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- **How to Create Great-Looking Front Panels for Projects**
- **Music on Computers**
- **Regulator Circuits**
- **Build a Coaxial Cable r-f Communications System**
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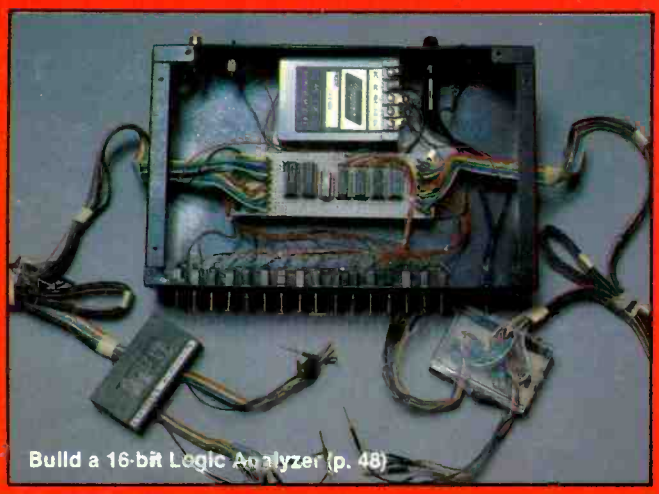

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Dress Up Project Front Panels (p.28)

Magnavox Portable Stereo/Hi-Fi VCR (p. 12)

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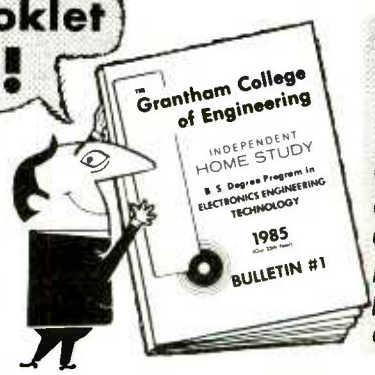

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List price $499.95/**CE special price $159.00**
Multi-Band - 16 Channel • No-Crystal Scanner
Frequency range 26-88, 108-180, 380-514 MHz.
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Frequency range: 30-50, 144-174, 440-512 MHz.
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NEW! Bearcat® 100XL-J

List price $349.95/**CE price $229.00**
9-Band, 16 Channel • Priority • Scan Delay Search • Limit • Hold • Lockout • AC/DC
Frequency range: 30-50, 118-174, 406-512 MHz.
The world's first no-Crystal handheld scanner now has a LCD channel display with backlight for low light use and aircraft band coverage at the same low price. Size is 1⅜" x 7½" x 2⅞". The *Bearcat* 100XL has wide frequency coverage that includes all public service bands (Low, High, UHF and "T" bands), the AM aircraft band, the 2-meter and 70 cm. amateur bands, *plus* military and federal government frequencies. Wow...what a scanner!

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Bands: 118-136, 144-174, 440-512, 800-950 MHz.
The HX2000 scanner operates on 120V AC or 6 VDC. Scans 15 channels per second. Size 3" x 7" x 1½." Includes wall charger, carrying case, belt clip, flexible antenna and nicad batteries. Selectable AM/FM modes.

NEW! Bearcat® 800XLT-J

List price $499.95/**CE price $329.00**
12-Band, 40 Channel • No-crystal scanner Priority control • Search/Scan • AC/DC
Bands: 29-54, 118-174, 406-512, 806-912 MHz.
The Uniden 800XLT receives 40 channels in two banks. Scans 15 channels per second. Size 9¼" x 4½" x 12½."

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BC 20/20-J *Bearcat* 40 channel scanner	$274.00
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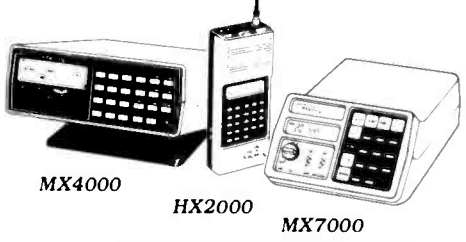

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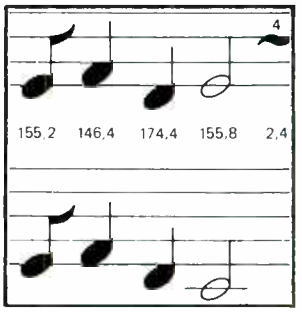

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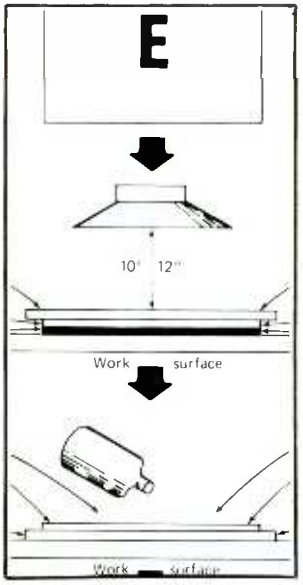

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PRODUCT EVALUATIONS

DEPARTMENTS

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EDITORIAL

Leapfrogging

Manufacturers are constantly refining their electronic products: an extra output here, a slightly improved video resolution there, a doubling of chip memory, etc.

From time to time, however, there's a quantum jump to a new technological plane. We've witnessed this many times: from transistor to integrated circuit, from monophonic sound to stereo, from analog records to digital laser-read discs, and so on. There's lots more churning in the developmental stage right now that can come to fruition sooner than one might think.

For example, lots of people dream about living in a "smart" house, with all manner of electronic contrivances for them to control. A few individuals have indeed created such homes. Now, however, there are some thrusts being made to eventually spread this concept as a reality to a great many people.

Eighteen companies are involved in Smart House Development Venture Inc. to do just this. They include Apple Computer, General Electric, and Honeywell, with support from 130,000-member NAHB (National Association of Home Builders).

The basic approach to the "smart" house is to replace our standard 120 Vac electric circuits with an integrated power and signal bus line. This would enable the integration of entertainment equipment, security systems, computers, energy management, telephone gear, etc. Key to this system concept is a microprocessor-based system controller, which would control power or signal demands from whatever a plugged-in device calls for. A new, single plug would have to be used and the National Electrical Code would have to be changed to allow its use.

Honeywell is already a step ahead here with a hotel-office complex that's to be a "smart" building that provides computer services, advanced communications systems, etc. All this is said to cost a 15-employee tenant about $1,000 per month or only half as much more as one would pay for a phone system. It's called the Renaissance Center, in Fairfax County, VA.

In about two years, the NAHB expects a smart-house system to be installed in 1½-million new homes every year. I'm saving my pennies for it right now.

There have been plenty of bummers, of course. Developments that are still waiting on the sidelines, held back for a variety of reasons. Such very promising concepts include Videotex—information services at your beck and call through your home TV set. Electronic banking, shopping, and so on. It's (very) slowly growing, but nowhere near being a big market . . . yet.

High-definition TV was supposed to be right around the corner, too. Our skylines were envisioned to be broken up by direct-broadcast satellite dishes on rooftops around the country, while cable-TV was to be relegated to interactive applications. It hasn't happened . . . yet. Nor has optical computers made the grade. Verbatim, though, recently revealed a 40-megabyte disk drive that uses erasable optical disks. And AT&T is furiously working away in its Bell Labs on optically sensitive gallium-arsenide devices. So who knows?

Whatever happens down the road, however, you can be certain that more power will be packed on chips. So just as the 256K-bit IC with its 2-micron circuit size made it possible to produce much more powerful microcomputers, so will the 1-micron chip with its 1-Megabit power that's soon expected to debut give us powerful pocket computers, among other small-size electronic products that can do marvelous things. And before you know it, in about a decade, you can expect chips with 4-million transistor equivalents on it. This 4-megabit, ¼-micron-size device will open up the world of artificial intelligence to small devices, say, personal home robots that can "think" logically, place supercomputers that now cost many millions of dollars on our desks for only hundreds of dollars, etc.

So we've got a lot of fun happenings to look forward to, even if some exciting concepts do fall through the cracks. There'll still be plenty of revolutionary leapfrogging of technology that we electronics activists will be able to savor.

Art Salsberg

LETTERS

Designing For Safety

• "An Experimenter's Multi-Voltage Power Supply" (May 1985) was a good construction article but it was marred by a potentially dangerous design flaw. It doesn't incorporate a three-wire safety ac line cord, and its fuse should be located before—not after—the power switch. Good design practice calls for using the three-wire ac line cord in any project housed inside a metal cabinet. The white and black wires would go to the power supply's ac input terminals, while the green wire would connect directly to chassis ground.

Richard Jon Jansma
Raleigh, NC

Back Issues

• I'm a new subscriber to *Modern Electronics.* The issues I got mention an article in the January 1985 issue about the "Digital Humidity Controller." I have a great need for such a piece of equipment. How can I either secure a copy of the January issue or a copy of the article?

G. Baldauf
Wernersville, PA

Send $2.50 for the issue to Modern Electronics, 76 North Broadway, Hicksville 11801.—Ed.

Extra Credit

• Since your first issue in October of '84 I have been an avid reader of your publication and have been enthusiastically recommending it to my students at Suburban Technical School, Hempstead, NY. I also offer extra credit for building any of the many projects you often publish in your magazine because it enables them to apply their training in computers and electronic communications technology while building useful circuitry.

M.E. truly offers something for all, be you a novice or an advanced student of electronics. Personally, I most enjoyed the article by Stan Prentiss on satellite TV (December '84).

Kevin Coppola
Suburban Technical School
Hempstead, NY

SATELLITE TV RECORD SETTER. The R.L. Drake Company claims it has sold more than 270,000 TV earth station receivers, a remarkable milestone when you consider that the entire satellite TV industry sales hardly exceed one-million receiver units.

ELECTRONIC ENGINEER SALARIES UP. EE's are doing quite well, thank you, according to a recent IEEE report that the national median salary was $46,100 in 1984, an increase of 15% compared to 1983. Top pay area was San Francisco, with $53,000, followed by metropolitan New York City with $51,500. Starting salaries in the New York area are now said to be $24,852 to $28,404 for EE's with Bachelor's degrees. The top starting wage is reportedly about $2,000 under the national average, though. Sorry, Liberal Arts people.

TALK, TALK, TALK. A 1,000-word speech recognizer was announced by Kurzweill Applied Intelligence. Called the KVS-3000 system, it compares spoken input with 3,0000 speech tokens, which may be expanded by more memory boards to up to 15,000 tokens and 5,000-word recognition. It's yours for $6,000, which includes an RS-232 interface, in a self-contained desktop package.

On another talk front, Motorola has introduced a "convertible" cellular phone that's designed for hand-held portable use as well as for in-vehicle mobile applications. It incorporates automatic tone alerting for signalling incoming call attempts in marginal-coverage areas. $2850 (with case, shoulder strap and belt clip).

COMPUTER SECURITY. Software publisher BrainPower "unprotected" all its software recently. The company concluded that copy protection only limits product use and makes it harder for users to protect themselves against media failures. On the other side, Arnet Controls of Nashville, TN introduced a new device, called Gardware, to fight software piracy and unauthorized computer access. It's a little black box that must be plugged into the computer before software can be used. It works with the IBM PC and Apple Macintosh.

VCR-COMPANY SHAKEOUT COMING? Videocassette recorders have been selling at record paces this year, causing the EIA to revise its 1985 sales forecast upward to 11.5-million units, which compares very favorably to the 7.6-million sold in 1984. Nonetheless, there are some worries because there are some reported 15 to 16 million that could reach our shores from the Far East in total. U.S. warehouses are said to have an inventory backup at this time. So even though the VCR star shines bright, with a projected 12-million units for 1986, manufacturers are getting scared. With 68 brands out there vying for your money, it's felt that some will bite the dust soon.

AUDIO RECORDING IN A PEN. A microminiature pen in a holder is actually a miniature cassette tape recorder for on-the-sly voice recording. From CCS Communication Control, New York City, the recorder systems fits into a breast pocket and is activated when a black Cross pen is removed.

For more information on products described, please circle the appropriate number on the Free Information Card bound into this issue or write to the manufacturer.

Computer/VCR Interface

Video-Memory Manager from Kirsch Technologies is a software-driven hardware plug-in board that inexpensively allows any Apple II, II+ or IIe, IBM PC or XT, or true workalike computer to use a videocassette recorder for mass storage. It operates with standard video signals that allows any-format VCR or laser disc to be used in this manner.

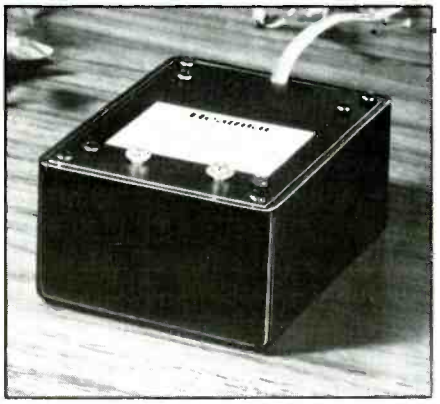
The hardware board plugs into any open slot in the computer and converts digital data into an analog signal for easy operator interaction with video pictures and software-generated prompts. Through use of a unique error-detection scheme, as much as 96M bytes can be reliably stored on a single videocassette. A Video-Data Filer utility program on floppy disk provides the capability of backing up and restoring memory between floppy diskettes, hard-disk systems and video tape. The assembly-language software is menu-driven. With it, not only does Video-Memory Manager greatly increase computer memory storage, but it also provides backup of hard-disk images and individual files.

CIRCLE NO. 128 ON FREE INFORMATION CARD

Home Security Device

Home security is just a telephone call away with the new Model GD-1702 Vacation/Home Sentry kit from the Heath Company. This security device monitors internal house conditions and relays the information to you over the telephone line. As supplied, the GD-1702 detects low temperatures, but it can optionally be equipped to detect the presence of water, lights, an intruder, etc. with appropriate sensors connected to it.

In operation, a vacationing home owner or neighbor simply calls the house. After a predetermined number of rings, the Vacation/Home Sentry automatically activates. If a sensor has been tripped by a temperature below 40°F or by some other condition, the Sentry will emit a beeping signal through the telephone. If conditions are normal, you will hear nothing and the Sentry will automatically disconnect and return to its monitor mode after a few seconds.

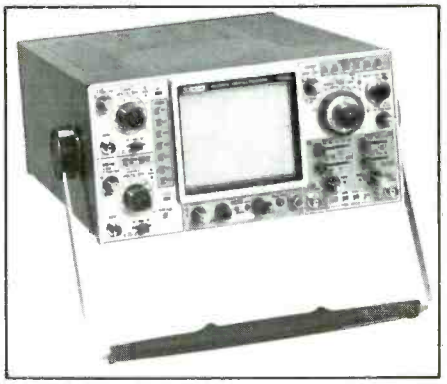


The GD-1702 plugs into any modular phone line and is powered by two 9-volt transistor batteries. Power from the batteries is drawn only when the device is relaying information in response to a phone query.

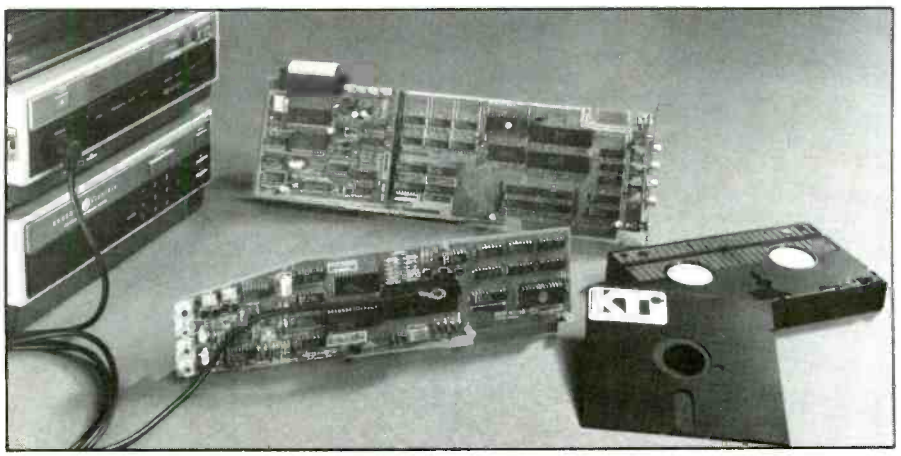
CIRCLE NO. 129 ON FREE INFORMATION CARD

150-MHz Oscilloscope

A quad-input, dual independent timebase oscilloscope with a 150-MHz bandwidth for both bench and field use has been introduced by B&K-Precision. The Model 1596 scope offers ±2% vertical accuracy and features 500-μV/division sensitivity to 70 MHz (cascade channel 1 to channel 2), 1 mV/division to 100 MHz, and 5 mV/division to 150 MHz. Waveforms are displayed on an 8×10-division (one division = 1 cm) rectangular CRT with internal graticule, scale illumination and 20-kV acceleration voltage.



In addition to standard A only, ALT, A-INT-B, B DLY'D sweep op-



eration, the scope features Dual mode in which A and B sweeps operate independently of each other. Two signals can be viewed in different sweep times in the Dual mode. Trigger modes include AUTO, NORM and Single Sweep operation. Other features include 20 ns/division sweep speed (2 ns/division with ×10 magnification); 20-MHz bandwidth limiter to eliminate high-frequency noises when viewing low-frequency signals; video sync circuitry for viewing video signals; channel-1 output to which a frequency counter or other peripheral device can be connected; and a beam finder. Functions are selected by LED-lighted, microprocessor-controlled pushbutton switches. Weight is 16.3 lbs. $2905.

CIRCLE NO. 130 ON FREE INFORMATION CARD

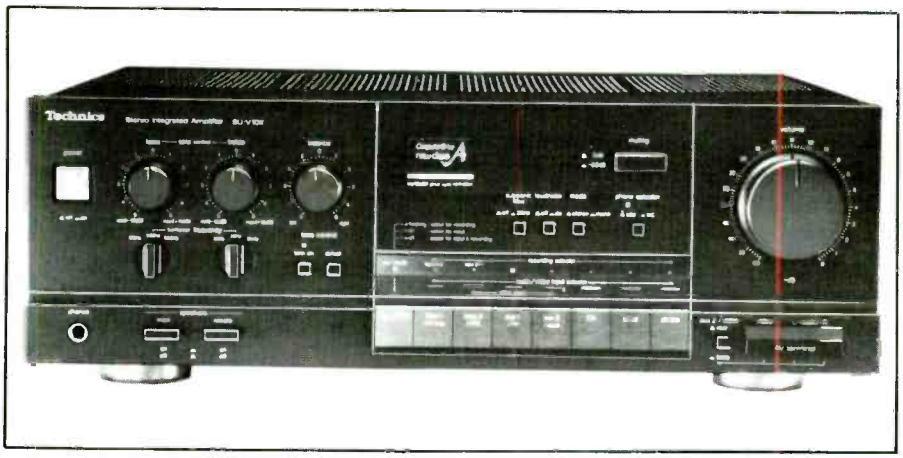
Audio/Video Hi-Fi Amplifier

Technics' new Model SU-V10X integrated stereo amplifier has been designed to meet the needs of modern digital audio and hi-fi video. Its constant-gain predriver, along with Computer Drive class-A circuitry and a power linear circuit, have been designed from the ground up, says the manufacturer. To avoid possible signal interference between sight and sound, the amplifier has separate audio and video circuit paths. In addition, two separate record selectors allow you to listen to the phono source while recording from another program source.

A total of seven audio inputs (phono, tuner, CD, TV/AUX 1, video/AUX 2, tape 1/DA tape, and tape 2/VTR) can be handled by the Model SU-V10X. The three video inputs, of course, are TV/AUX 1, video AUX2 and tape 2/VTR. With the video inputs, you get simultaneous audio/video signal switching capability. With video/AUX 2, there are sets of jacks on both the front and rear panels, allowing you to select one or the other for video dubbing and quick hookup of a portable deck. Other features include: low-noise FET MM/MC phono equalizer; turnover frequency selectors for the tone controls; external jacks for connection of a graphic equalizer or other accessory; subsonic filter; audio muting; tone-defeat switch; and a main and/or remote speaker selector.

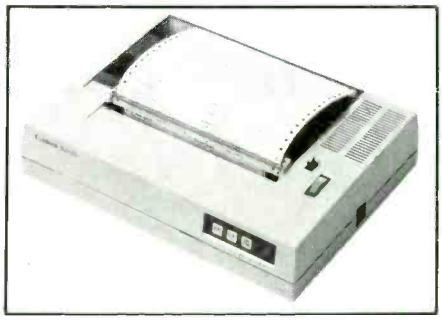
Output power from the amplifier is rated at 120 watts/channel continuous rms into 8 ohms from 20 Hz to 20 kHz at no more than 0.003% THD. $600.

CIRCLE NO. 131 ON FREE INFORMATION CARD



Bubble-Jet Matrix Printer

High-speed low-noise printing are offered by Canon USA's new Model BJ-80 nonimpact Bubble-Jet Printer. The 80-character-per-line printer uses a 9×24-matrix printhead to hammer out copy at a speed of 220 cps in draft mode, while operating at a noise level of less than 45 dB. In the near-letter-quality mode, the printer shifts to an 18×24-matrix printhead format to produce high-density copy at a speed of 110 cps.



The compact, lightweight printer is compatible with the IBM PC and PC-compatible computers. It provides high-density graphics printing in addition to its condensed, enlarged and superscript/subscript character set. International character sets are optionally available. The printer uses black ink-jet cartridges and can accommodate both continuous fanfold and single-sheet paper. $599.

CIRCLE NO. 132 ON FREE INFORMATION CARD

Surface-Mount Test Clip

A P Products has introduced a new surface-mount test clip that addresses the problems of other such fixtures for testing plastic leaded chip carrier (PLCC) ICs. The 20-conductor size test clip features an innovative action wedge design that enables all four sides of the test clip to open simultaneously to provide saf-

(Continued on page 86)

Train for the Fastest Growing Job Skill in America

Only NRI teaches you to service and repair all computers as you build your own 16-bit IBM-compatible micro

As computers move into offices and homes by the millions, the demand for trained computer service technicians surges forward. The Department of Labor estimates that computer service jobs will actually *double* in the next ten years—a faster growth than any other occupation.

Total System Training

As an NRI student, you'll get total hands-on training as you actually build your own Sanyo MBC-550-2 computer from the keyboard up. Only a person who knows *all* the underlying fundamentals can cope with *all* the significant brands of computers. And as an NRI graduate, you'll possess the up-to-the-minute combination of theory and practical experience that will lead you to success on the job.

You learn at your own convenience, in your own home, at your own comfortable pace. Without classroom pressures, without rigid night-school schedules, without wasted time. Your own personal NRI instructor and NRI's complete technical staff will answer your questions, give you guidance and special help whenever you may need it.

New from NRI—the only home study course that trains you as you assemble a top-brand computer!

After you construct this digital logic probe, you'll install the "intelligent" Sanyo detached keyboard, with its dedicated microprocessor.

You next assemble the power supply into the main unit of the computer. Using the digital multimeter, you check all keyboard connections and circuits.

After you install the disk drive and monitor, you'll make a backup copy of the MS-DOS operating disk, explore the 8088 microchip and additional circuits.

The Exciting Sanyo MBC-550-2—Yours To Keep

Critics hail the new Sanyo as the "most intriguing" of all the IBM-PC compatible computers. It uses the same 8088 microprocessor as the IBM-PC and the MS/DOS operating system. So, you'll be able to choose thousands of off-the-shelf software programs to run on your completed Sanyo.

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How the pro computer critics rate the Sanyo 550:

"Sanyo BASIC is definitely superior to IBM Microsoft. . . lets you use two or three keystrokes for entering BASIC commands."

—MICROCOMPUTING Magazine

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"I went to have a look at the MBC-550. . . what I found made me an owner the next day!"

—Bill Sudbrink, BYTE Magazine

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Video

Magnavox Portable VCR System: Stereo Hi-Fi in a Small Package

Like some other companies in the onrushing videocassette recorder industry, Magnavox is also featuring a two-piece compact VHS portable that's equally at home for lightweight camera recording or stacked as an integrated unit for off-the-air recording or simple playback. Foremost among its many features is its ability to record and play back *audio* with high-fidelity quality, in either monophonic or stereo modes. Moreover, it uses standard-size video cassettes, permitting as much as 8 hours recording time.

Called a 4-head VCR, it's actually an 8-head machine if you count the two audio heads that are on the spinning drum with the video heads and the two stationary heads for "standard" VCR audio and erase purposes. The spinning audio heads are used as part of the VHS Hi-Fi system, which is an audio frequency modulation format that enables the machine to be used as an audio-only stereo hi-fi tape machine as well as a video/audio unit. (See *Modern Electronics*, Oct. 1984, for a description of how VHS Hi-Fi works).

The new design greatly reduces the tabletop space required for the VCR by piggybacking the sections instead of connecting them side by side. Only finger pressure is needed to separate the battery-powered portable section from the ac-powered tuner section. Docked together, it measures only 14¼" L × 8¾" W × 4⅝" H, which is indeed a very small "footprint."

The system includes a wireless IR remote control, and a carrying strap is provided for use with the 7 lb. 10 oz. recorder (with supplied rechargeable battery pack). There's a premium charge for this very deluxe VCR, whose many outstanding features we'll soon discuss, which is a suggested retail price of $1,399.

Description

The pewter/black-colored plastic cabinet is smartly styled. Many controls are hidden behind flaps. The portable section's visible operating controls, such as Eject, Rewind, Search, Pause/Still, Play, Stop, FF Search, Slow, Record, Audio Dub, Reset, and Memory are all on the upper front panel, while Normal/Thin Tape, SP/LP/SLP speeds, Camera/Remote jack, Power Off/On, and Tracking and Slow Tracking, are on the lower part of the front panel. There's also an LCD readout window on the right that's blank without power.

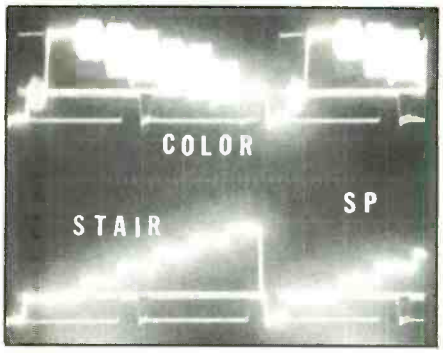
On the Recorder's left side are L and R microphone inputs, Phones, Video In/Outs, a Stereo/Mono switch, Ch. 3-4 TV selector, Video/Audio or Audio only switch, an Audio Mixing selector for audio-program dubbing, and an Audio Selector for TV or hi-fi earphones with a 10-pin camera receptacle adjacent. On top you will find a hi-fi identification lamp that lights for high-quality sound.

Fully current with newest technology, the 8-event, 14-day programmable tuner section features phase-locked loop feedback channel selection, AFC automatic fine tuning, and channel lock for memory auto programming. Magnavox also supplies a special chart for CATV channel selection, and desired channels may be placed in memory, along with those broadcast for a total of 139 U/V/CATV channels. Thereafter, they may be accessed sequentially by Up/Down tuning or selectively via direct address from on the remote.

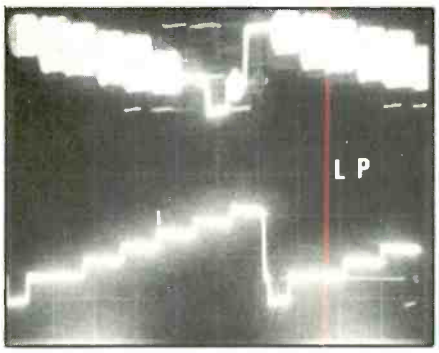
On the tuner's front are Up/Down channel buttons, Power, VCR/TV switches, and a green-glowing series of function readouts behind dark plastic. On the rear are battery charger and 5-pin auxiliary inputs, the latter to accommodate a separate battery pack charging cord, 300-ohm UHF inputs/outputs, as well as 75-ohm inputs and outputs for VHF. Below are an RCA-type video input and right-left audio inputs (but no baseband outputs).

Above these signal inputs and r-f outputs you will find under a small top panel a Dim/Brightness switch, Add/Erase memory buttons, On/Off Remote and TV/CATV slide switch for normal, superband or hyperband channels, in addition to a rotary-type switch with Normal or 12 special cable settings 2-13, just like VHF television, below "Pay TV."

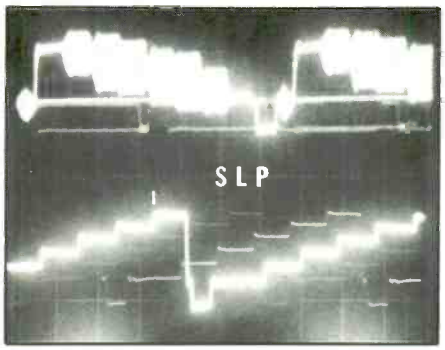
Supplied with Deck and Tuner is the wireless remote, VHF and UHF cables, a 300/75-ohm matching transformer, stereo line adapter, battery and charging cord, shoulder strap, audio output cable, earphone, and V-lock tool used to compensate for any vertical jitter. Optional



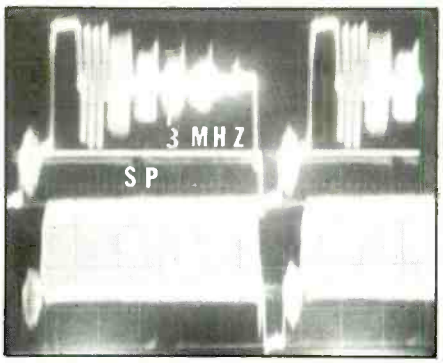
Standard play (SP) at baseband is always your best signal, as demonstrated by this oscilloscope trace photograph.



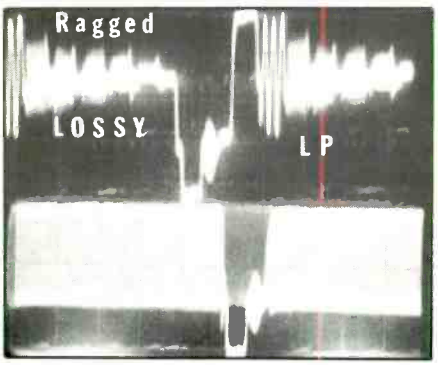
Long play (LP) is next in picture quality. It has just a bit more staircase overshoot.



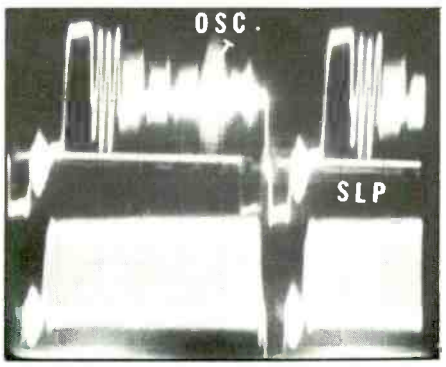
Super long play (SLP) increases staircase overshoot further, but doesn't disturb colors in this Magnavox VCR.



The multiburst (top) and red field (bottom), r-f in/baseband out, in SP mode are good for this or any other VCR.



In the LP mode, however, frequencies from 1.5 MHz and up begin to deteriorate and noise increases.



At SLP, even the 3.58-MHz subcarrier frequency oscillates. The red-field picks up some noise, as shown.

equipment includes automobile battery charge cord, recorder carrying case, and extra batteries that you'll want.

Operation

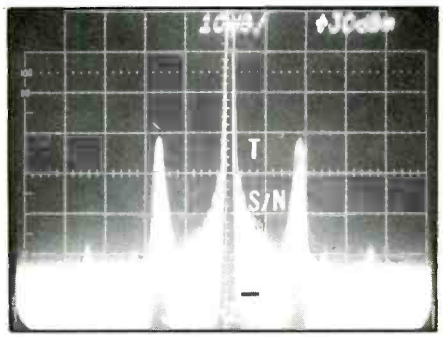
In the VR8486SL01 combined package, U/V/CATC recording pretty well follows the routine of any other VCR except that CATV channels must be chosen and compensated carefully. First check between channels 5 and 6, selecting whatever CATV NOR/HRC/IRC mode that produces the best picture. Then see if other cable channels are compatible also, leaving the Mode Selector in one position thereafter for all this particular system's CATV reception.

Clock and programmed time settings are routine for program number, day, time On and Off, and the particular channel number. Visual monitoring of play/record functions appear on a lighted CCD display on the Deck's upper right. But if you wish to operate manually without special timing, then 30-minute intervals up to four hours may be recorded by simply pushing the OTR orange button next to the timer for the desired number of half-hour segments. Underneath, the Tuner display glows with softly-lighted green alpha/numerics for time, day, and channel settings, plus any CATV and AFT engaged.

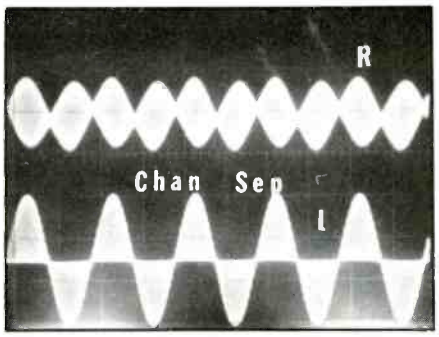
Considering the Deck (Recorder) by itself, however, is another matter altogether. For here must be taken into account the camera or tuner function, tape speed, electronic counter setting (with or without memory marks), audio/video or just audio, Ch. 3-4 output selection, 75 or 300-ohm U/V inputs, or cable, where only a single channel may be recorded according to setting.

Then there's a tape length indicator in 5-minute increments and a 0.00 flashing symbol for the final 5 minutes before tape's end. Fortunately, hi-fi or normal audio are automatically recorded; but for sound only, V/A must be switched to the A (audio) position when the VR8486SL01 records either hi-fi or lo-fi, including composite audio baseband output from a stereo radio tuner-amplifier.

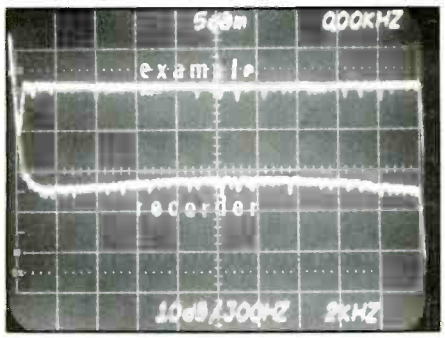
Camera recording is more involved since you may want to use audio or video dubbing, other sound tracks, mixed sounds, or recording of any other tapes. All this may be monitored through the TV receiver or on stereo earphones, with



There's no more than 1-dB difference between color bars and red field at baseband at SP mode.



Stereo separation between the left and right channels is an impressive 48 dB.



In its hi-fi mode, the Magnavox portable VCR displays excellent audio response all the way out to 20 kHz.

microphone inputs taking priority over audio or camera/sound inputs.

User Comments

This is an impressive little VCR package for video recordists who do a lot of recording on-the-run and also want all the features that a tabletop offers, such as timer programmability. More importantly, of course, is the desire to record and play back top-quality audio sound, which this Magnavox makes possible through its VHSHi-Fi system.

Its video signal-to-noise ratios appear closer to 39 dB than the 41-43 dB specified by its manufacturer. But it would be unlikely for a typical user to discern the difference. However, he or she will immediately be aware of the differences in sound quality when listening to audio that was recorded from a hi-fi source—the sound is superb! Recording a musical selection from a good FM stereo station, using a Luxman tuner, the video tape copy was indistinguishable from the tuner's direct playback. A top-notch stereo amplifier/speaker system was used for playback, of course.

Video quality suffers in the slowest speed, naturally, where higher-frequency video is impaired. But this fault, common with all VCRs, still enables one to record and view pictures with fair quality.

The LCD readout display isn't anywhere near as good as the more traditional lighted-segment ones, nor do the key controls have activity indicator lights. But this is a tradeoff for the mobility that battery power can give you.

In all, this is a neat VHS system that gives you great flexibility in a package that has reasonable weight for carrying around and small size when used for tabletop purposes. It also uses a full-size, long-recording-capability video cassette. Furthermore, the wireless remote control has a full complement of function keys, including numeric keys and TV channel up/down keys. It even features variable-speed slow-motion control, as well as "still" picture.

The system is a top choice for portable/home VCR use, but at its rather high price, the new 8-mm camcorders could challenge it in time if enough movie rental programs become available for the latter format.—*Stan Prentiss.*

CIRCLE NO. 177 ON FREE INFORMATION CARD

Magnavox Model VR8486SL01 Portable VCR

TV/tuner sensitivity	
vhf channels 3/10	−1/−2 dBmV
uhf channels 15/40	+1/−0 dBmV
Ac power drain	
record	24.96 Wrms
playback	24.48 Wrms
Tape times	
play (on time)	5 sec
stop (off time)	3 sec
fast-forward & rewind *execution* time	2 sec
record	3 sec
Horizontal resolution (r-f in, baseband out) max.	3 MHz (SP)
Audio response, L and R, VHS AFM	>>20 kHz
Stereo, R/L channel separation	48 dB
Wow/flutter (NAB at 2 KHz)	
SP (Avg/Peak)	0.005%/0.0125%
LP	0.0045%/0.125%
SLP	0.0035%/0.11%
Fast-forward/rewind times (120-min. tapes)	<4 minutes
Max. record/playback times (160-min. tapes) in SLP	8 hours
Heads:	
video	4 rotary
audio	3 (2 rotary, 1 sta.)

Test equipment: Tektronix Models 7L5 and 7L12 spectrum analyzers; Hameg Model HM605 oscilloscope; B&K-Precision Models 1260 NTSC color/multiburst, 3020 sweep-function, 2007 stereo generators, and 1035 wow and flutter meter; Sadelco Model FS-3D VU field strength meter; Data Precision Model 945 multimeter; Sencore Model VA48 video analyst (modified); Kodak T-120 HGX VC tape; and RCA Model VGM2023S TV receiver monitor.

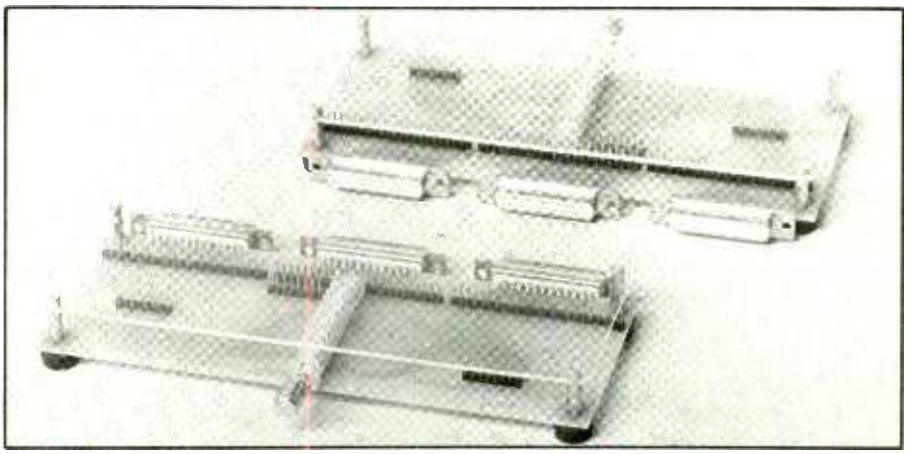
Computers

RS-232 Switches

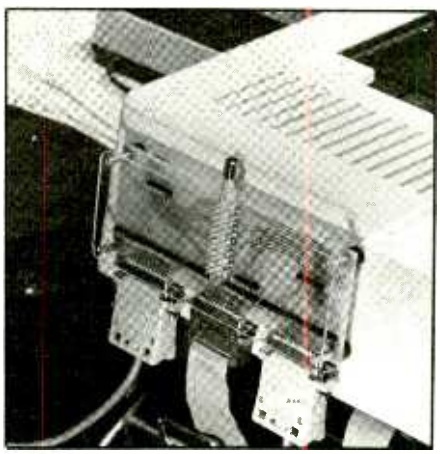
If you've ever hooked up a serial-interfaced device to a computer, especially a printer, you know what a hassle it can be. This isn't surprising when you realize that the venerable RS-232C standard for serial interfacing wasn't set up for printers and many other peripherals with connection to a computer's input/output ports in mind. Consequently, you can never be sure which connector pins the manufacturer selected to do what signal or control chore. To make the interconnected equipment work properly, you often have to buy special, costly cables/connectors or try to modify connections yourself.

