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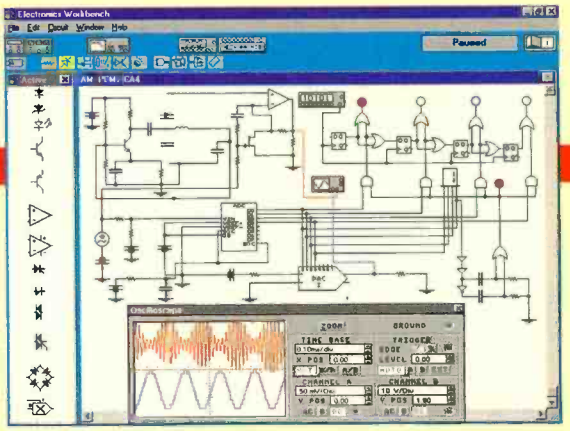

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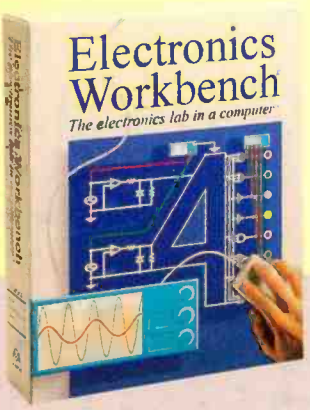

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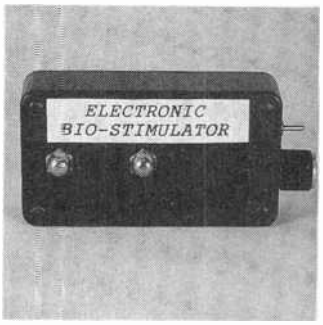

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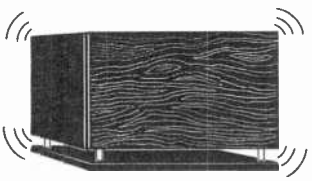
CONSTRUCTION



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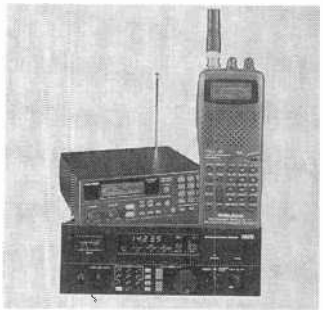

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JUNE 1996

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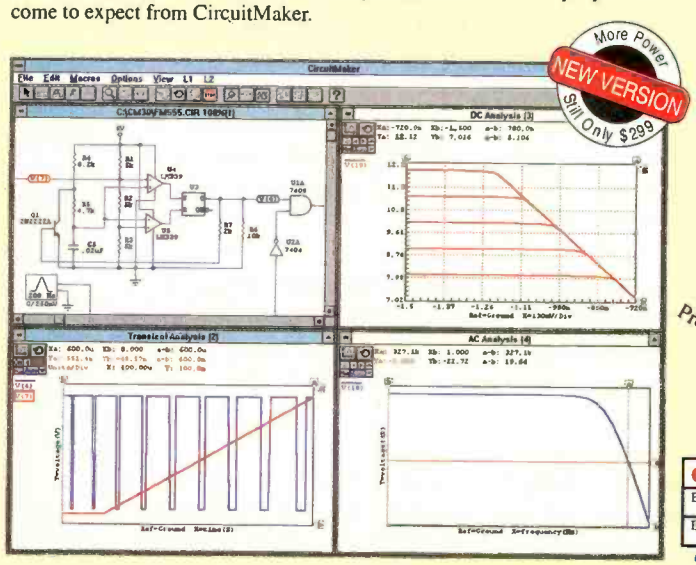

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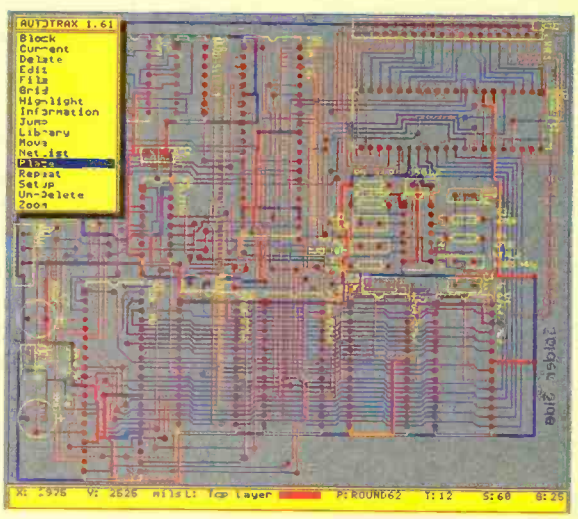

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CIRCLE 157 ON FREE INFORMATION CARD

Editorial

Updating an Ancient Technique

Acupuncture has been an accepted and respected medical technique in China for many centuries. Despite that, medical practitioners in the West had long regarded it as a combination of superstition, hokum, and old-wives tales.

However, in the face of growing evidence that it does, at least on some occasions, provide relief from some types of pain, it has begun to receive some grudging acceptance on this side of the Pacific.

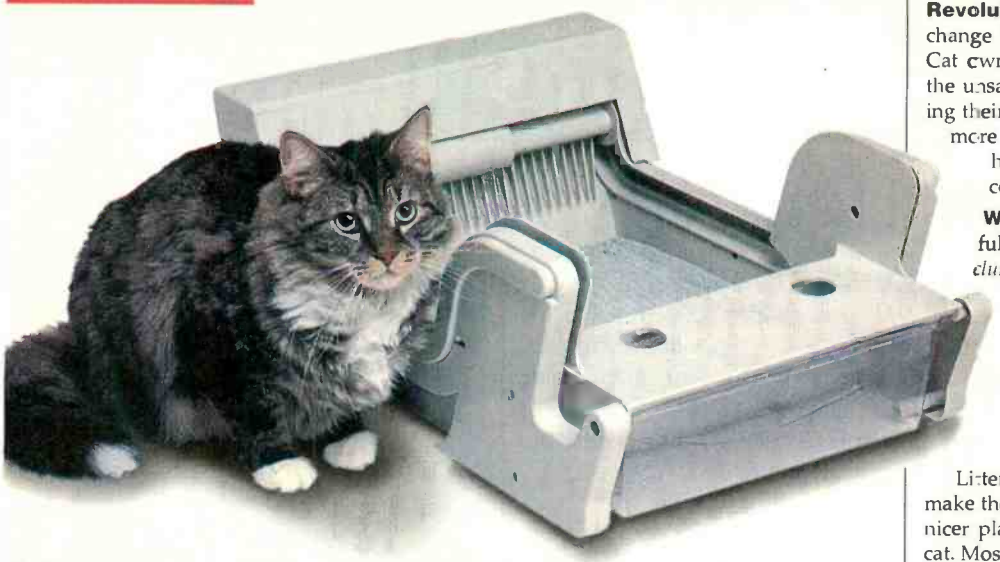
The problem with acupuncture, aside from the needles involved, is that medical doctors and other scientists are not really sure how, or if, it provides its claimed relief. Then again, there's a lot about the human body that we just don't fully understand yet.

Examples of that include the aging process, and how and why seemingly normal cells suddenly turn into malignant cancers. Even new muscles are still being discovered: Shortly before this was written, I read about a heretofore unknown muscle that runs from behind the eye to the jaw that was found, apparently for the first time, when a head was dissected in a non-standard way; scientists are theorizing that this muscle might be the source of certain hard-to-treat headaches.

In any event, this is not a medical magazine, it is an electronics one, and the point of all of this is to introduce our cover story this month—The Bio-Stimulator. If you've ever wondered about the effects of acupuncture, but were hesitant about having someone stick needles into your body, here's a way you can experiment with it on your own. In place of needles, it uses low-voltage electronic pulses to achieve similar effects.

Why not build it, and give it a try. Just remember to keep an open mind. The story begins on page 31.

Carl Laron
Editor



Never scoop cat litter again... Computer technology creates the only self-cleaning litter box!

You and your cat will love the way LitterMaid eliminates the hassle, mess and odor of the ordinary litter box.

by Shirley Liberles

Computer technology revolutionizes the litter box...

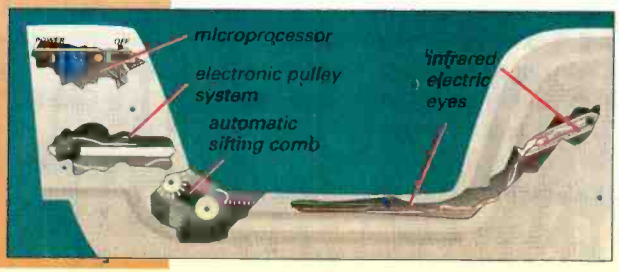
LitterMaid, a patented product from Waters Research Company, is a completely self-cleaning litter box operated by a microprocessor, but your cat uses it just like a normal litter box. Approximately 10 minutes after LitterMaid's "electric eyes" sense that your cat has exited the litter box, they signal the start-up of the automatic sifting comb.

★ The comb sifts through the litter, scooping up any waste.

★★ The waste is deposited into a sealed, air-tight waste container and the comb returns to its original position, smoothing the litter. The system resets, ready to repeat its cycle the next time your cat uses the litter box.

★★★ When the waste container is full, you can throw it away and put a new one in its place or empty it and reuse it for up to one year!

LitterMaid's microprocessor computer and infrared electric eyes combine to create the world's first self-cleaning litter-box.



House cats. Large or small, affectionate or independent, young or old, long-haired or short, they all create the same dilemma for their owners—the litter box.

There are few things I can think of that are as foul as cleaning the litter box at my house. Even when I clean it daily, it's difficult to keep odor away. And this problem is multiplied because I have two cats! But because I love them, and that's virtually all the maintenance they require, I do it...because there's no other option.

Well, today there's a solution that cat owners across the country will be thrilled about. LitterMaid, manufactured by Waters Research, is destined to make ordinary litter boxes obsolete!

Automatic cleaning. LitterMaid is a computerized, completely self-cleaning litter box. Its operation is controlled by a microprocessor. Electric eyes sense when the cat has exited the litter box, and minutes later, they signal the start-up of the automatic sifting comb. The comb sifts through the litter, scoops up any waste, and deposits it into a sealed, air-tight disposable waste container. The comb then returns to its original position, smoothing the litter. Now it's ready to begin another cycle as soon as necessary.

Revolutionary. LitterMaid may permanently change the face of the cat-product industry. Cat owners will never again have to endure the unsanitary and odor-filled chore of cleaning their cat's litter box. Plus, there will be no more embarrassing litter-box odor in your home, because the disposable waste container is sealed and totally air-tight!

What do I have to do? LitterMaid is fully automatic. Just fill the pan with *clumping* cat litter (a premium brand will provide the best results). LitterMaid does the rest! When the waste container is full, just throw it away and put a new one in its place. You'll never have unsanitary contact with cat waste again!

Good for your cat. Not only will LitterMaid make *your* life easier, it will make the litter box a nicer place for your cat. Most cats dislike using litter boxes that are dirty, and that can lead to them not going to the bathroom. Or worse, they may choose to use the bathroom around the house! With LitterMaid, your cat will always have a healthy, clean litter box.

LitterMaid eliminates...

- *Embarrassing litter-box odors*
- *Having to endure the unsanitary and odor-filled chore of cleaning your cat's litter box*
- *Limiting the areas within your home in which you can place the litter box*
- *Worrying about how to clean the litter box if you go on vacation*
- *Having a cat who refuses to use the litter box because it's dirty*
- *Some risk of catching a disease from the cat's waste—this is especially important for pregnant women and people with immune deficiencies*

Fail-safe. LitterMaid plugs into any outlet in your home, but it can also operate on eight "D" batteries. Even in the event of a power failure, LitterMaid will continue cleaning. It is equipped with an alarm that alerts you when the batteries are running low.

Put it anywhere. LitterMaid is only a couple inches longer and taller than conventional cat litter boxes. It should fit easily where your litter box is now— and you should put it there at first, until your cat gets used to it. But later, because LitterMaid is sanitary and odorless, you can place it virtually anywhere in your home—without ordinary litter-box worries!

Try it risk-free. LitterMaid is backed by our exclusive risk-free home trial and a one-year manufacturer's limited warranty. If you're not satisfied, return it within 90 days for a full refund, "No Questions Asked."

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LETTERS

Changing a Switching Amp

SWITCHING-AMP HAZARD

The power supply that Mr. Burbon has presented in his "Build A Switching Amplifier" article (**Popular Electronics**, April 1996) poses a potential hazard that was not mentioned. Because this is a non-isolated design with a floating ground, the possibility exists for dangerous voltages to be present on the exposed speaker wiring or the shield connection of the input cables in the event of a component failure.

The article contains a passing mention of line-voltage operation, but implies that once the enclosure is closed up, everything is okay. The only completely safe way to operate this circuit, in my opinion, is through an isolation transformer, which I highly recommend for all line-voltage powered projects.

B.D.M.
Des Plaines, IL

SWITCHING-AMP CORRECTIONS

I have discovered a few labeling errors in my article "Build a Switching Amplifier," which appeared in the April 1996 issue of **Popular Electronics**. The output of the power supply (Fig. 2) that reads "−51V" should read "0V." Likewise, the "−51V" connection in Fig. 1 that is labeled as going "To Power Supply" should be "0V."

In Fig. 1, the open-circle points for +12V and −12V are labeled correctly, but the +51V and −51V open-circle points should read "+25.5V" and "-25.5V," respectively. As a result, the +51V and −51V arrows connected to the MOSFETs should also read "+25.5V" and "−25.5V," respectively.

For those who already built the device, keep in mind that the above corrections do not affect the physical wiring of the amp. As long as the connections were made as shown in the schematic and parts-placement diagrams, the amplifier will work.
—Rolando Burbon

CORRECTIONS

A sharp reader pointed out to me that there were errors in the formulas in my article, "Build an Autoranging Capacitance Meter" (**Popular Electronics**, January 1996). Here are the corrected formulas:

$C = 1.44/(R1 + 2R2)f$
$R11 = ((3{,}000{,}000 - R9)/2) - R10$
$R8 = ((30{,}000 - R6)/2) - R7$
$R5 = ((300 - R3)/2) - R4$

The formulas were correct in my original article but were typeset improperly. The Gernsback BBS phone number was also printed incorrectly; the correct number is 516-293-2283.
—Robert Gotchall

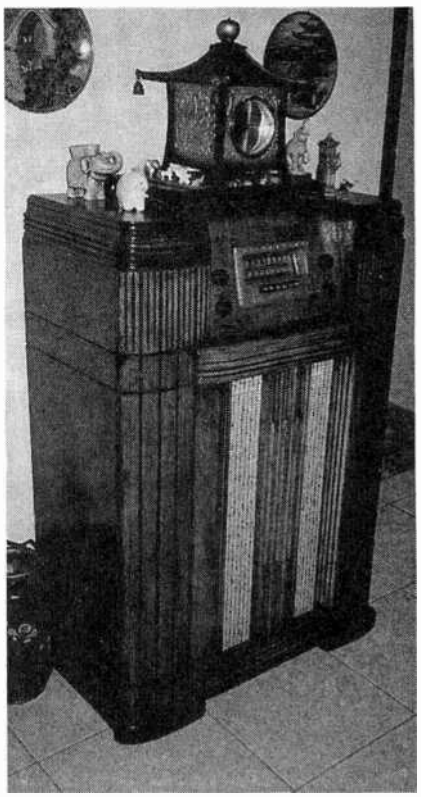
VINTAGE RADIO RESTORATION

I read with curiosity and amazement L. G. Robertson's article, "Restoring a Vintage Radio" (**Popular Electronics**, February 1996). As you can see by the photo, I restored a console very similar to the one shown in the article.

When I found my 1941 Silvertone in a junk yard in Orlando, Florida, it was in almost the same condition as the one found by Mr. Robertson. The chassis on my Silvertone is smaller, with less tubes, and it has space for a record changer. (If anyone knows where I might find such a turntable, please contact me at the address below.) The speaker was gone, so I replaced it, using a choke as the field coil of the speaker.

I replaced all the condensers and, before firing the radio up, I got rid of the humidity in the power transformer so that it would not short-circuit. To do so, I took out all the tubes, plugged the radio in, and turned it on for about 12 hours. The heat released by the transformer took out all the humidity.

The Silvertone now works perfectly.



Ramon Figueroa's restored Silvertone has space for a turntable. Do you know where he could find one?

It is a beautiful example of the consoles of the 1940s.

I have restored about a dozen radios. The oldest is an American Bosch Model 7, which I think was manufactured in 1938. All are in perfect condition.

RAMON R. FIGUEROA
122 Sandalwood Drive
Kissimmee, FL 34743

HAVES AND NEEDS

I am looking for a user's manual and/or a schematic for a Philips oscilloscope, model PM3230. I would gladly reimburse for photocopying and shipping costs. Thank you.

DARREN GREEN
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DSS STARTER KIT

from Crutchfield Corporation

The Digital Satellite System (DSS) is one of the hottest-selling consumer-electronics products in years. The small-dish satellite system can be installed by the consumer, with a bit of advance preparation. Because satellite signals can be blocked by trees, buildings, and other obstacles, industry experts recommend that consumers do a site survey before buying a DSS system.

The DSS Starter Kit contains everything needed to do such a site survey, and more. It consists of a compass, a "Satellite Elevation Angle Indicator," and an instructional booklet. Written in non-technical language, the booklet explains how DSS works, how to do a site survey, and how to install and set up a system. The compass and satellite elevation indicator help the consumer determine if a site can receive DSS signals and where the receiving dish should be placed.

The DSS Starter Kit is available for $4.95 from Crutchfield Corporation, 1 Crutchfield Park, Charlottesville, VA 22906; Tel. 800-555-9507.

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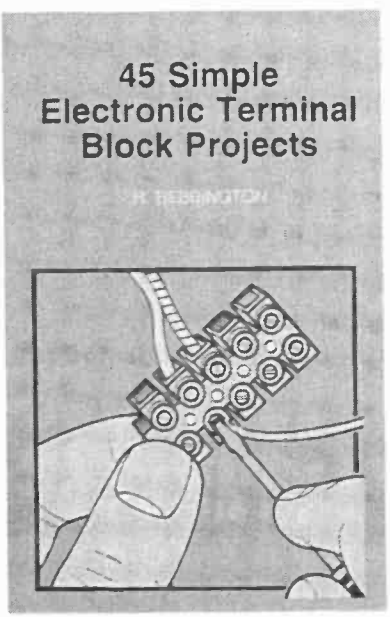
45 SIMPLE ELECTRONIC TERMINAL BLOCK PROJECTS

by R. Bebbington

This book features 45 easy-to-build electronic projects that can be constructed, even by absolute beginners, on terminal blocks using only a screwdriver and other simple hand tools. No soldering is required. Most of the projects can be simply screwed together, following the layout diagrams, in just a few minutes. To reuse the parts in other circuits, the finished projects can easily be unscrewed. A theoretical circuit diagram is included with each of the projects.



The projects cover a wide range of interests in several different categories, including connections and components, sound and music, entertainment, security, communications, and test and measurement.

45 Simple Electronic Terminal Block Projects (Order #BP378) is available for $6.26 plus $3 shipping and handling from Electronics Technology Today Inc., P.O. Box 240, Massapequa Park, NY 11762-0240.

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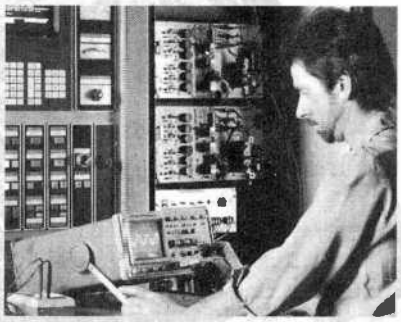

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PRODUCT TEST REPORT

Aiwa AD-S950U Audio Cassette Deck

BY STEPHEN A. BOOTH

Many pundits insist that we've arrived at the digital era, and by and large that is correct. But one area where digital technology has made little if any headway is in home audio recording.

For example, DAT, or Digital Audio Tape, arrived a decade ago and still languishes in semi-pro limbo. Despite their initial hype, Philips' Digital Compact Cassette and Sony's digital MiniDisc haven't set the world afire since their 1992 debut. Why that's the case is debatable—maybe it's their price, maybe it's because the home PC has displaced home taping as a hobby, or maybe everyone's waiting for inexpensive recordable CDs.

Meanwhile, analog cassette decks still sell at a rate of 15-million units a year in the U.S. alone. That's largely because they do a good job for what most people want—make a reasonable facsimile of a CD, LP, or broadcast for replay in a car stereo or headphone portable—and the price is right.

While relatively cheap, dual-transport copying decks dominate the market, we decided to take a look at what the serious home recordist gets for the price of a top-shelf VCR these days. The AD-S950U reviewed here is a fine deck, solid and reassuringly quiet mechanically, that sells for about $400. It doesn't quite hit the performance numbers its manufacturer claims, but Aiwa chose some puzzling and nonstandard methods of expressing its specs. Based on recognized, standard testing procedures performed at the Advanced Product Evaluation Laboratory, the numbers posted by the AD-S950U are very respectable. We can only speculate why Aiwa shot itself in the foot with its spectacular claims—but we won't.

The Aiwa AD-S950U audio-cassette deck.

FEATURES

The big selling-point of the AD-S950U is the incorporation of Dolby's new S-type noise reduction system (that comes in addition to the industry-standard Dolby B/C NR). Dolby-S was developed to meet the demands placed on analog home-recorders by digital source material, such as CDs. It's derived from a studio noise-reduction system called Dolby SR ("Spectral Recording"). Dolby SR enables studio analog open-reel gear to make quieter masters for CD-bound recordings.

Primarily, where S differs from Dolby's older B/C is that noise-reduction is applied across the entire frequency range, including low frequencies. Dolby B/C operates only in the higher ranges, where tape hiss is most noticeable. Dolby S is a dynamic system: It applies noise reduction only when needed and only in the frequency bands where needed. That depends on the level of the signal. High levels don't need treatment because they mask any tape noise, but those quieter, low-level passages might need the Dolby boost-and-cut to overcome hiss. Just as CDs provide greater dynamic range than older LPs, Dolby S is capable of greater noise reduction: Up to 24 dB compared to about 10 dB in the older NR systems.

Dolby S is best used for critical recordings—those with lots of dynamic range and frequent silent passages, as you might find in classical music. You'd probably make those recordings with the best (and costliest) tapes available, Type IV metal compounds, and that is how APEL tested the feature. Dolby B noise reduction was tested with Type I normal-bias tapes while Dolby C was paired with Type II (high-bias, or chrome/CrO2) cassettes. For your information, cassettes recorded with Dolby S can be played back compatibly on simple gear equipped with only Dolby B.

TEST RESULTS

We'll jump right into the numbers and save the hands-on evaluation and further chat on features for later. You'll find the measurements corresponding to APEL's tests in Table 1.

Fifteen years of microelectronic research makes conventional antennas a thing of the past!

This little box uses your home's electrical wiring to give non-subscribers, cable subscribers and satellite users better TV reception!

by David Evans

Technology corner

1. Why don't conventional antennas work as well as the Spectrum?

- When TV signals are tuned at the TV channel's center frequency, optimum tuning has been achieved.
- Other antennas can't offer center frequency tuning like the Spectrum Antenna can. They only offer such tuning up to the edge of the center frequency. As a result your TV picture remains snowy.

2. How does Spectrum use a home's electrical wiring as an antenna?

Believe it or not, the Spectrum Antenna simply "activates" the giant antenna that already exists in your home. Essentially, it uses all of the wiring throughout your home's walls and ceilings to make an antenna as large as your house for unbelievably clear reception of local broadcasting.

3. Spectrum antenna features

Parallel 75 ohm resistance
For minimum loss of signal

Signal search control
For selecting multiple antenna configurations

Polarized three-prong plug for grounding
For optimum signal grounding to eliminate noise and static

Resonant fine tuner control
For dialing in crisp, clear TV/stereo reception, eliminates ghosting

Dual AC outlets with built-in surge protection
For plugging in additional TV/stereo equipment guarding against damage and electrical surges

Until recently, the only convenient way to guarantee great TV reception was to have cable installed or place an antenna on top of your TV. But who wants to pay a monthly cable fee just to get clear reception, or have rabbit-ear antennas that just don't work on all stations? Some people just aren't interested in subscribing to cable. Or they may live in an area where they can't get cable and TV-top antennas aren't powerful enough. And what about those people who have cable or satellite systems but still can't get certain local stations in clearly?

Now, thanks to fifteen years of microelectronics research, a new device has been developed that is so advanced, it actually makes conventional antennas a thing of the past. It's called the Spectrum Universal Antenna/Tuner.

Advanced technology. Just imagine watching TV and seeing a picture so clear that you'd almost swear you were there live. Just plug the Spectrum Antenna into a standard AC outlet and plug your TV into the Spectrum. You can remove the unsightly clutter of traditional TV-top devices gathering more dust than television signals. Get ready for great reception. Your TV will suddenly display a sharp, focused picture thanks to its advanced design "Signal Search" and "Fine Tuner" controls.

Uses your home's electrical wiring. The Spectrum Antenna is a highly sophisticated electronic device that connects into a standard wall outlet. The outlet interfaces the Spectrum Antenna with the huge antenna that is your home wiring network. It takes the electrical wiring in your house or apartment and turns it into a multi-tunable, giant TV reception station which will improve your TV's overall tuning capability. The results are incredible. Just think how much power runs through your home's AC wiring system—all that power will be used to receive your local broadcasting signals.

How it works. Broadcast TV signals are sent out from the local broadcast station (ABC, CBS, NBC, etc.). They interface with your home's AC power line system, a huge aerial antenna network of wiring as large as your home itself. When the Spectrum Antenna interfaces with the AC line, the signal is sent to its signal processing circuit. It then processes and separates the signal into 12 of the best antenna configurations. These specially processed signals route themselves into 12 separate circuits. The Spectrum Antenna includes a 12-position rotary tapping switch, the "Signal Switch" control, which gathers twelve of the best antenna configurations.

The "Signal Search" offers varying antenna configurations for the user to select from the best signals of all those being sent. The signal then passes through the Spectrum Antenna's special "Fine Tuner" circuit for producing crisp, clear reception.

Risk-free offer. The Spectrum Universal Antenna/Tuner comes with our exclusive 90-day risk-free home trial and a 90-day manufacturer's warranty. Try it, and if you're not satisfied, return it for a full "No Questions Asked" refund.

Who can use Spectrum?

- *Cable users-You have cable but you can't get certain local stations in clearly.*
- *Non-cable users-You don't have cable and want the stations to come in more clearly*
- *Satellite users-You have a digital satellite system but can't get local stations in clearly*

We said the Aiwa deck has a solid feel and quiet mechanics—no shake, rattle, or roll in the tape-transport functions. In terms of measurable performance, that is reflected in the flutter tests. By either the "Weighted Root-Mean-Square" or *Deutsche Industrie Normen* methods, speed fluctuation for the AD-S950U was no greater than the 0.2% considered acceptable for variations in pitch.

Among the electrical measurements, distortion is negligible at the fraction-of-a-percent readings measured in our tests. Frequency response, the range of sounds from bass through treble that the deck will reproduce accurately, is appropriately broad for each of the tape types tested, but some explanation is needed.

You'll see two sets of measurements for this test. The first shows the deviation from flat response, in decibels, at the low- and high-frequency extremes cited in Aiwa's specifications for the deck. The second group measures the range of frequencies over which recorded signal does not deviate more than plus or minus 3 dB from the original input signal—the spread considered to be "flat" or accurate. That is the standard way of measuring and expressing frequency response, and APEL's tests show the AD-S950U to be an able performer: flat all the way from 20 Hz through 15 kHz for Type I tape, and to 20 kHz for Types II and IV.

You can't ask for much more from an analog deck running at 1-7/8 inches-per-second, so why Aiwa claimed frequency response from 15 Hz to 18, 19, and 21 kHz for the respective tape-types is a puzzlement. Yes, something gets recorded at those extremes, but (at, for example, -8.0 dB) it's not flat or accurate reproduction.

Signal-to-noise measurements are about par for the course for each tape type and with the noise-reduction system applied, but here too, there's a deviation between Aiwa's claim and APEL's measurement that needs explaining.

Specifically, it concerns the S/N ratio when using Type IV (metal) tape with Dolby S. Aiwa's literature claims 84 dB of S/N at "Peak Level" but specifies no frequency. APEL, using the standard 1-kHz test signal and the recommended record level for the tape (+4 dB in this case), measured S/N at 72.4 dB.

TABLE 1—TEST RESULTS

The following test results were furnished by the Advanced Product Evaluation Laboratory, an independent testing facility located in Bethel, CT. The following brands of 90-minute tape cassettes were used for this evaluation:
Type I — BASF LH-MI
Type II — Sony UX-S
Type IV — Sony Super Metal Master

BRAND: Aiwa
MODEL: AD-S950U Cassette Deck
PRICE: $500
POWER CONSUMPTION: 16 watts
DIMENSIONS (H×W×D, inches): 5⅛ × 16⅛ × 12⅝

0-VU REFERENCE: 25 mM/mm (millimaxwells per millimeter) @ 315 Hz

OUTPUT LEVEL (@ 315 Hz):	Type I 412 mV	Type II 412 mV	Type IV 412 mV
FLUTTER (@ 3 kHz):	Type I	Type II	Type IV
(WRMS) 0.06%	0.06%	0.04%	
(DIN) 0.20%	0.20%	0.10%	
DISTORTION (@ 400 Hz):	Type I	Type II	Type IV
(Level -10 dB)	(Dolby B) 0.12%	(Dolby C) 0.08%	(Dolby S) 0.04%
SIGNAL TO NOISE RATIO:	Type I	Type II	Type IV
(@ 1 kHz, "A" Weighted)	(Dolby B) 64.2 dB	(Dolby C) 72.9 dB	(Dolby S) 72.4 dB
FREQUENCY RESPONSE:	Type I	Type II	Type IV
(@ -10 dB)	(Dolby B)	(Dolby C)	(Dolby S)
Low (15 Hz)	-8.0 dB	-9.0 dB	-7.0 dB
High (18 kHz)	-7.0 dB		
HIgh (19 kHz)		-3.0 dB	
High (21 kHz)			-5.0 dB
(+/- 3-dB points)			
	20 Hz (-1 dB) 15 kHz (-3 dB)	20 Hz (-1 dB) 20 kHz (-2 dB)	20 Hz (-1 dB) 20 kHz (+3 dB)

The same result was obtained with a 10-kHz input signal. Even when the lab set the record level to the deck's maximum (+10 dB peak), S/N was 80 dB at best, still short of the claim. Bottom line: Aiwa's 84-dB spec is meaningless when comparing this deck to others, because the method of measurement used is neither specific nor standard. APEL's test is specific and conventional, so the measurement can be used when comparing models and brands.

HANDS-ON

For any of these performance measurements, APEL used the AD-S950U's "fine-bias adjustment" to get the optimal recording from each tape. That is the kind of feature you'd expect on a high-end deck; lower-end decks only have a fixed bias current for each tape type. Recording characteristics vary among tapes and brands and do change, usually for the better, with successive generations of tape formulations. So it's nice to be able to tweak an individual cassette for all it's worth. Dolby HX/Pro—another feature of this deck—plays a role here. High-frequency sounds tend to add bias of their own to the tape. HX/Pro monitors the audio signal and modifies the bias current dynamically, so that the tape doesn't become over-biased, resulting in dull trebles.

Bias fine-tuning and features like "recording sensitivity" calibration are more easily appreciated on a three-head deck such as the AD-S950U. Because there are separate magnetic heads for recording and playback (and for erasure), you can monitor a tape as you record it, comparing the input source against the recording. That isn't possible with two-head decks, which combine record and playback in one head.

You can monitor that recording with headphones—the AD-S950 has a front-panel jack and volume dial. But you won't be making recordings with a microphone—there's no "mic-level" jack provided. For live recording, you'll have to go through the line-level inputs, probably through some sort of equalizer or mixer. For the record,

equalization is not adjustable; it is fixed at 120-microseconds for Type I and 70-ms for II, IV, and the extinct "ferrichrome" Type III. Also, "EQ" is selected automatically by the sensor-holes in the cassette.

One very nice feature of the AD-S950U is its real-time tape counter—minutes and seconds instead of some arbitrary odometer. You'll know exactly how much recording time the tape holds, how much you've used, and how much is left.

Among similar conveniences, the deck offers "music sensor (MS) and review." That advances you to the next song (or returns you to the preceding one) by detecting the "mute" segments between selections. Those can be the hiatus between tracks on a CD or LP, or, the "rec mute" feature lets you record 4-second silent passages when you're rolling your own compilations. All these features can be controlled by the IR remote control.

CONCLUSION

Don't lose any sleep over the discrepancy between Aiwa's S/N claim and APEL's finding. For critical home listening, you most likely will (and should) use the original CDs. If you're recording CDs for car stereo or headphone/portable listening, the ambient noise (traffic, tires, wind) will be greater than any hiss you might hear.

If you're recording LPs for home listening, the deck's S/N ratio is well above that of the average vinyl record and about the same as the quietest (and costliest) audiophile platters. The only compromise might be if you are making a composite tape from different CDs for critical listening. In that case, you might want to use a HiFi stereo VCR (80 dB S/N), or you probably should be shopping for a digital recorder or an analog open-reel unit.

For more information on the Aiwa AD-S950U audio cassette deck, contact Aiwa directly at the address below, or circle 120 on the Free Information Card. ■

FOR MORE INFORMATION

AIWA AMERICA, INC.
800 Corporate Drive
Mahwah, NJ 07430
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A Hands-on Electronics® REPORT

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Cartridgemate Inkjet Refill System

An ink-jet cartridge refill system that saves money and minimizes messy clean ups.

The next time your car runs low on gas don't limp into a service station for a refill. Instead, consider replacing the fuel tank, gas lines, fuel pump, and carburetor. Sound silly? Not according to most of the major manufacturers of computer inkjet printers.

Take Hewlett-Packard, for example. Their popular DeskJet printers use an expensive ink cartridge that runs dry after a thousand sheets or so. Their recommendation? Buy another cartridge! At about $30 each, a dozen of those would equal the cost of the printer itself.

Why so costly? In addition to the ink reservoir, the cartridge houses the complex print head and necessary circuitry to produce the printed page. It seems wasteful to cast out the whole device just because you ran out of ink. Enter the third-party vendors with their refill solutions.

Nearly a dozen companies offer inexpensive answers to refilling the ink reservoir and thus salvaging the cartridge itself for further use. Most of the products are variations on a squeeze bottle of ink with a thin needle spout that punctures the seal at the top of the cartridge and allows you to squirt ink back into the plastic chamber. Those solutions are generally unsatisfactory as they overlook the design of the cartridge and its ball-type seal. That frequently results in a leaky cartridge that, at best, leaves your fingers ink-stained, and, at worst, messes up the printer rather badly. You'll swear off refill bottles the first time you spend an hour mopping up the inside of your DeskJet printer.

However, a near perfect solution is now available—the *CartridgeMate* work station from *JetFill* takes you quickly through a five-step procedure for refilling and resealing your HP 51626A cartridges, arguably the most popular ink cartridge being sold today.

The Cartridgemate. The CartridgeMate is an injection-molded plastic unit measuring 5.5-inches high by 5-inches wide and about 4-inches deep. The package also includes two "ink tanks" and a set of three, small, plastic balls. The startup kit sells for $29.99 but additional ink tanks (sold only in pairs) cost $10 each, a considerable savings over the $30 cost of a complete cartridge replacement.

The five-step operation for refilling your empty HP cartridge is quite simple.

Step 1. You flip open the top half of the CartridgeMate after first sliding a lever, located near the base of the unit, to the far left. That positions the cartridge carrier inside the unit into its proper location for the refill operation. Your empty cartridge is then placed in that carrier. The lid is then closed and snap-locked into place.

Step 2. The top of the unit houses two separate plungers. Pressing down on the left-hand plunger pushes the 0.125-inch diameter fill-hole ball down into your HP cartridge. The plunger door is then opened and one of the two supplied ink tanks is firmly seated into the plunger housing. That punctures the ink-tank seal and ink flows by gravity into your cartridge. In about 45 seconds, the ink tank has transferred its contents and can be removed. Stenciled illustrations on the top and front of the CartridgeMate guide you in the proper orientation of your cartridge, the slide lever, and the ink-tank positioning.

Step 3. The slide lever is moved to the far right and the plunger door is closed. That positions your HP cartridge for the last two steps, the reinsertion of a new sealing ball.

Step 4. One of the three, small, plastic sealing balls supplied with the CartridgeMate is dropped into a chute located on the right side of the unit. It rolls down into position for the final operation.

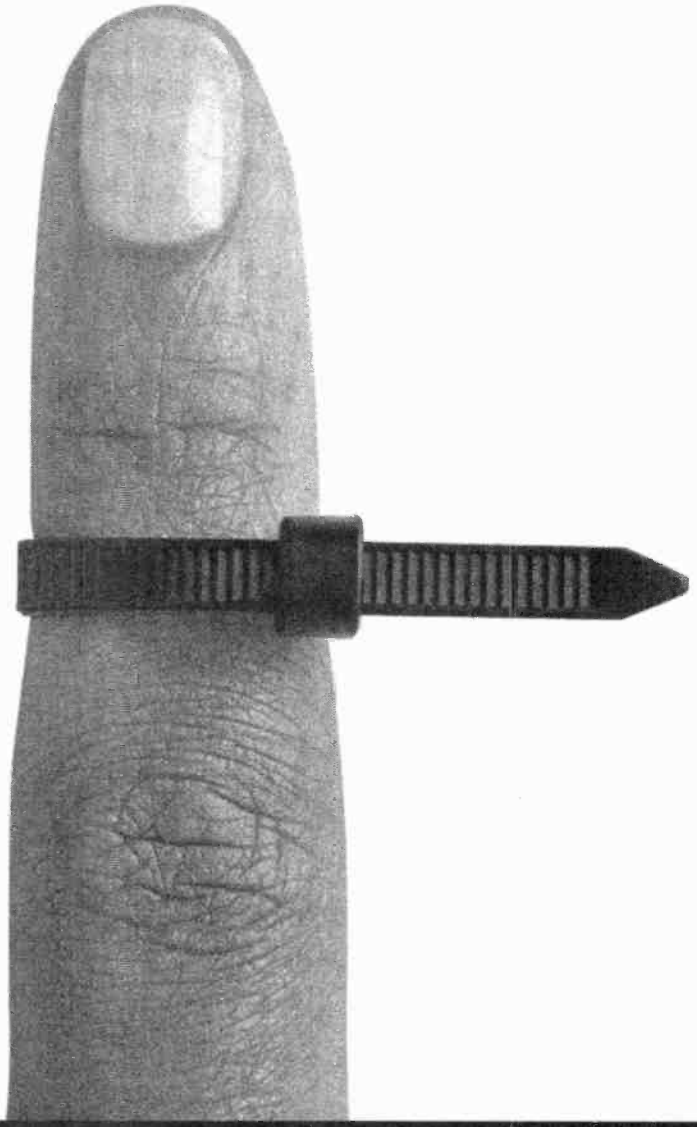
Step 5. Pushing down firmly on the small right-hand plunger mounted on the top of the CartridgeMate pops the new ball in place.

Voila! Opening the unit and removing your HP cartridge is all that remains to be done. The transparent reservoir reveals that your old cartridge has, indeed, been refilled and is ready for use in your printer.

The procedure described above probably sounds more complicated than it really is. The entire operation takes no more than a minute-and-a-half including the wait time while the ink tank drains itself into your empty HP

(Continued on page 16)

Just a reminder.



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We've got answers.®

INKJET REFILL SYSTEM

(Continued from page 14)

cartridge. The well-illustrated instruction sheet (in six languages) plus the stenciled illustrations on the unit itself make the refill operation nearly foolproof.

The only problem you are likely to encounter while performing this task is the overflow of ink from the ink tank into the interior of the CartridgeMate. It appears that the people at JetFill, in their desire not to short-change you, have put an extra dollop of ink in their tanks that ensures a messy cleanup after the final operation. That situation could be further aggravated by attempting to refill a cartridge that was not completely dry. Therefore, be sure to run your HP cartridge to the empty mark before using the CartridgeMate unit to refill it.

Fortunately, while the cleanup task is unpleasant, it is easily accomplished using an absorbent towel stuffed down the inside chamber of the unit. Still, JetFill would be well advised to hold back an ounce or two from their ink tanks and prevent the nasty letters with ink-stained fingerprints that many users might feel inclined to send them.

Your HP 51626A High Capacity Cartridge is good for between five and ten refills depending on the type and frequency of printing that you do. At some point, therefore, you will have to discard the cartridge and invest in a new one.

In summary, the $30 startup cost for the CartridgeMate unit and two Ink Tanks is recovered with the second refill you do. Thereafter, the $10 price versus a $30 new cartridge cost is a money saver we can all appreciate. The CartridgeMate unit appears to be well made and should be able to perform its useful task for years.

For more information on the CartridgeMate from JetFill, contact the company directly at the address given below, or circle 119 on the Free Information Card. ■

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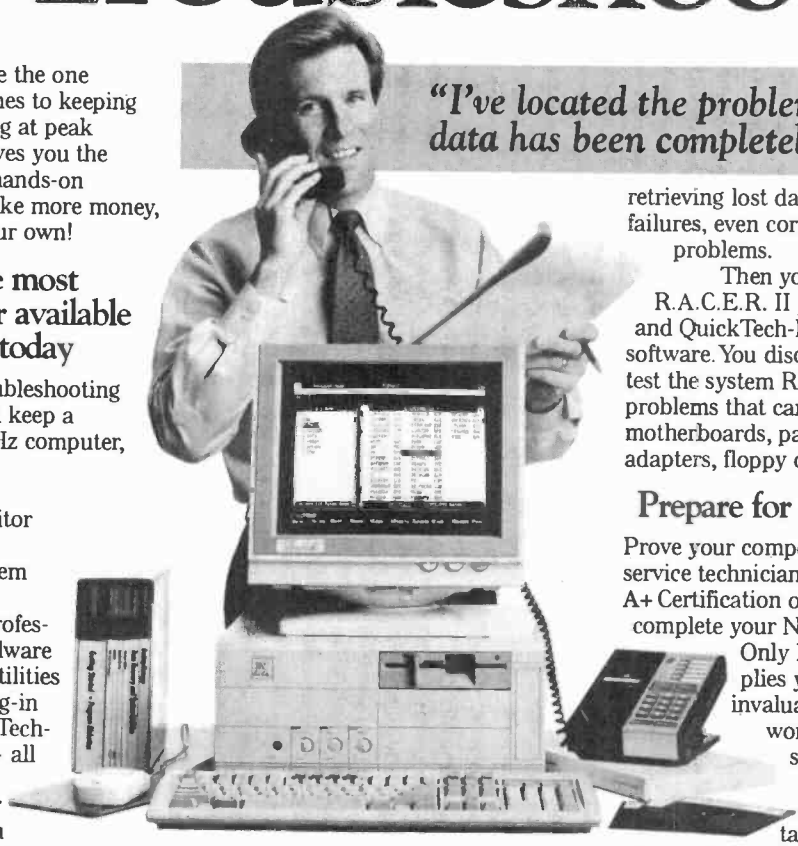

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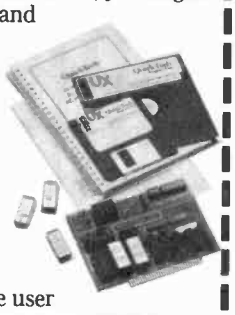

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Multimedia Watch

Monitors, Cameras, and More

BY MARC SPIWAK
TECHNICAL EDITOR
WINDOWS MAGAZINE

When it comes to monitors, I've been spoiled lately. I'm now using 17-inch units both at home and at work, and hope to never have to use a smaller one again. Larger monitors let you actually use windows within Windows. You get to see the whole picture on a big monitor.

