip is designed to modify a triangular wave into a sine form and requires a symmetrical input for proper shaping action.

While the output signal waveform symmetry with respect to time depends on the ratio of the two timing resistors (R_A and R_B), the symmetry with respect to ground depends on the type of power source used. If a single-ended power supply is used, the average levels of the triangular and sine-wave outputs will be one-half the supply voltage, with the square wave alternating between $+V_{CC}$ and ground. The square-wave output is not committed, however, and requires an external load resistor. If desired, this resistor may be returned to a different dc source. In computer or control applications, for example, the square-wave output load could be returned to a +5-V dc source even though the 8038 is operated on a 15-V dc supply. Here, the output level would be compatible with TTL devices, permitting the square wave to be used as a clock signal for logic circuits. On the other hand, if a dual or split power supply is used, *all* signal waveforms will vary symmetrically on either side of circuit ground (or 0 V).

The 8038 can be used as a basic signal or clock source in timers, signal generators, alarm systems, audio sweepers, computer circuits, control networks, musical instruments, tone generators, and special-purpose test instruments. Two units may be cascaded, with one serving as a sweep signal source for the second, or the IC may be used in combination with other special-purpose devices, such as *TI*'s SN76477 complex sound generator. A small sampling of the scores of possible application circuits for the 8038 is given in Figure 4. Abstracted from Intersil's 8-page data brochure for the device, these circuits feature standard components and may be duplicated quite easily in the home laboratory or workshop for experimental tests or incorporation into more complex equipment designs. Neither layout nor lead dress is critical but good wiring practice should be followed.

Referring, first, to Fig. 4A, the 8038 is controlled by a FET switch to form a simple tone-burst generator. Timing capacitor C is effectively shorted to ground by the 2N4392 FET as long as the FET's gate is held positive or near ground potential, thus preventing oscillation. The circuit is strobed on by applying a negative pulse to the FET's gate through a 1N914 isolation diode. A second diode, connected to output terminal 9, ensures oscillator start-up on the same slope each time it is switched on.

The second circuit, Fig. 4B, is a wide-range audio oscillator covering from 20 Hz to 20 kHz without band switching. This 1000:1 range is achieved by applying a variable dc control voltage to the IC's FM sweep input terminal (8) while holding the voltage across timing resistors R_A and R_B at a relatively low level. A 1N457 series diode drops V_{CC} and the voltage applied to the timing resistors through the Duty Cycle (or symmetry) potentiometer to several millivolts below the maximum voltage available from the 10,000-ohm frequency control. A large trimmer (15 megohms) connected to pin 5 helps minimize duty-cycle variations with frequency, while a 100-kilohm potentiometer connected to pin 12 as a distortion control serves to optimize the sine-output waveform.

In contrast to Intersil's 8038, which is essentially a signal source, National Semiconductor's LH0094 multifunction converter is a versatile signal processor. With analog inputs, the

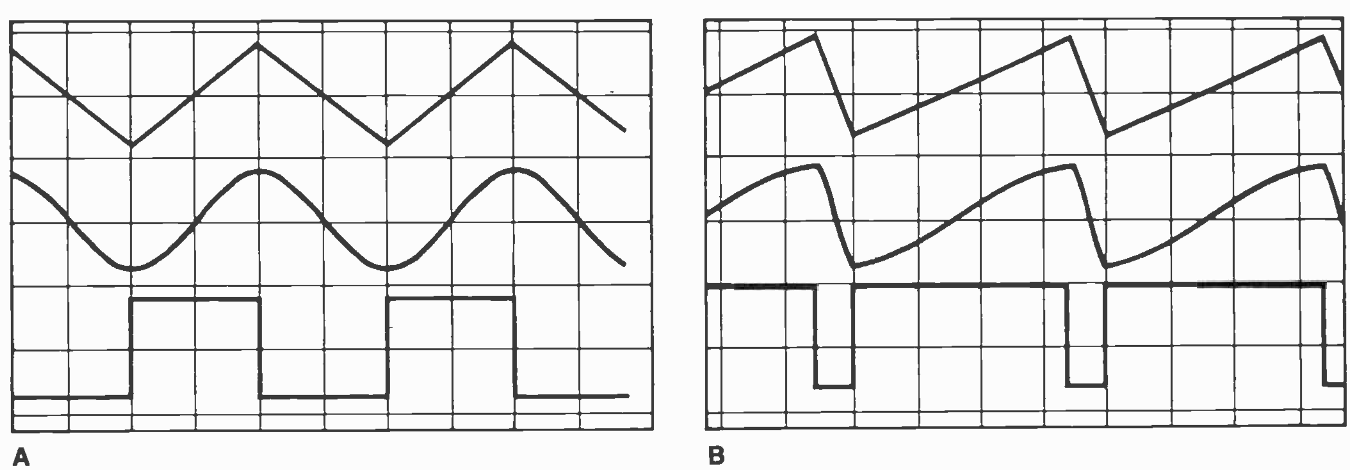


Fig. 3. Typical waveforms with (A) 50% and (B) 80% duty cycles.

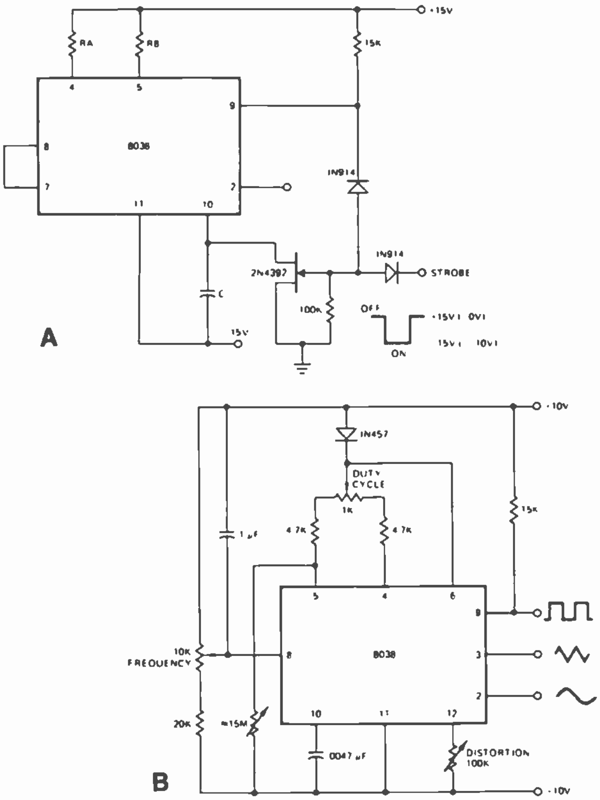


Fig. 4. Typical 8038 circuits; (A) tone-burst generator; (B) audio oscillator.

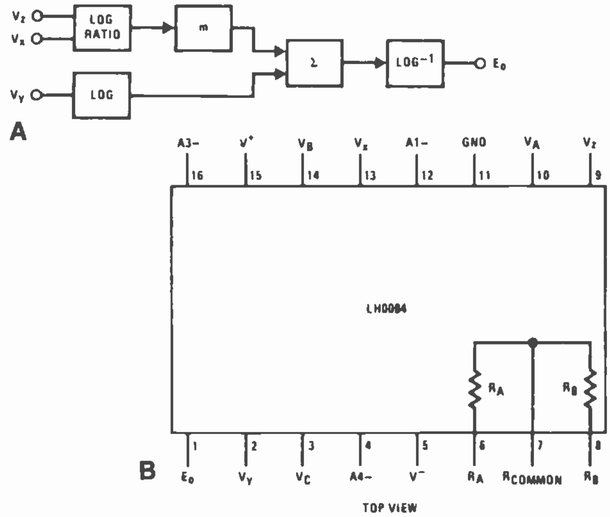


Fig. 5. National's LH0094 multifunction converter: (A) functional block diagram; (B) pin connections.

device can be used for precision multiplication and division, for squaring and extracting square roots, for generating trignometric functions, as an exponentiator, and as a logarithmic amplifier. Depending on the auxiliary circuits used, the IC can be employed in compressors, expanders, analog computers, alarm systems, sensor translators, controls, measuring instruments, and test equipment.

Functionally, the LH0094 comprises circuits for determining the logarithmic ratio of two input voltages, multiplying this by a known constant (m), summing the result with the logarithmic equivalent of a third input voltage, and determining the antilog of the final value, as shown in Fig. 5A. In a broad sense, the device is the electrical equivalent of a sliderule. Assembled in a 16-pin metal DIP, the LH0094 includes two uncommitted precision resistors, R_A and R_B, which may be used for setting the multiplying factor (m) to either 0.5 or 2.0 (Fig. 5B). Offering typical input impedances of 100,000 ohms, the IC will accept input levels up to 10.0 volts, and can be operated from dual dc sources from ±5.0 to ±22.0 volts. Its output impedance is approximately 1 ohm and, with an average output load of 10,000 ohms, it can supply an output signal swing of 12.0 volts max. when operated on a standard ±15 V dc supply. In ac applications, the device offers a 3-dB bandwidth of 10 kHz.

Typical application circuits for the LH0094, abstracted from National Semiconductor's 10-page data brochure for the device, are illustrated in Fig. 6. Precision multiplier and divider circuits are shown in Figs. 6A and 6B, respectively. In both designs, optional clamp diode *D1* should be included for those applications in which the inputs may be either "open" or subject to negative voltages.

Referring, first, to Fig. 6A, this circuit develops an output voltage, E_O, equal to the product of input voltages V_Y and V_Z divided by 10, and offers a typical accuracy of 0.02% when properly adjusted. Here, a precise 10-volt reference level is applied to the V_X terminal (pin 13). Prior to use, an accurate 10-volt level is applied to the V_Y and V_Z terminals and trimmer *R2* is adjusted until the output is precisely 10.000 V.

In the divider circuit, Fig. 6B, output voltage E_O is equal to 10 times the result of input voltage V_Z divided by input V_X. Again, a precise 10-volt reference level is required, but applied, in this case, to the V_Y terminal (pin 2) through trimmer R2 and to the A3- terminal (pin 16) through R1. With a typical accuracy of 0.05%, the divider requires multiple adjustments

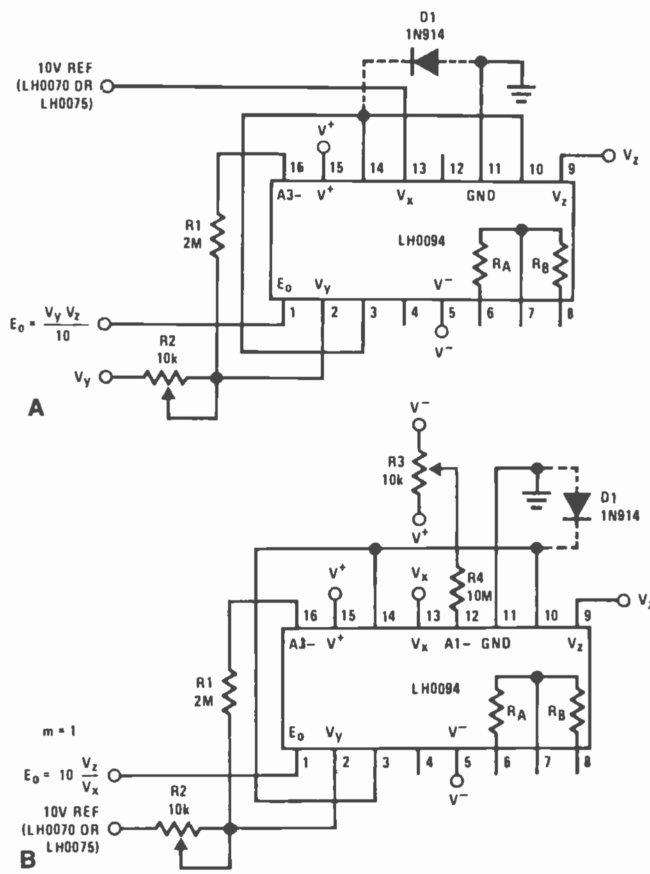
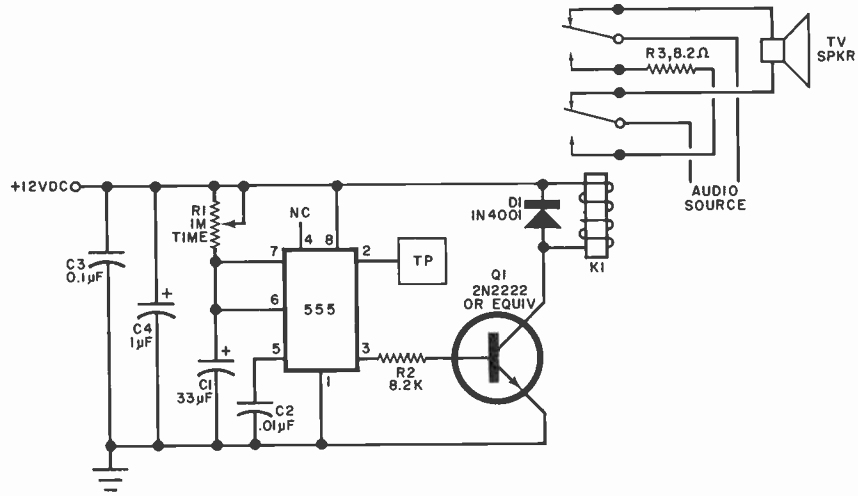


Fig. 6. Precision multiplier (A) and (B) divider circuit.

Fig. 7. Reader's circuit for a television commercial killer uses the ubiquitous 555 timer integrated circuit.



prior to use. First, with the 10-V reference applied to V_Y, 0.1 volt is applied to V_X and V_Z and *R3* is adjusted until E_O is exactly 10.000 V. Second, 10 volts is applied to *all* inputs and *R2* is adjusted until E_O is 10.000 V. The entire procedure is then repeated at least once.

Reader's Circuit. Guy Isabel (1725 Henri-Bourassa East Blvd., Apt. 25, Montreal, Quebec, H2C 1J5, Can.) has sent us another of his simple, but interesting, circuits. Guy writes that each time one of his circuits is featured, he receives a flood of correspondence from other experimenters and hobbyists, and that this has resulted in his establishing a number of "pen pals" with whom to exchange ideas and circuits. Dubbed a *TV Commercial Killer*, Guy's latest circuit, shown in Fig. 7, is another application for the 555 IC. Easily duplicated in a single evening, Guy's design is essentially a simple touch-plate controlled time-delay relay. When connected to a TV set, the control permits the viewer to shut off the sound for adjustable periods up to more than thirty seconds simply by lightly touching a small control plate. At the end of the preset period, sound is restored automatically.

Referring to the schematic diagram, the 555 is wired as a monostable multivibrator. In operation, the circuit's timing cycle is initiated by a random voltage pulse applied to pin 2 when the control plate (TP) is touched by the operator's finger. Afterwards, the circuit is insensitive to further control pulses until its operating cycle is completed. The duration of the timing cycle is directly proportional to the time required to charge *C1* through *R1* and hence is dependent on *R1*'s adjustment. With the component values specified in the diagram, the maximum period is somewhat over a half minute. During the timing cycle, pin 3 is high, supplying a base bias to npn transistor *Q1* through series current limiting resistor *R2*, and causing the transistor to conduct, closing relay *K1*. A dpdt type, *K1* switches the TV set's audio output terminals, from the loudspeaker voice-coil leads to an 8.2-ohm load resistor (*R3*), thus silencing the set. At the end of the timed period, pin 3 goes low, *K1* drops out, and the TV set's loudspeaker is reconnected, restoring normal operation.

Guy has used standard, readily available components in his circuit design. Transistor *Q1* is type 2N2222, although other general-purpose npn transistors should work as well. A conventional 1-megohm potentiometer is used for *R1*, *R2* is a half-watt resistor, and *R3* a 2-watt unit. Capacitors *C1* and *C4* are 16-volt electrolytics, while *C2* and *C3* may be low-voltage ceramics, paper tubulars, or plastic film types. Relay *K1* is a dpdt type with a 12-V 50-mA dc coil (Radio Shack #275-206 Calectro D1-974, or equivalent). Finally, the touch plate (TP) is simply a small metal plate of a few square inches.

Neither layout nor lead dress is critical and the project can be assembled using the builder's choice of wiring techniques. All dc polarities must be observed, of course, and care must be taken not to overheat the semiconductor devices when soldering.

The final installation is quite simple. With the TV set's power off, the loudspeaker leads are disconnected and these, together with the audio output leads, are connected to appropriate terminals on *K1*. Next, time delay trimmer *R1* is adjusted for an optimum interval long enough to cover most TV commercial messages. Guy set his unit for 28 seconds. ◇

Experimenter's Corner

By Forrest M. Mims

ANALOG COMPUTER CIRCUITS, PART 1

IF YOU'RE like most readers of this column, you prefer to have us describe digital circuits. Considering how the microprocessor revolution is making a major impact in virtually every area of electronics, that's to be expected. All the excitement about digital technology, however, has left a less glamorous but very valuable technology virtually ignored by experimenters and engineers alike. The technology to which I refer is *analog computation*.

