IS DSS SATELLITE TV RIGHT FOR YOU?

January 1996

Popular Electronics®

A Guide to Direct-Broadcast Satellite TV

How DSS, Primestar, and others are changing the face of television forever

Build a Telephone Transmitter

Listen in on telephone conversations using any FM radio

Remembering Radio Row

A nostalgic look back at the great radio emporiums of yesteryear

Build a Voice-Activated Switch

Use it to control a tape recorder or any other device

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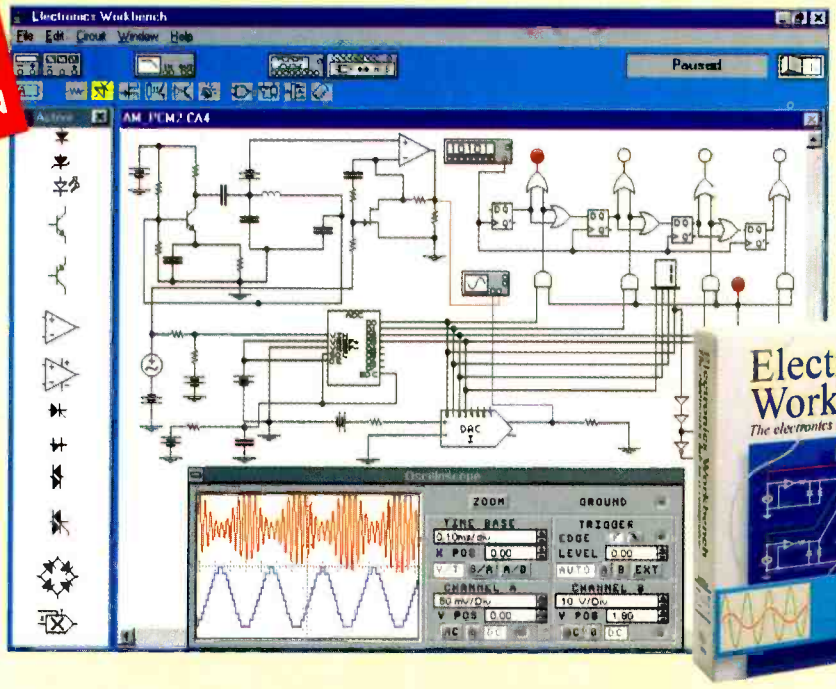

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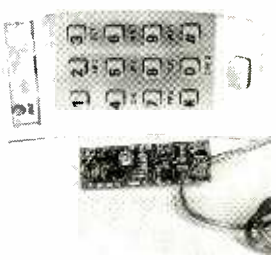

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EDITORIAL

DSS: ONE YEAR LATER

Regular readers of **Popular Electronics** might recall that around this time last year I took the DSS plunge. Fed up with my local cable company, and with C-band not being a viable alternative for aesthetic and practical reasons, I felt DSS was an ideal alternative—as I stated at the time: "A dream come true."

A little less than a year later I am here to report that my initial impressions have changed—I am even happier with my system than the day I purchased it! That's because the already-wide range of available programming has increased further, and the system's already-good performance has become even better with the launch of the system's third satellite.

However, that does not mean that DSS is necessarily right for you. First of all, there is the initial outlay for equipment. While hardware has become available from a second source (Sony), and discounting is now going on, it is still not an insignificant cost. Another potential problem is that you must have a clear line of sight to the satellites.

And DSS does not have the DBS field to itself. Primestar, for one, has proved to be a formidable competitor, and one that offers a cost advantage because no equipment needs to be bought. Further, by the time you read this, those two might be joined by the soon-to-be-launched AlphaStar and EchoStar DBS systems.

Even so, the future of DSS seems bright. To learn more about DSS, and direct-broadcast satellite TV in general, see our Guide to Direct-Broadcast Satellite TV in this month's installment of Gizmo. The story begins on page 9.

Carl Laron
Editor

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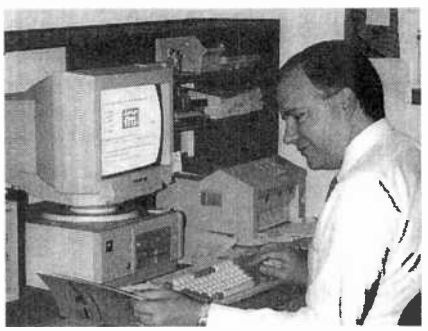

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LETTERS

The Readers Write

SPEAKER-ENCLOSURE DESIGN

I was pleased to see William R. Hoffman's article, "Build a Subwoofer" (**Popular Electronics**, July 1995). I would like to do just that, using the transducers that I already have, and have had for a good number of years.

I have a pair of Tannoy Dual-Coaxial 15-inch transducers that I acquired in infinite baffles more than 25 years ago. Those boxes were 23 cubic feet each, so when I moved to a smaller home in 1993, I had to sacrifice the enclosures. But I saved those magnificent speakers for just such purposes as you have now highlighted.

I do not have the full specifications on them, but they are known. What I need to know is how to determine the important dimensions for the bass reflex boxes needed for them to be returned to service as subwoofers. I would hope that each box might be of a size that approximates that of an end table, suitable for either end of a living-room couch. Incidentally, the professional crossovers come as companion units, and I would simply disconnect that circuit, which fed the aluminum spiders for the top end.

Is there a book that will show me how to determine the box dimensions and the tube location and length? Plus instructions on what I might need for sound-damping material inside? I will greatly appreciate your assistance so that I might once again enjoy those beauties.

H.S.
Benicia, CA

There are at least two different ways that you can get information on speaker-enclosure design: from books published on the subject and from readily available software packages for IBM-compatible personal computers. Those programs will calculate the values for the enclosure size and tuning requirements.

Two books that can be found at most Radio Shack stores are Building Speaker Systems *(#62-1087A) and* Advanced Speaker Systems *(#62-2317).*

*As for software, try one of the many freeware/shareware programs available on the subject. They can be obtained at any large computer shop or store that offers computer software. My article, "Design Your Own Loudspeakers" (***Popular Electronics***, February 1994) contains a BASIC program for doing sealed-box loudspeaker system design.*

But before you go out and purchase any of those books or programs, it would do well to keep in mind that they all depend on you knowing some specific pieces of information about your drivers: their Thiele/Small parameters. Since the work of those two engineers, done originally back in the late 1960s and early 1970s, most drivers recently produced (in the past 10 years or so) come supplied with those parameters by their manufacturers or distributors. And you can't get by without them! *If you don't have them, measuring them can take some time and a fair amount of experience and electronic/acoustic testing equipment. Such information as the magnet size, voice-coil diameter, cone material, etc., I am afraid, is completely useless to you! So it is important to keep in mind that when it comes to drivers made in the 1950s through the early 1980s, it is possible that you might find yourself unable to use them at all.*

I hope this information proves to be some help to you. Best of luck in your project.—William R. Hoffman

NEW VLF RECEIVER

The February 1995 issue of **Popular Electronics** carried a short article titled "Monitoring SID's" (*Ham Radio*) by my friend Joe Carr. I've not spoken to Joe since moving to Wisconsin, so I assume he is unaware that AAVSO no longer recommends the VLF receiver described in his column. Our new receiver—also designed by our technical coordinator, Arthur Stokes—is a unique device that uses "gyrator" technology and, therefore, no induction coils. The unit was described in our newsletter, "SID Technical Bulletin," and also in the Spring 1994 issue of *Communications Quarterly*. I would be happy to send this information to anyone with a sincere interest in its construction and use. Send a self-addressed, stamped envelope to my attention at AAVSO, 4523 Thurston Lane #5, Madison, WI 53711.

Those who are not familiar with the AAVSO program that deals with anomalous ionospheric effects might be interested to learn that our contributors currently supply over 75% of those data to the National Geophysical Data Center in Boulder, Colorado. It is a fascinating and scientifically productive project that has now endured for nearly 40 years.

PETER O. TAYLOR,
CHAIRMAN
AAVSO
Madison, WI

HAVES & NEEDS

I am seeking a musical chip, the MO83, as advertised by Roy Devault of Devtronix. Can anyone help me locate that company or that chip? Thanks in advance for any help that anyone might provide!

JOSEPH LOMBARDO
67 Huguenot Drive
Mastic Beach, NY 11951

I would like to know if anyone out there could make me a copy of a schematic for a Zenith model number S255 2P3 television. I would of course pay for all shipping and handling costs. Thank you.

WILLIAM RIGHI
10801 Ackerman Lane
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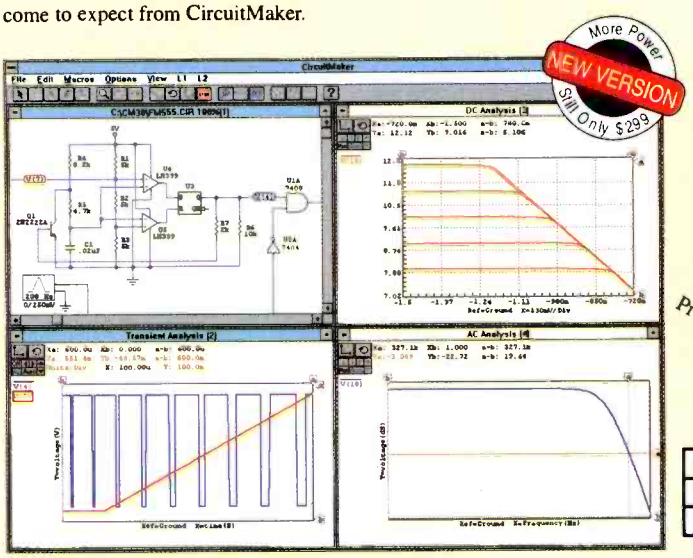

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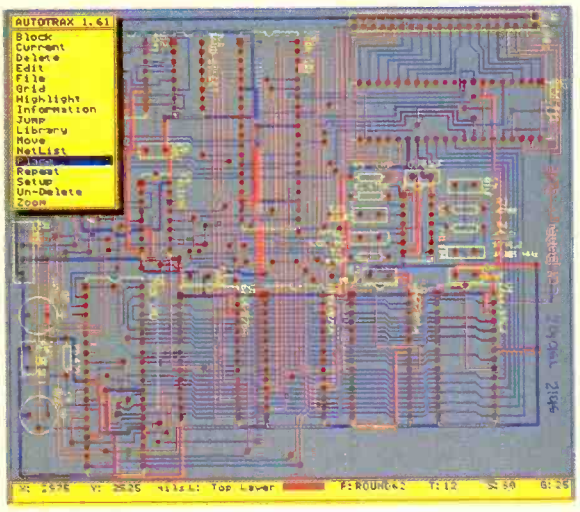

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NEW PRODUCTS

Telephone with Built-In Rolodex

Aimed at the small office/home office (SOHO) market, the *Telemaster* from *Rolodex Electronics* is a unique telephone/organizer that has the efficiency of a Rolodex phone-file system built right into a telephone. The organizer portion offers personal and business address/phone-number files; appointment and to-do lists with multiple-line data scroll that scan be searched by date or event; a real-time clock and alarm function; a 200-year monthly calendar; a 12-digit calculator; infrared data-transfer capabilities; and a confidential file that can only be accessed by a user-defined password. The phone features a speakerphone function, hold button, auto and speed dial, system-defined pause, and touch-tone compatibility. A large, Super-twist LCD screen has a six-line display with 24 characters per line for easy viewing.

The Telemaster is an integrated databank that is available in two-line (*Model 2000*) and one-line (*Model 1000*) versions. The Model 2000 has 128K memory and stores up to 2000 personal and business records. The Model 1000 has 64K memory and stores up to 2000 personal and business records.

The Telemaster 2000 and 1000 cost $129.95 and $99.95, respectively. For further information, contact Rolodex Electronics, 245 Secaucus Road, Secaucus, NJ 07096-2196; Tel. 201-348-3939; Fax: 201-348-0239.

CIRCLE 87 ON FREE INFORMATION CARD

REMOTE A/B SWITCH AND ANTENNA

It's common for people who live within several miles of broadcast towers to experience problems watching broadcast stations through their cable system. The metal connectors that hook the cable to the television delay the signal reception, causing distorted images, or ghosting, on the screen. TV viewers who are frustrated by faulty cable transmissions, or by satellite systems that don't include network stations, can switch to broadcast reception with the touch of a remote control using the *Emerson TV4706* remote A/B switch and TV antenna system from *Jasco*.

Turning the A/B switch automatically changes the reception from cable or satellite to broadcast, without unhooking the coaxial cable, or cable box. You don't even have to get off the couch, thanks to the system's remote control. The system, which includes a 12-position UHF/VHF/FM antenna, a remote control, and an A/B switch, is particularly well suited to areas that experience frequent cable outages.

The Emerson TV4706 has a suggested retail price of $69.95. For more information, contact Jasco Products Company, Inc., 311 N.W. 122nd, Oklahoma City, OK 73114; Tel. 800-654-8483.

CIRCLE 88 ON FREE INFORMATION CARD

PEN-STYLE DMM WITH LOGIC TEST

Extech's Model 381625 is an eight-function digital multimeter with a built-in logic probe tester. The pen-style meter measures DC/AC volts, DC/AC current, and resistance, and provides diode, continuity, and logic tests. It features a built-in positive test tip and sockets for a communications (negative) test lead and a logic power lead. The logic test provides red/green LED indication of CMOS/TTL high/low threshold levels. A large 0.5-inch LCD readout displays function and measurement, and indicates low battery and polarity. The pen multimeter comes with two 1.5-volt button batteries, a test clip lead for multimeter use, and power leads for logic tests.

The Model 381625 pen-style DMM costs $49. For additional information, contact Extech Instruments, 335 Bear Hill Road, Waltham, MA 02154-1020; Tel. 617-890-7740; Fax: 617-890-7864.

CIRCLE 89 ON FREE INFORMATION CARD

COMPUTER-CONTROLLED SCANNING

The *OptoScan535* from *Optoelectronics* is an add-on computer-control interface for the Radio Shack model PRO-2035 scanner. It provides optimum control in scanning, with the ability to tune the receiver from the computer while increasing the scanning speed. When equipped with the OptoScan535, the PRO-2035 scans faster than any other scanner using computer control.

(Continued on page 84)

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TECHNOLOGY UPDATE

Revolutionary new product heats, cools and humidifies. Finally—a solution to high fuel bills!

Small company introduces a new evaporative system that heats, cools and humidifies.

by Tyson D. Hindelang

Everyone knows what it is like to be cold or hot. Going outside in the dead of winter or the sweltering heat of summer, you expect it. You should not, however, be uncomfortable in your home. Unfortunately, most people are. You know what I mean—that one room that is never warm enough in the winter or cool enough in the summer.

People have many different ways to remedy the situation. The most common solution is to adjust the thermostat. Unfortunately, this is often the most costly. Today there is a solution that will help cut your fuel bills in the winter as well as the summer—it's name is Celsius.

Unlike any other. Celsius is the only device that combines the effects of a portable heater, cooler and humidifier. This three-way climatizer is all you need to supplement your home's heating and cooling system. It will heat a problem room in the winter, cool it in the summer and humidify it all year round.

Problem rooms. Imagine the benefits of being able to control the climate in different rooms of your home independently. Say you have a room that is always cold because it doesn't have proper ventilation. But because the rest of your home is comfortable, you don't want to adjust the thermostat. Now you don't have to! Just put Celsius in that room, and in no time it will be just as comfortable as the rest of your home.

Breakthrough material. The filter pad inside Celsius is unlike any other for several reasons. First, it rotates through the Celsius unit, absorbing water. Made of a washable nylon, the filter pad is mildew- and rot-resistant because it is always moving; it never sits motionless in a pool of stagnant water.

Another benefit of Celsius' filter pad is that it is pulled through two rollers, creating a self-cleaning effect. Celsius' filter pad can also aid in air filtration; airborne contaminants get trapped in the filter, giving you cleaner air.

Portable. Weighing only 24 pounds, Celsius is both light and portable. Its built-in wheels and side handles enable you to transport it easily from room to room, even when it is full. It is very compact (25" high x 17" wide x 13" deep)—it will fit virtually anywhere.

Health benefits. An environment with the proper level of humidity can alleviate common health problems: chapped lips, sore throats, cold and allergy problems and even asthma attacks. Physicians frequently recommend humidifiers for patients with upper respiratory problems. And because Celsius is also a humidifier, it is the perfect addition to any home.