But "large screen" is a relative description. A 17-inch monitor isn't really all that big when compared to a large-screen (27-inches and up) TV. And that's where movies and video games really come alive. Unfortunately, even 20-inch computer monitors are very expensive, and as far as anything larger goes, well, if you need to ask, you can't afford it.

That doesn't mean you can't play Doom on a 35-inch screen. Instead, what you need is the UMAX *Maxmedia TV Mini*. That $179 pocket-sized device converts the VGA output from a PC into an NTSC or PAL video signal that can be displayed on any TV. The TV Mini supports resolutions up to 640 X 480 for NTSC and 800 X 600 for PAL, and outputs composite video, S-video, and RGB component video. Now you can play your favorite video game on the biggest TV you can find.

The TV Mini works well with both desktop systems and notebook computers. It installs between the VGA output of a computer and the monitor. Power is supplied from the computer's keyboard connector by a supplied adapter, so the TV Mini never needs batteries. Controls let you adjust the TV picture's color, brightness, horizontal position and size, and vertical position. Hooking up the TV Mini and getting it working is a piece of cake. I had it working in only a few minutes. The picture on the TV screen is not as clear as it would be on a computer monitor, but it's reasonable considering how large a display you can have. The TV Mini is also handy for business presentations, training sessions, and for making PC demo tapes on a VCR.

The Maxmedia TV Mini converts the VGA output from a PC into an NTSC or PAL video signal.

DIGITAL CAMERAS

I've also recently been playing with a bunch of digital cameras. These cameras store pictures in memory rather than on film. When the memory is full, you simply download the pictures from the camera to a PC. Images can be saved in popular formats that can easily be viewed, manipulated, saved, and printed.

Digital cameras don't need any expensive film, and no developing is required. Electronic pictures can be e-mailed anywhere in the world right after they're taken. Or they can be instantly used in a desktop publication. I checked out three cameras that are all nearly identical, and all made by Chinon. One is a Chinon; the others carry Dycam and Kodak labels. They all sell for around $1000.

The cameras are powered from four AA batteries, and images are retained even with the batteries removed. Internal memory can hold up to 40 pictures in normal resolution, 10 pictures in fine resolution, and 5 pictures in super-fine resolution. PCMCIA memory cards can be added to the cameras, which can then store hundreds of pictures depending on what size memory card you install. A cable connects the camera to a serial port on the computer. Included software lets you import pictures from the camera.

NEW STUFF

A new CD-ROM from Future Vision Multimedia, *Explorers Of The New World,* takes a look at the journeys of over 60 famous and not-so-famous explorers, including Columbus, Cortes, and Magellan. The disc includes video, animation, maps, and more. It has a suggested retail price of $49.95.

The *1996 Grolier Multimedia Encyclopedia* is here. This disc is loaded with facts and information, an atlas, art, music, video, and more. It's a handy multimedia reference to have around the house. Software prices seem to drop all the time. The Grolier Multimedia Encyclopedia now sells for $49.95, and it really is a bargain at that price.

The Discovery Channel is still busy

Virtual Reality technology creates the world's first portable big-screen television

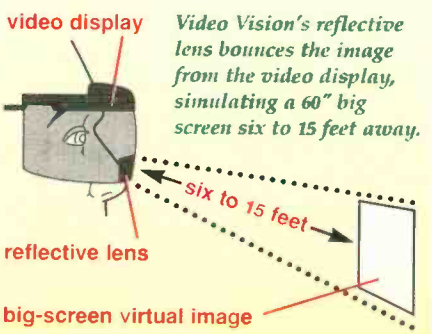
Breakthrough portable TV from Virtual Image Displays, Inc. creates a virtual image that simulates a 60" big-screen image at a distance of six to 15 feet away.

by Timothy B. Arnett

VIRTUAL TECHNOLOGY

How does Virtual Vision Sport create a virtual image that floats in space? Within the eyeware is a miniature video display and a sophisticated reflective optical system. Part of the optical system is a small, specially-engineered reflective lens which is mounted slightly below your normal field of vision on your dominant-eye side. (Your brain gives priority to whatever image is viewed by your dominant eye, so the image will seem to appear in both of your eyes. See the inset box at the right to determine which eye is your dominant eye.) The lens bounces the video image from the video display so that it appears to be focused a comfortable distance (about six to 15 feet) in front of you.

The Sport eyeware is easy to wear, and it lets you see your environment as well as the TV image.



Virtual reality. We've all heard about it. But if you're like me, you figure you'll never get the opportunity to experience it in your lifetime. Think again! The Virtual Vision Sport 200 is a breakthrough invention that uses virtual reality (VR) technology to bring big-screen virtual images to a portable TV.

Virtual Vision Sport is the ultimate portable television. You can wear it on the beach, in the gym, wherever you want. And because the TV image is part of the eyeware, *it moves with you.* With the Sport, you can maintain your active lifestyle without missing your favorite shows!

How it works. The Sport's portable battery-operated tuner picks up TV signals from the airwaves and transmits images to a miniature LCD video display in the eyeware. The image is reflected to your dominant eye, resulting in a floating virtual image that appears to be a comfortable distance away. The farther away you focus your vision, the larger the image appears. Special color optics provide projection TV-style imagery. The eyeware contains a pair of high-fidelity earphones. It also comes with an AC adapter for indoor use!

Monocular technology. The Sport uses monocular technology to create the virtual image. While your retinas are presented with different images, they are not so different that the brain can't fuse them together. The process of fusing two slightly different retinal images into a single picture with depth, called *stereopsis*, is the way most of us see the world around us.

VR, only better. Ordinary VR equipment is cumbersome and uncomfortable. Plus, the dual video displays used in VR can confuse the visual system, resulting in eyestrain and *binocular dysphoria*, a defect in depth perception that can last for hours.

The Sport is different. Weighing a mere five ounces, you will forget you're wearing it. And because you see your environment *and* the virtual image, eyestrain is minimized and depth perception is unaffected.

More than TV. You can connect the Sport to a camcorder, video game system or VCR. Watch a movie from your VCR in bed without disturbing your spouse. Plug the Sport into your video game system to battle life-size virtual characters. Used with a camcorder, the Sport serves as the ultimate viewfinder—no more missing any action. The Sport is also great for training and education—students can watch a training video while working. You can even use the Sport to impress your clients with a personalized multimedia presentation!

DETERMINING YOUR EYE DOMINANCE...

- Extend your arm out as far as you can.
- Bring your index finger and thumb together to form a circle.

- With both eyes open, visually center a small, distant object (like a light switch or door knob) within the center of the circle.

- Without moving your head or arm, close one eye at a time. *The eye that keeps the object centered in the circle of your fingers is your dominant eye.*

Risk-free. The Sport is backed by our risk-free home trial. If you're not satisfied, return it within 90 days for a refund, "No Questions Asked." The manufacturer provides a 90-day labor and one-year parts warranty. Most orders processed within 72 hours and shipped UPS.

Virtual Vision Sport 200 . . . . . **$499** $19 S&H
PLEASE SPECIFY RIGHT- OR LEFT-EYE DOMINANCE.

Please mention promotional code 1171-PL-6657.

For fastest service, call toll-free 24 hours a day

800-992-2966

To order by mail, send check or money order for the total amount including S&H (VA residents add 4.5% sales tax). To charge it, enclose account number and exp. date.

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Midlothian, Virginia 23113

WHERE TO GET IT

Ahrens Interactive, Inc.
400 North State Street
Chicago, IL 60610
CIRCLE 50 ON FREE INFORMATION CARD

Discovery Enterprises
7700 Wisconsin Avenue
Bethesda, MD 20814
CIRCLE 51 ON FREE INFORMATION CARD

Edmark
6727 185th Ave., NE
P.O. Box 97021
Redmond, WA 98073
CIRCLE 52 ON FREE INFORMATION CARD

Future Vision Multimedia
60 Cutter Mill Road
Great Neck, NY 11021
CIRCLE 53 ON FREE INFORMATION CARD

Grolier Electronic Publishing, Inc.
Sherman Turnpike
Danbury, CT 06816
CIRCLE 54 ON FREE INFORMATION CARD

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L3 Interactive
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Looking Glass Technologies
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Cambridge, MA 02140
CIRCLE 57 ON FREE INFORMATION CARD

Sony Interactive
919 East Hillside Blvd.
Foster City, CA 94404
CIRCLE 58 ON FREE INFORMATION CARD

UMAX Technologies, Inc.
3353 Gateway Blvd.
Fremont, CA 94538
CIRCLE 59 ON FREE INFORMATION CARD

Viacom Newmedia
1515 Broadway
New York, NY 10036
CIRCLE 60 ON FREE INFORMATION CARD

pumping out new CD-ROM titles, with two this month. For kids ages 4 to 8, *Big Job* is a new kind of disc from Discovery. It puts kids in charge of construction, farming, and fire-rescue adventures, and lets them "get behind the wheel" of heavy equipment. Kids can build cities, machinery, and almost anything else, for $49.95. More for adults, *Wings: Midway to Hiroshima* details aviation technology throughout the final years (1942 to 1945) of World War II. These are the planes that made the most difference, and you can explore them from the comfort of your home for $49.95.

Viacom NewMedia is also busy putting out multimedia with a new disc that features the crazy duo, Beavis and Butt-Head. *Beavis and Butt-Head in Virtual Stupidity* lets you explore the entire world of Beavis and Butt-Head. Included are games, music videos, and lots more fun.

DigiZINE is a new entertainment CD-ROM that's published quarterly by Ahrens Interactive for $9.95 an issue. Each issue will include wild graphics, music, games, interviews, articles, and more.

Inscape has two new titles out with *The Dark Eye* and *The Resident's Bad Day on the Midway*. The Dark Eye lets players assume different roles to solve puzzles in games that are inspired by Edgar Allan Poe stories. Bad Day on the Midway features a strange cast of characters involved in a murder mystery in a bizarre 3D carnival setting.

If you like flight simulators, then you will appreciate *Flight Unlimited* from Looking Glass Technologies. Flight Unlimited captures the sensation of flying with photo-realistic scenery and terrain. You can fly five performance aircraft over actual locations including Alaska, Maine, and France. You can take lessons, take on race courses, and more. Flight Unlimited has a suggested retail price of $59.95.

L3 Interactive sent me three new "how-to" CD-ROMs. These are intended to help you perfect certain hobbies. *MatheMagics* can teach you amazing math tricks through the simple, yet powerful methods of Dr. Arthur Benjamin, acclaimed mathematician.

Wings: Midway to Hiroshima details the planes that made a difference in World War II.

Slopestyle provides multimedia lessons in the extreme world of snowboarding. Real-Line helps you smooth out your in-line skating skills. These discs sell for $34.95 each.

Strategy Games of the World from Edmark is intended to help 8 to 14 year olds develop problem-solving strategies that will be helpful in day-to-day life. Centered around three games—Mancala, Nine Men's Morris, and Go-Moku—Strategy Games of the World helps kids learn how to identify and analyze problems, look for patterns, plan ahead, predict outcomes, and more. It will sell for around $40.

Last this month is something that driving enthusiasts will love, especially reckless driving enthusiasts. *Destruction Derby* from Sony Interactive is a wild automobile smash-up derby game with realistic crashes and smashes. ■

NET WATCH

Voice E-Mail

BY DAN KARAGIANNIS

If you've spent some time on the Internet, then chances are you have come across gigabytes of graphics and audio files. Without such files, the Net would seem a cold, lifeless realm indeed. Realizing that, I've decided to devote this month's column to two distinct ways that you can get your face and voice on the Net. Let's get right to them.

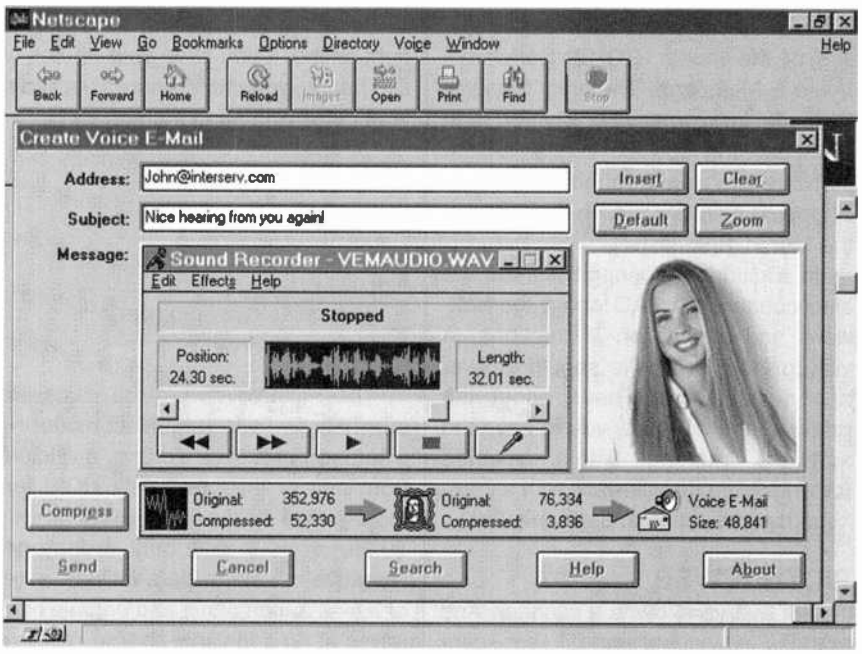
AUDIOVISUAL E-MAIL

Many computer users develop excellent typing skills over time; skills that come in handy if you send a lot of e-mail. In fact, an impressive speed for a professional typist is considered to fall between 60 and 80 words-per-minute. That's great, but did you ever stop to think that most people talk at a speed of 200 to 250 words-per-minute! Imagine being able to compose e-mail at that speed.

Well, there are two ways to do it: You can either invest about $2000 to get an accurate voice-recognition system for your computer, or spend about $29.95 on Voice E-Mail 3.0. Besides being about 70-times more affordable, Voice E-Mail lets you send actual recordings (as well as photos) over the Internet.

Face it, all the "emoticons" in the world—you know, a smile is represented by ":)" and a wink is ";)"—can't make up for actually hearing emotions in a voice. Using digital audio and the latest in sound-compression technology, Voice E-Mail 3.0 lets you send messages containing music, laughter, and sound effects all over the world!

Before we go on, it is important to note that it *is* possible to send both sound and video files via regular e-mail; after all, they're simply binary files. However, those files are usually enormous. That means they take a long time to transmit, and often annoy their recipients because it takes a long time to download them from an e-mail server. Voice E-Mail eliminates those problems by changing the way that binary files are sent.



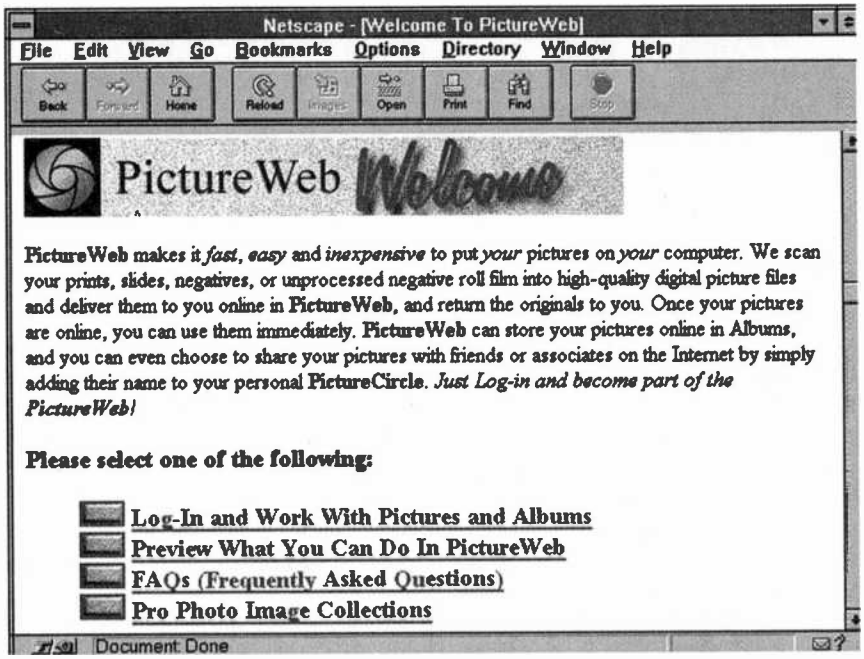
With Voice E-Mail, sending an audio message and photo of yourself is simple. With a few clicks of the mouse, your message can be on its way.

The software uses a new "lossless" compression technology specifically optimized for digital audio. Most audio-compression algorithms today lose digital waveform data during compression. Because there's no way to get that information back once it's gone, when the recording is uncompressed, it will never again sound exactly like the original. However, lossless compression (as the name implies) doesn't lose any of the original data and the uncompressed audio sounds exactly like the original recording.

Voice E-Mail files are also small in size because a low sampling rate can be used to create them. Old audio compression programs started with a 16-bit, 44-kHz recording (a few seconds of such a file can be hundreds of kilobytes in size), and then "tossed out" much of the digital waveform data during compression. Because Voice E-Mail doesn't lose any information, messages can be recorded with an 8-bit, 11-kHz sampling rate and still sound better than higher-rate, poorly compressed files.

To use Voice E-Mail, you need a PC with the following: a sound card, microphone, Internet connection, Windows 3.xx or Windows 95, 4 MB of RAM minimum (however, the more RAM, the longer the recording time), and 2 MB of free disk space. Note that no minimum processor requirements are mentioned; if your PC can work with .WAV files and send e-mail, it can run the software.

Different Voice E-Mail versions are available for use with various e-mail software. For those with a SLIP/PPP connection, versions are available for both Eudora and Netscape Navigator (at the time of this writing, only a 16-bit Voice E-Mail plug-in is available). There are also Voice E-Mail versions for use with America Online, Prodigy, and CompuServe, though, at the time of this writing, CompuServe users can only use Voice E-Mail with other CompuServe users (that's because



If you'd like to save on scanning costs and make your photos available online, PictureWeb is the site to visit.

CompuServe only allows users to send binary files to other CompuServe users).

Regardless of which e-mail program you use it with, Voice E-Mail 3.0 is a true plug-in program. That means that the software will completely and seamlessly add its features to your existing e-mail program's drop-down menus and dialogue boxes. In Netscape, for example, a new Voice menu will be added right to the main menu bar, containing the commands: Create Voice E-Mail, Play Voice E-Mail, and Help.

In Netscape, here's how you would send a Voice E-Mail: First, select Create Voice E-Mail. Then, when the mail window opens, enter the e-mail address and subject as you normally would. Click the Record button and speak into the microphone. You can also add a photo, if you'd like. Finally, click the Send button.

Now, how does the recipient of your message play the message? Obviously, because Voice E-Mail is an add-in program, and because you have to pay for it, not every computer user will have it. The good news is there is a freely distributable Voice E-Mail Player, so the recipients of your messages can decompress them at no cost. Of course, once they see how great the product is, they'll probably want Voice E-Mail 3.0 as well.

By now you might be wondering just how you can order the software. It's available through a link at our first site of the month, BONZI Software's Voice E-Mail page. The links found at that site let you order, pay for, and download the specific version of the software you want through the Internet Shopping Network (which I covered in the March 1996 issue).

In addition to ordering links, the site also contains an FAQ about the software and installation instructions. A visit to the BONZI site should answer any questions you have about the product, and will allow you to have the software running within minutes (downloading the software with a 28.8-kbps modem takes about 6 minutes).

PICTUREWEB

Not everyone owns a scanner. And of those individuals who do own scanners, only some have high-resolution, color units. If you aren't equipped with the hardware, but would still like to use a decent-looking picture in an application like Voice E-Mail, how do you get a roll of film onto your computer screen? Well, you can have the shots developed and take them to some place of business to be scanned in, but that can get a bit tedious. Besides, if you want to share all the photos with several other computer users, you wouldn't want to e-mail all of them.

Now there is a way to have your photos developed, scanned in, and made available online. The company that makes it possible is PictureWeb, which used to be known as PicturePlace when it was available only on America Online. Through partnerships with Adobe PhotoDeluxe and Mystic Color Lab, PictureWeb provides its users with terrific services from the PictureWeb home page.

Here's how the service works: You can send prints, slides, negatives, or unprocessed film (negative-roll only, they don't do slide-roll film). The photos will then be converted to high-quality digital picture files for use online (and with your offline applications too); they then return the originals to you. Once your pictures are online, you can use them immediately. And if you don't feel like downloading them all, or if you'd like others to see them as well, you can use a PictureAlbum to store your picture files online.

Ordering information is available right online. If you have your photos or film handy, you can prepare your order in minutes and send it on its way.

HOT SITES

Voice E-Mail
http://www.bonzi.com

PictureWeb
http://www.pictureweb.com

The PictureWeb service costs are surprisingly affordable, considering what you get. Converting a picture from any of the previously listed formats into a online picture file is only $0.99, even if you only order one. Negative-roll film orders include a set of 3.5- X 5-inch prints and original negatives at no additional charge. You are only charged for the number of pictures on the roll of film that are made into online pictures. A required return delivery and handling fee of $2.95 is added to each order total, regardless of how many pictures you send.

And that's it for this month. If you have any comments, questions, or sites you'd like to see covered, please e-mail me at peeditor @aol.com, or send snail mail to *Net Watch,* **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735. ■

SCANNER SCENE

Solving Some Problems

BY MARC SAXON

Uniden Bearcat's new *BCT-10* is a mobile integrated scanner and highway-information system that can be mounted in your vehicle's windshield or sun visor. That places the BCT-10 in a category of its own (best of all, it's just in time for your summer motoring).

The BCT-10 is not a radar detector, although it is about the same size and shape as one. Instead, it is a scanner/receiver that is pre-programmed to monitor police frequencies, including the frequencies used by low-powered mobile repeaters installed in most highway patrol vehicles. The unit sounds an alarm when it detects signals on mobile repeater frequencies, which it usually does within a three-mile radius of a highway-patrol car.

The unit features a fully pre-programmed memory that contains the frequencies of highway, state, and local police, as well as weather, transmissions. The driver needs only to switch to the state where the vehicle is located in order to set up proper coverage. The two-digit state/signal-strength LED clearly displays the state code.

Coverage includes high/low VHF, UHF, and UHF-T public-service bands, plus one-touch access to NOAA weather broadcasts. The BCT-10 also features channel lockout, memory backup, and built-in scan delay. An external speaker jack and attached swivel-mount rubberized whip antenna are also standard.

The BCT-10 has a manufacturer's suggested retail price of $289.95. It is available from Uniden's many dealers.

IDEAS

Based upon questions received over the months, here are some possible solutions to common problems encountered by our readers.

Several readers have written to say that they don't like to use their scanners' priority channel feature because it's too annoying (continually interrupting communications on other frequencies just to check its status every second). Alternately, some scannists complain that they would like to give increased attention to two or even three frequencies, but their scanners offer only one priority channel. What to do?

One effective trick can deal with either or both problems. There's no reason why you can't take a high-interest frequency and enter it at several scattered memory channels. So, if you have a 100-channel scanner, enter it into memory channels 20, 45, 70, and 95. If there is a second high-interest channel, program it into channels 21, 46, 71, and 96. That's what I call "painless priority."

Uniden Bearcat's BCT-10 is in a category all its own. It's an integrated scanner and highway-information system that is pre-programmed by state to monitor police frequencies.

Another topic that generates letters is monitoring phone calls from Air Force One, Air Force Two, and other VIP ("SAM") diplomatic and military aircraft. Most of those sent "in the clear" in the scanner range don't contain high-level security information.

Generally, the calls are between Crown (the White House Communications Agency, or WHCA) and various press, military, protocol, and other aides. Often calls are concerned with logistics, such as appointments, conferences, speeches, rallies, banquets, interviews, and ground transportation. Repairing snafus is a part of that. It's a fascinating insight into the behind-the-scenes operations of those staffers. With the election on the horizon, activity should be increasing.

The calls are downlinked from the aircraft on 415.70 MHz, and picked up by the nearest facility in a network of more than 50 ground stations located at points across North America. That network is remote controlled from the WHCA in Washington. The ground stations' uplinks use 407.85 MHz.

Scannists can easily copy the 415.70-MHz signals from the high-altitude aircraft from hundreds of miles away. In the event that the aircraft happens to be communicating from a ground facility near their location, they might also be able to hear the other side of the conversations taking place on 408.85 MHz. Neither station repeats the other, so both frequencies would need to be monitored to capture everything.

Unless you have two scanners, that is a lot easier to describe than to do. That's because both stations leave their carriers on at all times during calls. A scanner simply locks onto one frequency and stays there. My approach to the problem works with Radio Shack PRO-2035, PRO-2042, and other scanners that have a rotary tuning knob.

All you need to do is enter 415.70 MHz into one monitor memory position, and 408.85 into the adjacent slot. Then, as the conversation progresses, use the rotary tuning knob to manually shift back and forth between those two monitor memory channels. If you are in range of an active ground facility, you get to hear both sides. That works surprisingly well, and it isn't as awkward as it might at first appear.

MORE MAILBAG

Ken Albrecht of Gary, Indiana, dropped us a card to say that he occasionally picks up a mystery signal on

continued on page 28

ANTIQUE RADIO

Rescued By Radio!

BY MARC ELLIS

This month, dear readers, finds me at loose ends. The 1930's ham receiver series is wrapped up—not entirely to my satisfaction, but wrapped up nevertheless—and I haven't yet gotten into a new project. As it happens, I've just come across a very enjoyable book: *SOS To The Rescue,* by Karl Baarslag (Oxford University Press, 1935). It recounts the stories of the earliest marine disasters in which radio played a significant life-saving role.

The introduction of wireless communication had a dramatic impact on the safety and comfort of the passengers and crews of ocean-going vessels. Formerly, once a ship had passed over the horizon, it lost all contact with those left behind on land. Except for chance meetings with other vessels, the ship was out of touch with the world until reaching the other end of its journey.

Before wireless, vessels that burned or foundered at sea simply disappeared without a trace. But Marconi's invention, undaunted by intervening space and distance, made it possible for ships to remain in constant communication with land and—when necessary—summon help to the scene of a disaster. Here, then, retold from information in the Baarslag book, are the stories of the first three major marine disasters in which radio played an important part.

THE REPUBLIC AND THE FLORIDA

On Friday, January 22, 1909, The White Star Liner *Republic* sailed from New York bound for Gibraltar and the Mediterranean. But the voyage came to an untimely end just before dawn the next morning. Radio operator Jack Binns was awakened by a sudden increase in frequency of the ship's foghorn blasts. Next there was a terrific crash. The *Republic* had been rammed by the *Florida*, an Italian ship carrying a load of immigrants bound for the United States.

Running to the adjoining radio room, Binns found that one wall had been wrenched away. The equipment (which included a 10-inch spark-coil transmitter) appeared intact, and he had just begun to test it when the water filling the hold reached the ship's generators and power failed. Switching to emergency batteries, the radioman sent out the "CQD" (pre-SOS distress signal) for which he later became famous. It was picked up by the land station at Siasconsett, Massachusetts.

Radio Operator Binns of the Republic soon after being rescued.

Conserving the radio's batteries, Binns remained quiet after communicating the *Republic's* approximate position, and the land station took up the distress calls. Several ships were contacted, the nearest to the disaster scene being the *Baltic*—which was off Long Island, New York, inbound from Liverpool. She was only 64 miles from the *Republic* but, in those days before radio direction finders, had to cover 200 miles as she zigzagged through the fog groping for the sinking ship. In the meantime, 460 passengers were transferred to the more seaworthy *Florida*.

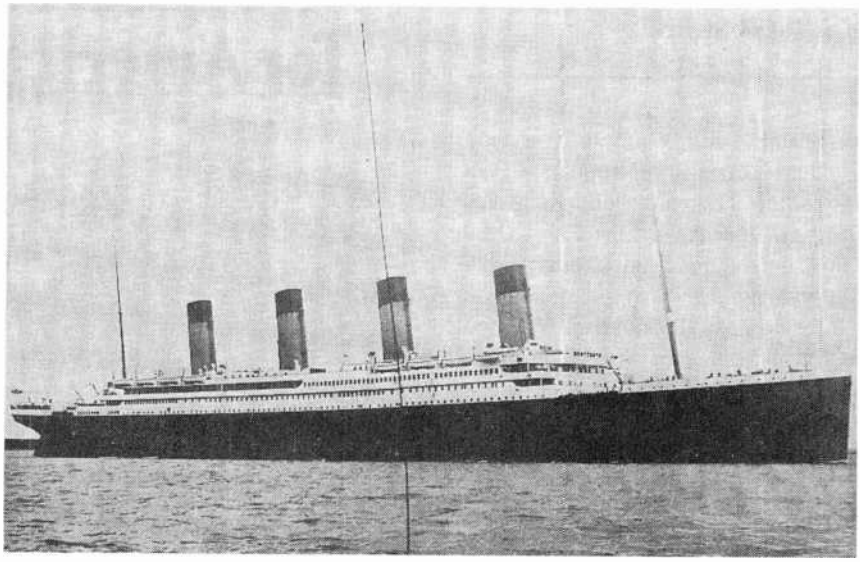
Because the *Florida* had no radio, Binns stayed aboard the *Republic* with the skeleton crew to maintain communications. By midday, Binns was able to get in direct touch with the *Baltic* (and the *La Touraine*, which was also participating in the rescue). Hundreds of emergency messages were exchanged during that period. But as darkness fell, the *Baltic* still had not found the *Republic* and the *Florida*.

The ships were setting off bombs, with explosion and listening times coordinated by radio, in an effort to find each other in the fog. Finally, the *Baltic* was down to its last bomb—but as it went off, Binns and one other crew member of the *Republic* heard it and they were able to radio the *Baltic* a bearing. Twenty-five minutes later the *Baltic*, all lights ablaze and cheering passengers lining the rail, drew up alongside.

The *Republic* sank before it could be landed—but the *Baltic* delivered her own, the *Republic's,* and the *Florida's* passenger loads safe and sound to port. The stove-in *Florida* also made it to land. Binns' heroism was long remembered. He had remained at his key in the half-destroyed and open-to-the-weather radio room through 36 hours of bone-chilling cold and dampness.

THE TITANIC

On the beautiful, clear, spring night of April 15, 1912, 1517 men, women, and children perished when the ill-fated *Titanic* hit an iceberg and sank in the icy waters of the North Atlantic. Among the many ironies associated with that haunting and poignant tragedy was the fact that the ship *Californian* was less than 15 miles from the sinking ship and in visual range.



The S.S. Titanic leaves Southhampton on her fatal maiden voyage.

Unfortunately, the radios that both ships carried were of little help in mitigating the disaster—not because of technological shortcomings, but rather because of the inadequate safety laws and the (to say the least) thriftiness of the entrepreneurs who ran many of the steam ship lines.

At the time, many ships carried but a single radio operator, so 24-hour radio watches were impossible. The *Californian's* operator, Cyril Evans, was to go off shift at midnight, just about the time of the disaster. But he had been on duty since 7 a.m. (April 14th) and, at 11:45 p.m., was chased off the air by the *Titanic's* operator because the *Californian's* broad spark note was interfering with the handling of messages from the land station at Cape Race.

So Cyril, exhausted from his long shift, shut down and turned in early. Had he stayed until midnight, he would have heard the alternate "SOS" and "CQD" being sent out by *Titanic's* incredulous radio operators who, even as they sent the signals, could not believe that their "unsinkable" ship was in danger.

Among the ships that eventually *did* respond to the crackling whine of the *Titanic's* rotary spark gap was the S.S. *Carpathia*, some 58 miles away. Actually, *Carpathia's* radio shack should have been shut down, too, but Cottam, the operator, wanted to hear news of a coal strike then going on in England and was up late listening to dispatches from Cape Cod.

The story goes that Cottam was starting to unlace his shoes prior to turning in and was also about to shut down the receiver when the distress call came in. After convincing his astonished captain that the *Titanic* was indeed in trouble, all hands were roused and the old *Carpathia* began its legendary race through the night and the ice floes to reach the doomed White Star Liner.

While steaming under forced draft at more than three knots above her normal 14, Captain Rostron began making preparations to receive an unknown number of survivors. His foresight would later be acclaimed as a "marvel" of masterly organization. Boats were swung out; lights, ladders, bosun's chairs, and life lines rigged; life rings, hot coffee, beds, and doctors were made ready.

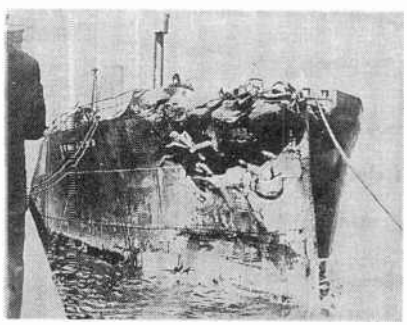
The scenes of terror and heroism taking place on the *Titanic* during the *Carpathia's* frantic dash to the rescue have been described many times, and we couldn't begin to do them justice here. The *Carpathia* reached the scene at 4 a.m., about an hour and a half after the *Titanic* had plunged headfirst to her icy grave. In all, 712 survivors were brought aboard.

THE EMPRESS OF IRELAND

Two years after the *Titanic* tragedy, another ghastly sinking claimed the lives of over a thousand people. Early in the morning of May 28, 1914, the Canadian Pacific liner *Empress of Ireland*, bound for Liverpool out of Quebec and proceeding down the St. Lawrence river through a patch of fog, was rammed amidships by the Norwegian collier *Storstad*. Fifteen minutes later, the *Empress* had sunk in less than 150 feet of river water and not more than three miles from the shores of the river.

Ronald Ferguson, the *Empress'* chief radio operator, had gone to bed about five minutes before the collision. Edward Bamford, the junior operator, was on watch. Rushing to the radio shack, Ferguson sent Bamford back to get his clothes and started up the transmitter. Not authorized to send an SOS, Ferguson nevertheless transmitted the message that the *Empress* had struck something and might need assistance. He made a point of sending the message very slowly because, at that hour, he knew that only junior operators were likely to be on duty.

Ferguson's idea was to pave the way for an SOS that might follow and make sure that senior operators would be aroused to take the watch. His strategy worked. The signal was answered immediately by Crawford Leslie, the 19-year-old junior on duty at the Father Point land station. He was instructed to get his senior.



The Storstad after her collision with the Empress of Ireland.

Soon Ferguson received orders to send the SOS. It was heard and answered by Whiteside, the Father Point senior, who had been hurriedly aroused by Leslie. The Canadian Government boat *Lady Evelyn* and the pilot boat *Eureka* were immediately sent to the assistance of the foundering *Empress*. The *Eureka* had taken the pilot off the *Empress* only 30 minutes before!

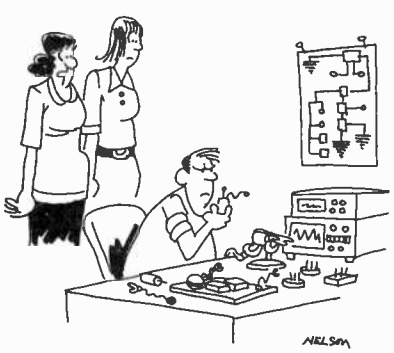
Back on *Empress*, the two radio operators were doing their best to stay on the air under deteriorating conditions. After the liner's approximate position was sent, Whiteside repeated it for verification. Ferguson had acknowledged with a "Y," "E," and the first two dots of an "S" when power began to fail. He held the key down so that Whiteside could hear the dying note and know that he would hear no more from the distressed ship.

The operators eventually made it to the lifeboats and were taken aboard *Storstad*. But Ferguson had barely begun to dry out, when he was summoned to the *Lady Evelyn*, which was equipped with wireless but had no operator. After some difficulty powering up the strange installation, Ferguson began sending out "saved" messages for the survivors.

But the ship had gone down so swiftly that, in spite of the prompt actions of the two brave radio operators on the *Empress* and the prompt response of the Father Point land station, only 465 of the almost 1500 passengers were saved.

The *Storstad* made it back to port, but was seized at Montreal to satisfy a judgment against her. Later, she was quietly bought back by her original owners working through agents. She was sunk in the North Sea, by mine or submarine, while carrying Belgian relief supplies during World War I.

That's all for now. Please send any comments to *Antique Radio*, **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735. ■



"I don't know what he is working on, but I'll bet it makes our electric bill go up!"

SCANNER SCENE

(continued from page 25)

400.55 MHz. Ken wonders what type of station uses that frequency. We intercepted that one too, Ken. We found out that it's a Low Earth Orbit (LEO) microsatellite in a polar orbit. The satellite is also authorized on 400.525 and 400.575 MHz, although we haven't detected activity on those two. It has the callsign KS2XDT, and is owned by Satellife of Cambridge, Massachusetts. The uplink frequencies are 148.8225, 149.8475, and 149.8725 MHz.

A letter from Howard Conte, of Maryland, mentions that he has seen Voice of America crews doing remote broadcasts. That caused him to repeatedly search/scan the 450- and 455-MHz bands looking for their communications, but nothing was found. More effort and checking around did turn up two frequencies used for VOA remotes: 418.05 and 418.575 MHz. Howard is now curious to find out if there are additional frequencies. He hasn't located any yet, but hopes our readers can write in with a few. Anyone know?

G.R.W., of St. Paul, Minnesota, asks if we can run the frequency of the Milwaukee Brewers. If he means the baseball club and not the brewers of Old Frothingslosh, we are definitely in business. Fire up the scanner on 151.625, 151.925, 936.6375, and 936.6625 MHz.

We hope to hear from you with your questions, thoughts, and newly discovered frequencies. If your scanner monitoring station is one you would like others to see, please snap a photo and send it along to us. We want to keep our column tops, and your input is what makes the difference. Write to us at *Scanner Scene*, **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735. ■

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Enjoy the benefits of electronic acupuncture without the use of needles.

BUILD A BIO-STIMULATOR

BY ROBERT A. HEIL

Ask around and you'll probably find that most people know what acupuncture is. However, not many of those individuals would want to have it actually done. That's because the treatment is often expensive and, let's face it, the idea of having needles poked into one's skin is not all that appealing. Well, with the *Bio-Stimulator* described in this article, you can avoid such drawbacks. The device provides a needleless and painless way to enjoy the benefits of acupuncture.

Acupuncture Basics. The Tabers Encyclopedic Medical Dictionary defines acupuncture as "the puncture with needles for diagnostic and therapeutic counter irritation purposes." Here's a look at how that technique came about.

Centuries before the Western world began to understand blood circulation and the nervous system, the ancient Chinese developed the theory that a system of energy circulation is present in the human body. The Chinese stated that vital life energy flows through a series of pathways, or meridians, 12 of which are located in each side of the body. Those meridians were said to course through the deep tissues of the body, surfacing occasionally.

Each of the areas where the meridians touch the surface were considered useful treatment points for ailments to one or more organs. It was believed that inserting needles at such surface points could cure problems with a patient's heart, lungs, colon, gallbladder, liver, or other organs.

Western interest in the technique (eventually called "acupuncture") did not become widespread until the 1970s, when physicians in the People's Republic of China demonstrated that it could be used to control surgical pain. After 20 minutes of stimulation, a recipient of effective acupuncture treatment would be wide awake, alert, and aware of all performed surgical procedures, but not aware of any pain.

The actual mechanisms by which patients are able to tolerate surgery during acupuncture stimulation are still unknown. Some scientists speculate that large sensory fibers are activated, thereby inhibiting the transmission of impulses from the small fibers carrying the sensory input of pain.

Other scientists believe that naturally produced, morphine-like substances (such as endorphins) might be released within the brain in response to the stimulation. When those types of substances bind to opiate receptor cells, a pain-inhibition system is activated. Patients suffering from pain in the back, head, abdomen, or other areas could experience short-term relief by such a pain-inhibiting process.

Although widely accepted throughout the Far East as a legitimate practice, acupuncture is viewed quite differently by the West. The main influential factor is the American Medical Association (AMA), which does not recognize acupuncture as a legitimate medical procedure to cure the sick.

Without the AMA's acceptance, acupuncture was for several years considered by many to be a form of "black magic." That's not surprising considering how many people find the idea of sticking needles into their skin repulsive. What's more, there is a considerable amount of danger present if the technique is performed by an unlicensed practitioner. One misplaced needle could do considerable damage if a major organ or artery is punctured.

The fear of possible needle damage led to the development of electronic acupuncture. That newer technique uses electronic pulses in place of needles to control pain, tone and strengthen muscles, increase blood flow, and release the body's

WARNING!!!

This article deals with and involves subject matter and the use of materials and substances that may be hazardous to health and life. Do not attempt to implement or use the information contained herein unless you are experienced and skilled with respect to such subject matter and materials. Furthermore the information contained in this article is being provided solely to readers for educational purposes. Nothing contained herein suggests the Bio-Stimulator system described herein can be or should be used by the assembler or anyone else in place of or as an adjunct to professional medical treatment or advice. Neither the publisher nor the author make any representations as for the completeness or the accuracy of the information contained herein and disclaim any liability for damages or injuries, whether caused by or arising from the lack of completeness, inaccuracies of the information, misinterpretations of the directions, misapplication of the information or otherwise.