If you think analog computers are a relic of the past, think again. Recent developments have made possible sophisticated analog computer ICs with unprecedented accuracy. One of these new circuits, billed as the first single-chip analog computer is the Analog Devices AD534 precision multiplier-divider. Available for about the same price as many microprocessors, the AD534 can perform all the MDSSR functions (multiplication, division, squaring and square rooting) with ease and in *real time*. There are no elaborate software requirements and the AD534 will perform any of these operations while the input information is changing at up to 1 MHz.

At the conclusion of the second installment of this two-part series on analog computer circuits, we'll take a closer look at the AD534 and see how it's used to perform each of the MDSSR functions. Meanwhile, we're going to cover the basics of analog computing by experimenting with a potpourri of homebrew analog computer circuits.

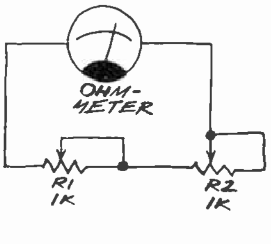


Fig. 1. Analog adder made from potentiometers,

After you've read this and next month's columns I think you'll agree that analog computer circuits can perform many tasks much more efficiently and for less money than microprocessors. Let's begin with a little background information that will help you better understand some of the key differences between analog and digital circuits.

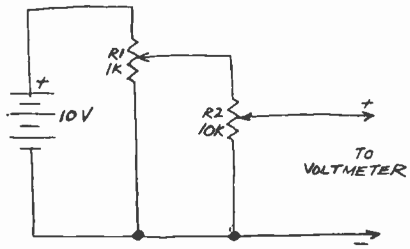


Fig. 2. Simple multiplier made from potentiometers.

Analog vs Digital. Most readers of this column already know the essential difference between analog and digital integrated circuits. Analog ICs, such as amplifiers, oscillators and timers, process or produce signals whose amplitudes are continuously variable over a given range. Digital ICs, on the other hand, process or produce signals which occupy either a low or high state.

An amazing number of applications use either digital *or* analog circuits. Lately, of course, the trend has been toward digital almost exclusively. In some ways, however, this trend (or is it a fad?) is clearly unfortunate. Consider the digital voltmeter (DVM). The unprecedented accuracy of a three- or four-digit DVM is ideal for making measurements of fixed voltages. But have you ever tried to monitor a slowly changing voltage with a DVM? If not, good luck! The stream of constantly changing numbers is almost impossible to read and makes little sense. An old-fashioned panel meter with an analog readout (pointer and scale) offers a much better solution to this common problem.

When it comes to computers, digital technology has the advantage in accuracy, programmability and computing power. Analog computers, however, are ideal for simulating a real-world system such as a structure, machine, dam, aircraft or missile. Simply rotating a few control knobs enables the computer's operator to observe the effect of changes on the system as they take place (in real time). Contrast this simple procedure with the elaborate software manipulation required to vary conditions in a digital computer's program.

Analog computers have one further advantage you should know about: low cost. You can build an analog computer capable of solving a general quadratic equation ($ax^2 + bx + c = 0$) with a dozen or so inexpensive op amps, a few dozen resistors and potentiometers and a digital voltmeter. And you can rewire (reprogram) this computer so that it can solve many other mathematical functions and equations also.

Adding with Resistors. A simple analog adding calculator can be made from a pair of linear potentiometers equipped with pointer knobs and scales and an ohmmeter. For best results, compromise with digital technology and use a digital multimeter. The circuit for the adder is shown in Fig. 1.

The total resistance of two resistors in series is the sum of their individual resistances. If the potentiometers in Fig. 1 each have a resistance of 1000 ohms, the adder will add any two numbers of up to 1000 and produce any total up to 2000. The accuracy of the adder is controlled by the accuracy of the ohmmeter, the linearity of the potentiometers and the calibration of the scales. Thanks to the high accuracy of the DMM, the error introduced by the ohmmeter can be very small. With this concession to digital technology, the potentiometers and their calibration scales become the major sources of error.

Assuming perfectly linear potentiometers are not available (a reasonable assumption), the adder can be *custom calibrated* with the help of the DMM. This is done by connecting the DMM to a pot and marking its scale with a fine index line at each 100-ohm interval. The index lines are then labeled 0, 100, 200, 300. . . .1000 and the space between index lines is further subdivided into smaller increments.

Depending upon the care exercised in calibrating the adder (a large-diameter

(Continued on page 83)

PROJECT OF THE MONTH

PHOTOTRANSISTOR RECEIVER MODULE

It's easy to squeeze miniaturized LED transistors and phototransistor receivers into 16-pin DIP modules with the help of 8-pin MINIDIP ICs. Figure A is a photo of an

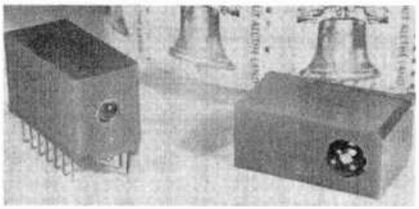


Fig. A. Miniature IR modules

infrared transmitter and receiver assembled in this fashion. This project this month is a phototransistor receiver in a DIP module. Next month, we'll build a companion transmitter module.

Figure B is a circuit diagram for the receiver. In operation, photons impinging upon the phototransistor cause a small photocurrent to flow. This signal is passed by *C1* to the 741 op amp which has a gain (determined by *R2* and *R3*) of 1000. The amplified signal appears at pin 6 of the 741

Fig. C. Phototransistor module.

where it can be coupled to another circuit or used to energize a small relay or drive a small speaker.

Figure C is a photo of the interior of the receiver module, and Fig. D shows the assembly details. Begin assembly by installing all the resistors in the bottom of the module header and inserting their leads deep in each pin slot. Next, install *C1* and solder it and the resistors in place. Avoid using too much solder.

Next, clip off the base lead of the phototransistor and install it on the module header as shown in the figures. Make sure the collector and emitter leads are properly oriented before soldering them in place.

Place the pins of the IC adjacent to or inside the slots in the appropriate module header pins. Make sure they don't protrude too far or the module cover will not fit. Carefully solder the pins in place. Then remove excess solder from the outside edges of the header pins with a file. Finally, drill a 3/16-inch (4.8-mm) hole in the module cover directly over the location of the phototransistor and snap the cover in place.

Test the module by inserting it in a solderless breadboard and applying power from two 9-volt batteries via jumper leads. A small speaker or earphone connected to the receiver output through a 1000-ohm series resistor will emit a loud buzzing sound when the phototransistor is pointed toward a flourescent lamp. If you use an earphone instead of a speaker, use caution when conducting this test! The sound from the earphone can be *uncomfortably* loud. It's best to hold the phone near rather than inserting it in your ear until you've had some experience with the receiver.

After the module is working properly, try listening to the pulsating tone from multiplexed LED displays in digital watches, clocks and calculators with the receiver. You will also be able to "hear" lightning, vibrating car headlights, flickering candle flames and other modulated light sources. Finally, you will be able to use the receiver to detect the signal from the LED transmitter to be described next month. ◇

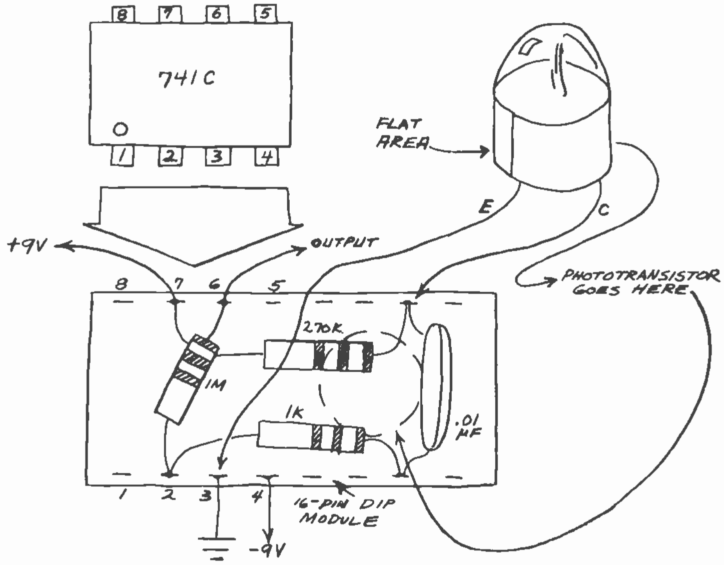


Fig. D. Assembly details of phototransistor receiver module.

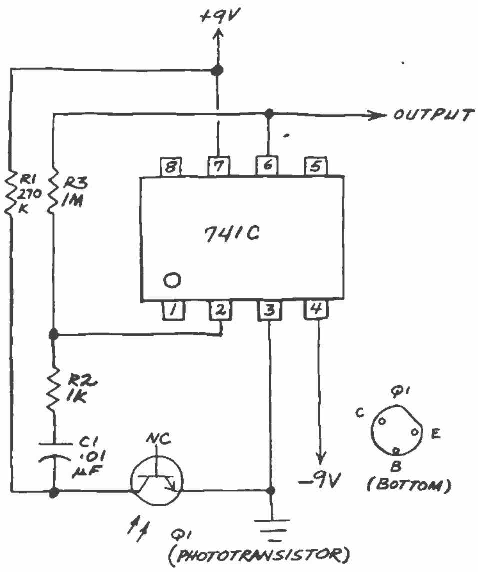


Fig. B. Schematic of an op amp phototransistor receiver.

(Continued from page 81)
scale helps), its accuracy can be better than 1 percent. While this is not as accurate as a pocket calculator, the analog adder operates in *real time* since it continuously adds even as the dials are being turned to new settings!

Multiplying with Resistors. Figure 2 shows a resistive circuit that multiplies. The circuit consists of two potentiometers and a DVM or conventional voltmeter. Potentiometer *R1* forms a voltage divider across the 10-volt power supply and *R2* forms a voltage divider across *R1*'s wiper and ground.

Can you figure out how the circuit multiplies? It's easy if you ignore the resistance of the two pots and consider only the positions of their wipers. Assume, for example, *R1* has a scale with eleven equally spaced lines marked 0 through 10. Also assume *R2* has a similar scale marked 0 through 1 in increments of 0.1. When *R1*'s shaft is rotated to its midpoint, its dial points to the 5 on its scale. This means the voltage at *R1*'s wiper is 5 volts. If *R2* is rotated to its midpoint or 0.5, the incoming voltage is again divided in half. The resulting voltage at *R2*'s slider is 2.5 volts, the product of the two potentiometer settings ($5 \times 0.5 = 2.5$).

Improving the Accuracy of Resistor Calculators. The adder and multiplier circuits we've been experimenting with can be made much more accurate by using ten-turn dial potentiometers. These pots are fairly expensive when new but can sometimes be purchased used or surplus from mail-order parts suppliers. They have a built-in turns indicator usually marked from 0 to 100 and can increase the accuracy of a simple resistor calculator significantly.

Op Amps Add Versatility. The simple resistor calculators we've experimented with are ideal for simple applications where input information is programmed by hand or, perhaps, by a mechanical device. Many applications, however, require that the information enter the calculator in the form of a raw voltage.

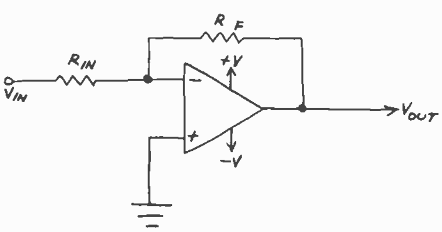


Fig. 3. Basic op amp circuit.

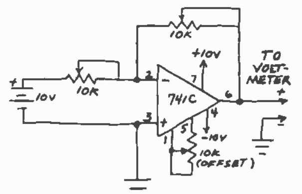


Fig. 4. Op amp multiplication.

Typically, a *transducer* is used to convert information such as windspeed, the rate of fluid flow through a pipe, temperature, weight or some other variable information into a representative voltage. This voltage may then be mathematically combined with the voltage from one or more other transducers to produce an output voltage.

The operational amplifier permits resistor calculators to process raw voltages without requiring the intervention of a human operator. The remainder of this and the next column will describe several op amp analog computer circuits.

Op Amp Fundamentals. Figure 3 illustrates the most important principle of the op amp—the output voltage (V_{OUT}) of an op amp equals the product of its feedback resistance (R_F) and the incoming voltage (V_{IN}) divided by the input resistance (R_{IN}). Algebraically, this is expressed as $V_{OUT} = -R_F V_{IN}/R_{IN}$. This simple relationship or *transfer function* means an op amp can both multiply and divide. If R_{IN} is 1 ohm, then the op amp will multiply the input voltage times the feedback resistance. Likewise, if the input voltage is a fixed 1 volt, the op amp will divide the feedback resistance by the input resistance.

Note that a negative sign appears in the transfer function. This is so because input signals are applied to the inverting input of the op amp, which causes output signals to be the opposite polarity with respect to the input signals. If R_F equals R_{IN} and a +1-volt dc level is applied between R_{IN} and ground, the output of the op amp will be −1 volt—the same magnitude (absolute value), but the opposite polarity. Keep this change of sign in mind when experimenting with this and the following circuits in this two-part series, all of whose op amps are employed in the inverting mode.

You can easily demonstrate op amp multiplication and division with a common op amp such as the 741, several potentiometers and a digital voltmeter. Figure 4 shows the 741 pin connections and how to connect the pots to the 741.

The op amp's offset voltage will introduce a small error in the output voltage. Figure 4 also shows how to connect a 10,000-ohm pot to the 741 to alleviate this problem. Adjust the pot so that the 741 output is exactly zero when pin 2 is grounded.

As you've probably noticed, these methods of using an op amp to multiply and divide still require at least one potentiometer adjustment to perform a calculation. There's a clever way to use op amp to multiply and divide *without* having to make manual potentiometer adjustments, and we'll examine it in detail in the second installment of this series. Meanwhile, let's look at ways to add and subtract using op amps that *don't* require potentiometer adjustments.

Adding with an Op Amp. Figure 5 shows an op amp adder that will accept two input voltages, add them and deliver the sum as an output voltage. *Summing*

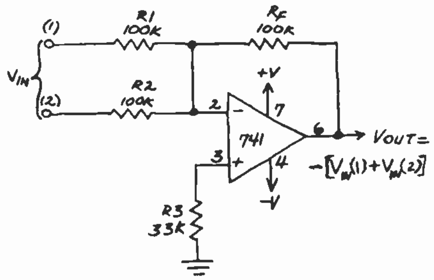


Fig. 5. Op amp summer.

amplifier is the technical name for this circuit.

Because the feedback resistor (R_F) has the same resistance as *R1* and *R2*, the voltage gain of the op amp is 1. This means the op amp has unity gain and doesn't alter the result of an addition. Changing the resistance of R_F or both *R1* and *R2* will cause the circuit to both add *and* multiply.

Resistor *R3* helps reduce errors caused by the op amp's input bias current. In non-critical applications it can be eliminated, in which case pin 2 is connected directly to ground. If you use *R3*, its value should be equal to the reciprocal of the sum of the reciprocals of *R1* and *R2*. In other words, $R3 = 1/(1/R + 1/R2) = R1R2/(R1+R2)$.

For a quick demonstration of how the adder works, connect the positive terminals of a few flashlight cells to the inputs. Connect the negative terminals of the cells to the adder's ground. If the cells each have identical voltages of 1.5 volts, the adder's output will be −3.0 volts.

For the best results, use 1-percent tolerance resistors for *R1*, *R2* and R_F. If you don't have, can't find or can't afford 1-percent resistors, use a DMM to select three resistors having values as closely matched as possible.

You can use a summing amplifier to add more than two voltages simply by connecting additional resistors to the noninverting input. The new resistors should equal the input resistors and R3 should be adjusted according to $R3 = 1/(1/R1 + 1/R2 + 1/R3 + \ldots 1/R_N)$.

Averaging with an Op Amp. A summing amplifier can also average two incoming voltages. All that's necessary is to make the ratio R_F/R_{IN} equal to the reciprocal of the number of input voltages. For example, to convert the adder circuit of Fig. 5 to an averager, leave the values of *R1* and *R2* undisturbed but change R_F to 50,000 ohms. This causes the ratio of R_F/R_{IN} (1/2) to equal the reciprocal of the number of inputs (2).

If you want to average more than two voltages, add additional input resistors and adjust the values of R_F and *R3* accordingly. The average of five incoming voltages is their sum divided by 5. Therefore, the reciprocal of R_F/R_{IN} should be 5. Because the resistance of R_{IN} is fixed at 100,000 ohms, the resistance of R_F should be 20,000 ohms.