The latter course is often taken for reasons of time. This led to development of a number of devices to simplify this work. First came the simple breakout box with 25 interconnecting leads (to match a connector's common DB-25 pins) that could be disconnected and cross-connected by moving jumper wires to different terminal sockets. LEDs between data terminal equipment and data transmission equipment indicates signal activity on a respective line. Once proper pin connections are known, you can fabricate a custom cable or modify a DB-25's connections.

More convenient devices are permanently connected fixtures that eliminate the need to modify cable connections. Two varieties are examined here: user-configurable 8-pole A-B switches and a "smart" RS-232 switch that makes proper connections automatically.



HackerSwitch-2 uses open construction and terminal posts.



HackerSwitch mounted on a printer.

Configurable RS-232 Switches

The pair of configurable switches we discuss both feature 8 poles and A-B switching. This combines the capability to custom-configure serial input and output wiring with the convenience of accommodating more than one peripheral (say, both dot-matrix and a formed-character letter-quality printers).

The HackerSwitch 2 from Litek (Grants Pass, OR 97526) is a $59.95 assembled switch that is really for the computer hacker. It consists of three DB-25 female connectors, an 8-pole double-throw in-out push switch, and a series of wire-wrap terminal strips, all soldered to a double-sided 7½" × 3" printed-circuit board. Four posts and screws support a clear plastic cover and four rubber feet.

Two thick, double-sided adhesive-backed foam strips are provided for mounting the HackerSwitch 2 on the side of your printer or computer, or on a wall, with the connectors facing down and the switch pointing up.

All connector pins (except #1) are brought to the wire-wrap terminals by circuit traces. The eight wires most commonly used with RS-232C interfacing (#2-#8 and #20) are routed through the switch. All #1 pins (equipment ground) are wired together and to PC board holes. Although #7 is always signal ground, it is one of the switched lines.

Custom configuration is provided by simply cutting the traces as required and using wire jumpers between terminal pins. These wire jumpers can be soldered or wire-wrapped.

For example, to swap wires #2 and #3, usually required for serial interfacing a printer with a terminal or computer, you cut the common (center connector) #2 and #3 traces, and use wire jumpers between their terminals. If you ever want to switch back, just change the jumpers.

If you only want to change an output connector, you can do that. The whole idea is that any of the three connectors can be configured any way you like, with up to eight lines switched.

The postion of the pushbutton switch determines which outside connector is wired to the center connector. Unfortunately, this is not clearly represented on the unit itself. For one thing, when the switch is mounted switch-up/cables-down (the only logical way to mount the HackerSwitch), all printed-circuit board legends are upside down.

The words IN and OUT, printed in large letters on the pc board, could refer to the connectors—a natural terminology for signals. Not so. Instead they refer to the switch position. Pushing the switch IN connects the center connector to the connector nearest the word IN on the pc board. Similarly, when the switch is in the OUT position, the connector nearest the word OUT on the PC board is connected to the center connector. To add to the confusion, it is not readily apparent to the eye when the switch is IN or OUT, since only about a quarter-inch movement is involved, and there is no close reference

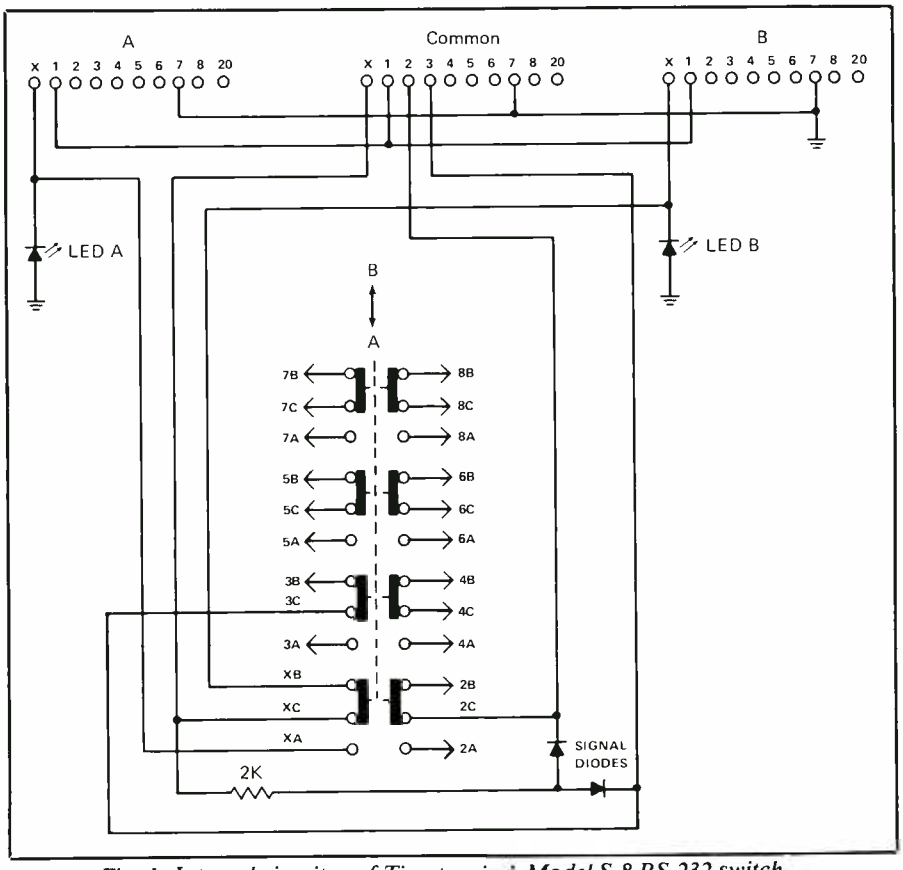


Fig. 1. Internal circuitry of Tigertronics' Model S-8 RS-232 switch.

Tigertronics Model S-8.

surface. Nonetheless, these are minor complaints. The device does its job well at a reasonable cost. Should you need to configure and switch more than two outputs, there's a HackerSwitch 3 at $79.95 that switches one device between three other devices.

When I first saw the HackerSwitch 2 I was impressed with its simplicity and cleverness. A good idea, easily accepted by a typical hardware-oriented computerist with no fear of soldering or wire-wrapping. Then I discovered the Tigertronics Model S-8—the same idea, but implemented for the no-dirty-hands crowd.

The Model S-8 RS232 Switch (Tigertronics, Inc., 2734-C Johnson Drive, Ventura, CA 93006) is available assembled for $79.95 or in kit form (Model S-8K) for $59.95. (Add $3 S and H; and 6% Sales Tax for California residents.)

This design is completely enclosed in a solid, two-part 5″ × 5¼″ × 2¼″ tan plastic cabinet with four rubber feet.

Two red LED's on the front panel, marked A and B, tell the user which switch position is active. These are driven from some clever internal circuitry (Fig. 1) that lights the switched LED using the lower voltage of either pin #2 or #3. Additionally, the in-out push switch has a large black cap, and its position in relation to the front panel is clearly shown with symbols for the A and B positions.

The back panel clearly marks the three DB-25 female connectors as COM., A, and B. There is absolutely no confusion.

Remove two screws from the bottom of the cabinet of the assembled unit and the top-half slips right off to reveal a square double-sided pc board held down with four screws. The switch is identical to the switch used on the HackerSwitch 2. Two diodes and a resistor are used with the two LED's. Twenty-seven yellow wires (nine for each of the three DB-25 connectors) are soldered to the pc board and inserted into the connectors. But there are no wire-terminal blocks!

"Hmmmm", you say, "I thought this was configurable?" It is but without cutting traces or soldering. The connector wires can be removed and replaced with a special tool supplied with the Model S-8 (or Model S-8K).

Each wire has a special pin on its end. This pin, when inserted into any connector socket from the back, locks into position, but can be removed with the extractor tool. You place the extractor tool around the wire you wish to remove and press into the face of that pin with a paper clip while you pull on the extractor from the back. It takes very little practice to remove a pin from any connector position and insert it into another. Swapping pins #2 and #3, a common requirement, takes less than a minute.

Pins #1 are connected together, and not switched. Pins #7, signal ground, are all connected to the ground foil of the pc board, and are not switched. Pins #2, 3, 4, 5, 6, 8, and 20, and the LED's, are switched. This unit is more sophisticated than the HackerSwitch model, but it is $20 more costly.

You can save $20, however, by assembling the kit version. This essentially involves soldering the 24-pin switch, 2 LED's, two diodes, one resistor, and 27 wires to the pc board. You then use screws to mount the three connectors to the rear panel, insert the LED's into small holders on the front panel, screw down the pc board to the cabinet bottom, insert the

(Continued on page 93)

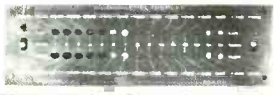
PINECOM INTERNATIONAL, INC.

12603 CRENSHAW BOULEVARD•HAWTHORNE, CALIFORNIA 90250•(213) 679-9999

MARK IV — 15 STEP LED POWER LEVEL INDICATOR KIT

This new stereo indicator kit consists of 36 4-color LED's (15 per channel) to indicate the sound level output of your amplifier from – 36dB to + 3dB. Comes with a well designed silk screen printed plastic panel and has a selector switch to allow floating or gradual output indicating. Power supply is 6-12VDC with THG on board input sensitivity controls. This unit can work with any amplifier from 1W to 200W. Kit includes 70 pcs driver transistors, 38 pcs matched 4-color LED's, all electronic components, PC board and front panel.

MARK IV KIT $31.50



20 STEPS BAR/DOT AUDIO LEVEL DISPLAY KIT

This new designed audio level display unit is using a new integrated circuit from National Semiconductor to drive 20 pieces of color LED's (green, yellow and red) on each channel. It provides two types of display methods for selection 'bar' or 'dot'. The display range is from – 57dB to 0dB. Kit is good for any amplifier from 2 watts to 200 watts! Power supply requires 12VAC or DC. So it is great for cars as well! Kit comes with printed circuit board, all LED's, electronic components, switches, and silk screen printed professional front panel.

MODEL TY-45 $38.50

0-15 VOLT 2AMP REGULATED POWER SUPPLY KIT

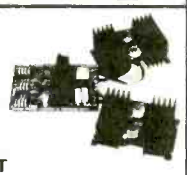
This is a professional power supply kit. Output voltage adjustable from 0-15VDC. Output current also can be limited to two range sections such as 200mA and 2A. An elaborated protection system also designed to give out a beeping sound and a flashing LED warning will appear when output was over loaded or short circuited. High stability and reliability resulting from employing a high quality voltage regulator IC. The front panel of the power supply is well designed with output terminals, on/off switch, voltage adjusting control, jumbo size meter for reading both AMPs and VOLTs. Also with a volt/amp switch as well as current limit select switch. Kit comes with refined metal case, silver color with sand brushed front panel, all electronic parts, pc board, 3" jumbo size meter, transformer, circuit diagram and instructions.

TR-100 KIT

$59.50

TA-1000 KIT $51.95

Power Transformer $24.00 ea.



100W CLASS A POWER AMP KIT

Dynamic Bias Class "A" circuit design makes this unit unique in its class. Crystal clear, 100 watts power output will satisfy the most picky fans. A perfect combination with the TA-1020 low TIM stereo preamp.

Specifications • Output power 100W RMS into 8Ω 125W RMS into 4Ω • Frequency response 10Hz-100KHz • THD less than 0.01% • S/N ratio better than 80dB • Input sensitivity 1V max. • Power supply ±40V at 5A.

LOW TIM DC STEREO PRE-AMP KIT TA-2800

Incorporates brand-new DC design that gives a frequency response from 0-100KHz ±0.5dB. Added features like tone defeat and loudness control let you tailor your own frequency supplies to eliminate power fluctuations!

Specifications: ● THD/TIM less than .005% ● Frequency response DC to 100KHz ±0.5dB ● RIAA deviation ±0.2dB ● S/N ratio better than 70dB ● Sensitivity; Phone 2mV 47KΩ, Aux 100mV 100KΩ ● Output level 1.3V ● Max output 15V ● Tone controls; Bass ±10dB @ 50Hz, Treble ±10dB @ 15Hz ● Power supply ±24VDC @ 0.5A. Kit comes with regulated power supply. All you need is a 48VCT transformer @ 0.5A.

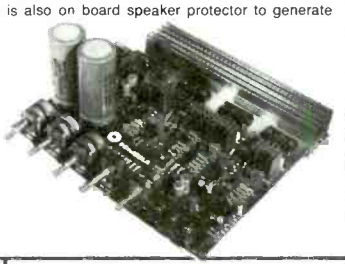
Only $44.50

Transformer $4.50 ea.

80W + 80W STEREO AMPLIFIER KIT

PRE-AMP — TONE CONTROLS — POWER AMP

TA-800 is an 80 watts + 80 watts stereo. The Low T.I.M. preamplifier employs a low distortion linear I.C. (LM4558) and three negative type tone controls for High, Medium and Low frequency control. The rear power amplifier uses newly developed high frequency darlington hybrid type transistors (AN7337/AN7338) in a push-pull circuit. There is also on board speaker protector to generate a delay time between the speakers and the amplifier. Large aluminum heat sink, which is mounted on pc board, requires no external hookup wires. The kit comes with instructions, all electronic parts, predrilled pc board, and heat sinks. Power transformer not included. Easy to build, guaranteed to work.



TA-800 KIT

$65.00

Transformer (52VCT 4A) **$22.50**

DISCO LIGHT ORGAN KIT

The TY-23B Color Light Organ is designed for use at home, party, disco or commercial advertisement purpose. It gives you the moving light effect coordinated with the frequency of the music changes. When music or an audio signal input is fed into this unit, it will be divided into High, Medium and Low frequency by means of an electronic equalizer circuit to drive three groups of light bulbs. Each group of lights has an independant sensitivity control.

Besides working as a Color Light Organ, the TY-23B also can be used in "Light Chaser" mode to perform light effects for signs as follows: (1) Switch on one after the other. (2) Flashes all together. (3) Switch off one after the other. Flashing rate can be controlled. The output power of this unit is 3,000 watts (110V) which is 30 100 watt color spot lights or 600 5 watt light bulbs. Build one of these color organs today and enjoy watching your music. Great for school projects! All electronic parts, metal case, predrilled pc board and instructions come with kit.

TY-23B DISCO LIGHT ORGAN KIT $64.50

★ SPECIAL ★
Excellent Price!
Model 001-0034
$29.50 per Kit
Transformer $10.50 ea.

TA-322 30 WATTS TOTAL 15W + 15W STEREO AMP KIT

This is a solid state all transistor circuitry with on board stereo pre-amp for most microphone or phone input. Power output employs a heavy duty Power Hybrid IC. Four built on board controls for, volume, balance, treble and bass. Power supply requires 48VCT 2.5A transformer. THD of less than 0.1% between 100Hz-10KHz at full power (15 Watts + 15 Watts loaded into 8Ω).

60W + 60W O.T.L. AMP

Stereo pre-amp + tone control + power amp. All in on unit, fully assembled! Compact in size: 7"x4¾"x2½". Can be fitted into most cabinets. Power transistors using 2SC1667 X 4 to give a max output of 60W + 60W (8Ω)

• Frequency response: 20Hz–85KHz(–1dB) • Total harmonic distortion: 0.02% (1KHz) • Signal/Noise Ratio: 88 dB (open loop) • Tone control: 100 Hz ± 16 dB 10 KHz ± 14dB • Dynamic range: 60 dB • Power Supply: 48V–70V 5 Amp. • Filter Capacitor: 4700 μ 75V or better.

MODEL: SA-4520

Part #370-0350 . . . . . $39.95 ea.
1 Transformer Part #670-0230 . . . $22.50 ea.
2 Filter Capacitor 4700μF 70V $6.50 ea.

MAGNETIC HEAD EQUALIZER

• Standard RIAA curve for all kinds of magnetic heads • 3 stages crossover circuit for best results • Output voltage guaranteed to be stable without any oscillation • Power Supply: 24 V.D.C.

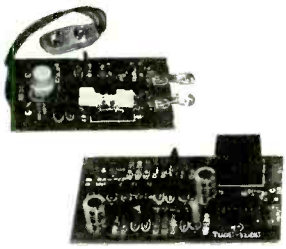
MODEL: MA-142
Part #370-370 . . . . . $6.95 ea.

STEREO MIC. AND ECHO MIXER FOR STEREO AMPLIFIER SYSTEM

The circuitry employs all integrated circuits, BBD type echo circuit, echo time can be adjusted (max. 30 Msec.) Also with a microphone preamp on the board. Fully assembled.

MODEL: MX205
Part #370-0360 . . . . . $29.95 ea.

TY-41 INFRA-RED REMOTE SWITCH KIT



This infra-red remote control switch kit is suitable for many kinds of electrical and electronic applications, such as light controller, garage door opener, TV on/off, alarm system and many others. It does not use any antenna to transmit the signal, but it transmits an invisable light signal so the receiver can pick it up as far as 30 ft. away. Kit comes with all electronic components, pc board, relay and the infra-red LED.

TY-41 INFRA-RED SWITCH KIT $23.50

DIGITAL PANEL METER KIT

3½ Digit Multi-Use Danel Meter. The TY-43 digital panel meter kit using the IC 7107 A/D converter from Intersil is a principal component which direct drives a 16mm high 3½ digit LED display. The unit needs very few external components and is extremely easy to assemble and adjust. You can produce various kinds of voltage, current and resistance measuring meters, by adding a limited number of components, you can even change it into a thermometer, frequency counter and capacitor meter. (Application Circuit diagrams enclosed with kit).

Input sensitivity is DC ± 199.9MV full scale
Input impedance is 10^{12} ohms
Operating source is 5 - 6VDC @ 150MA
Overall size: 1½" x 4"

TY-43 DIGITAL PANEL METER KIT $31.50

0-30VDC POWER SUPPLY KIT

This kit includes a high efficency regulating circuitry. By using the IC 723 and darlington power transistor to provide a stable and ripple free DC voltage from 0 - 30 volts at 3 amps or 0 - 15 volts at 5 amps (depends on the power transformer used, not included with kit). Overload and short circuit protection also featured on this kit. Easy to build! Guaranteed to work! All electronic parts, pc board, heat sink for power transistor, instructions included.

TR-355 POWER SUPPLY KIT $14.50

24VCT Transformer (for 0-30V) $10.50

LOW T.I.M. TRANSISTORS 100W + 100W

• Employs Hitachi low noise I.C. for pre-amp • Max. output 16 V P-P (non distortion) • With hi-low filter, and tone defeat circuit • Rear power amp with short circuit protection • Giant heat sink for maximum results • Tone controls ±14dB • All components (except pots for volume, and tone controls) are pre-assembled, the quality is guaranteed. • Power supply DC ± 35V-50V

MODEL: SA802C
Part #370-0340 . . . . . $85.00

POWER TRANSFORMER (68V-80V CT 6 AMP)
Part #670-0220 . . . . . $24.50

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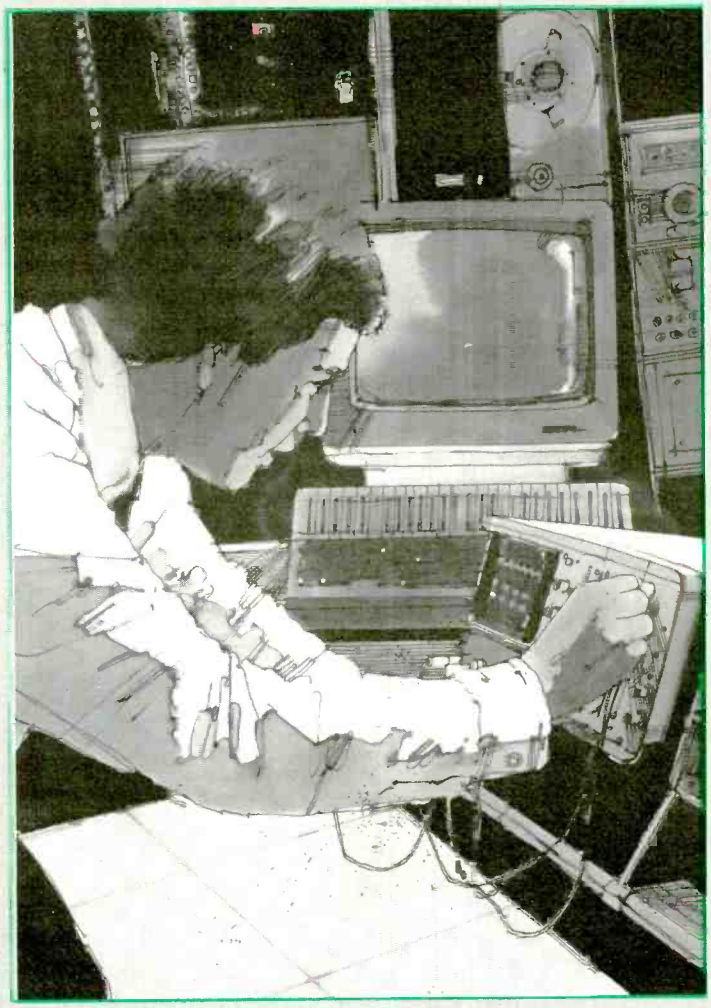

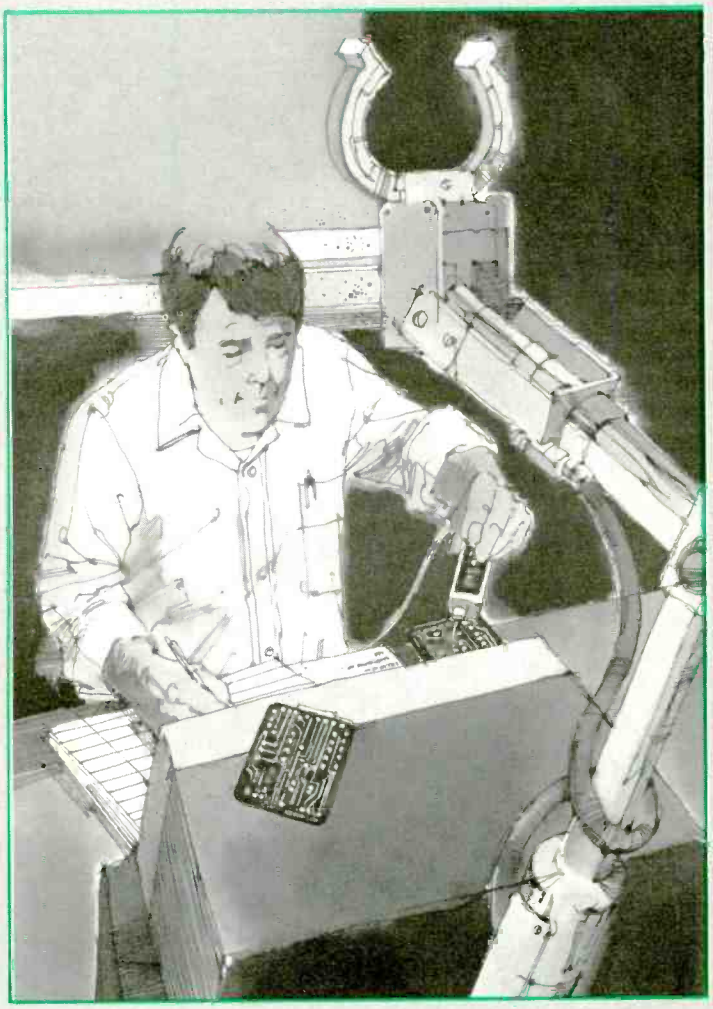

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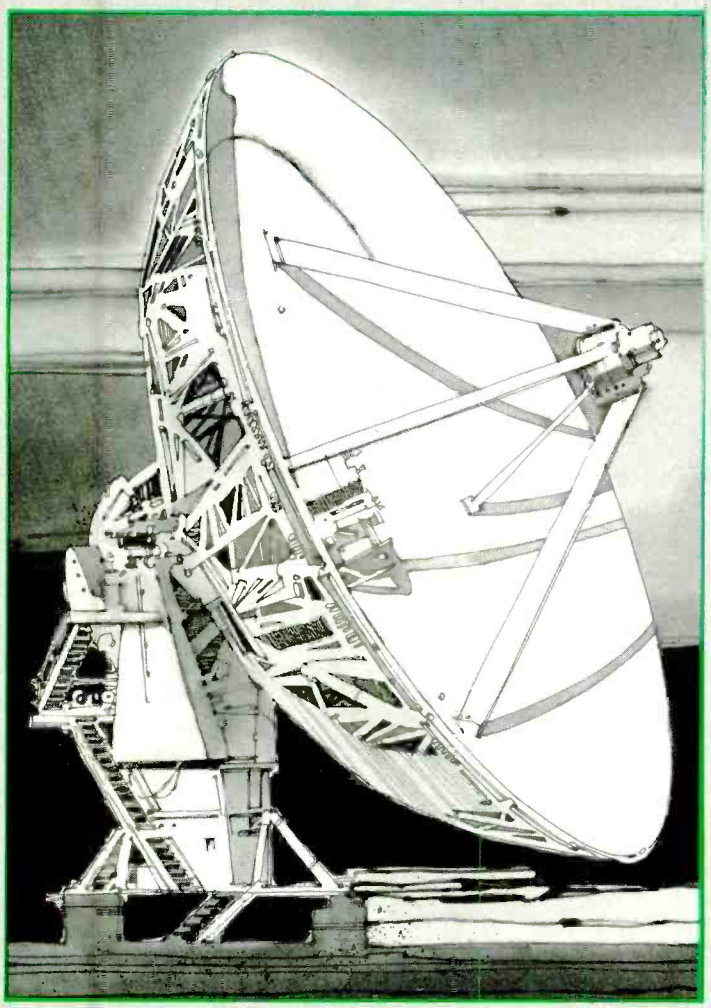

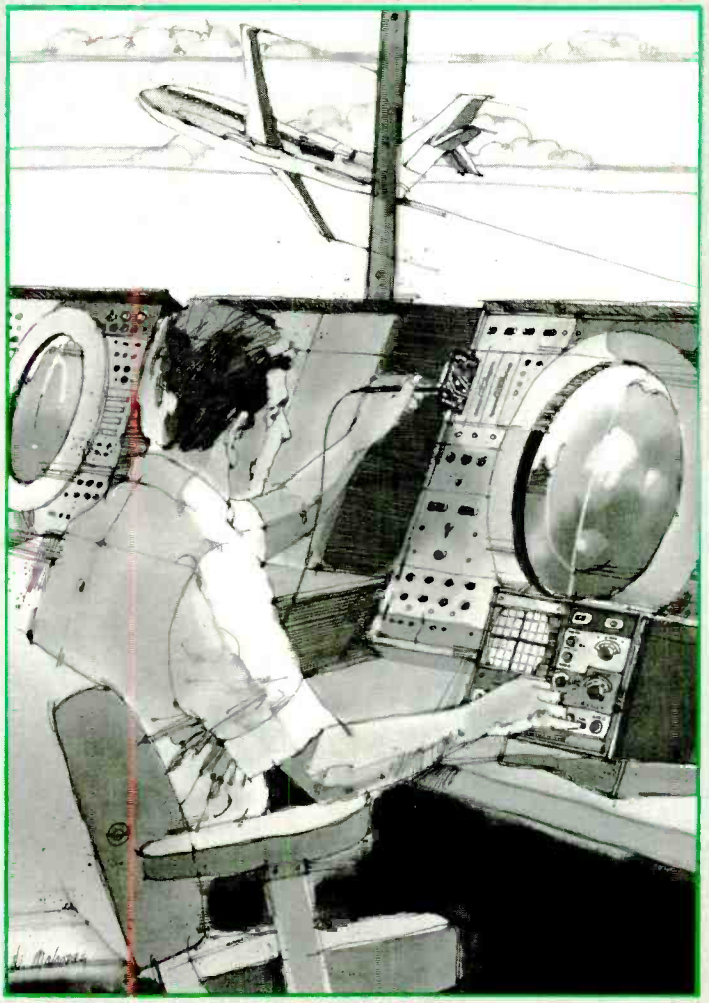

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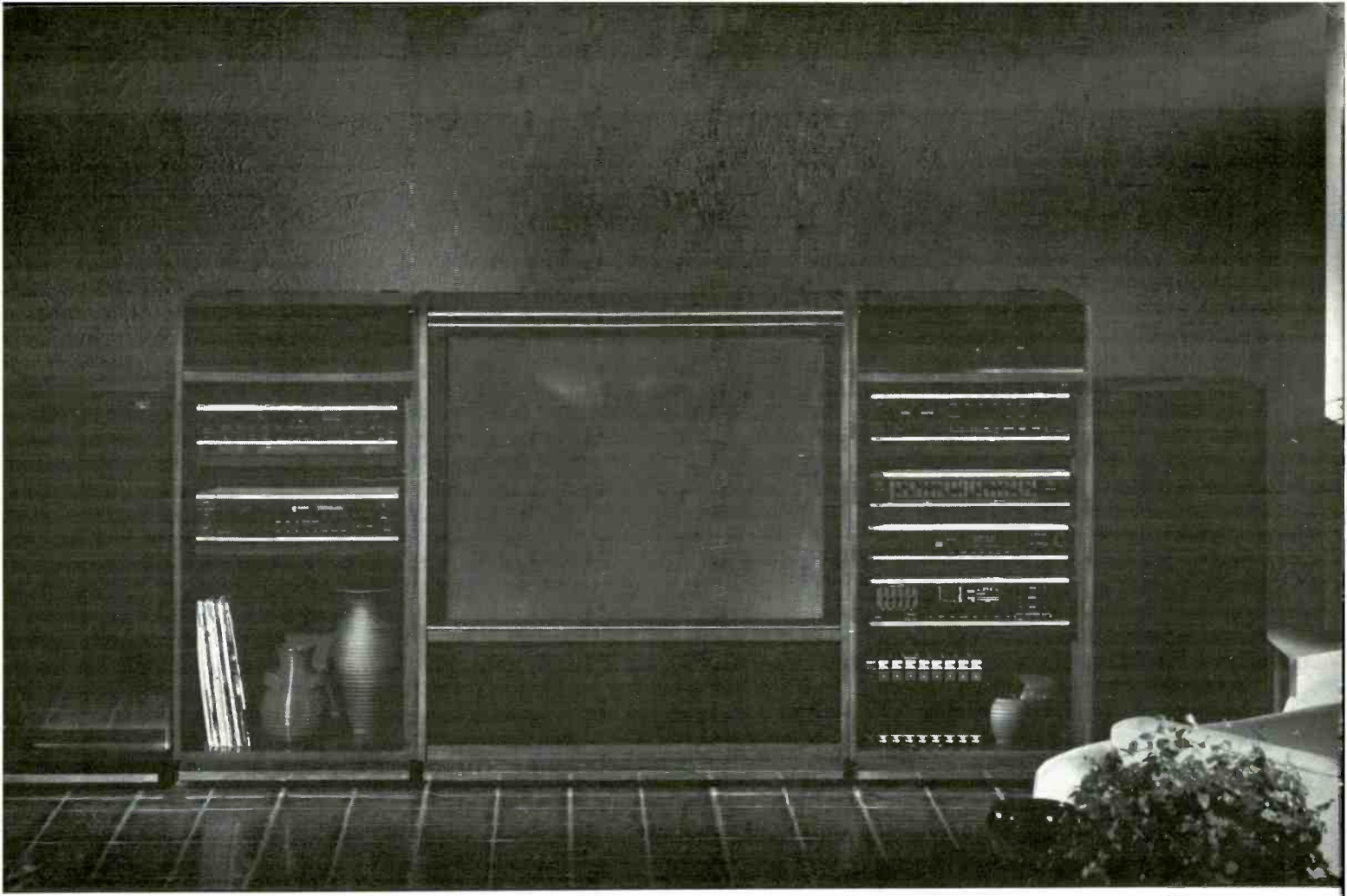


RCA's latest "Dimensia" A/V system now has a 40"-screen projection TV/Monitor with microprocessor intelligence.

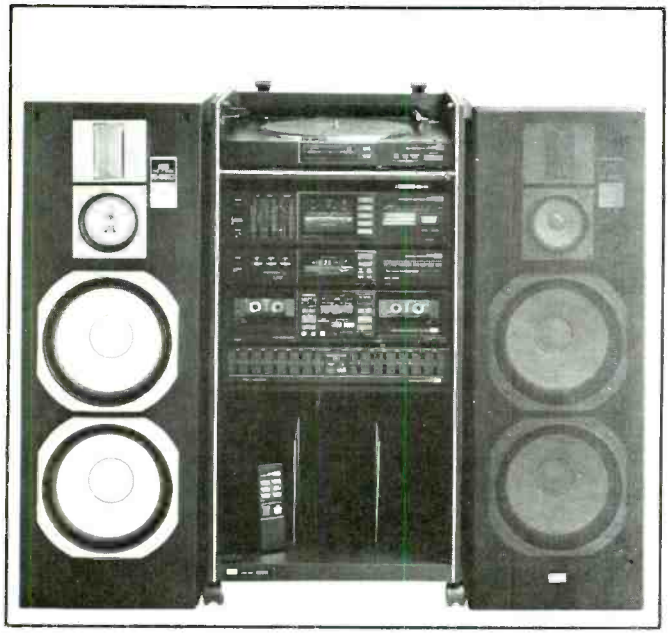
Audio and Video In Your Future

. . . As foretold at the 1985 Summer Consumer Electronics Show

By Len Feldman

As usual, the recently concluded Summer Consumer Electronics show, held on the shores of Lake Michigan in Chicago, was the "biggest" and had the "highest attendance ever." Of greater interest to most of us, though, is not so much the health of the electronics industry as the wealth of new products shown by more than 1300 exhibitors. These are the models you'll soon be seeing in stores. The star categories of the show were, without a doubt, audio and video. Futhermore, integration of audio and video products seemed more complete than ever before, as one company after another continued to echo that frequently overused phrase—"The marriage of audio and video."

There's always a large room at the show dedicated to the most innovative and original new products. A panel of judges, including myself, was given nearly 500 entries from which to choose the products for this special exhibit within an exhibit. We ended up selecting more than 150 of them, which were displayed in this tasetefully furnished room designated as the Design and Engineering Award display. More than 70 of the



Technics' SL-XP7 portable CD player is now "Smallest CD Player" and adds 15-selection programmability.

Sansui's one-brand, remote-control system has twin three-way tower speakers.

items seen in that room were audio related, while nearly 50 more had to do with home video. From this vast array of new and exciting audio and video products I've chosen just a few that particularly attracted my attention. Not all of the exciting products ended up in this special exhibit. Some had to be ferreted out by touring such out-of-the-way places as private hospitality suites in far-flung hotels. Others were to be founded in smaller exhibits relegated to hotels which were part of the show, but were geographically removed from it.

Audio/Video Systems

The all-in-one audio/video system is here, and in the months ahead you will see more and more of them. Furthermore, A/V systems have a great deal going for them. Call it synergy or whatever you like, but when one manufacturer has total control over all of the elements of a home entertainment system, that maker can provide the user with convenience features that are generally appealing. For example, being able to work with a single, hand-held wireless remote control and have *all* of your video and audio components respond to commands initiated from that single device could not be easily accomplished with separate components assembled by you.

The first, and perhaps most comprehensive audio/video system, was introduced by RCA last September. RCA calls its Dimensia system "Intelligent" Audio Video. The key to the system is the color monitor/receiver, with its multi-function built-in microprocessors and the single wireless remote control that commands all seven components within the system. With this single instrument, you can control all VCR programming, playing and recording functions. All controls of all the other components are also accessed by means of this single remote unit. All audio components operate independent of the video components; all volume levels, all stations selections, all channels are easily selected by the single "control center."

The user can even perform multiple functions simultaneously. For instance, you could record a broadcast TV channel on the VCR while recording an album on the stereo cassette deck, and at the same time watch a completely different TV broadcast channel. While the system can be sold in its entirety, it can also be assembled by the user a few components at a time. The 26″ monitor/receiver must be the first component, of course, since it is the one that comes with the ingenious wireless remote control center. Other component options that make up the system include a VHS HiFi VCR, an integrated amplifier, an AM/FM tuner, an audio cassette deck, a linear-tracking turntable, a CD player, and a pair of loudspeakers.

One of the most innovative high-tech features of the Dimensia system is the 26″ monitor's display, which keeps the user informed of every component's status. This display will even provide simple, easy-to-understand instruction for performing the various component functions. Interconnection of the various components is extremely simple, employing a sort of daisy-chain arrangement that RCA calls SystemLink.

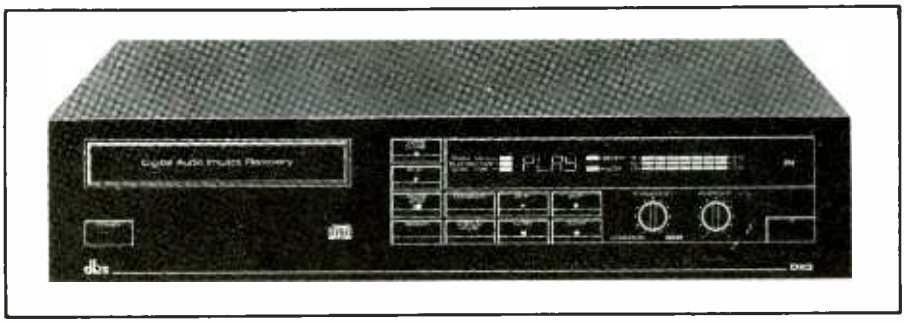
Flexibility of the RCA "Dimensia" system extends beyond its remote control and interactive functions. The components can be arranged in either double or triple cabinet setups.

A second-generation version of Dimensia at the Show gives you the option of a 40" (measured diagonally) rear-projection TV monitor/receiver instead of the 26" direct-view TV set offered with the original "Dimensia" system. The second Dimensia system also offers an optional ten-band graphic equalizer and a more powerful integrated amplifier (100 watts per channel instead of 50).