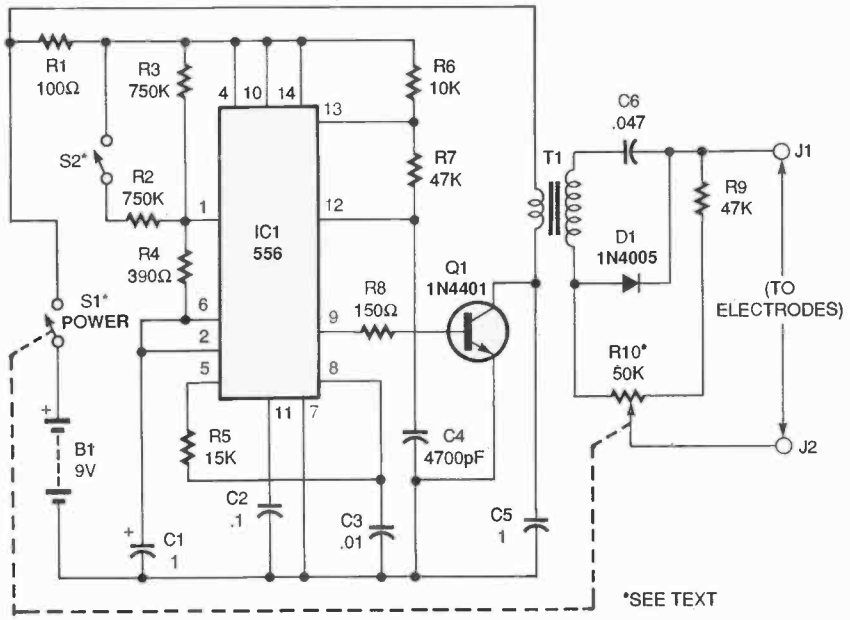


Fig. 1. Here's the schematic diagram for the Bio-Stimulator. Adjusting the settings of potentiometer R10 and switch S2 let you fine tune the output pulse.

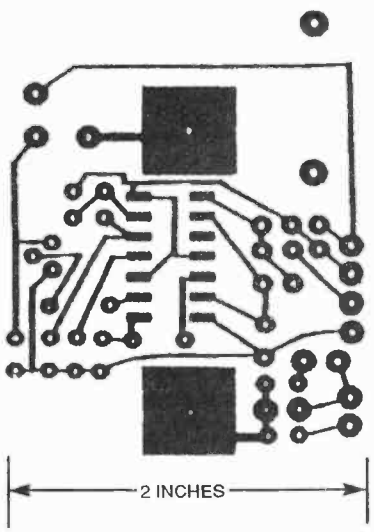


Fig. 2. Use this full-size template to make your own PC board.

own natural pain and inflammation reducers. Although still not fully recognized by the AMA, electronic acupuncture has recently gained acceptance among chiropractic practitioners and a small percentage of physicians as an alternative technique to their therapeutic methods; they feel it is safe and works well for certain problems.

The Bio-Stimulator produces the same basic waveforms found in professional electronic-acupuncture devices. It contains common components and easy-to-find hardware, and is designed to be rugged, easy-to-use, lightweight, and portable.

Just a word of caution before we go any further: **Misuse of the Bio-Stimulator can be dangerous.** Do not use the device on the eyes or on open sores, or if you have a pacemaker, are currently under treatment for heart disease or arrhythmia, or are pregnant. Even if you are in perfect health, you might want to consult your doctor before using the device.

Circuit Description. The schematic for the Bio-Stimulator is shown in Fig. 1. Power for the circuit is supplied by a 9-volt battery, B1. Switch S1 is used to turn the unit on and off, and resistor R1 acts a current limiter for the circuit.

Resistors R2–R4 and capacitor C1 form a timing circuit with IC1, a 556 dual timer. When S2 is open, the charge and discharge time of C1 is set at approximately 2 Hz. Closing S2 increases the charge and discharge time of C1 to approximately 4 Hz. The output of the first timer at pin 5 of IC1 is sent via R5 and C3 to pin 8 of IC1; that section of IC1 and components R7, R8, and C4 complete the second timing circuit. While the first timer creates the delay time in Hz, the second timer creates the actual pulse time for the inductor.

The inductor pulse time is applied to the base of transistor Q1 through a current-limiting resistor, R8. When Q1 conducts, the primary side of audio-transformer T1 is momentarily grounded, thereby energizing T1. Capacitor C5 charges and discharges every time T1 is energized and de-energized. That charge cycle slows down the rise and fall time of the pulse, which in turn increases the duration of the output pulse from T1, and at the same time shapes the edges of the output waveform to more closely resemble a half sinewave.

Components C5, D1, and R9 form the rest of the output-wave-shaping circuit. Potentiometer R10 is used to adjust the amplitude of the pulse up to a maximum of about 200 volts with a duration of 2 ms and an overall current drain of less then 10 mA.

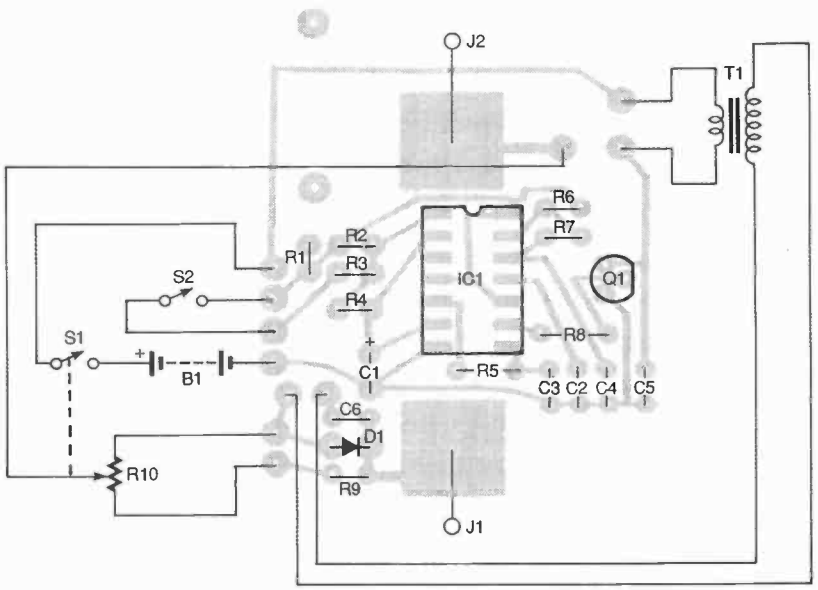
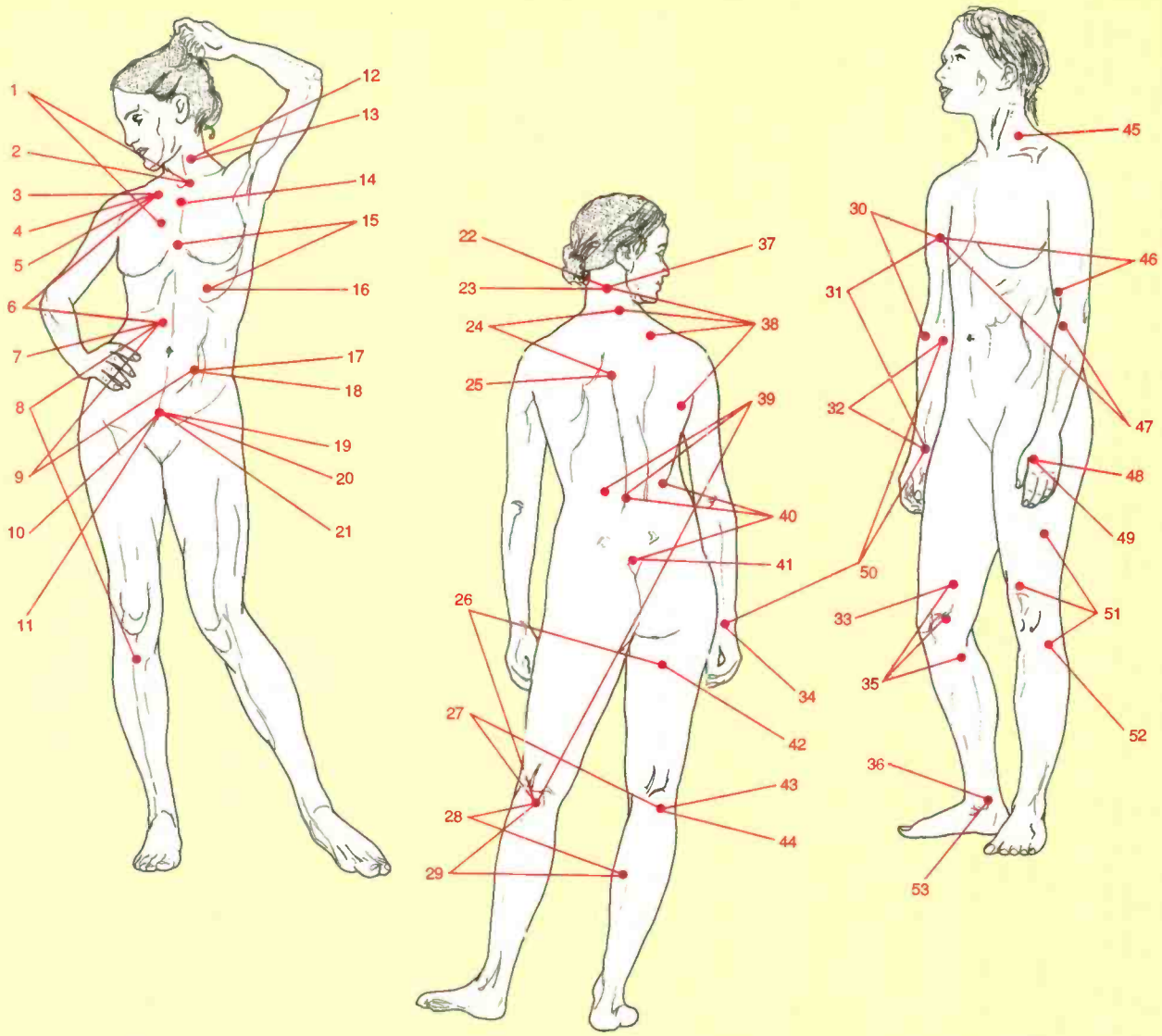


Fig. 3. If you're building the unit on a PC board, use this parts-placement diagram as a guide.



1. BRONCHITIS
2. HYPERTENSION
3. SHOULDER DISTRESS
4. PALSY OF THE UPPER EXTREMITIES
5. INTERCOSTAL NEURALGIA
6. GASTROPTOSIS
7. VOMITING
8. STOMACH ILLNESS
9. DIARRHEA
10. GYNECOLOGICAL DISTRESS
11. CYSTITIS
12. DIZZINESS
13. CERVICAL NEURALGIA
14. ASTHMA COUGH
15. GENERAL FATIGUE
16. DIABETES
17. INTESTINE ILLNESS
18. LIVER AND KIDNEY ILLNESS
19. ENURESIS
20. RECOVERY OF FATIGUE
21. CONSTIPATION
22. HEADACHE
23. SPASMOTIC PAIN OF THE NECK
24. DIZZINESS
25. GENERAL FATIGUE
26. SCIATICA
27. LEG FATIGUE
28. CLONUS
29. PALSY OF LOWER EXTREMITIES
30. HAND-MUSCLE PAIN
31. PALSY OF THE HAND
32. FINGER-JOINT PAIN
33. GYNECOLOGICAL DISTRESS
34. CONSTIPATION
35. KNEE-JOINT PAIN
36. EDEMA OF LEGS
37. ALCOHOLIC DROWSINESS
38. SHOULDER DISTRESS
39. LUMBAGO
40. RECOVERY OF FATIGUE
41. PILES
42. NEURALGIA OF LOWER EXTREMITIES
43. KNEE-JOINT FATIGUE
44. KNEE-JOINT PAIN
45. SHOULDER PAIN
46. ELBOW-JOINT PAIN
47. PALSY OF UPPER EXTREMITIES
48. EYE STRAIN
49. TOOTHACHE
50. HAND-JOINT PAIN
51. PALSY OF LOWER EXTREMITIES
52. HYPERTENSION
53. RECOVERY OF FATIGUE

Fig. 4. What ails you? By placing J2 of the Bio-Stimulator on one of these points, and having J1 touch your skin as well, you can explore the possibilities of electronic acupuncture.

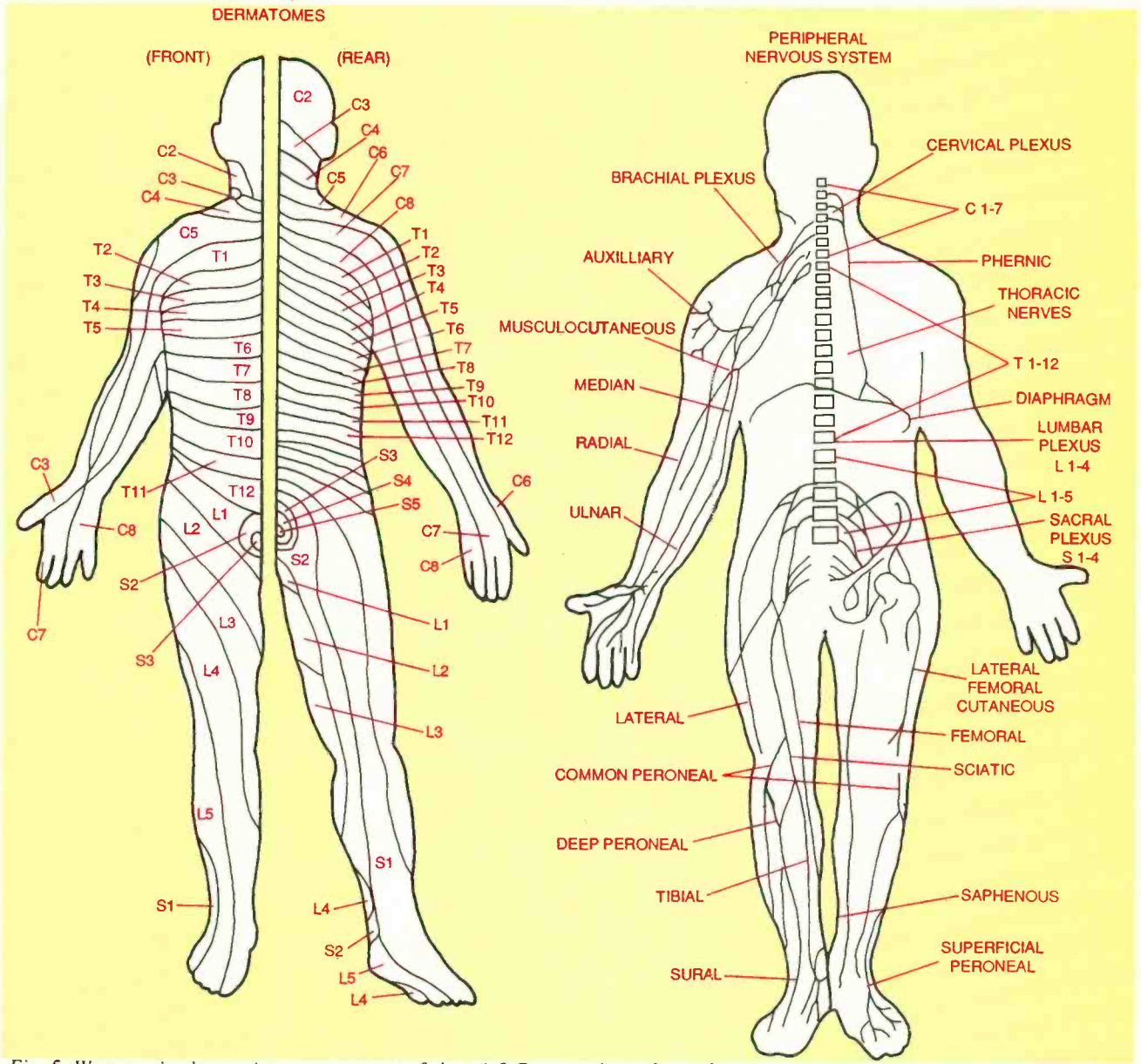


Fig. 5. Want to stimulate entire nerve groups to fight pain? Connect electrodes to the Bio-Stimulator and place them along the appropriate nerves.

Construction. The author's prototype was built on a printed-circuit board. That is the preferred way to build the Bio-Stimulator because it prevents stray capacitance and ensures that the unit is kept small. You can either etch your own PC board using the template shown in Fig. 2, or order one from the source mentioned in the Parts List. If you would rather use another assembly method, make sure to keep all wire leads short.

If you're building the circuit on a printed-circuit board, use the parts-placement diagram in Fig. 3 as a guide. Begin by installing an IC socket for IC1. Then solder the resistors and capacitors to the board, making sure the electrolytic capacitor, C1, is oriented properly. Mount the diode next.

Solder four-inch lengths of 22-gauge insulated wire to the board for the connections to the potentiometer/power switch (R10/S1), toggle switch (S2), and transformer (T1). Next, solder a battery clip to the board. Then complete the on-board assembly by installing Q1 and inserting IC1 into its socket. Check the orientation of both of those components.

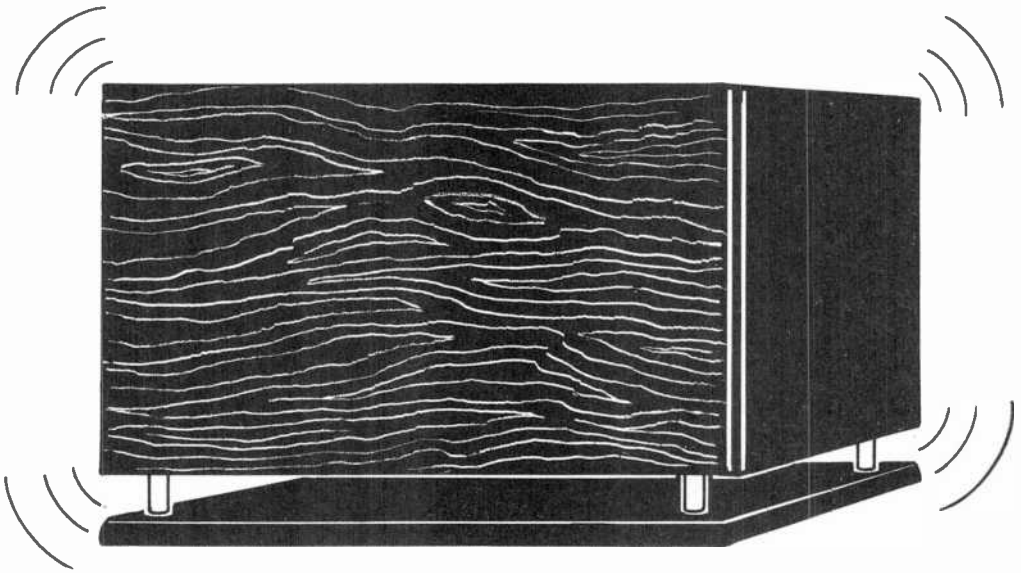
The next step is to mount the off-board components and PC board in a suitable project case; the one used in the author's prototype is a Radio Shack enclosure (part number 270-231). If you choose to use another case, make sure the dimensions are at least 4 × 2 × 1 inches.

At one end of the case, drill two holes and mount R10/S1 and S2. Then install two acorn cap nuts (J1 and J2) on the enclosure. You can either connect J1 and J2 to the PC board with wires, or try to position them directly over the pads and connect them with screws.

Once the jacks are connected, mount the board inside the project case using spacers and screws. To complete assembly, go on to solder the wires already connected to the PC board to their respective off-board components.

(Continued on page 77)

Design Your Own SUBWOOFERS



These computer programs can help you add the bass response you want to your existing speaker system.

BY WILLIAM R. HOFFMAN

When assembling a home theater, a lot of attention is paid to the video display device (most often a monitor or projection TV), but a sound system is as important, if not more so, in delivering the "theater" experience. Without the thundering bass that is an integral part of many of today's movies, especially action ones, watching those movies at home would be a lot like, well . . . watching ordinary TV.

So, then, how do we go about getting all that bass we want? Well, we can just run out and plunk down hundreds, or even thousands of our hard-earned dollars at our favorite audio emporium to buy some really big speaker systems. And then, when we get home, just set them up and start listening to our heart's content. With today's high-end, high-performance speaker systems, along with modern audio equipment and signal sources such as laserdiscs, we can hear it all, whether it be some prehistoric animal stomping around our living room, or the mighty growl of a giant pipe organ.

But what if we don't have all the money we need to get the speaker systems of our dreams? Can we build something to add the bass to our existing systems, and save a lot of money as well? The answer is yes—we can build a subwoofer! In this article, we will look at some of the more common designs used in commercial subwoofers, and then see what it takes to make our dream bass speaker come alive.

Some Basics For Bass. The five most common bass enclosure designs for a cone-and-magnet-type driver are: (1) the acoustic-suspension, or simple sealed cabinet; (2) the tuned-port or "bass-reflex" design; (3) the folded duct, or "transmission line;" (4) the double driver in a short connecting tunnel, called an "isobaric" system; and finally, (5) the multi-chamber "tuned-bandpass" cabinet.

Well then, just where do we start our design work? With one of today's personal computers, that's where. Using one of those machines, and the software programs we provide, anyone can do all the complex math required to design an effective subwoofer. And in the case of the bandpass-type system, the math can be very complex indeed!

Before we go further, let's review briefly some of the computer-based design work we've presented earlier. To begin with, a program to design the first enclosure type, a sealed acoustic-suspension system, was originally presented in "Design Your Own Loudspeakers," which appeared in the February 1994 issue of **Popular Electronics**. That was then followed with programs for crossover design and other functions ("Designing Loudspeaker Crossovers," **Popular Electronics,** July 1995). Finally, we added a program for creating a vented-box

design, which is the second enclosure type mentioned above ("Design your own Bass-Reflex Speakers," **Popular Electronics,** April 1996). This time, we will present some design programs for the last three system types we just mentioned: the transmission-line, isobaric, and bandpass systems.

To create an effective subwoofer design, we need two things. The first is good bass driver, at least 8-inches in diameter (but preferably larger). The second thing we need is some information about the driver, which is contained in its "Thiele/Small parameters" (which we will just abbreviate as "T/S" from now on).

But what are the T/S parameters? They are a numerical specification that today is almost universally supplied by most reputable driver manufacturers and retailers. Even companies like Radio Shack offer them with their products, right in their catalog, ready for our use. For those of you who have read the earlier articles outlined above, the T/S parameters that we need are the same ones we have already used in previous design programs. They are: (f_O) the bass resonance frequency of the driver in free air, in Hz; (V_{AS}) the volume of air that has a stiffness equal to the driver's cone suspension, in cubic feet; and finally (Q_{TS}) the total "Q" value of the driver at its bass resonance, which is specified as a number usually between 0.3 and 0.5 (at least for those drivers useful to us here).

It's important to note that those specifications have not always been supplied by manufacturers. If, by chance, we happen to have some old bass drivers lying around without these T/S values, forget about using them with these designs. Just as with all our other design programs, we MUST have the T/S values—no exceptions! (Note: You cannot effectively estimate what those parameters might be just by examining a driver's construction. They could conceivably be determined via testing, but the equipment and techniques required are beyond the scope of this article, and the average hobbyist.)

So with that said, let's begin!

The Transmission-Line Design.

The transmission-line system is one of those audiophile oddities that has been with us since the early 1970s in its present form, although in another, earlier form its history extends back to the 1940s. Shortly after the end of World War II, an American company, Sromberg-Carlson, began manufacturing a type of speaker enclosure called an "acoustic labyrinth." That design was simply a box, subdivided internally with many partitions in such a way as to form a folded, winding path for the bass driver's back acoustic wave to follow. At the end of the path was an opening, or port, leading out of the enclosure into the listening room.

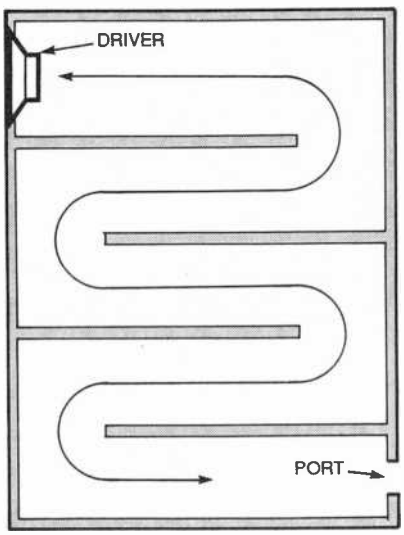


Fig. 1. This acoustic labyrinth, the forerunner of the transmission-line enclosure, was developed in the late 1940s.

Figure 1 shows an approximation of that early design. Note that it was really just a long folded tube, or pipe, and, in fact, it behaved just like one as well: It readily resonated like an organ pipe when ever its length equaled ¼ wavelength (or an odd multiple thereof) of any tone being reproduced by the enclosed driver. Needless to say, the speaker's response was anything but flat. Because of those resonance problems, and the complexity of construction and high cost, the system was soon abandoned.

The next development in the transmission-line speaker came along in 1972, when a British writer and engineer named A. R. Bailey published a design that was a variant on the labyrinth. It was similar to what Stromberg-Carlson had done, but the tunnel, or "line" as it was now called, was stuffed with fiberglass, wool, or something similar. In 1974, another British engineer, Arthur Radford, after some further development of the idea, apparently received the first patent on the basic design as it is known today.

The damping material both those men used in their design work was said to have two effects. First, it damped the pipe resonances, and, second, it absorbed the driver's back waves. In making that improvement, they claimed to have done just what was needed to make the system a success. Now we had, it seemed, a perfect enclosure: The line got rid of the driver's back waves without causing any other problems.

The question is how and why did that work? It was claimed that, when properly designed, the system behaved like the coaxial cable that connects a properly-matched radio transmitter with its antenna: It carried the sound waves down the line without allowing any to reflect back at the driver itself, thus the name "transmission line." A cutaway view of a transmission-line speaker is shown in Fig. 2.

But did it really work? Well, some thought that it did, while others saw additional problems with the design (reflections back and forth at each bend in the line, for instance). In 1976, Dr. L.J.S. Bradbury, a British aeronautical engineer published a study

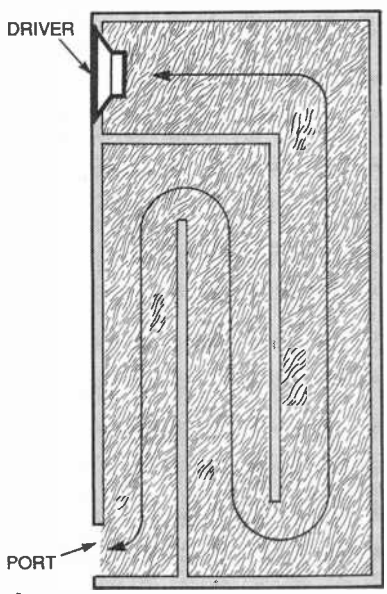


Fig. 2. Key to the success of the transmission-line enclosure is the use of damping materials at the rate of ½-pound-per-cubic-foot.

of the effects that damping material in a duct, or tube had. His study showed that it did two significant things. First, that the speed of a sound wave moving down the line was greatly reduced, and that the reduction was proportional to the density of the material used (see Fig. 3). And, second, that the stuffing tends to act like an excellent absorber at all but the very lowest bass frequencies. In other words, it acted like a low-pass filter of sorts (see Fig. 4). Both those effects were good news for TL-design fans, and are what make our design work here possible.

Listing 1 is a PC program written in generic BASIC and suitable for running under all current versions of GWBASIC or BASICA. Our program's file name is TLDES-1.BAS, and when run, will give us all the pertinent information for designing our TL bass speaker system. To load the program, just open your BASIC interpreter, and type the program listing in, line by line, exactly as it is printed. It's really very simple, as easy to do as typing a letter to someone. If you have never used BASIC before, try checking out a book from your local library on the subject. You will find that it is very easy to use once you get started.

Once we have loaded the program from Listing 1, and have started it running with the appropriate command-line prompt, the opening screen will ask us for two pieces of information about the bass driver we are using. The first is f_O, and the second is the driver's diameter (in inches).

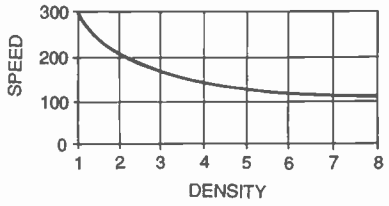


Fig. 3. This chart shows how the speed of sound through the transmission line is affected by increasing the amount of sound-absorbing material in the line.

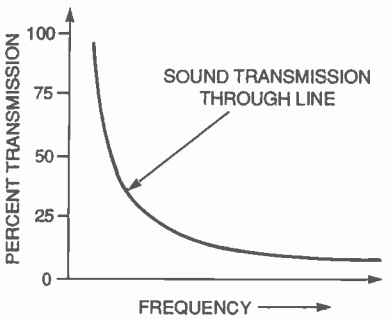


Fig. 4. Using sound absorbing materials in the transmission line also produces a low-pass-filter effect.

Once those are entered, the program will calculate and display on the screen five parameters of our design.

The first is "Line length," which is the physical length of our folded line, in feet, so that it will be acoustically ¼-wavelength long at the bass-resonance frequency of the driver. The length displayed is based on the assumption that the folded line will be uniformly filled with a damping material such as Fiberglas (or a similar material) at a density of ½-pound-per-cubic-foot and is based on a formula from Bradbury's work, mentioned above.

The next parameter displayed is "Line Cross-Sectional Area," which is the minimum area allowed for our line, and is equal to the driver's cone area. We can make that area somewhat larger if we wish without changing the performance of our system, though there is no particular advantage in doing that, but it must not be smaller. Making it smaller might cause excessive turbulence in the air flow, or cause other non-linear effects.

The third parameter is the "Vent Area," or the area of the port at the line's open end. Again, that is the same as the surface area of the driver, and can remain that size regardless of what cross-sectional area we choose for the line itself.

Fourth is the "Approximate Box Volume" in cubic feet, which is simply the line's length multiplied by the cross-sectional area. That will give us some idea of the size of our speaker cabinet, but not the exact size because it does not take into account the thickness of any of the wood. Obviously, if we make our line cross-sectional area larger than originally specified, then we will have to recalculate the new box size ourselves.

The final parameter is "Weight Of The Damping Material," which is simply the calculated volume of the line multiplied by the weight of the stuffing material figured at ½-pound-per-cubic-foot. Again, if we change the area of the line, we will have to recalculate the amount of material needed.

LISTING 1

```
100 PRINT:PRINT:PRINT:PRINT:PRINT
110 PRINT"              DESIGNING A TRANSMISSION LINE "
115 PRINT:PRINT
120 PRINT"                    LOUDSPEAKER SYSTEM"
125 PRINT:PRINT
130 PRINT"                          by"
135 PRINT:PRINT
140 PRINT"                      William R. Hoffman"
145 PRINT:PRINT:PRINT
150 PRINT"          The free air bass resonance frequency of the driver"
155 INPUT"          (Fo), in Hz. is =";FO
160 PRINT
165 INPUT"          The diameter, in inches, of the bass driver is=";D
200 LET A=(1130/FO)/4
210 LET F=1+(5.000000E-01/7.400000E-02)
215 LET F=SQR(F)
220 LET F=1130/F
230 LET B=(F/FO)/4
240 LET XS=(D/2)^2*3.145900
250 LET XF=XS/144
260 LET BV=XF*B
270 LET WS=BV*5.000000E-01
290 CLS:PRINT:PRINT:PRINT:PRINT:PRINT
300 PRINT"          For a bass driver"D"inches in diameter, with a free"
310 PRINT"          air resonance of"FO"Hz, and an enclosure packed with"
320 PRINT"          damping material at 1/2 lb. per cu. ft, the basic"
322 PRINT"          specifications for a transmission line enclosure are:"
325 PRINT
350 PRINT"                Line length ="B"feet."
355 PRINT
360 PRINT"                Line crossectional area ="XS"sq. in."
365 PRINT
370 PRINT"                Vent area ="XS"sq. in."
375 PRINT
380 PRINT"                Approximate box volume ="BV"cu. ft."
385 PRINT
390 PRINT"                Weight of damping material ="WS"lbs."
395 PRINT
400 PRINT"          Do you wish to try another set of specifications?"
410 INPUT"          (1=Yes, 2=No) and Enter=";X
420 IF X=1 THEN 145 ELSE 990
990 PRINT
995 PRINT"          Good listening!"
999 END
```

With the information just calculated for us, we can now sit down with a pencil, a piece of graph paper, and a ruler and design our TL system. Using Fig. 2 as a general guide, we next draw out a design with a folded line path anyway we might like it to be, say, to fit a particular enclosure shape we might have in mind. Our design doesn't have to be exactly like Fig. 2, but it should have the bass driver mounted near the top of the system's face, with the outlet port near the bottom. (That is a typical arrangement for the TL system, and seems to get good results from the design.)

Because the line will be folded many times along its length, to correctly calculate how long it is, all we need do is find the center-line distances along each section of the line, and add them together. That is very important, because at low frequencies, as Bradbury pointed out, the enclosure still transmits sound waves and acts like a tuned, resonant pipe. Because of that, our specifically determined line length will make the pipe's ¼-wave resonant frequency the same as our driver's bass resonance. And that will, in turn, produce a "node" (an area of increased pressure) right against the back of the driver, providing some necessary acoustic loading for best bass response. (Although our design here cannot actually provide the exact value of acoustic loading the driver might need, as the other systems we have designed have done, nonetheless, for our purposes everything should still work just fine.)

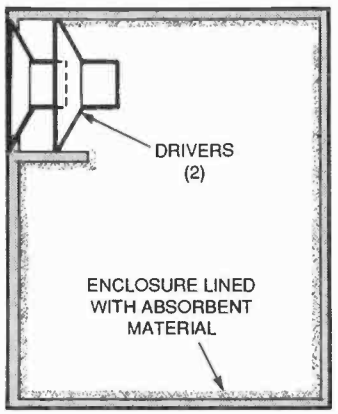


Fig. 5. The two-speaker design of the Isobaric enclosure allows for a box size that is half of what is required for a normal acoustic-suspension design.

By the way, that is just one of several features the TL design shares with its relative, the tuned vented system. Another is an approximately 24-dB-per-octave cutoff rate in its bass response below the system resonance frequency.

So what does a TL system sound like? And what will we get for our efforts in building such a complex enclosure? Those are good questions, and is where the arguments come in between audiophiles. Typically, a well-designed and -built TL system is prized for having a very smooth, clean, pure, and undistorted bass response. Audiophiles who like classical or jazz music really go for this design. But, on the other hand, if you like lots of bass "punch" or "sock" you might be happier with one of the other designs. Let's get to those next.

The Isobaric System. As you can see in the cutaway view in Fig. 5, the isobaric system uses two identical (this is important) bass drivers, wired in-phase and one behind the other, and mounted in a short tunnel. The tunnel should be just long enough to allow the magnet and frame of the front driver to clear the cone of the back one, even when the rear driver's cone is moving in-and-out its maximum distance while being driven by the amplifier. Beyond that, the rest of the enclosure is just like any other sealed, acoustic-suspension box, with one important exception: the volume required for the box behind the second driver is only half of what would be required for just one driver alone! We'll find out more about that in a minute.

The concept behind the isobaric system was first described in the 1950s by Dr. Harry F. Olson, then working at RCA. Included in his description was the curious halving of the required box volume. But it wasn't until the middle 1970s, when a company called Linn Products, of Glasgow, Scotland marketed a speaker called the "Isobarik," that the idea became a commercial reality. The system remains in limited commercial production today.

Now then, just how do we get the system to work with only half the enclosure volume normally needed? Do we just make our box too small, and live with the thick, muddy, boomy sound from the resulting high "Q" peak in the driver's bass output? Of course not, and here's why.

LISTING 2

```
9 PRINT:PRINT:PRINT:PRINT:PRINT
10 PRINT "      LOW FREQUENCY ISOBARIC (TWO DRIVER) ACOUSTIC"
11 PRINT:PRINT
12 PRINT "      SUSPENSION LOUDSPEAKER DESIGN PROGRAM"
13 PRINT:PRINT:PRINT
14 PRINT "                    By"
15 PRINT
16 PRINT "              William R. Hoffman"
17 PRINT:PRINT
20 INPUT "          Proceed? (1=yes 2=no) and Enter ";P
22 PRINT:PRINT:PRINT:PRINT:
25 ON P GOTO 30, 990
30 INPUT "          Free air resonance of driver (Hz) =";B
35 PRINT
40 PRINT "          Air volume compliance equivalent of"
45 INPUT "          one driver (Vas) in cu. ft. =";C
46 PRINT
50 PRINT "          Free air total Q of driver at"
55 INPUT "          bass resonance (Qts) =";D
60 PRINT
65 PRINT "          What is desired completed system  Q "
70 INPUT "          at bass resonance (Qcab) =";E
75 PRINT:PRINT:
100 LET Z=(E/D)^2*(1.149999)-1
110 LET Y=B*E/D
120 LET X=(C*5.000000E-01)/Z
121 CLS:PRINT:PRINT:PRINT:PRINT:PRINT
122 PRINT"          For an 'Isobaric' (dual driver) enclosure design"
123 PRINT"          where the drivers have an fo of"B"Hz, a"
124 PRINT"          Vas of"C", and a Qts of"D", the specifications"
125 PRINT"          are as follows."
126 PRINT
130 PRINT"          For an in cabinet bass driver Q of"E":
135 PRINT
140 PRINT"             The cabinet volume is ="X"cu. ft. which "
141 PRINT"             does not include the volume occupied by "
142 PRINT"             the two drivers and the space between them."
145 PRINT
150 PRINT"             And the driver bass resonance frequency"
155 PRINT"             will be ="Y"Hz"
172 PRINT
175 PRINT"          Would you like to try another driver?"
180 INPUT"          (1=yes 2=no) and Enter ";F
182 PRINT
185 ON F GOTO 30, 990
187 PRINT
990 PRINT"          Good listening!"
999 END
```

As we have learned from past discussions, the requirement for air loading on the cone of a bass driver is proportional to the mass of the cone (or sum of the masses of both cones, in this case) and the force generated by the "motor" (the magnet and voice coil), which in this case is also the sum of both magnets and both voice coils working together. So if one driver requires a 2-cubic-foot box to perform optimally, then two identical drivers connected together in the isobaric design, having effectively twice the cone mass, and twice the voice-coil force, but only the same cone area as one driver exposed to the air, can produce the same performance using only a 1-cubic-foot box. Mathematically, all we are doing is summing the cone masses and voice-coil motor strengths, and applying the same formulas Thiele and Small used to those summed values. Doing that, we always get a value for V_{AS} that is half that of one driver.

While the smaller enclosure size is nice, it is not the only advantage the isobaric system offers. Because we have two voice coils operating in phase together, we also have a system that can handle twice the power of a simple sealed box. Those two advantages—half the cabinet volume and twice the power—make this design principle really shine for a subwoofer.

The term "isobaric" comes from two words: "isothermal," which technically describes the sound-radiating conditions at low frequencies within the small volume of air in the tunnel between the drivers, and "baric," which refers to the idea that the front driver sees a constant pressure on the back of its cone because of the second driver—a theoretically ideal situation (or so the theory goes). Whether that second point is true, however, is a subject of real debate among audiophiles, some as adherents, and others as detractors. Debate aside, can we design a successful bass system with the isobaric principle? Of course, and here's how.

Listing 2 is our isobaric design program, ISBDES-1.BAS, and is again written in generic BASIC. It should be entered and run following the same procedures discussed for the first program. Once the opening screen appears, we are prompted for the same four basic pieces of information: f_O, V_{AS}, Q_{TS}, and the value of the completed system Q we want. For the first three of those, enter the T/S values of only one of the drivers—remember that we are assuming here we have a reasonably well-matched driver pair (most are, when of the same manufacturer and type).

As for the "completed system Q," we discussed that parameter when we first discussed sealed-box design in an earlier article, but for those of us new to the series, here is a short recap: Anytime we enclose the back of a driver in a small, sealed cabinet the resulting loading by the mass and compliance of the trapped air raises both the bass resonance frequency and the Q (degree of peaking) of the speaker at bass resonance. So, of course our value of completed system Q, (technically referred to as "Q_{CAB}, and that's how we will now refer to it) must be higher than that of the driver in free air. But then, just what should it be? Actually there is no one single value for it. What we actually have is a choice from a range of values, depending on how we like our bass to sound. Here are some guidelines for you to use when making your selection: For a bass response that is very clean, but maybe a little on the "lean" side, you want a Q_{CAB} of about 0.5 to 0.6. For a richer, but still very natural bass sound use a value of around 0.7. (That value is technically the best. For those into filter design, our system's bass response is of course, a high-pass function, and 0.7 is the coefficient value for a Butterworth filter that gives the fastest cutoff along with the least ripple and phase shift.)

Going on, in using Q_{CAB} values of 0.8 to 1.0 we need to be careful. With those, the bass can sound very rich and full, but if we are not careful in our placement of the speakers in our listening room, they can also end up giving us two types of problems related to room acoustics. The first is that the sound starts to become "thick and muddy," especially when the systems are placed in a corner, or almost anywhere in a small, cubical room. Second, room placement of the system can become quite critical in order to avoid getting exaggerated standing waves and other reflection problems. Systems with Q_{CAB} values of greater than 1.0 would have a distinct one-note-bass "boom-boom-boom" quality, regardless of where they are placed; while that might work for certain types of popular music, most people would find it very annoying to listen to for any length of time.

Once you have entered all the required information, the program then calculates the volume of the box behind the second driver, and the new value of the bass-resonance frequency. Below that resonance frequency the system's response will fall off at a rate of about 12-dB-per-octave, just like any sealed-cabinet design does.

Once we have our values, it is time to turn to the actual design. As before, all we need is a pencil, ruler, and some graph paper. To design the tunnel between the two drivers, use the ruler and measure the depth of one of the bass drivers, and then its front-cone depth. Deduct the second measurement from the first, then add about 1 to 2 inches to allow for cone travel to determine the spacing in our short tunnel. That done, we can then just follow the drawing in Fig. 5 to complete our cabinet design.

(Note: If you like, you can use the ENCDES-1.BAS program presented in my earlier article, "Designing your own Loudspeakers," **Popular Electronics** February 1994, to help design your box. Just enter the box volume into that program and it will calculate a suggested set of dimensions for the enclosure that will minimize standing waves and resonances.)

How is our system, once built, likely to sound? The answer is that the bass response will be pretty much set by the value of Q_{CAB} we choose, and therefore, as described above. But also, the relatively small cabinet and much higher power capacity will add to its appeal. In fact, the halving of the required cabinet size might allow us to use a bigger bass driver than originally planned and still get a manageable box size. And a bigger driver will get us even more bass power output.

The Dual-Chamber Tuned-Bandpass System. When we go shopping for a speaker system, what we often see as far as a subwoofer goes is just a simple box with a hole or port in one side. Not very impressive looking, but when we hear the mighty bass

coming from such systems, we immediately know—that is the one for us!

What we are looking at is a "dual-chamber tuned-bandpass" subwoofer, and it is shown in a cutaway view in Fig. 6. In that illustration, the fact that the design has two chambers is obvious, and we can see that the active bass driver is mounted into one wall of the interior divider within the system. The divider also creates a sealed air volume behind the driver, while the driver's front faces into another chamber that is vented through a port into our listening room. By now, most of us would right away recognize that the vent and front-air volume create a resonant system, like any normal tuned-port or "bass-reflex" design, and that the rear chamber is just a standard acoustic-suspension sealed box. So what we have here is those two designs mated together.