Subtracting with an Op Amp. The final analog computer circuit we will look at this month is the subtractor or *difference amplifier* shown in Fig. 6. This circuit is based upon the ability of an op amp to amplify the difference between the two voltages applied to its two inputs. If the ratio of R_F to the circuit's input resistors is 1, the circuit has unity gain and will produce the arithmetic difference of two input voltages.

The output voltage of the difference amplifier equals *V2−V1*. The circuit works for both positive and negative inputs and outputs. Thus, if *V1* is +5 volts and *V2* is +10 volts, the output will be +5 volts. Of course, the output cannot exceed the power supply voltage.

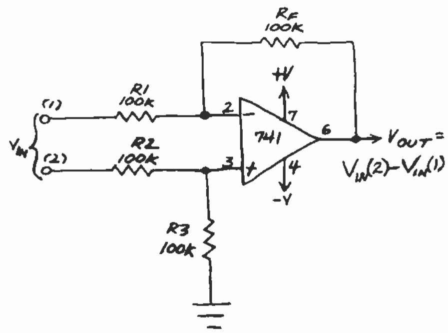
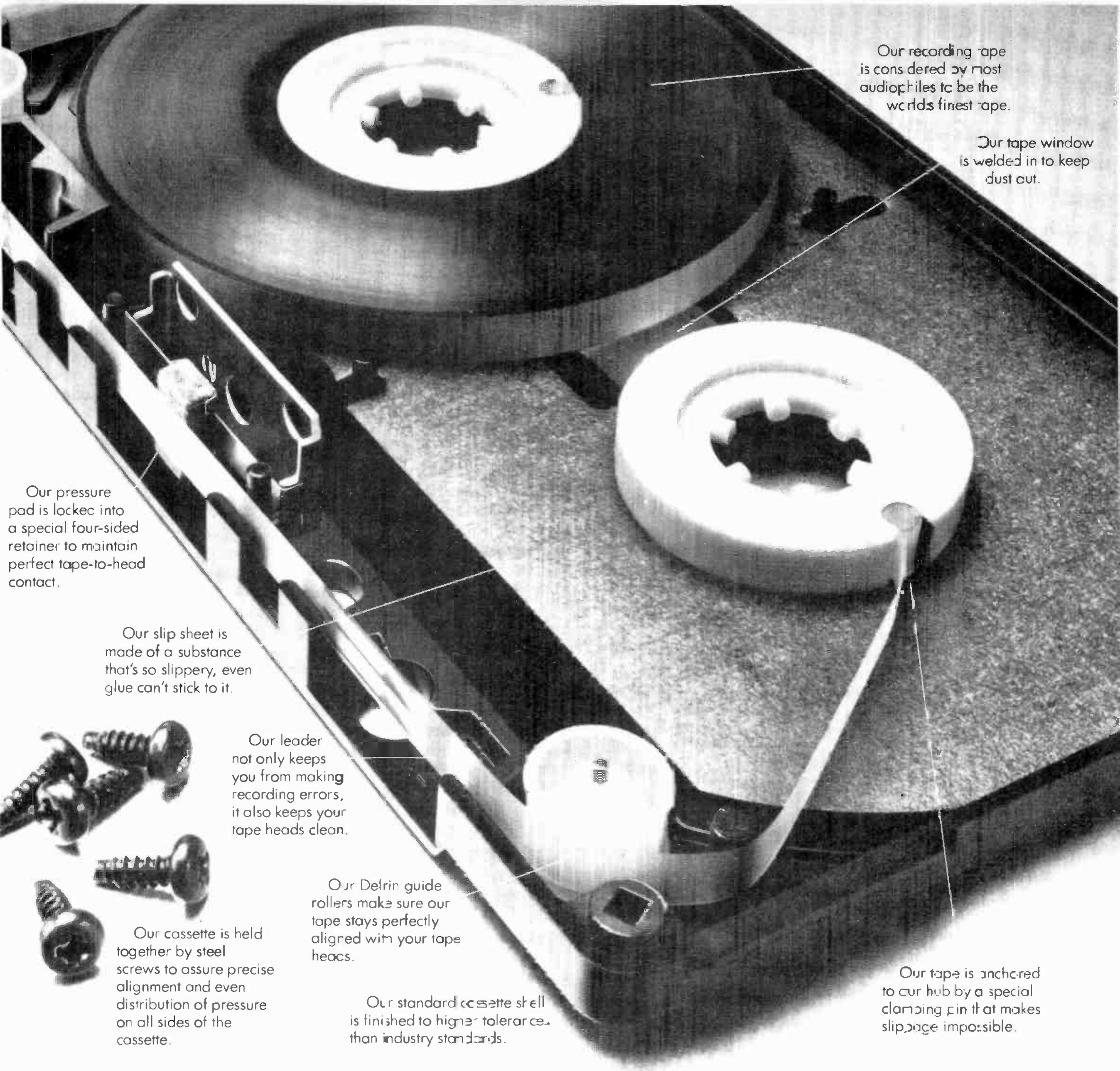


Fig. 6. Op amp subtraction.

Incidentally, an analog computer circuit that handles any of the four possible combinations of positive and negative inputs is called a *four-quadrant* device. A *two-quadrant* device responds to two of the four combinations of input polarities, and *one-quadrant* devices respond to one combination of input polarities.

Going Further. Be sure to experiment with both the resistor and op amp analog computer circuits described in this month's column. If you have a DMM, a dual-polarity power supply and a handful of 1-percent resistors, so much the better. With the help of a solderless breadboard you'll be able to change circuit parameters with ease and to try different op amps. Finally, you'll be well prepared to experiment with the sophisticated logarithmic amplifier circuits we'll explore in Part 2. ◇



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CIRCLE NO. 73 ON FREE INFORMATION CARD

Hobby Scene Q&A

By John McVeigh

Have a problem or question on circuitry, components, parts availability, etc? Send it to the Hobby Scene Editor, POPULAR ELECTRONICS, One Park Ave., New York, N.Y. 10016. Though all letters can't be answered individually, those with wide interest will be published.

NO-LICENSE LOW-FREQUENCY BANDS

Q. ***I've heard that it is legal to run up to 1 watt on the 160-to-190-kHz band. I've seen schematics for receiving equipment for these frequencies, but have found no information relating to transmitters and antennas. Help!—Fabian Lanzy, Redford, MI.***

A. Experimenters are permitted to operate unlicensed transmitters in the low-frequency region between 10 and 1600 kHz. Operations on the 160-to-190-kHz band are limited by FCC regulations to a power level of one watt and antenna length is restricted to 15 meters. See FCC Rules and Regulations, Volume II, Part 15, entitled Radio Frequency Devices. Despite these rather severe limitations, DX contacts between stations as much as several hundred miles from each other have been reported. A beacon in New Mexico is regularly monitored in Los Angeles, 700 miles away. Interestingly, there are no restrictions on operating modes—AM, FM, CW, etc. are all permitted.

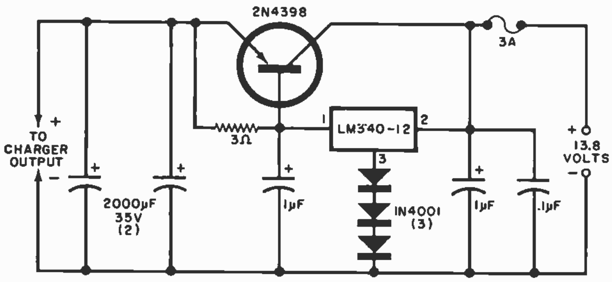
For more information, I suggest that you procure a copy of the Low and Medium Frequency Scrapbook by Ken Cornell, W2IMB. This 110-page publication contains a wealth of schematics and construction details for receiving and transmitting equipment, as well as antennas. Excerpts from relevant FCC regulations, information on the design and winding of low-frequency coils, and data on the conversion of low-cost military surplus gear are also included. The book, which costs $6.95, is available from some electronics retailers, as well as from the Ham Radio Communications Bookstore (catalog No. HR-LF), Greenville, NH, 03048. Also available is an Addendum 77/78 designed to complement the scrapbook ($3.95, catalog HR-LFA).

BATTERY CHARGER = POWER SUPPLY?

Q. ***I have a 4-ampere automotive battery charger. Is there any way I can use it as a base power supply for my mobile CB transceiver?—Wayne Gilbert, Westminster, CO.***

A. I have seen battery chargers which I think are of the same type that you have. They consist simply of a transformer, bridge rectifier, and perhaps a limiting resistor. The dc output is *not* filtered. Rather, it is a full-wave rectified pulsating waveform. At the peaks of the waveform, its voltage is greater than that across the battery, and charging current pulses flow into the battery.

Such a charger can be used with the circuit shown in the figure to power a CB transceiver, auto tape player, etc. The 1-μF capacitors should be solid Tantalum components rated at 25 volts or more. The 0.1-μF capacitor should be a disc ceramic type. Heatsink the pass transistor using a mica washer and silicone thermal compound. When the charger is used to power the regulator circuit and transceiver, the current limiting resistor in the charger (if any) should be bypassed. If room permits, the regulator circuit can be included in the charger's enclosure and a multi-pole switch used to select the charge or power-supply functions. This switch would bypass the limiting resistor, connect the rectifier to the filter capacitors (simultaneously disconnecting the charger output leads from the charger circuitry) and apply voltage to the power supply output terminals.



Computer Bits

By Hal Chamberlin

UPDATE ON GRAPHICS

WHEN PERSONAL microcomputers were first introduced, input/output facilities were a problem. The norm was a front panel brimming with toggle switches, and rows of binary lights representing memory and register contents. Some experimenters might have purchased a surplus Teletype for external communication with the computer system. But a "television typewriter" with 16 lines of 32 characters was considered to be sophisticated, indeed, while graphics was an unheard of luxury.

In contrast, many of the present crop of packaged and modular computers have CRT display provisions, many capable of displaying as much as 24 lines of 80 characters on the screen. Moreover, graphics capability of some kind is common today, implemented in a variety of ways, and with a wide range of capabilities.

The obvious reason for incorporating video provisions in today's breed of computers is to meet computer users' desires and needs for video. Many computer users, for instance, are interested in increasingly complex, realistic game boards; others wish to pursue creative computer art techniques. Schools form a large block of potential customers, too, with growing interest in graphics for teaching mathematics and physics concepts. Even business applications can use graphics for billing display, financial analysis, word processing, etc.

When selecting a system for a graphics application one must be careful to properly evaluate the capabilities of the systems being considered. There is a large variation in display quality, screen capacity, image resolution, image restrictions, and ease of display programming. For example, photographs of the display screen can be misleading, particularly when in color. As we shall see later, display quality depends heavily on the display monitor and the interface method utilized. Sometimes the images displayed have been painstakingly programmed a bit at a time solely for promotional reasons. Real software support for producing or working efficiently with the image shown may not be available. Also, many graphics systems have severe limitations on the types of images that can be displayed. Therefore, even if the "promotional" video example is possible, other images of similar complexity may not be.

The Display Monitor. If the system being considered does not include its own display (CRT) monitor, the user will have to provide one. The method of connecting a computer to the display is vitally important in determining the resulting image quality.

The least costly and most convenient method is via an r-f modulator connected to the antenna terminals of a television receiver. The r-f modulator simply transmits the computer's video signal on a locally unused channel, via a coaxial cable, to the TV. Unfortunately, in this approach, the display quality is mediocre at best. The sharp cutoff of video frequencies beyond about 3 MHz produced by the sound traps, cause horizontal smearing of characters and images so that 32 characters or 200 dots across is about its limit.

Even if brightness and contrast controls are carefully adjusted for an acceptable picture, the absence of dc-restoration in virtually all TV receivers causes the brightness to shift considerably as screen content changes. The result worsens with systems providing color video.

At this time the r-f modulator needed to effect this interface method is not supplied with the computer. Thus, the user must procure one. A recent FCC directive, however, emphasizes that all such modulators be type approved when combined with a computer since they fall into a Class I device category. Furthermore, the FCC has enjoined r-f modulator makers to desist in selling the devices separately!

The other—and by far preferable method of interface—is direct video to a broadband closed-circuit TV monitor. With this method, r-f modulation/demodulation distortions and the potential for external interference are bypassed. Video frequency response to 10 MHz and beyond is routine, producing sharp edges and consistent brightness to video characters and lines. Broadband monitors are expensive, however, with monochrome units costing from $150 to $300 and color starting at about $500.

Monitors usually have such features as excellent voltage regulation, improved sweep linearity, sharper CRT focus, and dc restoration. When shopping for a used surplus monitor, be sure that the model accepts *composite* video input, since some require separate horizontal, vertical, and video drive signals at TTL logic levels.

A TV receiver can also be converted to a monitor by a knowledgeable hardware person. Although a vast improvement over r-f modulation, the display is not as "clean" as with a true monitor. Usually, an isolation transformer must be added, which increases expense.

Many of the newer computers include a color-display capability. To realize the potential advantages of color, direct video into a color monitor is required. Even so, the display appearance is likely to be visibly worse than that of a monochrome display. Signal degradation is the result of NTSC encoding of the color signal necessary for composite color video. The blues and greens are limited to 1.5 MHz, while red is good only up to 500 kHz. The consequence is that 16 to 20 characters (about 100 dots) is the limit of usable color resolution. Also, unless the monitor is carefully converged, the edges of characters in corners of the screen may be a rainbow of colors, even when color is not being used. The best color systems utilize direct red-green-blue input. Generally, this is only available on a computer system with an integral CRT.

Graphic Generator Techniques. Almost every system or board that does so offers graphics capability in a different way. The wide variety of approaches used is a result of four difficult problems faced by graphics interface designers. The first is *memory usage*, since the image on the screen must be encoded into bytes stored in memory. The second is the amount of graphic detail or *resolution* that it is possible to display. The third is *flexibility*, or the variety of image types

(Continued on page 92)

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(Continued from page 87)

that can be displayed. And the fourth is *compatibility* with character generators so that nongraphics applications are simplified.

These are conflicting requirements. For example, a high-resolution flexible display will require considerable memory to store the image. On the other hand, maintaining compatibility with character generators minimizes memory usage but limits resolution and flexibility.

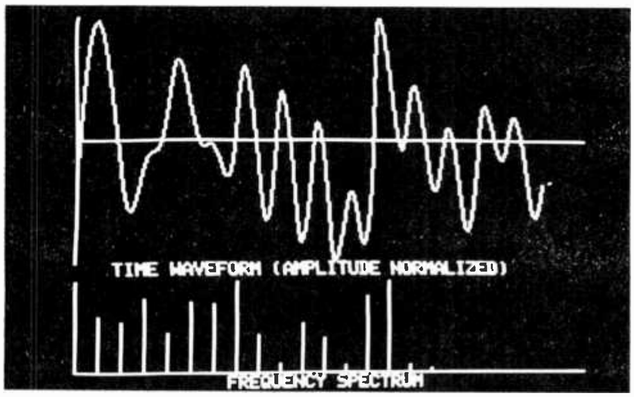
In most cases, designers have opted for compatibility with character-oriented displays. Such a display divides the screen into rows and columns of *character cells*. The PET computer for example, uses 25 rows of 40 characters per row for a total of 1000 character cells. Each cell, in turn, is divided into *pixels* or dots; the PET uses 8 rows of 8 dots per row. The characters that make up the display are therefore displayed centered in the character cells and are, in turn, composed of the dots. Each byte of display in the PET memory corresponds to a character cell. Hence, 1000 bytes (1 KB) of memory are used for the display.

Graphic images can be formed from a special *graphics character set* used in addition to the normal ASCII character set. Shapes such as horizontal, vertical, diagonal, and curved lines are provided and can be pieced together to form crude line drawings. Special symbols, such as hearts, clubs, spades, etc., are also included for a total of 64 graphics characters. Add the 64-character uppercase ASCII subset and a bit for inverse video (black-on-white) and all 256 possible character codes are used up.

Such a display is very adept at putting on-screen gameboards, simple line drawings, and, of course, text. On the other hand, mathematical curve plotting resolution is no better than the typical character plot with "*" for points. Although one may be able to hand-fit a curve with the line segments and other shapes available, there is no software support available to do this. Moving images can also be programmed, but the movement is quite choppy since it must be in character cell increments.

A related technique employs a *programmable* character generator, such as one made by Objective Design for S-100 bus compatible display interface boards. Essentially, the usual ROM character generator is replaced by a small RAM that can be written into to provide a changeable character set. In the Sorcerer from Exidy, for example, the character to be displayed can be determined by software. Thus, it is now possible for a user to tailor the graphic character set to match the application. If the application is line drawing, the RAM can be filled with a greater variety of line segments and curves. If it is chess, chesspiece symbols can be written. Whatever graphic set is chosen, it must be used for the entire display. Even with the added flexibility, the limitations of this scheme are basically the same as with the fixed-graphic character set.