Just about every other major exhibitor at the show had one or more complete audio/video systems on hand. Some of the more noteworthy came from such well known audio companies as Pioneer and Technics, with video-oriented companies such as Sanyo and Panasonic offering a variety of A/V system as well.

While not offering one-brand systems in the conventional sense, Kyocera showed three new components (a 100-watt receiver, a cassette deck and a CD player), each of which can be remotely controlled using the same remote hand-held unit by connecting the components themselves to a remote sensing unit. This arrangement even permits multi-room remote control. Other companies showing single audio components that can be remotely controlled included Luxman, Parasound, Yamaha, and Sansui, while NEC displayed a new A/V amplifier/control center with a wireless remote.

If audio/video and one-brand audio system took center stage at CES, that's not to say that many outstanding individual components weren't just as newsworthy and spectacular. Perhaps the most outstanding individual audio component introduced at the show was Technics' remarkable new portable CD player. Clearly snatching the "World's Smallest CD Player" title away from Sony Corporation, the tiny Model SL-XP7 obviously represents a case of "one upsmanship" against the earlier-introduced Sony D-5. The Technics CD player is not only smaller than the Sony unit (20% smaller outside its battery case, 40% smaller when housed in the battery charger/case compared to the Sony unit similarly configured), but it offers 15-selection random programmability plus display features not found on the Sony D-5. Its resistance to shock is also said to be superior to that of the Sony unit. The Technics player measures just under 5" wide by 1¼" high by under 5" deep.



The dbx DX3 CD player uses unique enhancement circuits to improve sound.

The most unusual table-top CD player introduced at the SCES was one from dbx. The dbx Model DX3 is aptly named, since it offers three special features not found on other CD players. The first of these is a special compression circuit. Many listeners of CDs have noted that there are situations in which the dynamic range of some CDs is too great to be enjoyed. For example, in an atmosphere where ambient noise levels are relatively high (e.g., inside your car or in a noisy residential setting), if you turn up the volume on your system so that you can hear the very quietest passages on some CDs, the loud passage that comes along will either blast you out of your seat or else they will overload your system's amplifier. Having a built-in, switchable compressor means that you can listen to Compact Discs at background music levels without loss of quiet passages. Also, you can make compressed cassettes for car stereo systems and personal portable using the Compressor feature.

A second feature of the dbx CD player is "DAIR," which stands for Digital Audio Impact Recovery, a circuit for adding impact to the transient attacks of music. This circuit was especially redesigned for the digital era.

Ambience control is the third "extra" found in the dbx DX3. Many audiophiles have maintained that some CDs sound better with an increase in out-of-phase, L-R information. The Ambience circuit allows users to either increase this component, essentially enlarging the stereo image, or to decrease it when tighter musical imaging is desired.

Another entry from dbx was a lower-priced version of its Soundfield One speaker system. The Soundfield Ten, like its predecessor, allows a listener to sit almost anywhere in the listening room without losing balanced, accurate stereo reproduction. The system expected to sell for about half the price of the earlier Soundfield One, comes with an outboard controller that has high and low frequency compensation controls, an ambience circuit for added spaciousness and a "wall EQ" switch that compensates for the effect that against-the-wall placement has on loudspeakers.

Digital Audio Via Video

It is no secret that a large committee of engineers and scientists has been at work for several years trying to agree

upon a standard for consumer digital audio tape recording. Of course, it has been possible for several years to use a VCR in conjunction with a PCM Processor to record digital audio on video tape, but many have objected to this two-component approach to digital tape recording. A dedicated system for digital audio tape recording, popularly known as DAT, has been long in coming. In fact, such standards, though almost ready for public disclosure, have still not been announced. It was therefore much to everyone's surprise that a totally unrelated digital audio tape recording system was shown at the CES by Kodak and, in a suite removed from the show, by Sony.

The surprising aspect of this disclosure was the fact that the recorders used for the new digital audio tape recording system were VCRs after all. But instead of using ½" videotape, these tiny machines used the new 8 millimeter video tape package. The 8-mm system standardized a few years ago made provision for stereo PCM (digital) audio tracks along with video pictures, and indeed the machines demonstrated by Sony and Kodak at CES were, for the first time, able to record digital stereo sound tracks along with a much improved 8-mm video picture.

But that's not the big surprise. In addition to the new video-plus-PCM-audio recording capability, Sony's newest home 8-mm deck is also able to record six pairs of stereo tracks, sequentially, using a digital PCM recording format. Since two-hour 8-mm tape cassettes are now a reality (only 90-minute tapes had been available), that means a potential audio recording time of six times two hours, or twelve hours all together! And as if that weren't enough, Sony's unit offers a slower speed (aptly dubbed LP) that increases recording time to four hours per tape. So, if you use that tape for audio-only PCM (digital recording) you can record 24 continuous hours on a single cassette that's not much larger than a standard audio cassette. The Kodak version of the home 8-mm VCR has only the one speed and you must therefore settle for a total of "only" 12 hours of audio-only PCM recording.

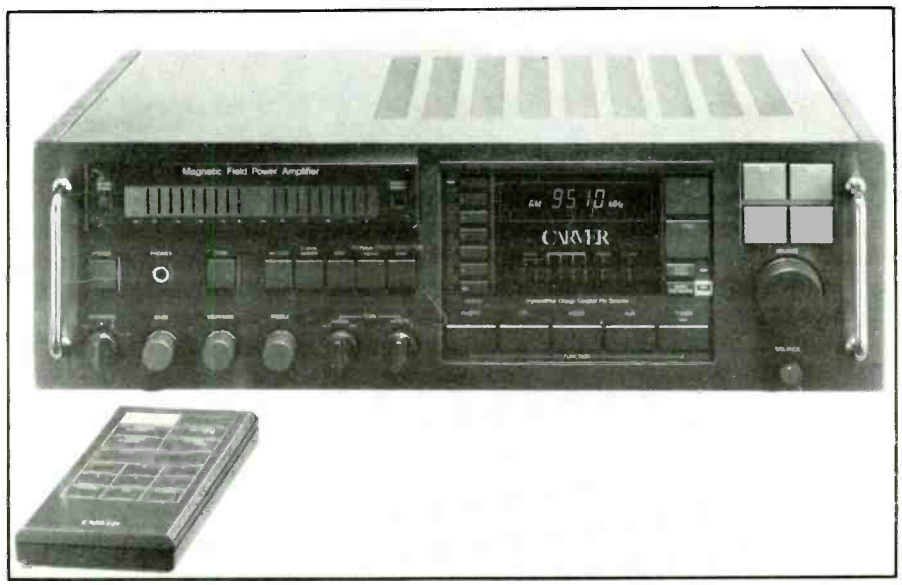
Kodak's MVS-5380 8-mm VCR features digital stereo sound recording.

The PCM format agreed to by 18 companies for this 8-mm tape application does not provide as high-quality audio as is available either on Compact Discs or on the DAT formats yet to be proposed. Nevertheless, the audio quality is superior to that obtained on conventional tracks of either Beta or VHS half-inch video tapes. Specifically, frequency response extends to 15,000 Hz (as good as FM radio and the stereo sound of multi-channel TV), while dynamic range is better than 80 dB.

The sampling rate is 32.5 kHz, and the equivalent of a ten-bit digital code is used. Normally, a ten-bit sampling code might be expected to yield a signal-to-noise ratio no greater than about 60 dB. The additional 20 dB of dynamic range is achieved using a system of linear companding (compression during recording, inverse expansion during playback). Early reactions to this system were favorable, in that there was no apparent "breathing and pumping" audible with the chosen linear companding system. The question in everyone's mind now is this: will PCM audio recording on 8-mm tape become a competing system to the yet-to-be announced DAT format? And even more to the point, if the DAT standards committee ends up proposing *two* DAT formats (one using rotary heads, the other stationary heads) as is now suspected, does that mean that consumers will be faced with having to choose from among *three* totally incompatible home digital audio tape systems?

High-Fidelity AM

If you haven't been all that excited about AM stereo up to now, no one can blame you. The AM tuner sections of most high-fidelity audio tuners and receivers are, for the most part, treated as an afterthought. Response is often deliberately cut off above 2 or 3 kHz, and dynamic range is severely limited. Yet, AM radio has always had the potential for much better sound reproduction. Many of you may remember an excellent AM-only tuner manufactured and distributed in North America as the McKay-Dymek tuner; its response was virtually flat to well beyond 10 kHz and its sensitivity was superb. Bob Carver, the innovative president of Carver Corporation, feels that the McKay-Dymek was just a bit ahead of its time, and that if it were available now, with stereo decoding built in, it might well prove to be a winning product. Accordingly, Carver proposes to add a superlative AM tuner section to his well-accepted TX-11 FM Tuner. He demonstrated a pro-



Carver Corp.'s new 2000 receiver produces an incredible 200 watts/channel from its built-in "magnetic-field" power amplifier.

totype of that AM circuit during the CES and, indeed, sound quality was almost indistinguishable from FM. Claimed response extended to 15 kHz, an achievement made possible with the aid of a very sharp 10-kHz "whistle" filter that eliminates adjacent-channel interference beats, but is so narrow in its band-elimination range that you hardly notice it's there. Even more astonishing, addition of this AM circuitry to his tuner would only add approximately $25 to $35 to its total retail price.

Just in case Carver's AM tuner addition doesn't take off, the energy-laden Carver developed a second generation all-in-one receiver—Model 2000— which delivers an incredible 200 watts per channel, includes a remote control, and has Carver's other special circuits such as his "Sonic Holography" and special FM circuits that help reduce noisy reception from weak signals. The high power level of this receiver stems from Carver's so-called magnetic field amplifier technology and it comes just when everyone is clamoring for more power with which to handle the wide dynamic range of new digital program sources such as CDs and PCM tape recordings.

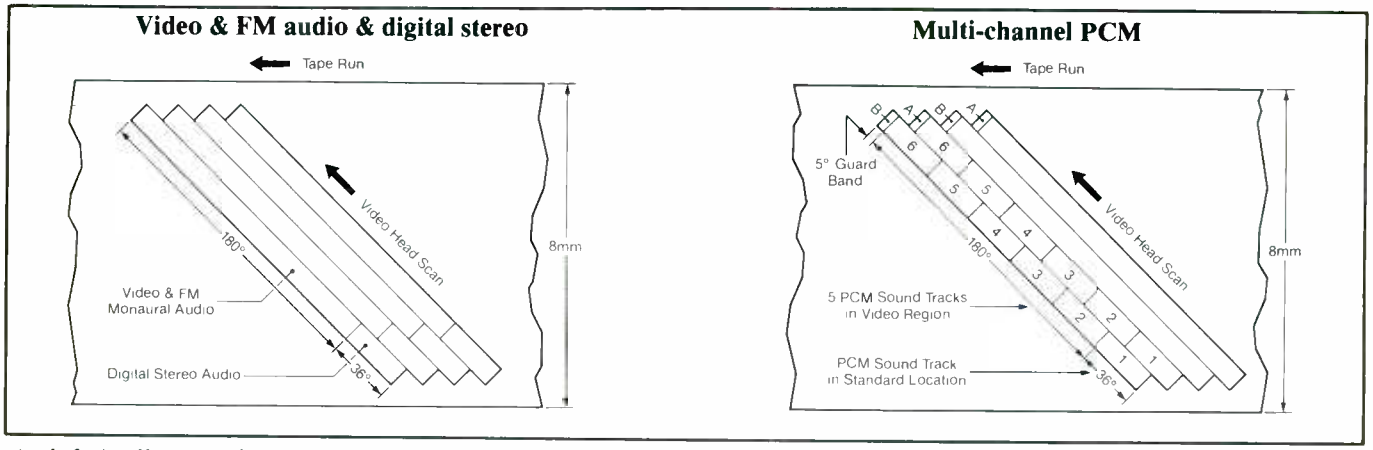
Stereo TV Decoder Add-On

By year's end TV viewers in most regions in the United States will be able to receive at least one TV station that is broadcasting some or all of its programming in stereo or in a second language using the so-called S.A.P. (Secondary Audio Program) facility of the new Multi-channel TV Sound System. Most TV viewers wishing to receive broadcasted stereo sound, however, will be faced with a problem because older TV sets cannot be easily converted to stereo. Such conversion would require wiring in a special multiplex jack that might not work with available outboard stereo TV decoders. Furthermore, wiring in such a jack and providing external access to it could expose one to dangerously high voltages. Only a very few of the TV sets built in recent years have safe multiplex jacks incorporated, and still fewer sets have built-in stereo decoders.

So, what's the owner of a perfectly good color TV set to do if he or she wants to listen to stereo TV or to bilingual broadcasts in that second language? The well known FM circuit designer, Larry Schotz, who has been a design consultant for such renowned companies as Crown International, NAD, Proton and Nakamichi, came up with a clever solution. He noted that most TV sets (and older ones in particular) radiate a certain amount of high-frequency energy. Some of that radiated energy is at 4.5 MHz, the frequency of the sound carrier after video detection. Schotz designed a stereo decoder which, in addition to conventional connection to a TV set's multiplex jack, can be used with a special small "r-f probe" that is supplied.

The plug at the end of the probe is connected to the input of the decoder, while the "business end" of the probe is carefully and slowly moved around the surfaces of the TV set's cabinetry. With audio cables connected from the decoder's output jacks to your stereo system's inputs, a point will be found where maximum 4.5-MHz r-f energy is radiated from the TV set and sound will be heard coming from your speakers. If the TV signal is being broadcast in stereo, a light will illuminate on the front panel to indicate that fact. Even in mono, though, sound will be much improved, since you will be bypassing your TV set's own minimal audio amplifier and tiny speaker. Mr. Schotz has licensed his "wireless" stereo TV decoder to Recoton Corp.

As usual, there were plenty of new loudspeaker models from a wide variety of manufacturers. Among the unusual ones was the John Bowers Ltd. "Active I" loudspeaker—a *powered* speaker system that achieves large loudspeaker performance from a comparatively small enclosure. If the John Bowers' name is unfamiliar to you, he is the Mr. Bowers who heads up the well-known B & W Loudspeaker firm in England. He felt that this new entry



At left is illustrated the helical track configuration for 8-mm video, which reserves one-sixth of the track for digital stereo sound information. For multichannel audio tapes, the video region is replaced by five more audio tracks that are identical in format to the standard PCM audio track format, illustrated at right.

was so different in concept from the passive systems produced under the B & W name that he decided to produce it under a separate, subsidiary company name.

Not to be outdone by its chief United Kingdom competitor, the KEF Electronics Ltd. Company, introduced a series of six loudspeakers called the C-Series. The least expensive of these, the C-10, suitable for shelf or wall mounting, carries a price tag of $220 per pair, while the most expensive C-80 has a suggested retail price of $1050. KEF's special conjugate circuitry, first used in its Model 104/2, reportedly balances out unevennesses of the drive unit and the network load by means of "mirror image" components that cancel out impedance peaks and dips.

Visions Of Things To Come?

In traversing the seemingly endless acres of show floors that make up the Summer CES, I always keep my eye out for something that is really unusual—even improbable. Touring the smaller exhibits located in the off-the-beaten-path hotels and manned by young companies just getting started, there was no shortage of really "far-out" products. To "sum up this summary," let me describe what I consider to be the most unusual—and most unlikely product talked about at the CES.

The company's name was Finial Technology & Innovation and, as I might have suspected, they were to be found not in the main convention center, where the "big" companies hold forth, but in a small hotel room at the nearby Americana-Congress Hotel, on Michigan Avenue. That hotel, along with the smaller Blackstone Hotel, was reserved for the smaller, so-called "esoteric" or high-end audio companies who could neither afford nor wanted to be on the "main exhibit" floor.

There was no sound at Finial's exhibit. Instead, there was nothing more than a museum-like display of phonographs—ancient and not so ancient. Starting with an Edison cylinder-phonograph, as I turned about the room I saw disc turntables and, finally, a CD player. Robert Reis, the intense young President of the firm, approached me when he saw me gazing at the CD player. "You are looking at soon-to-be-obsolete technology," he said. As I turned to face the last part of the exhibit, he explained that it was a mockup (not even a working prototype) of a new kind of record player that he and his staff had perfected and that actually was in working order "back at the lab." This record player, said Reis, was designed to play conventional LP records using a laser beam instead of a stylus and cartridge assembly following the wiggles in an analog record.

He must have seen how incredulous I was, because he invited me to join him in his private hotel room for further discussion. He and his marketing manager, Michael May, spoke earnestly for several minutes, and when they were through I was prepared to believe that perhaps they could perform this feat after all. As they pointed out, there are some 30 *billion* analog records out there in the world, and if a way could be found to play them more accurately than they had ever been played, and with no further wear, that might be a very worthwhile thing to do. The gentlemen from Finial maintain that they have perfected such system and that they will be exhibiting it at the next Consumer Electronics Show, or perhaps the one after that.

I'm willing to keep an open mind about this "optical turntable." Perhaps next year Finial will be on the show floor with a model that works. After all, I can remember when talk of digital audio discs was greeted with a certain amount of skepticism!

Dress Up Your Projects

The simple photographic procedure described here will let you produce project front panels that are indistinguishable from those on commercial products

By C. R. Ball

When was the last time you *really* finished a project, taking the time to give it a professional-looking front panel, with control legends and perhaps an eye-catching logo neatly and permanently rendered? If you're like many hobbyists, you just spray on a coat or two of enamel paint and label your panels with a dry-transfer lettering kit or a plastic tape labeler. Dry-transfer lettering is okay at first, but it inevitable wears away and/or drops off, while tape labels give a project an unprofessional "klugy" look, no matter what other pains you might take to give is a classy appearance. Worse still, both types of labeling eventually wear away or drop off, leaving you with a project whose control functions are a complete mystery if you haven't used it for some time. This is obviously leading up to something.

That something is the fact that you *can* make very durable front panels that are indistinguishable in appearance from those you see on commercially-made products. Using the procedure described here, you can make panels and decals that really dress up your projects, actually making you want to display them with pride. You can even use this procedure to make printed-circuit component identification overlays similar to the silk screening used on commercial pc boards. Best of all, you don't have to be specially trained to turn out professional-looking panels, and all materials are readily available at reasonable cost.

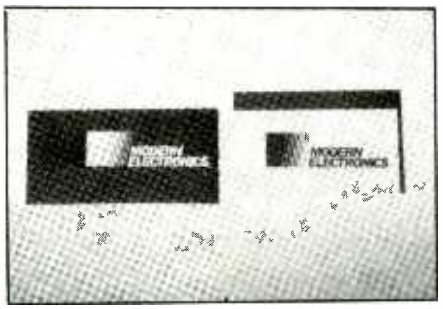
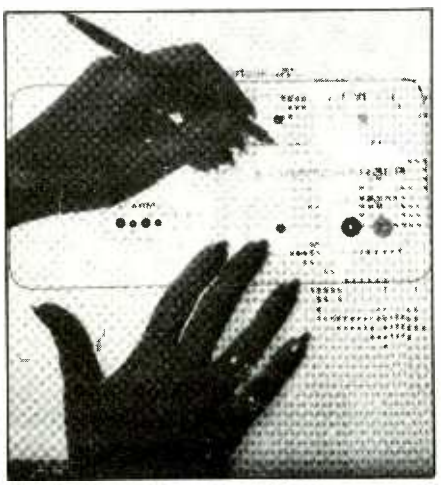


Fig. 1. Starting with positive art, first exposure and development produces the negative shown at the left. This negative is then used as original art to expose and develop the positive film shown at the right.

Fig. 2. After penciling your layout onto paper, cover with transparent film and use dry-transfer lettering and other drafting aids to transfer the drawn image. If the image is very small or contains lots of fine detail, work twice life size and then have the image photographically reduced.



Types of Nameplates

There are a number of processes for making professional-looking nameplates, all requiring easy-to-use light-sensitive material. Some nameplate fabrication methods use the light-sensitive material for selectively coloring, etching or screening a panel. Another process uses the light-sensitive material as the finished nameplate image. These fabrication methods go by such names as anodizing, etching, silk-screening, and photoreproducing, respectively.

Anodized Nameplates are prepared by trapping various colored dyes in the "pores" of an aluminum nameplate panel. The pores are opened electrolytically by immersing the aluminum (as the anode) in a sulfuric-acid solution. Then the opened pores are selectively filled with colored dye through an exposed and developed light-sensitive material (photoresist mask). The pores are then closed by immersing the panel in a boiling-water solution, permanently trapping the dye pattern under the surface of the aluminum.

The anodizing process produces an extremely durable and attractive nameplate. Since you can use any thickness of aluminum, the nameplate can be self-supporting and, therefore, be used as part of the chassis or as a front panel.

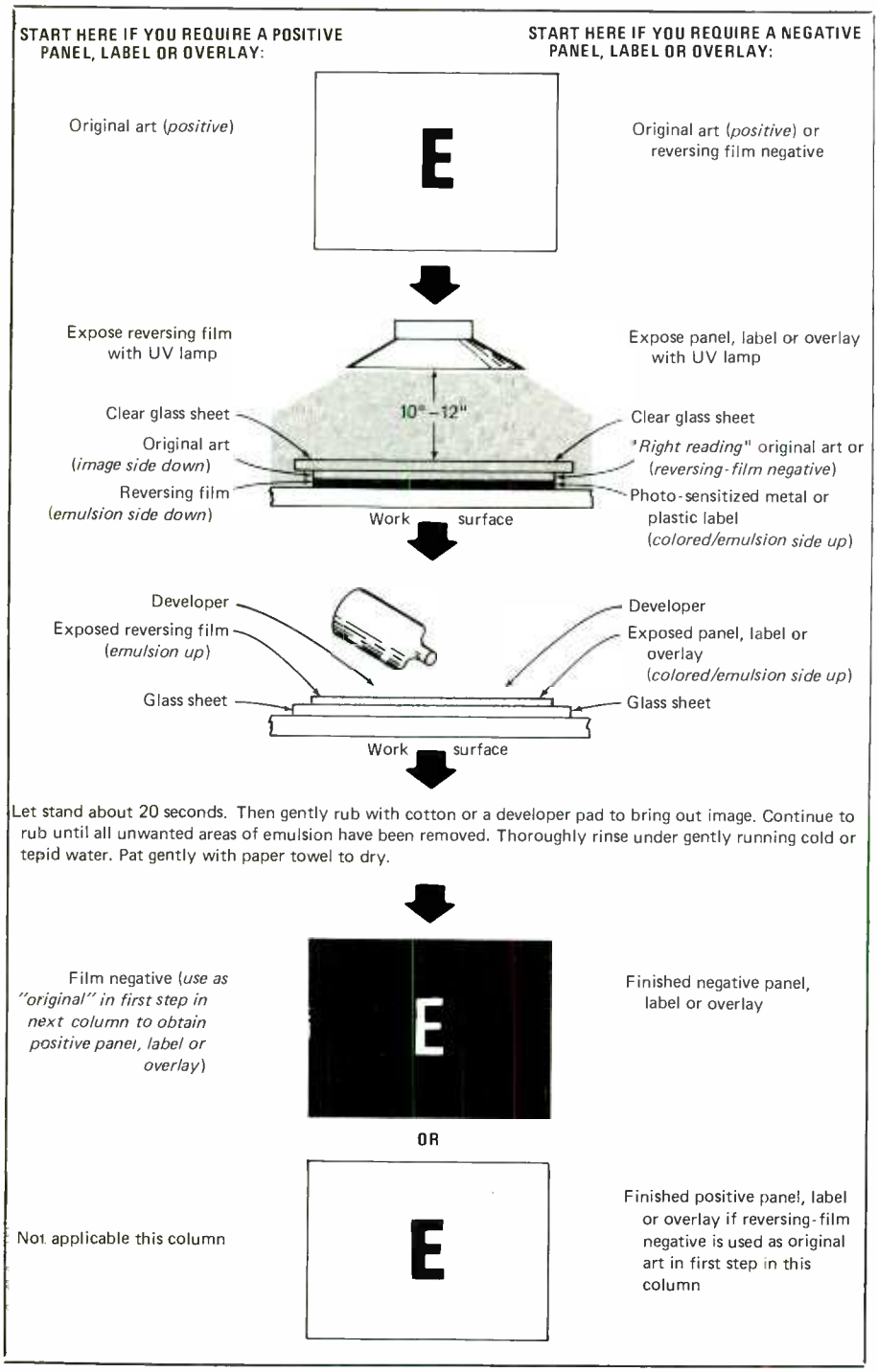


Fig. 3. To make a panel, label or overlay that is identical to (a positive of) your original art, perform all steps in both columns, starting at the upper-left. For a negative image, simply start at the top of the right-hand column, using your original film as the "original art" called for.

Etched Nameplates, as the name implies, are formed by etching an image into an aluminum surface. The aluminum panel is first coated with a negative-acting photosensitive material (photoresist) that is not affected by the etchant. (Precoated panels are available from the sources listed in the Table.) The panel is then exposed through negative or positive art and developed.

Following development, the aluminum is immersed in an etchant solution, usually caustic soda, that eats away the surface of the unprotected image areas. Then, after removing the photoresist, the etched areas can be ink filled. In the case of precoated panels, the coating is the image color and is selectively etched away.

Etched nameplates are extremely durable and can be self-supporting. Very colorful nameplates can be produced by flowing various colored inks into the etched image.

Silk-Screened Nameplates are produced by screening ink onto the surface of metal, plastic, or other material. The process begins by photographically transferring the artwork to a plastic film that, in turn, is secured to a silk screen. The screen is placed over the nameplate and ink is flowed through the open-mesh image areas of the screen. Aluminum must be anodized or treated with a chemical, such as Alodine 1000, to ensure that ink will adhere properly. Using epoxy inks, extremely durable nameplates can be made. Multicolor nameplates, of course, require a separate screen for each color.

Most nameplates on consumer electronic equipment are produced by the silk-screen process because they are easier and less expensive to manufacture in large quantities. However, because of the set-up time and equipment required, this process is not generally attractive to electronics hobbyists.

Photo Nameplates consist of a brushed-aluminum sheet between 0.007" and 0.140" thick or a 0.004"-thick transparent or colored polyester sheet. The aluminum or plastic sheet is coated on one side with a colored light-sensitive material called an emulsion and an adhesive on the other side. (A removable backing protects the adhesive side until the prepared sheet is ready for placement.) The

emulsion is exposed through negative or positive artwork, developed with a one-step rub-on chemical process, and finally coated with a clear protective spray or covered with a clear laminating film. The finished nameplate is easily cut to size with scissors and secured to a sub-panel, case, or chassis by its adhesive backing.

Many colors and color combinations are available on aluminum and plastic. Although the durability of photo nameplates is not as good as the other types, ease of fabrication and low investment cost make photo nameplates the best choice for experimental and prototype applications.

Because of its ready adaptability to home experimenting, the remainder of this article concentrates on the photo technique. We will discuss it in detail to provide you with all the information necessary to make professional nameplates for home and work projects.

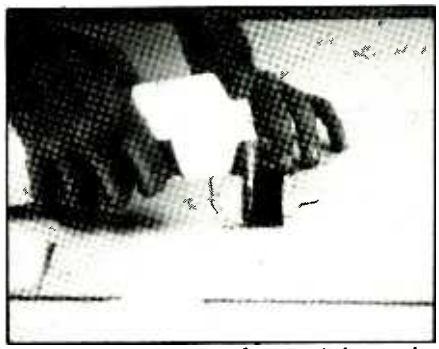


Fig. 4. Place exposed material, emulsion side up, on a sheet of glass and pour on enough developer to soak it.

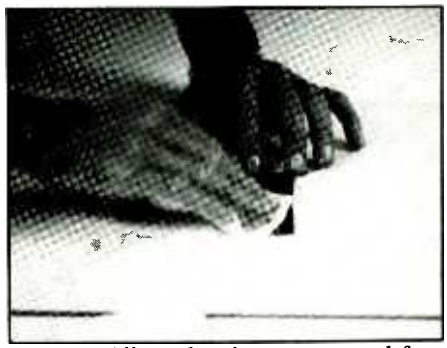


Fig. 5. Allow developer to stand for 20 seconds. Then gently rub with cotton or pad to bring out image.

Making a Photo Nameplate

The key to any attractive nameplate is good artwork. The finished product can be only as good as your original artwork. The kind of artwork you need depends on the type of final image you want.

Artwork ultimately takes one of two forms—positive or negative. Positive art is usually the original or an exact replica on transparent film. Negative art, on the other hand, is a photographic reversal of the original (positive) art. Figure 1 shows the difference between positive and negative art.

Nameplate material is negative-acting, with the final image being the reverse of the artwork used. For example, a piece of nameplate material exposed and developed using the positive artwork shown at the left in Fig. 1 will have a final image like that shown at the right for negative art.

You begin preparing your artwork by making an actual-size sketch of the nameplate. (If the nameplate is small or is to have fine detail, you may want to make a sketch twice actual size for ease of drafting.) After verifying the dimensions and placement of lettering, place a piece of clear or translucent drafting film, available from most art or office supply dealers, over your sketch.

Using your sketch as a guide, apply dry-transfer lettering as shown in Fig. 2. Alternatively, you can use a drfting pen and a template. Pc drafting tape can be used to group or outline various areas of functions. Once you have completed transferring the details from your sketch to the film, the latter becomes your original artwork. If the original is other than actual-size, you will have to take the artwork to a lithographer or print shop to have an actual-size positive or negative made. However, if the original art is actual-size and you want a negative of it, simply use the reversing film procedure discussed later in this article.

If you are planning to duplicate a nameplate for a project that appeared in a magazine article and want to avoid having to redo the art, again simply have a print shop make a positive or negative.

General Information

Although photo nameplates can be safely and easily made, certain precautions should be observed when handling the chemicals and the exposure light because both the developer and sealing spray are flammable, avoid using them near an open flame and do not smoke in their vicinity. If you have sensitive skin (or even if you do not, for that matter), wear rubber gloves when using the developer. Also, both chemicals are somewhat toxic and should be used in a well-ventilated area and should at all costs be kept out of the reach of children.

Care should also be taken to protect your eyes and skin from prolonged expoure to the ultraviolet light if you use a sun lamp. Wear sunglasses when the lamp is on, and minimize skin expoure to avoid sunburn. Keep in mind that as little as five minutes close to a UV source can result in sunburn.

Amost any ultraviolet light source can be used to expose the photo-nameplate material. You can, of course, make a sizeable investment in either 3M's Model EU800 ($375) or Kepro's Model BTX-200 ($445) exposure box. Or you can use a blueprint machine to expose thin nameplate material. However, you can obtain effective exposure results with a common 375-watt sun lamp, as long as nameplate sizes are kept down to 8″ × 10″ or less. Sunlamps are available in most drug, hardware, and department stores for about $30.

When using a sunlamp, keep in mind that most use bulbs have an internal starting mechanism that prevents them from starting unless they

Nameplate Materials and Manufacturers

Item	Manufacturer	Item	Manufacturer
Anodized nameplate supplies	Metal Photo Corp. 18531 South Miles Road Cleveland, OH 44128	Silk-screen supplies	Various
Etched-nameplate supplies	Kepro Circuit Systems 630 Axminister Fenton, OH 63026	Photo nameplate supplies	Kepro Circuit Systems 630 Axminister Fenton, MO 63026
	Fotofoil Division Miller Dial Corp. 4400 North Temple City Boulevard El Monte, CA 91734		3M Decorative Products Bldg. 223-1S, 3M Center St. Paul, MN 55144
		Drating film, dry-transfer lettering, templates, etc.	Bishop Graphics 5388 Sterling Center Drive Westlake Village, CA 91359

are cool. If you turn off the bulb after use, you will have to leave if off for approximately 15 minutes before attempting to turn it on again.

Nameplate material does not require strict darkroom conditions, but flourescent and other sources of ultraviolet light should be avoided when handling undeveloped material. Yellow "bug" lights make excellent safe lights for handling unexposed material.

Nameplate Material

Photo-nameplate material is manufactured by 3M and Kepro (see Table). The Scotchal™ brand manufactured by 3M offers the widest range of materials with 13 basic color combinations on polyester or aluminum and in sizes up to 24″×48″. (The instructions given below are specifically for the 3M products, although most apply equally to the Kepro product).

A starter kit from 3M contains all nine colors on 10″×12″ polyester film, four sheets of aluminum in various colors, overlay film, reversing film, grey scale, developer, developer pads and laminating sheets. The kit costs about $50. All you need to add is a light source, your artwork, and two pieces of glass. Individual colors and sizes are also available.

When using a sun lamp, two sheets of glass are needed: one to hold the artwork in close contact with the

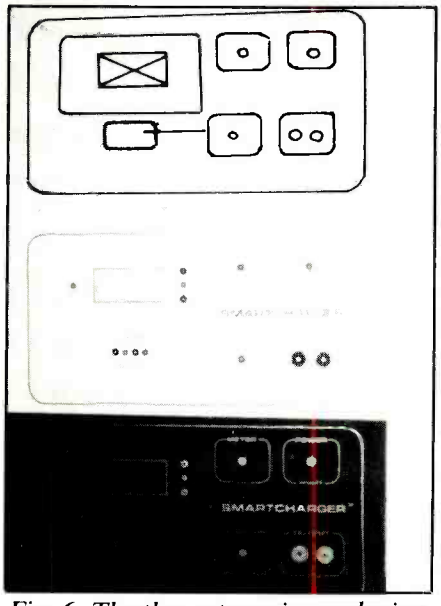


Fig. 6. The three stages in producing a finished nameplate. At top is pencil drawing; at center is original artwork; at bottom is finished panel.

nameplate material during exposure, and the other to use as a developing surface. These glass sheets should be at least twice the size of the nameplate you are making. Various sizes are available at hardware stores. (When you purchase the glass, do not get the tinted type. The tint filters out the UV light you need for exposing the photosensitive material.) Paper towels will also be helpful for cleaning up left-over developer and drying developed nameplates.

Before exposing the actual nameplate (details for this are given in diagram form in Fig. 3), it is necessary to determine the proper exposure time for the material color and light source you are using. To do this, select the material you are going to use for your nameplate under safe lighting conditions. Cut a piece slightly larger than the grey scale. (If you don't have the 3M kit, grey scales are available at most photography stores.) If you are using the yellow reversing film to make a negative, cut a similar piece. Place the nameplate material emulsion side up on a smooth, flat surface. Place the grey scale on top, and cover with a piece of glass. (*Cation:* Handle the nameplate material and reversing film *only* under safe-light conditions until the image is developed.)

Using the following exposure times as a starting point, expose the grey scale for the selected amount of time:

Material color	Exposure time in minutes
red	2½ to 3
blue	1½ to 2
green	3 to 3½
black	15 to 20

These are approximate exposure times for a 375-watt sunlamp located 10″ to 12″ from the exposure surface. When using positive art, increase these times by 10%. Keep in mind that these times are guidelines only and are not intended to replace grey-scale tests and that actual exposure time will vary with the UV bulb used,

its age and the distance to the exposure surface.

Position the sun lamp 10" to 12" from and parallel to the glass. After exposure, move the light source to a location away from your work area to prevent further exposure. Remove the glass and the grey scale. Place the exposed material, still emulsion side up, on another piece of glass and pour onto it enough developer to cover the surface (Fig. 4). Wait about 20 seconds and then gently rub the developer with a piece of cotton or a developer pad until the image appears (Fig. 5).

Compare the developed image to the original grey-scale exposure mask. If you are using plastic material, the image should be solid through step 2 on the mask. For metal material, the image should be solid through step 3, and for reversing film, it should be solid through step 4.

If you do not obtain the proper results, repeat the test and adjust exposure time accordingly. Longer exposures cause more steps to be solid and vice-versa.

Once you have established the proper exposure time for the material and light source being used, make a note of the time, distance from light source and material color/type for present and future reference.

Making a Nameplate

Cut a piece of the nameplate material so that it is at least ¼" larger than the actual nameplate all around. Repeat the procedure for using the grey scale and expose the nameplate. If the nameplate is large, rotate the light during exposure to be sure all areas receive equal amounts of light. In such a case, it may be necessary to increase exposure time slightly. Develop the nameplate or reversing film as before. If areas that should not wash away do, indicating underexposure, during development, increase exposure time by 10% and try again. Be sure to make a note of the time that works best and save for future use. Figure 6 shows a nameplate sketch, artwork prepared from the sketch and the finished nameplate. Examples of a variety of nameplates that give you some idea of what you can do with these materials are shown in Fig. 7.

There are two ways of protecting the finished nameplate. One is to spray several light coats of a clear acrylic, such as Krylon, or the matte or glossy sprays from 3M over the entire surface of the nameplate. The other is to layer on adhesive-backed clear laminating film, such as that supplied in the 3M starter kit. Both are best applied in a dust-free environment and before the nameplates are trimmed to final size. Other ways to mount the laminating film are detailed in 3M Instruction Bulletin #4-4.

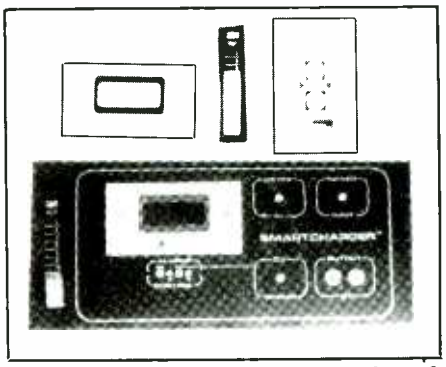


Fig. 7. Shown here are examples of finished labels to give you an idea of the kind of work that can be done with the photo-chemical materials. Note the grey scale at the lower-left.

Mounting the Nameplate

Use scissors to trim two adjoining edges of the nameplate. Starting with the corner formed by the trimmed

(Continued on page 100)

Fig. 8. Once you have trimmed two adjacent sides, remove protective backing, starting at finished corner.

Fig. 9. A squeege is helpful in layering the finished label onto the panel, working out air bubbles as you go.

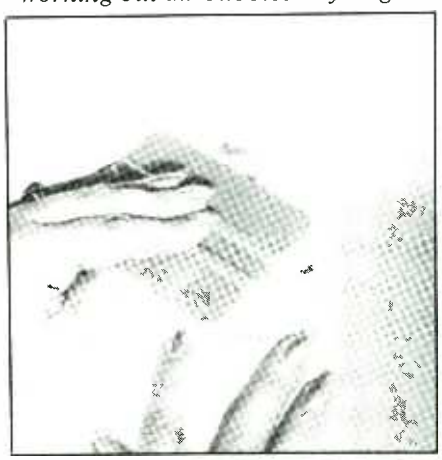


Fig. 10. After burnishing down the finished label onto the actual panel, use a knife to trim away all unwanted material from holes and cutouts.

Simple Tunes on Your Apple IIc

Though not up to Carnegie Hall standards, your Apple IIc can easily be programmed to let you play simple and even some complex tunes

By Fred Blechman, K6UGT

Computer-generated sounds can vary from simple tones to complex synthesized music that simulate various instruments or take on its own unique character. The popular Apple IIc has not been designed as a music synthesizer, but it can indeed be used to generate sound tones using relatively simple programming.

This article will discuss how to use simple notation and programming to have your Apple IIc play simple and even some complex tunes.