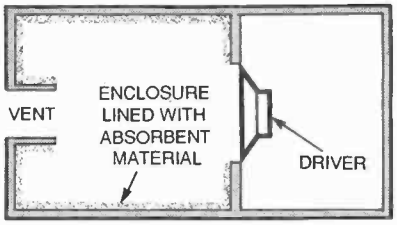


Fig. 6. Though complex to design, the dual-chamber, tuned-bandpass speaker can produce outstanding bass.

While mating the two designs obviously works well, the process of doing so can get very complicated. But with our next program, BPDES-1.BAS, shown in Listing 3, our personal computer will do all the hard math for us, making things very much easier.

But, first, a little background on the system. Although a patent was issued for a design called a "pass-band" speaker, a forerunner of the design shown here, in the 1950s, the world really did not become aware of it until 1979. That's when an engineer named Laurie Fincham, then with KEF loudspeakers in England, published a paper on his development of the design. Indeed, KEF still manufactures a line of loudspeakers using the design principles Fincham had worked out. Then, in 1989, another engineer, E. R. Geddes,

LISTING 3

```
100 PRINT:PRINT:PRINT:PRINT:PRINT
110 PRINT"       DESIGNING A DUAL CHAMBER BANDPASS "
115 PRINT
120 PRINT"                SUBWOOFER SYSTEM"
125 PRINT:PRINT
130 PRINT"                     by"
135 PRINT
140 PRINT"                William R. Hoffman"
190 PRINT:PRINT:PRINT
200 PRINT"       What is the free air bass resonance frequency of the"
210 INPUT"       driver (fo), in Hz. =";FS
215 PRINT
220 PRINT"       What is the drivers air volume compliance"
225 INPUT"       equivalent (Vas) value, in cu. ft. =";V
230 PRINT
235 INPUT"       What is the drivers total Q is free air (Qts) =";Q
240 PRINT
245 PRINT"       What is the desired low frequency cutoff"
250 INPUT"       of the system =";FL
255 IF FL>FS THEN 290 ELSE 260
260 PRINT
265 PRINT"       Your chosen value of cutoff requency is less than the"
266 PRINT"       free air resonance frequency of the driver, which is "
267 PRINT"       not permitted. Do you wish to try again with another"
268 INPUT"       value? (1=Yes, 2=No) and Enter";A
270 IF A=1 THEN 240 ELSE 990
290 PRINT
300 LET VF=(1.200000*Q)^2*V
310 LET A=FL/(FS/Q)
320 LET B=A+9.499999E-01
325 LET FH=B*(FS/Q)
330 PRINT"       For the system we are currently designing, the "
340 PRINT"       bandpass high and low frequency limits are going"
345 PRINT"       to be:"
350 PRINT
355 PRINT"            Low frequency cutoff ="FL"Hz.
360 PRINT
365 PRINT"            High frequency cutoff ="FH"Hz.
370 PRINT
375 PRINT"       Do you wish to continue with these values?"
380 INPUT"       (1-Yes, 2=No) and Enter =";B
385 IF B=1 THEN 400 ELSE 387
387 PRINT
390 PRINT"       Do you wish to try another value of low frequency"
395 INPUT"       cutoff? (1=Yes, 2=No) and Enter =";C
396 IF C=1 THEN 240 ELSE 990
400 PRINT
410 LET QT=A+3.700000E-01
420 LET VB=V/(((QT/Q)^2)-1)
430 LET FB=QT*(FS/Q)
440 PRINT
445 PRINT"       In order to calculate the length of the duct used to"
450 PRINT"       tune the front enclosure to the desired frequency, "
455 PRINT"       a value for its diameter must be selected. Enter any"
460 PRINT"       value of 1 in. to 6 inches that is convenient to use."
465 PRINT
470 INPUT"       Chosen duct diameter (in inches) =";D
475 PRINT
480 LET DA=(D/2)^2*3.145900
485 LET DL=((2691*DA)/(VB*(FB^2)))-(8.799999E-01*SQR(DA))
490 LET VT= VF+VB
500 PRINT"       For the chosen duct diameter of "D" inches, the "
510 PRINT"       required duct length is ="DL"inches.
520 PRINT
530 PRINT"       Is this value of duct length satisfactory?"
540 INPUT"       (1=Yes, 2=No) and Enter =";E
550 IF E=1 THEN 600 ELSE 560
560 PRINT
565 PRINT"       Do you wish to try another value for duct diameter?"
570 INPUT"       (1=Yes, 2=No) and Enter =";F
575 IF F=1 THEN 465 ELSE 990
600 CLS:PRINT:PRINT:PRINT:PRINT:PRINT
610 PRINT"       For a bass driver with a free air resonance of"FS"Hz,"
620 PRINT"       and a value of free air Q (Qts) of"Q", and an air"
630 PRINT"       volume compliance (Vas) of"V", the bandpass bass "
640 PRINT"       system has the following specifications:"
650 PRINT
660 PRINT"            Lower cutoff frequency ="FL"Hz.
670 PRINT
680 PRINT"            Upper cutoff frequency ="FH"Hz.
690 PRINT
700 PRINT"            Volume of front box ="VF"cu. ft."
710 PRINT
720 PRINT"            Volume of rear box ="VB"cu. ft."
730 PRINT
740 PRINT"            Total volume of both boxes ="VT"cu. ft.
750 PRINT
760 PRINT"            Front box tuning frequency ="FB"Hz.
770 PRINT
780 PRINT"            Tuning duct specifications:"
790 PRINT"                 Duct diameter ="D"inches."
800 PRINT"                 Duct length ="DL"inches."
990 PRINT
991 PRINT"       Do you wish to try another design?"
992 INPUT"       (1=Yes, 2=No) and Enter =";X
993 IF X=1 THEN 190 ELSE 995
995 PRINT
996 PRINT"       Good listening!"
999 END
```

published a technical paper that extended Fincham's work by creating a system with two, three, or even more vented chambers, both on the driver's front, and its back side. Also, Dr. Amar Bose, of the Bose Corporation here in the U.S., saw the use for those designs, and in 1985 took out a patent on the double-chamber, double-tuned system—which they jealously guard!

So why all the sudden activity in the last 10 years? Because despite the complexity of the design, it really works, and works well! Here's why:

Figure 7 shows the frequency response of a typical dual-chamber tuned-bandpass system. Note that this is indeed a true bandpass design, with our particular configuration having a cutoff slope of 24 dB-per-octave on either side of the pass band, just like a regular tuned, vented box. And note that no electrical crossover is actually required—a big advantage here since, for low frequency use, inductors and capacitors must be very big—and expensive! We get that bandpass response because the driver is entirely inside the enclosure, and the only sound comes out of the vent. Literally, the vent and the bass-resonance frequency of the driver shapes the entire response of the system, an important point to remember.

But, as we have said, such a system does become very complex to design. The bass cutoff frequency of the driver in the sealed portion of the cabinet must match the tuned frequency of the front, vented part. And the Q of the driver in the sealed box must be adjusted to match the Q of the vented front box to get the proper bandpass-response function. Further, because all those factors interact with each other, the bandpass system definitely is not a "cut and try" design.

So here is where the design program really helps us. By simply entering a driver's T/S values, and the bandpass low-frequency limit we want, the program designs our entire system for us. It calculates an exact set of values for both front and back air volumes, as well as the vent dimensions, and the bandpass-frequency limits, without our having to do any actual construction work. If our calculated design doesn't suit us in some way, we can then try other drivers with different T/S values until we find the combination that we want.

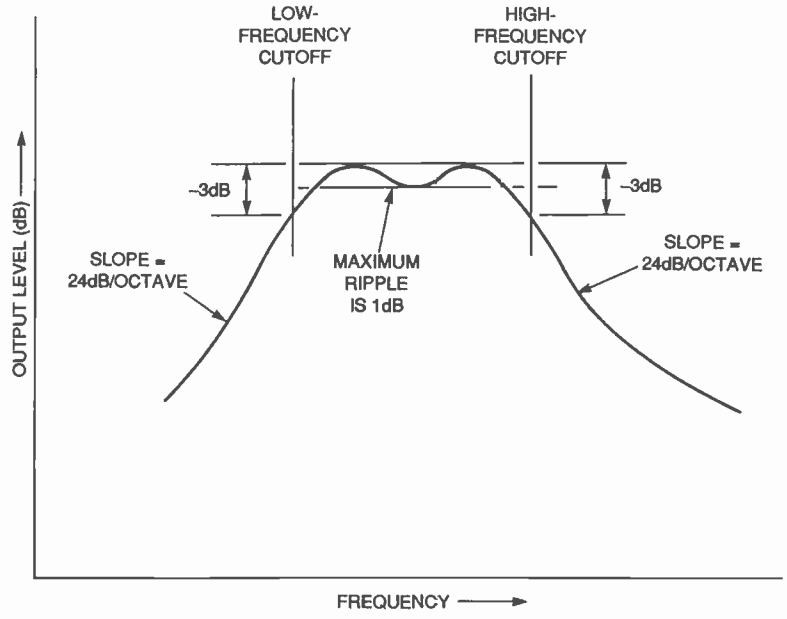


Fig. 7. Here's the frequency response of a typical dual-chamber, tuned-bandpass speaker.

Designing Our System. Just like the other systems, use a pencil, ruler, and graph paper to sketch out the final box design from the information supplied by the program. When designing the vent, use the largest diameter possible that will fit within the available space in the front box. That will help prevent "wind noises" due to turbulence in the air stream (which can be significant) through the vent. Remember, if the vent is so large that it occupies more than about 15% of the volume of the front enclosure, then adjust the box's dimensions accordingly so that its free volume stays at the value calculated by our program. Here, again, the ENCDES-1.BAS program can help us by getting our box dimensions for us.

It is a good idea, as Fig. 6 shows, to line the front chamber with a single layer of Fiberglas batting (not paper backed) or a similar absorbent material to reduce standing waves in the enclosure. However, never place any loose damping material in the front cabinet. Such material would tend to flop around inside the box, in time with the motion of the bass driver's cone, and, as Fincham observed, make odd "chuffing" noises and even upset the system's tuning; make sure all damping materials are securely attached to the chamber's walls.

Even with the bandpass action of our system, some kind of electrical low-pass filter (even a simple one like that designed by the XDES-1.BAS program in the article "Designing Loudspeaker Crossovers," which appeared in the July 1995 issue of **Popular Electronics**) should be used. If possible, limit the upper frequency range to about twice that of the vent's specified upper cutoff frequency. That is important because, even with its resonant tuning, it is still possible to get some direct sound output from the vent at higher frequencies.

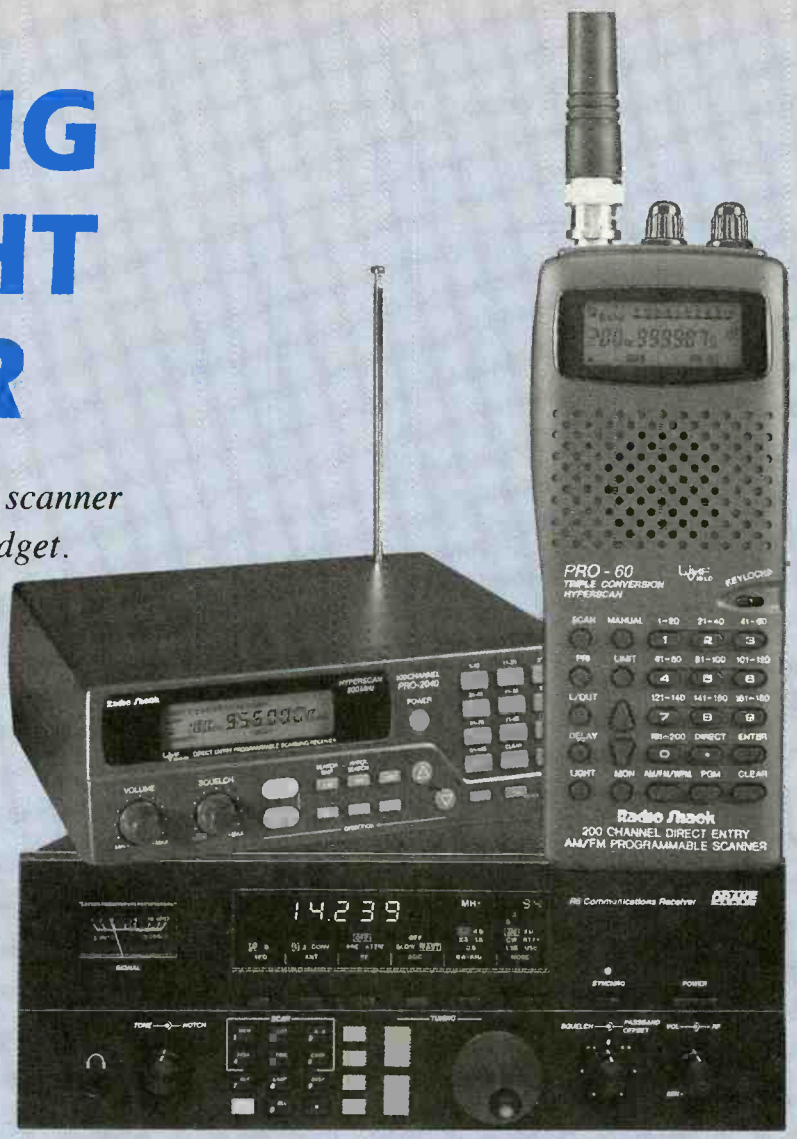
Some Final Thoughts. The only other things to keep in mind about any of these designs is that, in building them, use the same, simple, common-sense procedures that everyone else does in building a speaker system. Use good, heavy ¾-inch material, like chipboard or, better yet, floor underlayment for the boxes. Glue, and screw or nail all joints together, reinforcing them as necessary. Make sure that there are no cracks or other unintended openings in the finished system. As necessary, even put some silicon sealer around the driver's rim for a tight seal.

Especially watch out for air leaks around where the wires for the driver enter the box at the speaker terminals. Also, use a good grade of wire, at least 18 gauge or better, for making all electrical connections. Finally, make sure that the speaker wire is stapled down to the box wall to prevent it from buzzing or rattling. ■

CHOOSING THE RIGHT SCANNER

Here are some tips for buying the scanner that's right for your needs and budget.

BY KARL T. THURBER, JR.



Ask anyone with a scanner radio and he or she will probably tell you that it brings in some of the most exciting listening of all. Scanners can be the fastest and most reliable sources of local news and drama. And most important, during catastrophes and emergencies, the information your scanner offers could save your life or protect your property.

Although they're not yet everyday household appliances, scanner radios are becoming easier to use and have moved into the consumer market. After initial programming, you simply turn on the scanner to listen in on police, fire, medical-emergency, truck, bus, railroad, marine, amateur-radio, military, taxi, news-media, government, paging, business, and industrial services. You can listen at home or use a handheld or mobile scanner to monitor exciting communications wherever you go. It's all great fun, but to get the most out of the scanning hobby you should make sure you have the scanner that's right for you.

Scanner Technical Specs. For expensive gear like scanners, you should know exactly what you're after when you shop. Do you know what to look for in a radio? How well must a scanner radio perform to meet your needs?

Those questions are not easy to answer; selecting a scanner radio can be difficult. Obviously, the performance of the radio you buy should be as good as possible, consistent with the state of the art and with your pocketbook. But how good is "good enough?" We'll try to answer that question, first by giving you some idea of what goes on under the scanner's hood.

A scanner can be defined as any receiver that can switch automatically between four or more channels, stopping when a signal is detected on one of them. Functionally, most programmable scanners consist of the microprocessor, memory, display and display driver, keyboard, power supply, and the receiver. Most receivers are superheterodynes because certain of their features, such as amplifying the signal and rejecting interfering ones, are best accomplished at a fixed frequency.

Here are some important features and functions of scanners that you should familiarize yourself with:

Conversion Scheme: A single-conversion radio involves conversion to only one fixed frequency, the intermediate frequency (IF). There are also double-conversion sets, and some scanners use a third IF in a sophisticated triple-conversion scheme. The latter scheme is the most expensive, but it's the best choice because a good design can eliminate practically all undesired signals or "birdies."

Frequency Coverage: The most common frequency ranges monitored by scanner buffs are 30–50 MHz (VHF low band), 144–174 MHz (VHF high band), and 450–512 MHz (UHF). Most scanners now include the 406- to 420-MHz, Federal government, land-mobile band, and the 420- to 450-MHz amateur band. Some also include the 72- to 76-MHz VHF midband. Those bands use narrow-band frequency modulation (NBFM). The VHF civilian aircraft band (108-136 MHz, in AM mode) is another good target for monitoring. The 825-

to 845-MHz cellular mobile band and the 870- to 890-MHz cellular base band, sometimes lumped together and called the "microwave mobile" band would also be of interest, but you are not legally allowed to listen to them using a scanner or other radio.

Few radios include the military UHF aircraft band (225-400 MHz, in AM mode). But many scanners boast that they cover practically all frequencies (except for all or most of the 800-MHz band) to 1.3 or 2 GHz. Most scanners have an LCD frequency display and allow keypad entry of data, and some also have a tuning dial for entry.

Receiving Modes: Most VHF and UHF signals you're likely to intercept use NBFM, so all scanners receive NBFM. Other, lesser-used modes used by specialized services include wideband FM (WFM), AM, and single sideband (SSB). For maximum versatility, all major modes should be supported. That is especially important if the scanner also covers long-wave, medium-wave, and shortwave frequencies, as some now do.

Sensitivity and Signal-to-Noise Ratio: Sensitivity refers to the weakest signal voltage the radio will respond to readably; the lower the number, the better. It's typically defined as the input signal level necessary to give a "signal plus atmospheric noise" or "S+Noise/Noise" (S+N/N) output from the radio at a specified point above the radio's internal noise. That normally is specified as 10 dB, a logarithmic ratio between the two power levels. In a sensitivity specification, the smaller the number of microvolts, the more sensitive the radio. A good scanner radio could have a stated sensitivity of "0.5 microvolt for a 10-dB S+N/N ratio."

Selectivity: Selectivity refers to how well the radio rejects signals on adjacent frequencies, the desired signal window being referred to as the radio's bandwidth or bandpass. The overall width of a radio's bandpass commonly is stated as the two points at which an interfering signal is reduced by 6 dB and by 60 dB, though some manufacturers use other points that make comparison difficult. The sharper the selectivity, the better. Average NBFM selectivity for a good scanner is about 30 kHz or so. Selectivity in other modes varies widely and often is adjustable: WFM is 150 kHz or more, AM is 6–10 kHz, and SSB is from 2–4 kHz.

Image Rejection: Image rejection is the ability to reject the undesired "ghost signal" generated by the mixing or heterodyning characteristics of superhets. In the superhet, the image is offset from the actual frequency by twice the IF. To improve image rejection, high IFs are used so the image and true signals are widely separated and thus are easier to filter.

Dynamic range: Dynamic range refers to the range between the set's internal noise level (or minimal acceptable signal level) and the "overload point," the level at which signal overloading occurs. It's the ability of a scanner to handle extremely strong as well as extremely weak signals. Dynamic range is measured in dBs; most modern communications receivers have a dynamic range of 70 dB or more. However, few scanners handle overload well, so that spec is rarely stated by manufacturers.

Intermodulation and Birdies: Intermodulation results from a radio having inadequate dynamic range. It is internally generated interference (spurious signals) produced when strong signals mix together. Intermodulation is recognizable because of its typically distorted contents and its appearance at numerous frequencies.

Closely related to intermodulation are "birdies": all scanners and other receivers using frequency-synthesized circuits generate them. Those unwanted signals might interfere with your scanner's search function. If during search the radio encounters a birdie, scanning might stop and you must manually restart it.

Most high-end, triple-conversion scanners are relatively free of birdies, but all scanners have them. Many manuals include a list of such frequencies for your convenience, and some computer-control scanner programs even let you set up a "birdie-control file" for your scanner and bypass or lock them out.

Most scanners sold today have excellent sensitivity and reasonable selectivity, but many suffer from intermodulation and image interference from strong signals. Those deficiencies often show up only when you connect the scanner to an outdoor antenna.

Features to Look For. Now that we've covered the basics, it's time to examine what scanner functions can be useful to you. It's not enough to consider that the basic scanner passes over a number of selected frequencies, stops scanning when a transmission is received, and continues scanning after the transmission ends. Today's radios go far beyond that fundamental capability. They are multi-channel, frequency synthesized,

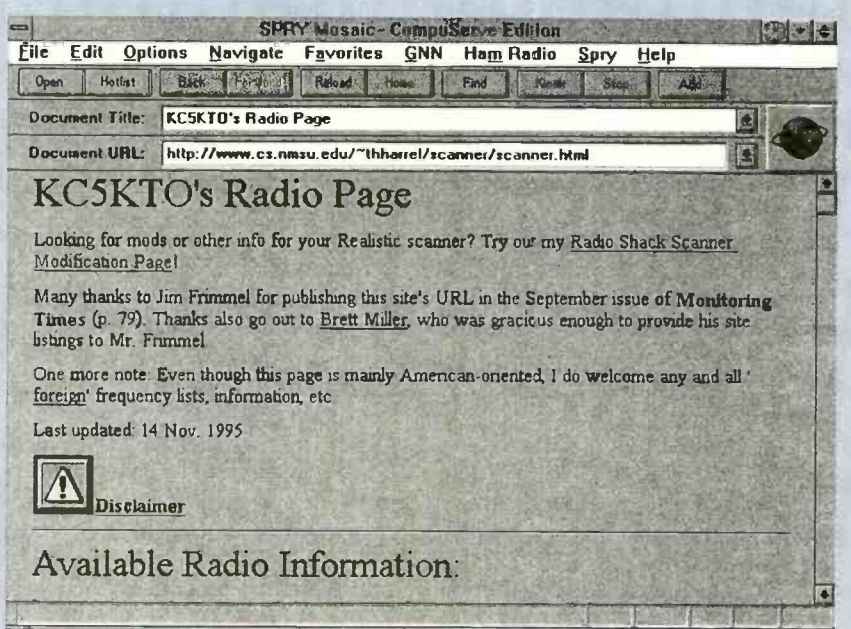


Fig. 1. While the main emphasis is on scanning and scanner mods, there's information on other aspects of radio on KC5KTO's Web page, including several beginner-oriented scanner FAQs you can download.

microprocessor-controlled, automatic VHF/UHF receivers with nonvolatile memories; such features contribute to making scanning convenient, easy, and fun. Furthermore, advanced search features allow you to capture and monitor unknown signals, and automatically store their frequencies in memory for recall later.

One of the basic features your scanner will come with is a keyboard, which is the main tool that lets you command a variety of functions. Some of those functions include convenient digital display of frequencies and channel numbers; direct channel access (to avoid having to step through all channels); a manual channel-access capability; unwanted-channel lockout (to keep the scanner from "hanging" on busy channels); a priority channel for important transmissions (critical if you must always monitor a certain frequency); programmable search, with adjustable upper and lower ranges; and a digital clock display.

Other basic features include a built-in antenna and speaker (but with external antenna and speaker jacks), volume and squelch controls, a bright display panel, frequency synthesis (meaning no crystals are needed), and track-tuning for even reception across an entire band of frequencies.

While those are the basics, you might want to consider some nice-to-have features like: control of auxiliary equipment (tape deck, lights, or alarm) when transmissions occur, automatic squelch, adjustable scan delay (to prevent missing transmissions when "calls" and "answers" are on the same frequency), and service search, which gives you access to preprogrammed signal categories (such as amateur, police, fire, marine, etc.).

Other convenience features include multiple channel banks to organize scanning coverage, coverage of all popular VHF/UHF bands, a line-output jack, count capability (to automatically count the number of transmissions on each channel to determine active frequencies), autoload (in which active frequencies discovered in searching can be automatically programmed into unprogrammed channels), and continuous tuning using a variable-frequency oscillator (VFO), in addition to programmable tuning.

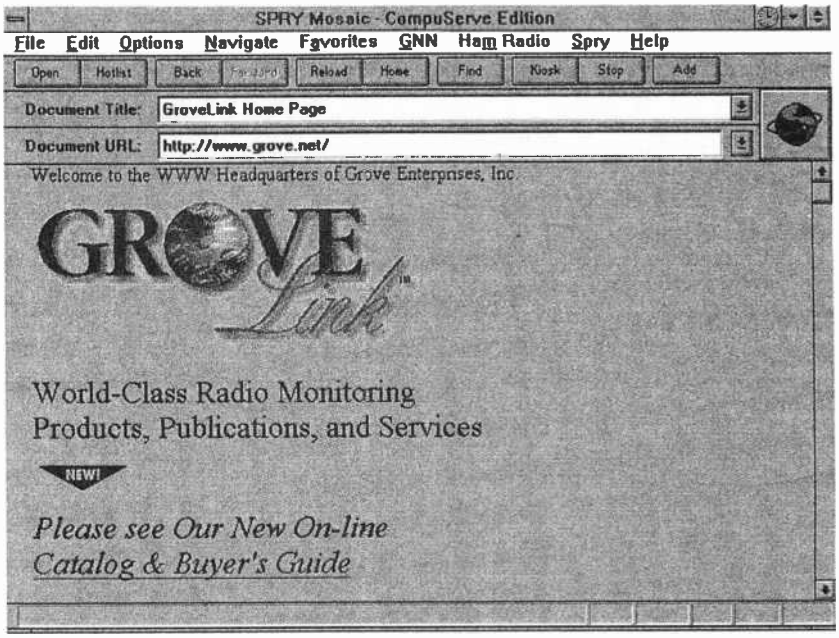


Fig. 2. The Grove Enterprises home page, GroveLink, is offered by this major scanner and shortwave radio dealer, and it contains a good deal of useful scanner information and an online catalog.

Still other nice features include an attenuator control (to reduce overload from strong signals), a hold feature (to let you stop a scan or search easily), preprogrammed weather-channel access, a signal-strength meter, optional high-speed scanning, a recorder output, and a computer interface (more on that later).

Mobile, Base, or Handheld? Scanners come in a variety of models to meet differing user needs. You can buy a small, battery-operated handheld scanner, an AC-powered base or desktop scanner, or a mobile scanner that connects to your auto's electrical system. If you spend a lot of time driving, your choice might be a mobile unit; if you're in and out of your car, office, or home, you might prefer a handheld model; and if you do most of your listening in your office or home, a base unit would be best.

There are tradeoffs between the three types. Base and mobile scanners have larger displays and deliver more audio than do portables. Some handheld units are more prone to interference when connected to outdoor antennas than are base models. Also, most handheld scanners have small speakers that do not compete well in a noisy environment. In that case, an external speaker or an earphone could be a good add-on.

Of course, when severe weather knocks out the power in your home, there's nothing like having a battery-operated scanner to monitor weather, power-utility, police, and fire channels. As a rule, handheld scanners are somewhat more expensive than base units with comparable features and performance.

Many scanners are capable of more than one application, having a dual power supply that allows 117-volt-AC or 12-volt-DC operation. In such units, you can use AC adapters to charge batteries and power the scanner when plugged in.

Programmable (frequency-synthesized) scanners, which don't require cumbersome crystals have almost completely replaced crystal-controlled models. Programmables are now relatively inexpensive so that it doesn't make sense to buy a crystal-controlled unit for most uses. It's also unwise to invest in an inexpensive, preprogrammed scanner that you can't reprogram.

Scanner Control by Computer. Programmable radios, with their digital circuitry, make it practical for you to effectively extend the set's front-panel controls to your computer's keyboard. Today's high-end scanners can be controlled externally by a computer, although admittedly that significant capability isn't yet important to many scanner owners.

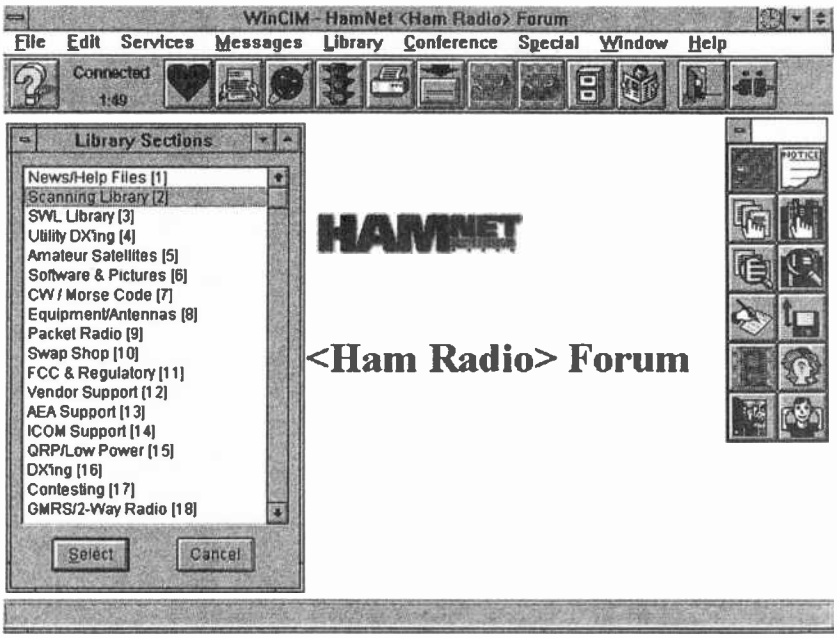


Fig. 3. The CompuServe HamNet Forum is a place where you and others who share interests in radio hobbies can meet.

Many deluxe scanners afford "smart," computer-controlled functions for sweeping frequencies and for loading of area frequencies. They have interface ports (usually RS-232 serial-based) that allow computer control of most functions. To that end, several firms have developed software to control the scanning pattern and other frequency functions of various ICOM, Kenwood, Yaesu, JRC, AOR, Uniden, Radio Shack, and other scanner radios, communications receivers, and amateur transceivers.

Some control programs allow complete management of all radio functions that are addressed to the radio's microprocessor. That means that in some cases you can even perform functions that are not available through front-panel, manual controls.

Computer-control programs offer you full automation of all microprocessor-controlled radio functions and parameters, including tuning, mode, band selection, scanning, sweeping, and memory. Tasks can include scanning of frequencies from banks of preprogrammed frequencies; searching a user-selectable frequency range; automatic loading of frequencies, mode, and signal descriptions from disk; and scanning of multiple groups, banks, or search ranges at the same time, in a single scan pattern.

Other computer-based features often include spectrum analysis, multi-radio scan strategies, logging or recording of intercept data to a file (including frequency, date and time, signal strength, air time or duration, the number of signal "hits," and even location), and exporting and importing of data to and from other storage formats.

Of course, to do all that, you need a PC, appropriate software, and sometimes additional hardware. You might go slowly with computer control at first, because its setup can complicate your enjoyment of the hobby. However, consider purchasing a scanner—especially a desktop unit—with built-in control capabilities or options you can easily implement later. Having such capabilities will open up tremendous future possibilities.

Your First Scanner. Having absorbed the technical details, specs, and features, how do you wisely select your first scanner? Trying to answer the question "which scanner is best?" is much like figuring out "which car is best?" To do either, you must list your goals, objectives, and requirements.

Your first scanner should cover at least the basic VHF low, VHF high, and UHF NBFM bands, and possibly also the VHF AM aeronautical band. The number of channels you need depends on where you live, but in busy urban areas you probably should have a scanner with at least 20 or 30 channels, possibly more. A search function is a near-must; channel lockout and at least one priority channel are also important for enjoyable listening.

There are many excellent scanners to choose from today; you should be able to find a good first scanner for about $200. Suitable entry-level scanners are available from Radio Shack, Uniden, and others.

Buying a New Scanner. Buying a quality, brand-new scanner at the outset is fine if you can afford to do so. You have the warranty backing of the dealer and/or manufacturer, and you know can easily find out the specs the scanner should meet. That way, if the radio doesn't measure up, you can usually return it.

Still, when placing your order for a new radio, don't rely totally on the salesman and the ads. Obtain the spec sheets, query experienced friends, consult reviews published in

SELECTED SCANNER CLUBS

Scanner monitor radio clubs offer you a number of benefits with membership. Typically, those include a technical advisory service, scanner frequency lists for your area, regional frequency directories, a subscription to the club's newsletter or magazine, access to a club BBS, free classified ads, and various membership paraphernalia (ID cards and certificates, bumper stickers, spectrum charts, etc.). Here are selected regional and national scanning clubs:

All Ohio Scanner Club: A relatively small club is the All Ohio Scanner Club that publishes the American Scannergram. Although concentrating on Ohio and the Northeastern states, it covers some frequency information from other states, product reviews, and scanning tips. Annual dues are $18.50.

Bearcat Radio Club: The Bearcat Radio Club, with over 10,000 members, covers the U.S. and Canada. It publishes National Scanning Report and operates a scanner BBS at 513-298-3663. The club reportedly is endorsed by Uniden.

Northeast Scanner Club: This club covers Maine through Virginia. It focuses on UHF and VHF public safety, aircraft, and military scanning, and it publishes Northeast Scanning News.

Radio Communications Monitoring Association: The world's largest scanner club is the Radio Communications Monitoring Association (RCMA). RCMA covers all activity above 30 MHz. It publishes a monthly newsletter, Scanner Journal. ■

SUGGESTED READING

Following are selected books, magazines, and newsletters of interest to scanner information seekers. These primarily are sources of scanner radio technical information, although some have pricing data, operating tips, and frequency lists. Addresses for many of these resources are in the "Names and Numbers" box, and most of the books are available from CRB Research Books and Radio Bookstore.

Books

AIR SCAN Guide to Aeronautical Communications. This 1995 book, now in the 6th Edition, is one of the most comprehensive guides to monitoring 26-896 MHz aeronautical communications yet compiled. It's written by Tom Kneitel, and costs $18.95.

Radio/Tech Modifications and *Lost Users Manuals*, by Artsci Publications. Artsci specializes in reference publications. *Radio/Tech Modifications*, available in several series for Alinco, Kenwood, ICOM, Standard, Yaesu, and other radios and scanners, are $19.95 each; and *Lost Users Manuals*, at $19.95, offers condensed VHF/UHF mobile, handheld, and scanner programming and operating instructions.

BBS Radio: The National Directory of Radio Hobby Bulletin Board Services. Mike Witkowski lists several-hundred BBSes that address various aspects of the radio communications, including BBSes of interest to radio amateurs, SWLs, and scannists. Most BBS listings show the board's name, area code, telephone number, and location. It's $9.95 from Tiare Publications.

Les Mattson's Dictionary of Scanner Terms, Slang and Abbreviations. This 110-page alphabetical directory is a roundup of on-the-air scanner terms, slang, jargon, and abbreviations. Police, fire, emergency medical, military, and federal terms are covered. The 1993 book is $12.95 from DX Radio Supply.

Listener's Lawbook. You can find out about legal scanning restrictions in the second edition of this paperback. Compiled by Frank Terranella, it discusses in some detail how the law affects your listening enjoyment. It's $9.95 from Grove Enterprises.

Monitor America, Third Edition. This 800+ page, 1995 book is published by Scanner Master and covers major metropolitan areas. Police and fire radio codes and unit identifiers are listed for several cities. It's $29.95 from Grove Enterprises.

Police Call Radio Guide. This comprehensive reference is published annually in nine regional volumes by Hollins Radio Data. It's sold at Radio Shack and larger book stores. The 1996 editions also contain selected business listings.

Scanners & Secret Frequencies. This 1993 book by Henry L. Eisenson is a 318-page handbook for scanner users that covers practically every aspect of monitoring. A large reference section lists scanner resources and must-have information in several categories. It's $19.95 from INDEX Publishing Group.

The Scanner Listener's Handbook. This 1989 book by Ed Soomre, N1BFF, though now 7 years old, is an excellent "how-to" look at scanning from 25 to 2100 MHz. The 130-page illustrated book is $14.95 and is available from Tiare Publications.

The Scanner Modification Handbook, Volumes 1 and 2. In these two books, Bill Cheek shows how you can make relatively simple equipment modifications and changes for a much-enhanced scanner. Volume 2 includes a listing of all known VHF/UHF scanning radios, alignment instructions, and guidelines on used scanners. Each is $18.95 from COMMTronics Engineering.

Scanner Radio Guide. Larry M. Barker's 1993 book is a beginner-oriented introduction to scanning. Its chapters include discussions on choosing a scanner, and an index includes a listing of scanner frequencies in use nationwide. The 148-pager is $14.95 from HighText Publications.

The "Top Secret" Registry of U.S. Government Radio Frequencies, Eighth Edition. A very authoritative source of sensitive government frequencies in the range of 30–420 MHz is this Tom Kneitel book. A guide to federal monitoring, it's published by CRB Research Books at $22.95.

Tune in on Telephone Calls, Third Edition. This 1996 book by Tom Kneitel is a guide to intercepting cellular, cordless, and other wireless telephone calls on scanners and shortwave receivers. Techniques, frequencies, stations, and applicable laws are covered. It's $16.95 from CRB Research Books.

The Ultimate Scanner. The third scanner modification guide by Bill Cheek, this 1995 book updates the popular series. The book purports to be a "system" that tells you how to cover all bands and channels with your scanner and to have complete control of everything that comes from your scanner's speaker. It's published at $29.95 by INDEX Publishing Group.

Magazines and Newsletters

Popular Electronics. The magazine you're reading right now contains the monthly column *Scanner Scene*, as well as classified ads, both of which are of interest to scanner enthusiasts.

Monitoring Times. This monthly, newspaper-style journal, published by Grove Enterprises, focuses on SWL, scanning, and other radio-hobbyist pursuits. A one-year subscription is $19.95.

National Scanning Report is a national, bimonthly scanner magazine published by the Bearcat Radio Club. It emphasizes equipment reviews, scanner mods, and the latest frequencies of interest to hobbyists.

U.S. Scanner News. This monthly is for the scanning hobbyist and covers antennas, FCC information, frequencies, public safety, satellites, books, beginner topics, and more. Subscriptions are $18 from U.S. Scanner Publications.

The Universal Radio Sales-Alert. This is a sales newsletter published by Universal Radio every 10 days or so that includes used equipment, demos, closeouts, and special sales. You can use it to check on radio pricing and availability.

The World Scanner Report is for those who like to follow the latest scanning technology. *WSR* offers guidelines, procedures, and methods, and it gets into scanner "hacking" and modifications in detail. Troubleshooting, problem diagnosis, alignment, and maintenance are covered. A one-year subscription is $25 from COMMTronics Engineering. ■

the radio books and magazines, and study the scanner specification and comparison guides often found in dealers' catalogs.

If you buy locally, you might pay more for your scanner than if you shop nationally. But there's a great deal to be said for local convenience. Almost every community of any size has a Radio Shack nearby. Also, discount stores like WalMart, Kmart, Service Merchandise, and Circuit City sell scanners, although they carry just a few models and stock few accessories. Department stores sometimes offer entry-level scanners, but their prices could be expensive.

Buying from the 800-number market is fine, and can net you the best "street price." Most mail-order vendors are reputable, though using a credit card adds some extra protection. But check on post-sale service: ascertain who will back the equipment in case something goes wrong. Inquire as to refund and exchange policies. There might be a restocking charge should you return your radio.

You'll probably notice that the best buys are often from reputable mail-order dealers. So be sure to peruse and compare ads by Ace Communications; Amateur Electronic Supply; Associated Radio; Barry Electronics Corp.; C. Crane Co.; Communications Electronics; Electronic Distributors

Co. (EDCO); Electronic Equipment Bank (EEB); Grove Enterprises; Ham Radio Outlet; The Ham Station; Lentini Communications; Scanner World, USA; Universal Radio; and other well-known radio dealers.

Buying a Used Scanner. Of course anybody with sufficient cash can buy a brand-new scanner, but if your finances are tight, you can save money by buying a used scanner of recent vintage. Depreciation takes its toll on scanners, so on older radios, cost decreases considerably. Actual prices depend on the condition of the equipment, sale terms, demand, availability of the operating and service manuals, and other factors. However, getting a bargain on a used radio isn't without some risk.

It's helpful to understand scanner history before you shop. You'll see radios from several eras at hamfests, flea markets, and garage sales. But you definitely should avoid early units whose technology by now has been transcended several times.

You might see ancient, single-band converters and tunable VHF receivers from the 1950s and 1960s, but they're unlikely to work well by today's standards. Better-performing, narrowband, crystal-controlled units followed; those let you change frequencies without turning a dial. However, those radios aren't really scanners because channel selection was by a rotary switch.

The first scanners were VHF single-band, crystal-controlled models, followed by multi-band models. Often, UHF scanners commanded premium prices, and some early multi-band, VHF/UHF scanners required an optional circuit board for each band.

The first programmable scanners—ones that didn't require crystals—were difficult to program and did not use keyboard entry or digital displays. Instead, you had to look up frequencies in a code book and tediously program the scanner in binary form, much like the way early PCs were programmed! Avoid such scanners, especially if the programming instructions are not available. More user-friendly keyboard-programmable scanners followed. Those were the real prototypes of the scanners we enjoy today.

So where should you look for used gear? Here are some sources to try:

This Radio Shack PRO-2033 scanner makes a good entry-level desktop unit. It has only 10 channels but offers convenient, one-touch access to NOAA weather broadcasts.

Dealer Trade-Ins: Your best bet might be to buy used radio equipment from a dealer, local or mail-order, who sells clean used radios traded-in on new equipment. Dealers often offer a limited warranty and even a return privilege, so you could avoid getting stuck with a useless radio. Some new-equipment dealers also accept trade-ins, and have good reputations among consumers.

Normally, a trade-in is checked over, and usually put into working order. In some cases it's reconditioned to "like-new" condition. In any case, the condition should be clearly known and labeled. Most dealers don't accept beat-up or modified equipment; if they do, it's usually sold "as-is." Check to see who pays for repairs after the return period, and for how long the warranty is valid.

Hamfests: Hamfests are great places to find used radios, but you must be familiar with the equipment and be willing to take some risk. Hamfests and flea markets are filled with older scanners. You often can buy what you need to minimally equip your scanning listening post for just a few dollars.

Nevertheless, the watchword at radio swap meets and hamfests is *caveat emptor*—let the buyer beware! There's little protection from bad deals. Bargains abound, but it could pay to be skeptical. Not all sellers are honest.

Most flea market deals are strictly on a no-refunds basis, so ascertain that what you buy is in good shape. Try out the radio before you part with your cash; there's no warranty but lots of risk. It's best to shop with specific equipment in mind.

Private Sales: Another source of used scanners is other hobbyists and the public. Sometimes you'll see used radios at auctions, estate sales, and garage and yard sales, or in classified ads in newspapers, trader sheets, and radio magazines. There are, of course, advantages and disadvantages associated with private sales; much of what we said about hamfests applies.