Another variation attempts to increase the screen resolution for random-dot graphics such as required for curve plotting. Radio Shack's Model TRS-80 display, for example, uses 16 rows of 64 character cells per row with a character cell being 12 rows of 8 dots each. For graphics, each character cell is divided into a two-wide by three-high array of blocks or pixels and any possible on/off combination of the six blocks can be specified. In the graphics mode, therefore, the screen becomes an array of 48 rows of 128 *blocks* per row and any conceivable combination of blocks can be on and off. While the resolution for line drawing and game boards is inferior to the graphic character generator approach, arbitrary curves are displayed with about twice as much resolution. Display memory in the TRS-80 is only 7 bits wide and comprises 1024 bytes. Normal ASCII characters take up 64 of the codes, while the other 64 codes are used to specify the 64 possible combi-



The Micro Technology Unlimited Visible Memory in action.

nations of graphic blocks in a character cell.

Bit-Mapped Displays. An entirely different approach to graphics ignores character generators altogether and simply divides the screen up into a very large number of individual dots, with one bit of display memory for each dot. Such displays are called *pixel* or *bit-mapped* displays to distinguish them from character displays. If a sufficient number of dots are provided, this is by far the most flexible graphic display technique because there are no restrictions on image type or placement.

When using the proper software, even text can be displayed with complete freedom as to character shape, size, and placement. This makes possible bold headlines, tilted italics, subscript and superscript for math and chemical equations, and proportionally spaced text for clean right-margin justification. Their main disadvantage is that a large amount of memory is needed for a high resolution display. Upwards of 8K bytes is not uncommon.

The Apple II computer, for example, has a black-and-white pixel display mode with 192 rows of 240 dots per row, which is sufficient resolution for well detailed drawings, graphs, and charts. The 120 by 96 full-color mode, which can display 7 colors at two intensity levels and black, is less useful for curve plotting but is capable of beautiful computer art.

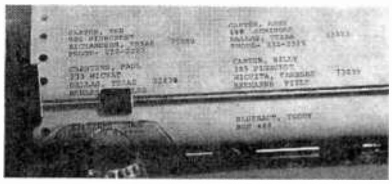
Users of KIM-1s can use the Visible Memory (see photo), which provides a 320-wide by 200-high dot matrix as well as 8K of refresh memory, all on one board. Owners of S-100 bus micros can utilize a new graphics interface from Vector Graphics that provides a 256 by 240 image in black and white or a 128 by 120 image with 16 levels of gray. The latter mode is useful for half-tone picture processing and display in applications such as amateur slow-scan TV.

Software support is important in any graphics application, particularly if only BASIC is used. Although the user can perform any graphic operation by POKEing data into memory, BASIC is likely to be very slow in manipulating the large amount of data required. Radio Shack, on the other hand, provides BASIC statements for setting and resetting any graphic cell given its *X* and *Y* coordinates. The Apple provides statements for setting the coordinates of endpoints and will automatically and rapidly draw the best straight line connecting them. ◇

Software Sources

8080 Debugging and File Management Software. Two programs for S-100 bus, 8080 or Z80 systems are among the first offerings of PRS, the Program of the Month Corp. Microfile, a Data File Management System, and DDS-II, a Dynamic Debugging System, are both available on CUTS, Tarbell or TDL cassette, for $50 each. Through computer stores, or from PRS, 257 Central Park West, New York, NY 10024.

Poly Disk Mailing-List Program. Written in Disk BASIC for a PolyMorphic 8810 or 8813. Mailing List is also available in hard-copy, adaptable to other computers.



Operations include Add, Delete, Search, Sorted List, Modify and Sequential Printout; remark fields up to 64 characters long can be used for sorting and retrieval. Default printing formats, for up to 5 labels across a page, with optional remarks-field printing and ZIP-code positioning, are also under user control. On diskette or as hard-copy, $40. Software Industries, 902 Pinecrest, Richardson, TX 75080.

Sol, Apple, TRS-80 and SWTPC Programs from GRT. GRT has expanded its tape offerings from sound recordings to program cassettes for the Sol, Apple 2, TRS-80 and SWTPC 6800. Several programs are available. "Dollars and Sense" includes checkbook programming with facilities to recall checks by grouping, such as car payments. "Best Choice," on the same tape, includes a decision matrix which helps evaluate decisions according to the user's options and preferences. The "Clinic" tape includes diet, longevity and biorhythm programs. "Beat the House" includes four game programs—blackjack, craps, roulette and slot-machine. $15 per tape, including 20-to-30 page manual. Sold through computer stores; information from GRT Music Tapes, 1286 Lawrence Station Rd., Sunnyvale, CA 94086.

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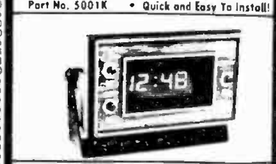

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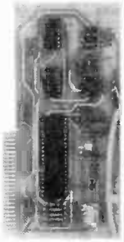

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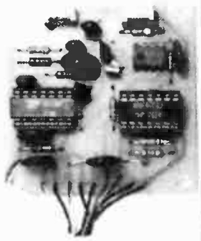
Baud rate is continuously adjustable from 0 to 30,000 • Plugs into any peripheral connector • Low current drain. RS-232 input and output • On board switch selectable 5 to 8 data bits, 1 or 2 stop bits, and parity or no parity either odd or even • Jumper selectable address • SOFTWARE • Input and Output routine from monitor or BASIC to teletype or other serial printer • Program for using an Apple II for a video or an intelligent terminal. Also can output in correspondence code to interface with some selectrics. Board only — $15.00; with parts — $42.00; assembled and tested — $62.00.

MODEM *

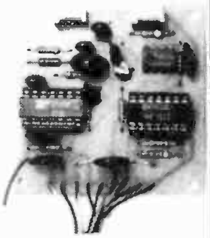


Part no. 109
• Type 103 • Full or half duplex • Works up to 300 baud • Originate or Answer • No coils, only low cost components • TTL input and output-serial • Connect 8 ohm speaker and crystal mic. directly to board • Uses XR FSK demodulator • Requires +5 volts • Board $7.60; with parts $27.50

DC POWER SUPPLY *

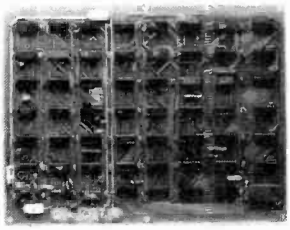
Part no. 6085
• Board supplies a regulated +5 volts at 3 amps., +12, -12, and -5 volts at 1 amp. • Power required is 8 volts AC at 3 amps., and 24 volts AC C.T. at 1.5 amps. • Board only $12.50; with parts excluding transformers $42.50

TAPE INTERFACE *



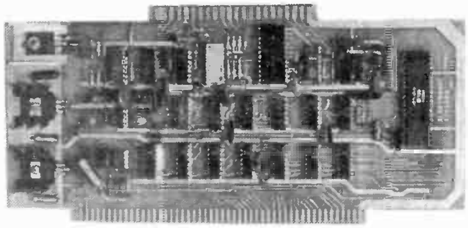
Part no. 111
• Play and record Kansas City Standard tapes • Converts a low cost tape recorder to a digital recorder • Works up to 1200 baud • Digital in and out are TTL-serial • Output of board connects to mic. in of recorder • Earphone of recorder connects to input on board • No coils • Requires +5 volts, low power drain • Board $7.60; with parts $27.50

T.V. TYPEWRITER



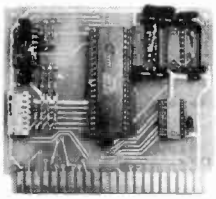
Part no. 106
• Stand alone TVT • 32 char/line, 16 lines, modifications for 64 char/line included • Parallel ASCII (TTL) input • Video output • 1K on board memory • Output for computer controlled curser • Auto scroll • Non-destructive curser • Curser inputs: up, down, left, right, home, EOL, EOS • Scroll up, down • Requires +5 volts at 1.5 amps, and -12 volts at 30 mA • All 7400, TTL chips • Char. gen. 2513 • Upper case only • Board only $39.00; with parts $145.00

TIDMA *



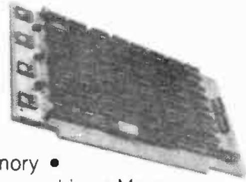
Part no. 112
• Tape Interface Direct Memory Access • Record and play programs without bootstrap loader (no prom) has FSK encoder/decoder for direct connections to low cost recorder at 1200 baud rate, and direct connections for inputs and outputs to a digital recorder at any baud rate. • S-100 bus compatible • Board only $35.00; with parts $110.00

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 with connector add $3.00

8K STATIC RAM

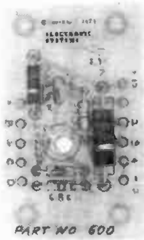


Part no. 300
• 8K Altair bus memory • Uses 2102 Static memory chips • Memory protect • Gold contacts • Wait states • On board regulator • S-100 bus compatible • Vector input option • TRI state buffered • Board only $27.50; with parts $160.00

RF MODULATOR *

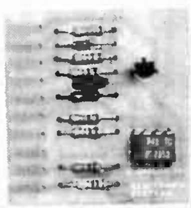
Part no. 107
• Converts video to AM modulated RF, Channels 2 or 3. So powerful almost no tuning is required. On board regulated power supply makes this extremely stable. Rated very highly in Doctor Dobbs' Journal. Recommended by Apple. • Power required is 12 volts AC C.T., or +5 volts DC • Board $7.60; with parts $13.50

RS 232/TTY * INTERFACE



Part no. 600
• Converts RS-232 to 20mA current loop, and 20mA current loop to RS-232 • Two separate circuits • Requires +12 and -12 volts • Board only $4.50, with parts $7.00

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 with connector add $2.00

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1N753A	6.2v	500 mW Zener	.25
1N758A	10v	"	.25
1N759A	12v	"	.25
1N5243	13v	"	.25
1N5244B	14v	"	.25
1N5245B	15v	"	.25

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14-pin	pcb	.20	ww	.40
16-pin	pcb	.20	ww	.40
18-pin	pcb	.25	ww	.75
22-pin	pcb	.35	ww	.95
24-pin	pcb	.35	ww	.95
28-pin	pcb	.45	ww	1.25
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2N2907	PNP	.15
2N3906	PNP (Plastic - Unmarked)	.10
2N3904	NPN (Plastic - Unmarked)	.10
2N3054	NPN	.35
2N3055	NPN 15A 60v	.50
T1P125	PNP Darlington	.95
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4001	.15
4002	.20
4004	3.95
4006	.95
4007	.20
4008	.75
4009	.35
4010	.35
4011	.20
4012	.20
4013	.40
4014	.75
4015	.75
4016	.35
4017	.75
4018	.75
4019	.35
4020	.85
4021	.75
4022	.75
4023	.20
4024	.75
4025	.20
4026	1.95
4027	.35
4028	.75
4030	.35
4033	1.50
4034	2.45
4035	.75
4040	.75
4041	.69
4042	.65
4043	.50
4044	.65
4046	1.25
4049	.45
4050	.45
4066	.55
4069/74C04	.25
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74C151	1.90

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7400	.10
7401	.15
7402	.15
7403	.15
7404	.10
7405	.25
7406	.25
7407	.55
7408	.15
7409	.15
7410	.15
7411	.25
7412	.25
7413	.25
7414	.75
7416	.25
7417	.40
7420	.15
7426	.25
7427	.25
7430	.15
7432	.20
7437	.20
7438	.20
7440	.20
7441	1.15
7442	.45
7443	.45
7444	.45
7445	.65
7446	.70
7447	.70
7448	.50
7450	.25
7451	.25
7453	.20
7454	.25
7460	.40
7470	.45
7472	.40

7473	.25
7474	.30
7475	.35
7476	.40
7480	.55
7481	.75
7483	.75
7485	.55
7486	.25
7489	1.05
7490	.45
7491	.70
7492	.45
7493	.35
7494	.75
7495	.60
7496	.80
74100	1.15
74107	.25
74121	.35
74122	.55
74123	.35
74125	.45
74126	.35
74132	.75
74141	.90
74150	.85
74151	.65
74153	.75
74154	.95
74156	.70
74157	.65
74161	.55
74163	.85
74164	.60
74165	1.10
74166	1.25
74175	.80

74176	.85
74180	.55
74181	2.25
74182	.75
74190	1.25
74191	.95
74192	.75
74193	.85
74194	.95
74195	.95
74196	.95
74197	.95
74198	1.45
74221	1.00
74367	.75
75108A	.35
75491	.50
75492	.50
74H00	.15
74H01	.20
74H04	.20
74H05	.20
74H08	.35
74H10	.35
74H11	.25
74H15	.45
74H20	.25
74H21	.25
74H22	.40
74H30	.20
74H40	.25
74H50	.25
74H51	.25
74H52	.15
74H53J	.25
74H55	.20

74H72	.35
74H101	.75
74H103	.55
74H106	.95
74L00	.25
74L02	.20
74L03	.25
74L04	.30
74L10	.20
74L20	.35
74L30	.45
74L47	1.95
74L51	.45
74L55	.65
74L72	.45
74L73	.40
74L74	.45
74L75	.55
74L93	.55
74L123	.85
74S00	.35
74S02	.35
74S03	.25
74S04	.25
74S05	.35
74S08	.35
74S10	.35
74S11	.35
74S20	.25
74S40	.20
74S50	.20
74S51	.25
74S64	.15
74S74	.35
74S112	.60
74S114	.65

74S133	.40
74S140	.55
74S151	.30
74S153	.35
74S157	.75
74S158	.30
74S194	1.05
74S257 (8123)	1.05
74LS00	.20
74LS01	.20
74LS02	.20
74LS04	.20
74LS05	.25
74LS08	.25
74LS09	.25
74LS10	.25
74LS11	.25
74LS20	.20
74LS21	.25
74LS22	.25
74LS32	.25
74LS37	.25
74LS38	.35
74LS40	.30
74LS42	.65
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SN7453N	.20	SN74154N	.99	SN74367N	.69
SN7454N	.20	SN74155N	.79	SN74368N	.69
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CD4023	.23	CD4059	9.95	CD4511	1.29
CD4024	.79	CD4060	1.49	CD4515	2.95
CD4025	.23	CD4066	.79	CD4518	1.29
CD4026	2.25	CD4068	.39	CD4520	1.29
CD4027	.69	CD4069	.45	CD4566	2.25

74C00

74C00	.39			74C163	2.49
74C02	.39			74C164	2.49
74C04	.39	74C85	2.49	74C173	2.60
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74C20	.39	74C107	1.25	74C922	5.95
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LM304H	1.00	LM340T-6	1.25	LM741CN/H	.35
LM305H	.60	LM340T-8	1.25	LM741-14N	.39
LM307CN/H	.35	LM340T-12	1.25	LM747N/H	.79
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LM320K-15	1.35	NE510A	6.00	LM3900N(3401)	.49
LM320K-18	1.35	NE529A	4.95	LM3905N	.89
LM320K-24	1.35	NE531H/V	3.95	LM3909N	1.25
LM320T-5	1.25	NE536T	6.00	MC5558V	.59
LM320T-5.2	1.25	NE540L	6.00	8038B	4.95
LM320T-8	1.25	NE544N	4.95	LM75450N	.49
LM320T-12	1.25	NE550N	1.30	75451CN	.39
LM320T-15	1.25	NE555V	.39	75452CN	.39
LM320T-18	1.25	NE556N	.99	75453CN	.39
LM320T-24	1.25	NE560B	5.00	75454CN	.39
LM323K-5	5.95	NE561B	5.00	75491CN	.79
LM324N	1.80	NE562B	5.00	75492CN	.89
LM339N	.99	NE565N/H	1.25	75493N	.89
LM340K-5	1.35	NE566CN	1.75	75494CN	.89
LM340K-6	1.35	NE567V/H	.99	RC4136	1.25
LM340K-8	1.35	NE570N	4.95	RC4151	5.95
LM340K-12	1.35	LM703CN/H	.69	RC4194	5.95
LM340K-15	1.35	LM709N/H	.29	RC4195	4.49

74LS00TTL

74LS00	.23			74LS138	.69
74LS01	.23			74LS139	.69
74LS02	.23	74LS47	.69	74LS151	.69
74LS03	.23	74LS51	.23	74LS155	.69
74LS04	.29	74LS54	.23	74LS157	.69
74LS05	.29	74LS55	.23	74LS160	.89
74LS08	.23	74LS73	.35	74LS161	.89
74LS09	.29	74LS74	.35	74LS162	.89
74LS10	.23	74LS75	.49	74LS163	.89
74LS11	.60	74LS76	.35	74LS164	.99
74LS13	.49	74LS78	.39	74LS175	.79
74LS14	.99	74LS83	.75	74LS181	2.49
74LS15	.29	74LS85	.99	74LS190	.89
74LS20	.23	74LS86	.35	74LS191	.89
74LS21	.29	74LS90	.49	74LS192	.89
74LS22	.29	74LS92	.59	74LS193	.89
74LS26	.29	74LS93	.59	74LS194	.89
74LS27	.29	74LS95	.79	74LS195	.89
74LS28	.29	74LS96	.89	74LS253	.79
74LS30	.23	74LS107	.35	74LS257	.69
74LS32	.29	74LS109	.35	74LS258	1.39
74LS37	.35	74LS112	.35	74LS260	.55
74LS40	.29	74LS123	.99	74LS279	.59
74LS42	.69	74LS125	.69	74LS367	.59
		74LS132	.79	74LS368	.59
		74LS136	.39	74LS670	1.95

Electronic Home Security Timer

Vigilite

A microprocessor-based pre-programmed light control that fits into a home wall socket, replacing the standard on/off light switch. Discourages intruders and burglars by turning lights on and off in a "real-life" pattern while you're away.