Music & The Apple IIc

My discussion and implementation of "music" on the Apple IIc may not be conventional, but it will be simple and understandable. If you're a musician you may come away from this chapter screaming at the liberties I take in my description and notation of music, but the information to make "music" on your Apple IIc will be here in rudimentary form nevertheless. On the other hand, if you are a musical novice, you should find this information easy to follow and use.

By using a short machine-language program entered with Applesoft BASIC into the Apple IIc memory, you can generate a wide range of tones. This subroutine can then be used for "playing" the keyboard or to generate tones within a program. If the tones are the proper frequency and duration, this becomes a rudimentary form or music. The object, then, is to not only generate tones, but to simulate the musical scale.

Figure 1 shows a typical piano keyboard, with notations based on the "American Equal Temperament Musical Scale." In this musical scale (there are others used in different countries or for special types of music) the standard frequency of A is 440 Hz (cycles per second), and the frequency of each key, moving from left to right, is one "semi-tone" higher than the preceding key (including the black keys). What's a semi-tone? Well, mathematically, that's exactly 2 raised to the $1/12$ power for this system of frequencies. For you and me, it's the next key on the instrument's keyboard!

For your convenience, Fig. 1 shows 25 keys (that's more than two "octaves" since there are 12 keys per octave), with the common music designations, the frequency, and a "frequency code" for each. We'll cover the meaning and use of the frequency code shortly.

You'll notice that some of the keys are marked with a "#." This is the musical symbol for "sharp," and it simply means the next key to the right (one semi-tone upscale). For example, C-sharp is the first key to the right of the C key. Now, just to confuse us all, musicians also refer to "flat," and use a symbol that resembles a "b." This merely means the next key to the left (one semi-tone downscale). So a "D-flat" is the same as a "C-sharp."

Musical Notation

Music is really just a specified sequence of tones, each played for defined durations. To describe music on paper, an elaborate scheme of special symbols and rules of notation have evolved. These are no doubt necessary for meaningful music, but since the Apple IIc was never meant for Carnegie Hall (and because regular musical notation still mystifies me) I've devised my own "hybrid" system that you should be able to follow easily. This notation is crude, but simple. I leave it for you music enthusiasts to embellish it with your own features.

Figure 2 shows the system of musical notation I use in this article. Different note symbols are used to designate duration. Their placement on the musical "staff" (the five horizontal lines) is conventional, and the "tails" all extend upward to keep things simple. No notes are connected together. This is simplistic, an equivalent to a kindergarten music primer, but it's easy to follow for non-musicians.

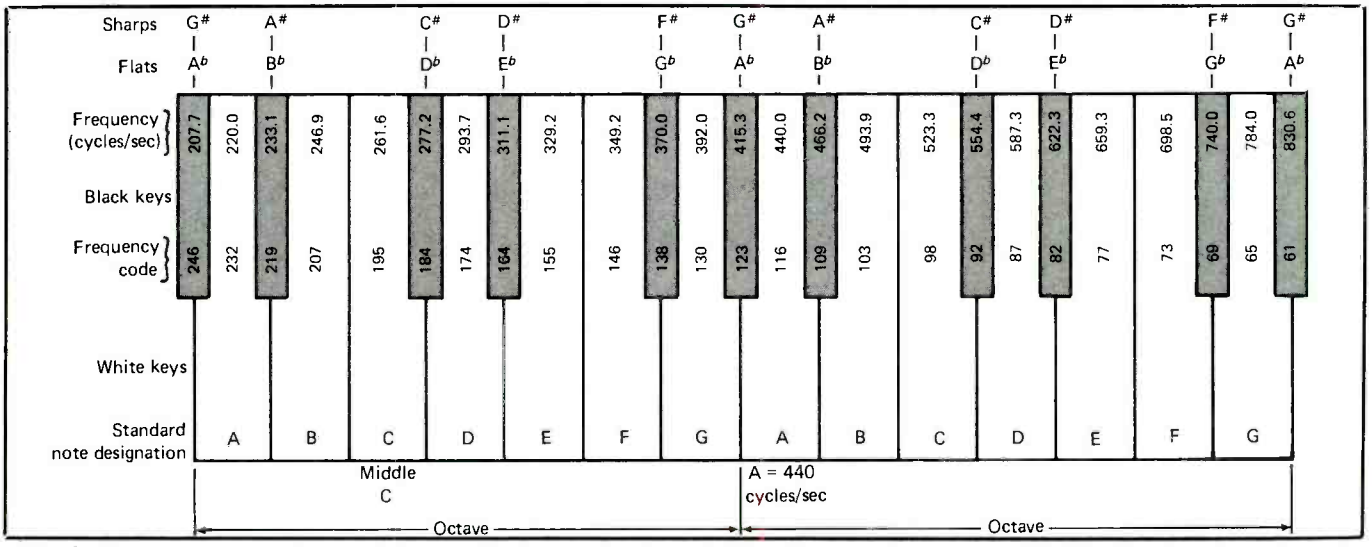


Fig. 1. Shown are two octaves of the standard piano keyboard. Note frequencies are specified by the American Equal Temperament Musical Scale.

On the left side of Fig. 2 you'll find the standard note designations and the mysterious "frequency code" to be explained very soon.

I designate some keyboard keys here to play certain notes, as if they were piano keys. First we have to program the Apple IIc memory to generate sound, and then find a way to have the computer detect when a particular key is pressed—and play the desired note. Actually, if we are willing to accept some inherent limitations, a relatively short program can put the musical scale on part of one row of the keyboard.

The program to do this is shown in Listing 1. Lines 100-130 use the POKE statement to insert a series of numbers into a section of memory starting at "address" (location) 768, normally reserved by the Apple IIc for custom machine-code instruction subroutines.

The numbers POKEd into memory locations 768 to 786 provide for toggling the speaker at a rate determined by a number in memory address 0, and for a duration controlled by the number in memory address 1. These are shown in program lines 1000 and 1010. The CALL 768 in line 1020 directs the program to the machine code starting at memory location 768 (the special code just entered by the POKE statements).

Listing 1. Play the Apple IIc Keyboard

```
10  REM  * PLAY THE KEYBOARD *
20  REM  * (C) COPYRIGHT FRED BLECHMAN 1984 *
100  POKE 768,173: POKE 769,48: POKE 770,192: POKE 771,136: POKE 772,208
110  POKE 773,4: POKE 774,198: POKE 775,1: POKE 776,240
120  POKE 777,8: POKE 778,202: POKE 779,208: POKE 780,246: POKE 781,166
130  POKE 782,0: POKE 783,76: POKE 784,0: POKE 785,3: POKE 786,96
200  GET K$
210  FOR S = 1 TO 8
220  READ F$,F
230  IF F$ = K$ THEN  GOSUB 1000
240  NEXT S: RESTORE : GOTO 200
500  DATA      Q,195,W,174,E,155,R,146,T,130,Y,116,U,103,I,98
1000  POKE 0,F
1010  POKE 1,50
1020  CALL 768
1030  RETURN
```

The "action" takes place when you press any of the keys marked Q, W, E, R, T, Y, U or I. *Make sure your keyboard is set with "caps lock" key down!* Program line 200 scans the keyboard, looking for a key press. When any key is pressed, the computer assigns that key to be K$ (K-string). Lines 210-240 search the DATA in line 500 to see if the key pressed matches any of the keys just mentioned. If so, a value F is POKEd into memory address 0 by line 1000, the subroutine is CALLed, and the speaker produces a tone for the duration specified by the POKE value in line 1010.

The RESTORE statement in line 240 sets the DATA pointer back to the beginning of line 500, and then the program goes back to line 200 to look some more. To exit this program, "control/C" won't always work. Use "control" and "reset" together. If you do this, The program will stay in memory.

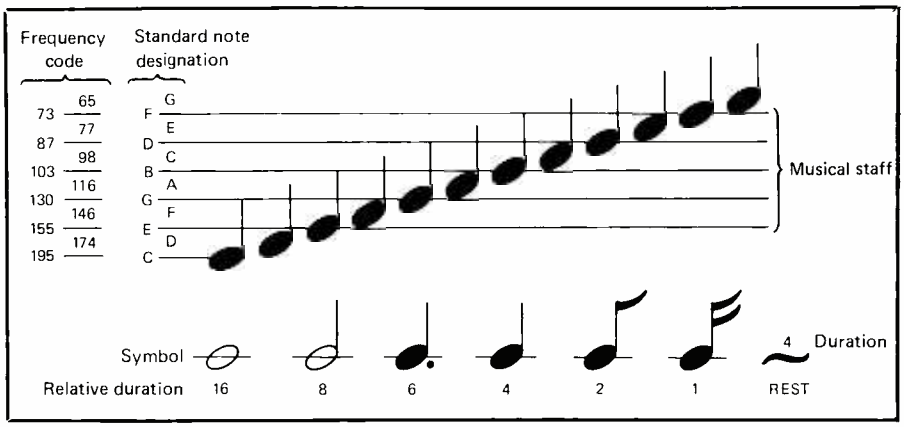


Fig. 2. Illustrated is the musical notation used in this article.

Frequency Codes

You'll find that keys Q-I play the musical scale, as shown in Fig. 1, from middle-C up to and including the next higher C key. Here's where the "frequency codes" come in.

Through experimentation (using a signal generator and oscilloscope) I determined that using the value 116 in memory location 0, with this sound routine, produced a speaker tone very close to the 440 cycles per second established by the American Equal Temperament Scale as note "A" above middle-C. (Refer to Fig. 1 again.)

Using 116, I then wrote a simple program for the Apple IIc that produced the numbers that are 2-to-the-$\frac{1}{12}$-power above and below 116. The results, rounded off to the nearest whole number, are the frequency codes for each key, as shown in Figs. 1 and 2. This, in effect, allowed me to play any note in the key of middle-C.

The frequency codes for the scale of C (white keys only) are those numbers shown in line 500 of the program. Each key is associated with a particular frequency code, used as F in line 1000.

The simplicity of this program (much easier to use than to explain) results in some shortcomings. Only upper-case keys Q-I along the second row of your keyboard create sounds. Also, each sound is of a specified duration. This means that when you play a tune with notes that have different durations, you have to use your imagination and hesitate between keystrokes. Also, this program won't "play" faster than the dura-

Listing 2. The Musical Scale on the Apple IIc

```
100  REM  * MUSICAL SCALE - KEY OF C *
110  REM   * (C) FRED BLECHMAN 1984 *
200  REM  * MACHINE LANGUAGE SOUND ROUTINE *
210  FOR X = 0 TO 18
220  READ ML
230  POKE 768 + X,ML
240  NEXT X
250  DATA   173,48,192,136,208,4,198,1,240
260  DATA     8,202,208,246,166,0,76,0,3,96
300  REM  * PLAY THE SCALE *
310  RESTORE
320  REM  * DUMMY READ *
330  FOR X = 0 TO 18: READ ML: NEXT X
340  REM       * SCALE - MIDDLE C=195 *
350  READ F,D: IF F = 999 THEN  GOTO 310
360  POKE 0,F
370  POKE 1,D
380  CALL 768
390  GOTO 350
1000  DATA      195,100,174,100,155,100,146,100
1010  DATA      130,100,116,100,103,100,98,100
1020  DATA       98,100,103,100,116,100,130,100
1030  DATA       146,100,155,100,174,100,195,100
2000  DATA  999,999
```

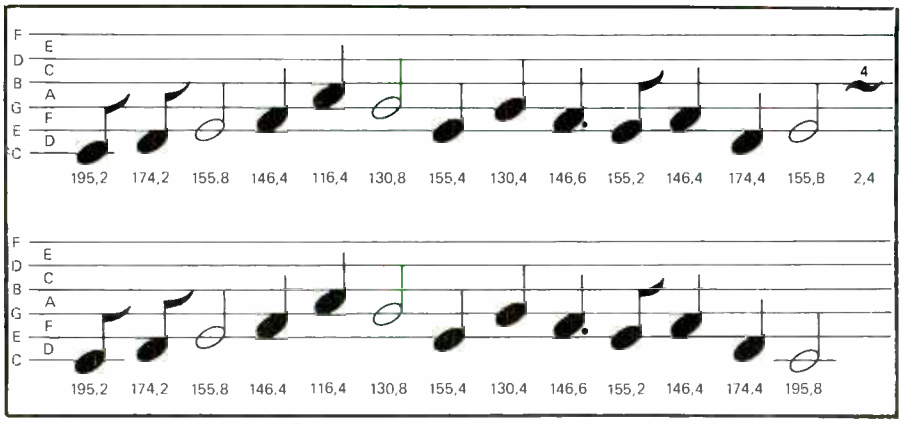


Fig. 3. Musical notation for "Home, Sweet Home." It can be programmed into the IIc using the frequency and duration codes given below each note.

tion specified by the "50" in line 1010. A smaller number will provide a shorter duration, and 255 is the maximum number allowed.

Furthermore, it's takes just a smidgen longer for the program to detect when the I key is pressed as compared to the Q key, since the DATA list must be READ further to find "I"—more loop time. Therefore, as you can see, this program is not designed for playing a stacatto tune like "The Sabre Dance."

Just to give you some keyborad practice, Fig. 3 gives you the "music" for "Home, Sweet Home." Just press the keys in the sequence shown (after RUN to start the program) and do the best you can on the timing. Underneath each note you'll see two numbers. The first number is the frequency code, the second the duration code, as used in a program later in this article.

Listing 3. Program to Play "Home, Sweet Home"

```
100  REM  * HOME, SWEET HOME *
110  REM   * (C) FRED BLECHMAN 1984 *
200  REM  * MACHINE LANGUAGE SOUND ROUTINE *
210  FOR X = 0 TO 18
220  READ ML
230  POKE 768 + X,ML
240  NEXT X
250  DATA   173,48,192,136,208,4,198,1,240
260  DATA   8,202,208,246,166,0,76,0,3,96
300  REM  * PLAY THE SCALE *
310  RESTORE
320  REM  * DUMMY READ *
330  FOR X = 0 TO 18: READ ML: NEXT X
340  REM       * SCALE - MIDDLE C=195 *
350  READ F,D: IF F = 999 THEN  GOTO 310
360  POKE 0,F
370  POKE 1,D * 30
380  CALL 768
390  GOTO 350
1000  DATA      195,2,174,2,155,8,146,4,116,4,130,8,155,4
1010  DATA      130,4,146,6,155,2,146,4,174,4,155,8,2,4
1020  DATA      195,2,174,2,155,8,146,4,116,4,130,8,155,4
1030  DATA      130,4,146,6,155,2,146,4,174,4,195,8
2000  DATA  999,999
```

Programmed Music

Once you've SAVEd the keyboard program on disk for possible future experimentation, type NEW, press "return," and then type in the program shown in Listing 2. This program plays the musical scale upscale, then downscale, then repeats, without your intervention.

Lines 200-260 POKE the machine code subroutine into memory at address 768, but using a FOR-NEXT-READ-DATA loop rather than individual POKE statements as done in Listing 1. The result is the same.

Lines 340-390, and the DATA lines 1000-2000, program the melody (in this case, the musical scale). Each READ statement in line 350 gets two numbers. The first number represents the frequency code, the second number the duration code. Notice that the frequency code numbers are the same ones used in the keyboard program of Listing 1.

You cannot use a frequency code smaller than 2. For some reason the computer locks-up with a 0 or 1. When using 2, you'll get a high-pitched sound to simulate a "rest" (no sound.)

The duration code can be from 0 to 255. The higher the number, the longer the tone is produced. The lowest practical number is about 10. The number 0 acts like 255.

Line 350, after each READ, looks to see if the value of F is equal to 999, which indicates the end of the melody. If so, the program RESTOREs the DATA pointer to the beginning of DATA (the first number in line 250). Do not remove line 2000, which

(Continued on page 89)

Designing With Switching Regulators

IC switching regulators simplify power supply design, increase efficiency and reduce size

By Anthony J. Caristi

Whatever your interest in electronics, by now you've probably noticed that a relatively new type of power supply is appearing in every type of sophisticated electronic equipment from color TV receivers to microcomputers. Called the "switching regulated supply," it has just about made obsolete the bulky and expensive 60-Hz power transformer that has heretofore predominated in power supply designs. Not only does the switching regulated power supply satisfy the compact design demands required in miniaturized products, it offers better efficiency and costs less to make compared to traditional designs.

On first encounter, a switching regulated power supply might appear to be extremely complicated. Earliest designs, built around discrete components, certainly were very complicated. However, development of specialized switching regulator integrated circuits have made switching supply design quite straightforward nowadays. One such IC is the Raytheon RC4192, which we'll be discussing at length in this article. Once you understand how this chip works, switching regulated power supplies should hold no mystery.

Raytheon's RC4192 is an excellent chip to use to illustrate the switching regulator circuit because of its simplicity and the fact that it works well in battery-powered equipment. Since it operates with an input of as little as 2.4 volts, the RC4192 is very practical to use in electronic equipment that requies 9 volts or more of battery power, such as small AM and FM radios. Using this chip in its step-up mode makes it possible to operate the equipment from a 3.6-volt NiCd rechargeable battery or even four solar cells connected in series.

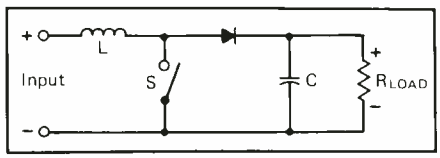


Fig. 1. In step-up mode, voltage at output is greater than that at input.

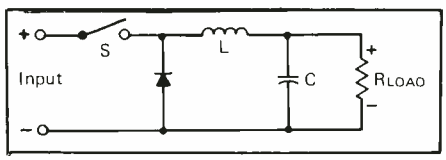


Fig. 2. In step-down mode, output voltage is less than input voltage.

Switching Regulation Defined

Basically, a switching regulator controls the output voltage of a dc supply by toggling a switch, usually a transistor, on and off in response to a change in input voltage or the demand of the load on the supply. Conected to the output of the supply, a sensing circuit monitors the voltage and varies the switching duty cycle to deliver more or less energy to maintain a constant output voltage.

Since a transistor has practically no dissipation when fully on and zero dissipation when off, there's much less power loss in this type of circuit than there is in a linear regulated supply that uses dissipative elements to control output voltage. This is the key to high efficiency. Since the frequency of the switching supply is usually above the audible range, ac line-powered regulators can be designed with an isolation transformer that is considerably smaller than the equivalent old fashioned 60-Hertz power transformer.

There are two basic categories of switching regulators: step-up and step-down, which produce regulated output voltages that are higher or lower, respectively, than the input voltage. Simplified diagrams of both types of regulators are shown in Figs. 1 and 2. The switch shown in both is usually a transistor that is turned on and off at a rate of 20 kHz or greater, with varying duty cycle. In general, if the regulated output voltage of the supply should tend to decrease, due to an increase in load or a drop in input voltage, the duty cycle of the transistor will automatically change to increase the amount of current delivered to the output circuit of the supply. Should the output voltage of

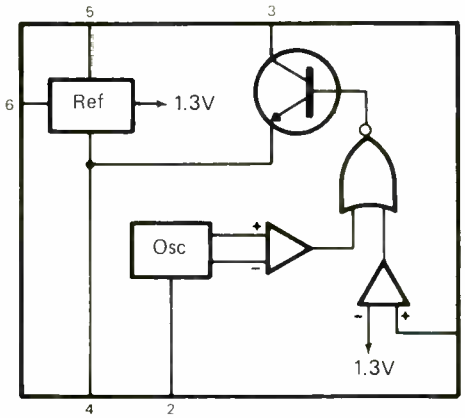


Fig. 3. This is the simplified block diagram of the RC4192 regulator chip.

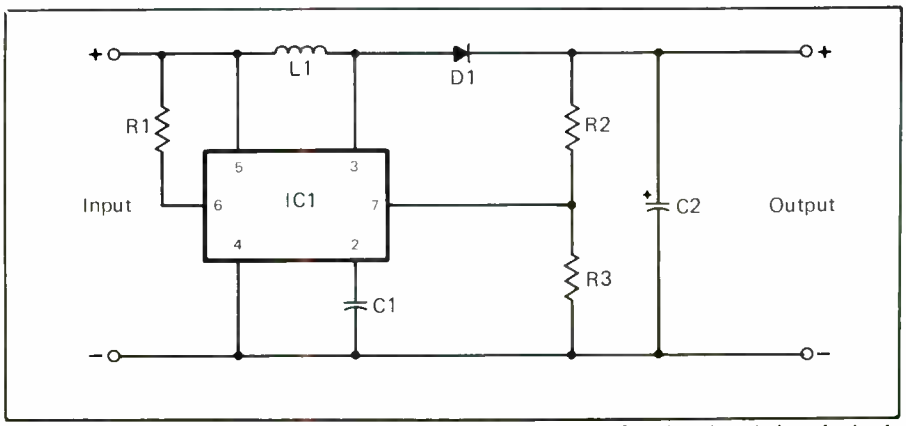


Fig. 4. Using the RC4192 regulator in the step-up mode, the circuit is relatively simple and straightforward, as shown in this schematic representation.

the supply tend to increase for any reason, the transistor's duty cycle would react in the opposite manner.

Theory Of Operation

In the step-up mode of Fig. 1, full input voltage appears across the inductor when the switch is closed, charging the inductor with a current that rises linearly with time. During the time the switch is closed, the diode is back-biased and current to the load is supplied by the charge on the capacitor. When the switch opens, the charged inductor develops a voltage, from the collapsing magnetic field, that aids the input voltage. This provides current to feed the load while replenishing the charge on the capacitor. When the switch opens again, the cycle is repeated. A sensing circuit (not shown in Fig. 1) monitors the output voltage of the supply and controls the duty cycle of the switch so that average current through the inductor is equal to load current.

The step-down circuit in Fig. 2 operates in a slightly different manner. In this mode, the switch is connected in series with the supply voltage source. When the switch is closed, the voltage across the inductor is equal to the input voltage minus the output voltage ($V_{in} - V_{out}$), and the inductor is charged with a current that increases linearly with time. As inductor current builds up, the capacitor feeds current to the load. When the current through the inductor exceeds load current, the capacitor is charged. When the switch opens, the diode is forward-biased by the voltage across the inductor and current provided by the charged inductor continues to feed the capacitor and load. The cycle is repeated when the switch closes again. As in the step-up configuration, the average current through the inductor is equal to the load current.

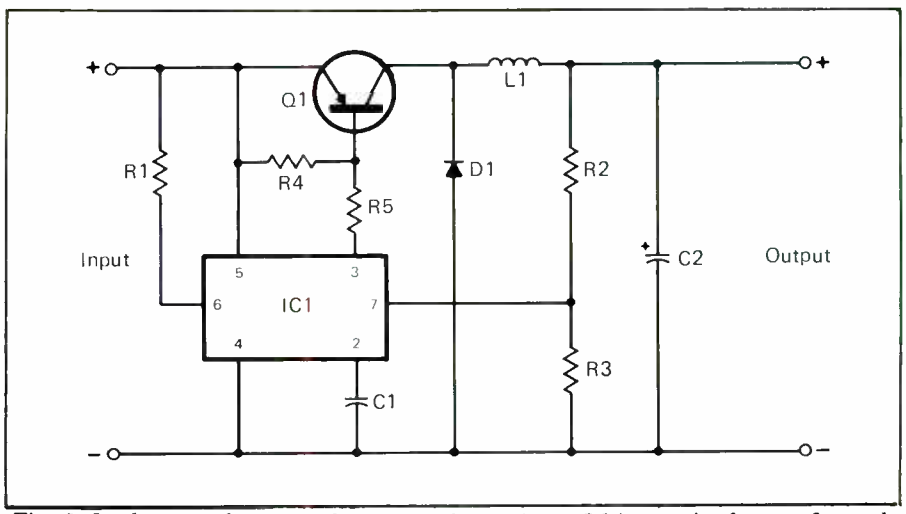


Fig. 5. In the step-down mode, external transistor Q1 is required to perform the switching function because of design restraints of the RC4192 regulator.

Figure 3 is a simplified block diagram of the RC4192 regulator. It contains a reference circuit that develops a stable output of 1.3 volts against which the output of the regulated supply is compared. Bias current (about 5 microamperes) for the reference circuit is set by an external resistor connected to pin 6 of the chip. The reference voltage is fed to one input of a comparator, the divided-down output of the regulator to the other input. Thus, when the voltage at pin 7 of the chip exceeds 1.3 volts, the comparator output goes high and cuts off the switching transistor through the NOR gate. An internal oscillator, whose frequency is determined by an external capacitor connected to pin 2, provides the

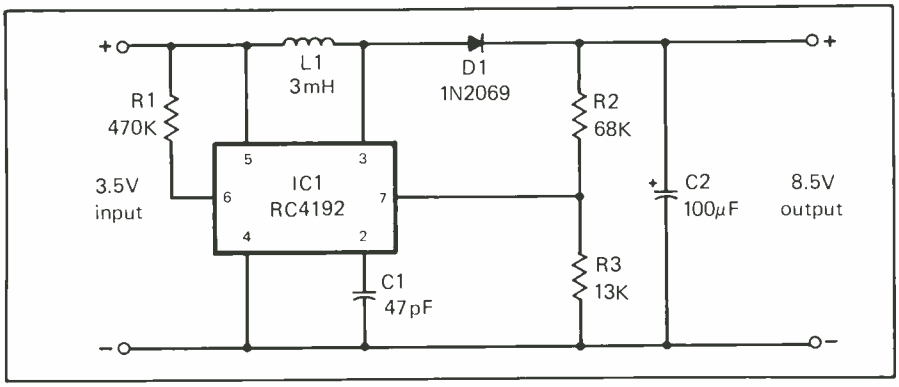


Fig. 6. Shown here is the complete schematic diagram of the step-up switching regulator built around the RC4192 and designed to deliver an 8.5-volt output.

switching signal through the NOR gate. The chip's internal transistor is the switch illustrated in Fig. 1. It's capable of switching currents as great as 150 milliamperes.

Although the step-up and step-down configurations of the switching regulator are different, it's possible to use the same IC to accomplish both tasks. Illustrated in Figs. 4 and 5 are the complete schematic diagrams of the two types of regulator circuits. In the step-down circuit, an additional transistor is required to perform the switching function, since the RC4192's internal switching transistor is connected to circuit common and cannot be placed in series with the input voltage.

Design Equations

Design of a step-up or -down switching regulator has been simplified by the Design Equation Table, which enables you to calculate the values of *R, L* and *C* for each circuit. The only things you must provide to solve the equations are input voltage, output voltage, and load currjent. The regulator's operating frequency is determined by the value of *C1*. This frequency is about 45 kHz for a *C1* value of 47 picofarads. The calculated value of *C2*, using the table, will provide a ripple output of about 0.1 volt rms or 0.3 volt peak-to-peak.

To illustrate an application that replaces a 9-volt transistor battery with a 3.6-volt NiCd battery as the power source that feeds a small AM/FM radio, it's assumed that load current (I_L) will be 10 milliamperes, input voltage (V_{in}) will be 3.5 volts, and that the switching regulator will provide an output (V_{out}) of 8.5 volts. Plugging these figures into the design equations for the step-up regulator, we obtain: *R1* = 460,000 ohms (460k); *R2* = 72,000 ohms (72k); *L1* = 0.0033 H (3.3 mH); and *C1* = 8.82 microfarads (8.82 μF).

Figure 6 illustrates the overall schematic diagram of this step-up switching regulator circuit in which the closest standard values for the calculated component values are shown.

Regulator Design Equations

Component	Step-Up (Fig. 4)		Step-Down (Fig. 5)	
R1	$\frac{V_{in}-1.2}{5\times10^{-6}}$	(ohms)	$\frac{V_{in}-1.2}{5\times10^{-6}}$	(ohms)
R2	$\frac{V_{out}-1.3}{0.0001}$	(ohms)	$\frac{V_{out}-1.3}{0.0001}$	(ohms)
R4	——		$\frac{35}{I_L}$	(ohms)
R5	——		$\frac{0.3V_{out}}{45{,}000I_L}$	(ohms)
L1	$\frac{0.3V_{in}(V_{out}-V_{in})}{45{,}000I_L(V_{in})}$	(Henrys)	$\frac{0.3V_{out}}{45{,}000I_L}$	(ohms)
C2	$\frac{2V_{out}-V_{in}}{0.018V_{out}}$	(microfarads)	$\frac{I_L}{0.018}$	(microfarads)
R3	13,000 ohms		13,000 ohms	
C1	47 pF		47 pF	

In Closing

When using switching regulator circuits, a word of caution is in order. Keep in mind that switching regulators operate at high audio frequencies and are rich in harmonics, the latter the result of sharp risetimes of the waveforms. If you use a switching regulator to power a radio receiver, be sure to use full shielding and filtering. If you don't, you'll find that the harmonics will cause considerable r-f interference with the signals being received. This interference is one of the penalties you must pay when using switching regulators. But it's little enough, considering the advantages to be gained. **ME**

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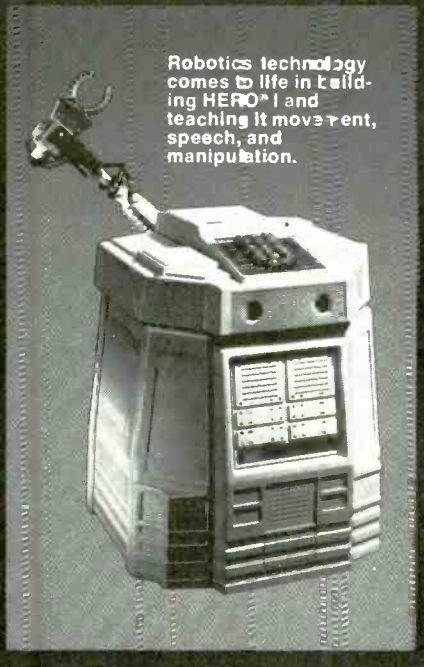

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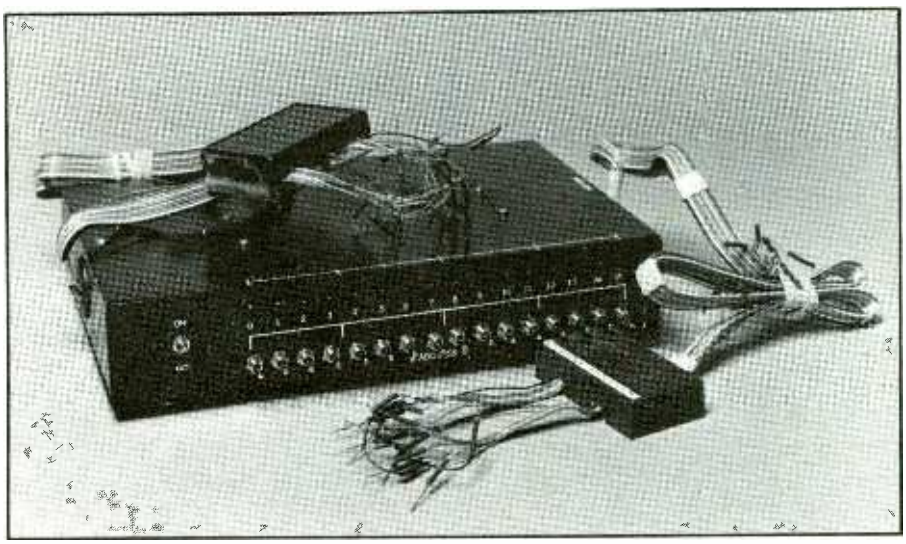
Store Soft: A 16-bit Logic Analyzer

Test instrument simplifies and speeds troubleshooting of computers and other digital systems

By Desmond Stelling



Knowing immediately what the software or hardware is doing in a digital fixture—whether it is a personal computer, digital controller or another digital device—is essential to good troubleshooting. You can, of course, use a digital logic probe or an oscilloscope to aid in tracking down a problem. However, the first won't give you the whole picture and the latter can be confusing if you're dealing with more than eight channels. The solution is to use a logic analyzer, such as the Store Soft described here.

Store Soft was designed to meet the troubleshooting needs of the technician involved in repairing the 16-bit breed of personal computer, though it can be used with any other digital system up to 16-bits. It acquires data at a single address on a rising-edge command and addresses from a data word on a falling-edge command. Therefore, it can be used to verify that a program is incrementing through its proper addresses. By storing a known data word at a given address, you can use the Store Soft analyzer to verify if this address is being executed.

Store Soft can store one 16-bit word from any computer or controller. Acquisition rates can exceed 8 MHz with 100% reliability. Store Soft simply compares incoming data or address with switch settings (the switches are in a single row on the project's front panel). When the data or address agrees and a valid strobe (trigger pulse) occurs, a latch driver stores the corresponding address or data and displays it via a row of LEDs, also on the front panel.

About the Circuit

In Fig. 2 is shown the entire schematic diagram of the basic Store Soft analyzer, including its ac power supply. Integrated circuits *IC1* through *IC4* are 54LS85 4-bit magnitude comparators. (Note: You can use either 54LS or 54S series TTL devices in this project.) When all four bits at A0 through A3 to *IC1* compare with the other four input bits at B0 through B3, the output at pin 6 goes high. The *S0* through *S3* switch arrangement on the inputs of *IC1* set up the least-significant-bit (LSB) code for the code being compared. Operation is identical for the *IC2, IC3* and *IC4* circuits and switches, which are identical to the *IC1* circuit.

As data is rippled through the inputs, the outputs for *IC1* through *IC4* compare as equal. When all four outputs (at pins 6) are high at the same time and a positive or negative edge is present, latches *IC6* and *IC7* store the information present at their inputs and selectively light *LED0* through *LED15* to display the unknown data. When the outputs of all four 4-bit comparators (pins 6 of *IC1* through *IC4*) go high, 4-input NAND gate *IC5A* is enabled and, in turn, applies a low on the enable in-

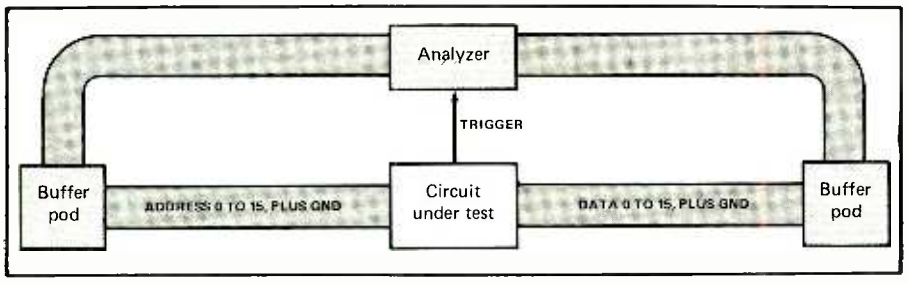


Fig. 1. Shown here is a typical setup for using a digital logic analyzer. Store Soft's buffer pods minimize undesirable effects due to long test leads.

PARTS LIST

D1 thru D4—1N4001 or similar power rectifier
IC1 thru IC4—54LS85 4-bit magnitude comparator
IC5—54LS20 dual 4-input NAND gate
IC6,IC7—54LS377 octal latch
IC8, IC9—54LS244 octal buffer line driver (four total)
IC10—LM309 +5-volt regulator
LED0 thru LED16—Light-emitting diode

Capacitors

C1,C2—0.1-μF disc (four total)
C3—1-μF, 10-volt tantalum (two total)
C4—100-μF, 50-volt electrolytic
C5—20μF, 10-volt electrolytic

Resistors (¼-watt, 10%)

R1 thru R16—5000 ohms
R17—1000 ohms

Miscellaneous

F1—½-ampere slow-blow fuse
J1—Panel-mount BNC jack
S0 thru S15—Dpst, center-off toggle switch
S16—Dpst toggle switch
S17—Spst toggle switch
T1—12.6-volt, 500-mA transformer
Perforated board and Wire Wrap hardware (or design-your-own printed-circuit board) for main circuit, two pc boards for buffer pods; sockets for all ICs except IC10; 12″×8″×2″ aluminum chassis box, bayonet fuse holder for F1; 17 panel-mount grommets for LEDs; two 3″×2″×1″ plastic boxes (see text); 6-ft. 20-conductor flat ribbon cable, preferably color-coded; ac line cord with plug and strain relief or rubber grommet; two large rubber grommets for pod cable holes; 1-lug (ungrounded) terminal strip; 34 machined push-on sockets; heat-shrinkable tubing; Wire Wrap materials; four spacers; silicone adhesive; spray paint; dry-transfer or other lettering kit; machine hardware; hookup wire; solder; etc.

Note: The following is available from DDS Systems, P.O. Box 5715, Glendale, AZ 85312: pod pc boards at $5.95 ea.

puts at pins 1 of *IC6* and *IC7*. The latch stores new data only when the enable inputs of *IC6* and *IC7* are low and a rising edge appears on pins 11.

To be able to analyze a particular system, Store Soft's input lines should be about 36″ long to permit access to various signals that may be widely separated. However, such long lengths can pose a number of problems that can interfere with proper operation of the analyzer. System noise and capacitance, for example, can result in improper levels for triggering an input gate. Therefore, buffer pods must be used near the far ends of the address and data cables, as shown in Fig. 1.

Store Soft's buffer pods each consist of two 54LS244 octal buffer line drivers, identified as *IC8* and *IC9* in Fig. 3. Buffering action of these ICs effectively minimizes undersirable effects introduced by long lead lengths, Hysteresis at the inputs improves the noise margins tremendously. Store Soft conveniently provides the +5 volts and ground required by the pods.

Power for the project is provided by the ac-line-driven circuit shown at the bottom of Fig. 2. In this full-wave supply, filtering is provided by *C4* and *C5* and voltage regulation is provided by *IC10*. Current-limiting resistor *R17* and POWER light-emitting diode *LED16* are optional and can be eliminated or replaced by a panel-mount neon lamp assembly wired across *T1*'s primary, after *S17*.

Construction

If you wish, you can design and fabricate a printed-circuit board on which to mount the *IC1* through *IC7* and power-supply circuits. It's not difficult to do. However, I found it easier and simpler to Wire Wrap these circuits on a small piece of perforated board. Besides saving time and eliminating the need to fuss with messy chemicals, the Wire Wrap approach kept the circuit assembly much more compact than it would have been if I had used a pc board.

For the two buffer pods, however, you do need pc boards to keep the depth within reasonable limits. It's much easier to connect and solder the multitude of wires that make up the ribbon cables between the main Store Soft assembly and the appropriate points in the pods if pc boards are used. An actual-size etching-and-drilling guide and components placement diagram are shown in Fig. 4.

Carefully following Fig. 2, wire the main circuit board. Use sockets for all ICs, regardless of whether you use the Wire Wrap technique or a pc board. Referring to Fig. 4, install and solder into place the three capacitors and two ICs on each of the buffer pod boards. Install the ICs, making sure you properly orient them.

Cut in half a 72″ length of 20-conductor ribbon cable. This cable should preferably be color-coded to limit the possibility of wiring errors.