The best heater. Celsius' heating system is the most efficient available. The heating process is similar to the cooling process. The ceramic coils of the heater retain their heat for a long time and radiate it very efficiently. The heater warms the air that passes through the moist filter pad and the fan disperses that warm, moist air into your room.

Where can you use Celsius?

- **ATTIC** Most attics don't get warm air because they don't have proper ventilation.
- **BEDROOM** Use it to warm a drafty bedroom.
- **WORKSHOP** Many workshops and garages don't have efficient heating systems.
- **LIVING ROOM** On cold days, it's hard to keep any high-traffic room comfortable.

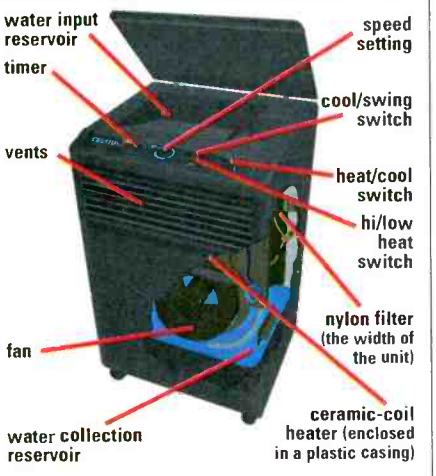
Saves money. Did you know that for every degree you lower your thermostat your fuel bill increases three percent? Celsius eliminates the need to constantly adjust your thermostat. Put Celsius in that one room that's too cold. Or lower your thermostat and keep Celsius in the rooms you occupy the most. It pays for itself by the end of one season! Plus, because it's a three-way climatizer, you don't need a separate cooler or humidifier—Celsius does it all!

Factory-direct savings. The combination of a heater, cooler and humidifier makes Celsius the perfect solution to maintaining a healthy, comfortable climate in your home. For a limited time, we're offering it at the introductory price of just $199. Try it and see what a difference it will make in your home!

Try it risk-free. Celsius is backed by Comtrad's exclusive risk-free home trial. Try it, and if you're not completely satisfied for any reason, simply return it within 30 days for a full refund, "No Questions Asked." Celsius also comes with a five-year manufacturer's warranty. (The first year, Celsius is 100% replaceable; remaining years are prorated.) Most orders are processed within 72 hours and shipped UPS.

Celsius makes cold, drafty rooms more comfortable without adjusting your thermostat.

HOW CELSIUS WORKS



Celsius is an evaporative room heater that is also a humidifier and cooler. Pour two gallons of water into the top of the unit. As water is collected in the bottom, a nylon filter pad rotates down into the water, making the pad moist. The pad then rotates upward into the air flow generated by the heater's ceramic coils, warming and humidifying the air. Oscillating louvers on the Celsius circulate that warm, moist air throughout the room.

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GIZMO®

DBS: The Changing Face of TV

Television broadcasting technology has gone through a few real revolutions since regular broadcasting began. Today's color pictures with stereo sound can provide a far more dramatic presentation than ever before.

In the home, TVs have changed in equally dramatic ways. Large screens and surround sound are taken for granted today. Remote control is no longer simply a convenience; many now consider it a necessity.

It's difficult to choose the single most significant change that TV has undergone since its invention. But without question, the most dramatic change in our lifetime is the sheer volume of programming that is now available.

The increase in programming is due directly to changes in TV distribution. From over-the-air to community-antenna TV (CATV), to cable, to satellite, to high-power direct-broadcast satellite, more people than ever before are tuning in every day to watch more programming than ever before.

Cable TV had its beginnings in the 1950s and was intended to bring TV signals to viewers living in rural areas too far from TV transmitters, or to viewers living in valleys where the ability to receive local broadcasts was hampered by the mountains that surrounded them. A single antenna mounted high on the mountain top was shared with all residents via cables running to each home.

Cable TV as we know it today began in September 1975 when Home Box Office became the first in the television industry to use satellites for the regular transmission of programming. The first presentation was the Ali/Frazier "Thrilla in Manila" heavyweight bout.

Another milestone was reached in the same year when a small UHF TV station in Atlanta beamed its signal to a satellite for distribution and in doing so became the first "superstation." WTBS is now enjoyed by millions.

The direct-to-home industry was launched in the fall of 1976 when TVRO pioneer Bob Cooper, Jr. became the first person in North America to operate a home satellite system. His 20-foot dish was able to receive signals from the three satellites that were in orbit at the time.

No one had expected that such home dishes would be a viable way of receiving television broadcasts. But many factors, including improvements in low-noise amplifier technology, allowed for smaller dishes, and a new industry was born. In those early days, everything was "in the clear" and programmers fought hard to make home satellite reception illegal.

The young industry fought back. Bob Cooper—in a contribution that is perhaps bigger than building the first home satellite system—petitioned the FCC to do away with two existing rules. One required a license for satellite receiving dishes, and the second required that a dish be no *smaller* than 9 meters (about 27 feet) in diameter.

In 1984, legislation was enacted to make the home reception of satellite programming specifically legal. In 1986, however, another law upheld the right of broadcasters to encrypt their signals, a move that almost was fatal to the direct-to-home satellite industry.

During the time that the debate over the existing C-band satellite issues was going on, new services were being envisioned at higher frequencies and at higher power. The new frequencies in the Ku region (11.7–12.7 GHz) were broken into two distinct bands by international agreement. In the Americas, the first band, 11.7–12.2 GHz, was set aside for fixed satellite service (FSS). The second band, 12.2–12.7 GHz, was the broadcast satellite service (BSS) band, intended for direct-broadcast satellites (DBS). The fixed-satellite-service band was intended to be used for point-to-point communications, while the BSS band was intended specifically for broadcasts to consumers. As it turns out, providers don't necessarily stick to those band definitions. There are direct-broadcast services provided at C-band, FSS, and BSS frequencies.

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Why DBS?

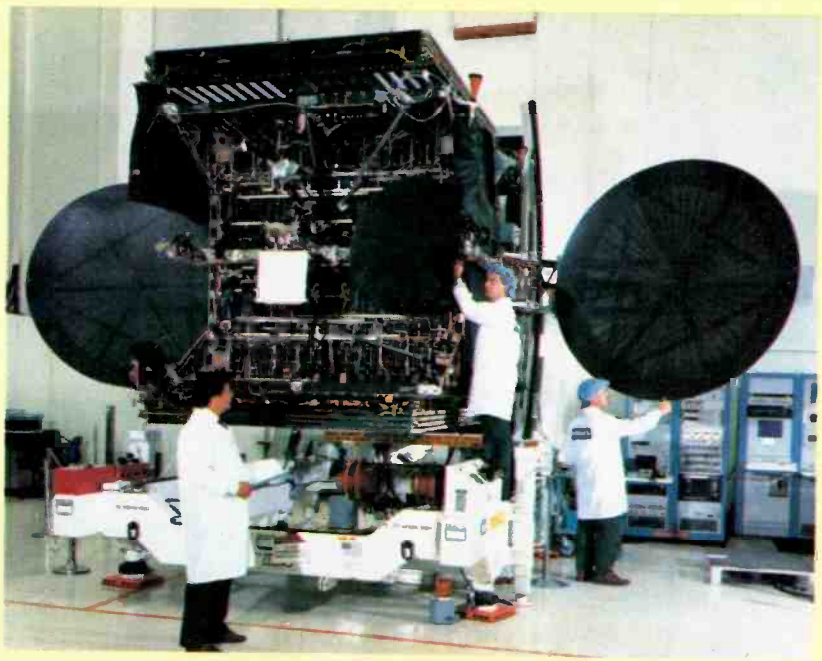
Satellite services operating at Ku-band frequencies have several potential advantages over similar services delivered at C-band. First—and considered by some to be most important—is that Ku-band dishes can be smaller. That has nothing to do with the frequency of operation, but is due solely to the fact that Ku-band satellites are more powerful than their C-band counterparts.

Today, C-band satellites typically operate at a power of between 8.5 and 16 watts. Current Ku-band satellites typically operate at a power of between 20 and 50 watts. The satellites that deliver DSS programming are operating at 120 watts.

Why are C-band satellites so weak? The earliest satellites, as well as some older satellites still in operation, are low powered for two reasons. First, the technology for high-powered microwave transmitters was not sufficiently advanced back when those satellites were launched. Second, satellites aren't the only inhabitants of the C band. They must share the spectrum with ground-based telephone microwave transmissions. Therefore C-band satellites are limited in power to avoid interfering with telephone transmissions. Interference from such microwave links, known as *terrestrial interference*—can often cause degradation of picture quality of home satellite receiving systems.

The smaller Ku-band dishes have other advantages besides simply being less conspicuous. They are easier to install, have less wind-load problems, and can often be easily roof-mounted—an important consideration in densely packed urban and suburban environments. Small dishes are also easier to manufacture and ship, and they can be made closer to a true parabolic shape than larger dishes. Because they are usually one-piece designs, they maintain their shape better than C-band dishes, which are often assembled from eight or more "petals."

Although suitable receiving dishes can be made smaller as the satellite transponder power increases, there is a limit to how small they can be made. That limit is determined by the "field of view" or beamwidth of the dish. Smaller dishes have wider beamwidths. If a dish is made too small, it will "see" two or more satellites at a time, each of which will interfere with the other. Therein lies the major difference between the C, Ku-FSS, and Ku-BSS bands. Satellites in the C- and Ku-FSS bands are spaced every two degrees, where Ku-BSS satellites have an orbital-slot spacing of nine degrees. Even with equivalent power levels, that allows smaller dishes to be used.



DSS-1, the first high-power direct-broadcast satellite, is shown here being assembled by Hughes.

The Business of DBS

In 1980, Satellite Television Corporation (STC) became the first company to file with the FCC for a DBS system. Other companies, including Comsat, and United States Communications, Inc. tried and failed to launch DBS services.

In the 1990s, DBS seems to be succeeding as a business. Two systems, Primestar and DSS are currently in operation. Two more, Alphastar and EchoStar, are hoping to be in operation by the time you read this or shortly thereafter. In all cases, the key element that has made that success possible is digital data reduction, or compression.

Primestar

Primestar, a DBS provider since 1990, became the first to deliver DBS programming digitally in April 1994. Primestar is a partnership of six multiple cable system operators in the U.S. and G.E. American Communications. The six cable companies are Comcast Cable, Continental Cable Vision, Cox Cable Communications, Newhouse Broadcasting, Tele-Communications Inc, and Time Warner Cable. G.E. American Communications owns the satellite (GE Americon K1, 85 degrees West longitude) used by Primestar.

A complete hands-on look at Primestar appeared in Gizmo's July issue. Here's a brief recap:

Primestar delivers about 70 channels of programming to dishes roughly three feet in diameter. Subscribers lease a dish and a decoder box that are maintained by the Primestar distributor. Primestar subscribers do not have to buy any equipment, but they must have the system professionally installed at a cost that typically varies between $100 and $200. Any required equipment upgrades will be handled at no charge to customers.

Primestar beams its programming up to its satellite from several transmission locations in Colorado and New Jersey. The signal reaches the satellite, is boosted in power, and then sent down to subscribers' reception dishes on earth, where it is channeled to a decoding box inside the subscriber's house, and then to the television.

Primestar is hoping to shift its service from its current medium-power satellite in the FSS band to a high-power service in the BSS band. However, in April 1995, the FCC dealt a major blow to those plans when it stripped Advanced Communications Corp of its high-power DBS orbital slot. Advanced had reached a deal to sell the 27 channels at its slot to a subsidiary of Tele-Communications Inc (TCI), a 15% owner of the Primestar service. As we went to press, it was still unclear whether an appeal by Advanced had any chance of succeeding, or whether the slot might be auctioned off to the highest bidder. The FCC revoked Advanced's permit because the company, licensed since 1984, was not close to providing DBS service to the public by itself.

At the beginning of 1995's fourth quarter, Primestar had more than 600,000 subscribers.

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DSS

The DSS digital satellite system became the first high-power DBS service in June of 1994. Within the first year, Thomson Consumer Electronics, the first DSS hardware supplier, had shipped over a million units from its factories under its RCA brand name. As of September 1995, about 800,000 consumers were subscribing to programming.

A number of companies joined forces—and invested over one billion dollars—to make the new satellite system a reality. Among the main players are Thomson Consumer Electronics, Hughes Space and Communications Company, DirecTV, and USSB.

Thomson not only built the first receivers, but also developed the digital-compression hardware on which DSS depends. Hughes built and launched three satellites that are currently providing programming. DirecTv, Inc., a unit of GM Hughes Electronics, is acting as one program provider. United States Satellite Broadcasting, or USSB, a subsidiary of Hubbard Broadcasting, Inc., is a second program provider.

Initially, programming from the satellite was compressed in the MPEG-1 format because Thomson was behind schedule producing MPEG-2 encoders. As we went to press, the switch to MPEG-2 transmissions was imminent. When Thomson completes its development of MPEG-2 encoders, all broadcasts will shift to that compression scheme. All DSS receivers contain MPEG-2 decoders.

RCA executives like to use the ability to shift from MPEG-1 to MPEG-2 as an example of the forward-compatibility of the DSS system. According to James E. Meyer, an RCA Sr. Vice President, "It has the capability for receiving 16×9 widescreen-format TV signals as well as HDTV broadcasts once that revolutionary technology is in place."

The first DBS satellite, called DBS1, was launched in December 1993 from Kourou, French Guiana aboard an Arian rocket. A second, and then a third satellite joined the original. They are co-located with the first satellite in geosynchronous orbit at 101° West longitude.

Each satellite has sixteen high-power (120-watt) transponders. In comparison, C-band satellites that distribute conventional satellite TV to dishes that are typically seven to ten feet in diameter have an average power of less than 16 watts per transponder.

On analog satellites, each transponder can distribute several audio signals and one, or sometimes two, video signals per transponder. The 48 transponders on the three DBS satellites can distribute over 175 channels of programming thanks to digital "compression" or bit-rate reduction. An exact number of channels can't be given because different programming will be compressed differently. The compression ratio for, say, a live sporting event would be much lower than for an old black-and-white movie. The frame rate of the source material—and the desired quality of the output—also affect the compression ratio that could be achieved. According to Hughes, each transponder can be used to broadcast up to four live video signals or up to eight movies.

The amplifiers, according to Hughes, are suitable for analog or digital signals, and will be capable of transmitting HDTV signals and compact-disc-quality audio. The uplink signals are sent from the DirecTv Castle Rock Broadcast Center in Colorado. The facility is capable of transmitting up to 216 simultaneous broadcast channels to the three satellites.

Artist's concept on of the high-power DSS satellite in orbit.

Sony Corporation became the second authorized manufacturer of DSS receiving hardware. Soon to join Thomson and Sony are Toshiba, Hughes Network Systems, and Uniden.

Like most satellites, Hughes' satellites have an expected operational lifetime of about twelve years. Although the electronics on board will likely be still operating after that time, the spacecraft will run out of fuel. Although in geostationary orbit, the satellites require propellants to ensure precise positioning because of the gravitational effects of the sun and moon.

AlphaStar

AlphaStar Digital Television is the U.S.-based subsidiary of Tee-Comm Electronics, Inc., a Canada-based company. AlphaStar plans to launch its service in late 1995 on a medium-power (60-watt) Ku-band FSS satellite. (The satellite is AT&T's Telstar 402R, the replacement for Telstar 402 that was lost shortly after launch in September 1994. The satellite has been successfully launched, and was being moved into position as we went to press.)

The 13 transponders that AlphaStar has secured on the new satellite will allow the company to broadcast "more than 100 video, audio, and information services using digital compression," according to AlphaStar statements.

That capacity is expected to be expanded to well over 200 services in 1997 with an additional 24 transponders secured on AT&T's planned Telstar 5 satellite. Those new transponders will be powered at 100 watts. That additional service will allow AlphaStar not only to increase the amount of services that it delivers, but also to reduce the size of the dishes that are required to receive the signals.

AlphaStar recently purchased its uplink center, located in Oxford, Connecticut, from GE Spacenet. One of the advantages of the site, according to AlphaStar, is the ability to see the European satellites lo-

(Continued on page 20)

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CIRCLE 60 ON FREE INFORMATION CARD

Dishing Up a Video Feast

RCA DIGITAL SATELLITE SYSTEM. From Thomson Consumer Electronics, 600 North Sherman Drive, Indianapolis, IN 46201; Tel. 317-267-6613. Price: $899. DSS PROGRAMMING PACKAGES. From USSB, 3415 University Avenue, St. Paul, Minnesota, 55114; Tel. 612-645-4500; and DirecTv, P.O. Box 92424, Los Angeles, CA 90009. Prices: see text.