In a private sale, you'll normally pay much less for the radio than if you buy it from a dealer. On the other hand, you're on your own. You must rely on the seller's word as to the set's condition and performance; there's no warranty, you can't use a credit card, and the set could even be stolen.

Buying a used handheld scanner is riskier than buying a base model because handhelds are subject to more physical abuse, and many have been dropped. Mobile scanners are almost as risky a buy, because they're subject to dust, vibration, and temperature extremes. Those considerations shouldn't dissuade you from buying a used handheld or mobile scanner,

but you should be aware of possible nasty complications after you get the unit home.

Useful Add-Ons. When you use your new scanner to listen to a frequency for the first time, you'll probably want to know who you're hearing. Let's look at some high-tech add-ons that can help you figure out what frequency is what.

PerCon, a private company, sells FCC license information to the public on CD-ROMs, offering FCC-based databases for businesses and hobbyists. PerCon offers extracts from the FCC Master Frequency Database, organized by region or group. Five regions cover the U.S., with each containing an average of 700,000 records. Those are $99.95 each, or $450 for the set.

More to hobbyists' tastes is SPECTRUM, a frequency database with over three-million records. Its 15 fields include frequency; callsign; radio service and class of service codes; transmitter city, county, and state; latitude and longitude; and the number of units for vehicle, marine, aircraft, portable, and pager services. It's $29.95.

Another version, SPECTRUM for Scout ($39.95), is for use with the Optoelectronics Scout hand-held frequency recorder (which we'll deal with in a moment). It has the same features and data content as SPECTRUM, but it also can read and process data from a Scout datafile. The Scout datafiles can be compared with SPECTRUM data.

The Scout is a hand-held frequency recorder that can give new meaning to "tuning your radio." It's similar to a frequency counter, in that it can measure frequency from 10 MHz to 1.4 GHz. But the Scout also can capture up to 400 frequencies and store them in memory, recording up to 255 "hits" on each frequency.

The Scout serial interface and an optional "interface converter" let you connect it to a PC for remote control, automatic data logging, and downloading stored frequency information. With the SPECTRUM CD-ROM, you can download all of your saved frequencies to check against the FCC database.

In addition, when the Scout is connected to a properly interfaced and modified Radio Shack Realistic Pro-2005, Pro-2006, or Pro-2035 scanner, or other radio that conforms to the ICOM CI-V interface standard (such as the ICOM R7000, R7100, and R9000, or the AOR AR2700 or AR8000), the Scout can automatically tune the radio to a frequency. That is known as Reaction Tuning. The basic Scout is $449; various accessories are available.

Scanner Repairs. If your scanner is broken and under warranty, and if the manufacturer still is in business, there's usually little problem. Just send the unit to the manufacturer or an authorized repair station for repair as you would any other electronic appliance.

In other circumstances, it can be very difficult to obtain scanner repairs. If you buy a used scanner, you have little recourse if the radio turns out to be defective. If you can't fix the radio yourself, you can pay to have the manufacturer or a service clinic repair it for you—if you can find either.

Unfortunately, the manufacturers of many older scanners have gone out of business and so you might no longer be able to obtain parts or technical data. There aren't many scanner repair shops, but often a local radio amateur or radio technician "moonlights" by fixing scanners, so check locally for a repair resource.

Here are two repair centers that work by mail-order. The first, Electronic Repair Centers (9490 Franklin Ave., Franklin Park, IL 60131; Tel. 708-455-5105) repairs Bearcat scanners for a flat rate and reportedly will fix some other scanners if the parts are available. A second firm, G & G Communications (9247 Glenwood Drive, LeRoy, NY 14482; Tel. 716-768-8151), repairs scanners and pagers, stocking parts for many makes and models. The latter company also buys and sells new and used scanners and parts.

The Optoelectronics Scout frequency recorder can record up to 400 unique frequencies and store them in memory. Here, the unit is hooked up to an AOR2700 scanner to provide Reaction Tuning capability.

Scanner Modifications. Many scanner enthusiasts love to modify their radios. If you're knowledgeable in electronics and handy with a soldering iron, you'll find many scanners can be modified in various ways. To many, the term "mod" means to make a change that lets a scanner receive cellular frequencies. But there are other ways you can modify a scanner as well, such as making changes to improve audio quality, expanding the number of channels, or adding a signal strength meter.

You'll find many modification articles on the Internet and on bulletin-board systems (more on those later). Many amateur-radio and radio-hobbyist CD-ROM software collections also have scanner mod files, such as *The World of Ham Radio*, offered by AmSoft; *HamCall and Electronics Software Compendium*, by Buckmaster Publishing; and the *QRZ! Ham Radio CDROM Callsign Database*, by Walnut Creek CDROM. Books on the topic are also available (see the "Suggested Reading" box).

What if you're not inclined to pop the cover on your scanner? In that case, you'll be happy to learn that some firms like Grove Enterprises advertise a modification-for-fee service in which they perform tried-and-true mods on your scanner.

High-Tech Selection Help. Whether you buy a new or a used scanner, today you can go online to help you make your choice, and once you've made it, you can use many of the same resources to keep up. You can use local BBSes, the Internet, and the online utility services such as America Online and CompuServe. Let's examine each:

Bulletin Board Systems: BBSes can be excellent sources of information for scanner buffs, shortwave listeners,

NAMES AND NUMBERS

Ace Communications
10707 E. 106th Street
Fishers, IN 46038
Tel. 800-445-7717

All Ohio Scanner Club
Dave Marshall
50 Villa Road
Springfield, OH 45503-1036

Amateur Electronic Supply
5710 W. Good Hope Road
Milwaukee, WI 53223
Tel. 800-558-0411

American Radio Relay League, Inc.
225 Main Street
Newington, CT 06111-1494
Tel. 860-594-0200

AmSoft
P.O. Box 666
New Cumberland, PA 17070-0666
Tel. 717-938-8249

Artsci
P.O. Box 1848
Burbank, CA 91507
Tel. 818-843-4080

Associated Radio Communications
8012 Conser
P.O. Box 4327
Overland Park, KS 66204
Tel. 800-497-1457

Barry Electronics Corp.
540 Broadway
New York, NY 10012
Tel. 800-990-2929

Buckmaster Publishing
Route 4
Box 1630
Mineral, VA 23117
Tel. 800-282-5628

C. Crane Company
558-10th Street
Fortuna, CA 95540-2350
Tel. 800-522-8863

CRB Research Books, Inc.
PO Box 56
Commack, NY 11725
Tel. 800-656-0056

COMMtronics Engineering
P.O. Box 262478
San Diego, CA 92196-2478
Tel. 619-578-9247

Communications Electronics
P.O. Box 1045
Ann Arbor, Michigan 48106-1045

DX Radio Supply
P.O. Box 360
Wagontown, PA 19376
Tel. 610-273-7823

Electronic Distributors Co. (EDCO)
325 Mill Street, N.E.
Vienna, VA 22180
Tel. 703-938-8105

Electronic Equipment Bank (EEB)
323 Mill Street, N.E.
Vienna, VA 22180
Tel. 800-368-3270

G & G Communications
9247 Glenwood Drive
LeRoy, NY 14482
Tel. 716-768-8151

Grove Enterprises, Inc.
P.O. Box 98
Brasstown, NC 28902-0098
Tel. 800-438-8155

Ham Radio Outlet
933 N. Euclid Street
Anaheim, CA 92801
Tel. 800-854-6046

The Ham Station
P.O. Box 6522
220 N. Fulton Avenue
Evansville, IN 47719-0522
Tel. 800-729-4373

HighText Publications, Inc.
P.O. Box 1489
Solana Beach, CA 92075
Tel. 800-247-6553

Hollins Radio Data
Box 35002
Los Angeles, CA 90035

INDEX Publishing Group, Inc.
3368 Governor Drive
Suite 273
San Diego, CA 92122
Tel. 800-546-6707

Lentini Communications, Inc.
21 Garfield Street
Newington, CT 06111
Tel. 800-666-0908

National Scanning Report/Bearcat Radio Club
P.O. Box 291918
Kettering, OH 45429
Tel. 513-299-6440

Northeast Scanner Club/Northeast Scanner News
P.O. Box 62
Gibbstown, NJ 08027
Tel. 609-423-1603

Optoelectronics, Inc.
5821 N.E. 14th Ave.
Ft. Lauderdale, FL 33334
Tel. 800-327-5912

PerCon Corporation
4906 Maple Springs/Ellery Road
Bemus Point, NY 14712
Tel. 716-386-6015

Radio Bookstore
P.O. Box 209
Rindge, NH 03461-0209
Tel. 800-457-7373

Radio Communications Monitoring Association (RCMA)
P.O. Box 542
Silverado, CA 92676

Scanner Master
P.O. Box 428
Newton Highlands, MA 02161
Tel. 800-722-6701

Scanner World, USA
10 New Scotland Avenue
Albany, NY 12208
Tel. 518-436-9606

Tiare Publications
P.O. Box 493
Lake Geneva, WI 53147
Tel. 800-420-0579

U.S. Scanner
Box 14923
Portland, OR 97214
Tel. 800-890-6999

Universal Radio, Inc.
6830 Americana Parkway
Reynoldsburg, OH 43068-4113
Tel. 800-431-3939

Walnut Creek CDROM
4041 Pike Lane
Suite D
Concord, CA 94520
Tel. 800-786-9907

amateur-radio operators, and other radio hobbyists. Besides thousands of programs, datafiles, and frequencies available to download, some hobbyist BBSes have text files with tips on buying new and used radios as well as reviews of new equipment. Some services also have online classified ads.

A sampling of BBSes of interest to scanner buffs includes the Grove System/Monitoring Times BBS at 704-837-7081; the Hertzian Intercept BBS at 619-578-9247; the CARMA BBS at 708-852-1292; the Bearcat Radio Club BBS at 513-298-3663; the American Radio Relay League (ARRL) BBS at 203-594-0306; Signal Intelligence BBS at 212-864-0112; and The Frequency Forum at 703-207-9622.

World-Wide Web Sites: Recently, the hot place for you to be on the Internet has been the World-Wide Web. One of the beauties of Web browsing is that once you've located a few pages of interest, you'll find links to many other pages. With that in mind, here are a few Web pages featuring some scanner topics, pages you can access easily with any Web browser:

Radio Resources on the Internet is at the Web URL http://www.wave-rider.co.uk/~paulj/radio.html. It lists

many links, so it's a good place to begin your search for scanner information. You can use its links to go to other sites.

KC5KTO's Radio Page is at the Web URL http://www.zianet.com/files/users/kc5kto/scanner.html. While the emphasis is on scanning and scanner mods, there's information on other aspects of radio (see Fig. 1).

The Long Island Area Scanning Resources home page is at http://www.li.net/~j4dice/scanli.html. It boasts a wealth of useful scanning information, including frequencies and many links to other Internet pages and resources.

The Grove Enterprises home page, GroveLink, is offered by a major scanner radio dealer, and it contains a good deal of useful scanner information in an online catalog. It can be found at the URL http://www.grove.net (see Fig. 2).

The Railfan Scanning home page is a treasury of railroad scanning information and frequencies. You'll find it at http://bjr.acf.nyu.edu/railinfo/scanning/scanning.html.

The PerCon Corporation supplies databases of FCC frequency data useful to scanner buffs. It has its home page at the URL http://www.percon-corp.com.

Radio Control Systems, Inc. (RCSI) offers computer scanner-control software. It has its home page at the URL http://www.cts.com/browse/rcsi.

U.S. Scanner Publications publishes U.S. Scanner News and is found at http://www.pacifier.com/~ussn.

USENET Newsgroups: There also are scanner, radio-hobbyist, and amateur-radio resources in Internet USENET newsgroups. Those are discussion groups that focus on specific subjects. They're the Internet equivalent of the forums found on the online services and some bulletin-board systems.

You might find the discussions and information postings on several newsgroups to be helpful in searching for a scanner radio and other information on scanning. The most useful scanning-related newsgroup is rec.radio.scanner. Other USENET newsgroups in which you might find scanner-related information, many of them having to do with amateur radio, Citizens Band (CB), and shortwave, include the following:

alt.radio.scanner
rec.radio.amateur.equipment
rec.radio.amateur.misc
rec.radio.cb
rec.radio.info
rec.radio.swap
sci.electronics
sci.electronics.repair

FTP Sites: FTP or File Transfer Protocol, is a standard method of transferring files between computers on the Internet. These sites let you download from on-screen lists of files. Some FTP sites with amateur-radio-related files (and some scanner-related files, including modification information) include:

ftp.qrz.com
oakland.oakland.edu
nic.funet.fi
ftp.cdrom.com
hamster.business.uwo.ca
ftp.cs.buffalo.edu

Online Services: Besides BBSes and the Internet, you also can obtain radio hobbyist information via the major online services. Here are several resources:

For starters, check out the Ham Radio Club (Keyword: HAM or HAM RADIO) and ARRL areas (found in the Ham Radio Club) on America Online. There is also the CompuServe HamNet Forum (see Fig. 3), which has swap shop and vintage gear areas in which you can exchange messages and download software files. The related HamNet Companion Internet Web page is at http://www.web-com.com/~sjl/HamNet—Companion.

Both AOL and CompuServe have classified advertising sections you can peruse for used radio equipment, including scanners. On CompuServe, GO CLASSIFIEDS; on America Online, use the Keyword: CLASSIFIEDS.

Choosing a scanner that's right for you can be a formidable task, especially for the beginner. But, armed with the information in this article, you're well on your way. ■

A Radio Shack Pro-2005 scanner equipped with an Optoelectronics OptoScan 456 computer-controlled interface, a PC, and the appropriate software, all form a complete computer-aided VHF/UHF scanning system.

SOURCES

Barker, Larry M. 1993. *Scanner Radio Guide*. Solana Beach, CA: HighText Publications, Inc.

Eisenson, Henry L. 1993. *Scanners & Secret Frequencies*. San Diego, CA: INDEX Publishing Group.

Parnass, Bob, AJ9S. 1995. "Buying a Used Scanner Radio" and "Introduction to Scanning." Two FAQs posted to KC5KTO's Radio Page Internet Web site.

Soomre, Edward, N1BFF. 1989. *The Scanner Listener's Handbook*. Lake Geneva, WI: Tiare Publications.

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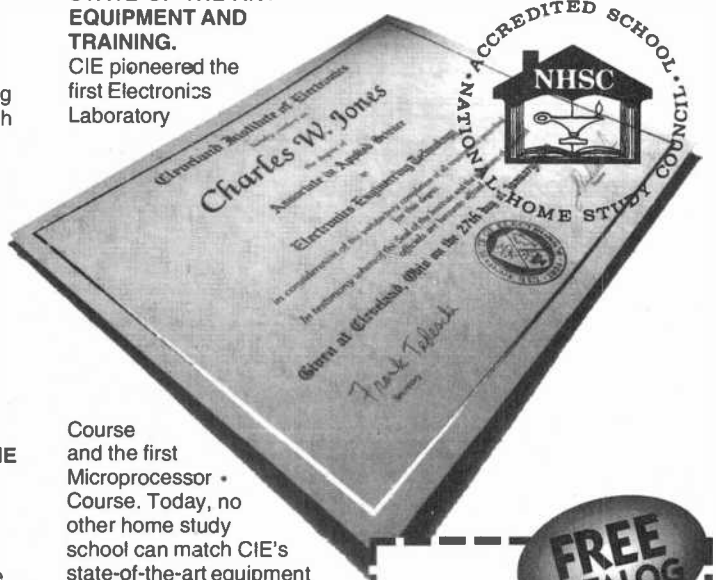

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Build A Versatile DTMF TONE PAD

It's an affordable way to add a DTMF keypad to your current transceiver.

BY BRIAN PLILER

One of the greatest benefits to being an electronics hobbyist is that you can build equipment you need rather than spending a lot of money to buy it. A great example of such a money-saving, do-it-yourself project is the *Versatile DTMF Tone Pad* described in this article; it can be built for about $20 (that's a fraction of the cost of commercial units). The Tone Pad can generate all 16 standard DTMF tone pairs (0–9, *, #, A, B, C, and D), will automatically key a connected transceiver whenever any key is pressed, and contains a built-in monitor amplifier and speaker that allows the actual tone pairs to be heard as they are transmitted.

Circuit Description. The schematic diagram for the DTMF Tone Pad is shown in Fig. 1. An input 12-volts DC (which can most likely be provided by a transceiver) is regulated by transistor Q1, resistor R1, and Zener-diode D2 to provide the circuit with a 5-volt supply.

A telephone-type keypad, KPD1, is used to enter a desired DTMF tone. When a button is pressed, a column and a row of the keypad are both connected to ground. Then, a TP5089N DTMF dialer (IC1), in conjunction with a 3.58-MHz color-burst crystal (XTAL1), generates the corresponding tone.

Switch S1 makes it possible to select all 16 DTMF tone pairs with the 12-button keypad, KPD1. When S1 is in the NORM (normal) position, column 3 on the keypad operates normally. But when S1 is placed in the EXP (expanded) position, DTMF tone pairs representing "digits" A, B, C, and D are generated in place of digits 3, 6, 9, and #, respectively.

When any key is pressed, pin 10 on IC1 goes low. That low is applied to the base of transistor Q2 through resistor R3, and causes 5 volts to appear at Q2's collector. Then, LED1 lights and, at the same time, transistor Q3 turns on via diode D3, which then keys the transceiver.

Resistor R5 and capacitor C3 create a short time delay that keeps the transceiver keyed between dialed digits. That keying circuit is compatible with the majority of modern transceivers using electronic switching. If the Tone Pad is used with a transceiver that uses relay switching, a spike-suppression diode (D5) should be added as shown in Fig. 1. That will prevent damage from occurring to transistor Q3.

The DTMF tone output from IC1 is coupled to trimmer-potentiometer R7, which controls the amplitude of the transmitted DTMF tones. Transistor Q4 operates as a buffer amplifier with an output impedance of approximately 500 ohms (that allows for direct connection to the microphone input on most transceivers). If the transceiver used with the Tone Pad has an input impedance that is greater than 500–600 ohms, the value of R10 must be changed accordingly.

Note that resistor R10 is not connected directly to ground, but to the anode of diode D4 and to capacitor C6 instead. That allows the buffer amplifier to be disabled when it is not needed. Recall that pin 10 on IC1 goes low when any key is pressed. That low pulls R10 low via diode D4 and discharges capacitor C6, thereby allowing the buffer amplifier to operate. As soon as the key is released, pin 10 on IC1 goes high, C6 charges, and the buffer amplifier is disabled once again.

The DTMF tone output from IC1 is also coupled to trimmer-potentiometer R6, which controls the unit's monitor volume. An LM386 audio amplifier, IC2, changes the low-level DTMF output from IC1 into a signal suitable for driving speaker SPKR1. Switching-jack J1 is wired so that when a plug is inserted, SPKR1 is disconnected and audio comes from the jack. Jack J2 provides speaker-level audio without silencing SPKR1.

Construction. The author's prototype was assembled on a small section of perforated board using point-to-point wiring. However, if you'd like to build the project on a printed-circuit board, you can use the foil pattern shown in Fig. 2 to etch and drill one. For those building the project on a printed-circuit board, a parts-placement diagram is provided in Fig. 3.

To make assembly of the tight circuit board easier, it is recommended that you mount low-profile parts first. Begin with sockets for IC1 and IC2. Next, install the jumper wires and resistors (mount R2, R4, R9, and R10 vertically), followed by the two trimmer potentiometers. Continue by adding the diodes, being sure to check their polarity (as mentioned earlier, whether or not D5 is installed depends on the type of transceiver you plan on using with the Tone Pad).

Go on to solder the capacitors next,

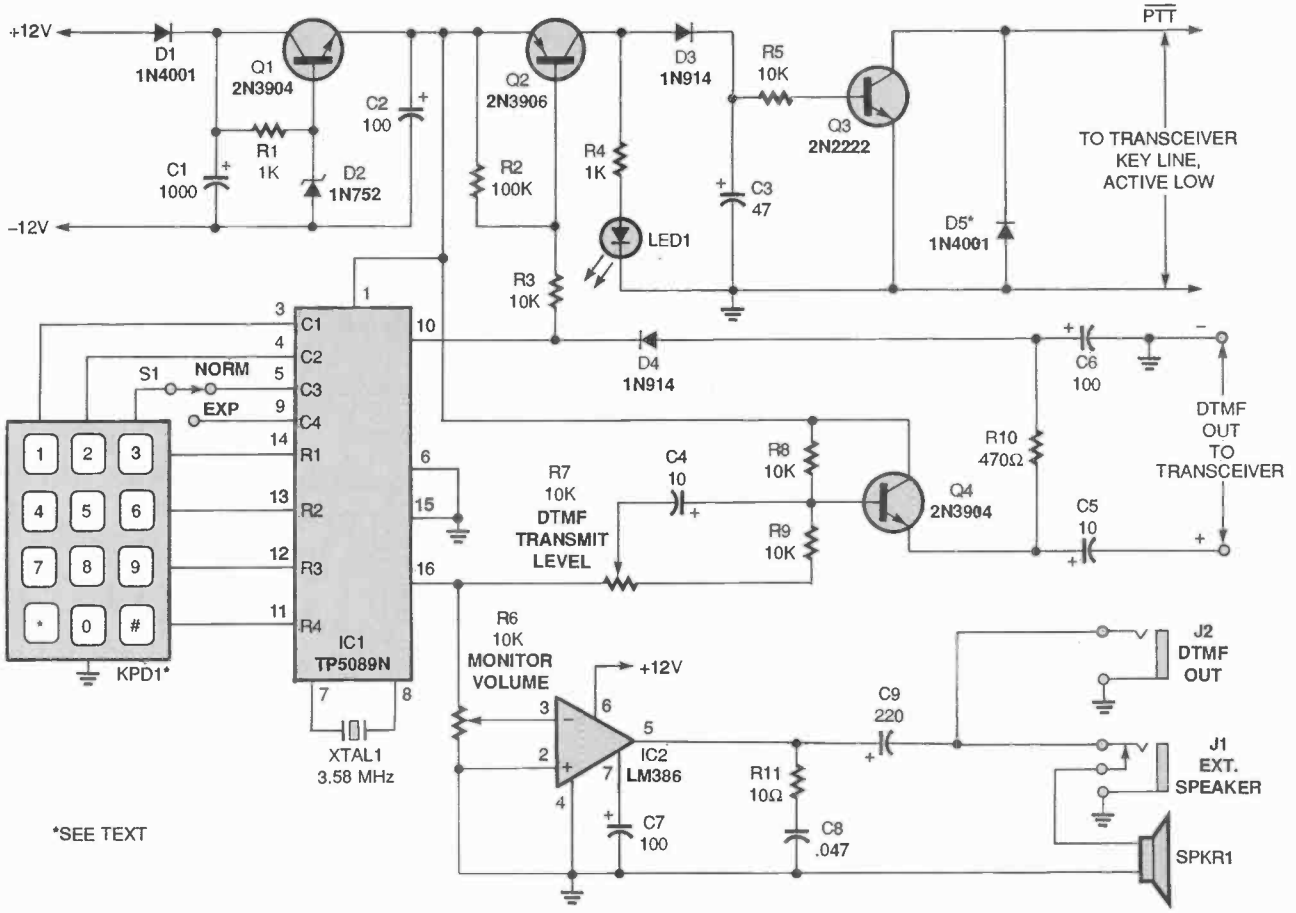


Fig. 1. This is the schematic for the DTMF Tone Pad. Switch S1 makes it possible to get 16 DTMF tones from a 12-digit keypad, KPD1. Just set S1 to EXP and digits 3, 6, 9, and # will produce tones A, B, C, and D, respectively.

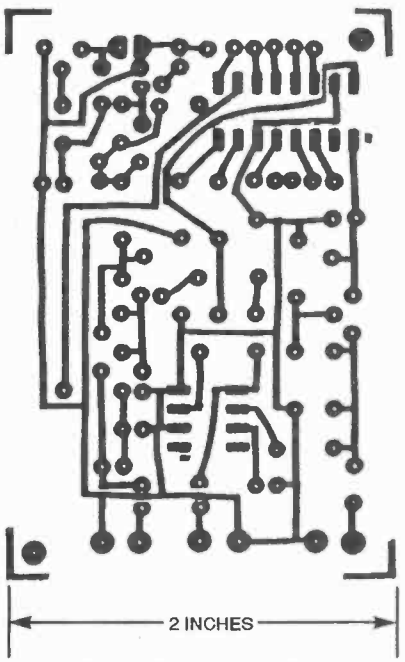


Fig. 2. Here's the full-size foil pattern for the Tone Pad PC board.

noting the polarity of the electrolytic units. Then install the transistors, being sure to orient them as shown in the parts-placement diagram. Before continuing with assembly, double check all connections and perform the following two tests:

Apply power to the board to confirm that the 5-volt regulator circuitry is operating correctly. Capacitor C2 should be supplying +5 volts. If that voltage is missing, ensure that diodes D1 and D2 are installed correctly. After you confirm that the regulator circuitry is working properly, temporarily connect LED1 to its pads on the board, and use an insulated jumper wire to temporarily ground the junction of resistor R3 and diode D4. As long as that jumper is held in place, LED1 should stay lit.

Disconnect the power source you just used from the board before continuing with assembly. Solder wires to the circuit board to facilitate the off-board connections to the keypad, jacks, switch, speaker, and LED. Also, solder long wires to the points on the board that will go to power and transceiver connections. Then insert IC1 and IC2 into their respective sockets to complete the on-board assembly.

Mount the 12-digit keypad to the enclosure you will use. If you have a difficult time buying a suitable keypad locally, you can do one of the following: First, try salvaging a keypad from an existing piece of telephone equipment (the keypad in the author's prototype came from a non-working cordless telephone). If that fails, try ordering one from Alltronics Corp. (2300 Zanker Road, San Jose, CA 95131), Electronic Goldmine (P.O. Box 5408, Scottsdale, AZ 85261), Electronix Express (365 Blair Road, Avenel, NJ 07001), or MECI (340 East First Street, Dayton, OH 45402). Write and ask for a catalog from one or all of those sources.

Another option is to make your own keypad, although the amount of parts and effort required might make finding a pre-existing keypad seem more desirable. To make a keypad of your own, wire normally open, SPST

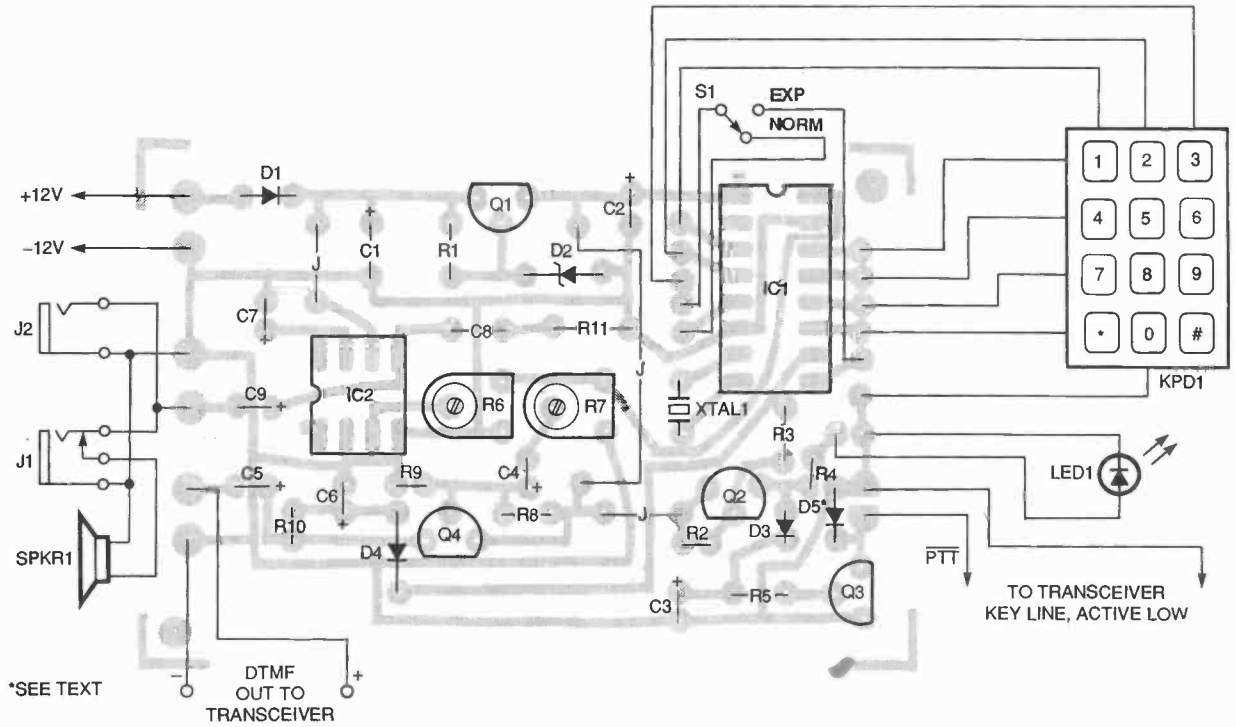


Fig. 3. If you're using a PC board to build the Tone Pad, this parts-placement diagram should make assembly easy.

PARTS LIST FOR THE VERSATILE DTMF TONE PAD

SEMICONDUCTORS

IC1—TP5089N, TCM5089N, LR4089, or ECG1690 DTMF dialer, integrated circuit (Digi-Key TP5089N-ND or equivalent)
IC2—LM386 low-power audio amplifier, integrated circuit
Q1, Q4—2N3904 general-purpose NPN transistor
Q2—2N3906 general-purpose PNP transistor
Q3—2N2222 general-purpose NPN transistor
D1—1N4001 silicon rectifier diode
D2—1N752 Zener diode
D3, D4—1N914 general-purpose silicon diode
D5—1N4001 silicon rectifier diode (optional, see text)
LED1—Light-emitting diode, red

RESISTORS

(All fixed resistors are ¼-watt, 5% units.)
R1, R4—1000-ohm
R2—100,000-ohm
R3, R5, R8, R9—10,000-ohm
R6, R7—10,000-ohm trimmer potentiometer, PC-mount (Digi-Key D4AA14-ND or similar)
R10—470-ohm
R11—10-ohm

CAPACITORS

C1—1000-µF, 16-WVDC, electrolytic
C2, C6, C7—100-µF, 16-WVDC, electrolytic
C3—47-µF, 16-WVDC, electrolytic
C4, C5—10-µF, 16-WVDC, electrolytic
C8—0.047-µF, Mylar
C9—220-µF, 16-WVDC, electrolytic

ADDITIONAL PARTS AND MATERIALS

XTAL1—3.58-MHz color-burst crystal
J1—3.5-mm switching panel-mount jack, normally closed
J2—3.5-mm panel-mount jack
KPD1—12-button telephone keypad (3 × 4 matrix with common)
SPKR1—8-ohm, 0.2-watt, 2-inch diameter speaker
S1—SPDT miniature toggle switch
Printed-circuit materials, project enclosure, IC sockets, rub-on labels, clear lacquer, wire, solder, hardware, etc.

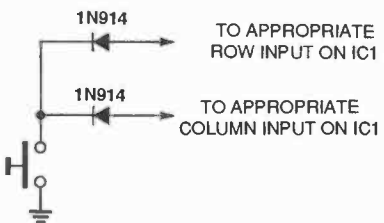


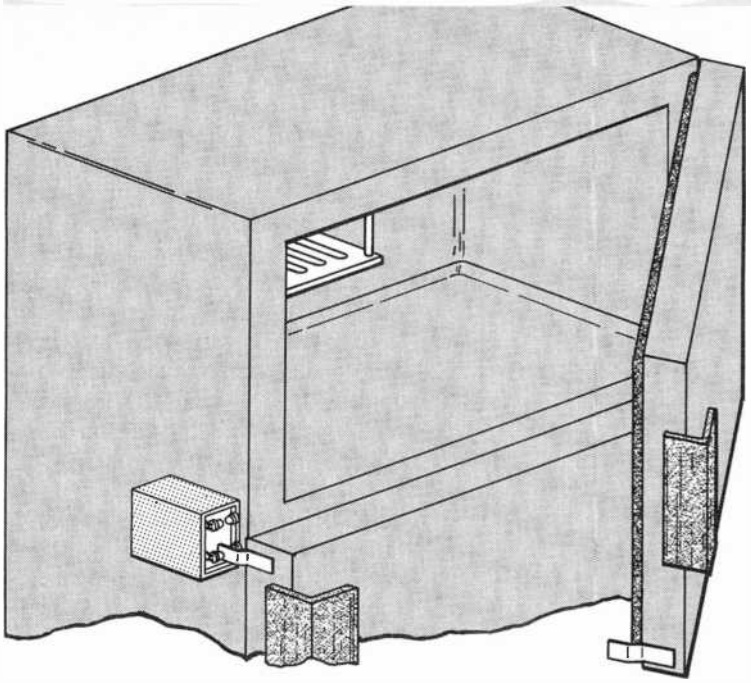
Fig. 4. This diagram shows you how to wire switches and diodes for use instead of KPD1 in the circuit.

pushbutton switches as shown in Fig. 4. Note that each "digit" will require one switch and two 1N914 diodes.

Once you have mounted the keypad, go on to mount the jacks, switch, speaker, and LED to the enclosure. Make the connections between all those off-board components and the circuit board as shown in Fig. 3. Then, before mounting the circuit board, reapply power and make sure that the unit operates properly. Pushing a button on KPD1 should result in a tone being heard from SPKR1. If that is not the case, recheck your connections. Adjust trimmer-potentiometer R6 at this time to vary the speaker volume. Then, set the transmission-level potentiometer, R7; about halfway should be fine for now, although you might want to change it after you've used the unit with your transceiver.

When the project is working, mount the board, close up the enclosure, and prepare to label it. Labels are necessary to prevent confusion as to which jack is which, and to make it easier to remember which setting of S1 will yield the expanded tones. The author used rub-on labels and

(Continued on page 77)



Save money on electric bills and keep food from spoiling with this simple device.

BUILD A Refrigerator-Door Alarm

BY EDWARD ANDREWS

Refrigerators do, on occasion, get left open, whether it's because the kids run off with their snacks and neglect to close the door, or you aren't awake enough during your midnight snack to realize your error. However, there is a way to make sure your milk won't get spoiled—build the *Refrigerator-Door Alarm* described here. This simple project, which can be built in an afternoon, sounds an "obnoxious" tone when either the refrigerator or freezer door is open or ajar.

Circuit Description. The schematic for the Alarm is shown in Fig. 1. Power for the circuit is supplied by a 12-volt DC source, and is filtered by capacitor C1.

The core components of the Alarm are two IR, LED-and-phototransistor pairs: LED1 and Q1, and LED2 and Q2. If IR light shines from LED1 onto Q1 or from LED2 onto Q2, piezoelectric-buzzer BZ1 emits a tone in the 2000- to 3000-Hz range (the part specified for BZ1 is self-contained, combination oscillator and sounding element). Resistors R1 and R2 limit the current flow to the phototransistors and the buzzer.

The sound quality produced by BZ1 is influenced by filter-capacitor C1. If C1 is reduced in value (or omitted entirely), the DC supply will have a noticeable 60-Hz AC component; the circuit will still operate, but the alarm will sound very "raspy." If it's of the value specified in the schematic, C1 will produce an "alarm-clock"-like sound having some of the 60-Hz component. For a clean, sinewave-like sound, increase the value of C1 to 100 µF or more.

The Mechanics of the Alarm. The circuit just described will only sound the buzzer when IR light reaches either or both of the phototransistors. Therefore, for our application, the flow of IR light to those detectors should be blocked when both the refrigerator and freezer doors are closed.

The diagram in Fig. 2 shows how that can be accomplished. A metal strip is attached to each of the refrigerator doors so that when the doors are closed all the way, the beam of IR light flowing between the detector pairs is blocked. If one of the doors is opened, the alarm will sound.

Construction. Considering the low parts count of the Alarm, it is easiest to build it on a small piece of perforated board using point-to-point wiring. Begin assembly by mounting the capacitor, resistors, and buzzer on one side of the board. Double-check the polarity of the capacitor and buzzer.

On the other side of the board, you should mount the two LED/phototransistor pairs (be sure to use the ones specified in the Parts List). Note that the LEDs and phototransistors have spherical lenses. Position LED1 and Q1 so that the rounded ends of their lenses are facing each other. They should be separated by a distance of about ⅛ to ¼ inch. Do the same for LED2 and Q2 (see the photo of the unit shown elsewhere in this article).

Because the LEDs look a lot like the phototransistors, you have to take care not to interchange them; the circuit will not work with the devices swapped! The LEDs are the units in the clear or translucent epoxy cases, while the phototransistors are the ones in the dark or opaque epoxy cases. When you're certain of the identity of the devices, electrically connect them to the circuit, making sure to orient them properly.

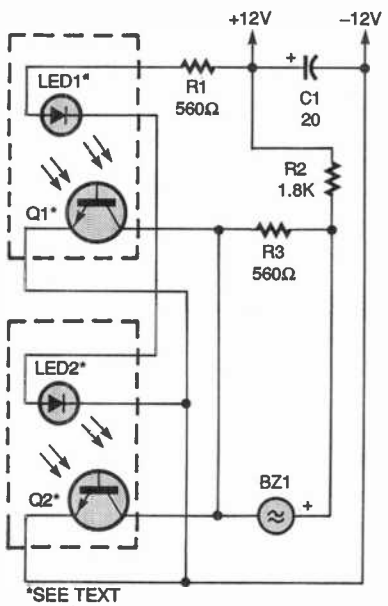


Fig. 1. Here's the schematic for the Refrigerator-Door Alarm. Buzzer BZ1 will sound when IR light from LED1 shines on Q1, or when LED2 shines IR light on Q2.

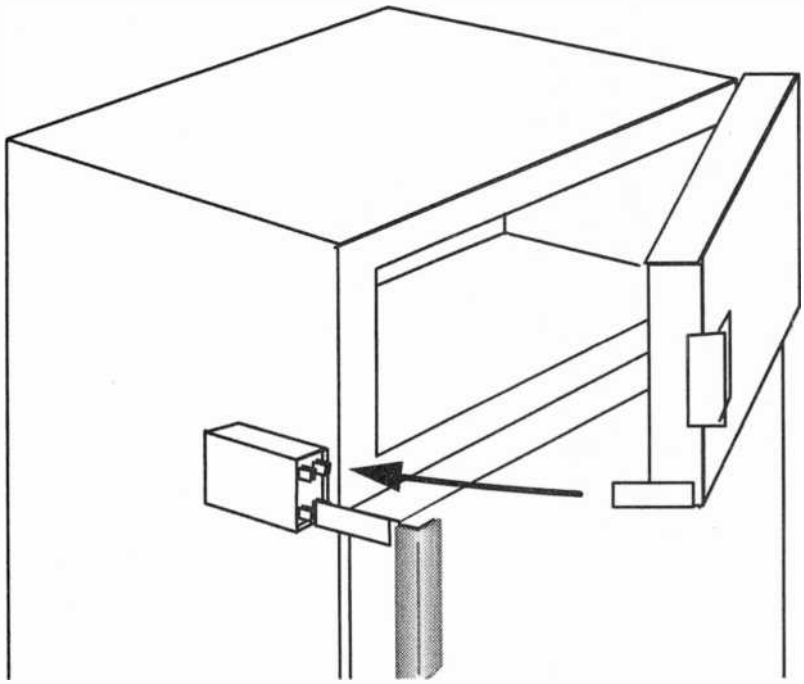


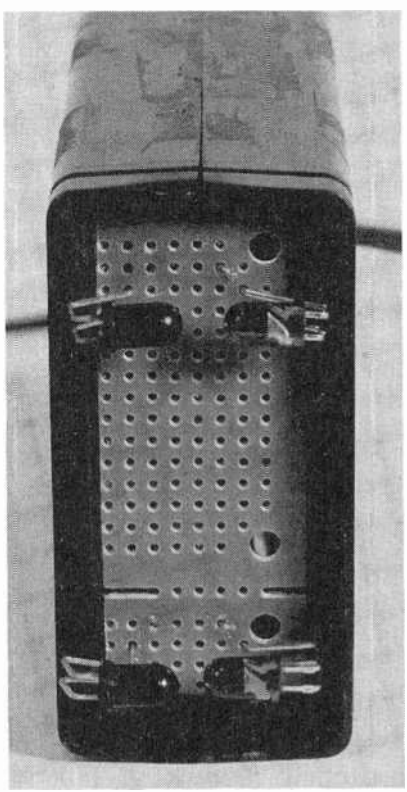
Fig. 2. As this diagram shows, two metal strips should be mounted on the refrigerator so that when a door is opened, the IR light path of an LED/phototransistor pair is unobstructed.

PARTS LIST FOR THE REFRIGERATOR-DOOR ALARM

Q1, Q2—Infrared phototransistor (part of matched IR emitter and detector pair, Radio Shack part no. 276-142 or equivalent)
LED1, LED2—Infrared light-emitting diode (part of matched IR emitter and detector pair, Radio Shack part no. 276-142 or equivalent)
R1, R3—560-ohm, ¼-watt, 5% resistor
R2—1800-ohm, ¼-watt, 5% resistor
C1—20-μF, 50-WVDC, electrolytic capacitor
BZ1—Piezoelectric buzzer (Radio Shack part no. 273-065A or equivalent)
Perforated construction board, enclosure, 12-volt DC power source (520-mA maximum current), light-gauge metal strips, wire, solder, hardware, etc.

When the circuit board is complete, mount it in an enclosure with an opening in it so that the LED/phototransistor side of the board is facing out. Then, wire the circuit board to a 12-volt power supply to complete the unit.

Checkout and Troubleshooting. Before you install the Alarm, you should check it to make sure everything works as it should. As soon as the Alarm is powered, you should hear a loud tone from buzzer BZ1. By blocking the path of IR light between the LED/phototransistor pairs with a solid material (such as a strip of metal), the tone should stop. If you remove the blocking material, BZ1 should sound again. If BZ1 produces no sound at all, here are a few simple things to check:



This front view of the Alarm shows how the IR LED/phototransistor pairs should be positioned.

First, is the power supply working? When the unit is plugged in to a 12-volt supply, 9- to 20-volts DC should be present across C1. If that isn't the case, replace the power supply you're using.

The next thing to check if your Alarm still isn't working is the buzzer. Is it wired correctly? If it is, and still isn't producing sound, then it might be defective. Unplug the power supply, temporarily connect an insulated jumper wire between the negative lead of BZ1 and the negative lead of C1. Then plug in the power supply again; if no sound is heard, BZ1 is either defective or wired backwards.

Now, if the buzzer *does* work when it is shorted with a jumper, but doesn't work otherwise, you might have a problem with an LED or phototransistor. Because the LEDs operate in the infrared region, the only way to determine if current is flowing through the LEDs is to plug in the power pack and look for voltage across R1. When the LEDs are operating, there will be 3 to 15 volts present across R1, and 2 to 3.5 volts present between the anode of LED1 and the cathode of LED2.