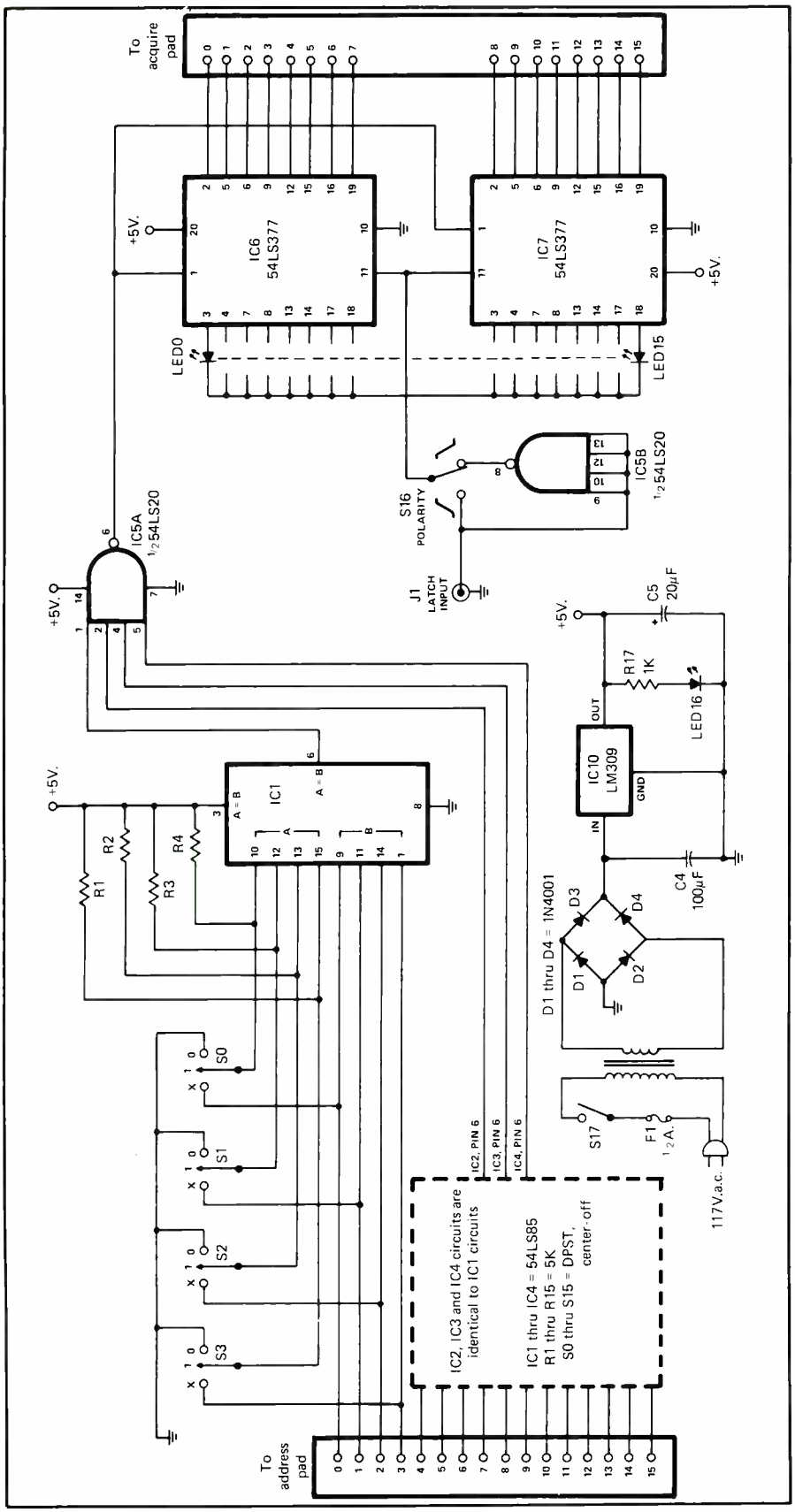


Fig. 2. This is the schematic diagram of the analyzer's main circuitry, including a 117-volt ac-line-operated power supply, shown at lower-left.

Next, divide the two cable halves into 12″ and 24″ lengths. Remove two conductors from each section of cable. If you're using single-color ribbon cable, remove the conductors from the *un*marked side. Carefully separate the conductors at both ends of the 24″ and one end of the 12″ cables for a distance of about 2″ and at the other ends of the 12″ cables for a distance of about 6″.

Strip ¼″ of insulation from both ends of all conductors in all four cable sections. Twist together the fine wires in each conductor and lightly tin with solder. Set one 12″/24″ cable pair aside and wire the other pair to one of the pod circuit board assemblies, referring to Fig. 4 for details. Note in the drawing that the pads to which the cable conductors connect are labeled with a letter/numeral designation. The prefix letters are either an "I" for input from the circuit under test or an "O" for output to the analyzer. Keep this in mind as you wire each conductor to the board at the 2″ separated ends of first the 12″ (I prefix) and then the 24″ (O prefix) cables.

If you're using single-color cable, start connecting at pin 20 of *IC8* with the marked conductor and finish at pin 11 of *IC9* with the last conductor of the 24″ cable. Similarly, start with pin 2 of *IC8* with the marked conductor and end at pin 10 of *IC9* with the 12″ cable.

At the free end of the 12″ cable, install onto each conductor a machined push-on socket. Cut short lengths of small-diameter heat-shrinkable tubing and slip a length over each of the 18 sockets. The tubing should be long enough to cover the entire socket and soldered connection but not overlap

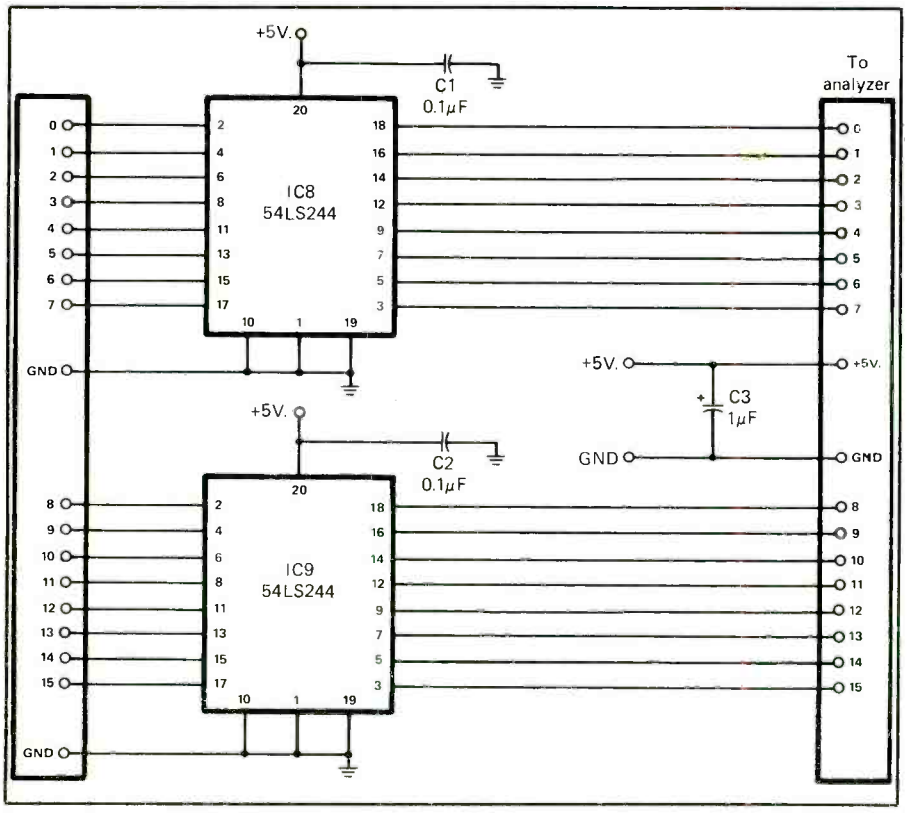
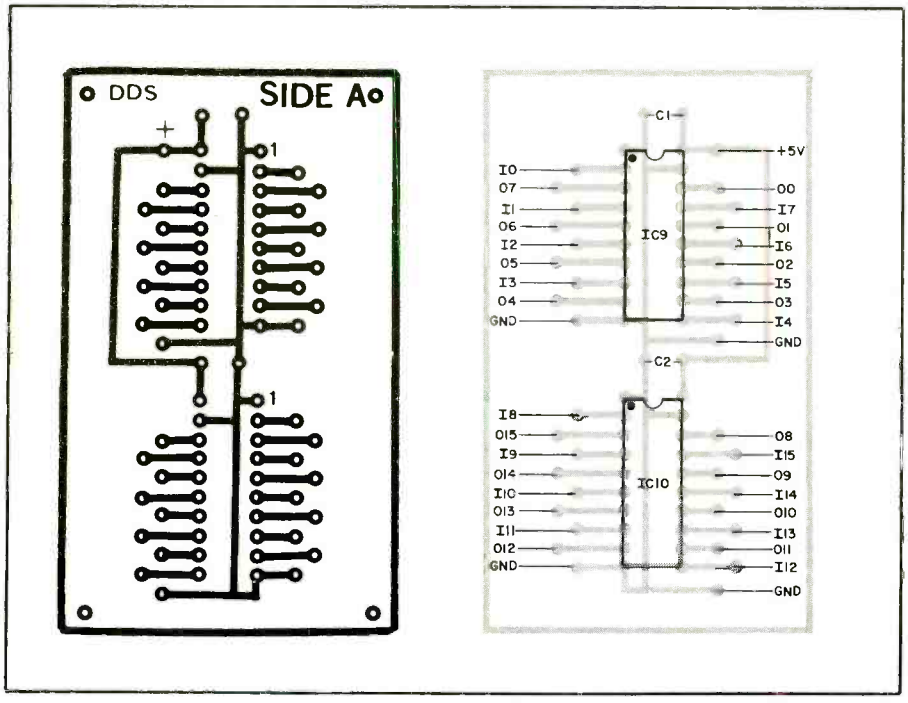


Fig. 3. Two octal buffer line drivers, located at the ends of the cables that connect the circuit being tested to the analyzer, offset noise problems.

Fig. 4. Shown here are the actual-size etching-and-drilling guide to use when fabricating the two printed-circuit boards needed for the buffer pods, plus the components placement/orientation and ribbon cable wiring diagram.



the open end of the socket when shrunk. Attach identification labels (+5V, GND, 0, 1, etc.) from a tag strip or hand made from tape to each conductor just past the tubing.

Repeat the above procedure for the second buffer pod circuit board assembly and remaining ribbon cable sections. When you've done this, separate the 12″ cables in each pod assembly into two bundles, each containing nine conductors, such that all conductors for *IC8* and ground are in one bundle and all those for *IC9* and the second ground are in the other.

Separate the two sections of two 3″×2″×1″ plastic boxes (the clear-top/opaque-bottom kind sold in hardware and variety stores). Set a pod circuit board assembly into the bottom (opaque) half of each box, with the 24″ cables exiting the rear of the boxes between the hinge "knuckles" and the two nine-conductor bundles exiting the front. Space the nine-conductor bundles far enough apart to avoid interference with the locking mechanism. Mark the limits of the cable sections on the box halves. Remove the pod electronics and reassemble the boxes. Transfer the marked locations to the top halves. Then carefully remove just enough plastic from the top halves to provide exit room from the cable sections without causing interference with the hinges and locking mechanisms. Return the pod electronics to the boxes; reassemble the boxes and tape them shut.

A 12″×8″×2″ aluminum chassis box is an ideal cabinet for the Store Soft's main electronics. It has sufficient room for the circuitry, a low silhouette and a high enough front panel to permit the data switches and LEDs to be arranged in two paired horizontal rows (see lead photo).

Drill the mounting holes for TRIGGER input jack *J1* and the fuse holder for *F1* and the entry holes for the ac line cord in the rear panel. Carefully mark the hole locations for the LEDs

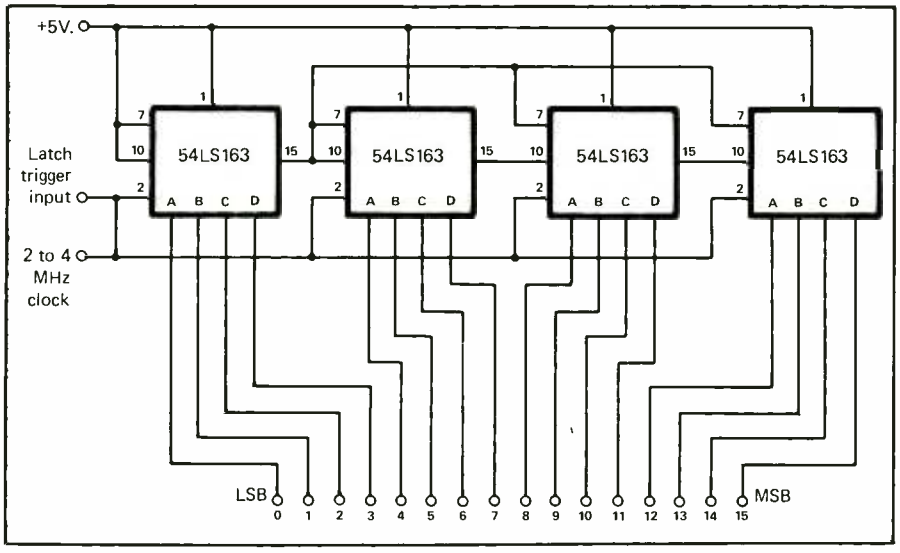


Fig. 5. Breadboard this 16-bit synchronous counter and use it to check out Store Soft's operation before putting it into service on your bench.

and all switches (except POLARITY switch *S16*) on the front panel. Dimple each marked location with a center punch to prevent the bit from slipping when you drill the holes.

Narrow rectangular slots are required for the entry holes for the buffer pod cables. A nibbling tool will speed and simplify making these slots. If you don't have a nibbler, you'll have to drill a series of interconnecting holes and use a file to obtain the desired shape.

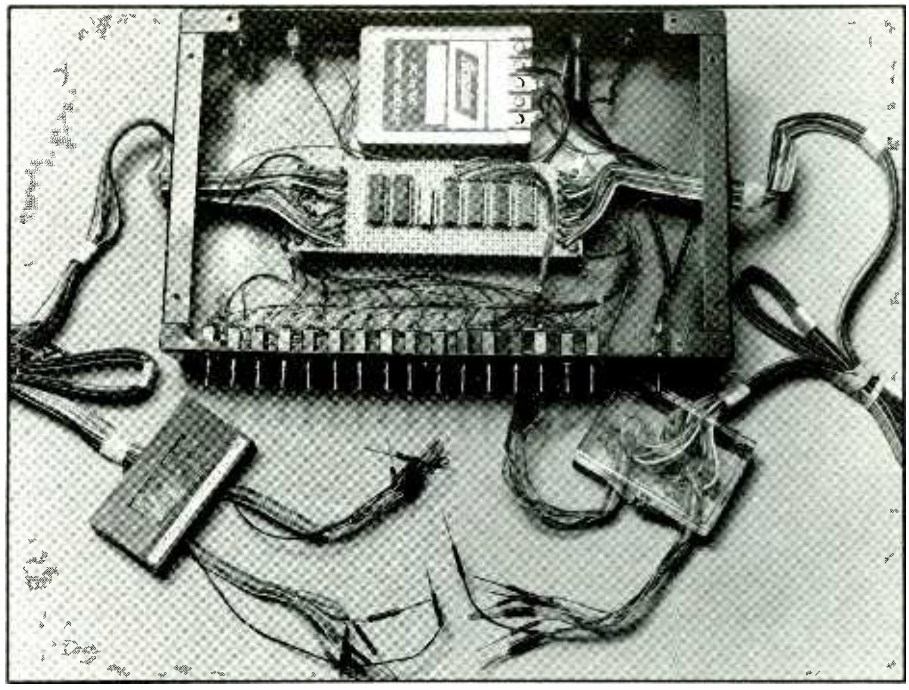
Drill the mounting holes for the main circuit board and power transformer *T1*. Deburr all holes and thoroughly clean all exterior surfaces of the box. Allow the box to fully dry before painting it. For best results, apply two or three *light* coats of spray paint, allowing each to dry before spraying on the next. When the paint is completely dry, use a dry-transfer lettering kit or other means to label the LEDs, switches, jack and pod cables (see lead photo). If you use dry-transfer lettering, protect it with two or more very light coats of clear spray lacquer.

Line the pod cable slots with large grommets and install a small rubber grommet in the ac line cord hole to protect the wires from fraying against bare metal. Mount *J1*, the fuse holder, LEDs (in panel-mount grommets) and switches. Feed the unprepared ends of the pod cables into the box through the slots. Mount *T1*, placing a single-lug (ungrounded) terminal strip under the hardware of one mounting tab.

Strip ¼" of insulation from the unprepared ends of both ac line cord conductors. Tightly twist together the fine wires in both conductors and lightly tin with solder. Pass this end through its grommet into the box. Tie a knot in the cord about 6" from the prepared end and separate the conductors for a distance of about 3". Crimp and solder one *primary* lead from the transformer and one line cord lead to the lug on the terminal strip. Then, referring back to Fig. 2, complete wiring the primary circuit of the power supply, connecting and soldering the other line cord conductor, fuse holder, POWER switch and remaining transformer primary lead in series.

(Continued on page 90)

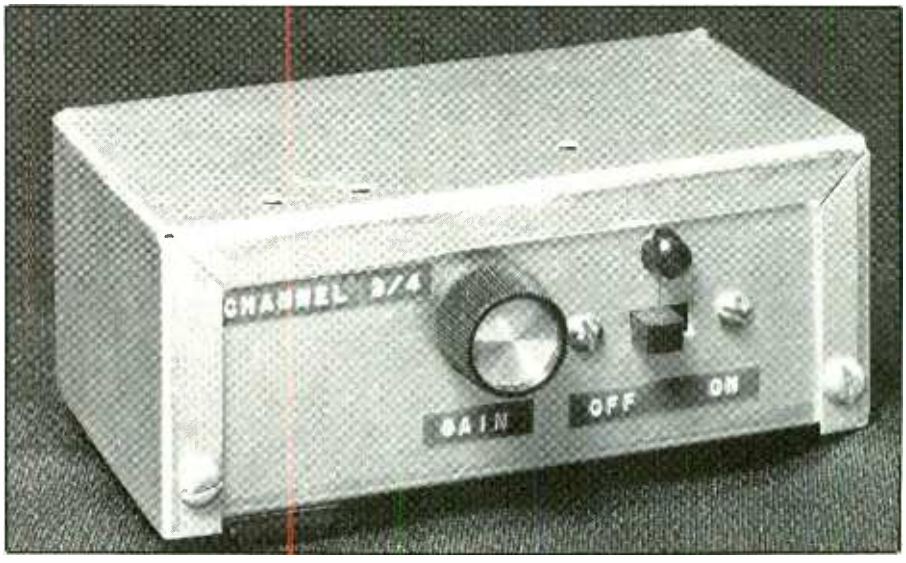
This is the interior view of the author's prototype. Main circuitry is wire wrapped on perforated board. The commercial power supply module shown was used because author had it on hand.



A Simple Cable Communications System

A standard TV/video-game r-f modulator plus a home-brew dual-IC receiver lets you use cable to transmit analog or digital signals over long distances

By Duane M. Perkins



Transmission of high-frequency signals over a coaxial cable is easily achieved using a vhf carrier. The "transmitter" for such a system is a readily available Aztec Model UM1285-8 (or similar) r-f modulator commonly used to transmit pictures from a home computer or video game to a TV receiver. The modulator is a relatively inexpensive item that doesn't require any "construction" on your part. It's designed so that you can simply use the signal you want to transmit to modulate the video carrier. Then all you need to complete the system is a receiver at the other end of the cable. We'll tell you how to build this receiver inexpensively from components you can obtain from local electronics parts stores and mail-order houses.

Although the r-f modulator is designed to serve as a transmitting device for pictures from a video signal source to a TV receiver, it isn't restricted to just this use. It can also be modulated with any analog and/or digital signal that falls within the 4-MHz bandwidth of the commercial broadcast TV video (picture) signal. Since the modulator can accommodate high-frequency dc pulses, the system is a natural for digital transmission. An obvious application here would be high-speed transmission of data from a home computer over a substantial distance. Time- or frequency-division multiplexing would allow for simultaneous transmission of multiple signals.

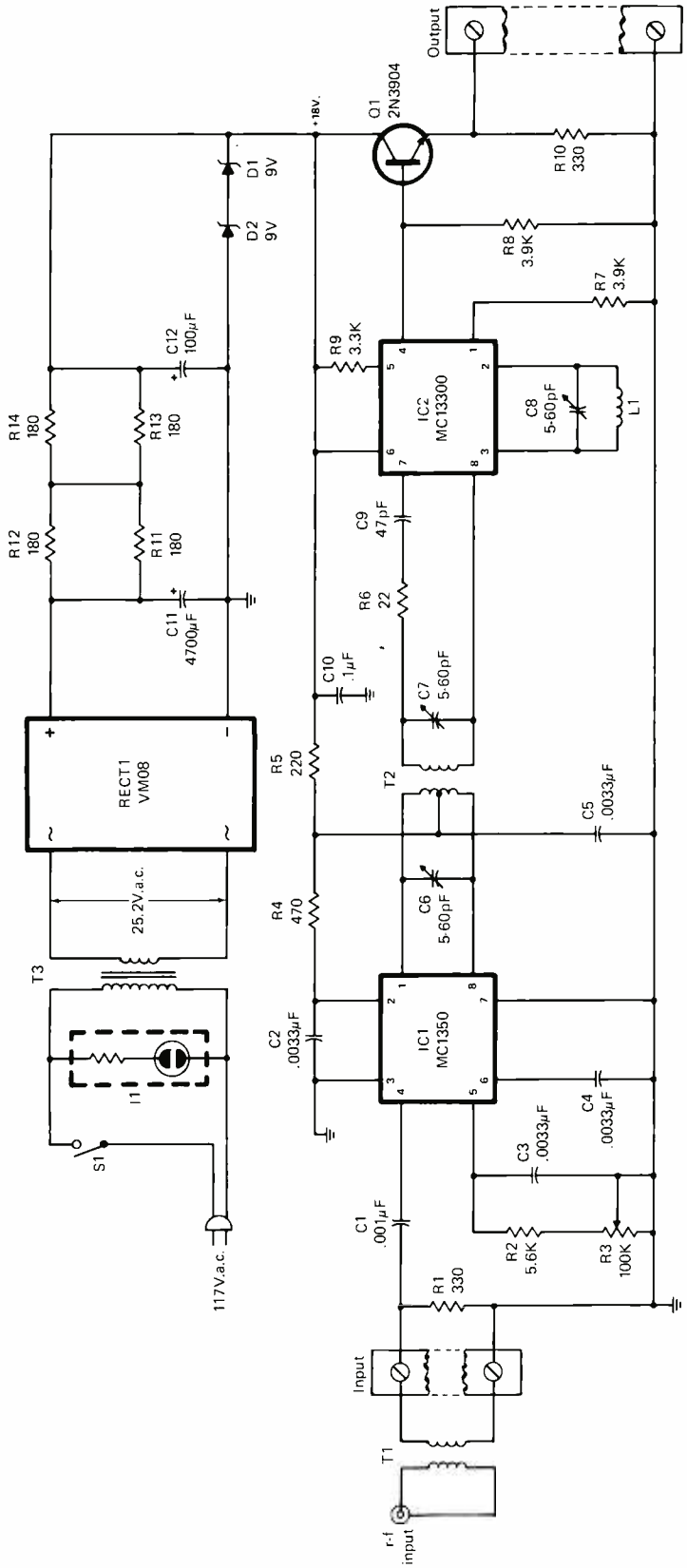
About the Receiver

A suitable receiver for your cable communication system can easily be built with the aid of two ICs that greatly simplify assembly, since they contain all of the circuitry required for their separate functions. These ICs are the MC1350 i-f amplifier and the MC1330 video detector. Just add a few capacitors, resistors and coils, plus a suitable power supply, and you have a complete receiver (see Fig. 1). The coils are all hand-wound, using magnet wire, and are easy to make. A 75-to-300-ohm TV matching transformer provides the means for coupling the input from the 75-ohm cable to the receiver.

To match the capability of the transmitter, the receiver must be capable of demodulating a carrier on the 61.25-MHz channel-3 or 67.25-MHz channel-4 frequency to deliver a dc output signal with frequency components that do not exceed the 4-MHz bandwidth.

Considering what it does, the receiver circuit shown in Fig. 1, along with its ac-line-operated power supply, is really quite simple. Though the MC1350 specified for *IC1* is described by the manufacturer as an i-f amplifier, in our receiver we use it as an r-f amplifier.

Transformer *T1* isolates the cable from the receiver's ground (this may not be necessary) and doubles the in-



PARTS LIST

Semiconductors

D1,D2—9-volt, 1-watt zener diode
IC1—MC1350 i-f amplifier
IC2—MC1330 video amplifier
Q1—2N3904 or similar npn silicon transistor
RECT1—VM08 or similar bridge rectifier

Capacitors

C1—0.000-μF disc
C2 thru C5—0.0033-μF disc
C6,C7,C8—5 to 60-pF trimmer
C9—47-pF disc
C10—0.1-μF disc
C11—4700-μF, 35-volt electrolytic
C12—100-μF, 35-volt electrolytic

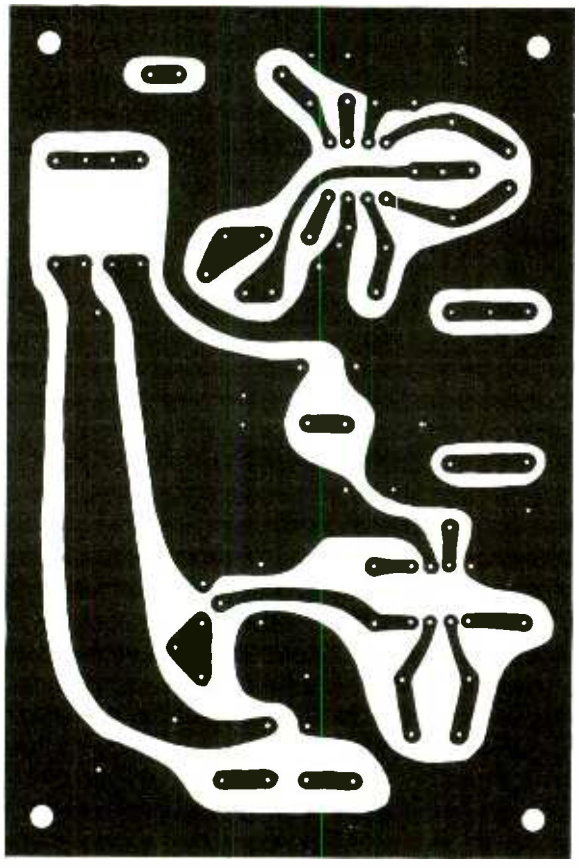
Resistors (¼-watt, 10%)

R1,R10—330 ohms
R2—5600 ohms
R4—470 ohms
R5—220 ohms
R6—22 ohms
R7,R8—3900 ohms
R9—3300 ohms
R11 thru R14—180 ohms
R3—100,000-ohm linear-taper potentiometer

Miscellaneous

I1—Panel-mount neon-lamp assembly
L1—R-f coil (see text)
S1—Spst slide or toggle switch
T1—75-to-300-ohm TV matching transformer
T2—R-f transformer
T3—25.2-volt, 300-mA transformer
Suitable size aluminum case (Radio Shack No. 270-238 or similar); printed-circuit board; 4-contact barrier block; ac line cord with plug; control knob for R2; 22-gauge magnet wire; ½" spacers (4); rubber grommets; rubber feet (4); machine hardware; hookup wire; solder; etc.

Fig. 1. In this overall schematic diagram of the receiver, circuit design is greatly simplified by the use of specialized i-f amplifier (MC1350) and video amplifier (MC1330) integrated circuits. Coils L1 and the primary and secondary of T2 are hand-wound. The ac power supply is shown at top.



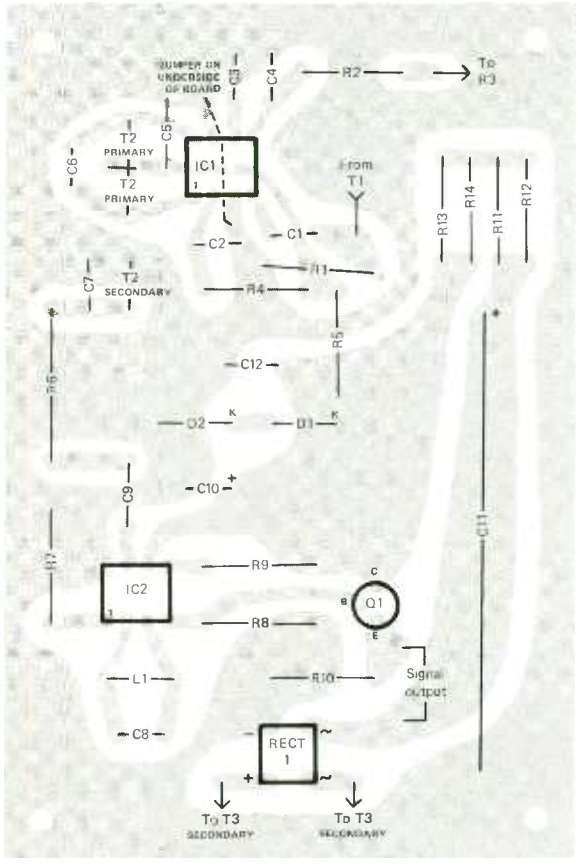


Fig. 2. Shown at the left is the actual-size etching-and-drilling guide to use when home fabricating the receiver printed-circuit board. The illustration at the right gives details for installing and orienting components.

put voltage. If you wish, you can connect the cable directly to the input, though there will be a loss of half the gain. If you make a direct connection to the input, change the value of *R1* to about 75 ohms.

R-f transformer *T2* couples the amplified r-f signal from the output of *IC1* and delivers it to the input of detector *IC2*, which further amplifies the signal prior to demodulation. Detector output at pin 4 of *IC2* has a peak-to-peak amplitude of about 6.5 volts, which is fed to *Q1*. The purpose of emitter-follower stage *Q1* is to lower output impedance to about 300 ohms.

High-frequency ac signals can be matched to a 75-ohm coaxial cable with another matching transformer connected to the output of the receiver at the emitter of *Q1* through a suitable coupling capacitor. Subcarriers can be pulled off in this manner and sent to a suitable receiver/demodulator.

Potentiometer *R3* controls the r-f amplifier's gain as needed to compensate for cable attenuation in long runs. Lowest gain is ample for a short cable run. However, cable losses of 18 dB or more, which occurs at about 900 feet with RG-59/U, can be compensated for by adjusting *R3* to increase gain.

Power for the circuit is derived from the 117-volt ac line through a power supply, shown at the top in Fig. 1. This is a simple, straightforward supply in which a pair of zener diodes (*D1* and *D2*), each rated at 9 volts, regulate the 18 volts dc required by the circuit. Power-on indicator *I1* is optional.

Construction

Careful consideration must be given to the high frequencies and high gain involved in the circuit when building the receiver. This is particularly important with regard to *L1* and *T2*. Any coupling between these two components is almost certain to result in undesired oscillations. Therefore, it's necessary to arrange your layout so that *L1* and *T2* are physically separated from each other and that their axes are in 90° opposition. Construction is best done on a printed-circuit board, an actual-size etching-and-drilling guide for which is given in Fig. 2. Also shown in Fig. 2

is the components placement/orientation diagram.

Before you begin construction, prepare the coils that make up *L1* and *T2* by closely winding 22-gauge magnet wire on a ¼" form, such as the shaft of a potentiometer. Wind five turns for each half of the primary and 10 turns for the secondary of *T2* and 10 turns for *L1*. Then carefully scrape away the enamel coating from each end of each coil and the center tap of *T1*'s primary and tin with solder. Note that these coils all have an air core.

Referring to the components placement/orientation diagram in Fig. 2, install the components exactly as shown. Make sure all are properly oriented and indexed before soldering them into place. Note that the primary and secondary coils that make up *T2* mount in-line, rather than parallel to each other as is usually the case with transformers.

Remove ¼" of insulation from each end of three 4" lengths of red- and four 4" lengths of black-insulated hookup wires. Loosely twist together three red/black wire pairs. Remove an additional ¼" of insulation from only one end of the black wire in one pair and install and solder the *opposite* ends of these wires in the holes labeled R3 on the components-placement diagram. Plug one end of each of the remaining wire pairs into the holes labeled INPUT and OUTPUT and solder into place. (Note: Use the red wire for signal "hot" and the black wire for signal ground in all three cases.) The fourth black wire goes to the hole labeled S1.

Temporarily set the pc board assembly on the floor of the aluminum enclosure in which the project is to be housed and mark the locations in which its mounting holes are to be drilled. Remove and set aside the board and drill the holes. Machine the front panel (the side of the box nearest the trimmer capacitors) to accommodate *I1*, *R3* and *S1*. Make sure you locate these holes where the components that mount in them won't interfere with or touch the components on the circuit board. If you wish to avoid having to cut a rectangular hole for a slide switch, use a toggle switch for *S1* so that only a single round hole need be drilled. Then drill the five holes through the rear wall, sized according to the needs of the hardware for the barrier block and the rubber grommets for the input and output wire pairs and the line cord.

Mount the barrier block on the outside real wall of the box. Strip ¼" of insulation from each lead of *I1*. Tightly twist together the fine wires in each lead and sparingly tin with solder. Remove the retaining nut from *I1* and mount the lamp assembly in its holes on the front panel. Repeat this procedure for the two conductors at the unfinished end of the ac line cord and then separate the conductors for a distance of about 3".

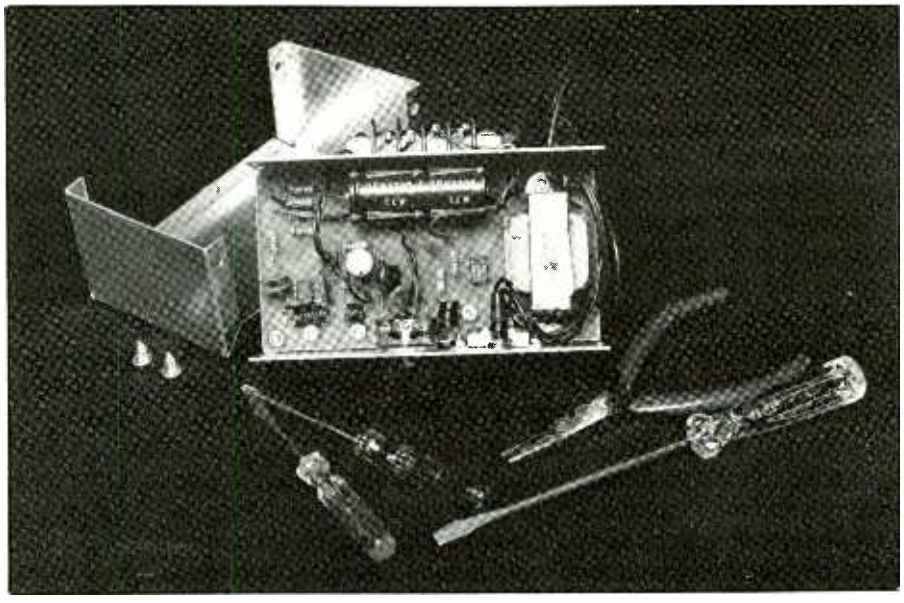
Pass the free end of the ac line cord through its rubber grommet, feeding it from the outside into the box. Tie a knot about 4" from the prepared end to serve as a strain relief. Insert either lead of the line cord in the hole labeled AC INPUT on the board and solder into place. Crimp and solder the other ac line cord lead to one lug of *S1*. Mount *S1* on the front panel. Then locate the single fourth black wire and one lead of *I1* and crimp both to the other lug of *S1*. The other *I1* lead goes into the hole labeled I1 on the pc board.

Mount *R3* on the front panel, pointing its lugs upward and in line with the top lip of the box. Viewing the project with the front panel facing you, the lugs on *R3* are now 1, 2 and 3 from left to right. Locate the red/black twisted-pair wires for *R3* (the one with the extra ¼" of insulation removed from the black wire). Pass the bare conductor of the black wire through lug 2 and crimp it around lug 3 and solder both connections. Crimp and solder the red wire to lug 1.

Feed the remaining two pairs of red/black twisted-pair wires through the two small rubber grommets in the rear wall of the box and solder to the ends of each wire a spade lug. Slip the

(Continued on page 94)

Interior view of project. Note that 4-contact barrier block mounts on rear panel. Position pc board with large filter capacitor along rear panel.



Connector Replacement Service Tips *

How to remove damaged connectors without damaging the pc boards on which they are mounted

Frequent insertion and removal of circuit cards on which connectors, such as the Amphenol types commonly used in personal computers, are mounted can result in broken plastic edges or/and broken or bent fingers or pins (see Fig. 1). Replacement of such connectors entails desoldering and possible heat damage to the boards. However, if you go about the job in the correct way, you should never encounter this problem.

A procedure that will not damage pc boards has been developed at Hewlett Packard's Mountain View Service Center. Though the procedure was developed for use in a well-equipped service center, the tools required to do the job are common items in most small shops and on many home workbenches. What you need to perform the procedure properly are: a Dremel Moto-Tool™ or similar rotary tool; a grinding disc; an adjustable vise, such as those designed by Panavise for electronics use; a 60-watt soldering iron; long-nose or similar pliers; and perhaps a solder-sucking tool and/or desoldering braid. Also, since the work to be performed involves grinding of metal, which can pose a hazard to your eyes, you should use a faceplate or, at the very least, safety goggles.

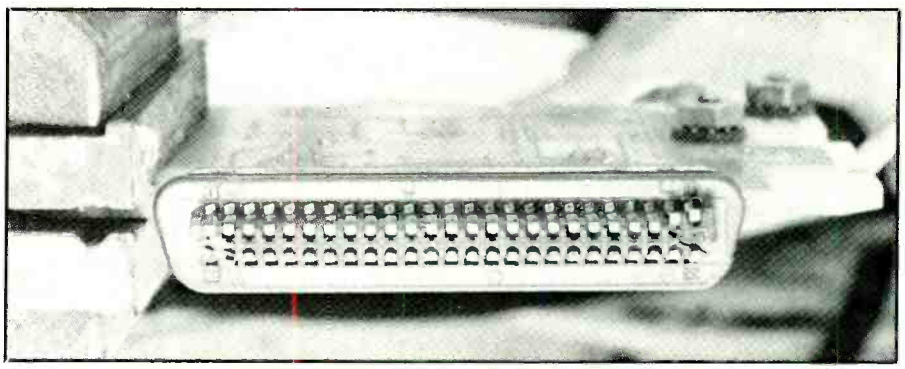


Fig. 1. A typical example of a damaged Amphenol connector.

Connector Removal. The first thing you do is clamp the board from which a connector is to be removed in the vise. Orient the board so that the connector will always be in full view during the grinding operation as shown in the Fig. 2 photo.