Unlike other electromechanical timers Vigilite can simulate the lighting patterns of five different rooms as selected by the user. Vigilite can also control over-head lights, which other timers cannot. Three Vigilite units, simulating kitchen, bathroom, and bedroom lighting can give a home ultimate protection, because the user chooses a lighting pattern that depicts his real life pattern. He then sets the Vigilite clock and room pattern accordingly. (See bar chart below.) The house actually looks occupied, although no one is home.

Easy to install, the Vigilite unit contains an accurate digital LED clock plus pre-programmed independent lighting patterns for bedroom, bathroom, kitchen, living room, and outside porch lights. All-solid-state components assure the user long product life and reliability.

Technical Specifications

1) Electrical requirement—120 VAC, 60Hz, 2½ Amps
2) For use with permanently installed incandescent 40 W to 300 W light fixtures—single pole circuits
3) Cannot be used to control television, appliances, or other motor driven equipment
4) One Vigilite unit required for each room circuit

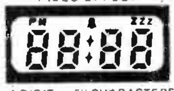
Part Number **VGL-1**

$39.95 ea.

DISCRETE LEDS

.200" dia.			.125" dia.		
XC556R	red	5/$1	XC209R	red	5/$1
XC556G	green	4/$1	XC209G	green	4/$1
XC556Y	yellow	4/$1	XC209Y	yellow	4/$1
XC556C	clear	4/$1			
.200" dia.			.185" dia.		
XC22R	red	5/$1	XC526R	red	5/$1
XC22G	green	4/$1	XC526G	green	4/$1
XC22Y	yellow	4/$1	XC526Y	yellow	4/$1
.170" dia.			XC526C	clear	4/$1
MV10B	red	4/$1			
.085" dia.			.190" dia.		
MV50	red	6/$1	XC111R	red	5/$1
INFRA-RED LED 1/4"x1/4"x1/16" flat 5/$1			XC111G	green	4/$1
			XC111Y	yellow	4/$1
			XC111C	clear	4/$1

TIMEX T1001
LIQUID CRYSTAL DISPLAY
FIELD EFFECT



4 DIGIT — .5" CHARACTERS
THREE ENUNCIATORS
2.00" X 1.20" PACKAGE
INCLUDES CONNECTOR

T1001-Transmissive	$7.95
T1001A-Reflective	8.25

DISPLAY LEDS

TYPE	POLARITY	HT	PRICE	TYPE	POLARITY	HT	PRICE
MAN 1	Common Anode-red	.270	2.95	MAN 6730	Common Anode-red ± 1	.560	.99
MAN 2	5 x 7 Dot Matrix-red	.300	4.95	MAN 6740	Common Cathode-red-D.D.	.560	.99
MAN 3	Common Cathode-red	.125	.25	MAN 6750	Common Cathode-red ± 1	.560	.99
MAN 4	Common Cathode-red	.187	1.95	MAN 6760	Common Anode-red	.560	.99
MAN 7G	Common Anode-green	.300	1.25	MAN 6780	Common Cathode-red	.560	.99
MAN 7Y	Common Anode-yellow	.300	.99	DL701	Common Anode-red ± 1	.300	.99
MAN 72	Common Anode-red	.300	.99	DL704	Common Cathode-red	.300	.99
MAN 74	Common Cathode-red	.300	1.25	DL707	Common Anode-red	.300	.99
MAN 82	Common Anode-yellow	.300	.99	DL728	Common Cathode-red	.500	1.49
MAN 84	Common Cathode-yellow	.300	.99	DL741	Common Anode-red	.600	1.25
MAN 3620	Common Anode-orange	.300	.99	DL746	Common Anode-red ± 1	.630	1.49
MAN 3630	Common Anode-orange ± 1	.300	.99	DL747	Common Anode-red	.600	1.49
MAN 3640	Common Cathode-orange	.300	.99	DL749	Common Cathode-red ± 1	.630	1.49
MAN 4610	Common Anode-orange	.300	.99	DL750	Common Cathode-red	.600	1.49
MAN 4640	Common Cathode-orange	.400	.99	DL338	Common Cathode-red	.110	.35
MAN 4710	Common Anode-red	.400	.99	FND70	Common Cathode	.250	.69
MAN 4730	Common Anode-red ± 1	.400	.99	FND358	Common Cathode ± 1	.357	.99
MAN 4740	Common Cathode-red	.400	.99	FND359	Common Cathode	.357	.75
MAN 4810	Common Anode-yellow	.400	.99	FND503	Common Cathode(FND500)	.500	.99
MAN 4840	Common Cathode-yellow	.400	.99	FND507	Common Anode (FND510)	.500	.99
MAN 6610	Common Anode-orange-D.D.	.560	.99	5082-7730	Common Anode-red	.300	1.30
MAN 6630	Common Anode-orange ± 1	.560	.99	HDSP-3400	Common Anode-red	.800	2.10
MAN 6640	Common Cathode-orange-D.D.	.560	.99	HDSP-3403	Common Cathode red	.800	2.10
MAN 6650	Common Cathode-orange ± 1	.560	.99	5082-7300	4 x 7 sgl. Digit-RHDP	.600	19.95
MAN 6660	Common Anode-orange	.560	.99	5082-7302	4 x 7 Sgl. Digit-LHDP	.600	19.95
MAN 6680	Common Cathode-orange	.560	.99	5082-7304	Overrange character (±1)	.600	15.00
MAN 6710	Common Anode-red-D.D	.560	.99	5082-7340	4 x 7 Sgl. Digit-Hexadecimal	.600	22.50

RCA LINEAR

CA3013T	2.15	CA3082N	2.00
CA2023T	2.56	CA3083N	1.60
CA3035T	2.48	CA3086N	.85
CA3039T	1.35	CA3089N	3.75
CA3046N	1.30	CA3130T	1.39
CA3059N	3.25	CA3140T	1.25
CA3060N	3.25	CA3160T	1.25
CA3080T	.85	CA3401N	.49
CA3081N	2.00	CA3600N	3.50

CALCULATOR CHIPS/DRIVERS

MM5725	$2.95
MM5738	2.95
DM8864	2.00
DM8865	1.00
DM8887	.75
DM8889	.75
9374 7 seg. C.A. LED driver	1.50

CLOCK CHIPS

MM5309	$4.95
MM5311	4.95
MM5312	4.95
MM5314	4.95
MM5316	6.95
MM5318	9.95
MM5369	2.95
MM5387/1998A	4.95
MM5841	9.95

MOTOROLA

MC1408L7	$4.95
MC1408L8	5.75
MC1439L	2.95
MC3022P	2.95
MC3061P	3.50
MC4016(74416)	7.50
MC4024P	3.95
MC4040P	6.95
MC4044P	4.50

IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin LP	$.17	.16	.15	22 pin LP	$ .37	.36	.35
14 pin LP	.20	.19	.18	24 pin LP	.38	.37	.36
16 pin LP	.22	.21	.20	28 pin LP	.45	.44	.43
18 pin LP	.29	.28	.27	36 pin LP	.60	.59	.58
20 pin LP	.34	.32	.30	40 pin LP	.63	.62	.61
SOLDERTAIL STANDARD (TIN)							
14 pin ST	$.27	.25	.24	28 pin ST	$ .99	.90	.81
16 pin ST	.30	.27	.25	36 pin ST	1.39	1.26	1.15
18 pin ST	.35	.32	.30	40 pin ST	1.59	1.45	1.30
24 pin ST	.49	.45	.42				
SOLDERTAIL STANDARD (GOLD)							
8 pin SG	$.30	.27	.24	24 pin SG	$ .70	.63	.57
14 pin SG	.35	.32	.29	28 pin SG	1.10	1.00	.90
16 pin SG	.38	.35	.32	36 pin SG	1.65	1.40	1.26
18 pin SG	.52	.47	.43	40 pin SG	1.75	1.59	1.45
WIRE WRAP SOCKETS (GOLD) LEVEL #3							
8 pin WW	$.39	.35	.31	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

1/4 WATT RESISTOR ASSORTMENTS – 5%

ASST. 1	5 ea.	10 OHM 27 OHM	12 OHM 33 OHM	15 OHM 39 OHM	18 OHM 47 OHM	22 OHM 56 OHM	50 PCS	$1.75
ASST. 2	5 ea.	68 OHM 180 OHM	82 OHM 220 OHM	100 OHM 270 OHM	120 OHM 330 OHM	150 OHM 390 OHM	50 PCS	1.75
ASST. 3	5 ea.	470 OHM 1.2K	560 OHM 1.5K	680 OHM 1.8K	820 OHM 2.2K	1K 2.7K	50 PCS	1.75
ASST. 4	5 ea.	3.3K 8.2K	3.9K 10K	4.7K 12K	5.6K 15K	6.8K 18K	50 PCS	1.75
ASST. 5	5 ea.	22K 56K	27K 68K	33K 82K	39K 100K	47K 120K	50 PCS	1.75
ASST. 6	5 ea.	150K 390K	180K 470K	220K 560K	270K 680K	330K 820K	50 PCS	1.75
ASST. 7	5 ea.	1M 2.7M	1.2M 3.3M	1.5M 3.9M	1.8M 4.7M	2.2M 5.6M	50 PCS	1.75

ASST. 8R Includes Resistor Assortments 1-7 (350 PCS.) $9.95 ea.

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HD0165	Keyboard Encoder (16 keys)	7.95
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ICM7207	Oscillator Controller	7.50
ICM7208	Seven Decade Counter	19.95
ICM7209	Clock Generator	6.95

NMOS READ ONLY MEMORIES

MCM6571	128 X 9 X 7 ASCII Shifted with Greek	13.50
MCM6574	128 X 9 X 7 Math Symbol & Pictures	13.50
MCM6575	128 X 9 X 7 Alphanumeric Control Character Generator	13.50

MISCELLANEOUS

TL074CN	Quad Low Noise bi-fet Op Amp	2.49
TL494CN	Switching Regulator	4.49
TL496CP	Single Switching Regulator	1.75
11C90	Divide 10/11 Prescaler	19.95
95H90	Hi-Speed Divide 10/11 Prescaler	11.95
4N33	Photo-Darlington Opto-Isolator	3.95
MK50240	Top Octave Freq. Generator	17.50
DS0026CH	5Mhz 2-phase MOS clock driver	3.75
TIL308	.27" red num. display w/integ. logic chip	10.50
MM5320	TV Camera Sync. Generator	14.95
MM5330	4½ Digit DPM Logic Block	5.95
LD110/111	3½ Digit A/D Converter Set	25.00/set

LITRONIX ISO-LIT 1
Photo Transistor Opto-Isolator
(Same as MCT 2 or 4N25)
2/99¢

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SOUND GENERATOR
Generates Complex Sounds
Low Power - Programmable
3.95 each

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AY-3-8500-1 and 2.01 MHZ Crystal (Chip & Crystal Includes score display, 6 games and select angles, etc. **7.95/set**

EXAR

XR205	$3.40			XR2242CP	1.50
XR210	4.40			XR2264	4.25
XR215	4.40			XR2556	3.20
XR320	1.55	JE2206KA	14.95	XR2567	2.99
XR-L555	1.50	JE2206KB	19.95	XR3403	1.25
XR555	.39	XR1800	3.20	XR4136	1.25
XR556	.99	XR2206	4.40	XR4151	2.85
XR567CP	.99	XR2207	3.85	XR4194	1.45
XR567CT	1.25	XR2208	5.20	XR4202	3.60
XR1310P	1.30	XR2209	1.75	XR4212	2.05
XR1468CN	3.85	XR2211	5.25	XR4558	.75
XR1488	1.39	XR2212	4.35	XR4739	1.15
XR1489	1.39	XR2240	3.45	XR4741	1.47

DIODES

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
				1N4002	100 PIV	1 AMP	12/1.00
1N746	3.3	400m	4/1.00	1N4003	200 PIV	1 AMP	12/1.00
1N751	5.1	400m	4/1.00	1N4004	400 PIV	1 AMP	12/1.00
1N752	5.6	400m	4/1.00	1N4005	600 PIV	1 AMP	10/1.00
1N753	6.2	400m	4/1.00	1N4006	800 PIV	1 AMP	10/1.00
1N754	6.8	400m	4/1.00	1N4007	1000 PIV	1 AMP	10/1.00
1N757	9.0	400m	4/1.00	1N3600	50	200m	6/1.00
1N759	12.0	400m	4/1.00	1N4148	75	10m	15/1.00
1N959	8.2	400m	4/1.00	1N4154	35	10m	12/1.00
1N965	15	400m	4/1.00	1N4305	75	25m	15/1.00
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
1N5242	12	500m	.28	1N4742	12	1w	.28
1N5245	15	500m	.28	1N4744	15	1w	.28
1N456	25	40m	6/1.00	1N1183	50 PIV	35 AMP	1.60
1N458	150	7m	6/1.00	1N1184	100 PIV	35 AMP	1.70
1N485A	180	10m	5/1.00	1N1185	150 PIV	35 AMP	1.70
1N4001	50 PIV	1 AMP	12/1.00	1N1186	200 PIV	35 AMP	1.80
				1N1188	400 PIV	35 AMP	3.00

SCR AND FW BRIDGE RECTIFIERS

C36D	15A @ 400V	SCR(2N1849)	$1.95
C38M	35A @ 600V	SCR	1.95
2N2328	1.6A @ 300V	SCR	.50
MDA 980-1	12A @ 50V	FW BRIDGE REC.	1.95
MDA 980-3	12A @ 200V	FW BRIDGE REC.	1.95

TRANSISTORS

C106B1	.50			2N3904	4/1.00
MPSA05	.30	2N3055	.89	2N3905	4/1.00
MPSA06	5/1.00	MJE3055	1.00	2N3906	4/1.00
TIS97	6/1.00	2N3392	5/1.00	2N4013	3/1.00
TIS98	6/1.00	2N3398	5/1.00	2N4123	6/1.00
40409	1.75	PN3567	3/1.00	PN4249	4/1.00
40410	1.75	PN3568	4/1.00	PN4250	4/1.00
40673	1.75	PN3569	4/1.00	2N4400	4/1.00
2N918	4/1.00	MPS3638A	5/1.00	2N4401	4/1.00
2N2219A	2/1.00	MPS3702	5/1.00	2N4402	4/1.00
2N2221A	4/1.00	2N3704	5/1.00	2N4403	4/1.00
2N2222A	5/1.00	MPS3704	5/1.00	2N4409	5/1.00
PN2222 Plastic	7/1.00	2N3705	5/1.00	2N5086	4/1.00
2N2369	5/1.00	MPS3705	5/1.00	2N5087	4/1.00
2N2369A	4/1.00	2N3706	5/1.00	2N5088	4/1.00
MPS2369	5/1.00	MPS3706	5/1.00	2N5089	4/1.00
2N2484	4/1.00	2N3707	5/1.00	2N5129	5/1.00
2N2906	4/1.00	2N3711	5/1.00	PN5134	5/1.00
2N2907	5/1.00	2N3724A	.65	PN5138	5/1.00
PN2907 Plastic	7/1.00	2N3725A	1.00	2N5139	5/1.00
2N2925	5/1.00	2N3772	2.25	2N5210	5/1.00
MJE2955	1.25	2N3823	1.00	2N5449	3/1.00
2N3053	2/1.00	2N3903	5/1.00	2N5951	3/1.00