USSB, one of the two DSS program providers, recently conducted a telephone poll in which 1000 randomly selected men and women, aged 18 and older, were quizzed regarding their television-viewing habits. The results of the "USSB Telescoop Survey" were sometimes alarming (19% of respondents said that they could not survive without television), sometimes amusing (15% have left the TV on when they were out of the house to keep their pets company), and sometimes reassuring (three out of five said that they are *not* watching the O.J. Simpson trial). Providing a glimpse at American home life, the survey also revealed that 78% of adults consider watching TV with their children to be a family activity.

Getting down to the business end of the poll, however, the questions and responses were somewhat predictable. Asked "Would the following be considered beneficial to your TV viewing pleasure," 59% answered "yes" to laserdisc quality picture, 59% said "yes" to CD-quality sound, 84% value the ability to "watch what you want, when you want," and 70% would appreciate having parental channel control.

That multi-part question was somewhat skewed to reflect the attributes touted by DSS—rather like a Volvo dealer asking potential customers if they felt that side-impact airbags would increase their driving safety. After all, audio and video quality and the tremendous selection of programming are DSS's primary selling points—and viewers with children need some way to control their kids' video intake.

The DSS system gives viewers high-quality (though not "laserdisc-quality") video, superb audio, a few ways to determine "when" and "what" they view, and what their children don't view. But, first and foremost, it provides an incredible array of programming. Let's take a look at the big picture by examining all of the programming available on DSS, before delving into how the system is used.

The Sky's the Limit

The two DSS programming providers, USSB and DirecTv, offer distinctly different but highly complementary packages. DSS system owners can opt to subscribe to packages from either one or both providers, and will receive separate bills from each company.

USSB offers "multichannels" of the most popular premium movie channels—five channels of HBO, three Showtime channels, two stations showing The Movie Channel, three Cinemax selections, and a single Flix channel. It also provides Lifetime, Comedy Central, Nickelodeon, MTV, VH1, and the All News Channel.

Customers have several package choices, ranging in price from $7.95 a month for "USSB Essentials"—MTV, VH1, Nickelodeon/Nick at Nite, Lifetime, Comedy Central, and All News Channel—to $34.95 a month for "USSB Entertainment Plus"—consisting of the Essentials, Flix, plus all of the multichannel premium movie channels mentioned above. Unlike the "tier" system used by most cable companies, USSB allows viewers to subscribe to a movie channel without getting the basic package. All five HBO channels, or three Showtime channels plus Flix, can be purchased for $10.95 a month.

DirecTv offers close to 150 additional channels, including up to 50 Direct Ticket pay-per-view movie options, with hit films starting as often as every 30 minutes; several sports packages; regional sports programming or Prime Sports Network; and movies on seven Encore channels, each with a different theme. DirecTv also offers a host of popular stations such as The Learning Channel, The Disney Channel (East and West), CNN, The Sci-Fi Channel, A&E, Bravo, Court TV, and The Weather Channel.

Again, subscribers have several package (and one "non-package") options. Packages range from Plus DirecTv, with 14 channels plus 28 digital music channels on Music Choice for $14.95 a month, to $29.95 a month for some 40 channels plus Music Choice. All DirecTv packages provide access to up to 60 channels of movies, sports, and live special events on a pay-per-view basis, a "coupon" worth $2.50 off the first Direct Ticket program purchase each month, and three channels previewing current and upcoming movies, sports, and events.

Those who prefer to avoid pre-assembled packages can opt for DirecTv Limited. For $5.95 a month, it provides Bloomberg Information Television (24-hour coverage of worldwide business and financial news) and access to all DirecTv pay-per-view programs and a la carte sports and entertainment offerings.

Viewers can then create their own packages by ordering a la carte programming, choosing to subscribe on a monthly basis to The Disney Channel ($9.95), The Golf Channel ($6.95), Multichannel Encore ($5.95), Multichannel Encore with Starz! ($10.95), Music Choice ($2.95), Playboy

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TV ($9.95), and TV Asia ($14.95). Playboy TV can also be ordered for $4.95 per night. Viewers who live in areas that are not served by the local broadcast network affiliates—ABC, CBS, Fox, NBC, and PBS—can pay $3.95 a month to receive those channels via DirecTv.

DirecTv does not provide local channels, independents, superstations, or affiliates of the Warner Brothers or United Paramount Networks. Star Trek fans, for example, will have to use a rooftop antenna or local cable service to catch their favorite show. (Fortunately, the receiver provides an easy one-button solution for switching between the two sources.)

Sports packages include NFL Sunday Ticket ($139 for up to 197 regular season games); NBA League Pass ($149 for over 700 out-of-market regular season pro basketball games); and NHL Center Ice ($119 for most NHL regular season pro hockey games). The ESPN/ABC Sports College Football package costs $9.95 per weekend for three to five out-of-market top-conference games. And for $79.95 per year, or $7.95 per month, DirecTv Sports Choice provides hundreds of college football, basketball, and baseball games per season, as well as coverage of boxing, pro tennis and golf, minor-league hockey, soccer, volleyball, horse racing, and wrestling.

Obviously, in sheer volume alone, DSS lets you "watch what you want, when you want." With scores of available programming, you're practically guaranteed to find something that you consider worth watching. Multichannel premium movie channels afford you a better chance to catch special events and the movies you want to see. And Direct Ticket pay-per-view films start as often as every 30 minutes. If you've started to watch a movie at 8 P.M., and get a 10-minute phone call at 8:15, you can call DirecTv and ask to see the film again, starting at 8:30. That allows you to pick up where you left off, without being charged for two movies.

Of course, you could always record the film for viewing later. However, the RCA DSS system provides no easy, one-step time-shift solution. You will either have to record shows manually, or leave your DSS receiver on with your VCR set up to record it at the appropriate time.

Navigating the System

With so many programming choices, you could easily spend an entire evening just flipping through the channels looking for the best show to watch. The DSS on-screen programming guide makes it easier to make your choice.

The grid-style guide resembles the printed TV schedules found in many newspapers and magazines. The screen displays six channels arranged vertically by channel number and two hours of programming, divided into half-hour segments. The times are displayed in a bar across the top of the grid, the station names and numbers appear in a bar on the left-hand side of the grid. To see more channels, you use the up and down arrow buttons on the remote control or receiver front panel. To see programming a couple of hours, or several days (up to 54 hours), down the road, you use the right arrow to pan the screen.

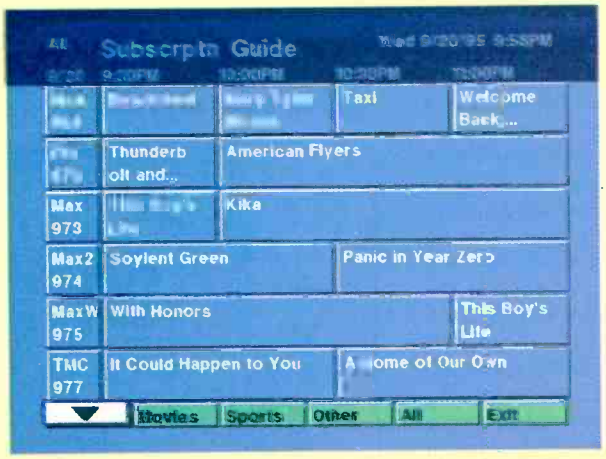
To actually view a show that you've seen listed on the grid, you use what RCA calls the "point and select" technique. First, you use the arrow keys to move the on-screen cursor to point to (highlight) that show; then you press the SELECT/DISPLAY bar. (Point and select is used throughout the DSS menu system as well as the program guide.) A new screen appears, featuring a basic description of the program along with three option "buttons"—view, info, and exit. To view the show, simply press SELECT again. To learn more about the program, point to info and press SELECT. Choose exit to return to the on-screen guide.

If, however, you've bought the top-of-the-line packages from both providers, you could easily spend the whole night just browsing through the on-screen guide. To avoid that dilemma, DSS allows viewers to customize their programming grids in several different ways.

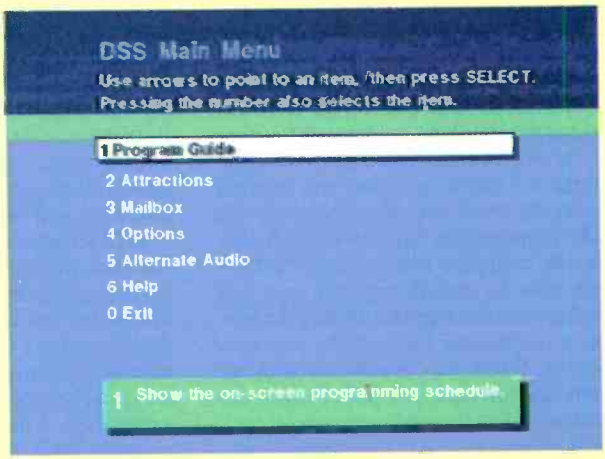
A bar across the bottom of the grid features a down arrow for scrolling through the channels, an exit button for exiting the guide, and keys labeled Movies, Sports, Other, and All. Selecting Movies, Sports, or Other simplifies the guide by limiting it to all movies, all sports, or a sorting topic such as series, specials, news, or shopping from the Other list. You can further simplify the guide by then choosing from the Theme lists that appear, selecting only comedies or action movies, or just baseball games, for instance. Pointing to and selecting the All button resets the program guide to show all available channels and listings.

"All available channels and listings" refers not to those channels to which you subscribe, but to all that are offered by the programmer(s) to which you subscribe—close to 175 in all. But you don't have to see all those channels in the list all the time. Selecting "Channel Lists and Limits" from the DSS main menu allows you to create four custom channel lists. The Channel Lists and Limits screen displays four vertical columns of boxes—labeled Normal, Fav A, Fav B, and Parent-Approved—that correspond to the channels listed on the left-hand side of the screen. Using the point-and-select method, you can place check marks inside the boxes of the channels that you want to include in each list, and delete the check marks to remove unwanted channels from that list.

The Normal list is the program list that will be in effect each time you turn on the DSS receiver. It can include as many channels as you like. Although we often watch them, we deleted all the pay-per-view and premium movie and sports channels from our Normal list. When we want to view a



The DSS on-screen guide makes it easy for viewers to find out what's on.



Virtually all of the functions of the DSS receiver can be accessed through menus and submenus.

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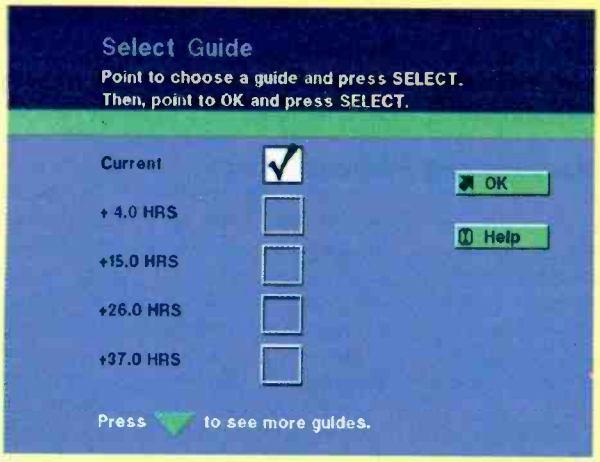
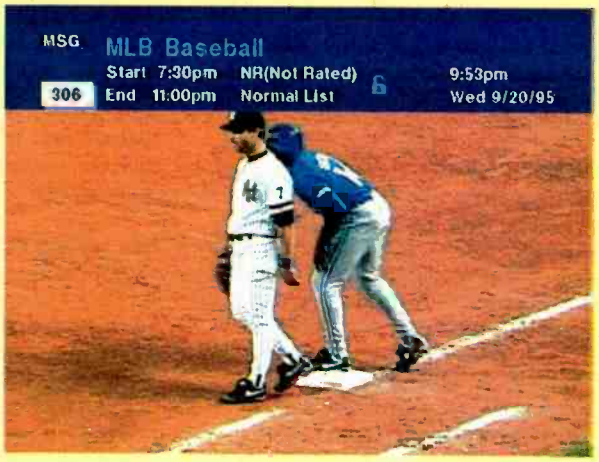


The program guide can show you what's on up to 54 hours in the future.



As you flip through the channels, a top-of-screen bar lets you know what you're watching.

movie or sporting event, we can simply point-and-select the on-screen Movies or Sports keys. We also deleted the 28 Music Choice channels (preferring to listen to music delivered by the DMX system reviewed elsewhere in this issue), and a score of channels that we don't often watch.

At any time, we can return to the All list by pointing and selecting it from the on-screen bar, or we can use the FAV button on the DSS remote control to scroll through the various channel lists. With each press of the FAV button, a different list is activated, always cycling in the same order: All, Normal, Fav A, and Fav B.

The Fav A and Fav B lists allow you to edit the grid down to just ten channels each. A husband and wife might each have their own favorites list, or you might create one for the adults in the house and one for the kids.

The channels in the Parent-Approved list are also selected by checking boxes—in this case, only those boxes whose channels are deemed acceptable for young viewers. But another step is required to prevent those channels without checks from being viewed—you must lock the system.

The Locks, Limits, and Channel Lists menu also allows you to set ratings and spending limits. You might decide to set the ratings limit at PG-13, for instance, and restrict your kids' purchasing power to $6, or two movies. Once you've set the ratings and spending limits, and selected parent-approved stations, selecting the lock system option enforces those limits. You are prompted twice to enter a four-digit code to lock the system, and that number must be entered to unlock the system or override the set limits for your own viewing. When you override one limit, all limits are off until you power down the receiver. When the receiver is turned back on, the limits will be in place once again.

It's fairly easy to master the art of navigating the DSS on-screen menu system and program grid. The point and select method works throughout the entire system.

If you prefer channel surfing to reading the on-screen guide, you can always find out what you're watching by pressing the SELECT/DISPLAY button. A bar appearing across the top of the screen tells you the channel name and number, the program name, the start and end times, the rating, and the current time and date.

And if, for some reason, you still manage to get lost or confused, there are several places to turn for help.

Just about all of the display screens include a prompt at the top of the screen (To purchase a program, point to BUY and press SELECT. Then point to EXIT and press SELECT.) Most of the menus feature a short description of what the menu is used for, appearing at the bottom of the screen. Other display screens provide on-screen help buttons that, when selected, provide still more information about that screen.

There's also a separate Help menu that lists a variety of topics about which you can learn. Submenus describe the remote control, the program guide, the menu system, program types, and the receiver's front and back panels. The Help menu even offers a glossary of DSS terms.

Once you've learned your way around the system, watching TV on the Direct Satellite System is a pleasure. DSS meets its promise of delivering high-quality video and audio. Reception is almost always crystal clear, approaching the quality of laserdiscs and full-size satellite delivery.

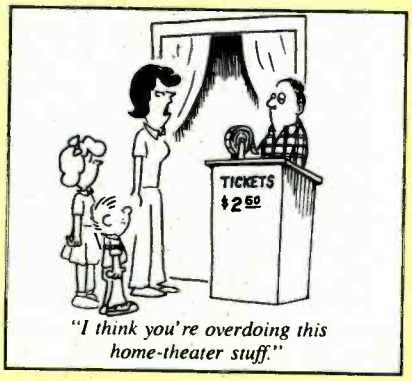
DSS reception is not perfect, however. Occasionally, the picture will break down into large, blocky pixels. Other times, the screen will freeze for a few frames. Such digital artifacts were relatively rare, and although they could be a bit disconcerting, they didn't really detract from our viewing experience. Viewers accustomed to the typically awful signals delivered over most cable systems should find the digital artifacts easy to overlook.

Since the service launch, all parties involved have been striving to improve system quality. Complaints from users continued to drop as quality improved thanks to such technology as statistical multiplexing and MPEG-2 encoding.

DSS is potentially subject to rain fade—a phenomenon that we did not experience during our tests. During heavy thunderstorms, it is possible for the received signal level to drop far enough for the picture to be lost or for the artifacts to increase to an unacceptable level. We didn't experience any rain heavy enough for that to happen.

Clearly (pun intended), DSS provides those features that respondents to the USSB Telescoop survey considered beneficial to their viewing pleasure. Audio and video quality are excellent, and program choice is vast. The system is easy to use, and afforded a strong sense of control over our viewing environment.

We did have a few complaints, however. First, we would have preferred to hear the audio of the program tuned while we browsed through the program guide. Second, we would have appreciated an easy way to record programs from DSS on our VCR. We also would have liked larger personal favorite lists. Lastly, we found DSS to be hazardous to our real lives. It's far too easy to just keep watching, neglecting sleep, family, and work! ■



"I think you're overdoing this home-theater stuff."