If a voltage is measured across R1, yet zero volts is measured across a particular LED, that LED is defective or there is a wiring error. Keep in mind that wiring errors are usually to blame (that goes for the buzzer and phototransistors too), so be sure to double check all electrical connections if there is a problem.

Another problem might simply be that the distance between the LEDs and phototransistors is too great. Make sure they are directly facing each other, and separated by no more than ⅛ to ¼ inch.

If all the preceding checks still result in an inoperative Alarm, check the phototransistors next. To do that, obstruct the light path between LED2 and Q2. Then, connect a voltmeter between the collector and emitter of Q1. Next, obstruct the light path for LED1; no current should be flowing and the voltage across Q1 should be

(Continued on page 76)

DX LISTENING

Radio Happy Isles

BY DON JENSEN

You can almost hear the ukuleles strumming when you say the name: Radio Happy Isles. More formally, that Pacific-region station is called the *Solomon Islands Broadcasting Corporation*, and it transmits on shortwave from Guadalcanal, a name well-known to the World-War II Marines who fought there over a half century ago.

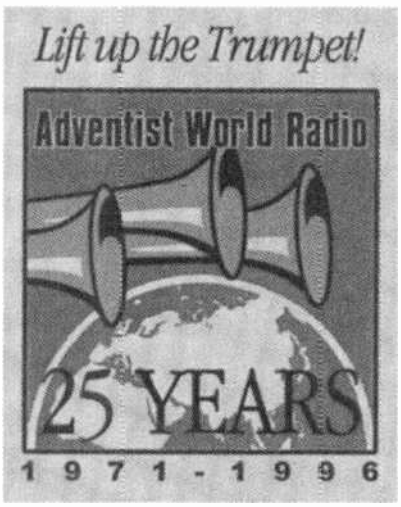
Since 1978, that volcanic-island-chain nation has been independent from Great Britain. Honiara, on Guadalcanal, is the capital and home to SIBS Radio Happy Isles. Its people, mostly, are dark-skinned Melanesians. English and a *patois* called "Pidgin English" are the most commonly spoken languages, but another 90 tongues are spoken in the islands.

The Solomon Islands Broadcasting Corp. seems to be a very efficient and effective radio operation for the "Third World," broadcasting regularly on both medium wave and shortwave. It defines its national role as informing and entertaining its peoples.

For DXers, though, tuning the SIBC offers a fascinating glimpse into this exotic part of the world. The station, with 10-kilowatt transmitters at Honiara, broadcasts on 5,020 kHz, from 1900 to 1130 UTC daily, the latter several hours of which offer North-American SWLers their best listening opportunities. It also is scheduled for 9,545 kHz, from 1800 to 0730 UTC, and again, the last hour or so is best for U.S. and Canadian listeners.

SIBC programming includes national and foreign news, some of it relayed from major SW broadcasters such as the BBC, Radio Australia, and the Voice of America. It also airs its own music, current-affairs, health, agricultural, and religious programming. Solomon Islanders also used its programs to send greetings to friends and relatives on the out islands. On a personal note, as something of a meteorological "nut," I get a charge out of the local weather forecasts heard on SIBS.

If you're willing to do a little early morning SWLing, chances are pretty good that you'll come across the Solomon Islands Broadcasting Corp. Happily, Radio Happy Isles is a reasonably good verifier, sending out QSL cards for reception reports. It's address is Solomon Islands Broadcasting Corp., P.O. Box 654, Honiara, Solomon Islands.



Adventist World Radio is a prolific religious broadcast that is celebrating its 25th anniversary this year.

WINDUP

What'll they think up next? Al Quaglieri and Chris Lobdell, co-editors of the "Listener's Notebook" in the North American SW Association's *JOURNAL*, note that Internet shortwave groups have been abuzz with talk about a new windup radio. They cite a Reuters dispatch reporting that a new, cheap set, called the "BayGen Freeplay" radio has gone on sale. While primarily intended for distribution in Third-World countries, where both AC power and batteries are in short supply, it also is offered by London's upscale Harrod's department store.

Manufactured in South Africa, the "Freeplay," with tough plastic case and flip-out winder to power its own internal generator, will give about 40 minutes of listening with a few seconds of winding. Inventor Trevor Bayless hit on the idea while watching a TV program about how the expense of radio batteries was hampering efforts to disseminate health-education broadcasts in impoverished African nations.

Bayless says he viewed his efforts to create a clockwork radio as a puzzle to be solved. "It was simply because I wanted the intellectual challenge."

Presently, the Freeplay radio covers long and medium wave and FM. Can windup shortwave be far behind?

MAILBAG

Country and western music has a lot of fans out there. I know, personally, because I regularly get mail from SWLers who ask where they can find C&W programming on shortwave radio. This month, that question was received from two readers, George Case of Lander, WY, and William Warrenton, Jackson, MS.

So, Messrs. C & W, where can you hear C&W on your worldband radio dial? Here's one answer. *World Wide Country Radio, WWCR* in Nashville, TN, joined last year with CURB Records, American Network Radio, and Tim Riley & Associates to present country music by the likes of Hank Williams Jr., Lyle Lovett, Wynonna Judd and other recording stars. "The program, The International CURB Country Showcase," says spokesman Tim Riley, "is a chance for us to expose the product world wide . . . to listeners in western Europe, Australia, the Pacific Rim, and South America."

continued on page 65

CREDITS: Brian Alexander, PA; Richard D'Angelo, PA; Marie Lamb, NY; Ed Newbury, NE; Mary Jo Ondrechen, MA; Al Quaglieri, NY; Charles Rippel, VA; Kirk Trummel, MO; Dave Valko, PA; North American SW Association, 45 Wildflower Road, Levittown, PA 19057

COMPUTER BITS

Disk Partitions and Win95 Gems

BY JEFF HOLTZMAN

According to my mail, many readers are interested in using multiple disk partitions to install and run multiple operating systems on one computer. In the March issue, I discussed my "clean-room" approach, which involved using an external switch to change SCSI IDs of several hard disks. In response to that, embedded-system designer Jim Brain sent me an extended e-mail describing his software-only approach, which might also be useful to some readers. Let's take a look at it.

Jim used FDISK to create 9 partitions, as shown in Table 1, and subsequently uses the OS/2 Boot Manager to select from the bootable choices (DOS, OS/2, Linux, and various flavors of Windows). I'll let Jim speak for himself concerning some of the details of his setup:

"Now, I can run Word in all environments, and the sizes of those environments are specific to my needs. You can put Win95 in 65MB, DOS in 5MB, both Win 3.1 and 3.11 in 20MB, and OS/2 into 50MB pretty easy. NT is big, no matter what.

"This setup allows me to boot anything. Since I am in the same position as you (I actually develop for all of these platforms and have to be able to boot any of them on my box), I did this to simplify my work.

"Both Win95 and NT disable the OS/2 Boot Manager, but you can re-enable it using FDISK. You don't have to reconfigure it, as I recall."

My only *caveat* is that trying to run the same applications from the various partitions can end up seriously confusing those applications. If you're mostly running command-line utilities and simple applications, that might not be a problem. But I had trouble with large Windows apps (*e.g.*, MS Office).

WIN95 SHAREWARE GEMS

It has been almost six months since Win95's formal release, and software developers are starting to catch up. Several programs that I've found useful are detailed below. They can be found on CompuServe, other online services, as well as on the Internet.

DOS Explore (DOSEXP.ZIP) adds to the Explorer a new right-click item that allows you to launch a DOS box in the currently selected directory. The software works with both COMMAND.COM and 4DOS. (By the way: to go the opposite way—from a DOS box to an Explorer window—type "start." at the command line.)

Windows Commander (WINCMD.ZIP) is a Windows adaptation of a DOS classic, the Norton Commander. It's nicely done, although there are some anomalies. The program includes a DOS command line, the ability to ZIP files (using an external ZIP utility), and extensive customization. Unfortunately, the version I checked does not support long file names.

Hot Corners (HOTC.ZIP) is a small utility that allows you to force your screen saver on or off, depending on which corner you push the mouse pointer into.

WinBrowse (WINBRW95.ZIP) adds a right-click item to the Explorer that allows you to browse the selected file with a hexadecimal or text display. It's faster than Windows' QuickView; I use it all the time. Once the program is launched, you can also drag and drop files on the browse window.

Aeco Zip Explorer (ZIPPRO.EXE) is a well-done, Win95 Zip-file manipulator that's more integrated than WinZip. It features an Explorer-type interface showing hierarchical view of files contained in a ZIP. It also has a built-in hex/ASCII viewer.

PowerToys (POWERTOY.ZIP), produced by Microsoft's own Win95 team, is a group of utilities for tweaking the Win95 user interface. The handiest item for me is a one-click resolution changer, which is useful in software development to verify that screens work at various resolutions. It also includes a CD player, and a CAB file viewer. Once installed, the latter allows you to view and extract the contents of the CAB files on the Win95 installation disks (and others) simply by double clicking on the desired file in the Explorer.

Trayicon (TRAYICON.ZIP) allows you to add an icon to the "tray" on the Win95 taskbar. (The tray nominally contains the clock and a few other items.) The icon can represent any executable program. I use it for quick access to a DOS command line. The current version allows multiple icons, but they all run the same app.

ACTS (ACTS.ZIP) lets you synchronize your PC's clock with the National Institute of Standards and Technology (NIST) or United States Naval Observatory (USNO) time source. It can optionally run as a batch program, so you can schedule it to run periodically.

WinGrep (WINGREP.ZIP) is a super-powerful text-search utility, named after the UNIX utility GREP.

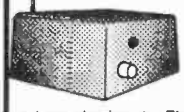
TABLE 1—DISK PARTITIONS

Size MB	Use
10	DOS 6.22
100	Win95
100	OS/2
15	Win 3.1
15	Win 3.11
150	NT
100	Linux
25	Linux Swap
Rest...	Applications

And remember—shareware programs are *not* free! Please register any that you end up keeping. Many good ideas come from the developers who create these programs, and for the shareware concept to continue working, they need our support. ■

RAINBOW KITS

Many of our kits are available completely built



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Listen through walls, hear conversations across the room. Add a parabolic reflector and hear blocks away. The BIG EAR can be hidden about anywhere. Makes an ultra sensitive intercom. Can be used as a 1.5W AMP. We supply a mini-electret mike in the kit. Power requirement 6 to12v DC. SIZE:1.75"x 1"

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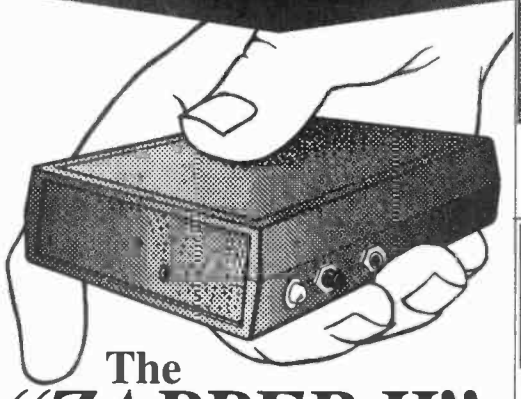

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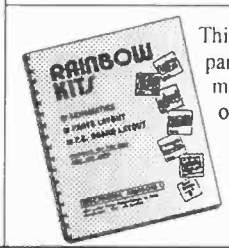

This Manual contains schematics. parts lists & P.C. board layouts for many of the Rainbow Kits. Use your own parts to construct our kits.

KIT BOOK $14.95

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Small but mighty this little jewel will out perform most units many times its price. It really stomps out a signal. The WM-2 kit is a buffered wireless mike that operates from 80MHz to 120MHz FM, the frequency of any broadcast FM radio. Includes a mini-electret mike. 6 to 12v DC. SIZE: 1.25" x 1"

WM-2 KIT $14.95

MICRO-MINIATURE PHONE TRANSMITTER

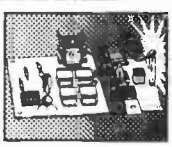
We haven't seen a smaller phone transmitter than the MMPT2 kit. Powered by the phone, it requires no battery. Transmits both sides of a phone conversation to an FM radio up to a 1/4 mile away.Tunable from 88 to 108MHz FM. Attach it to one phone or add it to the line to pick up all incoming calls. The MMPT2 is undetectable if properly installed. Unit has surface mounted parts, you install the leaded parts. Size .45 "x .6"

MMPT2 KIT $29.95

MICRO-MINIATURE WIRELESS MIKE

So small you could hide this one on some real bugs! It's the smallest we've ever seen. With it's super sensitive mike it transmits a whisper or a room of conversation to an FM radio, tunable from 88 to 108MHz FM. With a proper antenna it transmits about 1/2 mile. The kit is made with surface mounted parts, we have already mounted these parts. You install the leaded parts. Power requirement 6 to 12v DC. Size .35"x.9"

MMWM5 KIT $34.95



STROBE LIGHT

Do you need an attention getter, warning light,or flashing light for model airplanes? Then this kit is for you. Use it as an emergency light for your auto, radio tower, even use it on your bicycle. Has a variable flash rate. Power requirement 6 or 12v DC . Size 3.5"x1.9"

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- Decodes digits 0 thru 9, #, *, A, B, C, on a 2 line 16 character LCD display.
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- Records Voice mailbox, answering machines, and modem access numbers.
- Records Cellular or repeater phone numbers heard over your phone. Even hook to a scanner, and learn scores of emergency phone numbers. Also decodes tones stored on a tape recorder. Never before has such sophisticated gear been available to the public. And not at this price.

Power requirement 9v DC.SIZE: 3.5" x 4" x 1" BLACK ANODIZED ALUMINUM CABINET

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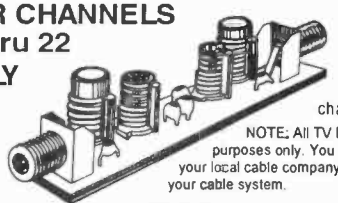

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6A

CIRCLE 137 ON FREE INFORMATION CARD

Think Tank

Workbench Circuits

BY JOHN J. YACONO
TECHNICAL EDITOR
WINDOWS MAGAZINE

This month's letters are from Skip Campisi, an avid reader of, and contributor to, this column and the magazine in general. Because he sent in enough stuff for a full column, we've sent him a kit and an individually packaged, 1967, MCL1010 chip, in addition to a book. We still have chips, kits, and books for other equally ambitious participants. And remember, even if you only have one or two circuits we can use, at least you'll get a book per published circuit.

But before we get to Skip's work, let's continue our tutorial series by exploring the tantalum family of capacitors. Tantalum capacitors come in three styles: foil, wet, and solid. In the foil style, a tantalum-foil strip is used as the anode. The foil is etched to increase its surface area, and placed in a bath that forms a dielectric layer of oxide on the etched surface. That surface is placed in contact with a porous spacer containing an electrolytic solution, which forms the cathode. Sometimes, two layers of foil surround the spacer, forming a non-polarized electrolytic.

The foil design withstands high working voltages (in excess of 300 volts) and high reverse voltages. However, it has a lower capacitance-per-unit volume than the solid and wet tantalum types, so it's the least commonly used of the family.

To make a wet tantalum capacitor, tantalum powder is formed into a porous slug that acts as one plate. Oxide is electroplated inside all the pores to form a dielectric with incredible surface-area-per-unit volume. Then the assembly is sealed in a gel- or liquid-electrolyte bath in a tantalum or silver case. The case acts as the other plate. Such capacitors work at up to 150 volts and display extremely low DC leakage. Also, tantalum-case units can withstand high temperatures and significant ripple current, making them useful in aerospace and other hostile-environment applications.

The solid devices start off the same as the wet ones: a porous tantalum slug is plated with a dielectric oxide. But then the oxide is coated with manganese dioxide—the first step in creating the second electrode. A coating of graphite particles is applied to connect the manganese dioxide in all the pores to form a single electrode. A silver coating is applied to make soldering an electrode easy, and the capacitor is complete.

The enormous surface-area-per-unit volume and high dielectric strength of the tantalum oxide results in a high capacitance in a small package. The solid units can withstand more than 10% of their rated voltage in reverse polarity, and are fairly temperature stable. Also, of the three types, the solid ones are the least expensive

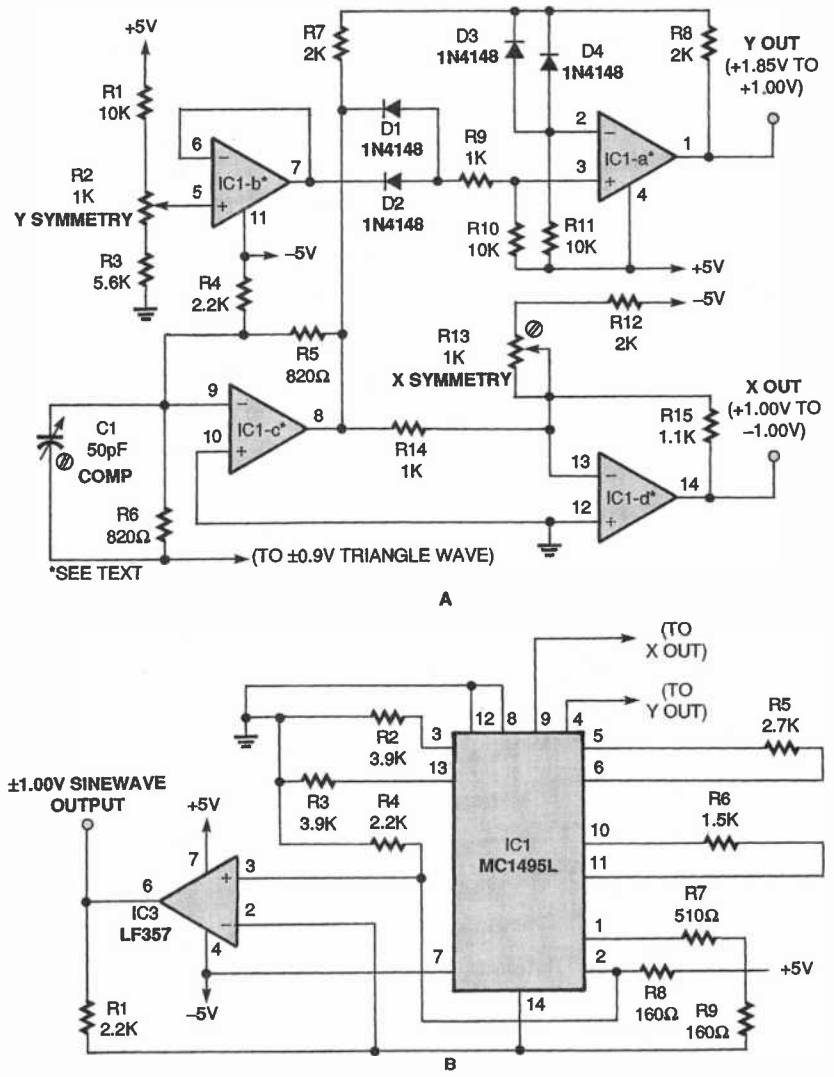
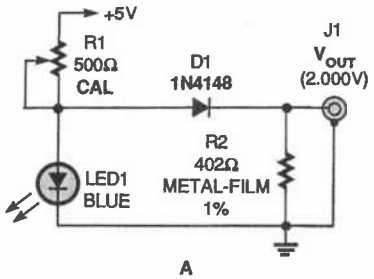


Fig. 1. This sinewave converter (A) will work with an input ±0.9-volt triangle wave. If you need an analog multiplier as well, try this simple circuit (B).



A

D1 (GLASS)	V_F @ 5mA
1N34A	0.37V
1N4148	0.70V

B

LED1 (T1 TYPE)	V_F @ 5mA
INFRARED	1.20V
RED	1.70V
YELLOW	1.85V
GREEN	2.00V
BLUE	2.70V

C

Fig. 2. Want to design your own temperature-stable voltage references? Substituting the desired semiconductors in this circuit makes it possible.

and the most common in hobbyist electronics.

High capacitance in a small package epitomizes the tantalum family. They are often used for AC bypass and coupling in small circuits. While they are fairly temperature stable, the more common types aren't useful in accurate timing circuits because of their dielectric absorption and high leakage.

Now, let's move on to Skip's circuits.

NEW SINE CONVERTER

In the November 1991 issue, you were kind enough to publish my sinewave-converter circuit. I have since decided that a new high-speed design was in order—this latest circuit has a bandwidth greater than 1.0 MHz, using a similar, but more complex approach (see Fig. 1).

This design consists of a level-shifting/absolute-value circuit that drives an analog multiplier chip of your choice. As you can see in Fig. 1A, one quad op-amp, IC1, provides the functions needed to provide the proper X and Y signals to the multiplier. For lowest distortion, use metal-film, 1% resistors throughout, and match the forward voltage drop of the four diodes to within 1%. With the circuit as shown, the input requires a ±0.9-volt triangle wave, but R6 can be changed to accommodate any voltage. Use R2 to set the Y symmetry and R13 to set the X symmetry; C1 can be used to adjust for the best sinewave at 1 MHz.

Integrated-circuit IC1 should be selected for wide bandwidth and high slew-rate: I used a TLE2074 that resulted in a sine output that was down less than 1 dB at 1 MHz. An LF347 resulted in 2-dB output, and a TL084 gave a 3-dB output; an MC34084 might be a good choice, also. Remember, sinewave distortion increases with the slower amplifiers, as the output at IC1-a is double the input frequency! Use short leads when building the circuit.

If you need a good, fast, analog multiplier circuit, refer to Fig. 1B. That circuit uses an MC1495L chip (IC1) configured for a bandwidth that's much greater than 1 MHz. It accepts the input voltages from the circuit in Fig. 1A and converts them to differential output currents, where IC2 (an LF357) provides the single-ended output voltage. Integrated-circuit IC1 is available from Circuit Specialists or DC Electronics. Refer to the February 1993 *Think Tank* column for my "Function Generator" circuit if you need a 1-MHz triangle-wave generator.

—Skip Campisi, So. Bound Brook, NJ

Excellent work! You've squeezed a lot out of three ICs, especially the quad op-amp. A unity-gain buffer, voltage follower, active rectifier, and amp, all out of one chip, should help keep distortion low.

SIMPLE REFERENCE

Here's a simple method to design your own cheap, temperature-stable voltage references. If you have a good stock of LEDs and small-signal diodes, you're ready to start right now!

Using the schematic diagram in Fig. 2A as an example, first select a diode from the choices in Fig. 2B and an LED from those in Fig. 2C so that the forward voltage difference of both

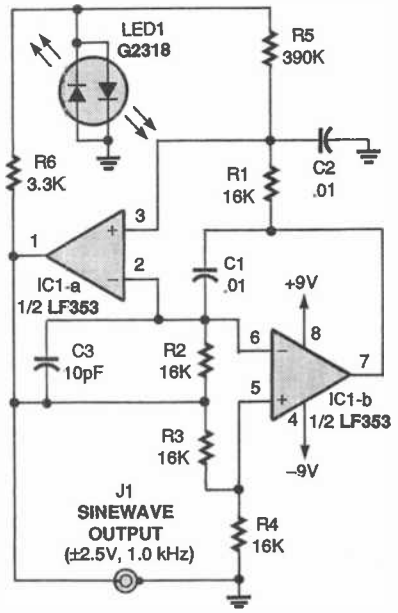


Fig. 3. Here's an L/C oscillator without the L. The inductance is provided by IC1, R1-R4, and C1.

semiconductors is close to the required output voltage. The diodes listed all have temperature compensations in the range of -1.8 to -2.0 mV/°C, so you can mix-and-match as needed. I wanted a 2.000-volt output, so I used a silicon-carbide blue LED (forward drop of 2.70 volts) and a 1N4148 silicon diode (0.70-volt drop).

Resistor R2 (402 ohms) was selected to draw 5 mA at 2.0 volts. Trimmer-potentiometer R1 was selected to drop 2.3 volts (5.0 volts minus 2.7 volts) at 10 mA, as each diode was to draw 5 mA; that would make R1 about 230 ohms, so I used a 500-ohm unit for the potentiometer. You can use any current the diodes can handle to achieve the proper voltage difference, but have each diode pass at least 2 mA to stay above their "knee" voltage. Below the knee, the temperature compensation begins to degrade. The example circuit showed less than +0.1 mV/°C temperature compensation; not too shabby!

Install the parts on a breadboard for fine tuning. Most 3-terminal, fixed-voltage regulators, such as the 78L05, have temperature compensations of about ±0.01%/C, which makes them excellent current sources for your reference. Carefully adjust R1 and trim R2, if needed, to obtain your desired output. Once you're satisfied, solder

D1 and R2 right onto LED1, so that you have a nice compact package. Pot the assembly in clear epoxy for best heat transfer among components and it's ready to use!

By the way, blue T1-case LEDs are available for less than $1.50 from Marlin P. Jones & Associates. Call 407-848-8236 for their catalog.

—Skip Campisi, So. Bound Brook, NJ

That is pretty cool. I've used diodes as voltage references before, but just by stringing them together; no temperature compensation in mind. That is a great technique for more sensitive applications. By the way, potting the components with epoxy after thermally connecting the diodes together with heat-sink grease might improve temperature compensation a tiny bit.

"L/C" OSCILLATOR

The simple circuit in Fig. 3 provides ultra-stable, low-distortion (0.3% THD at 1.0 kHz) sinewaves when built with quality metal-film resistors and poly-film capacitors matched to about 1%. However, even 5% components give similar results with a loss in frequency stability over temperature.

Looking at the schematic, you'll notice that there's no inductor in the "L/C" oscillator! The inductance required for oscillation at 1.0 kHz with a 0.01-μF capacitor is about 2.5 H—that's not available at Radio Shack. Instead I used a simulated inductor composed of IC1 (an LF353 op-amp), R1-R4, and C1. Those components provide an inductance, L, as follows:

$$L = C1 \times R2$$

where R1 through R4 (all equal R values) were selected to equal C1's reactance at 1.0 kHz. By adding C2 to the "inductance," you then have a tuned L/C circuit, and by applying positive feedback, the result is an L/C oscillator. Note that C2 is equal to C1 in value.

The heart of the circuit is LED1, a dual-element infrared LED, which is available from Electronic Goldmine (Tel. 602-451-7454), as part number G2318, at a cost of 3 for a $1. Both elements are matched within 1 millivolt, and the package has two long leads that you short together to form one terminal, and one stubby lead used for the other terminal. Of course, you can fabricate LED1 from two standard infrared LEDs if so desired.

The LED functions as a hard limiter to provide a squarewave to the tuned filter circuit, which has a Q of 25 (R5/R1). The Q can be raised to a maximum of about 100 for even lower distortion if desired, and the frequency can be changed by using different-value capacitors for C1 and C2. At a frequency below 100 Hz, you might have to reduce the Q to ensure start-up.

—Skip Campisi, So. Bound Brook, NJ

I've seen gyrator circuits that replace inductors, but this is something special. I suppose you could use the diode trick presented in your last letter to improve the accuracy of the LED1 section in the circuit.

DELAYED SWEEP ADAPTER

If you're like me and don't want to fork out that extra $200 or $300 for an oscilloscope with delayed sweep, then my Delayed Sweep Adapter is for you (see Fig. 4). The DSA will let you observe any part of any type of waveform on your scope. The minimum pulse width required for triggering is about 25 to 50 nanoseconds, and the duty cycle can go below 0.1%, depending on how bright the trace is and how much jitter is in the input signal.

The input to the DSA comes from your scope's channel-one output, through a 50-ohm cable terminated with a 50-ohm load (R1). The input to IC1 (LM360) has to be limited to ±5 volts, so check your scope output—

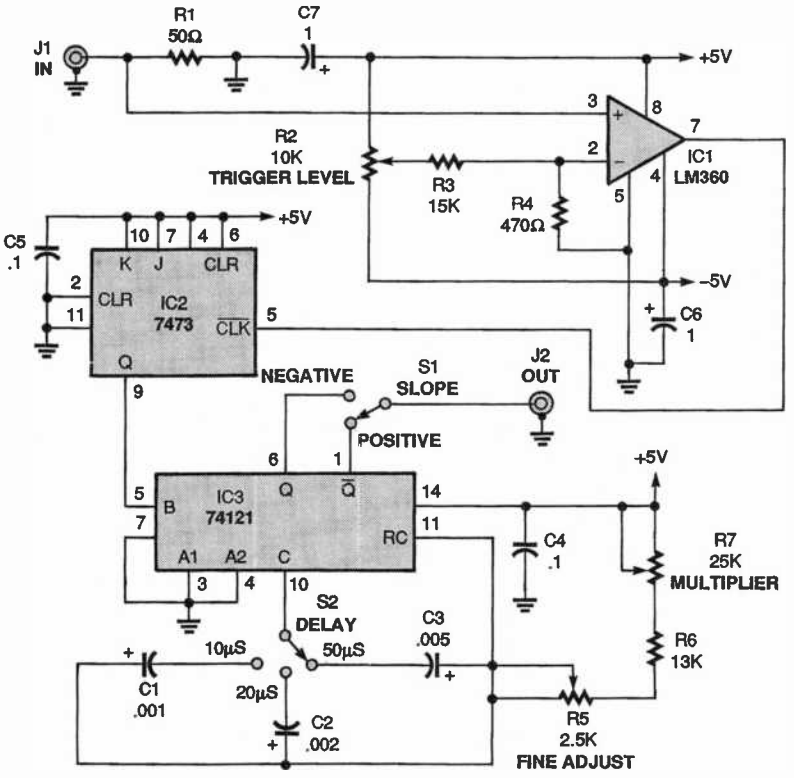


Fig. 4. Building this delayed sweep adapter could squeeze some expanded capabilities out of an older oscilloscope, or make an inexpensive one seem worth hundreds of dollars more.

mine puts out 25 mV/division, so the maximum input will only be 200 mV into 50 ohms. The output from the DSA goes through another 50-ohm cable (un-terminated) to the trigger input on your scope. Integrated circuit IC1 is a fast comparator that level-shifts the input to TTL logic levels, IC2 is a J/K flip-flop, and IC3 is a mono-

stable multivibrator.

Only three positions are shown on the delay switch, S2, but you can use as many as you want. Use the following formula:

$$C = t/10^4$$

where C is the value in farads of the capacitor used, and t is the time in seconds.

Label the center position of R2 "0 volts" and the center position of R5 "Calibrated." You should also label R7 "×1.0" to "×2.8" (*i.e.*, "×1.0" = 0.0 ohms, "×2.0" = 14.3k, etc.). That will help you set things up for fast pulses.

To use the DSA on narrow pulses, set your scope to internal trigger and display 2 or 3 cycles, noting the time period. Set S2 and R7 to match the time period, leaving R5 (the fine adjust) at mid position. Set S1 (the slope) to match your scope slope and switch your scope to its external-trigger mode. Adjust R2 (the trigger level) on the DSA for a steady trace, and reduce the multiplier setting, using R7, until you see a full pulse at the extreme left side of your screen. Now you can increase sweep speed while adjusting R5 and R7 to keep the pulse centered. Other types of waveforms can likewise be observed, using all of the variable controls to select any part of the waveform.

This project has to be built into a shielded cabinet, and all signal leads should be kept as short as possible, especially around IC1. Jacks J1 and J2 should be BNC connectors. Use good quality components throughout for the best stability.

—Skip Campisi, So. Bound Brook, NJ

This is an excellent addition to old scopes or to today's less expensive models.

Well, that's all for this month. Remember, if you submit enough suitable stuff for a column, you stand to win a kit, and a 1967 MCL1010 chip in addition to the usual book. Even if you only have one circuit, send it in; it could earn you one of our books. Send your circuit schematics and descriptions to *Think Tank*, **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735. ■

DX LISTENING

(continued from page 59)

Obviously, to that distant audience, you can add North American C&W enthusiasts, such as George and Bill. As this is written, the two-hour-long The CURB Country Showcase was being aired Monday through Friday, 1800 to 2000 UTC, on WWCR's frequency of 12,160 kHz. It is repeated from 0700 to 0900 UTC, on 5,065 kHz. WWCR's programming hours do change occasionally. So if you fail to find the program at those times and frequencies, give WWCR a call at 615-255-1300 for an updated schedule.

DOWN THE DIAL

Here are some SW goodies you might wish to tune. Times, as always, are in Universal Coordinated Time (UTC), which is equivalent to Eastern Daylight Time plus 4 hours, CDT plus 5, MDT + 6, or PDT + 7.

ALGERIA—15,205 kHz. *Radio Algiers International* signs on with English programming here, and on the parallel frequency of 11,715 kHz, at 1800 UTC, with national anthem, identification, news, and music.

ANGOLA—9,535 kHz. *Radio Nacional* in the African capital of Luanda has English news at 2000 UTC, followed by popular music. That station switches to Portuguese programming at 2100 UTC.

BOTSWANA—7,255 kHz. Africa's *Radio Botswana* operates in English on this frequency, and 3,356 kHz, at about 0300 with pop music.

BRAZIL—6180 kHz. *Radio Nacional da Amazona* is heard, and in parallel on 11,780 kHz, after 0915 with Brazilian pop music and the Portuguese language news show, "Jornal Nacional."

EQUATORIAL GUINEA—15,185 kHz. From this island country off the west coast of Africa, *Radio Africa* sells air time to a wide variety of English-language religious-program producers. Tune this one in at around 1730 UTC.

IRELAND—12,160 kHz. *Radio Telfis Eireann*, the national broadcaster of Ireland, has returned to SW for the first time in decades. But these transmissions are not from the "*Auld Sod*," but, rather, are relayed from U.S. shortwaver, WWCR, Nashville, TN. Times for those programs are 1930-2000 UTC, weekdays, and half hours from 2000 UTC, Saturdays, and 2100 UTC, Sundays.

MEXICO—2,390 kHz. *Radio Huayacocotla*, a rural Mexican broadcaster on this very-low SW frequency, is sometimes heard here with Spanish programming, including music and personal messages. It identifies as "en Antena Huayacoctla" around 0000, or midnight UTC.

MYANMAR—4,725 kHz. *Radio Myanmar* in what most of us still think of as Burma, broadcasts to local audiences. It has been heard in mid-America, at around 1100, with Asian music and talk.

NICARAGUA—5,770 kHz. *Radio Miskut*, a station serving the Indian population of eastern Nicaragua, has been reported with Spanish programming and Latin pops until its 2341 sign off.

SENEGAL—7,170 kHz. *Radio Senegal*, a west-African broadcaster, puts a good signal into the eastern U.S. during the 2100 to 2200 time slot.

SLOVAKIA—9,440 kHz. *Adventist World Radio* programs in English, French, and Arabic are transmitted via Slovakian transmitters at Rimavska-Sobota from 2000 to 2300. That prolific worldwide religious broadcasting organization is 25 years old in 1996.

SURINAM—4,990 kHz. *Radio Apintie* can be heard evenings to 0400 UTC. That station on the Northeast "shoulder" of South America, was noted with easy-listening music and identifications in both Dutch and English.

VENEZUELA—4,830 kHz. *Radio Tachira*, with some great Latin-America music, is reported during the early mornings, around 1045 UTC, on this frequency. Programming, of course, is in Spanish. ■

CIRCUIT CIRCUS

More Diode Circuits

BY CHARLES D. RAKES

In our last visit, we were deep into circuit applications using the diode when we ran out of space. So we'll continue this month with even more diode circuits. Just because the diode seems like such a simple component, don't let its usefulness pass you by. Electronics as we know it would be crippled greatly if it were not for the versatile semiconductor diode.

CLAMPING CIRCUITS

Our first two diode circuits, shown in Fig. 1, each use a single 1N914 silicon diode to clamp either the positive

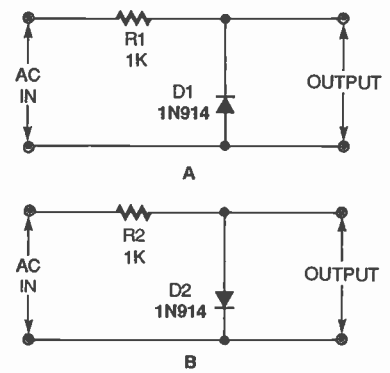


Fig. 1. The circuit in A clamps the negative half of an AC waveform to zero, leaving only the positive half cycles. The circuit in B does the same, except it clamps the positive half cycles.

or negative portion of an AC signal. The negative half is clamped to ground in Fig. 1A and the positive half in Fig. 1B.

PROTECTIVE CIRCUIT

In our next two circuits, shown in Fig. 2, the diode is used as an electronic guard to protect equipment or circuitry from reverse-voltage damage. Here's where a buck spent for a power diode can save mega bucks in equipment repair. The circuit in Fig. 2A connects between a negative-ground DC power source and its load. Unlike the case where a power diode is placed in series, this circuit does not produce a

PARTS LIST FOR THE CLAMPING CIRCUITS (Fig. 1)

D1, D2—1N914 silicon diode
R1, R2—1000-ohm, ¼-watt, 5% resistor
Wire, solder, etc.

forward voltage drop and the full voltage is fed to the load. If for some reason the voltage is reversed D1 will conduct, blowing F1 and protecting the load circuitry. The circuit in Fig. 2B is

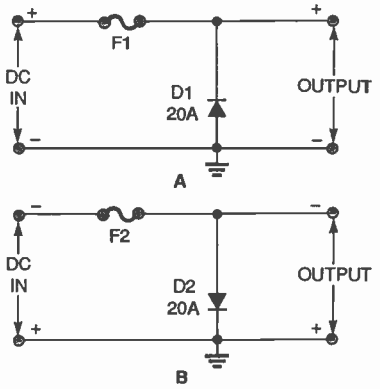


Fig. 2. Use these circuits to protect against damage due to reverse polarity. The circuit in A is for a negative ground; the one in B for a positive ground.

similar to the one in Fig. 2A, except that it is used to protect a positive-ground circuit. The diodes used for D1 and D2 are not critical, but should be rated for at least 20 amps and 100 volts.

METER GUARD

Continuing in the protective mode, the circuit in Fig. 3 will help a meter keep its cool and its needle true and straight. Diodes D1 and D2 are connected back-to-back to limit the maximum voltage that can reach the meter.

PARTS LIST FOR THE PROTECTIVE CIRCUITS (Fig. 2)

D1, D2—20-amp, 100-volt, silicon diode, see text
F1, F2—10- to 15-amp fuse
Wire, solder, etc.

D1 protects the meter from a normal-polarity overvoltage input and D2 keeps a reverse input voltage from rapping the meter's needle in the reverse direction.

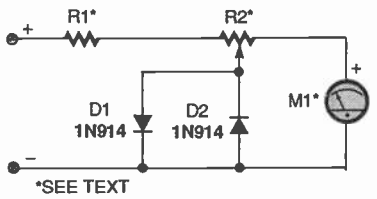


Fig. 3. This circuit uses a couple of inexpensive diodes to protect a more expensive meter.

Note that when a meter is connected in a circuit to measure voltage, a single resistor is usually connected in series to set the maximum meter current to indicate a full-scale reading at the desired full-scale input voltage. For the diodes to protect the meter, that resistor will need to be split into two separate units as shown in Fig. 3.

The values of the resistor, R1, and the potentiometer, R2, will depend on the meter and the application, though the following guidelines will help you make the appropriate selection: The

PARTS LIST FOR THE METER GUARD (Fig. 3)

R1, R2—See text
D1, D2—1N914 silicon diode
M1—Meter, see text
Wire, solder, etc.

value of the potentiometer, R2, must be large enough to produce about a 1-volt drop across it when the meter reads full scale. The total resistance value of R1 plus R2 should be selected to let the meter read full scale at its rated input voltage.

Adjusting the protection circuit is easy. Set R2's wiper for maximum resistance and connect the circuit to a variable DC power source. Raise the input voltage until the meter reads full

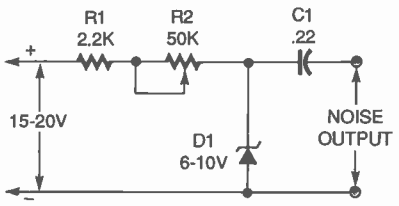


Fig. 4. Zener diodes have lots of applications, but here one is used in an uncommon way—as a noise generator.

scale. Now increase the input voltage about 10% to 20% above the full-scale reading; the meter's needle should then be against the peg. Reduce the resistance of R2 until the meter's needle just comes off of the peg and you are all set.

NOISE GENERATOR

Our next entry, see Fig. 4, uses a Zener diode in a noise-generator circuit. While that's not their usual application, Zeners generate a broadband noise signal under certain situations. Potentiometer R2 adjusts the noise generator for the desired output. Just about any 6- to 10-volt Zener can be used for D1. If you have a number of junk-box Zeners try each in the circuit until you find the one that produces the maximum noise output.

PARTS LIST FOR THE NOISE GENERATOR (Fig. 4)

D1—Zener diode, 6 to 10 volt, see text
C1—0.22-µF, ceramic-disc capacitor
R1—2200-ohm, ¼-watt, 5% resistor
R2—50,000-ohm potentiometer
Wire, solder, etc

SYMMETRY MONITOR

An AC-waveform symmetry-monitor circuit is shown in Fig. 5. Here diodes D1 and D2 are operating as rectifiers with opposing outputs feeding a zero-center, 100-µA meter. Capacitor C1 removes any DC content from the input signal source.

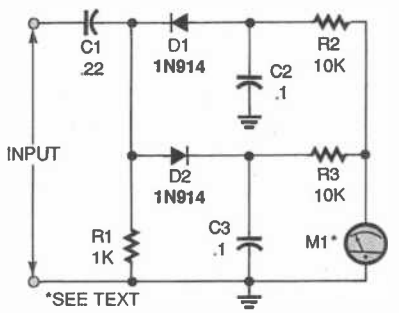


Fig. 5. This simple circuit can be used to monitor the symmetry of an AC waveform.

PARTS LIST FOR THE SYMMETRY MONITOR (Fig. 5)

D1, D2—1N914 silicon diode
C1—0.22-µF, ceramic-disc capacitor
C2, C3—0 .1-µF, ceramic-disc capacitor
R1—1000-ohm, ¼-watt, 5% resistor
R2, R3—10,000-ohm, ¼-watt, 5% resistor
M1—100-0-100-µA, center-zero, meter
Wire, solder, etc.

When a symmetrical waveform is fed to the circuit the output voltage of both rectifiers will be the same but opposite in polarity. Under those conditions the meter will read zero, or center scale. If the signal is non-symmetrical, the meter will read off zero by the polarity and the amount of error in the symmetry of the waveform.

AMPLIFIED NOISE GENERATOR

Our second noise generator, shown in Fig. 6, adds a single-stage transistor amplifier to the Zener circuit to increase the output noise level.