Cutting away the connector is done in two stages. With the grinding disc chucked into the rotary tool, grind completely through each connector pin, just below the connector housing, as shown in Fig. 3. Remove the board from the vise, flip it over, and repeat for the pins on the other side of the board. This done, remove any machine hardware that anchors the connector to the board. Discard the damaged connector.

Cleaning Characteristics of Various Solutions

Cleaner type	Concentration	Times tested	Times satisfactory
NH4OH	29.5% NH3 by weight	18	16
IPA only	99.5% assay	8	0
IPA/H2O	50:50, 99.5% assay	10	1
IPA/H2O	80:20, 99.5% assay	18	7
KOH	45.0% to 46.0%	18	5

*Material in this article has been adapted with permission from articles in *Bench Briefs*, a Hewlett-Packard publication.

Fig. 2. Connector removal setup.

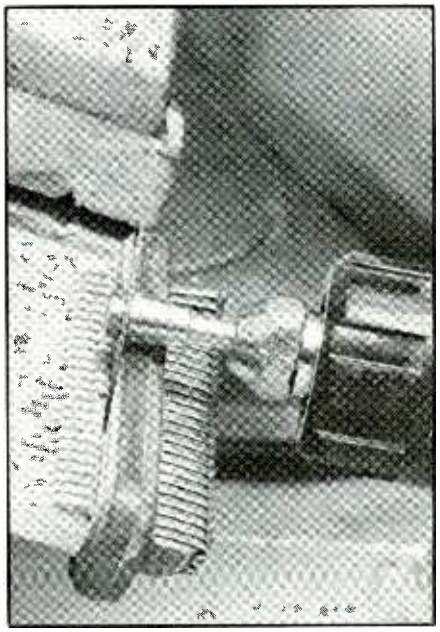
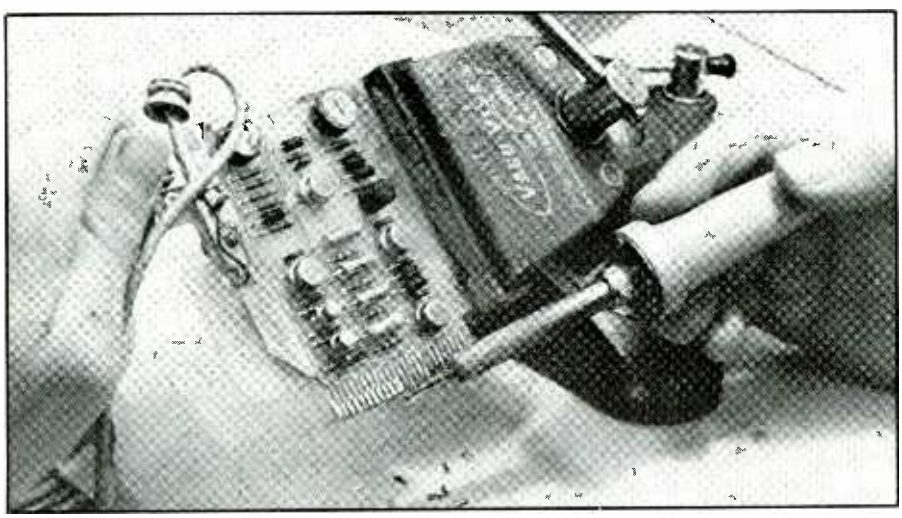


Fig. 3. Cutting tool position.

You now have the stubs of the connector pins protruding from the surface of the board. (If you removed an Amphenol connector like that shown in the photos, there will be a row of such stubs on both sides of the board. With other types of connectors, you might have only one row or two parallel rows of such stubs. In any case, the procedure that follows is basically the same.) Make sure your soldering iron tip is up to operating temperature. With your pliers, firmly grasp a pin stub, apply heat to the connection, and when the solder flows, gently pull the pin stub out of the hole. Wait for the solder to be completely molten before you pull on the pin stub; otherwise, you might still damage the board by lifting the foil trace. Also, use a relatively high-wattage soldering iron so that the time it takes for the solder to flow is very short. Repeat the procedure for each remaining pin stub.

Fig. 4. Removing the pin stubs.



Connector Replacement. Having removed the pin stubs from the board, you will probably note that some or all of the holes are clogged with solder. Before you can install a new connector on the board, you must clear the holes of this solder. This involves reheating each solder pad until the solder flows and either sucking the solder up with a solder sucker or wicking it up with solder wick. Again, heat each pad only as long as necessary to insure against damage to the board's substrate or lifting of the foil traces.

Install the new connector on the board, carefully aligning its pins with the appropriate holes and making sure the connector is properly oriented. Anchor the connector to the board with appropriate machine hardware. Finally, solder each connection point. Use heat and solder sparingly (you need only enough to assure good electrical and mechanical joints). Take care to avoid creating solder bridges.

If you follow this procedure in every detail, you will find that connector removal and replacement is indeed a simple and easy task to perform.

Clean Fingers. In a related matter, the subject of dirty or/and corroded or oxidized foil "fingers" on the edges of pc boards designed to plug into connectors can be a very real problem, especially in personal computers. Many computers and other electronic products sent to service facilities for repair need nothing more than a good cleaning (and protection from causes of dirt and oxide contamination) to put them back into service. Again, the people at Hewlett Packard have devised a solution that can be used in any repair and maintenance facility, including the home workshop.

In the HP Labs, a number of popular cleaning solutions for edge-connector fingers were studied to determine their effectiveness. The results are summarized in the table. Note that the three solutions that performed the best were ammonium hydroxide (NH4OH), an 80:20 mix of isopropyl alcohol and water (IPA/H2O), and potassium hydroxide (KOH). Ammonium hydroxide was obviously the best, doing a good job of cleaning, improving cosmetic appearance, and providing no decay in resistance to atmospheric corrosion in tests following cleaning. A moderately successful second choice was the 80:20 alcohol/water solution.

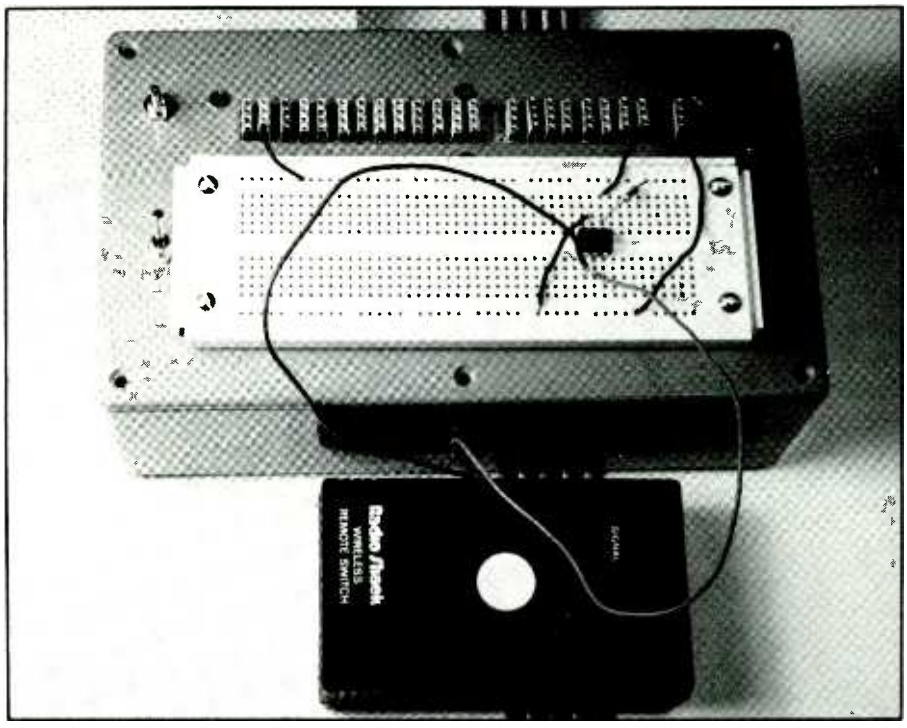
From these results, one can conclude that the alcohol/water solution, though not ideal, is the better choice of cleaner, basically because it does not require special handling procedures or special ventilation.

The cleaning procedure is relatively simple, too. Simply saturate a cotton swab with the alcohol/water solution and vigorously scrub the connector fingers to remove dirt, oxidation and corrosion. Thereafter, just let the circuit board air dry. **ME**

Using the Experimenter's Interface Device

Experimenting with input and output lines on a Commodore-64 computer

By Dovell M. Bonnett
and
Kendra R. Bonnett



The Experimenter's Interface Device (EID) presented in earlier articles (April and May 1985 issues) offers Commodore-64 users an opportunity to explore custom hardware applications. With the EID, you can operate or control virtually any electrical device from your C-64 simply by controlling the computer's input and output (I/O) lines. In this article, we'll show you how to connect devices to the EID's I/O lines and control them with software. To get you started on your own experimenting, we've included a simple home alarm circuit that can be expanded into a very sophisticated system and a wireless remote-control switch that lets you turn on and off an electrical appliance or light plugged into an ac socket.

Before we do this, however, it is important that you understand how to access the C-64's I/O lines and program them as needed for a given application. To this end, we start off with a couple of experiments you should breadboard and run. You're invited to make changes in the software to gain familiarity and confidence in actually programming and using the I/O lines. Almost certainly, the experiments and projects presented here will trigger ideas of your own—which is really what the LED is all about.

Controlling I/O

You control input and output through the EID's PB7 through PB0 data lines. Fig. 1(A) will get you started experimenting with a simple light-emitting diode (LED) indicator circuit. Wire the circuit exactly as shown in Fig. 1(B), making sure you properly orient the LEDs before plugging them into the breadboarding socket. (Note: Component descriptions and values for all circuits in this article are given in the General Parts List.)

Plug the EID into the user port in the rear of the C-64 and the 9-volt power supply into the EID and an ac outlet. Turn on your computer. Flip *S2* to ENABLE. All LEDs should light. Key in 56579,256 and RETURN to extinguish all LEDs.

The input and output lines of the C-64's user port are controlled by two memory locations—56579 (data direction register, or DDR) and 56577 (port). The DDR sets each of

GENERAL PARTS LIST

Semiconductors

LED0 thru LED7—Light-emitting diode

IC1—TIL111 optocoupler

Q1—General-purpose npn silicon transistor (2N3904 or similar)

Resistors (¼-watt, 10%)

R0 thru R7—300 ohms

R8—330 ohms

R9,R10—1000 ohms

Miscellaneous

LDR—Cadmium-sulfide light-dependent resistor

MT1—Pc-board mount piezoelectric buzzer (Radio Shack No. 273-065 or similar)

Wireless remote control switch (Radio Shack No. 61-2665 or similar); red and black No. 22 stranded hookup wire; No. 22 solid hookup wire (for breadboarding wires); solder; etc.

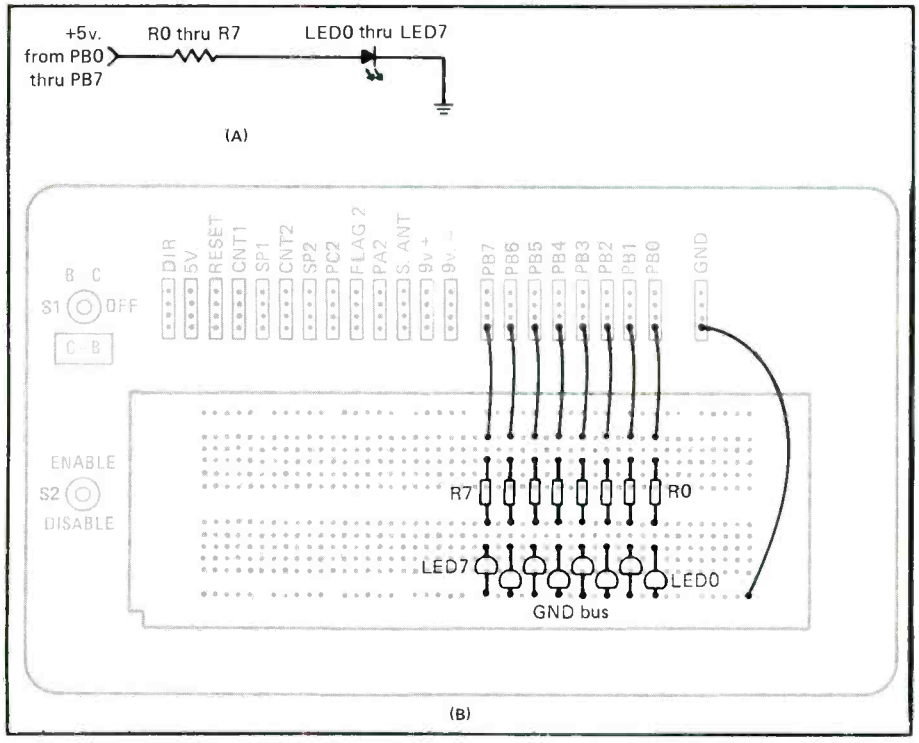


Fig. 1. Experiment for understanding how C-64 computer and EID are used to control input/output. Circuit is shown in (A), wiring details are shown in (B). Circuit can be modified to allow C-64 to serve as programmable alarm clock.

the eight data lines to receive or send information, serving as input or output, respectively. If a bit in the DDR is 1, the corresponding data line is set for output. If a bit is 0, that data line is set for input.

For example, PB7 through PB0 might be set as follows in descending order: 01110100. Here, data lines 2, 4, 5 and 6 would be outputs, while the other lines would all be inputs. Converting the binary code in this example into decimal format yields 116, and keying POKE 56579,116 sets the ports accordingly. If you wished to set all ports to the output state, enter POKE 56579,255; pressing RETURN after keying in this code will extinguish all LEDs. To turn all ports into inputs and light up all the LEDs, simply enter POKE 56579,0.

Now that you know how to set the data lines to the desired I/O functions, let's use selected outputs to light specific LEDs, using the computer's 5-volt power source as an output "signal." To direct this signal to selected ports, use POKE 56577 and a decimal number between 0 and 255, depending on which lines you want to be outputs and which you want to be inputs. Just as you control input and output with decimal equivalents of binary numbers, you can also turn on various combinations of data lines.

An example of this might be to set only lines PB7, PB6, PB3, PB2 and PB0 to outputs and the remaining lines to inputs. To do this, convert the binary code 11001101 to its decimal equivalent (205). Before keying in this new code, however, type in POKE 56579,255 and then RETURN to first set the system so that all lines are outputs. Then enter POKE 56577,205 to set up the lines as indicated by the binary code. At this point, only the LEDs in the selected *output* lines should be on. When you've completed this exercise, type POKE 56577,0 and then hit RETURN to extinguish all LEDs (turn off all data lines).

Now let's enter a short program that lights the LEDs in sequential binary order, starting with 00000000 and ending with 11111111. To do this, use the decimal equivalents of these numbers in the POKE commands. Enter Program 1 and then type RUN, followed by pressing RETURN. The program will start printing decimal numbers on the screen, pausing between each for you to look at the status of the LEDs. (The REM statements in all programs in this article explain what's happening at each step in the programs.)

Slight changes to the circuit and program can turn your C-64 into an alarm clock, using the computer's internal 24-hour clock. You set the clock by typing TI$ = "000000" (the two left-most zeros are the hours, two center zeros the minutes and two right-most zeros the seconds).

First change the hardware by replacing *LED7* with a piezoelectric buzzer, inserting the negative lead into the ground bus and the positive lead into the hole vacated by *LED7*'s anode. Enter Program 2 to set the clock. Arm the alarm by typing RUN, followed by touching RETURN.

Program 1. Sequential Binary Counter

```
5 REM SEQUENTIAL LEDS
10 POKE 56579,255:REM SETS PORTS TO OUTPUT
15 FOR X=0 TO 255
20 POKE 56577,X:REM OUTPUTS SIGNAL TO PORTS IN BINARY ORDER
25 PRINT X
30 FOR D=1 TO 1000:NEXT D:REM DELAY LOOP
35 NEXT X
```

Program 2. Using the C-64 as an Alarm Clock

```
5 REM ALARM CLOCK
10 PRINT "{SHIFT-CLR/HOME}"
15 PRINT 56579,255
20 PRINT "HOURS","MINUTES","SECONDS"
25 PRINT LEFT$(TI$,2),MID$(TI$,3,2),RIGHT$(TI$,2)
30 PRINT "{2UP}":REM PRESS SHIFT/UP ARROW TWICE
35 IF TI$="080000" THEN POKE 56577,255
40 IF TI$="080030" THEN POKE 56577,0
45 GOTO 25
```

By changing lines 35 and 40, you can control when during any 24-hour period you want the alarm to sound.

Programming Input & Output

Most projects you design are going to require both input and output. For example, a surveillance alarm system requires sensors to monitor for intruders and such dangerous conditions as fire, smoke, gas, etc. If any emergency condition is detected, this information is sent to the computer via data (input) lines. Responses—such as closing a vent, sounding an audible alarm or turning on a light—are sent out over output lines.

Our alarm circuit, shown in Fig. 2(A), uses a light-dependent resistor (*LDR*) as a sensor that turns on and off a transistor switch (*Q1*). This circuit uses only one bit of the binary word, or one data line. Hence, if you wish, you could create a more complex system by using the other seven data lines and combinations thereof to handle a maximum of 256 sensors.

Before doing anything else, set *S2* to DISABLE and *S1* to its center OFF position (by now you should have replaced the *S1* switch described in the first installment of this series with an spdt center-off switch). In this experiment, terminal 1 of DIRECTION switch *S1* controls the direction in which the data flows.

Wire the circuit as shown in Fig. 2(B). Make sure you properly set up the +5-volt and ground buses and that *Q1* is properly oriented. (The emitter, base and collector leads of *Q1* are on the left, center and right, respectively, when the flat on *Q1*'s case is facing you and its leads are pointing downward.) Note also that piezoelectric buzzer *MT1*'s positive (+) lead is tied to solderless block PB7 and its negative (−) lead is tied to the ground bus.

Operationally, this circuit is quite simple. When *Q1* is off, PB0 is high and with it on PB0 is pulled low. The computer monitors the high and low states. Pull-up resistor *R9* insures a good high value when *Q1* is conducting but has no effect on the low value.

Light-dependent resistor *LDR* and *R8* form a voltage divider that controls the flow of current into the base of *Q1*. When *LDR* is dark, it has a very high resistance and, therefore,

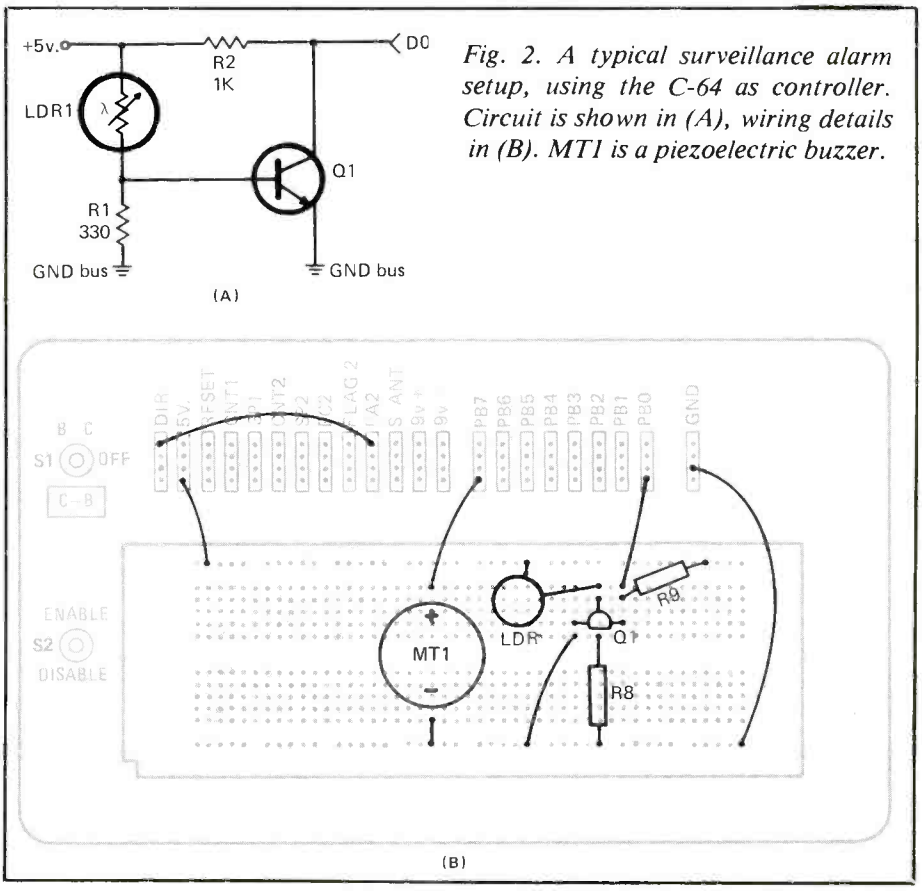


Fig. 2. A typical surveillance alarm setup, using the C-64 as controller. Circuit is shown in (A), wiring details in (B). MT1 is a piezoelectric buzzer.

drops most of the voltage. Any small leakage current that flows through *LDR* goes directly to ground and not through *Q1*'s base circuit.

When light falls on *LDR*, dramatically dropping its resistance, more current flows through *R8* and turns on *Q1*. In turn, *Q1* puts a low on data line PB0. Hence, the value of *R8* controls circuit sensitivity; increase its value to obtain a more-sensitive circuit response. With the 330-ohm value specified for *R8*, about 2 mA of current flow will cause *Q1* to turn on.

You can lower the sound of *MT1* by installing a low-value resistor in series with either of its leads. If you expect any sound at all out of the buzzer, however, keep this resistance to less than 10,000 ohms.

Because the circuit requires both input and output of data, *S1* cannot be used to manually set data flow direction. Instead, you must connect directly into the direction control pins of the 74LS245 buffers inside the EID via solderless terminal block 1 and program the computer to send a signal to PA2 to set the direction. Memory location 56576 sets PA2 for direction control. POKE 56576,151 sets PA2 to high and directs data to flow from the computer to the EID (C-B). POKE 56576,147 sets PA2 to low and directs data to flow in the B-C direction. The wire between terminals 1 and 10 sends the signal from PA2 to the buffers.

Having assembled the Fig. 2(A) circuit on the EID, as shown in Fig. 2(B), key in Program 3. This short program monitors the circuit for a chance from dark to light. When light is detected, data line PB0 inputs a low to the computer. In turn, the computer outputs a high on data line PB7 to turn on the buzzer.

You will probably think of several ways to use the Fig. 2(A) circuit. For example, you can change the software so that the computer looks for a *decrease* in light, in which case, the circuit can count people passing a given point or items on a conveyor belt flanked by the LDR and light source. Alternatively, you can program the computer to display information on a video screen, or even talk in synthesized speech, when a person approaches a given point. Replace the LDR with a different type of sensor to monitor for temperature, humidity, or smoke, to name a few.

Program 3. Computer Control of Security/Emergency Alarm

```
1 REM ADDRESS 56576 SETS PA2 FOR THE DIRECTION CONTROL.
2 REM VALUE 151 SETS PA2 HIGH -- COMPUTER TO BREADBOARD.
3 REM VALUE 147 SETS PA2 LOW -- BREADBOARD TO COMPUTER.
4 REM ADDRESS 56579 CONTROLS THE DATA DIRECTION REGISTER.
5 REM POKE 56579,128 SETS PB0-PB6 TO INPUT AND PB7 TO OUTPUT.
6 REM ADDRESS 56577 SETS PB0-PB7 TO THEIR RESPECTIVE VALUES.
7 REM POKE 56577,127 SETS PB0-PB6 HIGH AND PB7 LOW.
8 REM ************************************************
10 POKE 56576,147:POKE 56579,128:POKE 56577,127
15 PRINT "(SHIFT-CLR/HOME)":REM CLEAR SCREEN
20 PRINT "56576","56579","56577"
25 PRINT PEEK(56576),PEEK(56579),PEEK(56577)
30 IF PEEK(56577)=126 THEN GOSUB 1000:REM TEST TO SEE IF LIGHT
35 REM IS ON. IF LIGHT IS ON, THEN PB0 HAS LOGIC LOW (SET TO 0)
40 REM AND PEEK(56577) WILL BE SET TO 126.
45 GOTO 10:REM RESUME TEST AND RESET ADDRESSES
50 REM ************************************************
1000 REM CHANGE DIRECTION OF DATA FLOW AND TURN ON BUZZER
1005 POKE 56576,151
1010 FOR I=1 TO 50: REM SETS DURATION OF ALARM
1015 POKE 56577,128: REM TURNS ON BUZZER
1020 PRINT "(SHIFT-CLR/HOME)"
1025 PRINT "56576","56579"," I"
1030 PRINT PEEK(56576),PEEK(56579),I
1035 POKE 56577,127: REM TURNS OFF BUZZER FOR PULSATING SOUND
1040 NEXT I
1045 RETURN
```

Controlling AC Power

If you want your stereo system, lights, and other electrically operated devices to be computer controlled, you need more current than the computer can produce. What you need in fact, is a way to switch on and off the ac outlets into which the items to be controlled are plugged. Radio Shack makes an inexpensive wireless remote-control switch (transmitter and receiver) that fills the bill nicely. The receiver plugs into any standard ac outlet and the device to be controlled plugs into the receiver. To operate the system as supplied, you press the transmitter button once to turn on the switch and again to turn it off.

For obvious reasons, the Radio Shack system won't work as is. However, with a simple modification to the transmitter, you can use your computer to operate the system.

Before you modify the transmitter, test the system to verify that it operates as designed. In addition to making sure that both transmitter and receiver work, you want to determine if there is any source of interference that might cause the system to trip when you don't want it to. Fortunately, the Radio Shack system has four different frequency settings you can try if you do encounter any interference. One or more should be able to obviate any problem.

Once you've verified proper operation, remove the battery and back cover from the transmitter. Carefully lift the battery clips out of their slots, push back the plastic clip (lower left

corner with the transmitter oriented with the battery compartment at the bottom) that holds the circuit board in place, and lift out the board.

On the trace side of the board, locate and remove the spring metal switch contact to expose the solder pads for the switch. These contacts look like a solid circle with a ring around it. Carefully drill a small hole through each pad. One pad, usually the largest or widest, is the ground contact, the other the connection for the positive voltage source.

Strip ¼" of insulation from each end of a 12" black and a 12" red No. 22 stranded hookup wire. Tightly twist together the fine conductors at both ends of each wire and lightly tin with solder. Insert one end of the red wire into the positive-voltage pad from the component side of the board and solder into place, the black wire in the ground pad.

Drill a ⅛" hole in the case on the side to the left of the switch, locating it where it won't interfere with the circuit board when the transmitter is reassembled. Tie a knot in both wires about 3" from where they connect to the board. Feed the free ends of these wires through the hole from inside the case. Replace the circuit board and reassemble the transmitter.

Test the transmitter for proper system operation by momentarily shorting together the two wires. Do this several times to verify on/off operation of the receiver. If everything works fine, temporarily set aside the transmitter.

Set *S2* to DISABLE and *S1* to C-B. The circuit for this application is shown in Fig. 3(A). Wire it on the EID as shown in Fig. 3(B). Make certain the TIL111 optocoupler is installed correctly, bridging the groove in the center of the large solderless breadboarding socket and with pin 1 to the right.

Set data control line PB0 to output by keying in POKE 56579,1 followed by RETURN. POKE 56577,1 produces a signal to PB0 that turns on the LED

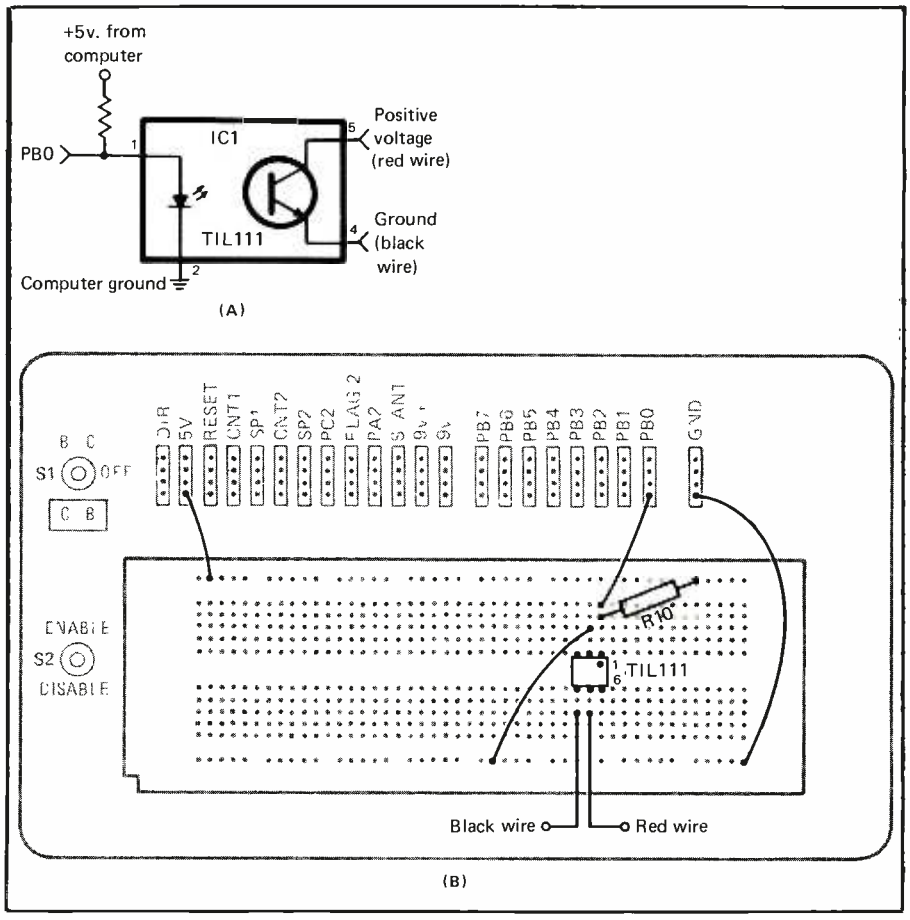


Fig. 3. This setup shows you how to use the system as an ac power controller, using a wireless remote-control switch available from Radio Shack.

inside the optocoupler and illuminates the base of the built-in phototransistor [see Fig. 3(A)]. When this happens, the emitter-to-collector circuit of the transistor shorts (like the closing of the mechanical switch it replaces) and shorts together the red and black wires connected to it.

You want the "closing" action to be only momentary. Therefore, following POKE 56577,1 you must immediately type POKE 56577,0. The device plugged into the receiver remains on until you toggle PB0 again.

In Conclusion

With just a little thought, you will no doubt devise some unique control systems of your own. For example, you might combine a sensor circuit with the wireless remote-control switch circuit to obtain the ultimate control around your home or office. You can actually create a very sophisticated security system. With additional receivers, you can control several outlets simultaneously or use four separate transmitter/receiver systems to control four different items individually.

A final word: you may sometimes have to operate your system manually, bypassing any sensors to which it is connected. You can do this quite easily with the Commodore 64 by programming the function keys to send signals to given data lines. Your C-64 manual contains details for programming the function keys. **ME**

Experimenting with Small dc Motors

By Forrest M. Mims III

Small dc motors are used in robotics and remote-control applications, toys, tape recorders, servos, plotters and printers. They can even be used as self-generating transducers for measuring rotation rates and wind speed.

There was a time when experimenters who needed a small dc motor had to make their own. Today miniature dc motors suitable for many of the foregoing applications can often be purchased for less than a dollar. Much higher quality motors are available for more money. Some include built-in reduction gears and speed-control governors.

Motor Suppliers

Small dc motors are available from most hobby supply stores, particularly those that specialize in radio-controlled model planes, cars and boats. Many of these stores also sell the miniature motors that are used in radio-controlled servos. These motors may cost as much as $10 or more, but they are generally of very high quality.

Electronics stores also sell small dc motors. They may also be a good source for defective tape recorders and calculator and computer printers from which you can salvage motors. I've salvaged good quality motors from broken cassette recorders and radio-controlled toy cars picked up at the "as is" table at Radio Shack stores.

Motors are also available from mail-order suppliers. The Edmund Scientific (101 E. Gloucester Pike, Barrington, NJ 08007) industry and education catalog lists many different kinds of small dc motors. For example, catalog No. H31,827 ($4.95) is a pair of 1.5- to 6-volt motors connected to a common shaft and interfaced by a magnetic clutch. One application for this motor is a drive mechanism for small toys and robots. Catalog No. H33,601 ($2.95) is a 12-volt motor with a built-in speed-control governor. Several motors sold by Edmund include built-in reduction gears.

Another mail order supplier is Ace R/C, Inc. (Box 511, 116 W. 19th St., Higginsville, MO 64037). Ace sells many kinds of radio-controlled servos and the motors and gears they use. For example, catalog No. MR012 is an ultra-miniature 10-ohm motor that measures only 12 mm in diameter and sells for about $12.00.

If your motor requirement cannot be satisfied by either Edmund or Ace, you may have to contact a motor manufacturer or a supplier that specializes in motors. For example, Portescap US (730 Fifth Ave., New York, NY 10019) is a Swiss company that manufactures a broad line of precision dc motors. Rapidsyn (Industrial Power Transmission Div., 11901 Burke St., Santa Fe Springs, CA 90670) and (Warner Electric Brake & Clutch Co. (Beloit, WI 53511) both make a complete series of dc stepping motors. Additional suppliers and manufacturers of small dc motors are listed in various electronics industry catalogs.

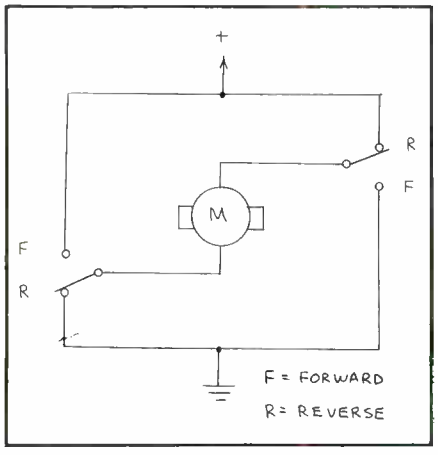


Fig. 1. Simple motor-reverser circuit.

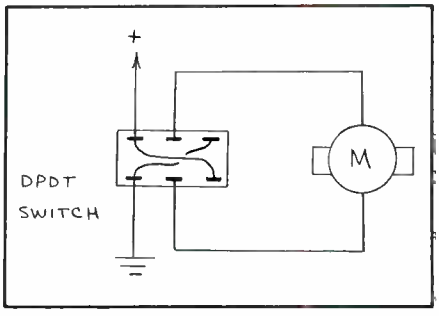


Fig. 2. A dpdt switch can be used to reverse motor rotation as shown here.

Motor Control Circuits

Many kinds of low-voltage dc motors can be directly controlled by simple transistorized or integrated circuits. A common example is the drive motor in inexpensive radio-controlled cars. When controlling a motor with a semiconductor device, it's important to avoid exceeding the device's power and voltage ratings. Often a heat sink will be required to couple excess heat into the surrounding air.

CMOS circuits and power MOSFET devices are often used in motor control circuits. Be sure to follow appropriate handling and soldering precautions when using these devices. Excessive voltage and static electricity can cause permanent damage to such components.

Motor Reversers

Figure 1 shows how a pair of single-pole, double-throw (spdt) switches can be used to reverse the direction of rotation of a dc motor. The switches permit the polarity of the applied current, and hence the direction of rotation, to be reversed.

Generally the switching arrangement in Fig. 2 is used to implement a motor reverser. Here the two spdt switches of Fig. 1 are replaced by a single double-pole, double-throw (dpdt) switch. This permits circuit control with a single switch.

The switches in Figs. 1 and 2 can be replaced by power MOSFET transistors that permit the rotation direction of a small dc motor to be controlled by an external logic signal. Figure 3 shows one circuit I've devised for this purpose. A pair of gates in a CMOS 4011 quad NAND gate provide the steering logic necessary to switch the MOSFETs on and off. Bipolar power transistors can be used in this kind of circuit, but MOSFETs are a better choice because they're more easily interfaced with external logic circuits.

Referring to Fig. 3, when the input is low MOSFETs *Q1* and *Q2* are switched on and *Q3* and *Q4* are switched off. Therefore, the A terminal of the motor

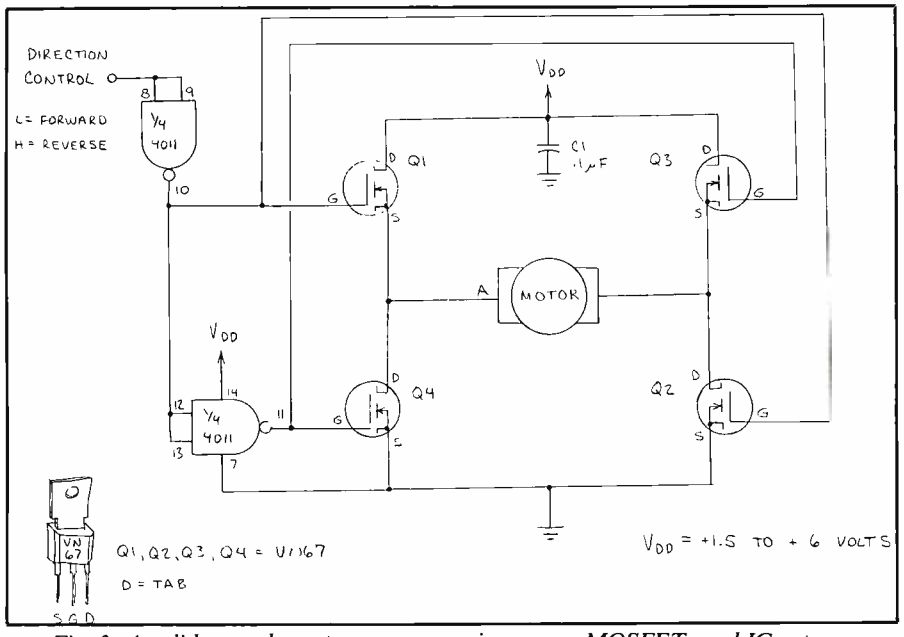


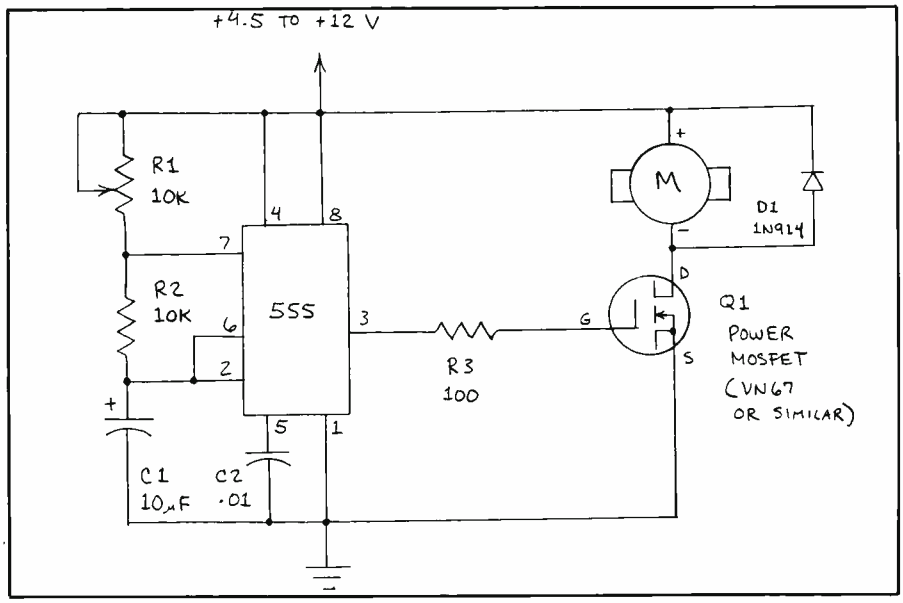
Fig. 3. A solid-state dc motor reverser, using power MOSFETs and IC gates.

receives a positive bias and the motor's armature rotates accordingly. When the input changes from low to high, *Q1* and *Q2* are switched off and *Q3* and *Q4* are switched on. The A terminal of the motor then receives a negative bias. Now that the polarity of the voltage applied to the motor is reversed, the armature's direction of rotation is also reversed.