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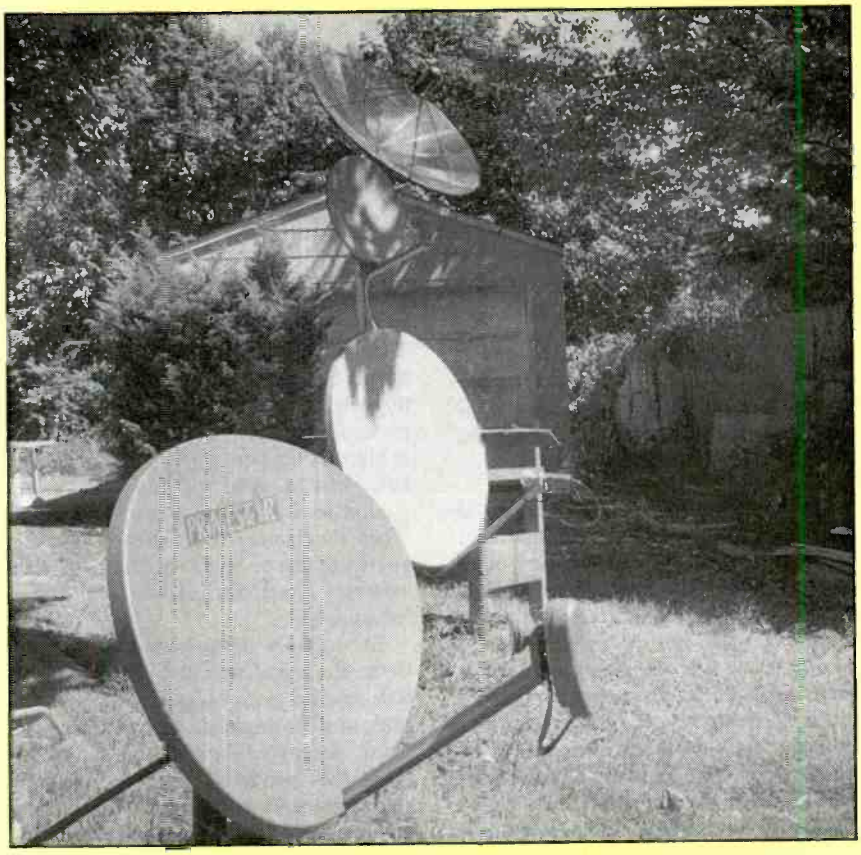
Easy Installation



Anyone who has ever installed a traditional terrestrial TV antenna should have no trouble installing the RCA DSS dish. Anyone who has installed a C-band or traditional Ku-band dish will chuckle at the simplicity of the DSS installation. Even people who have never installed any antenna previously can have the RCA satellite dish installed and properly aimed in an afternoon—it's just that easy.

Nonetheless, most people opt to have their DSS equipment professionally installed. If you're uncomfortable routing coaxial cable from your TV out to the dish or climbing on your roof if a roof installation is necessary, or if you just want someone else to blame in case something goes wrong, then you, too, should consider having a professional install your dish.

The most important installation step comes before you open a box, and even before you buy any equipment. That's the site survey. The site survey ensures that you have a clean line of sight to the DBS satellite.

All geosynchronous communications satellites are located in the *Clarke belt* over the equator, some 22,000 miles up. The three satellites beaming DSS programming are co-located at about 101° West longitude. So, for example, to people located in Texas, the satellite will appear pretty much due south (true south, not magnetic south). For people on the east coast, the satellite will appear to the southwest. To people on the west coast, the satellite will appear to the southeast. The elevation of the satellite or the distance above the horizon will appear to decrease as you move further north.

The accompanying table lists approximate pointing coordinates for various cities in the U.S. Keep in mind, however, that the azimuths shown are based on true south. You will need to find the magnetic deviation before you can accurately determine azimuth. The magnetic deviation for your area can usually be found by calling your local airport.

Once you determine the approximate pointing coordinates for the satellite, you'll need to get a compass, a protractor or inclinometer, and a sighting stick. Then using your compass, point the stick in the direction indicated by the azimuth at an angle above the horizon at the elevation angle. You must have a clear view in that direction. Anything such as a tree, house, or other obstruction makes receiving the signals impossible. Remember, trees grow, sometimes quickly.

When you are satisfied that you have one or more locations that provide a clear line of sight to the satellite, then you can unpack the DSS equipment. The carton contains the receiver and a second carton that contains the dish, the LNB (low-noise block downconverter) and its support arm, a mounting foot with mast, and a hardware packet.

Additional material that is not provided with the system but that is required for installation includes RG-6 coaxial cable, F connectors, a grounding block, ground wire, and a ground rod. Tools that are required include 7/16- and 1/2-inch wrenches, plumb line and/or bubble level, screwdrivers, and a drill.

The dish is easy to assemble—it is attached to the LNB support arm with four bolts. The LNB is installed after the coaxial cable has been routed.

The dish can be mounted in a great variety of ways, but the two basic options are to mount the dish on the supplied mast with mounting foot, or to mount it on a mast of your own. Our installation used our own mast. Installation kits are available from RCA, but they contain material that can usually be purchased cheaper elsewhere.

TABLE 1—
FINDING THE SATELLITE

City	Azimuth	Elevation
Atlanta, GA	207°	46.6°
Chicago, IL	199°	39.7°
Dallas, TX	188°	51.8°
Denver, CO	173°	44.0°
Des Moines, IA	191°	41.4°
Las Vegas, NV	157°	45.6°
Los Angeles, CA	150°	46.2°
Miami, FL	221°	51.6°
Nashville, TN	202°	45.6°
New Orleans, LA	201°	52.9°
New York, NY	211°	37.5°
Pittsburgh, PA	210°	38.4°
Portland, ME	221°	30.9°
St. Louis, MO	196°	44.0°
Salt Lake City, UT	163°	41.2°
Santa Fe, NM	171°	47.8°
Seattle, WA	151°	31.5°
Washington, DC	215°	38.4°
Wichita, KS	185°	46.3°

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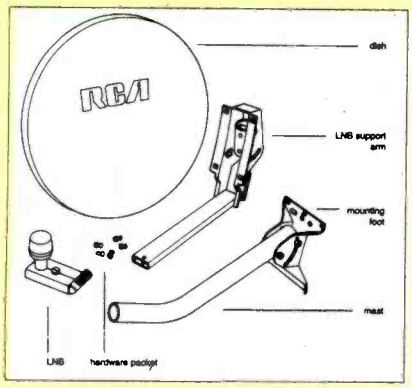


Fig. 1. This diagram, reproduced from the RCA installation manual, shows the components of the DSS dish carton.

The mounting foot can be attached to the top of a deck railing, the side of a house, a chimney, or virtually any other sturdy surface. The mounting materials vary depending on the surface, but not in surprising ways. For example, to mount the dish on the side of a hollow wall, you'll need toggle bolts. To mount on a stud, you'll need lag screws. To mount on a chimney, you'll need a chimney-mount kit similar to the kind that would be used for attaching a standard antenna to a chimney.

As with any satellite antenna installation, the most important constraint on mounting is that the mast be installed so that it is vertical and sturdy. The mast can be adjusted in the mounting foot so that it is vertical. A plumb line or level must be used to ensure that it is perfectly plumb.

We chose to mount the dish on our own pole—a 1¼-inch inside diameter, schedule-40 galvanized steel pipe. The pole must be installed so that its bottom is at least three feet below grade level, and at least six inches below the frost line. The bottom of the pole should be cut diagonally so that it can't rotate in the ground. Alternative ways to keep the pole from rotating are to either weld a metal cross piece to the bottom of the pole or install a bolt through the pole.

To install the pole, you must first dig a hole with a 12-inch diameter and to a depth as described in the preceding paragraph. Then the pole is placed in the hole and the hole is backfilled with enough dirt to hold the pole upright. The pole must be made perfectly vertical in all directions and held in place by temporary guy wires. Then the hole must be filled within two inches of ground level with quick-drying cement. When the cement is completely dry, the guy wires can be removed. The LNB/dish assembly is then placed on top of the mast for aiming.

To comply with the National Electrical Code, the metal structure of the outdoor dish antenna must be grounded, and the cable must be grounded where it enters the house. To ground the dish, you'll need an eight-foot ground rod, a ground-rod clamp, ground wire, and a zinc-plated bolt (supplied). For our pole-mounted configuration, we grounded the pole. For other installations, the mounting foot would need to be grounded.

The cable is attached to the LNB after routing it up the LNB support arm. Then the LNB is fastened to the support arm with the supplied bolt and nut. Of course, all entry points to the house should be sealed to prevent water entry.

The receiver has a couple of features built in to make pointing the dish almost foolproof, especially if you did your homework correctly during the site survey. After our pole was up, we were able to align the dish in about five minutes.

To aim our dish, we brought the DSS receiver and a portable TV out to the dish. A few pushes of the remote control let us navigate through the on-screen menu to the selection "Point dish using your zip code." We then entered our ZIP code with the remote control, and were presented with the azimuth and elevation for our location.

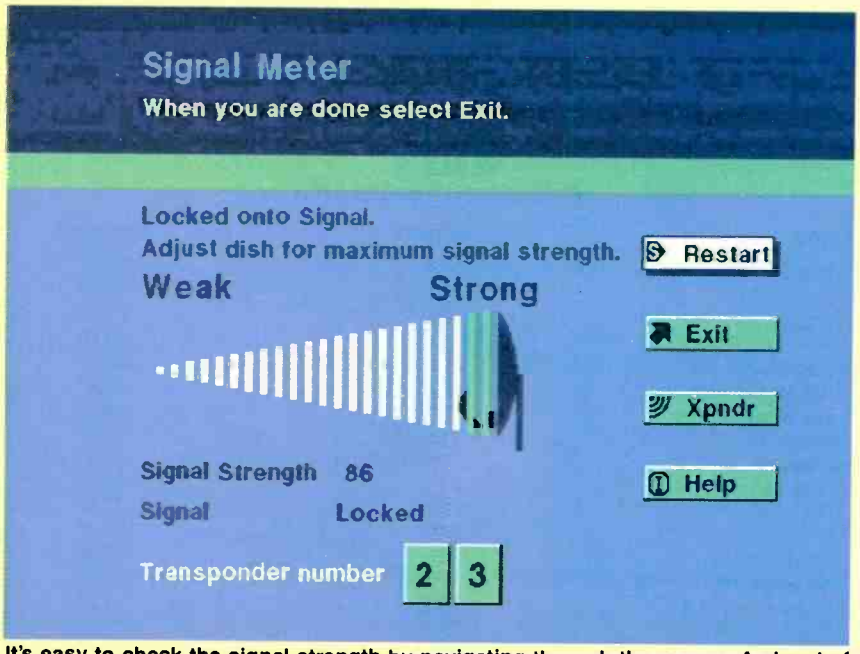
We then loosened the elevation bolt on the sides of the mount and moved the dish so that the scale on the side aligned with the indicator at 34°. We already had the dish pointed in the general direction of the satellite, but we needed to set the azimuth exactly. For that, we used the receiver's built-in signal-strength meter. The meter provides both audible and visual indicators of the relative signal strength. As the dish comes closer to locking in on the satellite signal, the short tones become one long, continuous tone and the display shows the relative signal strength both graphically and with a number.

It would be possible to adjust the outdoor dish using assistance from someone else stationed inside in front of the receiver. Perhaps wireless headphones would make such remote aiming possible by allowing you to hear the beeps. However, we recommend bringing the receiver out to the dish along with a portable TV so that you can get instant feedback, and to avoid both yelling back and forth and what are sure to be many frustrating trips in and out of the house.

After the azimuth is adjusted for a signal peak, the elevation can also be fine tuned for a maximum signal reading. Once that's done, make sure to re-tighten the elevation bolt.

The installation guide provided with the DSS system doesn't leave any questions unanswered. For example, it contains sections on how to route coaxial cable under floors and through walls. It also contains information on basic hardware techniques such as how to use toggle bolts in cinderblock walls, or how to install expansion anchors in brick.

We understood the general procedures of dish installation before we undertook the DSS installation, and we have previously installed C- and Ku-band antennas. However, we were still surprised at the ease with which we were able to install and align the DSS dish. If you are at all adept at these kinds of tasks, we would encourage you to give it a try, too, and put the more than $100 that you'll save toward some of the superb programming that's available on DSS. ■



It's easy to check the signal strength by navigating through the menus. A signal of about 40 or over is required for reception. A higher signal helps to reduce the chance of losing the signal during heavy rainstorms.

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Spaced-Out Music

DIGITAL MUSIC EXPRESS DIRECT BROADCAST SATELLITE SERVICE. From DMX, Inc., 11400 East Olympic Blvd., Suite 1100, Los Angeles, CA 90064-1507; Tel. 310-444-1744; Fax: 310-444-1717; Prices: Businesses: $80–$100 month includes equipment lease and programming. Home Satellite Dish Owners: $150 for DMX receiver, plus $15 monthly subscription fee. Cable subscribers: $5–$10 a month for 30 channels.

We recently found ourselves humming along to a tune playing over our local supermarket's Muzak system. It took a minute or two for us to realize that the song was the Door's "Light My Fire." We began listening a bit more closely, and also heard Muzak renditions of songs by Bob Dylan, the Jefferson Airplane, and the Rolling Stones. We didn't know whether to be horrified or amused to hear the music that had had such a profound influence on an entire generation reduced to the innocuous, canned sound of Muzak.

Yes, Muzak has its place, and serves a purpose. After all, business owners don't want to regale their customers with commercial radio broadcasts (with its ads for other, perhaps even competitors', companies). And it's become increasingly difficult to find a station that plays only the type of music you want to hear, now that so many formats have become catch-alls. "Classic rock" stations, for instance, play everything from 60's oldies to today's alternative rock, from heavy metal to folk rock—sometimes in the same set. That mix is practically indistinguishable from that played by the station a short way down the dial, which calls its programming "alternative rock."

Not many business owners have the time or inclination to program their own, commercial-free music mixes. And copyright laws prohibit businesses from using the radio to entertain their customers. If a business wants to keep the sound unobtrusive and inoffensive, Muzak is one possible solution. The problem is that many find their sanitized renditions of beloved classics to be offensive.

Now there's a better way for businesses to provide music to shop or dine by. *Digital Music Express*, or *DMX*, offers up to 120 channels of CD-quality stereo music, 24 hours a day, with no commercial or disc-jockey interruptions. Delivered via direct-broadcast satellite (DBS), or through local cable companies, the service provides thousands of songs in virtually every imaginable musical genre, played by the original artists. Best of all, DMX is also available to consumers.

After all, business owners aren't the only ones plagued by the frequent commercial breaks, often annoying disk jockeys, and inconsistent music content found on commercial radio. Whether we are trying to work or relax at home, we don't like having to change stations or hit the mute button at every station break or each time the DJ plays a song we can't stand. Sometimes we load the CD changer with discs that fit our current mood, and set it for random play. Usually, though, it's easier to just put up with whatever is on the radio—making frequent use of the mute and station preset buttons.

All that changed, however, when we added the DMX DBS system to our audio setup. Suddenly, we had more listening options that we'd ever imagined possible. As we go to press, there are more than 90 stations available on the DMX "satellite radio" system; the full complement of 120 channels should be airing by the time you read this.

Let's take a look at the system components and how they work, before we describe the programming available from the DMX music service.

The DMX music programs are compiled on digital audio tape at the DMX facility Denver, using a compression algorithm to reduce the required data rate. The tapes are then uplinked to the AT&T T401 satellite, which relays the programming signals to the home (or business) satellite dish antenna. The dish can be as small as one meter in diameter (larger sizes might be required in areas that experience heavy, frequent rainfalls). The antenna then relays the programming to the receiver.

Three versions of DMX are available. There are two DBS systems, one for businesses and the other aimed at TVRO owners. The DMX business system consists of a small satellite dish, a receiver, and a remote control. No equipment purchase is required; the subscription cost of the service—between $80 and $100 a month—includes the lease of the equipment. The consumer version of DMX requires users to purchase the DR200 receiver, which costs about $150, and use their own satellite dish to pick up the signals. The subscription then runs about $15 a month, comparable to the cost of a compact disc.

In some areas, DMX is also available through the local cable company. Cable DMX is limited to about 30 channels, and adds between $5 and $10 a month to the cable bill.