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-99	100-		1-9	10-99	100-
10 pf	.05	.04	.03	.001µF	.05	.04	.035
22 pf	.05	.04	.03	.0047µF	.05	.04	.035
47 pf	.05	.04	.03	.01µF	.05	.04	.035
100 pf	.05	.04	.03	.022µF	.06	.05	.04
220 pf	.05	.04	.03	.047µF	.06	.05	.04
470 pf	.05	.04	.035	.1µF	.12	.09	.075
100 VOLT MYLAR FILM CAPACITORS							
.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22
+20% DIPPED TANTALUMS (SOLID) CAPACITORS							
.1/35V	.28	.23	.17	1.5/35V	.30	.26	.21
.15/35V	.28	.23	.17	2.2/25V	.31	.27	.22
.22/35V	.28	.23	.17	3.3/25V	.31	.27	.22
.33/35V	.28	.23	.17	4.7/25V	.32	.28	.23
.47/35V	.28	.23	.17	6.8/25V	.36	.31	.25
.68/35V	.28	.23	.17	10/25V	.40	.35	.29
1.0/35V	.28	.23	.17	15/25V	.63	.50	.40
MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS							
Axial Lead				Radial Lead			
.47/50V	.15	.13	.10	.47/25V	.15	.13	.10
1.0/50V	.16	.14	.11	.47/50V	.16	.14	.11
3.3/50V	.14	.12	.09	1.0/16V	.15	.13	.10
4.7/25V	.15	.13	.10	1.0/25V	.16	.14	.11
10/25V	.15	.13	.10	1.0/50V	.16	.14	.11
10/50V	.16	.14	.12	4.7/16V	.15	.13	.10
22/25V	.17	.15	.12	4.7/25V	.15	.13	.10
22/50V	.24	.20	.18	4.7/50V	.16	.14	.11
47/25V	.19	.17	.15	10/16V	.14	.12	.09
47/50V	.25	.21	.19	10/25V	.15	.13	.10
100/25V	.24	.20	.18	10/50V	.16	.14	.12
100/50V	.35	.30	.28	47/50V	.24	.21	.19
220/25V	.32	.28	.25	100/16V	.19	.15	.14
220/50V	.45	.41	.38	100/25V	.24	.20	.18
470/25V	.33	.29	.27	100/50V	.35	.30	.28
1000/16V	.55	.50	.45	220/16V	.23	.17	.16
2200/16V	.70	.62	.55	470/25V	.31	.28	.26

Jameco ELECTRONICS New Kits

Regulated Power Supply

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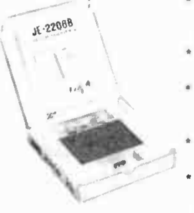
- Heat sink provided
- P.C. board construction
- Provides a solid 1 amp @ 5V
- Includes components, hardware and instructions
- Sizes: 3-1/2" x 5" x 2" high

JE200 $14.95

Function Generator Kit



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

JE2206B $19.95

Digital Stopwatch Kit

- Use Intersil 7205 Chip
- Plated thru double-sided P.C. Board
- LED display (red)
- Times to 59 min. 59.59 sec. with auto reset
- Quartz crystal controlled
- Three stopwatches in one: single event, split (cummulative) and taylor (sequential timing)
- Uses 3 penlite batteries
- Size: 4.5" x 2.15" x .90"

JE900 $39.95

4-Digit Clock Kit

- Bright .357" ht. red display
- Sequential flashing colon
- 12 or 24 hour operation
- Extruded aluminum case (black)
- Pressure switches for hours, minutes and hold modes
- Includes all components, case and wall transformer
- Size: 3-1/4" x 1-3/4" x 1-1/4"

JE730 $14.95

6-Digit Clock Kit

- Bright .300 ht. common cathode display
- Uses MM5314 clock chip
- Switches for hours, minutes and hold functions
- Hours easily viewable to 20 feet
- Simulated walnut case
- 115 VAC operation
- 12 or 24 hour operation
- Includes all components, case and wall transformer
- Size: 6-3/4" x 3-1/8" x 1-3/4"

JE701 $19.95

Jumbo 6-Digit Clock Kit

- Four .630" ht. and two .300" ht. common anode displays
- Uses MM5314 clock chip
- Switches for hours, minutes and hold functions
- Hours easily viewable to 30 feet
- Simulated walnut case
- 115 VAC operation
- 12 or 24 hour operation
- Includes all components, case and wall transformer
- Size: 6-3/4" x 3-1/8" x 1-3/4"

JE747 $29.95

MICROPROCESSOR COMPONENTS

8080A/8080A SUPPORT DEVICES

8080A	CPU	$ 9.95
8212	8-Bit Input/Output	3.25
8214	Priority Interrupt Control	5.95
8216	Bi-Directional Bus Driver	3.49
8224	Clock Generator/Driver	3.95
8226	Bus Driver	3.49
8228	System Controller Bus Driver	5.95
8238	System Controller	5.95
8251	Prog. Comm. I/O (USART)	7.95
8253	Prog. Interval Timer	14.95
8255	Prog. Periph. I/O (PPI)	9.95
8257	Prog. DMA Control	19.95
8259	Prog. Interrupt Control	19.95

6800/6800 SUPPORT DEVICES

MC6800	MPU	$14.95
MC6802CP	MPU with Clock and Ram	24.95
MC6810API	128X8 Static Ram	5.95
MC6821	Periph. Inter. Adapt (MC6820)	7.49
MC6828	Priority Interrupt Controller	12.95
MC6830L8	1024X8 Bit ROM (MC68A30-8)	14.95
MC6850	Asynchronous Comm. Adapter	7.95
MC6852	Synchronous Serial Data Adapt.	9.95
MC6860	0-600 bps Digital MODEM	12.95
MC6862	2400 bps Modulator	14.95
MC6880A	Quad 3-State Bus. Trans. (MC8T26)	2.25

MICROPROCESSOR CHIPS—MISCELLANEOUS

Z80(780C)	CPU	$19.95
Z80A(780-1)	CPU	24.95
CDP1802	CPU	19.95
2650	MPU	19.95
8035	8-Bit MPU w/clock, RAM, I/O lines	19.95
P8085	CPU	19.95
TMS9900JL	16-Bit MPU w/hardware, multiply & divide	49.95

SHIFT REGISTERS

MM500H	Dual 25 Bit Dynamic	5.50
MM503H	Dual 50 Bit Dynamic	.50
MM504H	Dual 16 Bit Static	.50
MM506H	Dual 100 Bit Static	.50
MM510H	Dual 64 Bit Accumulator	.50
MM5016H	500/512 Bit Dynamic	.89
2504T	1024 Dynamic	3.95
2518	Hex 32 Bit Static	4.95
2522	Dual 132 Bit Static	2.95
2524	512 Static	.99
2525	1024 Dynamic	2.95
2527	Dual 256 Bit Static	2.95
2528	Dual 250 Static	4.00
2529	Dual 240 Bit Static	4.00
2532	Quad 80 Bit Static	2.95
2533	1024 Static	2.95
3341	Fifo	6.95
74LS670	4X4 Register File (TriState)	1.95

UART'S

A-Y-5-1013	30K BAUD	5.95

MICROPROCESSOR MANUALS

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

ROM'S

2513(2140)	Character Generator(upper case)	$9.95
2513(3021)	Character Generator(lower case)	9.95
2516	Character Generator	10.95
MM5230N	2048-Bit Read Only Memory	1.95

RAM'S

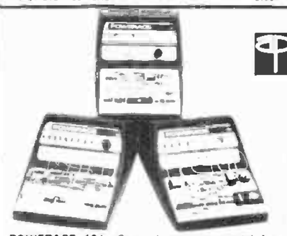
1101	256X1	Static	$1.49
1103	1024X1	Dynamic	.99
2101(8101)	256X4	Static	3.95
2102	1024X1	Static	1.75
21L02	1024X1	Static	1.95
2111(8111)	256X4	Static	3.95
2112	256X4	Static MOS	4.95
2114	1024X4	Static 450ns	9.95
2114L	1024X4	Static 450ns low power	10.95
2114-3	1024X4	Static 300ns	10.95
2114L-3	1024X4	Static 300ns low power	11.95
5101	256X4	Static	7.95
5280/2107	4096X1	Dynamic	4.95
7489	16X4	Static	1.75
74S200	256X1	Static Tristate	4.95
93421	256X1	Static	2.95
UPD414 (MK4027)	4K	Dynamic 16 pin	4.95
UPD416 (MK4116)	16K	Dynamic 16 pin	14.95
TMS4044-45NL	4K	Static	14.95
TMS4045	1024X4	Static	14.95
2117	16,384X1	Dynamic 350ns (house marked)	9.95
MM5262	2KX1	Dynamic	4/1.00

PROM'S

1702A	2048	FAMOS	55.95
TMS2516 (2716)	16K*	EPROM(Intel 2716)	49.95
	*Requires single +5V power supply		
TMS2532	4KX8	EPROM	89.95
2708	8K	EPROM	10.95
2716 T.I.	16K**	EPROM	29.95
	**Requires 3 voltages, −5V, +5V, +12V		
5203	2048	FAMOS	14.95
6301-1(7611)	1024	Tristate Bipolar	3.49
6330-1(7602)	256	Open C Bipolar	2.95
82S23	32X8	Open Collector	3.95
82S115	4096	Bipolar	19.95
82S123	32X8	Tristate	3.95
74186	512	TTL Open Collector	9.95
74188	256	TTL Open Collector	3.95
74S287	1024	Static	2.95

NEW!! IN STOCK... POWERACE

ALL-CIRCUIT EVALUATORS WITH POWER



- 1680 solderless, plug-in tie points...will hold up to 18 14-pin DIP's.
- Breadboard elements accept all DIP sizes...including RTL, DTL, TTL and CMOS devices. TO-5's and discretes with leads up to .032" dia.
- All connections to/from switches, indicators, power supplies and meters are made via solderless, plug-in, tie-point blocks on control panels.
- Interconnect with any solid 20 to 30 AWG wire.
- Breadboard elements are mounted on ground planes...ideal for high-frequency and high-speed low-noise circuits.
- Short-circuit-proof fused power supplies.
- Operate on 110 to 130 VAC at 60 Hz
- Space-age compact styling and high-grade components permit convenient, organized and quick prototyping.
- All models are 7.5" wide 11.5" deep and 4.0" high (rear) 0.75" high (front) and weigh approx. 2.5 lbs.

POWERACE 101 - General purpose model for prototyping all types of circuit.
#923101 $ 84.95

POWERACE 102 - Complete digit prototyping lab with built-in logic probe
#923102 $114.95

POWERACE 103 - Triple-output power supply for prototyping both linear and digit circuits.
#923103 $124.95

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 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

CONTINENTAL SPECIALTIES CORPORATION

- 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

New CSC Mini-Max 6 Digit 50MHz Frequency Counter

- Guaranteed frequency range of 100 Hz to 50 MHz
- Full 6 digit display with antiglare window
- Fully automatic-range, polarity, slope, trigger, input level switching not required.
- Lead-zero blanking—All zeros to the left of the first non-zero digit are blanked. Kilo Hertz and Mega Hertz decimal points automatically light up when the unit is turned on.
- Built in input overvoltage protection.
- Use 9V Battery or 110/220V power.
- Complete with mini antenna.
- Lightweight — Only 8oz.

MINI-MAX $89.95

Accessories For Mini-Max

Part No.	Description	Price
MM-A4	Antenna	$ 3.95
MM-C5	Carrying case	5.95
MM-PC	Input cable with clip leads	3.95
MM-AC2	110V adapter	9.95
MM-AC3	220V adapter	9.95

$5.00 Minimum Order – U.S. Funds Only
California Residents – Add 6% Sales Tax

Spec Sheets – 25¢
1979 Catalog Available—Send 41¢ stamp

NEW 1979 Catalog

Jameco ELECTRONICS

PHONE ORDERS WELCOME (415) 592-8097

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1021 HOWARD AVENUE, SAN CARLOS, CA 94070
Advertised Prices Good Thru January

CIRCLE NO. 29 ON FREE INFORMATION CARD

The Incredible "Pennywhistle 103"

$139.95 Kit Only

The Pennywhistle 103 is capable of recording data to and from audio tape without critical speed requirements for the recorder and it is able to communicate directly with another modem and terminal for telephone "hamming" and communications. In addition, it is free of critical adjustments and is built with non-precision, readily available parts.

Data Transmission Method	Frequency-Shift Keying, full-duplex (half-duplex selectable).
Maximum Data Rate	300 Baud.
Data Format	Asynchronous Serial (return to mark level required between each character).
Receive Channel Frequencies	2025 Hz for space, 2225 Hz for mark
Transmit Channel Frequencies	Switch selectable. Low (normal) = 1070 space, 1270 mark. High = 025 space, 2225 mark
Receive Sensitivity	−46 dbm accoustically coupled
Transmit Level	−15 dbm nominal. Adjustable from −6 dbm to −20 dbm
Receive Frequency Tolerance	Frequency reference automatically adjusts to allow for operation between 1800 Hz and 2400 Hz
Digital Data Interface	EIA RS-232C or 20 mA current loop (receiver is optoisolated and non-polar).
Power Requirements	120 VAC, single phase, 10 Watts.
Physical	All components mount on a single 5" by 9" printed circuit board. All components included

Requires a VOM, Audio Oscillator, Frequency Counter and/or Oscilloscope to align.

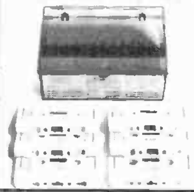
TRS-80 16K Conversion Kit

Expand your 4K TRS-80 System to 16K. Kit comes complete with:
* 8 each UPD416 (16K Dynamic Rams)
* Documentation for conversion

TRS-16K $115.00

Special Offer - Order both your TRS-16K and the Sup'R' MOD II Interface kit together (retail value $144.95) for only $139.95

COMPUTER CASSETTES

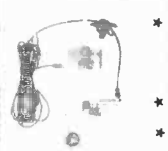


- 6 EACH 15 MINUTE HIGH QUALITY C-15 CASSETTES
- PLASTIC CASE INCLUDED 12 CASSETTE CAPACITY
- ADDITIONAL CASSETTES AVAILABLE #C-15-$2.50 ea.

CAS-6 $14.95
(Case and 6 Cassettes)

SUP 'R' MOD II

UHF Channel 33 TV Interface Unit Kit

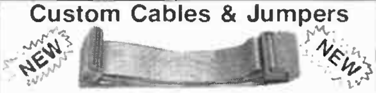


Wide Band B/W or Color System
* Converts TV to Video Display for home computers, CCTV camera, Apple II, works with Cromeco Dazzler, SOL-20, IRS-80, Challenger, etc.
* MOD II is pretuned to Channel 33 (UHF).
* Includes coaxial cable and antenna transformer.

MOD II $29.95 Kit

Custom Cables & Jumpers

NEW NEW



DB 25 Series Cables

Part No.	Cable Length	Connectors	Price
DB25P-4-P	4 Ft.	2-DP25P	$15.95 ea.
DB25P-4-S	4 Ft.	1-DP25P/1-25S	$16.95 ea.
DB25S-4-S	4 ft.	2-DP25S	$17.95 ea.

Dip Jumpers

DJ14-1	1 ft.	1-14 Pin	$1.59 ea.
DJ16-1	1 ft.	1-16 Pin	1.79 ea.
DJ24-1	1 ft.	1-24 Pin	2.79 ea.
DJ14-1-14	1 ft.	2-14 Pin	2.79 ea.
DJ16-1-16	1 ft.	2-16 Pin	3.19 ea.
DJ24-1-16	1 ft.	2-24 Pin	4.95 ea.

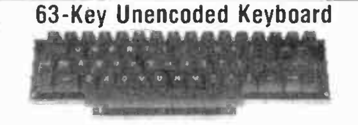
For Custom Cables & Jumpers, See JAMECO 1979 Catalog for Pricing

CONNECTORS

25 Pin-D Subminiature

DB25P(as pictured)	PLUG	$2.95
DB25S	SOCKET	3.50
DB51226-1	Cable Cover for DB25 P or S	1.75

63-Key Unencoded Keyboard



This is a 63-key, terminal keyboard newly manufactured by a large computer manufacturer. It is unencoded with SPST keys, unattached to any kind of PC board. A very solid molded plastic 13 x 4" base suits most application. IN STOCK **$29.95/each**

Hexadecimal Unencoded Keypad

19-key pad includes 1-10 keys, ABCDEF and 2 optional keys and a shift key. **$10.95/each**

FAIRCHILD RED LED LAMPS

#FLV5057 Medium Size. Clear Case. RED EMITTING. These are not retested off-spec units as sold by some of our competition. These are factory prime, first quality, new units.

10 FOR $1.19

50 FOR $4.95

"WE BOUGHT 250,000 PCS."

COMPUTER KITS

We stock our own line of top quality computer kits.

8K STATIC RAM (S-100) — $129

16K STATIC RAM (S-100) — $295

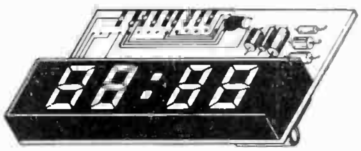
16K EPROM (2708) BOARD (S-100) — $59.95

16K STATIC RAM (SWTPC 6800 SS-50) BOARD — $295

ADDITIONAL DATA ON ANY KIT AVAILABLE ON REQUEST

NATIONAL SEMICONDUCTOR JUMBO CLOCK MODULE

MA1008A BRAND NEW!