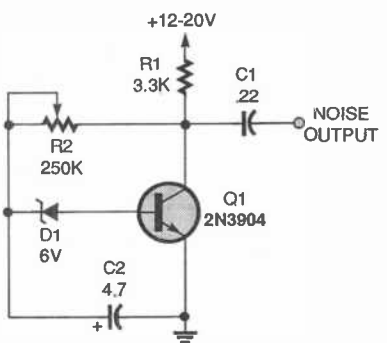


Fig. 6. For even more noise, use this amplified version of the Zener-based noise generator.

Depending on which Zener you select, the output can be as much as ten volts peak-to-peak. Once again, R2 is used to set the noise output level.

RF SWITCHING CIRCUIT

Figure 7 shows a simple diode-based RF switching circuit. When switch S1 is closed, the circuit feeds the RF output of a transmitter to an antenna through the two forward-biased diodes. The DC current path that causes D1 to conduct flows through S1, R1, L2, and L1. Diode D2's current flows through S1, R1, L2, and L3. In that condition the two diodes look like a closed switch to the RF signal, allowing it to pass on to the antenna with almost no power loss. When S1 is open, both diodes are in the off state, allowing no RF to flow through to the antenna.

PARTS LIST FOR THE AMPLIFIED NOISE GENERATOR (Fig. 6)

D1—Zener diode, 6-volt, see text
Q1—2N3904 NPN transistor
C1—0.22-µF, ceramic-disc capacitor
C2—4.7-µF, 16-WVDC, electrolytic capacitor
R1—3300-ohm, ¼-watt, 5% resistor
R2—250,000-ohm potentiometer
Wire, solder, etc.

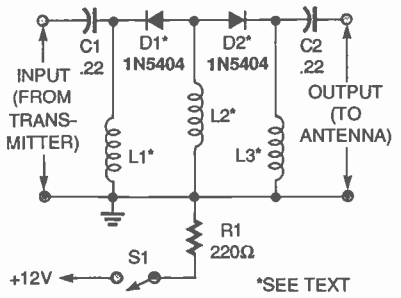


Fig. 7. Closing switch S1 lets the input signal (from a transmitter) to reach the output and be fed to an antenna.

The values of the RF chokes, L1-L3, are not critical but should be selected for the frequency range used. The inductive reactance of the chokes should be at least ten-times greater than the circuit's 50-ohm input/output impedance. If the reactance is too low, some of the output power will be dissipated in the chokes and will not make

PARTS LIST FOR THE RF SWITCHER (Fig. 7)

D1, D2—1N5404 or similar 2-amp, 400-volt silicon diode
C1, C2—0.22-µF, ceramic-disc capacitor
R1—220-ohm, 1-watt, 10% resistor
L1-L3—100- to 250-µH RF choke, see text
S1—SPST switch
Wire, solder, etc.

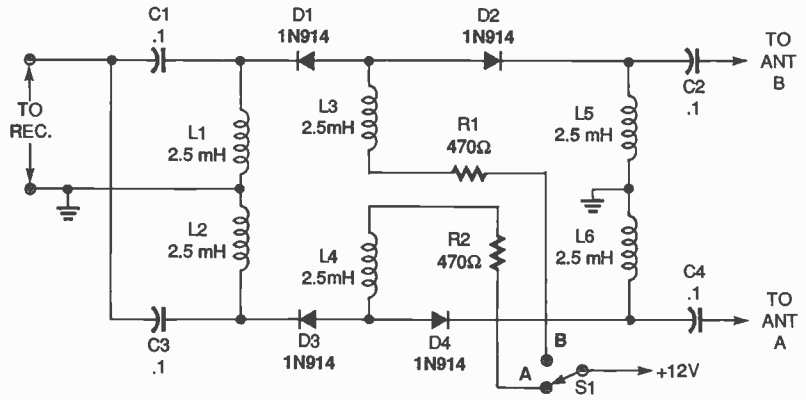


Fig. 8. This antenna switch lets the user select whether antenna A or B is connected to a receiver.

it to the antenna. The diodes should be rated for 2 amps and 400 volts.

ANTENNA SWITCHER

Our next diode switching circuit, shown in Fig. 8, builds on the principles of the previous circuit to create an antenna switcher that operates without placing a relay or mechanical switch in the RF path. With S1 in the A position, diodes D3 and D4 are biased on through R2, L1, L4, and L6 to allow signals from antenna A to reach the receiver. When S1 is in position B, current flows through R1, L1, L3, and L5, turning D1 and D2 on and allowing the receiver to use antenna B.

PARTS LIST FOR THE ANTENNA SWITCHER (Fig. 8)

D1-D4—1N914 silicon diode
C1-C4—0.1-µF ceramic-disc capacitor
R1, R2—470-ohm, ¼-watt, 5% resistor
L1-L6—2.5-mH RF choke
S1—SPDT switch
Wire, solder, etc.

TRANSCEIVER SWITCH

Our next diode-based RF switching circuit, and our last circuit for this visit, is shown in Fig.9. That circuit switches both the transmitter and receiver circuitry to the antenna at the proper time for high-speed transmit/receive operation. In the receive state, transistor Q1 receives no forward bias and is turned off with its collector high, allowing Q2 to be biased on. Transistor Q2's collector is pulled low and Q3, a PNP transistor, is turned on supplying current to diodes D1 and D2 through L1, R6, and R7. That completes the RF path from the antenna to the receiver through C5, C2, D1, D2, and C3.

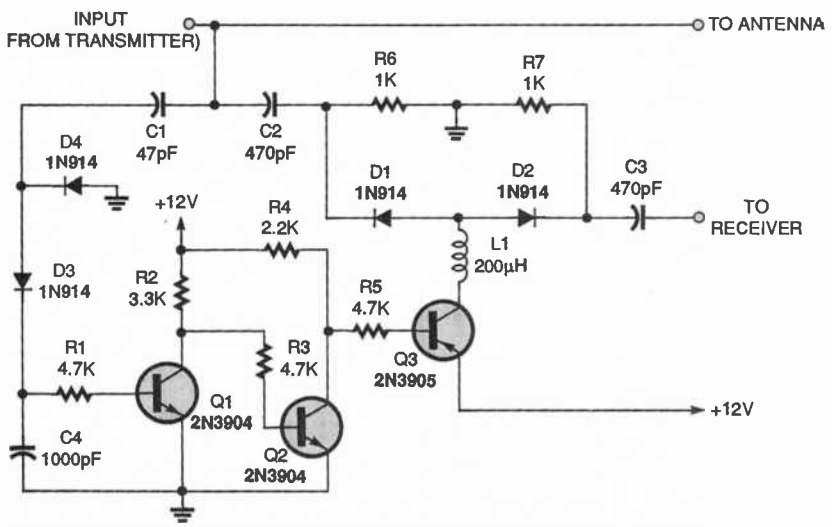


Fig. 9. This switching circuit automatically routes the antenna to either the receiver or transmitter as appropriate.

PARTS LIST FOR THE TRANSCEIVER SWITCH (Fig. 9)

SEMICONDUCTORS
D1-D4—1N914 silicon diode
Q1, Q2—2N3904 NPN transistor
Q3—2N3905 PNP transistor

RESISTORS
(All resistors are ¼-watt, 5% units.)
R1, R3, R5—4700-ohm
R2—3300-ohm
R4—2200-ohm
R6, R7—1000 ohm

CAPACITORS
C1—47-pF, ceramic-disc
C2, C3—470-pF, ceramic-disc
C4—1000-pF, ceramic-disc

ADDITIONAL PARTS AND MATERIALS
L1—200-µH choke
Wire, solder, etc.

When the transmitter kicks in, diodes D3 and D4 receive a sample of the RF through C1, producing a positive voltage at the base of Q1 turning it on and Q2 and Q3 off. With Q3 off, diodes D1 and D2 are no longer conducting and the receiver is switched out of the RF path. The transmitter's RF then goes to the antenna.

Well, that's all for now. We hope that the elementary diode circuits that we've covered in this and last month's Circus have helped to illustrate just how useful and necessary that solid-state device really is. See everyone again next month. ■

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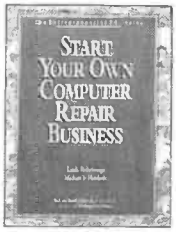

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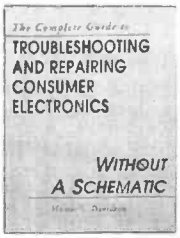

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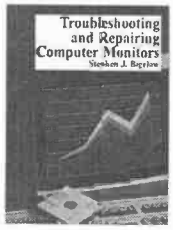

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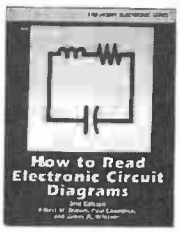

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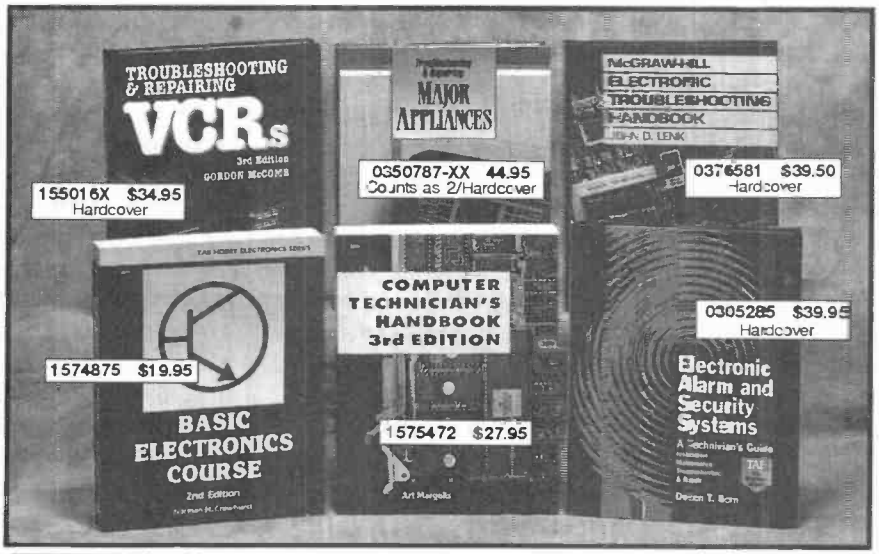

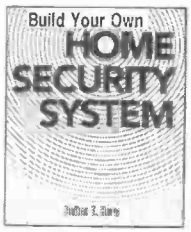

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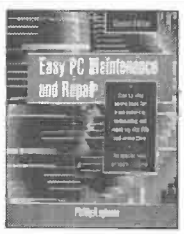

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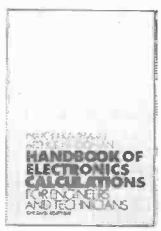

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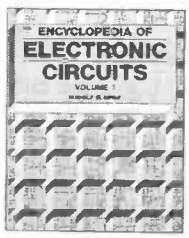

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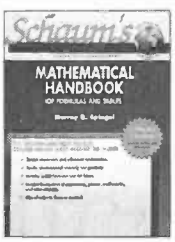

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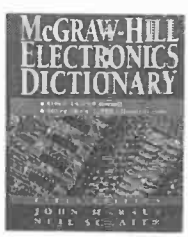

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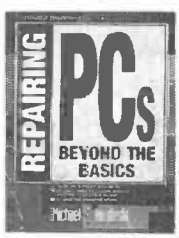

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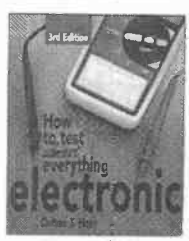

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More on Antenna Topics

BY JOSEPH J. CARR, K4IPV

Low-frequency antennas remain a problem for most amateurs. Unless you own a huge amount of real estate, then it's unlikely that you will be able to put up an optimum antenna for the low-frequency bands. For example, in the middle of the 75/80-meter (3.5-4.0 MHz) band, a half-wavelength dipole is 125 to 133 feet long. On 160-meters (1.8 MHz), the same antenna runs down the block a good distance—260 feet or more! Similarly, have you noticed that verticals get tall on those frequencies? It takes more than 60-feet on 75/80-meters, and 130-feet for 160-meters, to make a quarter-wavelength vertical.

Figure 1 shows one option for the "low-end" of our HF spectrum, although it is not problem free. That antenna is called the "coaxial-tee" antenna. There are two ways to make it. One way uses a half-wavelength dipole cut to the next higher harmonically related band. For example, as a Novice class ham in 1959, I used a 40-meter dipole on 80-meters CW by tying the inner conductor and the outer conductor of the coaxial cable together (as in Fig. 1), and then connecting it to the output of an antenna tuner. In that case, dimension "A" is half wavelength on the higher band (*e.g.* make A = 66 feet for 40 meters, and then operate on 75/80), and dimension "B" is ignored.

The trouble with that arrangement is that harmonics of your transmitter look into a resonant antenna that is just aching to radiate their energy into other people's territory! Be sure to use a resonant antenna tuner (not a "line-flattener" type that's actually a kind of high-pass filter), and use a low-pass filter that has a cut-off frequency between the two bands.

The other approach is to use the coaxial cable as part of the antenna system (Fig. 1 still applies). In that case, "A" is still a half wavelength, but so is dimension "B" (keeping in mind the foreshortening due to the velocity factor (V) of the coax (*e.g.* $L_{FEET} = 492V/f_{MHz}$)).

Another option is shown in Fig. 2. That antenna is made of either 300-ohm or 450-ohm twin-lead. It consists of a horizontal section ("A") and a vertical section ("B"). The vertical section should be as vertical as possible, consistent with installation realities. That antenna will work on two bands, either 160 and 75/80 meters, or 75/80 and 40 meters. The dimensions for the antenna are given in the Table 1.

Those antennas don't work as well as a real dipole placed high and away from everything else, but when the issue is getting on the air or watching *Geraldo*, then they are more than good enough.

MORE ON ANTENNA ZONING

In a past column, I discussed zoning problems and mentioned the preeminence of the Federal Communications Commission's PRB-1 (erroneously called PRC-1 by me) rule in which it takes sole jurisdiction for antennas of licensed stations, except for reasonable and proper mechanical and electrical requirements. In other words, the existence of the tower or antenna is the business of the FCC, while local and state authorities may place certain reasonable engineering requirements on the installation in order to assure safety (lightning grounding, guys, height restrictions, etc.). A lawyer wrote to me informing me that some recent court decisions have weakened PRB-1 to some extent, and warned that amateur-radio operators need to be perpetually alert to problems in their local government. Or, alternatively, one could opt for the Massachusetts solution. According to a source, Massachusetts Governor

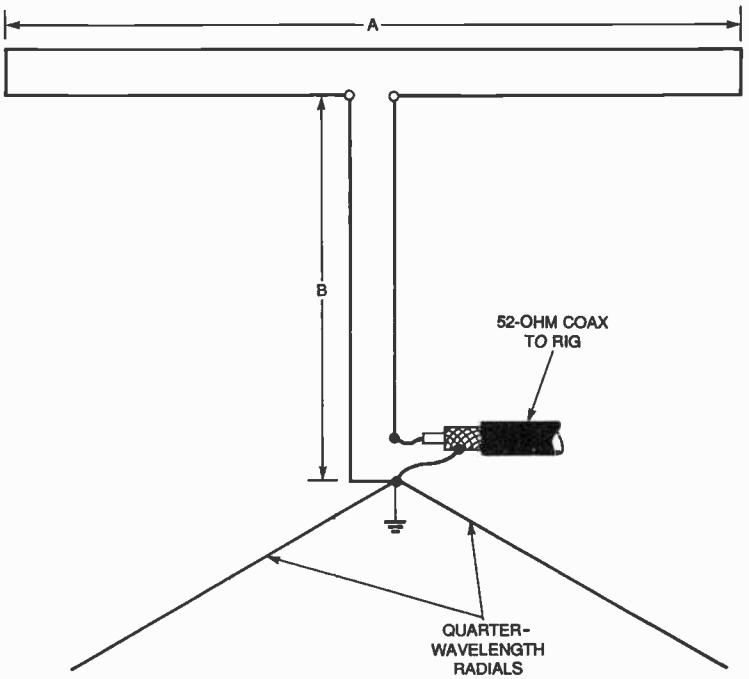


Fig. 1. This coaxial-tee antenna can be used in a couple of different ways . . . just watch out for harmonics!

TABLE 1

BAND (Meters)	DIMENSION A	DIMENSION B
160 and 75/80	70 feet	52 feet
75/80 and 40	35 feet	26 feet

Weld signed bill H-2782 into law. It states that no zoning ordinance or bylaw may prohibit antennas of federally licensed amateur-radio stations. The law allows local ordinances and bylaws to regulate the antenna structure for purposes of health and safety, provided that the regulation is ". . . the minimum practical regulation necessary to accomplish the legitimate purpose of the city of town enacting the legislation." The law also provides that the regulation must allow sufficient height ". . . to effectively accommodate federally licensed amateur radio operators . . . ." practical" are golden opportunities for lawyers to litigate. Also, what does "health" and "safety" mean? Do reports in the popular media distorting the scientific data on the effects of electrical and magnetic fields on humans constitute a reasonable threat to health and safety, and therefore make it legal to restrict ham-radio operations?

Although some progress has been made with respect to homeowners associations in townhouse and condo developments, those rules still nettle many ham operators. If you can't afford to sue the pants off the homeowners association, and make yourself a pariah, then try running for office in the association and lobby to get some of the rules changed. The ham-radio lesson in this little diatribe is that you could conceivably run into difficulties with your antenna, despite your FCC license. Either your neighbors or the local government could wreak havoc with your hobby and your wealth . . . so keep the peace as best you can . . . and be politically active. ■

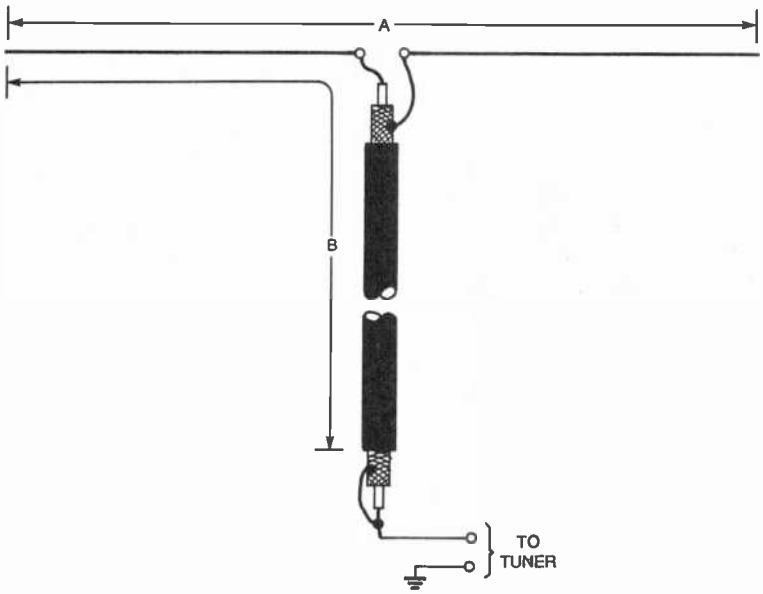


Fig. 2. The twin-lead, low-frequency tee antenna will work on two bands. The dimensions can be found in Table 1.

Sounds pretty good, huh? Well, maybe . . . and that's a big maybe once you learn how politicians and lawyers (not to mention neighbors who want you off the air) think. There are enough weasel words in the law to keep you in court for years if you run afoul of some local problems.

I talked to a friend of mine who is both a ham and a lawyer. He pointed out several problems. Ambiguous words like "sufficient" and "minimum

New Products

NiCd/ALKALINE BATTERY CHARGER

Saitek calls its *Eco Charger* a "fountain of youth for old batteries." The battery charger will help reduce the amount of batteries used by consumers and relieve the stress on the environment caused by batteries that are used once and then tossed away.

The Eco Charger is designed for use with standard household batteries. Its microchip technology determines the exact charge necessary to revitalize ailing batteries and bring them back to their peak efficiency levels. Each battery is analyzed to determine the amount of charge required, whether the battery can be recharged, and the maximum length of time needed for recharging. The device has been independently tested for safety, and will not overcharge.

The Eco Charger's bay holds four different or same-sized batteries for simultaneous charging. Each of the four charging beds has an adjustable arm that allows AAA, AA, C, and D batteries to fit. With the flip of a switch, the Eco Charger will accept either regular alkaline or rechargeable nickel-cadmium batteries. All the information needed by the user appears as symbols on the LCD screen.

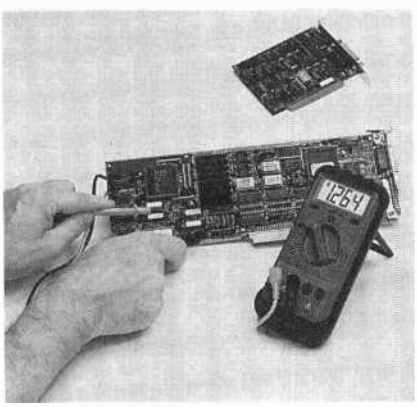
According to Saitek, the Eco Charger will increases the net worth of a $5 set of batteries to $30 by increasing their life. For instance, a person who uses a Walkman-type cassette player for two hours a day would go through 19 sets of batteries, with an approximate price of $95, over the course of a year. With the Eco Charger, only three sets of batteries—at a total cost of $15—would be needed. It costs less than a penny to recharge a battery using the Eco Charger.

The Eco Charger has a suggested retail price of $59.95. For further information, contact Saitek Industries, Ltd., 2295 Jefferson Street, Torrance, CA 90501; Tel. 800-452-4377.

CIRCLE 80 ON FREE INFORMATION CARD

DIGITAL MULTIMETER/ COMPONENT TESTER

In addition to providing the features you'd expect from a digital multimeter—such as measuring volts, amps,



and ohms—*Wavetek Corporation's DM16XL* also measures frequency and capacitance, and has logic-, transistor-, continuity-, and diode-test functions. Measuring functions include AC and DC voltage to 600 volts, current to 10 amps, resistance ranges from 200 ohms to 20 megohms, capacitance to 20°F, frequency counting to 15 MHz, transistor gain, and CMOS and TTL logic tests. The DM16XL has applications in circuit-design testing, appliance verifications, incoming component inspection, computer troubleshooting, photocopier repair, Fax troubleshooting, and security-system installations.

For user convenience, the instrument offers data hold, which freezes the reading on the display for later evaluation. It also has the largest LCD readout in its class, with 0.7-inch-high numerals. The DM16XL is lightweight, compact, easy to carry, and comes with an operator's manual, test leads with alligator clips, a battery, and an extra fuse.

For user safety, the DM16XL's test leads are shrouded in plastic to eliminate the possibility of shock. Incorrect test-lead placement will cause the DMM to issue a warning beep. The meter also features a fused 10-amp current jack, which is normally found only in expensive meters. The DM16XL meets IEC 1010-1 and UL3111 standards.

The DM16XL digital multimeter/ component tester costs $99.95. For more information, contact Wavetek Corporation, Instruments Division, 9045 Balboa Avenue, San Diego, CA 92123; Tel. 619-279-2200; Fax: 619-565-9558.

CIRCLE 81 ON FREE INFORMATION CARD

DBS SURGE PROTECTOR

Designed specifically for use with Direct Broadcast Satellite (DBS) systems, the *Powermax DBS* from *Panamax* features guaranteed lifetime protection with a catastrophic surge

circuit that prevents damage during massive surges, including lightning strikes. It also provides an up-to-$25,000 warranty on properly connected equipment.

The Powermax DBS offers a master on/off light, plus filtration of electromagnetic and radio frequency interference (EMI/RFI), and 480 joules of energy dissipation. It includes a 330-volt UL 1449 rating, a 200-volt clamping level, and instantaneous response time.

The surge protector comes with one set of low-voltage coaxial connectors for rooftop antennas or cable, and a set of high-voltage coax protectors to safeguard the satellite signal. There are also RJ-11/45 modular jacks that provide automatic disconnects from the telephone line under surge and sneak current conditions, with an automatic reconnect when fault conditions are no longer present.

The Powermax DBS costs $99 in the United States and $139 in Canada. For more information, contact Panamax, 150 Mitchell Blvd., San Rafael, CA 94903; Tel. 415-499-3900 or 800-472-5555 (U.S.) or 800-443-2391 (Canada); Fax: 415-472-5540.

CIRCLE 82 ON FREE INFORMATION CARD

CLAMP-ON POWER METER

Extech's Model 382090 clamp-on power meter measures true, apparent, and reactive power, as well as the power factor, without interrupting circuit connections. It can be used to monitor load demands, perform preventive maintenance checks, capture and record current surges, and perform surveys to understand power costs.

The meter measures current, voltage, resistance, continuity, and frequency with autorange or manual-range selection for voltage and current. It displays true RMS, average, surge, max/min, and crest factor on a large, 3500-count, 0.8-inch LCD readout. The surge mode captures and retains current readings. The clamp jaws open to two inches. Batteries, alligator clips, test leads, and a pouch case are included with the meter.

The Model 3828090 clamp-on power meter costs $499. For additional information, contact Extech Instruments Corporation, 335 Bear Hill Road, Waltham, MA 02154; Tel. 617-890-7440; Fax: 617-890-7864.

CIRCLE 83 ON FREE INFORMATION CARD

NOISE-CANCELLATION HEADPHONE

Discwasher's Model NC 200 stereo headphone substantially attenuates low-frequency environmental noise, relieving stress and helping to preserve hearing. It diminishes the roar of engines and heavy machinery, the din of construction, and annoying sounds produced by traffic. The headphone can be used in outdoor settings where power equipment is in use, on industrial plant floors, and on airplanes or trains. It weighs just 7 ounces and will run for 25 hours or more on a 9-volt alkaline battery.

The noise-cancellation process begins when small microphones built into the NC 200's ear cups sense ambient noise. The headset's patented circuitry then generates and sends out sound waves with frequencies identical to those coming in, but reversed in phase. The crest of each outgoing sound wave is timed to encounter the trough of the incoming wave. The resulting collision cancels incoming sound waves and, consequently, unwanted ambient noise. The NC 200 diminishes the level of frequencies in the 30- to 2000-Hz band by 10 to 20 decibels.

As it reduces unwanted ambient sounds, the NC 200 can be used as a conventional headphone to deliver audio from such sources as laptop computers, personal portable stereos, and on-board aircraft sound systems. Built-in equalization circuitry eliminates electroacoustical frequency variations inherent in some active noise-cancellation headphones and enhances sonic balance.

The NC 200 noise-cancellation headphone has a suggested retail price of $99.95. For more information, contact Discwasher, Division of Recoton, 145 East 57th Street, New York NY 10022; Tel. 212-644-0220 or 800-742-3438; Fax: 212-644-8205.

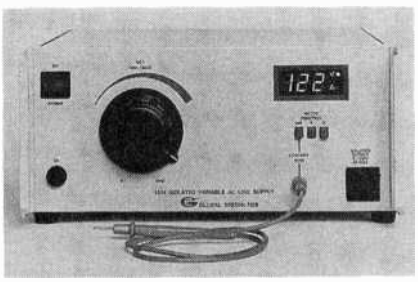
CIRCLE 84 ON FREE INFORMATION CARD

VARIABLE POWER SUPPLY

Global Specialties' Model 1504 is a continuously variable, digital, AC power source. It is designed for circuit design and development in electronic laboratories, as well as in production-line testing and repair facilities, companies doing incoming electronic inspection, vocational-training schools, and other applications in which a clean, electrostatically and

galvanically isolated variable line supply is required.

The super isolation transformer output voltage is continuously adjustable from 0 to 150 volts AC at 0 to 4 amps, and is triple-shielded from the input line to protect the user against shock. The Model 1504 can measure power line leakage current by means of a probe and a switch-selected range of the output digital panel meter. Fuses in the primary and secondary fully protect the unit.



The Model 1504 variable power supply costs $420. For additional information, contact Global Specialties, 70 Fulton Terrace, New Haven, CT 06512; Tel. 800-572-1028; Fax: 203-468-0060.

CIRCLE 85 ON FREE INFORMATION CARD

DIGITAL VIDEO CAMCORDER

Panasonic's AG-EZ1U DV-Cam is a digital video (DV) format, 3-CCD, digital-signal-processing camcorder aimed at cable television and local news crews, event videographers, and multimedia producers. Weighing less than 2.4 pounds, the camcorder will record one hour of digital component video on a miniature ¼-inch cassette.

In digital recording, the analog video signals are converted to binary numbers, processed, and recorded, eliminating analog distortions and noise. Once in the digital domain, the video signal can be viewed, edited, and manipulated by digital equipment such as personal computers. The transparent DV signal won't degrade through successive generations of recording, and the format offers an easy interface with other emerging digital technologies, such as nonlinear editing, video-on-demand, and HDTV.

Three ⅓-inch IT CCDs produce 500 lines of horizontal resolution, a signal-to-noise ratio of 54 dB, and minimum illumination of 5 lux while drawing only 7.5 watts of power. Tapes recorded in the DV format can be played by the DVCPRO studio VTRs with an optional AJ-CS750 adapter, making it easy to use digital video footage in broadcast and other professional applications.

The DV camcorder records component digital video to assure high image quality and uses 5:1 intra-frame compression to prevent motion artifacts. The result is cost-effective, standardized, full-motion digital video with 16-bit, CD-quality Pulse Code Modulation (PCM) audio.

The AG-EZ1U features a large, adjustable, 180,000-pixel color viewfinder; digital electronic stabilization; a 10:1 optical and a 20× digital electronic zoom lens; a built-in SMPTE time-code generator; three-dimensional digital noise reduction; a 14-step electronic shutter to record fast-moving subjects; four-step manual gain-up; 16:9 wide aspect ratio recording capability; Y/C and composite outputs; auto white balance and black balance; five-pin control; and stereo audio output. A "macro" function allows close-up focusing down to a minimum distance of 1.5 inches. The user has manual control over iris, white balance, shutter speed, and backlighting.

The AG-EZ1U has a suggested list price of $4500. For more information, contact Panasonic Broadcast & Television Systems Company, One Panasonic Way, 2A-2, Secaucus, NJ 07094; Tel. 201-392-4319; Fax: 201-392-6001. ■

CIRCLE 86 ON FREE INFORMATION CARD

DOOR ALARM

(Continued from page 58)

between 9 and 20 volts. When LED1 is unobstructed, the voltage between Q1's collector and emitter should be close to zero.

As a last test, obstruct the light path between LED1 and Q1. Place a voltmeter between the collector and emitter of Q2 and then obstruct the light from LED2; no current should be flowing, and the voltage across Q2 should be between 9 and 20 volts. When you stop blocking the light of LED2, the voltage between Q2's collector and emitter should be close to zero.

The preceding tests, in conjunction with careful wiring, should ensure that your Refrigerator-Door Alarm will work. When you're satisfied with its performance, you can go on to mount it.

Installation. Attach the completed project to the side of your refrigerator (as shown in Fig. 2), near the doors, with double-sided foam tape. If your refrigerator doesn't have its freezer door on top of the other one, and instead has its two doors opening outwards and side by side, you will need to mount the Alarm on top of the refrigerator.

Whichever way you mount the Alarm, the point is to position it so that two metal strips attached to the doors can obstruct the light path of the IR LED/phototransistor pairs when the doors are closed. Use light-gauge metal strips for that purpose; aluminum is a great material to use as it is easy to cut and bend, and will not rust.

Attach the strips to each door using screws, epoxy cement, or double-sided tape. Note that because moisture might condense on or near the door openings, a good mounting scheme is needed to make sure that the interrupters don't come loose due to moisture build up. You will know if an interrupter strip falls off as the alarm will sound!

Once the Alarm is connected, you shouldn't have any more problems with spoiled food (unless you keep it too long, of course). And by the way, if you do plan on getting a midnight snack, be prepared to fully wake up when you hear the sound of the alarm! ■

BIO-STIMULATOR

(Continued from page 34)

Calibration and Use. Insert a battery and turn on the power using R10/S1; then continue to adjust R10 to its middle setting. Place the acorn nuts across the inside of your arm and toggle S2 to each position. You should feel an increase or decrease of the shock pulse. Slowly turn R10 clockwise or counterclockwise to feel an increase or decrease (respectively) of the shock-pulse intensity.

See Fig. 4 for a list of ailments that traditional acupuncture has been claimed to remedy. If you suffer from one of those problems, then choose the appropriate acupuncture point and place cap-nut J2 directly over it. The other cap nut, J1, can be placed on any part of the skin. For best results, try applying the Bio-Stimulator up to three times a day for durations of between 5 and 15 minutes. You should be able to stop when the pain is reduced to your satisfaction.

Electrode Pads. Many electronic-acupuncture practitioners attach electrode pads to a patient's skin at various pressure points (determined by an electrode-placement chart), thereby allowing stimulation of an entire group of nerves covering a large area. With a simple modification, electrode pads can be attached to the Bio-Stimulator, adding to the unit's versatility. However, keep the following in mind:

Note: Federal and State laws regulate the sale of electrode pads. Check with your doctor to find out if you need a prescription to purchase them.

Three items are necessary to add electrodes to your unit: alligator clips (Radio Shack part number 270-347 or equivalent), test leads with pin tips (Radio Shack part number 278-705 or equivalent), and Unipatch 624 electrode pads (available at major medical suppliers). Assembly is simple. Remove the probe from each test lead, then solder an alligator clip on to each exposed wire. When finished you should have pin tips at one end and alligator clips at the other.

Clip the alligator clips to J1 and J2. Then insert the pin tips into the electrode receptacles. The electrode pads can be removed from the plastic sheet and applied to various body locations. Keep in mind that the adhesive material that is on the electrode pads allows for greater conductivity. Therefore, to keep the adhesive from wearing off too quickly, and to make it possible to use the pads more than once or twice, make sure to place them back on the plastic sheet after each use.

Refer to Fig. 5 to find the locations of nerves where you can place the electrode pads. The spinal system, which is the original base for all nerves, consists of 31 nerves divided into 4 major groups. The Cervical (C1 to C7) and Sacral (S1 to S4) groups spread to the arms and legs, while the Thoracic (T1 to T12) and Lumbar (L1 to L5) groups spread to all parts of the body as shown in the figure.

The path to both ends of the nerve groups can be found by looking for the C, S, T, or L locations in Fig. 5. You can place the electrode pads at both ends of or along the nerves crossing the pain area. You will then have to experiment to find the optimum locations for reducing pain.

Experimenting with all the possible uses of the Bio-Stimulator could take you quite a bit of time; however, the results you get from the device could be worth it. You just might be pleased to discover the benefits of East-meets-West technology. ■

PARTS LIST FOR THE BIO-STIMULATOR

SEMICONDUCTORS

IC1—556 dual timer, integrated circuit
Q1—1N4401 NPN transistor
D1—1N4005 silicon rectifier diode

RESISTORS

(All resistors are ¼-watt, 5% units.)
R1—100-ohm
R2, R3—750,000-ohm
R4—390-ohm
R5—15,000-ohm
R6—10,000-ohm
R7, R9—47,000-ohm
R8—150-ohm
R10—50,000-ohm potentiometer with SPST switch (S1)

CAPACITORS

C1—1-μF, 16-WVDC, electrolytic
C2—0.1-μF, ceramic-disc
C3—0.01-μF, ceramic-disc
C4—4700-pF, ceramic-disc
C5—1-μF, ceramic-disc
C6—0.047-μF, ceramic-disc

ADDITIONAL PARTS AND MATERIALS

T1—Audio transformer, 8-ohm primary, 1000-ohm secondary (Radio Shack part number 273-1380)
J1, J2—Acorn cap nut
S1—SPST switch (part of R10)
S2—SPST switch
B1—9-volt alkaline battery
Printed-circuit materials, project enclosure, battery clip with leads, alligator clips (optional, see text), test leads with pin tips (optional, see text), Unipatch 624 electrode pads (optional, see text), wire, solder, hardware, etc.

Note: The following items are available from RAH Projects (P.O. Box 15904, Newport Beach, CA 92659): etched and drilled PC board—$6.95; kit of parts including the PC board (but no project enclosure)—$30.00. Add $2.50 shipping and handling. California residents please also add appropriate sales tax. Check or money order only; personal-check orders will be shipped after the funds have been cleared. Allow 4 to 6 weeks for delivery.

DTMF TONE PAD

(Continued from page 56)

coated them with a layer of clear lacquer to protect them from damage in everyday use. You can do the same or use another type of labeling technique.

To use the Tone Pad with a transceiver you have to first decide how you would like to connect the two. While the unit could be hard-wired to the transceiver, using matching plug-and-socket connectors would be a better idea. Some transceivers have +12-volt, ground, transmit audio, and PTT keyline connections already available at an accessory socket on the rear panel. If that is the case, simply use matching plugs on the unit's connection wires.

And that's all there is to it! Once it's connected to your transceiver, the DTMF Tone Pad can be used for countless tasks, making it a constant reminder of the money-saving benefits you can enjoy by being an electronics hobbyist. ■

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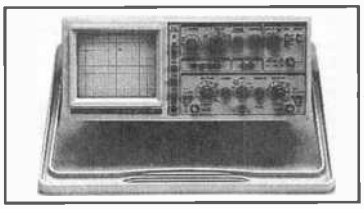

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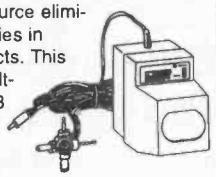

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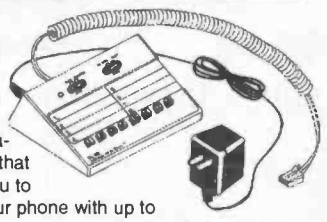

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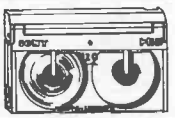

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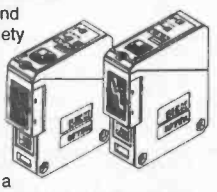

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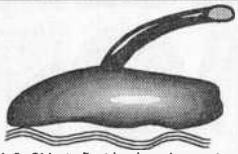

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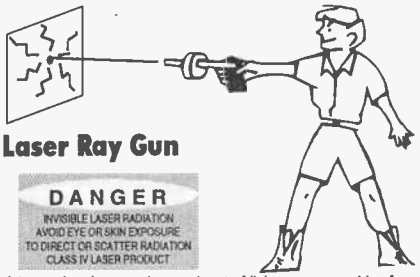

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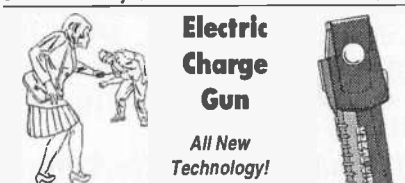

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TELECON10 Ready to Use $199.50

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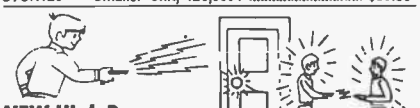
Easy to build, RED Beam, visible for miles. Use for light shows, window bounce holography, cloud illumination and much more! LAS1KM Kit w/1mw Laser Tube, Class II. $69.50
LAS3KM Kit w/2.5mw Laser Tube, Class IIIA $99.50

Life is Precious - *PROTECT IT!*

Hard hitting, crackling, sizzling HIGH VOLTAGE plasma! Stuns and immobilizes most attackers
STUN200 Ready to Use, 200,000V $69.50
STUN120 Smaller Unit, 120,000V $39.50

NEW High Power Ion Ray Gun



Projects charged ions that induce shocks in people and objects without any connection! Great science project as well as a high tech party prank. IOG7 Plans $15.00
IOG7K Kit/Plans $99.50

Invisible Pain Field Generator

Shirt pocket size electronic device produces time variant complex shock waves of intense directional acoustic energy, capable of warding off aggressive animals, etc.
IPG7 Plans .....$8.00 IPG7K Kit/Plans ...$49.50
IPG70 Assembled $74.50

1000 Ft++ Potato Cannon

NOT A TOY. Uses electronic or piezo ignition. CAUTION REQUIRED!
POT1 Plans.....
(Dangerous Product).....$10.00

FireBall Gun

Shoots flaming ball - two shot capacity
Great for special effects and remote fire starting. CAUTION REQUIRED!
FIREBALL Plans (Dangerous Product).....$10.00

TV & FM Joker / Jammer

Shirt pocket device allows you to totally control and remotely disrupt TV or radio reception. Great gag to play on family or friends. Discretion required.
EJK1KM Easy to Assemble Electronic Kit $24.50

ATTENTION: High Voltage Fans!

4,000 volts in the palm of your hand! Experiment with anit-gravity, hovercraft, ion guns, force fields, plasma guns, shock devices, wireless energy and electrical pyrotechnics. Input: 9-14VDC.
MINIMAX4 Ready to Use ..... $ 19.50

"Laser Bounce" Listener System

NEW - Latest Technology! Allows you to hear sounds from a premises without gaining access. Aim at room window and listen to sounds from within via reflected laser light. Not for illegal use. Requires video tripods.
LWB3K 5mw Laser and Receiver Kit $149.50
LWB30 Ready to Use $199.50

5mw Visible Red Pocket Laser

Utilizes our touch power control!
VRL5KM Kit / Plans..... $ 74.50

Electronic Hypnotism

Puts subjects under control using highly effective electronic stimuli. Intended for parties and entertainment but must be used with caution. Includes valuable text book reference and plans.
EH2 Plans and Text Book..... $19.50

Automotive NEON

Easy-to-Install 4-Tube Kit for Cars, Trucks, Vans! Available in Pink, Purple, Blue or Green - please specify color when ordering.
RG4K (Specify Color) .....$ 129.50

License Frame Kit (Specify Color)
LIC1K .....$ 24.50

Flash-To-Music Option for above kit FMU1.....$ 29.50

3 Mi FM Wireless Microphone

Subminiature! Crystal clear, ultra sensitive pickup transmits voices and sounds to FM radio. Excellent for security, monitoring of children or invalids. Become the neighborhood disk jockey!
FMV1 Plans.....$7.00 FMV1K Kit and Plans $39.50

Telephone Transmitter - 3 Mi

Automatically transmits both sides of a telephone conversation to an FM radio. • Tunable Frequency • Undetectable on Phone • Easy to Build and Use • Up to 3 Mile Range • Only transmits during phone use. VWPM7 Plans $7.00
VWPM7K Kit/Plans $39.50

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AR8000	.1-1900MHz[1]	$588
AR3000A	.1-2036MHz[1]	$1029
AR5000	10kHz-2600MHz[1]	$CALL
SDU5000	Spectrum Display	$995.95
AR3030	30kHz-30MHz Special	$599.95

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CUB	.1-2800MHz counter	$139.95
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Discounts on entire line...CALL!

Scout40, AOR2700/8000 package available...$779/$1039

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BC890XLT	Base/Mob. V/UHF-800[2]	$229.95
BC3000XLT	Portable 25-1300MHz[2]	$369.95
BC9000XLT	Base/Mob 25-1300MHz[2]	$389.95

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R8A	New Desktop	$1069
R8	Trade ins wanted, upgrade now!	