As seen in the photos, we had our system—which did include the DMX DBS dish antenna—installed by professionals. It is, of course, possible to do it yourself.

With setup complete, a phone call to the DMX/DBS National Authorization Control Center is required so that the receiver can be authorized to receive music programming.

When DMX is delivered via the local cable company, instead of by satellite, a signal splitter routes the DMX audio to the set-top receiver.

The DMX receiver is a digital-audio stereo decoder that features full CD-quality 20-kHz stereo, Dolby AC-3 decoding, and multi-zone expansion capabilities. Its front panel features a power button, up and down tuning arrows, and a display that shows which channel is currently playing, as well as information needed during some advanced DMX operations. Three status indicators are located to the right of the display. The authorization and sync indicators shine green to show that you are authorized to receive the current channel and that the receiver has locked onto the satellite, while a red fault indicator lets you

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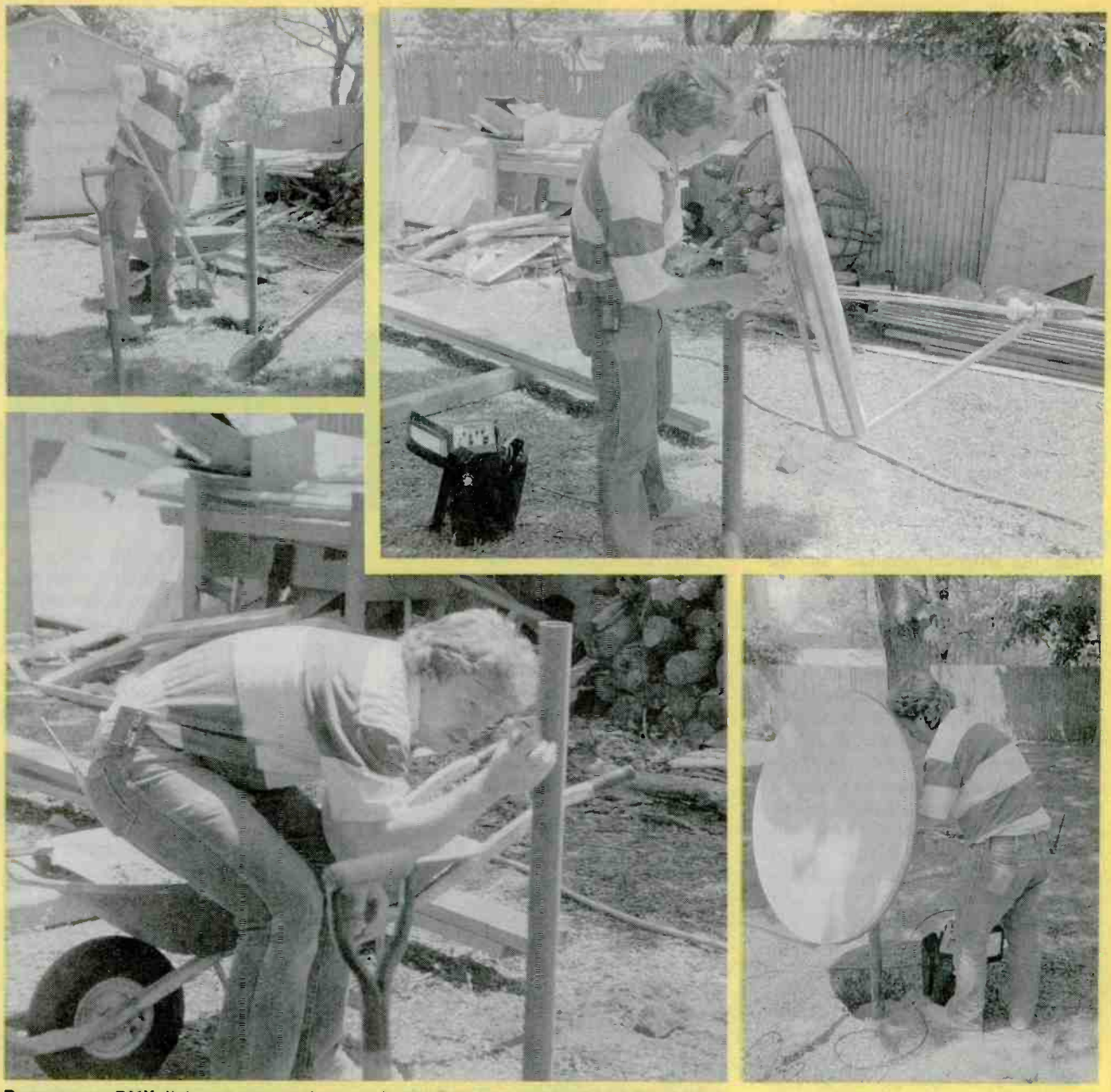

Because our DMX dish was mounted on a pole, the first step was to dig a hole at least three feet deep, and at least six inches deeper than the frost line. Then the pole was placed in the hole, which was backfilled just enough to keep the pole steady (top left). A bubble level was used to ensure that the pole was perfectly plumb (bottom left). After the concrete had set, the dish was mounted in approximately the right direction (top right). A spectrum analyzer, seen on the ground, was used to peak the dish to its maximum (bottom right).

know there is a problem of some type with the receiver.

A pull-down panel, located beneath the POWER button, opens to reveal a slot in which a future Smart Card can be inserted. The NDC Smart Cards, from News Datacom Ltd., are not yet available, but might eventually be required to receive the DMX music programming. The cards will provide authorization or conditional access to the programming.

The DR200's back panel offers a host of connectors used to provide a link from the satellite dish to your audio system. An RF-in connector attaches the receiver to the dish; mono and stereo out jacks are used to connect the DMX receiver to your mono or stereo audio receiver or amplifier. In addition, the receiver offers a digital out connector that conforms to the standard Sony/Philips Digital Interface Format (SPDIF); it is used to connect the DR200 to audio equipment that has a coaxial digital input. The signal-strength-out connector is used by installers to measure satellite signal strength while positioning the dish, and the data/control connector is for PC control and diagnostics.

The system's remote control—a.k.a. the "DMX-DJ"—lets you do much more than just change channels and volume levels. It helps you keep track of what you're listening to, and it allows you to customize your listening schedule.

So that you can tune directly to your station of choice, a printed listing of the station numbers and their corresponding formats appears on the back of the remote. On its front, the DMX-DJ features its own

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liquid crystal display. Pressing the VIEW button calls up the name of the song currently playing; subsequent presses of the NEXT button reveal the artist's name, CD title, composer or chart position (if applicable), and record label.

The remote control actually takes the place of a disc jockey, silently providing all the information that a traditional DJ might about a song as it plays. Even better, you can get the information without interrupting your enjoyment of the song or waiting for the end of a long set of songs to find out what you've been hearing. DMX Inc. boasts that the remote is "a disk jockey that is seen but not heard." Fans of classical music or jazz might prefer more information than the DMX-DJ can provide, however. For example, there's no way to find out who is conducting an orchestra, the composition date, or band members.

Maneuvering through all the DMX channels is simplified by the remote control's last-channel-recall function and its SCAN button. Pressing SCAN allows you to sample each authorized station for five seconds before the next one in order is tuned.

Some basic, and all advanced, DMX operations are accessed by pressing the remote control's PRESET button and then entering special three-digit command codes. To check the clock, for instance, you would press PRESET, 1, 0, 0. To activate or deactivate the remote volume controls, you would press PRESET, 9, 7, 5. (The DR200 receiver is shipped with the volume control off, assuming that you will want normal line-level outputs so that the volume can be controlled from your stereo system.)

The PRESET button is also used for several advanced functions. Those include adding and deleting authorized stations, setting the dynamic range of various channels, and what DMX calls "forced tune playing"—selecting up to six stations to play at specific times.

Just as many televisions allow you to customize your viewing lineup—deleting those stations that you don't watch—so DMX allows you to remove any authorized stations from your listening lineup. By tuning to the channel you'd like to delete and pressing PRESET, 9, 5, 0, the front panel display flashes "dEL" and the receiver marks the channel as locally deleted. You still receive that channel, and the authorization light remains on when the channel is tuned, but the receiver automatically mutes the locally deleted channel. Locally deleted stations can be readmitted to the lineup by pressing PRESET, 9, 4, 0.

The ability to change the dynamic range of various stations comes in particularly handy when the listening environment is noisy—in a crowded restaurant, for instance. Changing the dynamic range of individual stations might also provide a more uniform volume as you move through the channels. DMX allows you to set a different dynamic range for up to ten individual stations, or to change the dynamic-range setting across the board, setting all channels to a "global dynamic range default." (Individual dynamic range settings will take precedence over the global-dynamic-range default.)

Once again, the PRESET key is used with a three-digit command code. The front-panel display flashes the current dynamic-range code (00 for 90-dB, 01 for 80-dB, 02 for 60-dB, and 03 for 40-dB range). The numeric keypad or up and down tuning buttons are used to enter the new dynamic-range code, and then the STORE button is pressed to put the new code in memory.

Forced-tune programming is one of the most useful DMX functions—particularly for restaurant owners who might want to use music to set different moods for the breakfast, lunch, dinner, and late-night crowds. It allows you to program up to six listening events over a 24-hour period. You can have the same station come on at six different times, or set starting times for up to six different stations. You might want to wake up to some soft-rock music, listen to some album rock at lunch time, enjoy light jazz over dinner, and relax to classical music as you read the evening paper. By tuning to the desired station and pressing PRESET, 9, 3, 0, the front panel displays two flashing zeros, indicating that you should now enter the start time. You must then enter the hour (in 24-hour format), and then press STORE.

The DMX-DJ can only be used to program forced-tune events to start on the hour. If you need to start at a specific hour and minute, you have to have the DMX/DBS National Authorization Control Center program it for you. In fact, if you're technically inept or pressed for time, you can have the authorization center perform most of the advanced operations for you.

That shouldn't be necessary, however, thanks to one of the most clearly written,

The DMX/DJ remote control allows subscribers to call up the song title, artist, composer, album title, record label, and catalog number of the song they are currently listening to.

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logically arranged user's manuals we've seen in ages. Besides detailed, step-by-step system, installation, operation, maintenance, and troubleshooting instructions, DMX also included *two* quick reference cards—one to keep atop the receiver and a duplicate to remain in the book as backup, if and when the first one gets lost. Those reference cards list the steps and commands needed to perform basic and advanced functions, and list, in numeric order, the various three-digit preset command codes.

The only information missing from the manual is the station lineup—but that's provided both on the back of the remote and on a separate quick-reference chart that comes with the unit.

The DMX programming variety is truly impressive. There are five classical choices, five jazz selections, and eight listings under the rock heading. "Urban" stations include reggae, rap, traditional blues, dance, and the "Motor City Sound." Easy listening, or "adult" themes, include show tunes, love songs, soft hits, movie soundtracks, several instrumental stations, "great singers," and both adult contemporary and "new" adult contemporary. So the kids don't feel left out, there's a station that plays only children's music. There's folk music, Christian inspirational and contemporary tunes, Cajun songs, and contemporary blues.

On the international scene, there are African, Chinese, Dutch, English, French, German, Greek, Irish, Israeli, Italian, Japanese, Nordic, and Swiss selections—sometimes more than one under each heading. There are also Euro hits and Euro oldies, World Beat, and non-stop polka.

In a mystical mood? Try New Age or, better yet, tune into the environmental sounds of the ocean or tropical rain forest.

Winter getting you down? Pull out the suntan lotion, dark glasses, cooler, and boogie board, and tune into the Beach Party channel.

Or, if you're into the spirit of the season, you might prefer to listen to the Holiday Music channel. Available seasonally, the station plays the holiday favorites you'll want to hear as you deck your halls and carve your turkey. (Off season, that station is one of our favorites, playing a mix of Irish and Celtic traditional/folk songs.)

We were somewhat skeptical about DMX before it was installed. We've been exposed to too much canned music over the years to trust a system that promised to deliver continuous, uninterrupted music into our living room. We were sure that the mixes would be repetitious at best, boring, Muzak-style renditions at worst.

To our delighted surprise, those problems were virtually non-existent. Not only were all the songs performed by the original artists, but the all-digital satellite system provided sound quality far superior to that of our local FM stations. Although the data is compressed, the system delivered CD-quality sound with no interference or static, ever.

There is some repetition of songs on some stations, but certainly less than you'd hear on most "hit music" radio stations. (DMX's library of more than 500,000 selections is updated weekly.) After hearing the same Indigo Girls cut on the folk-rock station during lunch two days running, we wondered whether the entire program was being repeated in a loop each day. That wasn't the case, however. We haven't heard the song on that channel since, at noon or any other time of day, and have to imagine that it was just a rare coincidence.

Of course, just listening to the same narrowly defined *style* of music, day and night, can become repetitious. One of the nicest things about DMX is that, whatever your mood, you can always find more than one station to match. Looking for an upbeat sound while you clean the house? Try some classic rock, 50's oldies, or Motor City. Want to roll up the rugs and do some dancing? You have your choice of everything from salsa to polka, Hawaiian to urban dance, big band to flamenco. Soft music while dining? The selection is vast: lite classical, lite jazz, love songs, soft hits, folk rock, classical guitar, piano music, and beautiful instrumentals, to name a few.

If you're hosting a party, you can keep the evening rolling along with frequent music changes—done either manually or by programming forced tune events. Perhaps something softly upbeat while people are arriving and getting to know each other, classical or lite jazz during dinner, dance music for later in the evening, and back to the soft stuff when you'd like your guests to start heading home. And if you feel like throwing a "theme" party, setting the mood couldn't be easier, with 50's oldies, beach-party, reggae, and Cajun music right on tap.

We haven't completely given up on radio. There are a few disc jockeys on local stations whose wry wit, insightful commentary, and encyclopedic knowledge of their specialized genres greatly enhance the listening experience. We try as hard as we can not to miss their daily or weekly shows.

Nor is our CD player gathering dust. In fact, we've been inspired to go out and buy a few new discs after hearing interesting cuts on DMX—cuts and discs that were identified on the DMX-DJ.

The rest of the time, however, our stereo is tuned to the stars, with DMX providing a diverse, static-free, digital musical universe. ■

DIRECT-BROADCAST SATELLITE

(Continued from page 11)

cated over the Atlantic Ocean so that European programming can be distributed.

Receivers for the new system will be manufactured at the start by Tee-Comm and Samsung, with others sure to follow. Among the distributors will be Amway and O-Rourke Brothers.

EchoStar

Yet another new DBS system that is scheduled to launch by the time this report is published is EchoStar, a company headed by Charlie Ergen, a figure well known to the C-band TVRO world. Unlike AlphaStar, EchoStar will be a high-power DBS service operating in the BSS portion of the Ku band.

EchoStar had originally planned to launch its service in November, 1995. At press time, it appears unlikely that the company will beat AlphaStar to the launch. The major stumbling block is the launch of the EchoStar-1 satellite.

EchoStar-1, built by Lockheed Martin Corp., has been finished and is ready for shipping to the China Great Wall Industry Corp., which is scheduled to launch the satellite. The company must first launch an AsiaSat satellite. However, following two launch failures suffered by China Great Wall, AsiaSat has had trouble obtaining launch insurance.

When service does begin, EchoStar plans to deliver about 70 channels of programming, expanding to about 130 channels when its second satellite is launched.

EchoStar's uplink center is in Cheyenne, Wyoming.

The Future

The DBS industry is just in its infancy and it would be foolish for us to speculate on what things will be like when the next millennium begins. We'll make some safe bets, though. There will be more channels available than there are today (even if they are controlled by fewer companies). More than one DBS service will survive, and niche programming will become a reality because of the economics of delivering signals to the entire country from a single satellite.

DBS will likely be the place where true high-definition television (HDTV) is first seen by the public. It appears as if most terrestrial broadcasters will opt for what is being called wide-screen standard-definition TV (SDTV). The DSS receiver's high-speed data port could interface to an HDTV decoder to provide true HDTV. After more than 20 years, it appears that satellite-delivered TV has truly become a mass-market product. There's no turning back now. ■

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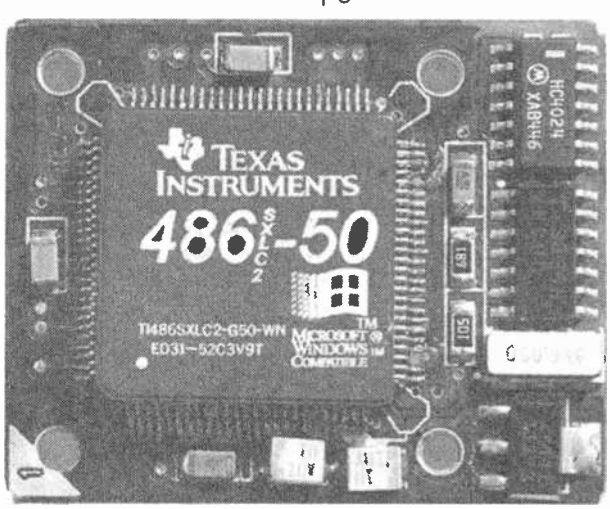
MULTIMEDIA WATCH

By Marc Spiwak
Technical Editor
Windows Magazine

Changes, Changes, and More Changes.