If you build and experiment with this circuit, you may notice that changes in the motor's direction of rotation can be implemented merely by momentarily applying a high or low to the input and then allowing the input to "float." When this occurs the circuit appears to "remember" the status of the last input signal.

In real applications, however, you should never allow the input of a CMOS gate to float. This is because the input lead acts as a miniature antenna that can pick up stray electrical signals. In other words, a floating input may appear to change states spontaneously in response to electrical noise. Even with no noise present a floating CMOS gate may spontaneously change states as the charge previously stored within it gradually leaks away into the surrounding air.

Fig. 4. A simple dc motor speed controller built around a common 555 timer.



Motor Speed Controller

It's possible to alter the rotation speed of a small dc motor by rapidly interrupting the continuous current normally applied to the motor. This can be readily accomplished by connecting the motor to a simple pulse generator. Increasing the pulse rate will increase the rotation speed.

For best results, the pulse generator should operate at a 50-percent duty cycle. Many different circuits can be used, including simple two-transistor oscillators, cross-coupled gate multivibrators, op-amp pulse generators and timer ICs. In most cases, the pulse generator drives a switching device, such as a power transistor or MOSFET transistor. The switching device, in turn, controls the amount of power delivered to the motor.

Figure 4 is a straightforward motor speed controller designed around a 555 timer IC connected as an astable multivibrator. In operation, *R1* and *C1* control the circuit's pulse rate. Since *R1* is a potentiometer, the pulse rate, and hence the motor's rotation rate, can be easily varied by altering *R1*'s resistance. The value of *R2* is selected so that the duty cycle is near 50 percent. The circuit's operating frequency is $1.44/(R1 + 2R2)C1$.

Pulses from pin 3 of the 555 are applied to the gate of *Q1*, a power MOSFET transistor such as the VN67. When *Q1* is switched on, current is applied to the motor. The pulse rate determines the speed of the motor's rotation.

Note that the motor terminals are bypassed by reverse-biased diode *D1*. Since

D1 is connected in the backwards direction, it has no effect upon normal circuit operation. It's included here simply to slow motor rotation between pulses.

This braking action results as follows. After a current pulse applied to the motor ends, the armature will continue to rotate until its angular momentum is overcome by the friction of the brushes and bushings. During this period, the motor functions as a generator. Since *D1* is connected directly across the motor's terminals, it places a heavy load on the motor when it is self-generating a current. This imparts a braking force on the armature that can substantially slow angular momentum.

You may wish to experiment with *D1*. Its presence may have a substanial effect on some motors and very little on others. You can also experiment with *Q1*. Though I've used several kinds of power MOSFETs for *Q1*, an npn power transistor will also work. Whatever type of transistor you use, make certain it's adequately rated and, if necessary, heat sinked.

How well this circuit functions is greatly determined by the motor. The circuit can drive some high quality motors that have low-friction bearings and brushes, at very slow rotation rates (a few tens of rpm). Cheaper motors can be operated down to a rotation rate not much less than a few hundred rpm.

I have had best results with motors fitted with a built-in gear reduction system. The reduction gearing provides reliable slow rotation speeds, while allowing the motor to be operated at a higher speed where the effect of the speed controller circuit is more dramatic.

Direction and Speed Controller Circuit

Figure 5 shows a circuit I've designed that controls both the direction and speed of rotation of a small dc motor. The direction-control portion of the circuit is identical to the Fig. 3 circuit. The speed-control portion of the circuit is formed by using the two unused gates in the 4011 as a cross-coupled multivibrator. The multivibrator has a duty cycle near 50 percent. Its output is applied to *Q5*, a power MOSFET connected in series with the direction-controller portion of the circuit. Therefore, current is applied to the motor only when Q1 *is* switched on by the multivibrator. Operating frequency of the multivibrator is determined by the values of *R2* and *C1* and is about $1/(2.2RC)$.

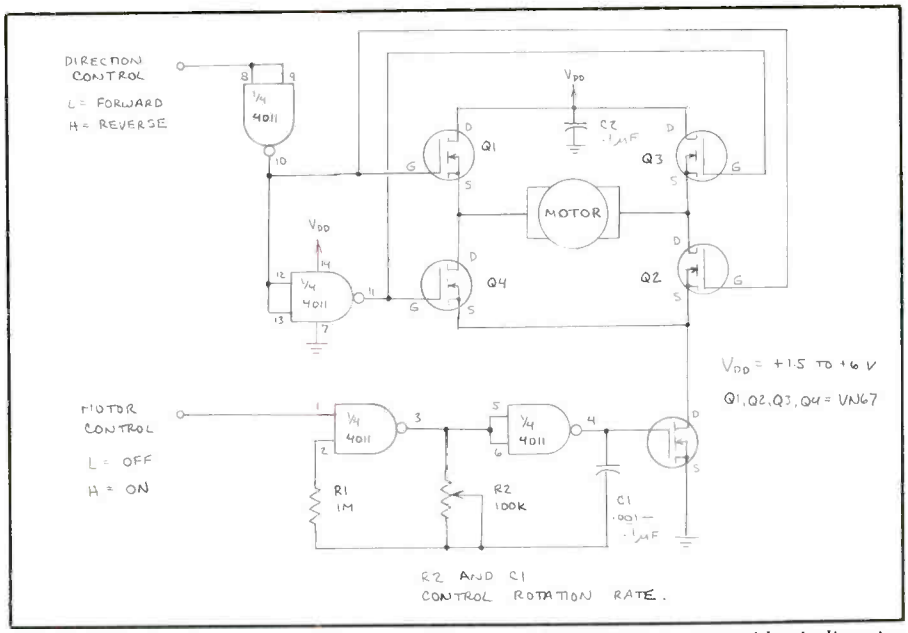


Fig. 5. This circuit uses a combination of gates and MOSFETs to control both direction and speed for a small dc motor, via logic level switching.

The speed control portion of the circuit in Fig. 5 can be replaced by the 555 timer pulse generator shown in Fig. 4. The 555 circuit is somewhat easier to adjust and can be connected directly to the gate of *Q5* in Fig. 5. However, the Fig. 5 circuit is much simpler, particularly since it uses all four gates in a single 4011.

Going Further

The circuits given here can be easily modified. For instance, replacing *R2* in Fig. 5 with a light-sensitive photoresistor will allow the motor speed control portion of the circuit to be controlled with a flashlight.

Both light and radio signals can be used to change the direction of a motor and to switch motors on and off. In a future column I'll touch upon these topics. I'll also cover some of the basics of do-it-yourself infrared and radio remote-control system. **ME**

HARDWARE HACKER

Understanding shaft encoders, more on E.T. watching, working with Gray codes, finding Commodore ICs, underground radio communications and more

By Don Lancaster

Seems to be a lot of interest in shaft encoders these days, so that's what we will center this month's column on. Then we'll end up with some shafts of a wildly different type.

But first some news and updates.

The old Apple IIe Absolute Reset (Modern Electronics, February and March 1985) will *not* work on the new IIe with the "upgraded" ROM set, nor will it work on a IIc. Instead, "alike but different somehow" patches are needed. Full details on the required upgrade will be presented next month.

Here's some more on E.T. watching. You might find two additional books of interest. The first is called *The Early Years of Radio Astronomy* by W. T. Sullivan and published by *Cambridge University Press* ($39.50). The second is titled *Serendipitous Discoveries in Radio Astronomy* by K. Kellerman and B. Sheets, and published by the *National Radio Astronomy Observatory* ($7). You'll find reviews on these in *Science,* Issue 4701, May 17, 1985, Volume 228, pp. 854-856.

I have got some brand-new Applewriter/Laserwriter Utility diskettes all ready to go. You simply will not believe what these gems can do. The *Gila Valley Apple Growers Association* will be most happy to send you a free packet of samples showing what you can do with an Apple IIe and a Laserwriter creatively interacting with each other. Things chosen, naturally, that are insanely easy to do on a IIe or IIc and extremely difficult on a Mac, using both *WPL* and *Postscript* working together, of course.

As usual, this is your column, so write or call your hardware hacker questions and problems to my address in the box at the end.

On to this month's goodies.

What is a Shaft Encoder?

A shaft encoder is any scheme to find out something useful about something that is turning. You might be interested in the speed, the direction, the absolute position, the relative position or phase, or possibly even such exotic things as acceleration, torque, or strain.

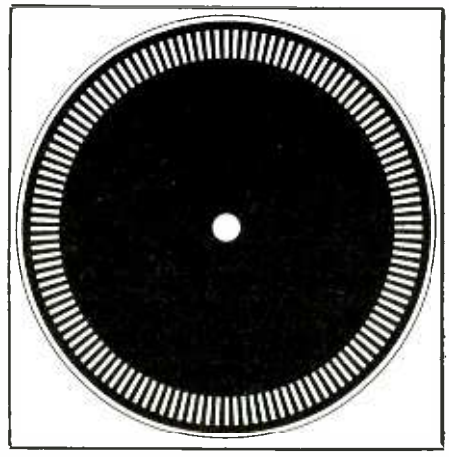


Fig. 1. An encoding disc for an incremental shaft encoder.

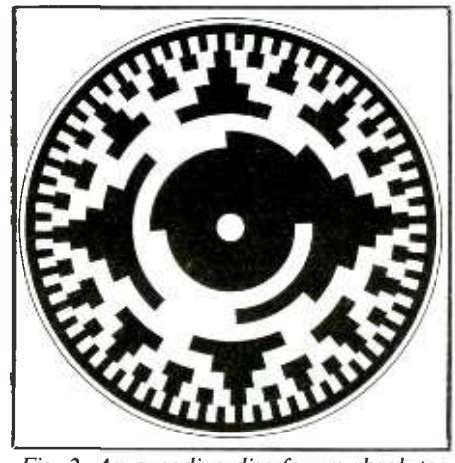


Fig. 2. An encoding disc for an absolute shaft encoder.

As an example, years ago I was working on a car safety radar and needed a way to measure vehicle speed. This was long before such niceties as integrated circuits or sanely priced electro-optic goodies existed. What I did was take an old surplus dc motor and removed everything but the brushes, the shaft, and the communtator. I then shorted every third bar of the 18-bar commutator together. The beast was then cut down and repackaged so you would unscrew the speedometer cable, add the encoder, and then replace the cable. As the shaft rotated, you got six commutator shortings, and thus six pulses per revolution.

Today, most shaft encoders are done using electro-optics. An optical disk that has clear and opaque areas usually interrupts a beam of infrared light. You can put an infrared LED on one side of the disk and an infrared sensor on the other, or else you can use an opto-interrupter. This one has a slot in it that accepts the edge of the disk. The advantage of an opto-interrupter is that all the electronics is in one $2 package; the disadvantage is that only the outside track of an encoder can normally be read.

Important suppliers of shaft encoders and opto goodies include *General Electric, General Instrument,* and *Hewlett-Packard.* Or write or call Forrest Mims (c/o Modern Electronics), since he is much more into opto stuff than I am.

Important advantages of opto shaft encoders are that they do not load the shaft, do no wear, and are simple, clean and reliable. They preform reasonably well when somewhat dirty or misaligned.

There are times, though, when mechanical shaft encoders may be the better choice. One example is in a wilderness data acquisition system that is totalizing wind speed from an anemometer. Sometimes you simply cannot afford the luxury of continuously lighting one or more LEDs for a month or more from a small battery. In this case, a "zero-power" mechanical contact may be the best choice.

You will find two basic types of shaft encoders. An *absolute* encoder has many sensing channels and always knows where it is at. For instance, a four-channel absolute encoder could give you the 16 points of the compass rose needed for a wind vane sensor.

The second type is the *incremental* encoder. An incremental encoder usually takes a single channel, or at most a very few channels. Incremental encoders only deliver pulses. An incremental encoder is ideal for something like an anemometer wind pickoff. You can count a few pulses

to obtain instantaneous wind speed, or count all pulses for totalized wind over a given period. Instantaneous wind speed would be useful for weather forecasting, while totalized wind is of interest to wind energy people.

An incremental encoder can become more or less of an absolute encoder if you add counting electronics to totalize the counts and remember where you are. This can be done either with add-on hardware or with software routines in a microcomputer. Counting is often far cheaper than going to a true absolute encoder, particularly if long run of wire or a long distance is involved.

The weather station stuff by the *Heath Company* gives a good example of both types of encoders, done elegantly and simply. In fact, the same circuit board can be used for either type of encoder. Once again, *Hewlett-Packard* has some ready-to go shaft encoders, such as the HEDS-5000 series. These have recently been available on a $20 special promotion. H-P has announced a lower-cost series of digital potentiometers as well.

Robotics makes lots of use of shaft encoders. It is often much easier to measure where you are and correct a position with feedback, compared to being extremely accurate in the first place. The use of feedback to correct speed or position is sometimes referred to as a "closed-loop servo" system.

Figure 1 illustrates the wheel pattern for an incremental shaft encoder. Figure 2 is the pattern for an absolute encoder. Note than though the absolute encoder seems coarser by a factor of two, both disks are eight-bit encoder wheels with a resolution of one part in 256, roughly ±0.7°. By the way, I have some software that makes designing master artwork for low and medium resolution encoder wheels utterly trivial and super cheap. How about six cents per original art master? Write or phone if you are interested in this software.

Oh yes—a gotcha learned the hard way. Infrared light sometimes behaves totally differently than regular light. Opaque may not be. Clear may not be. Be sure to check your encoder disk to make sure that what you think is clear is in fact transparent to infrared and what seems opaque really blocks infrared light. Certain plastics will actually behave exactly opposite of what you might expect; others will not give enough difference between "black" and "clear" to be of any use to you.

On to some fine points on encoders that create questions of their own . . .

How can I measure Direction With an Incremental Encoder?

Thought you would never ask. This very subtle problem has a most elegant solution. Position and direction are two different types of information, or two more or less independent variables. Thus, it is not reasonable to expect to handle both with a single channel. One or the other will end up ambiguious. Instead, you use two channels that are phase shifted by 90°. These are usually called sine and cosine channels and are set up so that the one channel changes in the middle of the black or the clear space of the other.

Now, if the sine channel changes while the cosine channel is black, you are going, say, counterclockwise. If the sine channel changes while the cosine channel is white, you are going clockwise.

Figure 3 shows how you can use a single D-type flip-flop to extract direction information from a pair of sine and cosine channels on an incremental encoder.

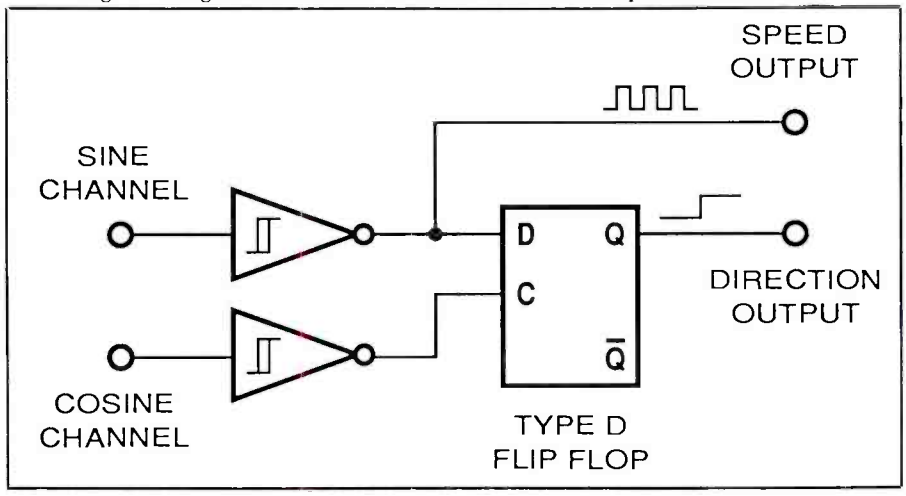
In this case, both channels are first conditioned with Schmitt inverters to eliminate noise. The sine channel is used as the actual speed pulse output. Every time the cosine channel changes, it samples the sine channel and stores it in the flip-flop.

If you are always going forward, the sine channel is always sampled when it is black, and you get a high direction output. If you are always going backwards, the sine channel is always sampled when it is white, for a low direction output.

Incidentally, this sine and cosine business also shows up in such diverse places as singe-sideband communication and various radar systems.

Do we really need two tracks on the encoder? We could used only one track and space the two sensors half a slot apart. That gets mechanically tricky. Instead, why not let the sine and cosine channels look at different slots at the same time? You can then space your opto-interrupters, say, 10½ slots apart, or even halfway around plus or minus half a slot. Thus, only one incremental encoder pattern is need to get both sine and cosine channels, if you are careful as to where and how you position your sensors.

Fig. 3. Using sine and cosine channels to sense both speed and direction.



Question: What happens if the hole is off center? How far off can you be for a given wheel size and resolution? Sometimes a single hole is placed in a second channel to give you an absolute "zero" reference in an otherwise incremental encoder. This lets you find out where you are every now and then. Some floppy disk systems also use this technique.

What is a Gray Code?

A Gray code is a very old and very special computer code that today nicely solves a sticky absolute shaft encoder problem.

There used to be all sorts of weird, wooly and wonderful computer codes that served many obscure and arcane uses. Thankfully, most of these are long gone. For instance, there was the EBDIC code used to purposely confuse IBM customers. There was an excess-three code that slightly simplified the hardware needed for decimal arithmetic. There were all sorts of binary-coded-decimal codes, such as the 1-2-2-4 or 1-1-2-5 codes that simplified early digital counting displays. And finally, there was, and still is, the Gray code.

Let's go back to our absolute shaft encoder. Suppose we tried to use the "obvious" straight binary code for the wheel. Say further that it is an 8-bit wheel with 256 positions of absolute encoding. What happens when you go from $FF to $00 on the wheel? Before the motion, we are in position decimal 255 or hex $FF. After the transition, we are in position 0 or $00. But there is no way that all the bits will simultaneously change from ones to zeros. Some bits will be slightly ahead and some will be slightly behind at the intended transition point. This happens because of mechanical alignment and channel sensitivity varitions.

As a result, when you are on the hairy edge between $FF and $00, wildly wrong results will be output. Should these results actually get used, very ungood things could happen very quick like—ferinstance, on a steel rolling mill that just got told to go forward and reverse at the same time.

0000	0000	0000
0000	0000	0001
0000	0000	0011
0000	0000	0010
0000	0000	0110
0000	0000	0111
0000	0000	0101
0000	0000	0100
0000	0000	1100
0000	0000	1101
0000	0000	1111
0000	0000	1110
0000	0000	1010
0000	0000	1011
0000	0000	1001
0000	0000	1000
0000	0001	1000
0000	0001	1001
	etc ...	

Fig. 4. Gray code changes only one bit at a time, eliminating false counts.

Instead, how about an encoder pattern that changes only one bit at a time for each count advance? Since only one bit can change, it either does or does not do so. There is no possibility of a wrong code at any time, since you either get the "old" value or the "new" value. The absolute position code either changed or it did not. A Gray code is a code that lets only one bit change at a time, regardless of absolute position.

Figure 4 is a listing of Gray code. Note that each successive state is only one bit different from the previous state. The process can continue for as many bits as you like.

You can get from a Gray code to a straight binary with either hardware or software. The only hardware needed is a stack of exclusive-OR gates. The equivalent software can be some shifts and EOR commands or a simple table lookup.

While it is equally easy to get from binary to a Gray code, reverse conversion is rarely needed. If you need to do this, exclusive-OR gates, shifts and EOR commands, or table lookup can be used.

If you look back at Fig. 2, you will see the Gray code of Fig. 4 wrapped around the wheel. Note that as you rotate the wheel, only one bit changes at a time.

Start with the "all-black" position pointing a tad above due east, and work your way around the disk counterclockwise. Only one bit changes at a time. Note that all more significant bits change in the middle of either the black or white area of the least-significant outside track.

Virtually all absolute encoders use a Gray code or some varition of one. Once again, this prevents any possible wrong answers when on the hairy edge between two different positions.

Thus, Gray lets you clearly tell black from white.

Read any Good Data Books Lately?

This month's data-book-of-the-month-club selection is the new *Exar* databook. It has bunches of neat things in it involving linear integrated circuits, particularly phase-locked loop and function generator devices.

As usual, you pick up one of these by making a professional request on a business letterhead, or else by phoning the address shown in the names and numbers box. Of, if you can find someone that already has one, use the bingo card in the back of their manual to order your own.

One thing that does need mention, though. Don't take their modern stuff very seriously, except as an excellent tutorial background. Modems done digitally take fewer parts, require no adjustment or setup, will not drift, and generally perform much better. Their analog modem circuits are a very good review of the way things *were*.

Some readers say they're having trouble finding my books in their local bookstores. You can get them directly from Synergetics if you wish. Personally autographed, too.

Where Can I Get Oddball Commodore ICs?

While I haven't personally checked them out, *Boufal Services* lists a wide variety of

NAMES AND NUMBERS

Alberta Safety Division
10709 Jasper Ave., Floor5
Edmonton, Alberta T5J 3N3 Canada
(403)427-0199

Boufal Services
244 Fitzwater St.
Philadelphia, PA 19147
(215) 925-6469

Cambridge Press
32 East 57th St.
New York, NY 10022
(212) 688-8885

Exar Corp.
750 Palomar Ave.
Sunnyvale, CA 94086
(408) 732-7970

General Electric
West Genesee St.
Auburn, NY 13021
(315) 253-7321

General Instruments
3400 Hillview Ave.
Palo Alto, CA 94304
(714) 581-5817

Gila Valley Apple Growers
Box 809
Thatcher, AZ 85552
(602) 428-4073

Hewlett-Packard
640 Page Mill Rd.
Palo Alto, CA 94304
(213) 970-7500

Radio Astronomy Observatory
NRAO Workshop 7
Green Bank, WV 24944
(304) 456-2011

Howard W. Sams & Co., Inc.
4300 West 62 St.
Indianpolis, IN 46206
(800) 428-SAMS

Science
1515 Massachusetts Ave. NW
Washington, DC 2005
(202) 467-4350

Synergtics
Box 809
Thatcher, AZ 85552
(602) 428-4073

Commodore chips and stuff, including the rare and hard to get 6560 and 6567 VIC chips and the 6581 SID chip.

Wonder of wonders, they also have KIM-1's at very attractive prices. The KIM-1 was far and away the greatest microcomputer Commodore ever built. Since then, it has been all downhill.

To this day, there is no better way to begin to learn the fundamentals of machine-language programming than on a KIM-1. The KIM-1 is also an excellent choice for a dedicated micro for a solar controller, a cattle feeder, a weigh station, a pump monitor, or whatever else you can dream up that needs some "plug and go" smarts. Apples and Commodores emulate the KIM beautifully and simply for system development. You can even download or upload through the cassette channels.

Boufal Services also carries most of the manuals, including the obscure and harder to find ones.

Check them out.

Is any Information Available On Underground Radio?

Underground radio communications is of interest in mining, cave exploration, and in search-and-rescue operations. Right now, the field seems split in two. On one hand, there are cavers doing their own thing on a limited budget and using older and not very sophisticated techniques. On the other hand, there's the military with extremely expensive equipment and classified information that is difficult if not impossible to access.

Two types of communication are of interst. In people-style communication, you are interested in getting information between two people underground, or one underground and one above ground. Often, coded signals or tones are preferred to voice because of the low frequencies usually involved.

In radar-style communication, you are interested in finding out whether something is on the other side of the rock you are looking through, such as another cave or an unknown cave below the surface. Miners are also interested in voids since they might contain such nasties as methane gas in a coal mine or extremely pressurized gas in a salt or gypsum mine. Or simply an unknown and partially collapsed old digging.

Generally, radio signals go through solid rock vastly better than they can go from the surface through a moist dirt interface into the rock. It is often the first foot or two of radio surface penetration that has the staggering losses. Part of this is caused by moisture, with water having a very high dielectric constant. Another factor is the problem of avoiding reflections between media with different loss factors and dielectric constants.

An excellent example of cavers doing caver-type stuff is the report "Construction and testing of an Underground Radio" by Julian Coward and Ian Drummond of the Alberta Speleological Society. Their report is available from the *Alberta Safety Division,* a branch of the Canadian government.

While they did a really great job on this, I'm left with the feeling that so much more could be done so much better by using the latest in integrated circuits, the newest of antenna and battery technology, and the best of inside military information, particularly if aided by someone with some decent aerospace background.

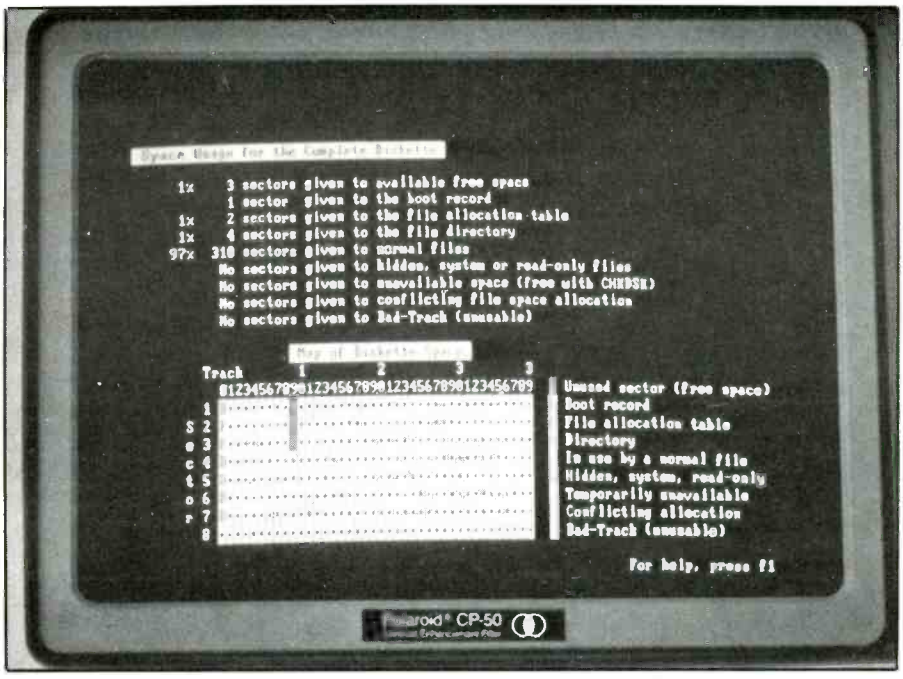
NEED HELP?

Phone or write your hardware hacker questions directly to:

Don Lancaster
SYNERGETICS
Box 809
Thatcher, AZ 85552
(602) 428-4073

Inside IBM's PC

By Charles Rubenstein



When you use the "DiskLook" utility on the first disk of the software package, you can obtain a breakdown of the contents and status of any disk.

Most software packages are accompanied by "documentation" of one sort or another. Some printed guides are encyclopedic in size and might even be considered as diskette/book packages. There are also books published that are accompanied by software packages. They're called, appropriately, book/diskette packages. Examined here is one that was introduced a year or so ago, and still quite popular—"Inside the IBM PC with Programming Access Tools."

"Inside the IBM PC with Programming Access Tolls"/By Peter Norton/Robert J. Brady Co., Bowie, MD, publisher/ Book, 114 pgs., $20/Diskettes, three 5¼" SS, $65.

In 1982, Peter Norton "published" a disk operating system supplement for use with the IBM PC computer that took the industry by storm, called "Norton Utilities." The disk listed for $80 and updated versions are still selling strong. Some elements of the utilities are still contained in the software package that optionally accompanies the author's book, "Inside IBM's PC."

The book is replete with information that illustrates how the IBM's microprocessor and PC-DOS operates, with hints and tips galore on squeezing the most from the machine and what it produces on floppy disks. The latest version brings the reader up to DOS 2.00 and IBM's XT model. I guess that some additional notes on DOS 2.10 will be added at some future update time.

In it you'll learn how to get the date in which your machine's ROM was designed, how each hardware element operates, details about DOS you'd never suspect, including various quirks, and so on.

More importantly is the role played by the optional diskette package. The book was developed with using this software in mind. As informative as the text is, in fact, a part of it can only be used in conjuction with the software to fully glean the intimate information imparted here.

"DiskLook," originally part of Norton Utilities, is still featured in this newest of Norton's bag of programs. It's as wonderful as it ever was, of course. It is a full-screen program whose menu is driven by the PC's function keys. Rather than printing the allocation map or file directory one line at a time as in standard "typewriter" style, the utility displays a full-screen of data at once. Actual file contents are displayable in hexadecimal or ASCII. Using the program on a "new" disc can divulge such secrets as where unusual copy-protected sectors exist (you might not be able to do anything about these, but you at least know that they are there). DiskLook continues its magic by enabling you to see the location of each file, noting erased files as well as their recoverability, and even directory sort.

Just as the text explores the IBM/PC, the programs (listed in the text as well) explore the software/hardware of the system. Using BASIC programs you are able to view all the PC's ASCII screen characters, demonstrate the various screen and color attributes, display the keyboard input information, and even find out where your machine's memory really resides.

A quartet of assembly-language programs exercise the audio capabilities of the PC. It brings forth pure tones, warbles, and a scale, under software control as well as generates sound via the system's programmable timer "Hardware Sound."

Norton includes programs to test out (and report the activity of) your PC's I/O ports, and to investigate contents of the dreaded IBM BASIC and BIOS ROMs. Should you upgrade your ROM, you can even check what changes were made in the new version. Perhaps more important than this is the assembly-language routines DOSA, DISKA, VIDEOA, KEYA, and MISCA, which allow the experienced programmer to access many of the heretofore undocumented DOS and BIOS service routines. By giving the source of these tools, Norton gives us the key to IBM's treasure house.

For those not attuned to the nuances of 8086/8088 assembly language, he goes one step further and supplies PASCAL listings as well for these programs. He also includes some memory-mapped video routines in Pascal that can be used for graphics displays. Using these programs the programmer can really interdigitate his programs into the PC operating system. Employing these constraints, clone-makers and testers can really check the compatability level of a machine.

The last set of programs on the disc may become increasingly useful to advanced programmers as they market their

own programs. In addition to a simple disc copy protection scheme, which reformats the 39th track on the first side of the disc giving it yet another sector, Norton supplies a program that allows us a simple way to customize our own copy protection by formatting, reading, and writing unconventionally sized sectors at any location we choose and yielding one or more copy-resistant sectors on a disk. Placing key data in these areas may protect them to such a degree that we may not ever figure out how to copy our own discs if we forget the key.

Equally important is the 27-page documentation booklet that can be effectively utilized as a users guide, allowing the accompanying book to be used for reference. Both are extremely well written.

The topics are covered rather completely in the text so as to encourage the novice to become an experienced programmer by following the many listed programs. Since PASCAL and assembly-language programs, as well as their compiled forms are included on the disc, the beginner can use these to gain experience in assembling and compiling files, looking into and fixing files in the directory, and, in short, knowing much more about his IBM PC. The experienced user, in turn, can milk the last drop of speed out of his programs as he accesses BIOS and DOS routines from his own programs using Norton's techniques.

In short, the text stands on its own as a creditable tool for the PC detective. Add to it the more than 60 individual program listings, *already typed onto the disc for you,* and you have a wealth of information on the PC at your fingertips. Add the famous Norton utilities and you have all the magic tricks necessary to do anything from disc and file manipulation through disc protection and ROM investigation.

This is truly Norton at his best. The text plus diskettes make up a very worthwhile package that shows an IBM-PC user how to get the most form his machine by being much more than just an "operator." **ME**

Combatting The Russian Woodpecker

By Glenn Hauser

The Woodpecker Project. Here's your chance to help do something about that annoying rat-a-tat-tat from Soviet over-the-horizon backscatter radar disrupting your listening to shortwave broadcasts. The OTH Radar Committee of the Association of North American Radio Clubs is coordinating a monitoring project during October to gather hard data about the extent of such interference. Once compiled, this will suport an effort to persuade as many nations as possible to go on record against the Woodpecker at the World Administrative Radio Conference.

If you can devote at least three hours of continuous monitoring of a 3-MHz-wide portion of the shortwave spectrum sometime in October, send a self-addressed stamped envelope and enclose another 22¢ stamp to cover duplication costs to: The Woodpecker Project, 1634 Fifteenth St. NW, Washington DC 20009. All requests should be in by September 1.

Equally important is a separate project to monitor specific Woodpecker interference to shortwave broadcast stations; report forms for this are also available through the end of September. Since this is an all-volunteer effort, funds are being raised by selling T-shirts with a "stop the woodpecker" logo (circle and slash over the bird); they're $10 each from the address above; when ordering, specify small, medium or large.

DX Conventions. As summer draws to a close, two major DX conventions remain, one on each coast, primarily for mediumwave DX listeners. Nonclub members are welcome! The International Radio Club of America convention takes place Aug. 23 to 25 at the Kingsway Best Western Motel in Portland, Oregon. The National Radio Club convention is on Labor Day weekend, Aug. 31 to Sept. 2, at the Ramada Inn, Portsmouth, Rhode Island. More information from Craig Healy, 66 Cove St., Pawtucket, RI 02861.

ICOM R-71A. An Australian purchaser discovered that there is an internal switch enabling the scan to stop at strong signals instead of whizzing along. A lot of other information about this versatile receiver

appears in an *R71 Performance Manual,* by independent engineer Don Moman. The 37-page booklet covers many simple modifications, detailed instructions, including schematics and pictorials, on how to improve AM selectivity, increase mediumwave sensitivity, enable the notch filter to function in the AM mode, tune below 100 kHz, and alignment instructions. From the U.S., it's US$10; from Canada, C$10; elsewhere, 25 IRCs, from Shortwave Horizons, 6815 Twelfth Ave., Edmonton, Alta., Canada T6K 3J6.

Spinning The Dial

Argentina. Following democratization of the country, different radio stations once associated with the government have developed a variety of political leanings. On the left is Radio Belgrano, whose transmitter site was blown up at the end of April. It quickly returned to the air using equipment borrowed from Radio Nacional; check 6090 kHz.

Brazil. To us, a country's international shortwave voice represents our prime impression of that country; it almost *is* the country. Yet, external broadcasters are too often unappreciated and unknown in their own country. This is the sad case with RadioBras, which has been forced to operate out of a makeshift studio, and due to its low priority compared to domestic services was in danger of being abolished by August under current austerity measures. Check 11745 kHz at 0200 UTC to see if they are still on the air in English; and a letter of support to the Brazilian Embassy wouldn't hurt!

Canada. A play about radio pioneer Reginald Fessenden, *All I Get Is Static,* is touring the country this year and next, culminating in a run at Vancouver's Expo 86.

China. Bruce MacGibbon in Oregon has been monitoring a local station, program three from Tianjin on 8400 and 10725 kHz, at 1400 and 1500 UTC. Programming includes English literature lessons and numbers in Chinese, rather mystifying until they were determined to be lottery numbers. This despite a major self-criticism in Beijing by China Central TV for having broadcast lotteries.

Colombia. Radio Marquetalia is an elusive clandestine, reported in April by DX South Florida members after 1200 and 2100 UTC on 10543 kHz (variable) and identified by Richard Stoller in Connecticut, a former resident of Colombia; it also calls itself "La Voz de las Fuerzas Armadas Revolucionarias de Colombia." Marquetalia was the name of the so-called "independent republic" run by communist guerrillas in the early 1960s.

Henrik Klemetz, who has been living in Cali, compiled this list of inactive shortwave stations; some of them have been off the air for three or five years, despite being listed in some current references:

4755	CARACOL, Bogota
4775	R. Kennedy
4815	R. Guatapuri
4835	R. Buenaventura
4855	R. Neiva
4875	La Voz del Norte
4905	Emisora Atlantico
4965	R. Santa Fe
5010	R. Surcolombiana
6015	R. Mira
6040	La Voz del Tolima
6045	R. Melodia
6095	La Voz del Centro
6105	R. Vision
6120	R. Super
6125	R. Continental
6150	R. Reloj
6170	La Voz de la Selva
6195	La Voz de Cali

On the other hand, during the past year he has monitored some unauthorized stations, all in Narino Department: on 3705, Emisora Radio Lux, Guachucal, around

BOOKS

The latest technical books and literature in the electronics and computer field.

Macintosh Notebook: MacPaint by John Heilborn. (Prentice-Hall; softcover; 213 pages; $7.95.)

This large-format book (it measures a full 8½″×11″) is interesting from a number of viewpoints. Firstly, it is a detailed hand-holding guide to the use of the MacPaint graphics program in the Apple Macintosh computer. Secondly, the entire book, from front piece to closing page, is printed from text and graphics actually generated by a Macintosh running under MacPaint. Thirdly, when you finish reading and using this book with a Macintosh computer you are almost certain to know virtually all there is to know about MacPaint.

To get the most out of this book, you have to set it on your lap in front of the keyboard and do what the author tells you to do at your Macintosh. The text style is witty, and the instructions are fun to perform, making you want to go on and on until you reach the last page and are still looking for more to do. Along the way, you are introduced to MacPaint's Toolbox, goodies, fonts, style and techniques. As you work along with the text, you are introduced to the various screens that are called up as needed, all shown in actual graphics presentations just as they would appear on-screen. Graphics here are great. One of the really nice things about this book is that it has not only the usual index, but it also includes a "Finder" that breaks down the standard table of contents into its component parts for easy location of a given topic.

If you own an Apple Macintosh computer, you'll want this important hands-on guide book.

Electronics: Circuits and Systems by Swaminathan Madhy. (Howard W. Sams & Co., Inc.; hard cover; 976 pages; $39.95.)

This book is designed to give nonelectronics engineers and scientists a good grasp of electronics, from devices through to systems. It can also serve extremely well, we feel, as a general reference text on electronics for any technically oriented person who wants to become familiar with electronics in general.

It begins with the basic concepts of signals, works its way up through devices and circuits, and concludes with analog and digital communication systems.

There are 15 chapters in all, each building on the previous ones. There's little in the way of math to deter anyone. The author's approach is to present subjects in a practical manner: a little how-it-works, a problem, a solution. All beautifully illustrated with block diagrams, charts and schematics. Practice drills with answers at the ends of chapters are helpful in using this book as a textbook to learn by and to reinforce what has been learned. Summary sheets at the end of each chapter are great aids, too.