GRUNDIG

YB305	New digital. Special	$129
YB400	All Mode, SWL. Special	$179.95

ICOM

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R100-11	Blocked 800-900MHz[1] " " "	$679.95
R7000	FCC qualified users only CALL	$1839
R7100A-12	blocked 800-900MHz[2] *No Blk Call*	$1515
R9000	FCC qualified users only CALL	$6250

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HF150	Compact 30kHz-30MHz	$519
HF225E	Table-top Europa HF	$1099
HF250	New Tabletop HF	$1199
HF250RS	Remote/Synchro Det.	$1349

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PRO26	NEW 200ch. WX, 25-1300MHz[2]	$349.95
PRO2037	200ch., V/UHF 800, triple conv.[2]	$294.95
PRO2039	NEW, 200ch. V/UHF 800 doub. conv[2]	$229.95
PRO2042	NEW, 100ch. 25-570/760-1300MHz[2]	$399

SANGEAN

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ATS606P	w/ Rec ANT AC adapt, 45 memo.	$169.95
ATS303	NEW, Digital 20 memories	$89.95
ATS818	NEW low Price, .1 - 30MHz	$140

SONY

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ICFSW77	162 memo. .1-30MHz Synchro	$459.95
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ICFSW1000T	NEW, all band synchro cassette	$539
ICFSW7600G	Our Biggest Seller, all band/SSB	$179
ICF2010	Proven winner w/ air band	$344.95

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No Block available to FCC qualified users.
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BearTracker with alert, pre-programmed, select your state, hear the action!!! National ads at $199.95

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.15 - 30MHz, AM, CW, SSB, 160 memories, Mate w/ most scanners for full coverage. List $399.95

while they last...**$369**

NEW IC706

Fantastic performance! Rec .1 - 200MHz. Xmit all Ham band, 160 - 6Mt, 100W, 2MT, 10W all mode List $1560

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ALL Controls in Mic, Secure Install, No unit visible, 40ch., 4 Watts Out. The Hottest Selling CB on the Market!

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SALE $97

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Hi-Quality, all mode SWL, AM/FM, cassette, Auto Reverse, Clock Timer, Tape Turn On. FREE KX-2 Headset

SALE $539

AOR AR2700

Scanner, .1-1300MHz, AM, FM, FMW, 500 memories, RS232, Opt. Digital 20 sec. Record, Scout compatible, NEW low Price! Reg. $399.95

SALE $349

GRUNDIG YB305

.1 - 30MHz, 88 - 108MHz, 30Mem, AM, FM, FREE KX2 Headset LIST $179.95

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Global Positioning System

GPS is sweeping the industry. know your location/altitude, anywhere in the world to a few feet. Trimble, Magellan, Garmin & Eagle.

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.1 - 30MHz, 88-108MHz, AM, CW, SSB, FM, SAVE over $100, FREE KX2 Headset incl., LIST $239.95

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Fashioned after the original Jeep dash. Rugged and water resistant, AM/FM/Cass/CD, end fire speakers, "O" ring water tight construction. Stores 30 CD's, 8 "D" (not incl.). 12GV AC AC adaptor Incl.

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Night Vision - Now the public can afford to see at night. A must for security, hunting, camping stargazing. NV-100 100mm, f1.4 lens w/ IR Lowest Price in U.S.

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GE SUPERADIO II

Puts the fun back in AM/FM DX'ing, Larger ferrite rod antenna, 4 I.F. stages. Every one needs this great sounding radio. 7-2887

SALE $59

AOR AR8000

Scan .1 - 1900MHz, All mode with SSB, 1000 memory, 10x100ch., RS232, Optional Software LIST $799

SALE $588

OPTO SCOUT 40

Counter, Digital capture of signal, Reaction Tune AOR Scanner 8000/2700, RS232 output. LIST $449 OPTDB232 Antenna Shown

SALE $419

SYSTEM PACKAGE DEAL

Includes: Scout 40, Scanner, Scanner Mods, Interconnect Cable, 1 year extended warranty.

AR8000, Scout 40 **$1039**

AR2700, Scout 40 **$779**

Send your AR8000 & Scout 40 in and we'll do the mods, incl. cable, 1 YR. warranty on our work, check-out system with your new Scout and return UPS. **$449**

PRO2042

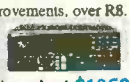
100CH, 25-570/760-1300MHz (less cell), Top End Scanner. Save $100

SALE **$399**

Drake R8A

Time to UpGrade

4 Star(IBS), over 12 improvements, over R8.



Now Just $1069

SONY ICF7600G

Our Biggest Seller! All SWL, Synchonous detection, SSB, Key input, 22memory channels. Opt AC not included!

NOW **$179**

AIWA HS-TS500

Its a radio...No, it's a cassette...No, it's BOTH!

- Covers AM/FM/SW 3.5 - 21.5MHz
- Easy analog tuning, plus fine tuning
- Auto stop cassette player
- Power: 2 AA (not incl.), opt. AC Adapter $9.95
- Free stereo headset included

Introductor Price...

$66.00

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Trade-Ins
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On our BBS.
Update list SASE

ICOM R100 NO BLOCKS

DEMO! .5-1800MHz, 120 memory channels, 13.8VDC, opt 120VAC adaptor $19.95. was $799. 1 year warranty.

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-80.7 to 81.4 dBm with 4Ω – 1200Ω 20 reference impedances
True RMS
Frequency counter: 0.01Hz-10MHz
Capacitance: 1pF-50,000μF
Measure AC volt to 20kHz
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Auto power off
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Volt, amp, ohm, logic, diode, continuity
Ruggerdized case
Rubber holster included

DMM 2360 $109.95

DMM+LCR Meter

Very Versatile DMM

Inductance: 1μH-40H
Capacitance: 1pF-40μF
Frequency: 1Hz - 4MHz
Temperature: -40-302 °F
TTL Logic Test: 20MHz
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Auto power off
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Temperature probe included
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Inductance: 1μH-40H
Capacitance: 1pF-200μF
Frequency: 1Hz-20MHz
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Fluke 76	$175
Fluke 87	$287
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LCR Meter 131D $229.95

Most Advanced LCR

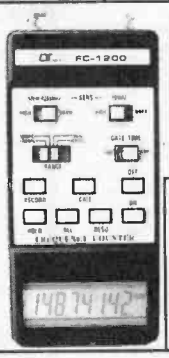
Dual display: L/Q or C/D
Inductance: 0.1μH-1000H
Capacitance: 0.1pF-10,000μF
Impedance: 1mΩ-10MΩ
0.7% basic accuracy
Auto/manual range
Dissipation factor & Q factor
Serial & parallel mode
Relative mode for comparison and to remove parasitics
Statistics, tolerance,
Best for design, incoming testing & production
SMD and chip component test probe $25.00

LCR Meter 814 $189.95

Best Resolution LCR

Inductance: 0.1μH-200H
Capacitance: 0.1pF-20,000μF
Resistance: 1mΩ-20MΩ
1% basic accuracy
Dissipation factor indicates leakage in capacitor and Q factor in inductor
Zero adjustment to reduce parasitics
Best for high frequency RF
SMD and chip component test probe $25.00

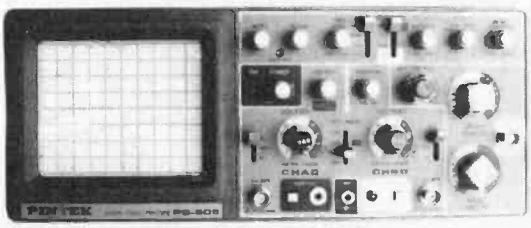
LIMITED QUANTITY SPECIAL
DIGITAL LCR 680 $74.95
0.1pF, 1μH, 10mΩ resolution



Frequency Counter FC-1200 $129.95

Frequency: 0.1Hz-1.25GHz
Display: 8 digit LCD
Period: 0.1μs-0.1s
Records Max/Min/Average
Data hold, relative mode
Telescoping antenna $8.00
Deluxe case $5.00

Also Available:
AC/DC clamp meter, Light meter, Thermometer, pH meter, High voltage probe, Digital caliper, Anemometer, Electronic scale, Force gauge, Tachometer, Stroboscope, Humidity & EMF adapter, Sound level meter, Frequency counter, SWR/field strength/power meter, Dip meter



20 MHz Oscilloscope with Delay Sweep PS-205 $429.95

Dual Trace, Component test, 6" CRT, X-Y Operation, TV Sync, Z-Modulation, CH2 Output, Graticule Illum, 2 probes each has x1,x10 switch. Best price with delay sweep.

PS-200	20 MHz DUAL TRACE	$339.95
PS-400	40 MHz DUAL TRACE	$494.95
PS-405	40 MHz DELAY SWEEP	$569.95
PS-605	60 MHz DELAY SWEEP	$769.95
PS-1000	100 MHz DUAL TRACE	$999.95

Scope Probe: 60MHz x1, x10 $15, 100MHz x1, x10 $22
250MHz x1, x10 $29, 250MHz x100 $39

Digital Storage Scope

DS-303 30MHz, 20M Sample/sec $849.95

DS-303P with RS-232 interface $1,049.95

Switchable between digital and analog modes
2 K word per channel storage
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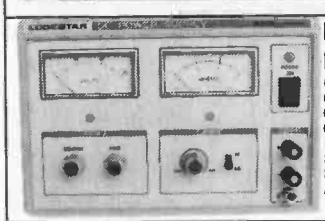
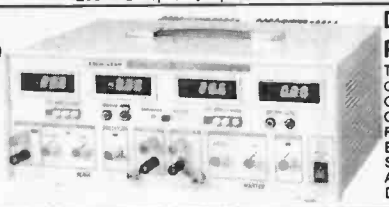


DC Power Supply PS-303 $159.00

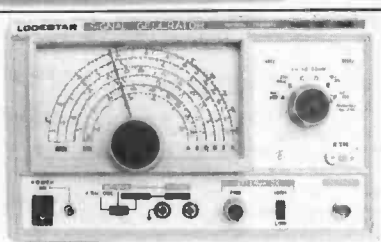
0-30 VDC, 0-3A output

Constant voltage & constant current mode
0.02% + 2mV line regulation
0.02% + 3mV load regulation
1 mVrms noise and ripple
Short circuit and overload protected
PS-8200 with digital voltmeter $179.00
Also available: 30V/5A, 60V/3A, 60V/5A 16V/10A, 30V/10A



DC Power Supply Triple Output PS-8202 $499.95

Two 0-30 VDC, 0-3A outputs
One fixed 5VDC, 3A output
Capable of independent or tracking operation
Constant voltage and constant current mode
Four digital meters for volt and current display
Excellent regulation and low ripple
Short circuit and overload protected
Also available: 30V/5A triple output $549.95
Dual tracking 30V/3A, 30V/5A, 60V/3A, 60V/5A



RF SIGNAL GENERATOR SG-4160B $124.95

100 kHz-150MHz sinewave in 6 ranges
RF Output 100mVrms to 35 MHz
Internal 1kHz, External 50Hz-20kHz AM modulation
Audio output 1 kHz, 1 Vrms

RF SIGNAL GEN./COUNTER SG-4162 AD $229.95

Generates RF signal same as SG-4160B
6 digit frequency counter 1Hz - 150 MHz for internal and external source Sensitivity <50mV

AUDIO GENERATOR AG-2601A $124.95

10Hz - 1MHz in 5 ranges
Output: 0-8Vrms sinewave
0-10Vp-p squarewave
Synchronization: ±3% of oscillation frequency per Vrms
Output distortion:
0.05% 500Hz - 50kHz
0.5 % 50Hz - 500kHz
Output impedance: 600 ohm

AUDIO GEN./COUNTER AG-2603AD $229.95

Generates audio signal same as AG-2601A
6 digit frequency counter 1Hz-150MHz for internal and external sources Sensitivity <50mV

FUNCTION GENERATOR FG-2100A $169.95

0.2 Hz -2 MHz in 7 ranges
Sine, square, triangle, pulse and ramp
Output: 5mV-20Vp-p
1% distortion, DC offset ± 10V
VCF: 0-10V control frequency to 1000:1

FUNCTION GEN/COUNTER FG-2102AD $229.95

Generates signal same as FG-2100A
Frequency counter 4 digits
Feature TTL and CMOS output

SWEEP FUNCTION GEN./COUNTER $329.95

0.5Hz to 5 MHz in 7 ranges
Sweep: Linear 10:1/Log 10:1 20ms to 2s
AM Modulation
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MULTI-FUNCTION DIGITAL & ANALOG I/O MULTI-LAB PACKAGE

The ACL-711S is a low cost, but fully integrated package designed for applications of general lab and industrial automation. It contains:

- **8 Single-Ended A/D Inputs**
  - Resolution: 12 bits
  - Input Range: -5V to +5V
  - Trigger Mode: Software trigger only
- **One Analog Output (D/A)**
  - Resolution: 12 bits
  - Output Range: 0 to +5V or 0 to +10V
- **16 Digital Inputs**
- **16 Digital Outputs**
- **ACLD-7115** Wiring terminal board (furnished with ACL-711S)
- **Utility Software Disk** Driver routines for BASIC and Quick-BASIC, demo and example programs

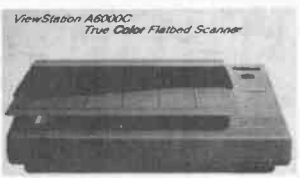
ACL-711S $199

24-BIT COLOR FLATBED SCANNER

- High-Speed 3-Pass Scanner
- Long Lasting Cold Cathode Technology (10,000Hrs)
- Up to 2400x2400dpi (300x600 hardware)
- Intelligent LCD Panel
- TWAIN Compliant
- Includes: PhotoStacker, WordLinx OCR & Media-House Multimedia Document Manager Software
- Includes SCSI Interface Card

A6000C

$299



A6ADF Optional 50pg Doc Feeder

$359

A6TK Optional Transparency Kit

$259

DIGITAL PANEL METERS

- 200mV Full Scale Input Sensitivity
- Single 9 Volt DC Operation
- Decimal Point Selectable
- Auto Polarity Indication
- High Input Impedence (>100M ohm)

AS LOW AS $5.25 EACH

CAT NO	DESCRIPTION	PRICE EACH 1	10	25	100	250
PM-128	3-1/2 Digit LCD Panel Meter	$ 9.90	$ 7.09	$ 6.40	$ 5.86	$ 5.25
PM-129	3-1/2 Digit LED Panel Meter	11.49	9.54	8.67	7.95	6.95
PM-328	4-1/2 Digit LCD Panel Meter	19.88	16.40	14.90	13.66	11.93

This very easy to use tool is a "must have" if you need to straighten the pins on your IC's. Made from anti-static material, this tool is suitable for IC's from 8 to 20 pins (narrow side) and 24-48 pins (wide side). A grounding terminal is also built-in to the tool allowing for easy grounding when using this tool at a fixed location.

CAT NO	PRICE EACH 1	10	100
ICS-01	$7.18	$6.44	$4.89

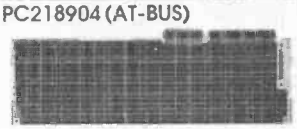
PC218902 (AT-BUS)

- Board Length: 13-1/8" (333mm)
- Board Width: 4-5/16" (110mm)
- Double Sided, 3-Hole Solder Pads and Power Buses
- Space Reserved for: Header, 32x2, 0.1" Spacing and Pin Grid Array

Vector Cross Ref. #4617

CAT NO	PRICE EACH 1	5
PC218902	$25.66	$20.25

PC218904 (AT-BUS)

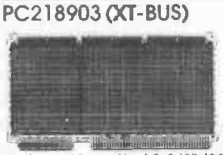


- Board Length: 13-1/8" (333mm)
- Board Width: 4-5/16" (110mm)
- Double Sided, Pad-Per-Hole and Power Buses
- Space Reserved for: 1 D-Type Connector, 25-pin

Vector Cross Ref. #4617-3

CAT NO	PRICE EACH 1	5
PC218904	$25.42	$20.06

PC218903 (XT-BUS)

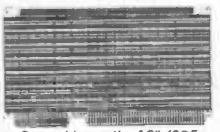


- Board Length: 13-1/8" (333mm)
- Board Width: 4-5/16" (110mm)
- Double Sided, Pad-Per-Hole and Power Buses
- Space Reserved for 1 D-Type Connector, 25-Pin

Vector Cross Ref. #4613-3

CAT NO	PRICE EACH 1	5
PC218903	$23.51	$18.63

PC232904 (Multi-BUS)

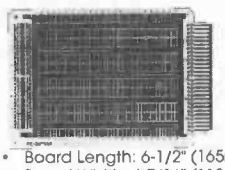


- Board Length: 12" (305mm)
- Board Width: 6-3/4" (171mm)
- Double Sided, Pad-Per-Hole and Power Buses
- Space Reserved for 1 Header, 100x2, 0.1" Spacing

Vector Cross Ref. #4608

CAT NO	PRICE EACH 1	5
PC232904	$38.40	$29.80

PC207905 (STD-BUS)

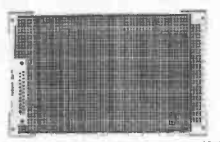


- Board Length: 6-1/2" (165mm)
- Board Width: 4-7/16" (113mm)
- Double Sided, 3-hole Solder Pads, Ground Plane and Power Bus
- Space Reserved for 1 Header, 34x3, 0.1" Spacing

Vector Cross Ref. #4610

CAT NO	PRICE EACH 1	5
PC207905	$13.66	$11.25

PC412902 (VME-BUS)



- Board Length: 6-5/16" (160mm)
- Board Width: 3-15/16" (100mm)
- Single Sided, Pad-Per-Hole and Power Buses
- Space Reserved for 1 D-Type Connector, 25-Pin

Vector Cross Ref. #4614-3

CAT NO	PRICE EACH 1	5
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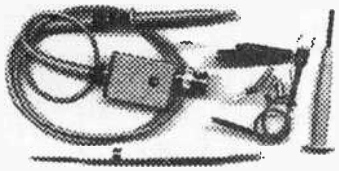

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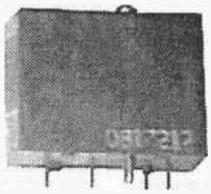

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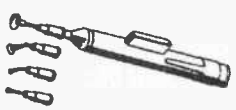

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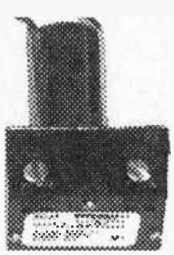

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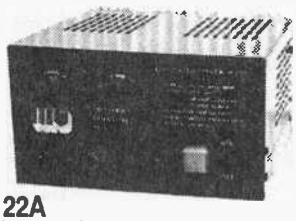

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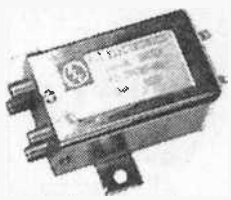

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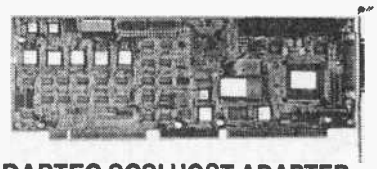

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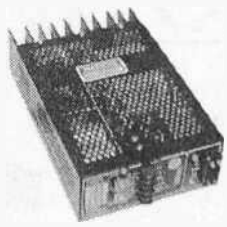

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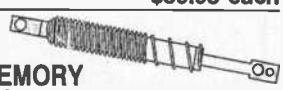

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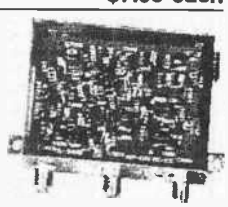

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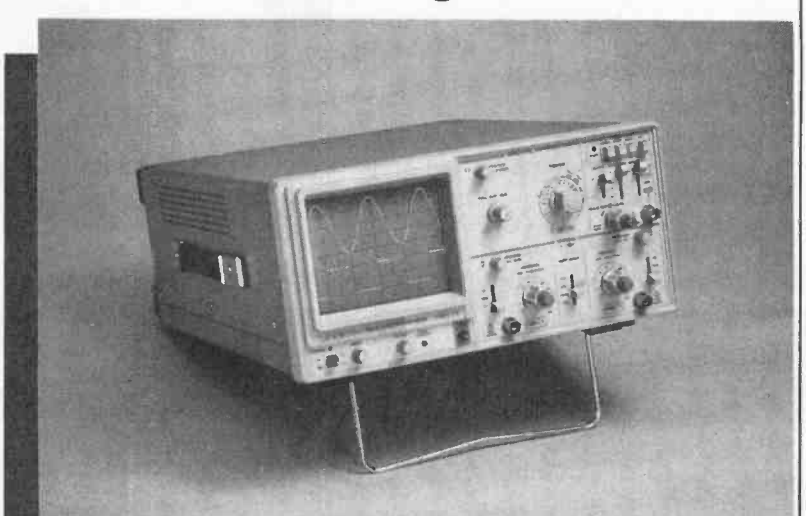

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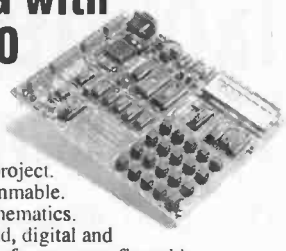

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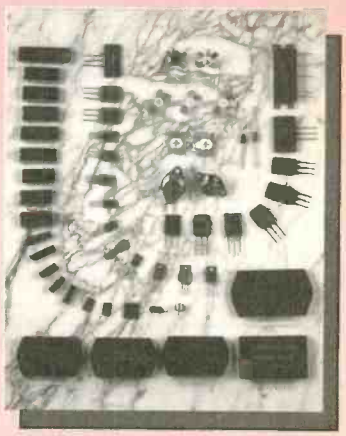

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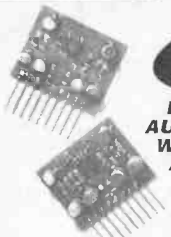


MENTION AD AND TAKE 5% OFF YOUR FIRST ORDER!

BUILD THAT AUDIO PROJECT WITH SESCOM AUDIO SIPS

Hassle-free SIP circuits have 9 pins on 0.1" centers. Approx. 1.1" W x 1.0" H x 0.5" D

Audio SIPs

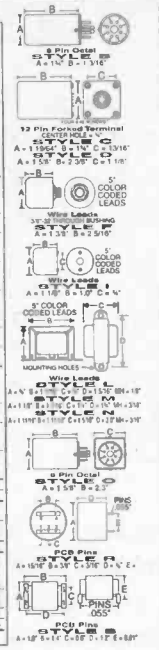
DESCRIPTION	MODEL	A*	B**
DUAL GEN PURPOSE GAIN AMPS	SIP-1	20.00	20.50
DUAL ELECTRONIC MIC INPUT AMPS	SIP-2	25.00	25.50
DUAL ELECTRONIC LINE INPUT AMPS	SIP-3	25.00	25.50
DUAL ELECTRONIC LINE OUTPUT AMPS	SIP-4	25.00	25.50
LINE AMP WITH BUFFER STAGE	SIP-5	21.00	21.50
DUAL SUMMING AMPS	SIP-6	15.00	15.00
DUAL HEADPHONE AMPS	SIP-7	20.00	20.50
ALC – LINE LEVEL	SIP-8	25.00	25.50
DUAL VCA	SIP-9	20.00	20.50
FOUR COMMON BUFFER AMPS	SIP-10	19.00	19.50
DUAL ELECTRONIC SWITCH	SIP-11	21.00	21.50
VIDEO DA – 3 OUTPUTS	SIP-12	35.00	35.50
DUCKER	SIP-13	20.00	20.50
ELECTRONIC MIC-LINE PAD	SIP-14	22.00	22.50
AUTO FEEDBACK CONTROLLER	SIP-15	30.00	30.50
FUNCTION GENERATOR – SINE/SQUARE WAVE	SIP-16	30.00	30.50
AUDIO OSC / METER DRIVER	SIP-17	22.00	22.50
RUMBLE SCRATCH FILTER	SIP-18	20.00	20.50
MIC PRE-AMP / ¼ WATT AMP	SIP-19	18.00	18.50
DC/DC CONVERTER	SIP-20	18.00	18.50
DUAL GAIN AMPS – SINGLE SUPPLY	SIP-21	20.00	20.50
DUAL SUMMING AMPS – SINGLE SUPPLY	SIP-22	20.00	20.50
LIMITER – FAST ATTACK / SLOW RELEASE	SIP-23	20.00	20.50
DUAL UNITY GAIN BUFFERS	SIP-24	20.00	20.50
AC POWER SUPPLY ±18V OUT	SIP-PS	30.00	31.00
AC TO ±18 VOLT REGULATOR CIRCUIT	SIP-18V	20.00	20.50

WE ALSO HAVE PC BOARDS TO MAKE CONSTRUCTION WITH SIPS EVEN EASIER!

Audio Transformers

PRIMARY IMPED	Ω	SECONDARY IMPED	Ω	USE	SECOND WINDINGS	POWER LVL 60Hz	MAGNETIC SHIELDING	CASE STYLE	MODEL	$
18.75 / 75		150 / 600		LO	1	+18	-10 dB	M	MI-75	37.25
18.75 / 75		150 / 600		LO	1	+18	-10 dB	C	MI-45	76.50
18.75 / 75		150 / 600		LO	1	+30	-10 dB	N	MI-83	46.75
18.75 / 75		150 / 600		LO	1	+30	-30 dB	D	MI-46	134.50
150		600		O	1	+24	NONE	S	MI-119	23.90
150		5k		MI	1	-20	-30 dB	R	MI-116	27.70
150 / 600		150 / 600		O	1	+18	-10 dB	M	MI-72	37.25
150 / 600		150 / 600		O	2	+18	-10 dB	M	MI-73	37.25
150 / 600		150 / 600		O	1	+18	-30 dB	C	MI-12	76.50
150 / 600		150 / 600		O	2	+18	-30 dB	C	MI-14	76.50
150 / 600		150 / 600		O	1	+30	-10 dB	N	MI-80	46.75
150 / 600		150 / 600		O	2	+30	-10 dB	N	MI-81	46.75
150 / 600		150 / 600		O	1	+30	-30 dB	D	MI-18	134.50
150 / 600		150 / 600		O	2	+30	-30 dB	D	MI-20	134.50
150 / 600		600		LI, LO	1	-10	NONE	L	MI-67	21.40
150 / 600		600		LI, LO	1	-10	-30 dB	I	MI-53	29.60
150 / 600		600		LI, LO	1	-10	-60 dB	B	MI-8	39.40
150 / 600		600		LI, LO	1	-10	-60 dB	F	MI-31	40.50
150 / 600		600		LI, LO	1	+4	-60 dB	F	MI-88	54.50
150 / 600		600		LI, LO	1	+4	-30 dB	I	MI-93	37.25
150 / 600		600		LO	1	+18	-10 dB	O	MI-97	56.50
150 / 600		600		LO	4	+18	-10 dB	M	MI-74	37.25
150 / 600		600		LO	4	+18	-30 dB	C	MI-43	76.50
150 / 600		600		LO	1	+30	-10 dB	O	MI-100	66.75
150 / 600		600		LO	4	+30	-10 dB	N	MI-82	46.75
150 / 600		600		LO	4	+30	-30 dB	D	MI-44	134.50
150 / 600		5k		MI	1	-10	NONE	L	MI-111	21.40
150 / 600		5k		MI	1	-10	-30 dB	I	MI-109	26.90
150 / 600		5k		MI	1	-10	-60 dB	B	MI-102	39.40
150 / 600		5k		MI	1	-10	-60 dB	F	MI-106	40.50
150 / 600		5k		MI	1	+4	-60 dB	F	MI-85	54.50
150 / 600		5k		MI	1	+4	-30 dB	I	MI-112	37.25
150 / 600		5k		MI	1	+18	-10 dB	M	MI-103	76.50
150 / 600		5k		MI	1	+30	-10 dB	N	MI-113	47.20
150 / 600		5k		MI	1	+30	-30 dB	D	MI-104	134.50
150 / 600		15k		LI, LO	1	-10	NONE	L	MI-64	21.40
150 / 600		15k		LI, LO	1	-10	-30 dB	I	MI-50	29.60
150 / 600		15k		LI, LO	1	-10	-60 dB	B	MI-5	39.40
150 / 600		15k		LI, LO	1	-10	-60 dB	F	MI-28	40.50
150 / 600		15k		LI, LO	1	+4	-30 dB	I	MI-89	37.25
150 / 600		15k		LI, LO	1	+4	-60 dB	F	MI-95	54.50
150 / 600		15k		LI, LO	1	+18	-10 dB	M	MI-76	37.25
150 / 600		15k		LI, LO	1	+18	-10 dB	O	MI-96	56.50
150 / 600		15k		LI, LO	1	+18	-30 dB	C	MI-9	76.50
150 / 600		15k		LI, LO	1	+30	-10 dB	O	MI-99	66.75
150 / 600		15k		LI, LO	1	+30	-10 dB	N	MI-77	46.75
150 / 600		15k		LI, LO	1	+30	-30 dB	O	MI-16	134.50
600		600		LI	1	+4	NONE	R	MI-117	27.70
600		600		O	1	+18	NONE	S	MI-118	21.75
3.75k / 15k	15k / 60k	LI, LO			1	+18	-10 dB	M	MI-76	37.25
3.75k / 15k	15k / 60k	LI, LO			1	+18	-30 dB	C	MI-13	76.50
3.75k / 15k	15k / 60k	LI, LO			1	+30	-10 dB	N	MI-84	46.75
3.75k / 15k	15k / 60k	LI, LO			1	+30	-30 dB	D	MI-18	134.50
15k	15k	LI			1	+14	-30 dB	R	MI-115	27.70
15k	15k / 60k	LI			1	-10	NONE	L	MI-58	21.40
15k	15k / 60k	LI			1	-10	-30 dB	I	MI-54	29.60
15k	15k / 60k	LI			1	-10	-30 dB	B	MI-22	39.40
15k	15k / 60k	LI			1	-10	-60 dB	F	MI-32	40.50
15k	15k / 60k	LI			1	+4	-30 dB	I	MI-94	37.25
15k	15k / 60k	LI			1	+4	-60 dB	F	MI-89	54.50
15k	15k / 60k	LI			1	+18	-10 dB	O	MI-98	56.50
15k	15k / 60k	LI			1	+30	-10 dB	O	MI-98	66.75

MI = MIC INPUT, LI = LINE INPUT, LO = LINE OUTPUT, O = OUTPUT



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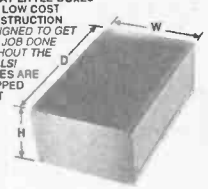

New Boxes for '96

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Large Project Boxes

MODEL	W x D x H in.	A*	B**
LPB-1	4 x 6 x 2	10.50	12.50
LPB-2	5 x 7 x 2	11.00	13.00
LPB-3	5 x 9.5 x 2	12.75	15.25
LPB-4	6 x 8 x 2	13.75	16.25
LPB-5	7 x 7 x 2	11.50	13.75
LPB-6	7 x 9 x 2	13.75	16.25
LPB-7	7 x 11 x 2	15.50	18.50
LPB-8	7 x 13 x 2	17.75	21.00
LPB-9	7 x 15 x 2	25.25	30.00
LPB-10	10 x 17 x 2	30.75	36.50
LPB-11	13 x 17 x 2	36.50	43.25
LPB-12	4 x 6 x 3	12.25	14.50
LPB-13	5 x 7 x 3	13.25	15.75
LPB-14	5 x 9.5 x 3	15.25	18.00
LPB-15	7 x 12 x 3	19.50	23.25
LPB-16	7 x 15 x 3	25.50	30.25
LPB-17	8 x 12 x 3	25.00	29.50
LPB-18	8 x 17 x 3	27.50	32.50
LPB-19	10 x 12 x 3	29.75	35.25
LPB-20	10 x 14 x 3	30.00	35.50
LPB-21	10 x 17 x 3	31.50	37.50
LPB-22	12 x 17 x 3	35.75	42.25
LPB-23	14 x 17 x 3	44.00	52.00
LPB-24	17 x 17 x 3	45.00	53.25

.050" ALUMINUM AND MINI EXTRUSION

Mini Project Boxes

MODEL	W x D x H in.	A*	B**	OPT***
MPB-1	1 x 2 x 1	2.05	2.35	1.35
MPB-2	1 x 4 x 1	2.55	2.65	1.90
MPB-3	1 x 6 x 1	3.00	3.35	2.45
MPB-4	1.5 x 2 x 1.5	2.15	2.35	1.60
MPB-5	1.5 x 4 x 1.5	2.65	2.95	2.45
MPB-6	1.5 x 6 x 1.5	3.10	3.80	3.30
MPB-7	1.5 x 2 x 3	2.35	2.65	2.05
MPB-8	1.5 x 4 x 3	2.85	3.25	3.30
MPB-9	1.5 x 6 x 3	4.15	4.65	4.55
MPB-10	1.5 x 2 x 5	2.60	3.60	3.30
MPB-11	1.5 x 4 x 5	3.05	3.70	4.40
MPB-12	1.5 x 6 x 5	4.40	5.20	6.25
MPB-13	2 x 2 x 2	2.30	2.70	1.90
MPB-14	2 x 4 x 2	2.75	3.25	3.00
MPB-15	2 x 6 x 2	4.55	5.15	4.15
MPB-16	2 x 8 x 2	6.85	7.60	5.25
MPB-17	3 x 2 x 3	2.55	3.05	2.45
MPB-18	3 x 4 x 3	3.00	3.65	4.15
MPB-19	3 x 6 x 3	4.35	5.05	5.80
MPB-20	3 x 8 x 3	4.80	5.65	7.50
MPB-21	4 x 6 x 3	4.70	5.30	4.45
MPB-22	4 x 10 x 3	5.65	6.10	10.55
MPB-23	4 x 12 x 3	5.90	6.50	12.55
MPB-24	4 x 14 x 3	6.30	7.00	14.50

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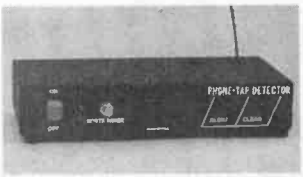

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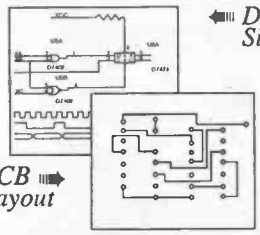

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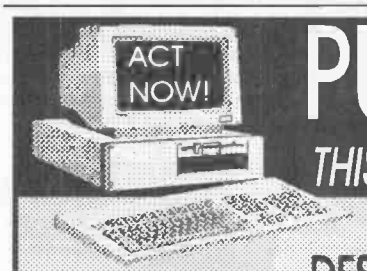

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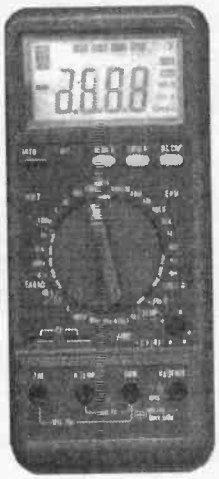

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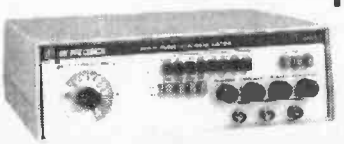

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1.3GHz Frequency Counter • 2MHz Sweep Function Generator
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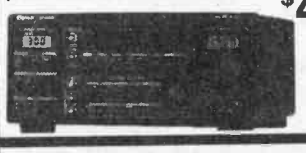

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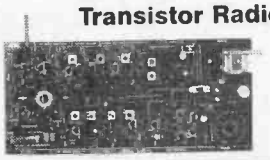

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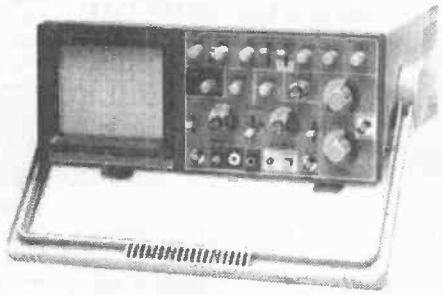

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DS-603 $1350
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- 20MS/s Sampling Rate

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- Analog w/ Cursors

S-1360 $759
- Analog with Delayed Sweep

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S-1340 $489
- Analog

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DS-303 $1095
- Analog / Digital Storage

S-1330 $439
- 25MHz Analog
- Delayed Sweep

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- 25MHz Analog

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ANALOG

Model	Bandwidth MHz	Sensitivity (max)	No. of Channels	Sweep Rate Max ns/div	Delayed Sweep	Video Sync	Component Tester	Beam Find	Time Base
S-1365	60	1mV/div	2	10ns/div	Yes	Yes	Yes	Yes	2
S-1360	60	1mV/div	2	10ns/div	Yes	Yes	Yes	Yes	2
S-1345	40	1mV/div	2	10ns/div	Yes	Yes	Yes	Yes	2
S-1340	40	1mV/div	2	10ns/div	No	Yes	No	No	1
S-1330	25	1mV/div	2	10ns/div	Yes	Yes	Yes	Yes	2
S-1325	25	1mV/div	2	10ns/div	No	Yes	No	No	1

DIGITAL STORAGE

Model	Bandwidth MHz	Analog Sen (max)	No. of Channels	Sampling Rate	Memory Channel	Internally Backed Up	Pretrigger %	Output
DS-303	30	1mV/div	2	20MS/S	2K	Yes	0, 25, 50, 75	RS232
DS-603	60	1mV/div	2	20MS/S	2K	Yes	0, 25, 50, 75	RS232

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20MHz Analog
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2125 - $539.95
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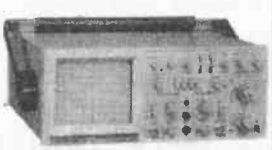

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Dual Trace

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Model 2260
$1225

Model 2160
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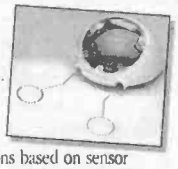

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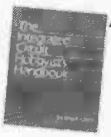

Toss those old IC data books! This practical collection has 80 common ICs to make 100s of circuits! Amps, linear, logic, CMOS – with specs, pinouts, sample circuits – even component values (gasp!). 120 pgs. A basic resource!

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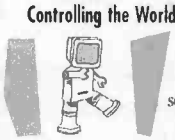

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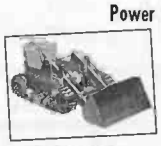

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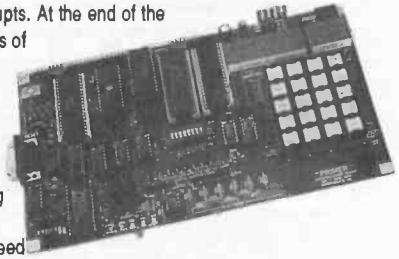

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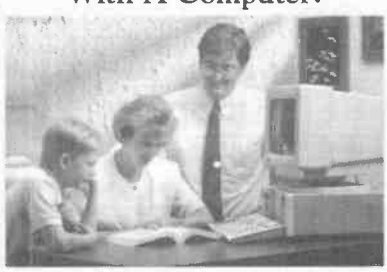

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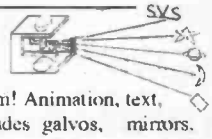

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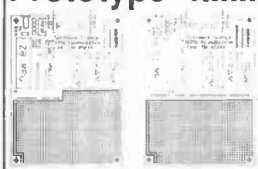

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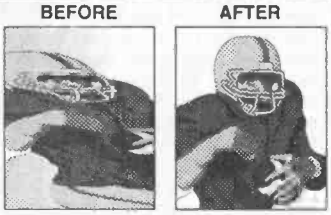

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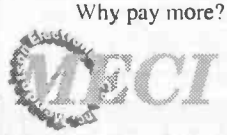

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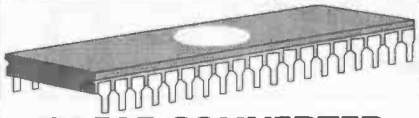

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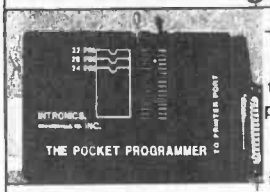

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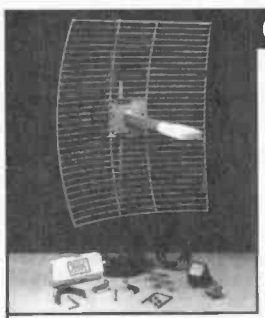

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BASIC STAMP® II

Tiny computer runs BASIC programs

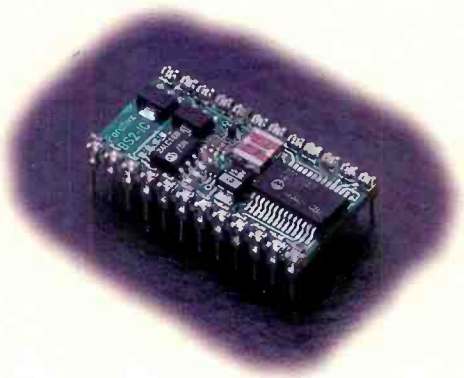
Also available at Digi-Key (800-344-4539) and Jameco (800-831-4242)

The BASIC Stamp II is a complete BASIC-programmable computer in a 24-pin DIP package. It has 16 I/O lines, which can be used for a variety of digital and analog purposes. And its BASIC language includes familiar instructions, such as FOR...NEXT, IF...THEN, and GOTO, as well as special instructions for DTMF tone generation, X-10 powerline control, tachometers, and serial communications (up to 50k baud!).

An easy language with special added commands makes really cool things simple. For instance, one customer uses the Stamp II as an interface between his home alarm system, answering machine, and telephone. When the alarm system is triggered, or a message is received, the Stamp II dials his pager and sends a code that let's him know what's going on at home. The Stamp II's built-in DTMF capability made this application short and simple.

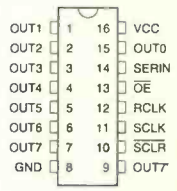
DTMFOUT

Generates DTMF tones with just one I/O pin. Another instruction, **FREQOUT**, generates one or two tones simultaneously. Each tone is programmable from 0-32767 Hz.



BS2-IC Module
(FaxBack #6002)

74HC595



SHIFTOUT

Uses two I/O pins to control common shift registers.

BASIC Stamp II Module (BS2-IC)

16 general-purpose I/O lines
2048-byte program space (600 instructions)
$49, $69 with optional carrier board

Marvin Green (first row, 2nd from left) uses BASIC Stamps in his Explorer Scouts robotics classes in Hillsboro, Oregon. These are some of his students with their Explorer-Bots, which are small Stamp-based robots that follow a light source while playing a tune.

COUNT

Counts cycles on an I/O pin. Makes tachometer applications simple.

XOUT

Generates X-10 powerline control signals using two I/O pins and an inexpensive interface module. Signals are received by small modules that control lights and appliances.

PARALLAX®

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- All frequencies are automatically saved until deleted.
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- Pager style vibrator for discreet recording. Distinctive beeper indicates frequency detection.
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