It is a time of many changes, perhaps more for me than for many of you. There have been many changes in my life during the past year or so. For one, my first son was born last January, and he is now over 7 months old. He has made a big change in my life, and for the better, except that my free time is rather limited now. Right now Daniel is playing with all the software boxes and press folders for this month's column, so I have to keep one eye on him and one on my monitor. Fortunately, he goes to bed soon!



The Make-it 486 will upgrade a 386 computer to a 486 with a built-in 8K cache and a doubled clock speed.

Also, as I write this column, it is the last day of summer 1995—Labor Day—and the end of a rather hectic summer for me. This is also the first column of 1996, and so I wish all of you a happy new year.

It is also time for a new operating system for many of us. Windows 95 was officially released a couple of weeks ago; some users actually camped out the night before in store parking lots so they could get their copy early.

I've played with Windows 95 here and there before its official release, but have yet to install it on any of my computers. It's not that I don't want to, it's just that I figured I ought to at least wait for its official release before I start trying to run the multimedia software under it. Even though I understand that Windows 95 quickly set a new record in software sales, I suspect that most readers won't want to switch over right away. I have a copy of Windows 95 just waiting to be loaded, and I think I will do so after I finish with this column.

Actually, I will soon become very familiar with Windows 95, and I won't have a choice. As you might have noticed from the byline at the top of this column, I have joined the staff of *Windows* magazine as a Technical Editor. Do not fear, however, my new position will not prevent me from continuing this column, and will put me in position to make it even better than before.

Well, that's enough change for one month. Let's get to our topics.

CPU CHANGE

I recently decided to give one of those CPU upgrades a try. I have a 486 SX/25 that I really don't do much with because of its slow speed. But it does have VESA local-bus video with 2 megs of memory, which I figured would be much better than the non-local bus ATI Ultra video card in my DX 2/50, if only the CPUs were equal. While the ATI Ultra was considered "ultra-high end" in its day, and sold for over $500, it is limited to 256 colors and has never really liked multimedia.

While the SX/25 never really blazed through multimedia, it did always seem to be more stable with some software than the DX 2/50. Once I learned that I could get an Intel DX 4/75 for $169 from the local outlet of a national computer retailer, I figured that it would be money well spent and I would have a really fast 486 for a small investment.

The chip installed in seconds, as the SX/25 has a ZIF (zero insertion force) socket for the CPU on the motherboard. Anyone can perform that simple upgrade. Upon bootup, the speed increase was certainly evident. The machine would boot faster and load software faster, especially Windows. Menus would pop open noticeably faster, as well. Benchmarks roughly doubled overall. But the stuff that always gave both computers fits, mainly real-time video, still wasn't so hot on the DX 4/75. But it was still slightly faster and somewhat more stable than my "ancient" DX 2/50—at least for some software. What was disappointing, though, was that the hopped-up SX

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wasn't nearly as fast or as stable as my DX 2/66 at work with its 64-bit PCI local-bus video.

Anyway, I reluctantly decided to keep the CPU upgrade and swap over my biggest hard drives to the DX 4/75. Soon I was up to my ears in 32-bit disk-access errors, but only with certain hard drives installed in the machine—it was fine with the stuff it came with. Evidently its BIOS had a problem with some of my hard drives.

Then it came to me: Why am I breaking my back trying to make old hardware happy in a new home when all I'll have in the end is a machine that's not even as good as the "old" machine I have at work? And it cost me nearly $200 for the pleasure! It just didn't make sense to me, so I returned the CPU to the retailer and got a full refund.

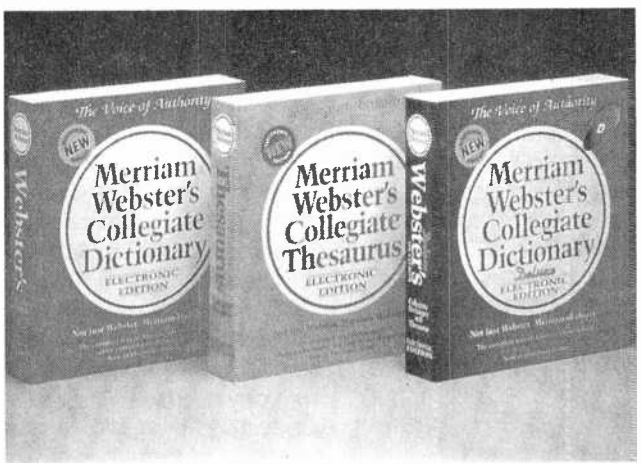
In the end, I was happiest with my cash back in my wallet and my computers returned to their original condition. Maybe I'll put that money toward a whole new computer, which is always the best way to go. Right now I can buy a fast, loaded Pentium for under $2000, and the prices continue to drop. Or at least I continue to get more and more for my money. And Windows 95 will surely be happier with newer plug-and-play compatible hardware, anyway. The moral of the story is that when you install a faster CPU in a less-than-ideal computer, all you end up with is a slightly faster less-than-ideal computer.

ON THE OTHER HAND

While upgrading a 486 to a faster 486 might not be one of the best investments, thousands of perfectly good 386s are lying around collecting dust because they simply aren't fast enough for modern applications. But there is some hope for those older machines. I recently saw a demonstration of a new processor upgrade for 386 SX and DX computers that turns them into 486s. The *Make-it 486* from Improve Technologies is based on the Texas Instruments SXL2-50 processor that includes an 8K internal cache and provides performance increases up to 300%. 286-to-486 upgrades are also available.

The addition of a built-in 8K cache was one of the major improvements that the 486 had over the 386, and it's also one of the main performance ingredients in this upgrade. The Make-it 486 also doubles the clock speed of any 386. Upgraded 386SXs will, of course, still be crippled by the 16-bit bus. However, the performance boost offered by the Make-it 486, for a 386 SX or DX, is certainly an affordable one with a list price of only $99.

Different models fit different motherboards, so check to see what kind of CPU you have before calling Improve Technologies. In many cases, the 486 upgrade module fits right over the original 386 CPU. Then all you have to do is install the cache-enabling software and you're off. This really is an inexpensive way to breathe some new life into an old 386, and DXs really do become "true" 486s. But just remember what I said about less-than-ideal computers.



Merriam-Webster's Collegiate Dictionary, Deluxe Edition on CD-ROM combines the full text of the printed Merriam-Webster's Collegiate Dictionary, Tenth Edition and Merriam-Webster's Collegiate Thesaurus on one disc.

NEW STUFF

As a writer and editor, it's always good to have a dictionary around. Even I don't know the spelling and definition of every word in the English language, so I need to look one up once in a while. The problem is that it's time consuming to leave the computer while I'm writing to go look up a word. Dictionaries and spell checkers have been built into word processors for years, but those aren't always the best or most-complete places to look up words.

Fortunately Merriam-Webster has gone electronic with its *Merriam-Webster's Collegiate Dictionary, Deluxe Edition* on CD-ROM. That deluxe package combines the full text of the printed Merriam-Webster's Collegiate Dictionary, Tenth Edition and Merriam-Webster's Collegiate Thesaurus on one CD-ROM for $79.95.

The disc includes over 160,000 dictionary entries, and 130,000 synonyms, antonyms, related and contrasted words, idioms, illustrations, and tables. Word lovers will like the puzzle-solving options that make it easy to solve crossword puzzles, cryptograms, jumbles, and letter banks. The disc also includes its own word games.

Virtual Reality Laboratories recently introduced *Formbuster 2.1 for Windows* on CD-ROM. That software

(Continued on page 81)

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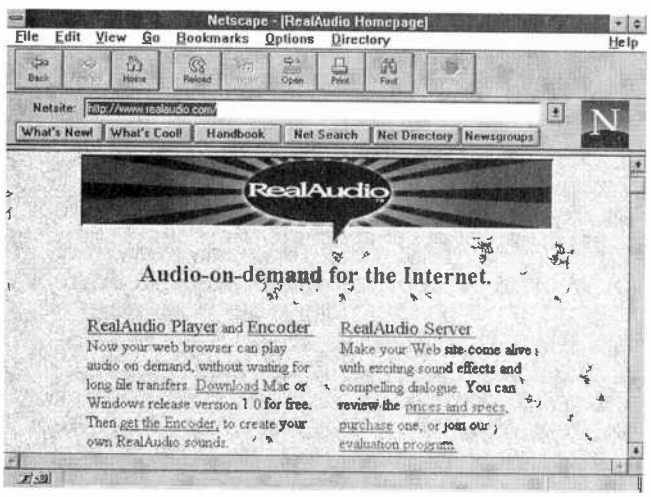
NET WATCH

By Dan Karagiannis

Web Broadcasting

Are you tired of waiting to download enormous .WAV or .AU files to get sound over the Internet? Well, this month we'll take a look at an Internet-broadcast technology that could make your audio enjoyment of the Net a lot more fulfilling. Also, in keeping with the broadcast theme, we'll take a look at sites on the Web that deal with direct-broadcast-satellite (DBS) television.



With the help of the RealAudio software, available at the site shown here, you can finally hear an audio file, in real time, as you download it.

REALAUDIO

The new technology that lets Web users listen to audio while it's downloading is called RealAudio. And what's best is that RealAudio can deliver real-time sound to your computer with a connection speed of only 14.4 kbps.

To use RealAudio, you have to first download the RealAudio Player from the RealAudio Homepage; the software is available in fully functional test versions for both Windows and Macintosh. The Windows player requires a 486/33 SX or better PC with Windows 3.1, 8MB of RAM, 2MB of free disk space, and a sound card. If you're a Windows 95 user, you already have the RealAudio software installed.

Once you download the software, you'll have to set it up and get it working properly. Fortunately, that's not too difficult. Just read the installation notes provided at the download site and you should have RealAudio working within five minutes.

Once you have the software set up, you will be able to access sound files from any of the several sites supporting RealAudio. Links to several of those are found right on the RealAudio Homepage, making your search a lot easier. Let's examine a few of the more notable sites:

For starters, there's the RealAudio: ABC News site, which features the latest news (updated hourly at 15 minutes past the hour), sports, and commentary. To get the news, just click on the Internet Hourly News button, and make sure your PC speakers are on. That's all there is to it.

Because the ABC site is updated hourly, many users will find that there's no need to turn on the radio anymore to hear what's going on. Sure, the Net has always had some form of news available online, but with RealAudio you can give your eyes a rest from the screen and just listen.

Another site that you can link with is the RealAudio: NPR page. There, you can access NPR's national call-in show, *Talk of the Nation* (which is available five days a week), as well as two other shows: *All Things Considered* and *Morning Edition*.

But what about independent sites? What are they doing with RealAudio? Well, one of the best sites I found was Radio Gotham, which is part of the Batman Forever site that promotes the Warner Bros. film of the same name.

Radio Gotham is one of the hottest RealAudio sites on the Net. Visit the site and listen to interviews with the stars of the latest Batman movie, or download clips of the movie soundtrack to check out later on.

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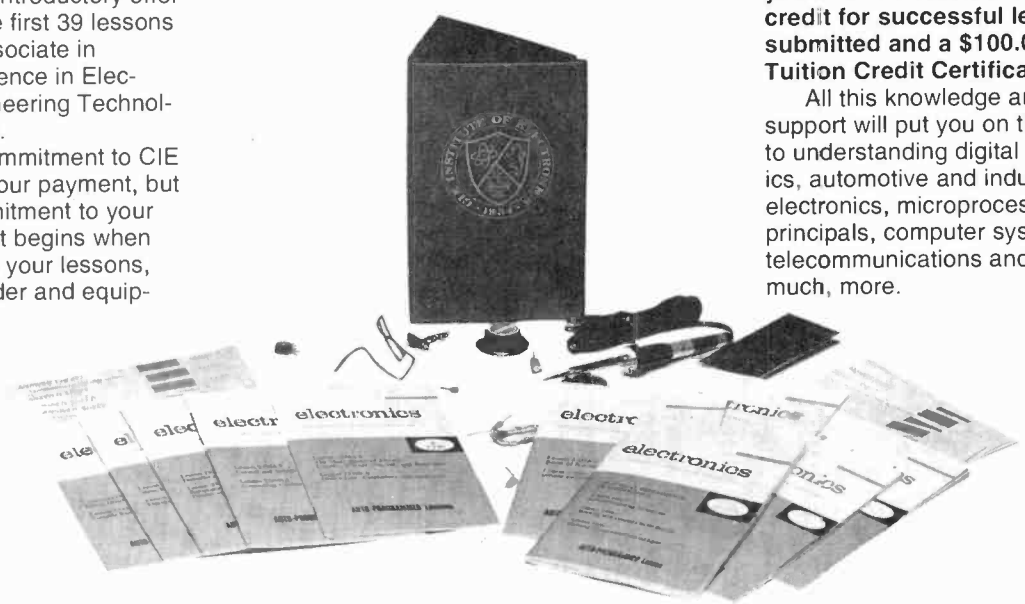

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At Radio Gotham, you'll find several RealAudio broadcasts, which could change by the time this hits print. At the time of this writing, however, the site contained RealAudio interviews with Nicole Kidman, Jim Carrey, Val Kilmer, Tommy Lee Jones, and other stars from the film.

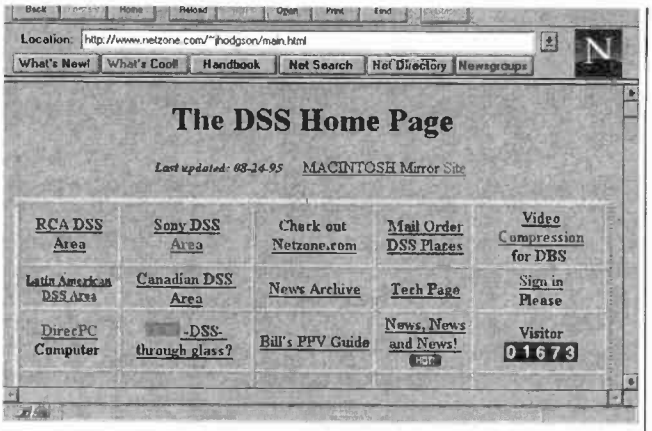
I was a bit disappointed to see that audio clips from the soundtrack were not available in RealAudio format, but only in .AIF and .WAV formats (which means they must be downloaded, and then played). Other than that criticism, though, it's a really innovative site.

DBS SITES

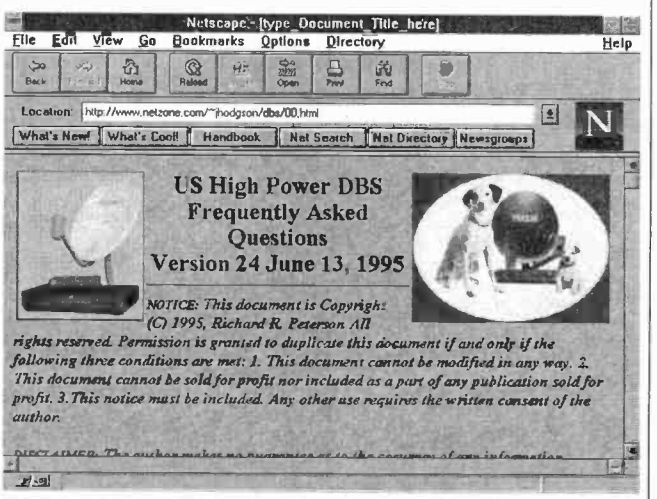
There's no doubt about it that DBS is the next big consumer electronic item. By using a DBS dish and service, you can get a far greater number of channels than with ordinary cable, and for much less. So naturally, just like anything that's even remotely popular, DBS has become a presence on the Net.