Whole chapters are devoted to Operational Amplifiers and Feedback Amplifiers, Optoelectronic Devices, Logic Circuits, Logic Packages and Memories, and Pulse Modulation and Digital Communication, among others. There's depth, too, along with breadth of coverage in the almost 1000 pages presented. Accordingly, the text makes for a fine reference book. Written in a no-nonsense manner that's geared to maximum comprehension, there's little fat here to wade through. Only the meat of the subject, which is most welcome. Don't let the book's seemingly high price put you off. It's worth every penny.

dBase II—A Comprehensive User's Manual by Kerman D. Barucha. (Tab Books; soft cover; 305 pages; $16.95.)

The dBase II data-base management software package was king of the hill for many years; the mark for others to shoot at for small computer business applications. Though long in the tooth now, with dBase III succeeding it for 16-bit machines, the original is widely used and still being sold for both 8- and 16-bitters.

As you might know, dBase II is more that a database system; it's also a programming language. As such, it's an extremely powerful program, though more difficult to learn how to use than some others. That's why a book such as the one reviewed here is so helpful. It amplifies what the program's user manual or documentation presents and issues tips and techniques that are sorely absent from it.

This book takes you by the hand, illustrating each process: creation, editing, sequencing and reporting. Helpful, real-life examples support the text, each with step-by-step explanations. An entire chapter is devoted to special tips, among them how to combine multiple fields, enhance screen layouts and table lookup. Most of the book is devoted to showing you how to program in dBase II, straight through to writing menu-driven systems.

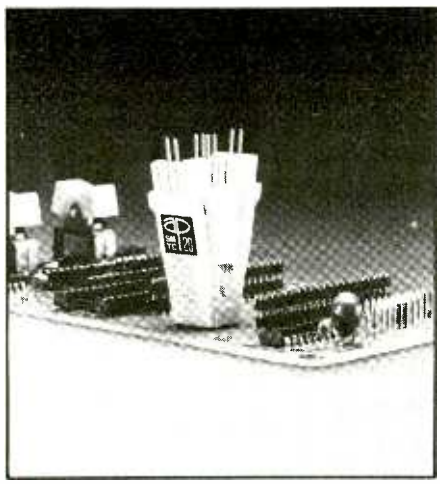
If you have dBase II and want to squeeze more out of it, this very comprehensive manual will show you the way painlessly.

NEW LITERATURE

Electronic Parts & Accessories Catalog. A new 132-page catalog from MCM Electronics is packed with listings and descriptions for test equipment, computer accessories, speakers, CATV equipment, TV parts and more, including the largest selection of original Japanese semiconductors. For a free copy of MCM Electronics Catalog No. 10, call toll-free 1-800-543-4330 (1-800-762-4315 in Ohio, 1-800-858-1849 in Alaska and Hawaii).

Antistatic Floor Wax Pamphlet. A pamphlet about Charleswater Products' Statguard® Conductive Floor Finish discusses product formulation, ESD protection, and application requirements. It provides a comparison with other products and a summary of advantages, including a discussion of static control properties. For a free copy, write to: Charleswater Products, Inc., David E. Maitland, National Sales Manager, 93 Border St., West Newton, MA 02165.

Data Communications Catalog. More than 500 problem-solving devices are listed and fully described in the 144 pages that make up the latest Black Box catalog. Special applications products, such as the company's newly developed Tone Activated Talking Switch (TATS)™, are explained in detail. Other new products featured in this data communications and computer hardware source book include such wide-area distribution items as modems, line drivers and multiplexers, gateway products, etc. Included is a technical reference section that explains asynchronous data transmission, binary encoding, cable fabrication techniques, and a glossary of technical computer terms. For a free copy of the Black Box Catalog, write: Black Box Corp., Box 12800, Pittsburgh, PA 15241.



er, more reliable connections to a PLCC. (Heretofore, surface-mounted test clips opened on only two sides.)

With its narrow body design, the A P surface-mount test clip allows components to be tested with as little as 0.1" lead-to-lead spacing. It is stackable at 0.2" spacing. The clip's compression spring and insulating contact combs ensure contact integrity when testing. Built-in safety features include probe access points that are immediately visible for fast and safe individual testing and staggered contact row on 0.1" centers that permit easy probe attachment and help prevent accidental shorting of adjacent probes.

The surface-mount clip is available with alloy contacts as part No. 923670-20 and gold contacts as part No. 923675-20, both in the 20-contact configuration. $19.95 alloy; $25.90 gold.

CIRCLE NO. 133 ON FREE INFORMATION CARD

Serial-to-Parallel Converters

Practical Peripherals is now offering two serial-to-parallel converters for personal computers. The Switchport™ IIc is designed expressly for use with Apple IIc computers to giver users a wider selection for their systems. The Switchport™232 is for use with any other computer that has an RS-232C serial port. Both come with utility disks with graphics dump routines and both are easy to install.

Both Switchports are transparent to software, eliminating the possibility of interference commands meant for the printer. Both also offer switch-selectable 7- or 8-bit word length. Switchport IIc's utility diskette contains graphic dump routines and Mousepaint drivers to permit printing of high-resolution graphics images. Switchport 232 offers switch-selectable 7- or 8-bit format and

works with virtually any Centronics-type parallel printer. It also features a selectable baud rate from 300 to 19,200 and comes complete with an ac power adapter. $109 both versions.

CIRCLE NO. 134 ON FREE INFORMATION CARD

Interseries Connector Adapter Kit

A new Model 4240-400 r-f Interseries Adapter Kit from Bird Electronic Corp. makes it easy to assemble compact precision 50-ohm adapters for 30 different matching requirements between four popular coaxial r-f connector series. The four series included in the kit are N, uhf, BNC and

TNC. One male and one female connector is provided for all but the N series, which has two each male and female connectors. Also included in the kit are five couplers so that five adapters can be assembled at any one time. This permits 28 combinations between series or with male/female of the same series. The two additional N connectors also permit assembling adapters with male N/male N and female N/female N functions. Precision machining and tight matching tolerances keep VSWR to less than 1.05 at frequencies up to 1 GHz and to less than 1.1 between 1 and 2.5 GHz. $85.

CIRCLE NO. 135 ON FREE INFORMATION CARD

Deluxe Satellite TV Receiver

R. L. Drake has unveiled its newest top-of-the-line earth-station satellite-TV receiver, the Model ESR 424. Among the microprocessor-controlled receiver's many features are: a full-function wireless infrared remote controller; audio seek tuning that automatically locates audio channels; a fluorescent display; a weatherproof downconverter; descrambler compatibility; and a clamped/unclamped video switch.

In addition to the basic single-conversion Model ESR 424, Drake also

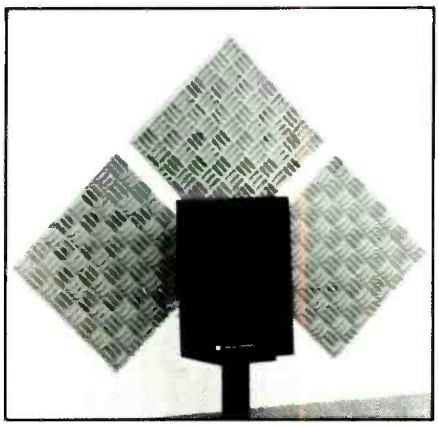
offers the Model ESR 424B block system that adds multichannel capability. Utilizing a 950- to 1450-MHz i-f output, the block-conversion model features dual input switching to eliminate the need for external relays for switching splitters and is compatible with Drake's 85° and 100° LNBs and Model BDC 24 block downconverter. $699 for Model EST 424; $759 for Model ESR 424B.

CIRCLE NO. 136 ON FREE INFORMATION CARD

In- and Out-of-Circuit Troubleshooting Accessory

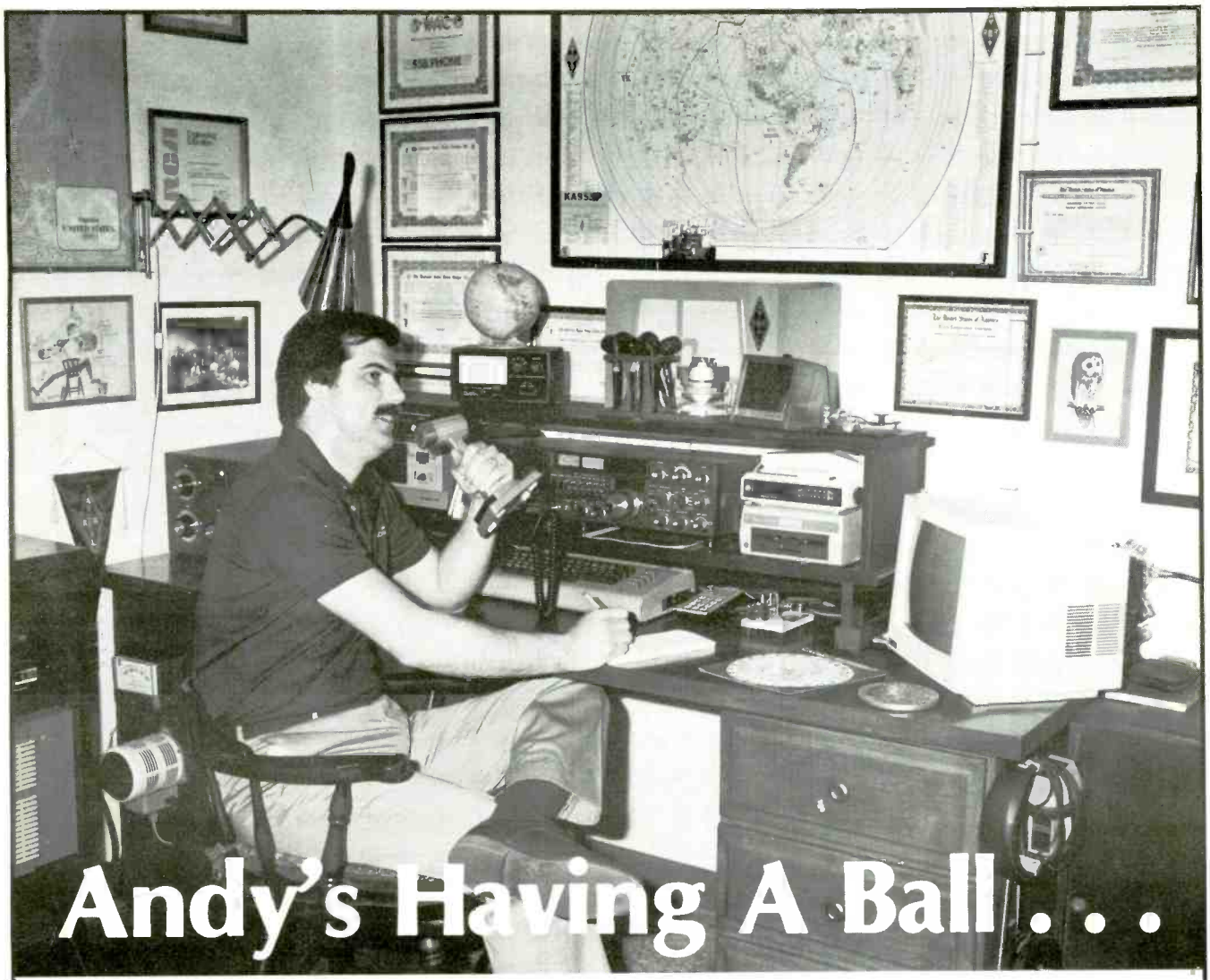
A time-saving accessory that provides a fast, efficient method of troubleshooting electronic assemblies down to the component level, both in- and out-of-circuit, can now be obtained from Jensen Tools. Used in conjunction with any dual-trace oscilloscope that has an X-Y function, or with a single-trace scope that accepts external horizontal sweep output, the "Octopus" accessory generates sinusoidal test signals of approximately ±3 volts peak-to-peak at 60 Hz. When applied to a component under test (resistor, capacitor, inductor, semiconductor, etc.), it will cause to be displayed on the scope's screen the current/voltage response curve. By comparing the suspected component's trace to a known good component's trace, the bad component can be quickly identified. The Octopus operates from 117 volts ac. It measures a compact 4″×3″×2″.

CIRCLE NO. 137 ON FREE INFORMATION CARD



Acoustical Foam Panels

Now you can control the sound in your home listening room the way the professionals do in studios with SONEX Junior foam panels. The new panels are 24″ square by 2″ thick and are made of the same acoustical foam used in recording and broadcast studios. The panels can be strategically placed around speakers, on other walls, or on the ceiling to let you better match the acoustic environment of your listening room to that in which the original recordings were made. Juniors are claimed to reduce standing waves, slap echo, and peak resonances. Juniors are available in charcoal, brown, and beige. They are packaged four panels to a box. $39.95 per box. Address: Illbruch, 3800 Washington Ave. N., Minneapolis, MN 55345.



Andy's Having A Ball . . .

and you can too!

Andy is a Ham Radio operator and he's having the time of his life talking to new and old friends in this country and around the world.

You can do it too! Join Andy as he communicates with the world. Enjoy the many unique and exclusive amateur bands . . . the millions of frequencies that Hams are allowed to use. Choose the frequency and time of day that are just right to talk to anywhere you wish. Only Amateur Radio operators get this kind of freedom of choice. And if it's friends you're looking to meet and talk with, Amateur Radio is the hobby for you. The world is waiting for you.

If you'd like to be part of the fun . . . if you'd like to feel the excitement . . . we can help you. We've got all the information you'll need to get your Ham license. Let us help you join more than a million other Hams around the world and here at home. Who are we? We're the American Radio Relay League, a non-profit representative organization of Amateur Radio operators.

For information on becoming a Ham operator
circle number 110 on the reader service card or write to:

AMERICAN RADIO RELAY LEAGUE Dept CQ, 225 Main Street
Newington, Conn. 06111.

2200 UTC; on 3837, Radio Cultural, La Voz de Celendin, also Radio Cultural Celendin, in Barbacoas, at 2300-0100; and on 6350, La Voz de Samaniego, around 0000.

Cuba [non]. The Reagan administration's answer to Fidel Castro, Radio Marti, finally went on the air May 20, the anniversary of Cuban independence, not only on mediumwave 1180 kHz from Marathon, Florida, but also on shortwave from VOA, Greenville: 0930-1200 on 6075, 1200-1400 on 9570, 1400-1730 on 11815, 2030-2300 on 11930, 2300-0300 on 9660. For the first two days 9580 was used instead of 9570, provoking many complaints from Radio Australia listeners (VOA chose the frequency on the assumption that RA's official registration of 9580 only for the Pacific was to be believed). Initially, Cuba reacted vehemently, but took little action. There was no quick response by jamming US mediumwave stations or starting up a "Radio Lincoln" (the Cuban government is infuriated by the very name of Radio Marti, not granting the Cuban exiles the right to consider Jose Marti their national hero too). As part of the VOA, Radio Marti had to strive for objectivity in news, but never lost an opportunity to portray communist Cuba in a negative light. Entertainment programs were straight out of the 1950s, which Cubans in Cuba reportedly found silly; Radio Marti also assumed the obligation of providing horoscopes to the Cubans.

Radio Havana Cuba, which has broadcast English in a rather stodgy style to the U.S. on shortwave ever since the Cuban revolution, recently adopted a more modern sound, and a few days after Radio Marti went on the air expanded its broadcasts somewhat, to start at 0000 instead of 0100 UTC on 6100 and 9740 kHz; the west-coast release at 0630-0800 on 9525 was expanded to start at 0600.

Meanwhile, Bob Rankin in Kansas reported to the Ozark Mountain DX Log that 5765 kHz is a hot frequency for Cuban SSB communications when there's a territorial intrusion.

Curacao. Radio Earth has picked its original studio location as the site to build its own 50-kilowatt transmitter. It hopes to be on the air by next June, financed not only by selling stock to listeners, but also by selling airtime to overseas stations who need a relay to North America, at $100 an hour. Radio Earth programming could be limited to one hour a day with the other 23 devoted to relay activities. (See also Italy and Venezuela.)

Ecuador. Henrik Klemetz has also compiled a list of apparently inactive stations here:

3240	R. Turismo
3270	R. Cosmopolita
3290	R. Panamaricana
3300	La Voz del Santuario
3340	R. Tropical
3515	R. Centro Gualaceo
4656	CRE
4750	R. El Mundo
4780	R. Atahualpa
4785	R. 11 de Noviembre
4815	Canal Manabita
4835	La Voz del Valle
4860	R. Mundial
4895	Ondas Orenses "CRO"
4950	R. Costa Azul
4990	R. Pillaro
5040	R. Nacional Espejo
5950	R. Cuenca
6140	R. Vision
6524	R. La Voz de la Juventud

Italy. Radio Earth planned to begin regular weekly broadcasts via Radio Milano International on Sept. 1, if not sooner, Sundays 0800-1500 UTC on 7295 kHz with 5 kW and a 17-element log periodic antenna beamed 305°. This should put a decent signal into western Europe as far as Britain.

Another private shortwave station, Adventist World Radio, Forli, has been heard in North America in English after 0600 on 7125, and before 2300 on 6205 kHz.

Mexico. Corrections to our July column: XEQK, not ZEQK; and XEWW is on 15160, not 16150.

Nicaragua. [non] The clandestine Radio Monimbo is often reported from Europe on 6230 kHz, and even South Africa, where Tim Hendel heard it at 0245-0300. The announcer accents appear to be Miskito Indian, in keeping with the station name derived from a Miskito barrio in Masaya where there were early uprisings against Somoza. Reporting to NASWA Listeners Notebook, Cathy Moore in Wisconsin suggests further reading about Monimbo: *Somoza,* by Bernard Diederich; *La Batalla de Nicaragua,* by Gregorio Selzer; and *A Revolucao das Criancas,* by Caco Barcellos.

Peru. Another station to have its transmitter site blown up, this time by Sendero Luminoso terrorists, is Radio Quillabamba, 5025. Gabriel Ivan Barrera says this happened June 8 at 0600 UTC; it was a Spanish missionary station, the only means of communication to peasants and jungle dwellers of the area.

Polynesia, French. An entry for the celebrities-who-are-hams roster: Paul Harvey reported that actor Marlon Brando has retired to an island near Tahiti, spending his time on ham radio using an assumed name. Anybody know his call? Watch out for a "Godfather" accent, hi.

Seychelles. Some changes in FEBA's English schedule, definite through August, tentative from September: Sunday only at 0712-0830 on 15115 and 17780 kHz, 100 kW on a broad (68° at 6-dB points) beam centered at 40° east of true north; for India. Daily 1457-1530 (Monday to 1600) on 11760, 25 kW, broadbeamed at 280° to East Africa; 1458-1530 (Monday to 1600) on 15325, 100 kW, narrow (36° at 6 dB points) beam 40°; 1530 (Monday 1600)-1608 on three channels and beams: 11760, 25 kW, 280° broad; 11895, 100 kW, 52° narrow; and 15325, 40° narrow.

Sri Lanka. The weekly half-hour DX program, "Radio Monitors International," has been one of the casualties of the Radio Earth hiatus, though it may be back now. Meanwhile, it continues over its original outlet, Sundays at 1100-1130 UTC on 11835, 15120 and 17850. We find the first frequency often audible in Florida. Producer Adrian Peterson has been required to leave India, due to new residency requirements, but has produced lots of programs in advance. Some upcoming highlights:

Aug. 18, Indian timesignal ("chronohertz") stations ATA and VWC. Aug. 25, Lesotho, New Zealand Radio Hauraki drama, part 1. Sept. 1, Sao Tome, Hauraki part 2. Sept. 8, Alaska, timesig-

COMMUNICATIONS...

nal stations. Sept. 15, Independent Newswatch American jingles, Hauraki part 3. Sept. 22, The Sound of VK2ME [Australia's pioneer shortwave station], Radio Earth. Sept. 29, shipping beacon NY on lonely Minicoy Island. Oct. 6, the sound of Thailand. Oct. 13, Best of 10 years, best of 20 years. Oct. 20, Musical Safari. Oct. 27, New Zealand DX Special. (If you find this on Radio Earth, the dates probably will not match.)

Sudan. The April coup in Sudan led to several changes in clandestine radio. Libya quit carrying "Voice of the Sudanese Popular Revolution" after a brief expansion to almost 24 hours on 17940. "Radio SPLA" was also dropped, but continued via Ethiopia. "Voice of the Libyan People," which had operated from Sudan, went off, but planned to return via Egypt. "Voice of the Free Sons of the Yemeni South" vanished, but proved to have been via Sudan since its old frequency, 11180 kHz, far out-of-band, was promptly taken over by Radio Omdurman, which suddenly became much more audible than before, e.g. at 0400 UTC. Previously one had to try to pull through the only other shortwave outlet, 5039 kHz. Terry Krueger suggests that the use of 11180 may explain what became of the old Sudan outlet on 11855.

Timor, East. [non] Frank F. Orcutt spotted this item of interest from Reuter: The operators of a clandestine radio link with an anti-Indonesian guerrilla group in East Timor have asked the Australian government to legalize their transmitter. Brian Manning, spokesman for the Australian Coalition for East Timor, told reporters that the group had applied for a license to transmit to guerrillas in the former Portuguese colony annexed by Indonesia in 1976, and now called Propinski Jawa Timur. Mr. Manning said that radio contact with East Timor had resumed in January after a six-year silence when the guerrillas obtained radio equipment. Indonesia said recently that it expected Canberra to close the radio link. Because journalists and other independent observers are unable to gain access to the island, radio contact should allow them to at least obtain the guerrillas' view of the situation. License application is pending.

Venezuela. Although not completely definite at press time, Radio Earth planned to resume transmissions by now via Ecos del Torbes, 4980 kHz, nightly at 0300 UTC. A secondary possibility was via Costa Rican stations Radio Reloj, 4832 and 6006, or Radio Impacto, 6150, later in the night. Another possibility is via the Voice of Nicaragua. (See also Curacao, Italy.)

Main frequency for Radio Nacional's external hour in Spanish is 9540, at 1100, 1400, 1800, 0000 and 0300; but a second transmitter has been trying a variety of parallels—15060, 11695, and most recently we've had it well on 9500 in the mornings, carrier somewhat reduced, while 9540 suffers VOA interference from 1130. Meanwhile, antennas for the projected Voz de Venezuela service are reportedly corroding in the salt air of Paraguana Peninsula. **ME**

Simple Tunes *(from page 41)*

```
100  REM   * AMERICA, THE BEAUTIFUL! *
110  REM   * (C) FRED BLECHMAN 1984 *
200  REM  * MACHINE LANGUAGE SOUND ROUTINE *
210  FOR X = 0 TO 18
220  READ ML
230  POKE 768 + X,ML
240  NEXT X
250  DATA   173,48,192,136,208,4,198,1,240
260  DATA   8,202,208,246,166,0,76,0,3,96
300  REM  * PLAY THE SCALE *
310  RESTORE
320  REM  * DUMMY READ *
330  FOR X = 0 TO 18: READ ML: NEXT X
340  REM       * MIDDLE C=195 *
350  READ F,D: IF F = 999 THEN  GOTO 310
360  POKE 0,F
370  POKE 1,D * 20
380  CALL 768
390  GOTO 350
1000  DATA     130,4,130,8,155,2,155,4,130,4,130,8,174,2
1010  DATA     174,4,155,4,146,4,130,4,116,4,103,4,130,8,2,4
1020  DATA     130,4,130,8,155,2,155,4,130,4,130,8,174,2
1030  DATA     174,4,87,4,92,4,87,4,77,4,116,4,87,8,2,4
1040  DATA     130,4,77,8,77,2,87,4,98,4,98,8,103,2
1050  DATA     103,4,98,4,87,4,103,4,116,4,130,4,98,8,2,4
1060  DATA     98,4,98,8,116,2,116,4,98,4,98,8,130,2
1070  DATA     130,4,130,4,116,4,98,4,130,4,87,4,98,12
2000  DATA  999,999
```

Listing 4. Program to Play "America the Beautiful"

contains the end-melody instruction DATA 999,999.

The numbers in DATA lines 250, 260 and 270 provide the machine code sound subroutine. Since they are already in memory there's no need to use them again. Therefore, a "dummy READ" is used to get past the DATA in lines 250-270, or those numbers would be used for melody frequency and duration. Line 330 READs and throws away these numbers, so line 350 starts with DATA in line 1000 (melody DATA).

By now you should realize that by putting the proper DATA statements in lines 1000-2000, you can program any tune within the range shown in Fig. 1. Listing 3 is identical to Listing 2 except for line 100, line 370 and DATA lines 1000-1030.

Line 100 identifies the tune. Line 370 uses a multiplier of 30 for the duration. This allows you to use small numbers for the duration code in the DATA, yet allows you to control the tempo easily by just changing the multiplier in line 370. If you change the multiplier to a smaller number, the tune will play faster. Although you can use a larger number for the multiplier, you must be sure that the DATA duration code times the multiplier does not exceed 255 or the program will stop with an "?ILLEGAL QUANTITY ERROR IN 370" error message.

Look back to Fig. 3 to see the correlation between the music and the frequency/duration codes.

Similarly, Listing 4 shows the DATA for "America, The Beautiful!", using the same programming technique. With these examples, you should be able to program simple tunes almost directly from printed music. And now your Apple IIc is also a "music machine." **ME**

Store Soft *(from page 52)*

Wire the LEDs and switches to the circuit board with wrap wire or No. 22 hookup wire. To conserve space on the circuit board, it's a good idea to connect one lead of *R1* through *R16* to the "X" lug on *S0* through *S15* and then wire the other leads into the appropriate points in the circuit, using hookup or wrap wire. Then, referring to both Figs. 2 and 3, wire the pod cables to the main circuit board.

Mount the circuit board in place on appropriate-length spacers. On the inside of the box, liberally bead with silicone cement the pod cables to the grommets and the grommets to the box walls to prevent the cables from pulling loose from the circuit board.

Checkout and Use

Before putting Store Soft into service on your test- or servicebench, it's a good idea to verify that it's operating as it should. This is fairly easy to do with the help of four commonly available ICs. What you need are four 54LS163 binary counters breadboarded to form a 16-bit synchronous counter, as shown in the circuit configuration in Fig. 5.

To use the Fig. 5 circuit, you simply parallel both pod inputs and use the counter's system clock as the TRIGGER input. Then, by incrementing the *S0* through *S15* switches one at a time, the latch display (*LED0* through *LED15*) should agree with every combination of switch settings. If all switches are in the "X" position (don't-care state), the LEDs should ripple count the same as the 16-bit test counter.

Once you've verified that Store Soft is indeed operating properly, you can out it into service. This instrument is used exactly as you would use any other digital logic analyzer. The connectors on the buffer pod cables can plug directly onto standard Wire Wrap pins or the pins on an IC test slip. **ME**

PRODUCT EVALUATIONS . . .

RS-232 Switches continued *(from page 16)*

wires (which already have pins crimped on their end) into the connectors, and screw on the cabinet top. There are no adjustments or test equipment required.

The "Smart" Way

Let the logic circuitry do the connecting could well be the theme for an "intelligent" interface known as the "Smart Cable" from IQ Technologies, Inc. (11811 N.E. First St., Suite 308, Bellevue, WA 98005). You just plug the standard cable into your computer and peripheral, then set two switches based on the status of five colored LEDs. The built-in logic examines the signals at each end and essentially tells you how to set the switches. Pretty smart!

The "universal" Smart Cable 817 sells for $89.95. It uses a built-in male or female (you specify) DB-25 connector at the logic end, and both a male and female DB-25 connector at the 6-ft. ribbon cable end. The status of one red, two green, and two yellow LED's determine the proper position of two slide switches.

The Smart Cable 807, for $49.95, is used with the IBM PC*jr*. Since the computer configuration is established, less logic circuitry, and only one slide switch, is required to interface serial printers and plotters. The Smart Cable 880, also $49.95, is designed specifically for the IBM PC AT.

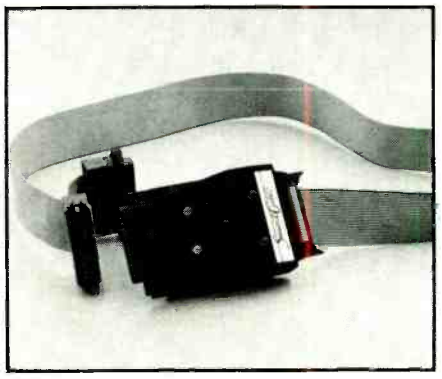
The Smart Switch Box SSB1000 ($159.95) uses built-in circuitry to read the transfer configuration of one computer's or peripheral's port and then matches it to the needs of the mating port. This unique device has one computer port and three peripheral ports. One is dedicated to modems, and the other two for printers, plotters and terminals. Five slide switches and six LED's are used for status and setting.

Deeper Study

There are at least two books that dig into the subject of RS-232 interfacing, in case you have a special problem.

"RS-232 Made Easy" by Martin D. Seyer, published by Prentice-Hall (ISBN 0-13-783472-1), has serial port pin assignments for 230 different computers, printers and terminals and 42 different interconnection diagrams! This gives you an idea of the scope of the non-standardization of the RS-232 "standard." Much of the equipment described is industrial, rather than personal-computer oriented, you should know.

"The RS-232 Solution" by Joe Campbell, published by SYBEX (ISBN 0-89588-140-3) shows you how to make your own simple RS-232 tools, and goes through a step-by-step interfacing procedure, with the emphasis on personal and small-business computers rather than industrial.—*Fred Blechman*



The Smart Cable model 817 has two switches and five LEDs.

CIRCLE 94 ON FREE INFORMATION CARD

CIRCLE NO. 107 ON FREE INFORMATION CARD

spade lugs under the screw heads of the barrier block and tighten.

Carefully measure the locations of the trimmer capacitor (*C6, C7* and *C8*) adjustment slots. Transfer these locations to the top of the box and drill a ⅛" hole at each point. These holes provide access for a tuning wand to the capacitors for easy tuning of the receiver.

Aligning the Receiver

Before attempting to align the receiver, check for proper operation by measuring the voltages at certain key points. Plug the line cord into a convenient ac receptacle and set *S1* to on. The approximate voltages you should obtain are as follows:

voltage	measurement point
18	IC2 pin 6, Q1 collector
15	IC1 pins 6 & 8
13	IC2 pin 5
11	IC1 pin 2
8	IC2 pin 1
6.7	IC2 pin 4, Q1 base
6.2	Q1 emitter
4.3-5.3	IC1 pin over full range of R3

Once you've verified that the voltages are approximately correct, connect 75-to-300-ohm transformer *T1* to the receiver's INPUT terminals. Then connect the r-f modulator (transmitter), set to channel 3 or 4, depending on channel activity in your viewing area, to the input of *T1*. Connect a suitable power supply to the transmitter and turn it on.

Begin alignment by using the full output of the transmitter. To do this, ground the video modulation input to the transmitter's case. Set the receiver for minimum gain and use a voltmeter to monitor the receiver's output. Tune each coil circuit inside the receiver for minimum output voltage, adjusting *C8, C7* and *C6* in that order. Repeat the tuning procedure as often as necessary until you obtain no further reduction in output voltage. However, it isn't necessary to try for the last few millivolts, since oscillation may occur if tuning is peaked too precisely. Just tune for less than 1 volt of receiver output.

After completing rough alignment, unground the transmitter's video modulation input and feed in positive-pulse modulation while osberving receiver output on an oscilloscope. Refine alignment to obtain best output, which should be about 6.5 volts peak-to-peak with 100% modulation. It may be necessary to stagger-tune slightly to obtain good waveform reproduction and avoid oscillation. Try changing the spacing between the turns of the hand-wound coils and/or between the primary and secondary of *T2* if necessary.

When properly aligned, the receiver should produce an output signal that is very clean and has fast rise and fall times and sharp corners. Use the highest-frequency pulses your scope will reproduce without significant high-frequency attenuation. In the final analysis, however, all you need tune for is best alignment for your application, which may not even require maximum gain.

Parting Comment

In addition to the video carrier, the r-f modulator can also put a 4.5-MHz audio carrier on the cable. With a suitable FM receiver, such as a TV set, the sound carrier can also be used simultaneously with the video carrier for voice, FSK or tone transmission. The sound carrier, however, is 22 dB below the level of the video carrier and can be used only for transmission of an ac signal in the audio spectrum. As such, it is of only secondary interest. **ME**

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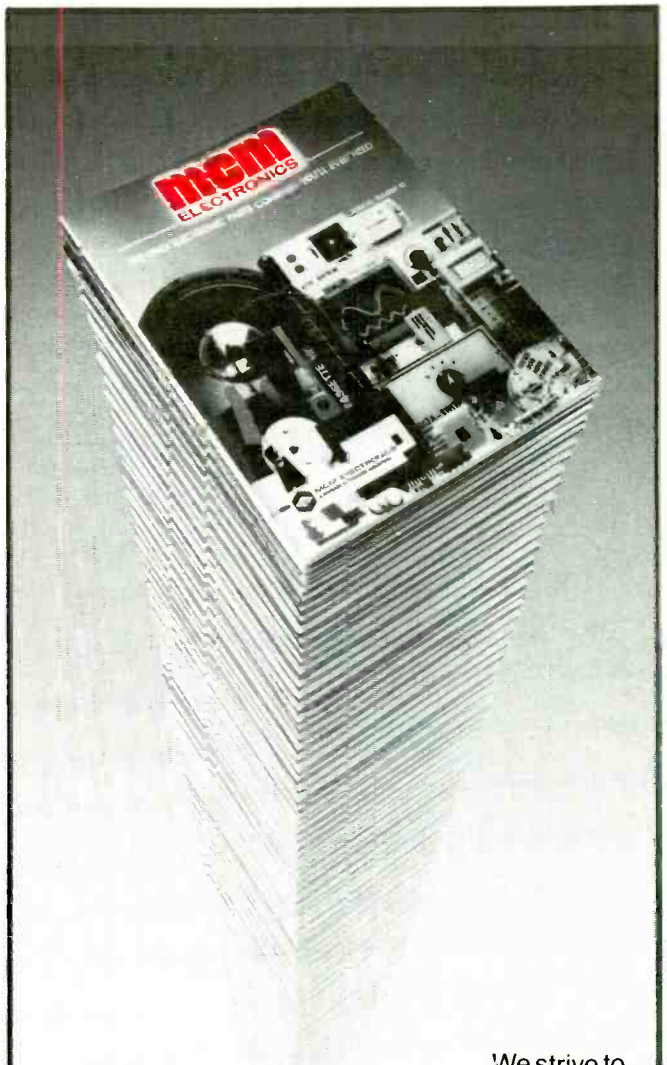

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MISCELLANEOUS

Dress Up Your Projects *(from page 34)*

edges, peel the protective sheet from the adhesive backing (Fig. 8). Align the two trimmed edges with the proper edges of the panel. Finish removing the protective sheet and smooth the nameplate onto the panel. A squeege is helpful in removing air bubbles (Fig. 9).

Once the nameplate is attached and smoothed, holes and other areas can be trimmed, using an X-acto or similar knife (Fig. 10). The nameplate and panel can then be mounted to the equipment.

Pc component identification can also be made into a nameplate on clear plastic and attached to the component side of a pc board in the same manner as attaching a nameplate to a metal or plastic panel. Component leads will then punch through the plastic when they are mounted.

Summing Up

As you can see from the foregoing, making of professional-appearing nameplates, decals and pc board overlays is really a simple, straightforward procedure. If you've already fabricated your own pc boards, using the photographic technique and materials, you'll be right at home with the procedure and materials employed in panel making. The results, of course, are well worth the effort and small additional cost. **ME**

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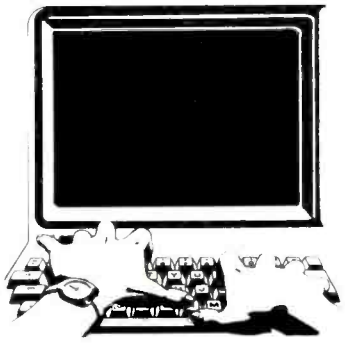

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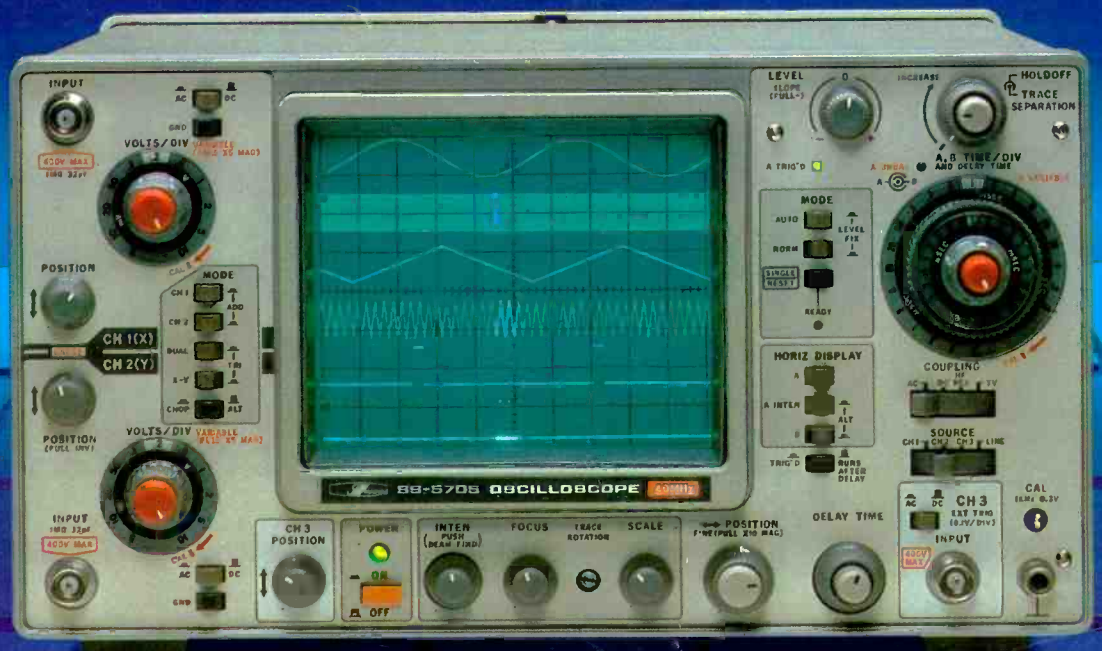

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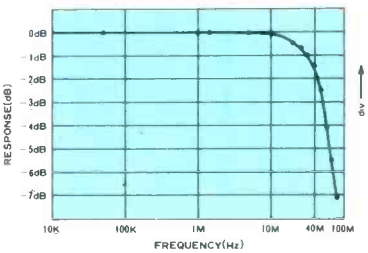
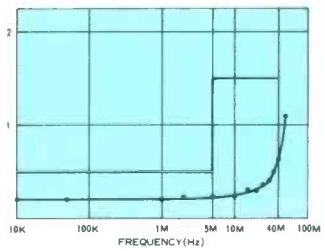


- **Superb trigger sensitivity** freezes even low level signals.



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