$6.95

2 FOR $13

(AC XFMR $1.95)

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

ASSEMBLED! NOT A KIT!

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

PERFECT FOR USE WITH A TIMEBASE.

COMPARE AT UP TO TWICE OUR PRICE!

MANUFACTURER'S CLOSEOUT!

16K DYNAMIC RAM CHIP

16K X 1 Bits. 16 Pin Package. Same as Mostek 4116-4. 250 NS access. 410 NS cycle time. Our best price yet for this state of the art RAM. 32K and 64K RAM boards using this chip are readily available. These are new, fully guaranteed devices by a major mfg. VERY LIMITED STOCK!

$14.95 each — 8 FOR $89.95

EXPERIMENTER'S CRYSTAL

262 144KHZ. This frequency is 2 to the 18th power. Easily divided down to any power of 2, and even to 1HZ. New by CTS-Knight. A $5 value!

$1.25 each

SALE! 1N4148 DIODES

High speed switching diodes. Silicon. Same as 1N914. Brand New. Full Leads. Prime!

100 FOR $2   1000 FOR $17.50

FAIRCHILD PNP "SUPER TRANSISTOR"

2N4402. TO-92 Plastic. Silicon PNP Driver. High Current. VCEO-40 HFE-50 to 150 at 150 MA. FT-150 MHZ. A super "BEEFED—UP" Version of the 2N3906.

8 FOR $1

DISC CAPACITORS

.1 MFD 16V. P.C. leads. Most popular value! By Sprague.

20 for $1.00

Full Wave Bridge

4 Amp 200 PIV

69¢ea. 10/5.75

VOLTAGE SUPPRESSORS

By Midwest. #67D5010. Silicon Carbide Varistors. These units grab voltage transients, spikes, surges, etc. For use on AC or DC in the range of 12 to 28 Volts. Small Size: .5 Inch Disc with radial leads. For use across transformer secondaries, relays, etc. More rugged and reliable than silicon devices. Rated at 30 WATT-SEC. .25 WATT CONT. Perfect for use on AC operated clocks and instruments.

SPECIAL PURCHASE: 3 FOR $1

FET SALE!

2N4304. Brand New N Channel, Junction Fet. BVGD0-30V IDSS-15 MA Typ. 1500 uMHOS. TO-18 Plastic Case. Mfg. by Teledyne.

6 FOR $1

TIP-30 POWER TRANSISTOR

Prime new units. TO-220 Case. PNP silicon. VCEO-40 IC-1AMP. FT - 3 MHZ. 30 WATTS.

3 FOR $1

SURPLUS SPECIAL!

COMPUTER CAPACITOR

By GE. 36,000 MFD 15W VDC. Small Size: 4¾ x 1¾ Inches. SUPER DEAL! $2.95 Each

3 FOR $8

RCA MICRO-POWER OP AMP.

#CA3078T Metal Can. Most OPAMPS require ±15V to operate. But the CA3078 is designed to operate from ±.75 V to ±6V!!! Perfect for battery use. Standby power as low as 700 NW.! High Gain. 92 DB typical Open Loop Gain. Requires only one capacitor for compensation. See RCA Linear Data Book for more details. Similar to National LM112. Originally cost about $2 each.

75¢ EACH   3 FOR $2

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↑ SEND FOR OUR FREE CATALOG — THOUSANDS OF SURPLUS BARGAINS AVAILABLE FOR HOBBYIST & ENGINEER ↑

SALE! SALE! SALE!

ULTRASONIC MOTION DETECTOR

This alarm sensor fills the protected area with an energy screen that cannot be seen, felt or heard. Triggers your alarm whenever burglar moves through detector field. Mounts on ceiling, wall, desk, shelf etc. Optional delay mode, auto-reset. Operates on 12.5 VDC. A close-out that originally sold for $179.00!
Qty Ltd.
Sh. Wt 3 Lbs. . . .8D30336. . . $49.88

BURGLAR ALARM BOARD

Neat new closed-circuit alarm boad will latch a relay if the alarm circuit is opened. This unit operates on 12-VDC at such a low price, it makes a perfect compact alarm component. With data.
Qty Ltd.
Sh. Wt 6oz . . . . 8K30267 . . . . $2.88
5 for $13.88 . . .8K30267 . . $13.88/5

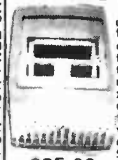
CALL DIRECTORS

3-Line-5 Line-11 Line, with rotary dial, reconditioned, Please state choice!
Sh. Wt 10 Lbs . 3 Line 8C30277 $29.88
Sh. Wt 10 Lbs. 5 Line . 8C0549 $39.88
Sh. Wt 15 Lbs . 11 Line. 8C0550 .$49.88
ALSO: TOUCH TONE-PAY STATION TELEPHONES! . . 8C30273 . . . $69.95

16/8 WATT Stereo Amp

Neat assembled board contains all solid state components. Contains a DARLINGTON drive, push-pull output, all with complementary power tab transistors & mounted to lg. heat sinks. Accepts input from tape decks, magnetic or ceramic phono cartridges, mikes,etc. Requires a 48V transformer & 1 meg volume control. (not supplied). Output 8 into 8 ohms. (Supplied with data).
Sh. Wt 1 Lb . . . . 8Y0513 . . . . $5.78
* Stereo Xformer . . .8G0530 . . $2.88
* Stereo Pkg. - 16 watts W/xformer & cont.
Sh. Wt 4 Lbs. . . . 8E0544 . . . $13.88

REMOTE CONTROL



$25.00

Originally made for TV use. You can use it to control stereo-on/off, tape, on/off power, volume control & more. All are controlled from across the room with a hand held xmitter. For the serious custom designer. Includes transmitter & receiver & will control 3-circuits. Includes DATA.
Sh. Wt 1 Lbs 8C0372
Price $25.00

WHERE SURPLUS REIGNS SUPREME

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No C.O.D's — Please add POSTAGE.

CIRCLE READER SERVICE CARD FOR FREE JUMBO CATALOG

B&F

CIRCLE NO. 9 ON FREE INFORMATION CARD

INTEGRATED ELECTRONICS

540 Weddell Drive, #4, Sunnyvale, CA 94086 (408)734-8470

SN6477 Complex Sound Generator — $3.50
This is a programmable sound effect generator capable of producing a wide variety of sounds from high to low frequency. Using this chip & a small number of inexpensive parts, a variety of projects may be built. Sp c shs & application notes $1.00

TL500 Analog Processor — $8.50
The TL500 contains all the active analog elements for an automatic zeroing and automatic polarity. It is a 13-bit dual-slope A/D converter that has true differential inputs. It requires 3 caps. & 2 resistors with no special matching or tolerances. It is designed for use with the TL502. Spec sheet $ .25

TL502 Digital Panel Meter L.D. — $5.50
This is a 4½-digit Digital Panel Meter L.D. that is designed to interface with the TL500 analog processor. It provides base drive for external PNP digit & segment drivers providing direct interface with 7-segment display. Spec sheet $ .25

LD130 A/D Converter — $5.50
Single-reference voltage, auto zero and auto polarity. It is designed for Digital Voltmeters, Panel Meters, Digital Thermometers, Microprocessor Interfaces to Analog Signals, & General Instrumentation. 34-pg. Spec & Application notes $2.50

MM5865 Programmable Stopwatch — $7.50
7-function Universal Timer and Stopwatch. Start/stop with elapse time, start/stop accumulative event time, split, sequential total elapse time, rally total elapse time, program up and down count. It uses 32.8 KHz crystal or external clock.
Spec sheet & 10-page Application notes $1.50

32.8 KHz Crystal — $4.00

Minimum order $5.00 US currency. Check or money order only. Add 5% to cover shipping and handling charges. Calif. residents add 6% sales tax. Santa Clara County residents add 6.5% sales tax.

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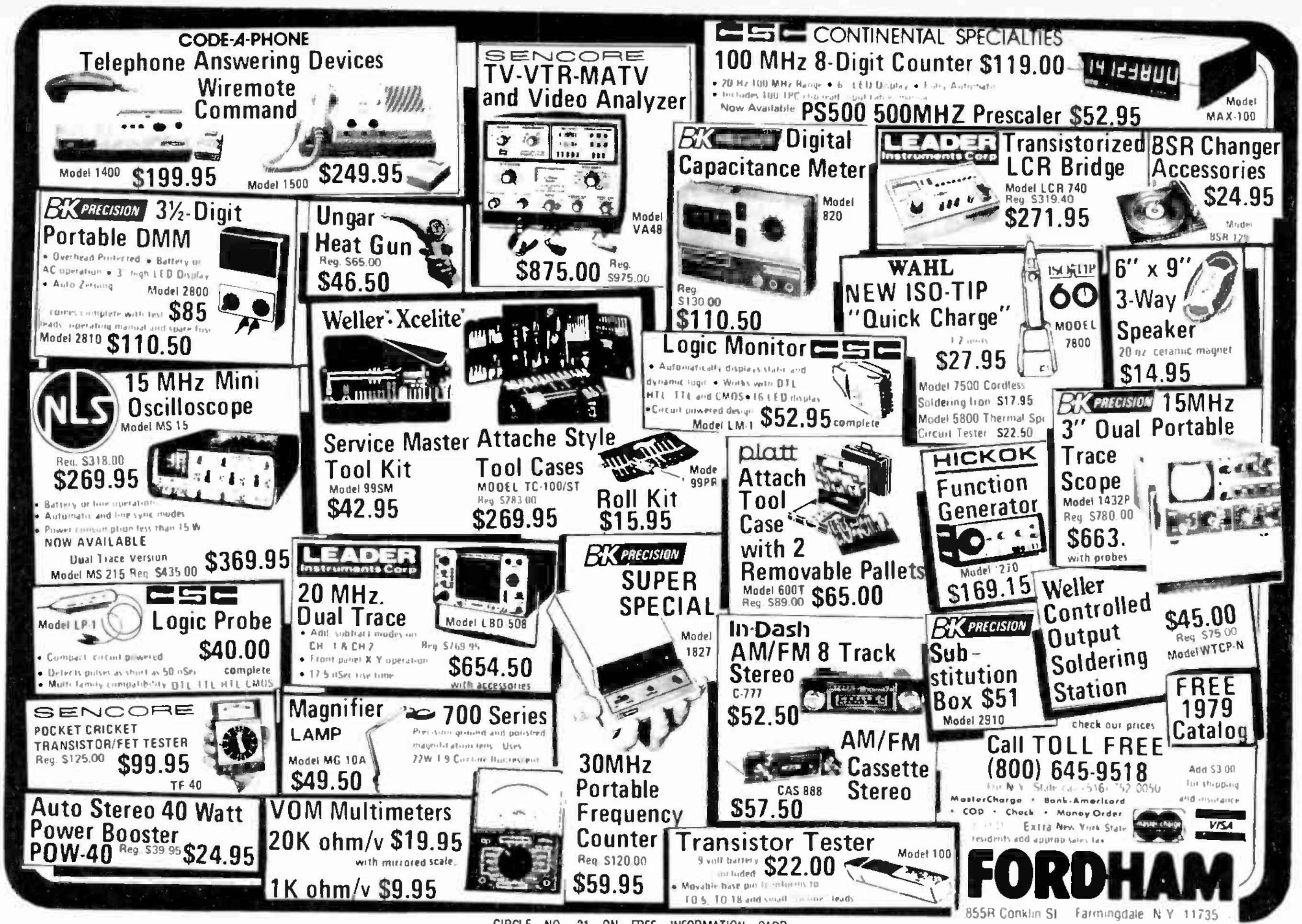

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PRIME TTL & CMOS AT LOWEST PRICES

74xx TTL

7400	$0.14
7401	0.15
7402	0.15
7403	0.15
7404	0.16
7405	0.16
7406	0.24
7407	0.24
7408	0.17
7409	0.17
7410	0.15
7411	0.18
7412	0.20
7413	0.25
7414	0.55
7416	0.22
7417	0.22
7420	0.15
7421	0.17
7423	0.25
7425	0.25
7426	0.22
7427	0.19
7430	0.15
7432	0.23
7437	0.21
7438	0.21
7439	0.25
7440	0.15
7441	0.70
7442	0.38
7443	0.55
7444	0.55
7445	0.55
7446	0.62
7447	0.57
7448	0.60
7450	0.15
7451	0.15
7453	0.15
7454	0.15
7459	0.15
7460	0.15
7470	0.27
7472	0.24
7473	0.24
7474	0.24
7475	0.45
7476	0.29
7480	0.31
7482	0.50
7483	0.54
7485	0.80
7486	0.27
7489	1.75
7490	0.40
7491	0.51
7492	0.40
7493	0.40
7494	0.60
7495	0.60
7496	0.60
7497	2.45
74107	0.29
74109	0.32
74121	0.29
74122	0.35
74123	0.39
74125	0.37
74126	0.38
74132	0.65
74141	0.70
74145	0.65
74147	1.50
74148	1.15
74150	0.79
74151	0.59
74152	0.59
74153	0.60
74154	0.95
74155	0.65
74156	0.65
74157	0.59
74158	0.59
74160	0.79
74161	0.79
74162	0.79
74163	0.79
74164	0.79
74165	0.90
74166	0.95
74167	3.20
74170	1.85
74173	1.10
74174	0.85
74175	0.75
74176	0.69
74177	0.70
74178	1.20
74179	1.20
74180	0.65
74181	1.75
74182	0.75
74184	1.75
74185	1.75
74188	2.80
74190	0.95
74191	0.95
74192	0.80
74193	0.80
74194	0.80
74195	0.49
74196	0.73
74197	0.73
74198	1.30
74199	1.30
74251	1.00
74279	0.49
74283	1.00
74290	0.59
74293	0.57
74298	0.92
74365	0.62
74366	0.62
74367	0.62
74368	0.62

74LSxx TTL

74LS00	$0.21
74LS01	0.27
74LS02	0.21
74LS03	0.21
74LS04	0.24
74LS05	0.24
74LS08	0.23
74LS09	0.23
74LS10	0.21
74LS11	0.21
74LS12	0.27
74LS13	0.40
74LS14	0.85
74LS15	0.26
74LS20	0.23
74LS21	0.23
74LS22	0.23
74LS26	0.31
74LS27	0.26
74LS30	0.23
74LS32	0.30
74LS37	0.31
74LS38	0.31
74LS40	0.26
74LS42	0.60
74LS47	0.75
74LS48	0.72
74LS51	0.25
74LS54	0.25
74LS55	0.25
74LS73	0.38
74LS74	0.35
74LS76	0.37
74LS78	0.36
74LS83	0.75
74LS85	1.30
74LS86	0.36
74LS90	0.50
74LS92	0.50
74LS93	0.50
74LS95	0.85
74LS107	0.35
74LS109	0.35
74LS112	0.35
74LS113	0.35
74LS114	0.35
74LS123	0.90
74LS125	0.46
74LS126	0.46
74LS132	0.72
74LS133	0.34
74LS136	0.35
74LS138	0.70
74LS139	0.70
74LS151	0.65
74LS152	0.65
74LS153	0.66
74LS154	1.00
74LS155	0.62
74LS156	0.62
74LS157	0.62
74LS158	0.70
74LS160	0.82
74LS161	0.82
74LS162	0.82
74LS163	0.82
74LS164	0.98
74LS168	0.83
74LS169	0.83
74LS170	1.60
74LS173	1.00
74LS174	0.75
74LS175	0.79
74LS181	2.50
74LS190	0.90
74LS191	0.90
74LS192	0.90
74LS193	0.90
74LS194	0.85
74LS195	0.50
74LS196	0.80
74LS197	0.80
74LS221	1.05
74LS251	0.80
74LS253	0.80
74LS257	0.70
74LS258	0.70
74LS259	1.60
74LS260	0.34
74LS266	0.26
74LS279	0.52
74LS283	0.72
74LS290	0.60
74LS295	0.90
74LS298	0.90
74LS365	0.52
74LS366	0.52
74LS367	0.52
74LS368	0.52
74LS386	0.36
74LS390	1.65
74LS393	1.35
74LS490	1.10
74LS670	2.29