One of the most impressive DBS sites is the DSS Home Page, where you'll be presented with more links than you could possibly hope to explore in a single visit. While it's impossible to cover everything you'll find at this site, here are a few interesting features:

First of all, what is DBS TV really? Those who have spent some time on the Internet know the importance of FAQ (frequently asked questions) files—they help those who are new to a particular site or concept get familiar with the basics. Well, to meet that type of need, the DSS Home Page provides an On Line DBS FAQ to clear up any questions you might have about the newest home-entertainment medium (of course, you could also turn to this month's **Gizmo** section, located elsewhere in this issue, to get some more information on DBS).



The DSS Home Page is the site to visit if you'd like to keep up to date on the latest in home satellite entertainment.



While at the DSS Home Page, be sure to click on the On Line DBS FAQ. In addition to these images, you'll find the answers to almost any conceivable DBS-TV question.

For those who are ready for DBS TV, the two big manufacturers of DSS systems, RCA and Sony, each have their own "areas" where you can find technical information about and even photos of available units. These are also good areas to watch if you'd like to know what new releases are on the way. Then, if you want to buy a DSS system without leaving your home, check out the Mail Order DSS Places link.

Are you interested in learning about the video-compression technology that makes DBS possible? If you are, then here's a link to check out: Video Compression for DBS gives a technical description of current and soon-to-be-available incarnations of MPEG, which is the standard that makes DBS possible. Just about everything is covered, including: forward error correction, how video signals are coded, the industry transition from MPEG1 to MPEG2, and how video compression occurs.

If you'd like to check out another site for DBS, take a look at DBS Online! Although I haven't really found anything at this site to rival the DSS Home Page, it's always interesting to take a look at more than one site covering a particular topic. In addition to the usual information on company products, of particular note at this site are the Satellite Elevation Azimuth Chart, and Satellite Direction Finder Form, which give a bit of an inside view to the process of installing a DBS system.

Also, let's not forget that the Internet is composed of more than just the World-Wide Web. Try checking out the rec.video.satellite.dbs newsgroup for daily postings about DBS TV. Just make sure to observe the etiquette (or netiquette) of the newsgroup before you post anything yourself. Post an inappropriate message and you could get "flamed." You'd be surprised how quickly cybernauts will express their displeasure!

Well, that's it for this month. If you have any questions, comments, or suggestions for what you'd like to see covered in future columns, you can e-mail them to me at peeditor @aol.com or snail-mail (s-mail) them to me at *Net Watch*, **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735. ■

HOT LINKS

RealAudio Homepage
http://www.realaudio.com/

RealAudio: ABC News
http://www.realaudio.com/contentp/abc.html

RealAudio: NPR
http://www.realaudio.com/contentp/npr.html

Radio Gotham
http://www.batmanforever.com/radio/radio.html

DSS Home Page
http://www.netzone.com/jhodgson/main.html

On Line DBS FAQ
http://www.netzone.com/jhodgson/dbs/00.html

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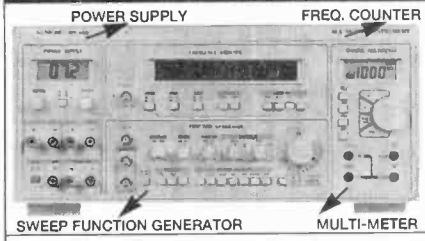

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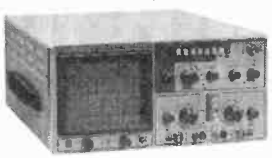

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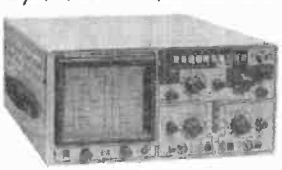

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- Alligator Clip Test-Leads
- Lead Holders/Velcro Strap Holster

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- 9 Function / 42 Range
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  - Ohm: Up to 2000MΩ
  - Amp: AC/DC 2 Amp
- Extended Capacitance Meter (9 Range)
  - **0.1pF - 20,000µF**
  - Zero Adjust Knob
- Trig Lamp

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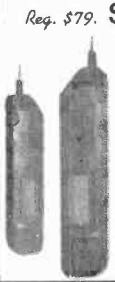

DM150
- 3 1/2 Digit
- Dual Display
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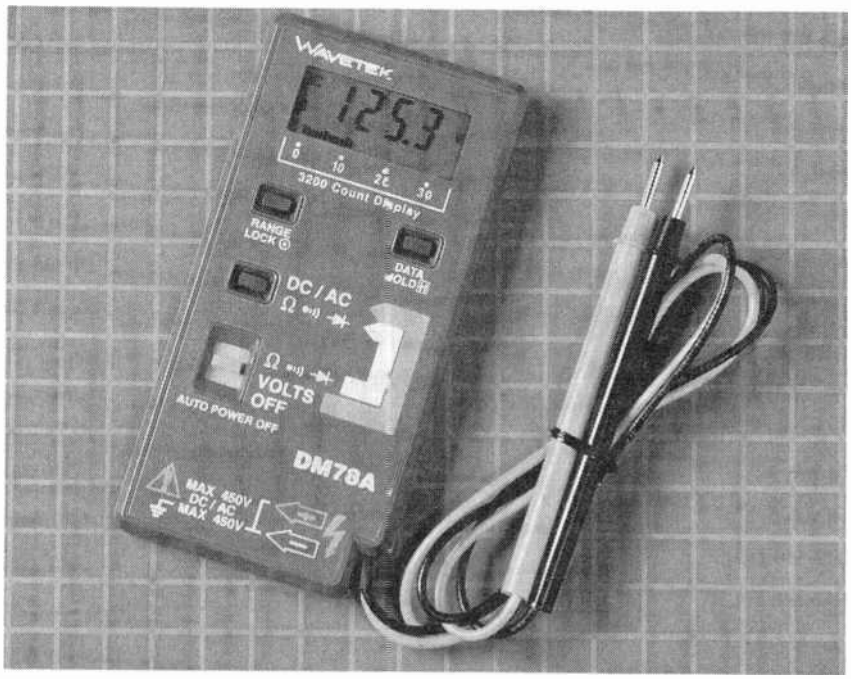
A Hands-on Electronics® REPORT

Wavetek DM78A DMM



CIRCLE 119 ON FREE INFORMATION CARD

A bigger multimeter is not always better.

We report on a lot of test equipment in this magazine, and plenty of DMMs, or digital multimeters, in particular. Reviewing DMMs can get to be like a game of "beat the features," with one new model packing more features than any other DMM, another having some unique feature, another having the same features as other DMMs but at a lower price, and so on.

Carrying some of those DMMs around is like having a portable troubleshooting lab with you out in the field. But many of those "loaded" DMMs are quite expensive and certainly don't fit in a shirt pocket. To carry one of those bulky meters around, you usually need a field bag, which might as well have some tools thrown in and perhaps a flashlight. But all of that stuff gets heavy after a while, leading one to put down the bag and perhaps lose track of it.

The truth is, many people who need to have a DMM with them don't really need a "super-deluxe" model much of the time, and would find it a lot more convenient to have a pocket-sized meter that's always in their pocket when they need it. In short, what is often ideal is a reasonably accurate, well-built meter that can read resistance and voltage, doesn't weigh a ton, and carries a lightweight price tag. Such a unit would also fill the bill for hobbyists that need a reliable and accurate basic meter.

The DM78A. Fortunately for all those in need of a basic and very portable DMM, Wavetek Corporation offers the *DM78A* for only $35.95. It's a rugged little DMM that packs enough features to get by most of the time, fits in a shirt pocket, and weighs only three ounces.

Even though the DM78A fits in a shirt pocket and sells for such a reasonable price, it is by no means short on functionality. The unit features a 10-millimeter-high, 3¾-digit LCD readout, with a maximum display reading of 3200. A 32-increment bargraph augments the digital readout. The DM78A can measure AC and DC voltage, measure resistance, perform audible continuity checks, and test diodes. The autoranging meter also has a manual range-lock button and a data-hold button.

You might have noticed that we did not mention any current-measuring capability. Measuring voltage and checking resistance and continuity are the most commonly used capabilities of any DMM. In practice, I have found that one rarely needs to measure current, and doing so with a regular DMM requires that the DMM be placed in series with the current path, which is often impractical when troubleshooting. So not being able to measure current is no big loss.

The display includes enunciators for AC (nothing for DC), audible continuity, low battery, millivolts, volts, ohms, kilohms, megohms, diode, range lock, data hold, minus, and decimal point. To help keep size and weight down, the DM78A is powered by two small button cells that will provide up to 70 hours of continuous use. The unit shuts itself off automatically after 10 minutes of inactivity to conserve battery life.

The DMM measures 4.3-inches high, by 2.2-inches wide, by 0.4-inches thick. Two test miniature probes are permanently attached to the bottom of the unit. That way they will never get lost and the bulky test-lead jacks are eliminated. The meter comes in a vinyl carrying case that has a Velcro strap to hold the test leads neatly in place when not in use. The case has an inside pocket that holds the operating manual.

Specifications. The DM78A can measure DC volts in five ranges, either autoranging or selected manually. The DC ranges are as follows: 320 millivolts with 100-microvolt resolution, 3.2 volts with 1-millivolt resolution, 32 volts with 10-millivolt resolution, 320 volts with 100-millivolt resolution, and up to 450 volts with 1-volt resolution. AC voltage can be measured in the same

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ranges with the exception of millivolts. The DM78A cannot be used to measure anything greater than 450-volts AC or DC.

There are six resistance ranges to choose from: 32 ohms with 100-milliohm resolution, 3.2 kilohms with 1-ohm resolution, 32 kilohms with 10-ohm resolution, 320 kilohms with 100-ohm resolution, 3.2 megohms with 1-kilohm resolution, and 32 megohms with 10-kilohm resolution.

Using the DM78A. The DM78A is very simple to use. A three-position slide switch moves from "Off" to "Volts" to "Ohms/Continuity/Diode." With the slide switch in the Volts position, a "Select" pushbutton toggles the meter between AC and DC. With the slide switch in the Ohms/Continuity/Diode position, the Select button toggles between those three options. A "Range-Lock" button toggles the meter between specific ranges and the autoranging mode. The "Data-Hold" button alternately freezes and releases the last reading on the display. That is handy if you can't see the display clearly while making a measurement or if you need to hang on to a reading without writing it down immediately.

For such a small meter, the DM78A really packs a punch. Its features, while kept to a minimum, still allow it to be used for most testing and troubleshooting tasks. The ability to carry it around in a shirt pocket is also a plus. Its compact size also makes it the perfect meter to throw in the glove box or tool box where it will always be when you need it. While it would not be the most convenient meter to use on a test bench due to its small display and lack of a stand, it is not intended to be used there. It is intended for use on the go, and that's where it really comes in handy. If you need a DMM that you can stick in your car or tool box, or just don't like to carry around your full-size DMM all the time, then contact Wavetek (at the address given below) today, or circle no. 119 on the Free Information Card. ■

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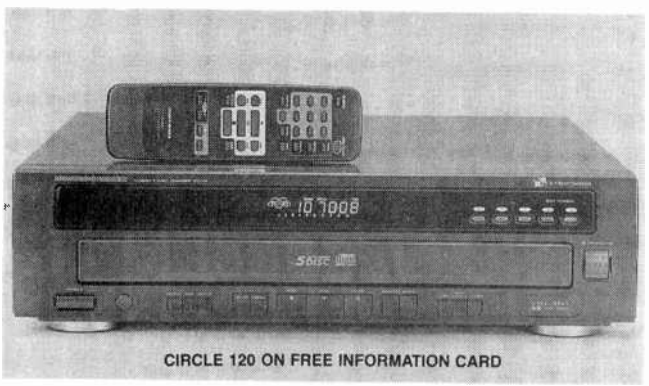
PRODUCT TEST REPORTS

Marantz CC45U Five-CD Carousel Changer

By Stephen A. Booth

In an age of androgynous, computer-generated names, it's reassuring to see the *Marantz* marquee on a consumer electronics product. Audio Hall-of-Famer Saul Marantz is a charter member of the hi-fi movement that sprouted in Long Island and New York City in the post World-War II years. For some years now, his namesake has been a brand of Netherlands-based Philips N.V., which produces in Singapore the *CC45* five-disc CD changer reviewed in this article.



The Marantz CC45U five-disc CD changer.

Multi-disc changers by far are the most popular form of compact-disc player. Among home-audio components, the carousel-turntable style represented by the CC45U outsells magazine-loaders, which have established niches in the autosound and boom-box markets. Carousel changers, with their retracting turntable drawer, let you install or change CDs even while one is playing. Magazine-loaders seldom offer that feature, though they have a place in the home for those who also own an autosound CD changer and want the option to swap magazines of the same brand between home and car.

As entry-level carousels go, the CC45U has most of the desirable convenience features, especially when it comes to programming multiple tracks and discs for playback or for dubbing on a connected tape recorder. Performance-wise, electrical tests at the Advanced Product Evaluation Laboratory found a capable player: If the specs didn't set benchmarks, they also revealed no deficiencies that will be audible. Hands-on evaluation turned up some minor quibbles, but in the areas that matter, the CC45U proved fast, quiet, easy to program, and easy to use.

FEATURES

The front-loading turntable drawer of the CC45U holds five CDs in individual trays. Three trays are accessible at a time—and those are the ones that can be loaded while another CD plays in the concealed transport. A load button advances the platter to fill the other trays. The rightmost visible tray is called the "preferred position" for the CC45's "Quick Play" feature. Plop a disc there and hit the button for instant gratification while you select and load the rest of the musical menu. Regarding programmability, the CC45U lets you select up to 30 tracks in any order from any number of discs.

Except for the power on/off switch and peak-search button, the included remote control has all the function controls found on the front panel—and then some. Unfortunately, the "some" includes the all-important button for entering programming-memory selections (and another for canceling them). In short, don't lose the remote control if you plan on doing any programming.

The lack of programming-memory controls on the unit is one pet-peeve about the CC45. While we're at it, so is the lack of a headphone jack, a power switch on the remote, and an output-level control to match volume input-levels with other source units at the preamp-stage. (There is a volume function on the remote, which provides temporary control over level during play in lieu of your preamp's or receiver's remote control. But that level-setting is canceled by the CC45's power switch.) A fader function on the front-panel and remote attenuates volume gradually when you pause the player, and ramps up to the previous volume setting when play is resumed.

The front-panel LED readout is another shortcoming. It displays every bit of information you'd ever need, including helpful prompts during programming. But it does so in an annoying mix of lower- and upper-case characters with arbitrary

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spacing between them. To wit: "nod ISC" and "no AUd IO d ISC"—the latter an alert that you've inserted a CD-ROM, CD-i, or Video CD instead of an audio CD. To its credit, the CC45U won't play those automatically, as hash from their opening data-track (Track 1) could damage other system components. After the warning, you may advance manually to Track 2 to play the audio tracks of a data CD.

Typography and control locations aside, the CC45U is a joy to use when programming tracks and discs to roll your own playlist for tape recordings. One very helpful feature is peak search. The CC45U scans a CD at high speed to find the loudest passage. It then repeats that passage (two seconds before and after the peak) continuously while you set the record level of your tape deck. The result: no oversaturation on the tape (mere distortion in analog, but binary stutter on digital dubbings). If you're compiling a tape from multiple CDs, you'll have to perform peak search on each disc to find the highest peak.

Another neat bit of automation in the CC45U is "edit record." Once you've programmed your playlist and entered the length of the tape (time in minutes) you'll be recording to, the CC45U calculates (and displays) how many tracks will fit on each side of the cassette. It can do that two ways: In the "edit-normal" mode, the tracks are played linearly in the order programmed. In "edit-optimal" mode, the CC45U calculates which order of tracks will make the fullest use of the allotted time (the machine's choice of sequence might conflict with your arrangements).

In both edit modes, the CC45U pauses play at the end of the last track that will fit on the tape. Once you've flipped your cassette, use the pause button to resume play. If you haven't noticed, there's a subtle bias here toward bi-directional tape-recording media (read Philips compact cassette). When you enter a cassette length (e.g., C-90) the

TABLE 1—TEST RESULTS

All electrical measurements were performed by the Advanced Product Evaluation Laboratory using the CBS CD-1 Standard test disc.