74Sxx TTL

74S00	$0.35
74S02	0.35
74S03	0.35
74S04	0.36
74S05	0.36
74S08	0.38
74S09	0.38
74S10	0.35
74S11	0.38
74S15	0.38
74S20	0.35
74S22	0.36
74S30	0.27
74S32	0.50
74S40	0.35
74S51	0.17
74S60	0.35
74S64	0.38
74S65	0.38
74S74	0.58
74S76	0.58
74S78	0.58
74S112	0.58
74S113	0.58
74S114	0.58
74S132	0.75
74S133	0.38
74S134	0.38
74S135	0.49
74S138	0.77
74S139	1.50
74S140	0.47
74S151	1.25
74S153	2.10
74S157	0.75
74S158	1.25
74S174	1.50
74S175	1.45
74S189	2.75
74S194	1.75
74S200	3.25
74S206	3.75
74S253	0.95
74S257	1.15
74S258	1.15
74S280	2.25
74S287	3.20
74S289	3.55
74S300	1.60
74S305	1.90
74S310	2.85
74S312	1.05
74S313	1.55
74S316	2.80
74S341	4.10
74S342	1.20
74S343	4.95
74S346	1.25
74S362	2.15
74S387	4.70

74Cxx TTL

74C00	$0.24
74C02	0.24
74C04	0.26
74C08	0.25
74C10	0.24
74C14	0.90
74C20	0.25
74C30	0.24
74C32	0.25
74C42	0.94
74C48	0.96
74C73	0.62
74C74	0.48
74C76	0.68
74C83	1.28
74C85	1.20
74C86	0.40
74C89	3.95
74C90	0.92
74C93	0.92
74C95	1.04
74C107	0.68
74C151	1.78
74C154	2.90
74C157	1.78
74C160	1.08
74C161	1.08
74C162	1.08
74C163	1.08
74C164	1.08
74C165	1.08
74C173	1.16
74C174	1.08
74C175	1.04
74C192	1.30
74C193	1.30
74C195	1.10
74C200	7.50
74C221	1.38
74C901	0.48
74C902	0.48
74C903	0.48
74C904	0.48
74C905	6.00
74C906	0.48
74C907	0.48
74C908	0.96
74C909	1.78
74C910	6.00
74C914	0.90
74C918	1.16
74C925	7.80
74C926	7.80
74C927	7.80
74C928	7.80

4xxx CMOS

4000	$0.16
4001	0.16
4002	0.16
4006	0.85
4007	0.16
4008	0.74
4009	0.35
4010	0.35
4011	0.16
4012	0.16
4013	0.31
4014	0.73
4015	0.73
4016	0.28
4017	0.78
4018	0.78
4019	0.21
4020	0.83
4021	0.83
4022	0.83
4023	0.16
4024	0.66
4025	0.16
4027	0.37
4028	0.73
4029	0.98
4030	0.21
4031	2.97
4034	2.75
4035	0.84
4040	0.86
4041	0.64
4042	0.64
4043	0.62
4044	0.62
4046	1.35
4047	1.45
4048	0.95
4049	0.33
4050	0.33
4051	0.89
4052	0.89
4053	0.89
4060	1.40
4066	0.54
4068	0.34
4069	0.26
4070	0.40
4071	0.19
4073	0.21
4075	0.21
4076	1.16
4077	0.46
4078	0.35
4081	0.19
4085	0.64
4086	0.64
4089	2.75
4093	1.55
4099	2.10
4104	2.40
4503	0.98
4507	0.37
4510	0.95
4511	0.93
4512	0.64
4516	0.76
4518	0.76
4519	0.62
4520	0.68
4527	1.48
4528	0.86
4532	0.86
4539	1.10
4555	0.67
4556	0.88
4582	0.88
4584	0.74
4702	7.10
4703	8.25
4704	7.30
4705	9.25
4706	9.75
4707	9.25
4708	14.35
4710	6.40
4720	6.95
4721	31.35
4723	0.93
4724	1.29
4725	1.29
40014	0.72
40085	1.47
40097	0.54
40098	0.54
40106	0.90
40160	1.08
40161	1.08
40162	1.08
40163	1.08
40174	1.08

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Operation Assist

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Rogers type 30 radio. Schematic, tube numbers. T. Branton, 1735 College La. S.W., Calgary, Alta, Canada, T2S 269.

Hammarlund 23-channel CB. Schematic and any information. Mark Sinchar, 3316 Ford St., McKeesport, PA 15132.

Dumont cathode-ray oscilloscope type 303, serial 257. Operation manual and schematic. Fred Rapant, 1327 Marion Ave., S. Milwaukee, WI 53172.

Electronic Designs oscillator model 190. Manual and schematic. F. Putman, 5374 S. Huron St., Littleton, CO 80120.

Concertone stereo tape recorder model 505. Operation manual and schematic. James Dunavant, 717 NE 5th Ter. Gainesville, FL 32601.

Grundig Satellite 2000 SW receiver. Adaptor with instructions needed. Tonyo Poweigha, 324 M.I. Building, University Park, PA 16802.

Hammarlund model HQ 100 A SW receiver. Need operation manual. Douglas W. Bucholz, Rhame, ND 58651.

Elico transistor TV model TVA-12. Schematic. Wyman Thompson, Box 63, Mead, WA 99021.

Hallicrafters model SX-100. Operator's manual, schematic and any other information. John M. Snider, 103 Mulberry, Scott City, MO 63780.

Panasonic FM/AM stereo cassette recorder model RS-280S. Schematic. H.L. Murdock, 517 Tilghman St., Kenton, TN 38233.

Harvey Wells Bandmaster TBS-50D transmitter. Instruction manual and schematic. H. Eddy, W2BU, 3 No. Belmont Circle, Oneonta, NY 13820.

General Radio type 650-A impedance bridge. Schematic and operator's manual. Mike Miller, 80 Sutton Dr., Glenbrook, CT 06906.

Frden 1154 and 1102 calculator. Schematic, parts list, service information. P.M. Erlenbaugh, Fremont High School, Box 655, Fremont, IN 46737.

Packard-Bell model SMC-2P dual-trace oscilloscope. Schematic, other data. Phil Hartman, 169 Boutwell, San Francisco, CA

MBI, Inc. Model 015 disc memory unit. Specifications, schematics and maintenance manual. Bert Richardson, 13 Fern St., Natick, MA 01760.

Concord VTR 600-1. Need manual. Robert Sloat, Box 0537, Tice, FL 33905.

Superior Instruments model TD-55 tube tester. Operations manual and schematic. Larry R. Cook, 362 East South St., Richland Center, WI 53581.

DeVry Technical Institute oscilloscope model 1G09. Schematic and assembly manual. Tom Williams, 1625 Greenview Cr., Windsor Ontario, Canada.

Tektronix 511AD oscilloscope. Manual and schematic. J.A. Call, 1876 E. 2990 So., Salt Lake City, UT 84106.

Hughes model 105A memo-scope and HAC H1051. Need operation manual. Ed McGarry, 3209 Spring Drive, Alexandria, VA 22306.

International Radio Corporation model 66x. Need JFD air-cooled ac-dc ballast type C. William Christoffel, 1110 Varsity Apt 225, DeKalb, IL 60115.

Emerson radio 8CW-334-2. Need i-f transformers and schematic. Ted Liszewski, 182 Fairview Ave., Paramus, N.J. 07652.

Fisher 550-T receiver. Service manual and schematic. Chuck Landresy, 409 Buena Vista, Windor, GA 30680.

Precision E-200 signal generator. Manual and schematic. Bill Hocutt, 926 So., Shades Crest Road, Bessemer, AL 35020.

Motorola model FMTRU-5V hi-band transceiver. Need schematic and instruction manual. Gordon E. Dahl, 604 9th St. So., Virginia, MN 55792.

Hewlett Packard model 410B VTVM. Schematic and manual. A. Reges, 16W761 White Pines, Bensenville, IL 60106.

Knight model 83Y125-J VTVM. Schematic and manual. P. Young, 16W761 White Pines, Bensenville, IL 60106.

Precision Apparatus Co., Inc. model ES525, serial #1019 oscilloscope. Service manual, owners manual, schematic and pc layout. STCM D.E. Miller, Code 915, Navseacenlant, St. Julien's Creek Annex, Portsmouth, VA 23702.

Moseley 135 x-y plotter. Service manual and schematic. Peter Braun, Box 399, Sunnymead, CA 92388.

Morrow model MBR-5 serial #R-1458 communication receiver. Schematic and service manual. Alex Kiriluk, 419-50th Ave., Bellwood, IL 60104.

Fujiya-Corder tape player recorder. Manual and schematic. W.D. Barry, 5050-147 Jackson St., N. Highlands, CA 95660.

Zenith Trans-Oceanik receiver #8G-005. Need schematic and manual. Steve Kritzberg, 1030-16 Franklin Ave., Valley Stream, NY 11580.

Heathkit Mohawk model RX-1 receiver. Manual and schematic. **Marauder** model HX-10. Manual and schematic. Stuart L. Ballinger, 57 S. Clinton St., Poughkeepsie, NY 12601.

Magnus organ. Circuit diagiarm for oscillator board 24-1353 revision D. M.W. Greene, 7 Maple Street, Bellport, NY 11713.

Olektron FP-CDB-115. Need double-balanced modulator module. Gene Cronenwett, 2618 Beecher St., Findlay, OH 45840.

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by Ted Nelson

This book concerns itself with the "why" of home computing and provides interesting insight to many facets of this infant industry. The beginning computer hobbyist and those casually interested will find much information on the development and applications of home computers. Likewise, there are many fresh ideas and interesting facts within its pages which will fascinate established computer hobbyists.

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by Jay Rusgrove, Doug DeMaw and George Grammer

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Published by the American Radio Relay League, 225 Main Street, Newington, CT 06111. 223 pages. $5.00 (soft cover) in the U.S., $5.50 elsewhere.

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by Austin Lesea and Rodnay Zaks

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Published by SYBEX Incorporated, 2161 Shattuck Ave., Berkeley, CA 94704. 348 pages. $9.95 soft cover.

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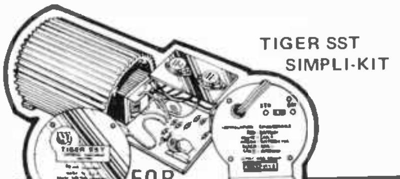

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First U. S. Digital Recording

The first commercial, classical music disc recorded in the U. S. by digital processing has been released on the "Telarc" label, distributed by Audio-Technica U.S., Inc. The disc, retailing at $14.95, features the Cleveland

Symphonic Winds, conducted by Frederick Fennell, with music by Holst, Handel, and Bach. A Soundstream digital tape recorder was used in the process, which is said to virtually eliminate distortion and other problems common to conventional tape recordings. The music signal is converted into binary computer pulse codes rather than analog magnetic waveforms. No compressors, equalizers or limiters were used in recording music signals on a master disc.

Cadillac's Trip Computer

The Trip Computer, manufactured by General Motors and available on 1979 Cadillac Sevilles, is a pre-programmed system which computes and displays operational information in three areas on the instrument panel. The first is a digital speedometer above the steering wheel. Second, a fuel gauge gives the amount of gas available in the tank. Finally, a command control center offers a variety of information by depressing of a console button: actual instantaneous fuel economy, average-fuel economy for trip, average car speed, total elapsed trip time, driving range on remaining gasoline, miles to go to a pre-determined destination, estimated time of arrival, time of day, engine rpm, engine temperature, and system voltage. The link between all the various analog quantities and the digital microprocessor is a National Semiconductor 16-channel, 8-bit ADC 0816 analog-to-digital converter. You don't have to buy a '79 Seville, however, to enjoy automotive computer benefits. Add-on systems, such as the Prince "on-board computer," will provide any car with this facility.

Japanese TV Gets Multiplex Sound

Japan's Radio Regulatory Council for the Posts & Telecommunications Ministry has approved a plan to authorize TV stations to start multiplex sound broadcasting. This will allow Japanese TV viewers to watch foreign movies in either original-language or Japanese-dubbed versions, or musical programs in stereo. In the future, TV receivers are expected to be built to include receivers for multiplex broadcasting. The receivers will also be available separately; adapters would be attached to TV receivers with multiplex terminals or to stereo systems, which could then be used on TV receivers without multiplex terminals. It's reported, too, that the government eventually plans to approve a facsimile broadcast service over the multiplex sound system.

FCC Fee Over-$20 Inquiry

The Federal Communications Commission has begun an inquiry on the refund of fees collected between August 1, 1970 and January 1, 1977, and on alternatives for future fee schedules (Gen. Docket No. 78-316). However, this action deals only with fees in amounts greater than $20 and therefore does not deal with fees paid by citizens band (CB) licensees. The Commission emphasized that action on fees under $20, including those for CB, would be taken in the near future. It asked that CBers not make inquiries at this time concerning fees.

Monthly NY Computer Flea Show

A Computer Flea Show and Market is now available to computer hobby enthusiasts in the New York area. It is scheduled for the third Sunday of every month at the Doral Inn (Lexington Ave. and 49th St.) and is intended for the experienced hobbyist as well as the new owner of a personal computer. Exhibitors are expected to include computer manufacturers and computer stores and sellers of used equipment. It is hoped that vendors of software will also be on hand to run their programs. Admission is $1 and hours are 11 a.m. to 5 p.m. For more information, contact Robert Schwartz, 375 Riverside Dr., New York, NY 10025.

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*These ratings are at 8 Ohms per FTC regulations.
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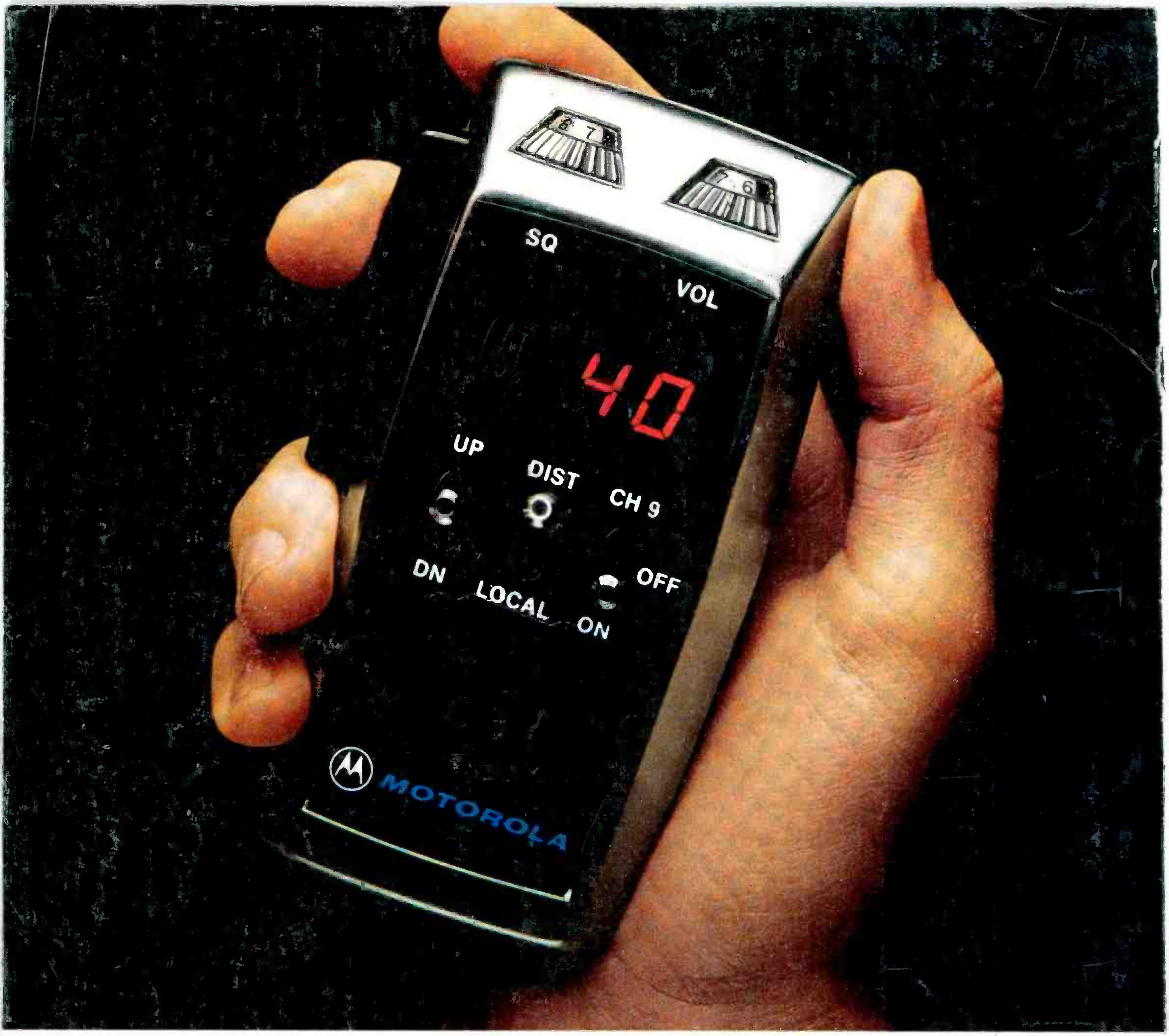

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