Brand:	Marantz
Model:	CC45U Carousel CD Changer
Price:	$299
Output voltage (@ 0 dB, 1 kHz)	
Left:	2.046 volts
Right:	2.066 volts
Frequency response (10 Hz to 20 kHz):	–0.1 dB to –0.2 dB
Dynamic range	
Left:	98.11 dB
Right:	98.26 dB
Signal-to-noise ratio:	–127.2 dB
Total harmonic distortion + noise (@ 0 dB)	
Frequency	THD (%)
31 Hz:	0.0034
1 kHz:	0.0043
10 kHz:	0.067
16 kHz:	0.127
Wow & flutter:	Unmeasurable
Channel separation (@ 0 dB, 1 kHz)	
Left:	140.0 dB
Right:	132.7 dB
De-emphasis error:	
Frequency (kHz)	Error (dB)
1:	0.09
4:	0.17
16:	0.18
Linearity error (@ 1 kHz)	
Signal level (dB)	Error (dB)
0:	–0.09
–10:	–0.08
–20:	–0.09
–30:	–0.09
–39.99:	–0.08
–49.97:	–0.09
–59.94:	–0.02
–70.31:	–0.09
–80.77:	+0.01
–90.31:	+0.19
Linearity error with dither (@ 1 kHz)	
Signal level (dB)	Error (dB)
–70.31:	–0.11
–80.77:	–0.15
–90.31:	–0.49
–100.0:	+0.40
Additional Data	
Short access time (track 1 to 2):	2.40 seconds
Long access time (track 1 to 21):	3.90 seconds
Disc access time (disc 1 to 5):	6.9 seconds
Power requirements:	10 watts
Dimensions (HxWxD, inches):	4.125 x 17 x 14.75
Weight:	15.5 pounds

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CC45U assumes there's a side A and side B, and divides the tape length to calculate two 45-minute programs. If you record on another medium (VHS Hi-Fi, DAT, MiniDisc) you'll have to trick the CC45U by entering double the record-time (say, 148 minutes for a 74-minute MiniDisc).

For your information, the CC45U will perform synchronized recording with Marantz tape decks, pausing to create a four-second blank space between selections and to wait for autoreverse decks to change direction. At that point, suffice to say the CC45U is quite fast at getting from one track or one disc to another. In shuffling among discs, the CC45U's bi-directional carousel always takes the shortest path—which at most means gliding past one CD. In other words, to go from disc 1 to disc 4 it reverses past disc 5—not forward through 2 and 3.

PERFORMANCE

Access times for discs and tracks are shown in the accompanying chart along with other measurements made by APEL. In most areas, the measured performance is very good—sometimes exceeding even Marantz's published specs. In areas where the CC45U veered from perfection, it's mostly academic. The lapses are measurable by lab equipment but won't be audible.

Frequency response was virtually ruler-flat, as you should expect in the digital format, and likewise wow and flutter is not an issue. Both signal-to-noise ratio and left/right channel separation tested out as very good and, in fact, were measurably better than Marantz' own claim. Ditto for dynamic range—the spread between the softest and loudest sound the player will resolve.

As for total harmonic distortion, APEL's reading at 16 kHz is par for the course, but the lower frequencies measured a tad greater distortion than the 0.0025% Marantz claims. Not to worry: THD would have to hit 1.0% to reach a point where most experts agree it's audible. Likewise, 3 dB is considered the threshold where errors get a public airing. Keep that in mind for the de-emphasis and linearity results.

De-emphasis error measures how accurately the player's internal circuitry reverses the pre-emphasis curve on the disc recording. In a perfect world, it would be a perfect mirror image. APEL's Frank Barr notes that those errors at least track with the curve.

Linearity error measures the accuracy of the CD player's DAC (digital-to-analog converter) section; that is, is each of the 65,536 possible digital codes on the CD being translated back to its exact frequency and level? The answer here is "close enough"—the errors won't be audible above the stereo system's inherent noise. Linearity error with dither factors-in system noise. Again, the performance wasn't perfect, but any problems are pretty much swept under the noise carpet.

For more information on the Marantz CC45U five-disc CD changer, contact the manufacturer directly at the address that follows, or circle no. 120 on the Free Information Card. ■

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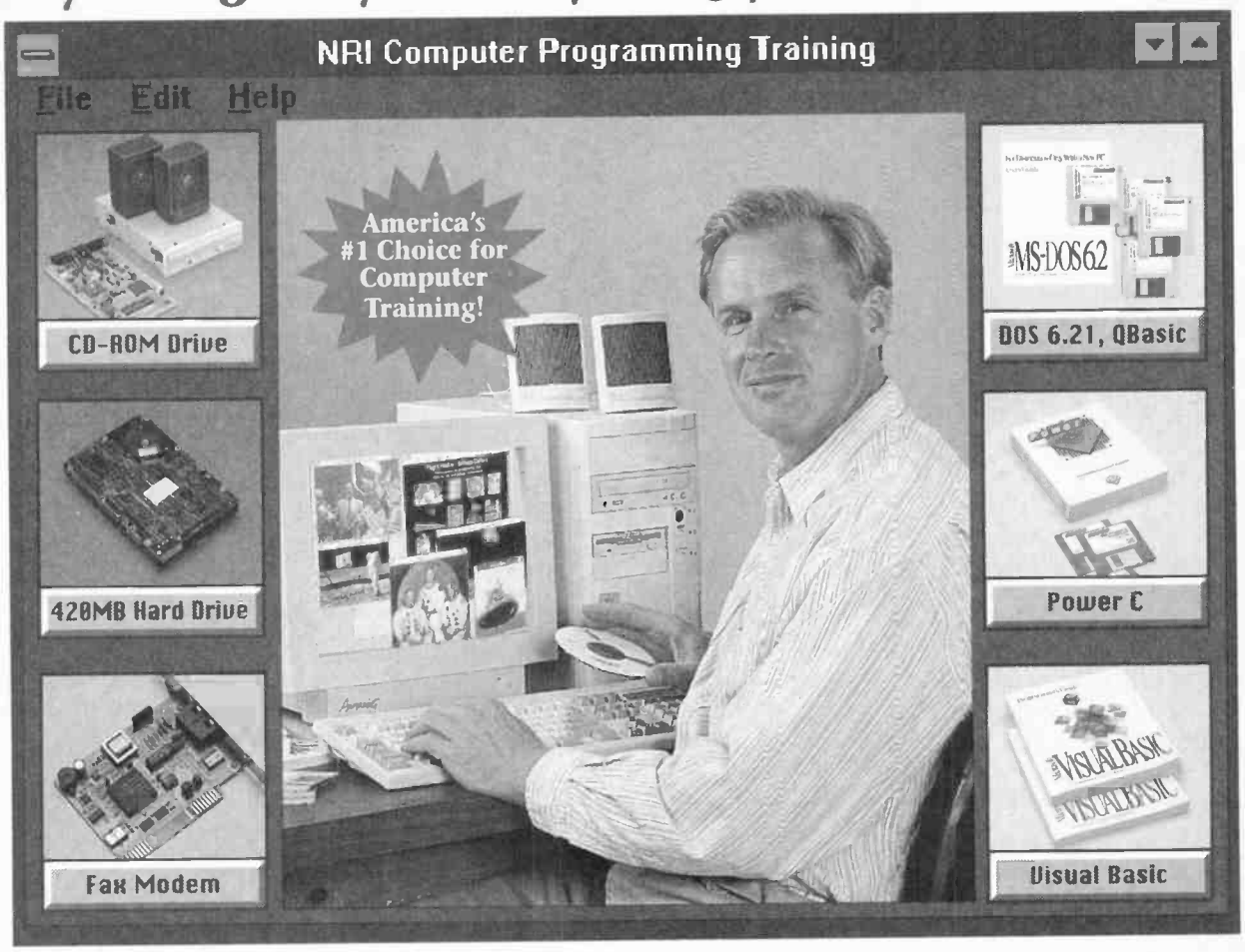

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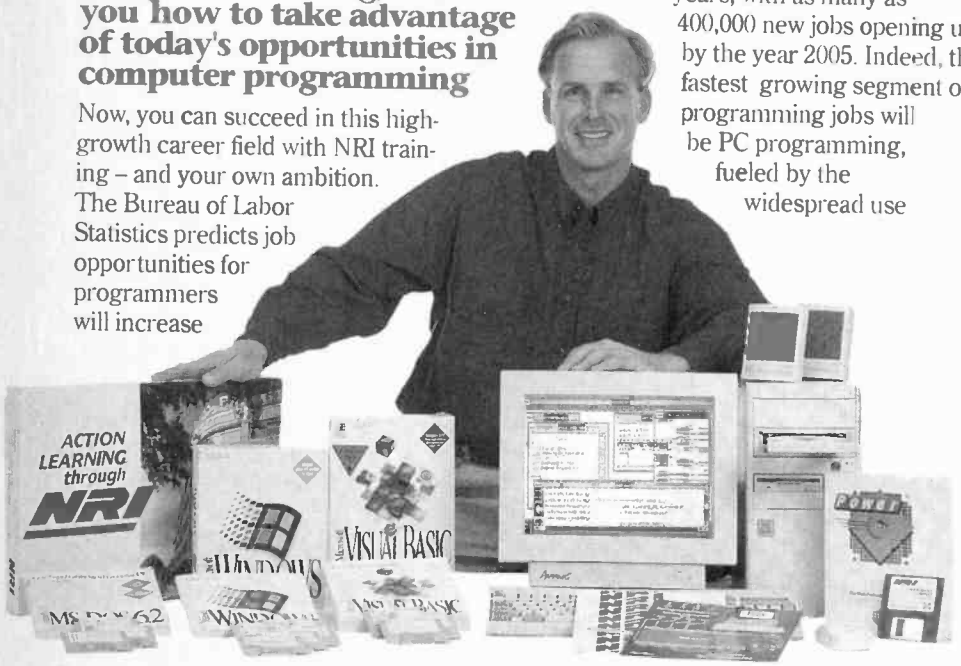

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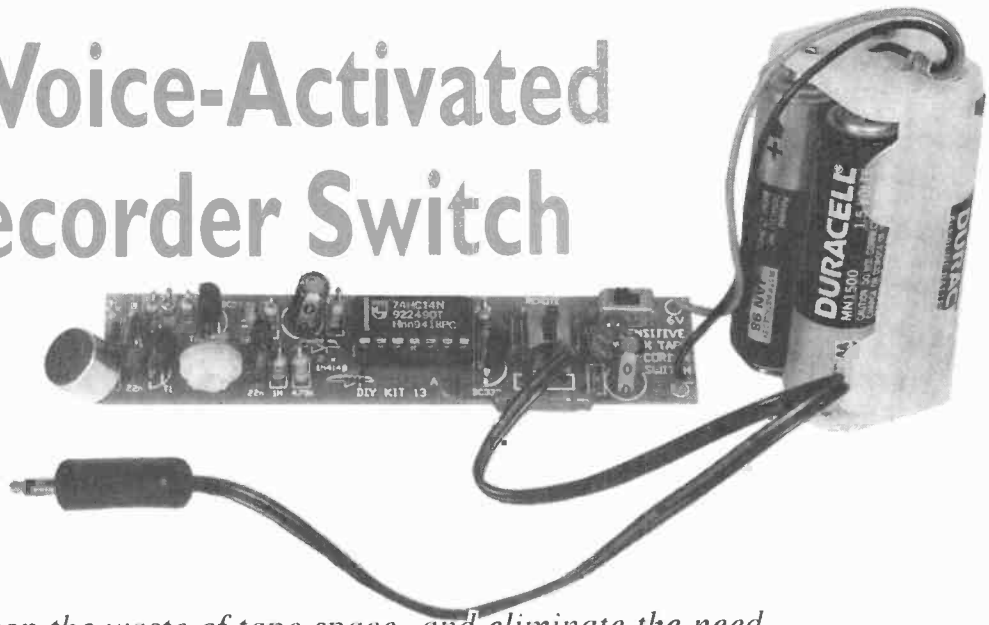
Build a Voice-Activated Tape Recorder Switch



Stop the waste of tape space, and eliminate the need to fast forward through silence, with this voice-activated switch.

BY MARC SPIWAK

Did you ever have to record a speech, presentation, or conversation and wish that you could do so automatically? Because it makes no sense to record silence, as that only wastes tape and increases playback time, some tape recorders come with voice-activated recording settings. Unfortunately, not *all* tape recorders come with that feature.

This article describes a sensitive, *Voice-Activated Tape-Recorder Switch*. When the circuit detects an audio signal, it grounds a mini plug that can be plugged into the remote jack on a tape recorder. That has the same effect as operating a remote recording switch. So if you build this neat little device, and have access to a tape recorder with a remote jack, you can easily add voice-sensitive recording to your setup.

Circuit Description. A schematic of the Tape-Recorder Switch is shown in Fig. 1. The circuit can be powered by B1, which is four AA batteries in series, or by any 6-volt DC supply.

Audio signals from the electret microphone, MIC1, are coupled via capacitor C1 to two audio-amplification stages centered around transistors Q1 and Q2. A 5000-ohm potentiometer, R12, provides a sensitivity control that sets the audio level at which the Switch will activate a tape recorder.

The audio input to the digital switching section of the circuit is biased at half the supply voltage by two 1%, 1-megohm, metal-film resistors (R6 and R7). Integrated-circuit U1 is a 74HC14 hex Schmitt trigger inverter. With a 6-volt power supply, the Schmitt inverter

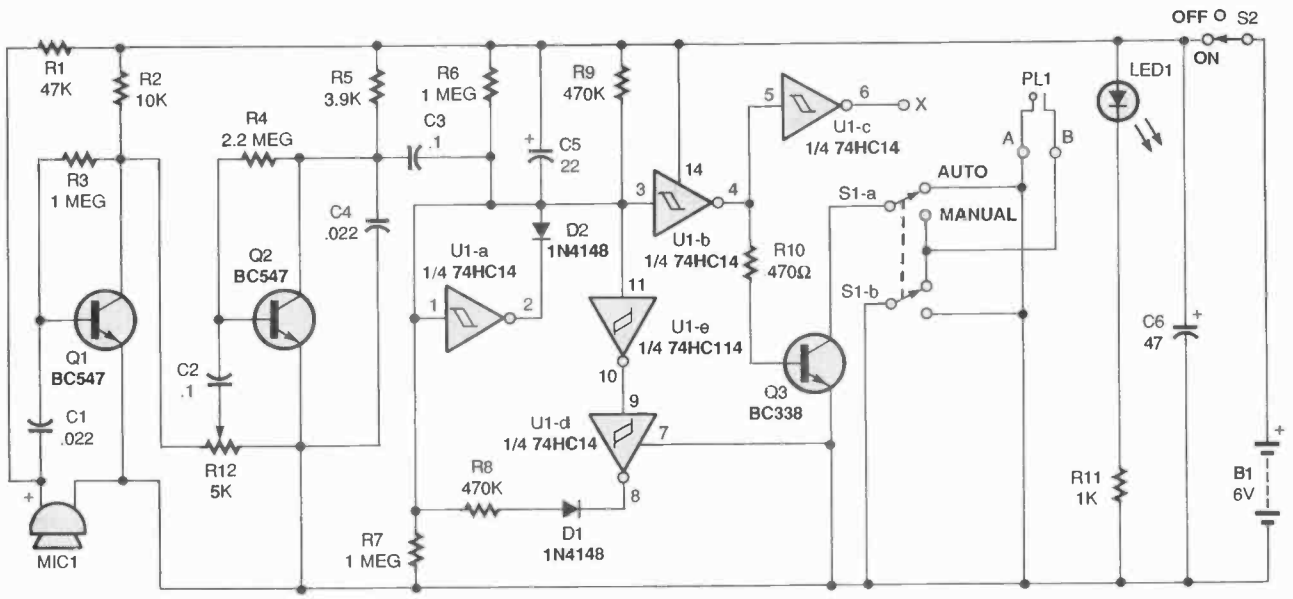


Fig. 1. Here's the schematic for the Voice-Activated Tape-Recorder Switch. A 5000-ohm potentiometer, R12, provides a sensitivity control for the audio level at which the switch will activate a tape recorder.

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gates will have a 1-volt hysteresis gap between 2.2 volts and 3.2 volts. That means that the input to a Schmitt inverter must rise above 3.2 volts for the output to go low, but must fall below 2.2 volts for the output to return to a high.

Now assume that the input to U1-a (pin 1) is held high by an audio signal from the microphone and that the output (pin 2) would be low. That causes capacitor C5 to charge rapidly through diode D2. The low from pin 2 also pulls the input to U1-b (pin 3) low; the output of U1-b (pin 4) would then be high. That resulting high from pin 4 turns on transistor Q1, which then grounds terminal A if S1 is in the "Auto" position. Terminal B is held to ground by S1-b. That has the effect of shorting terminals A and B together, and thus the two conductors of PL1, which is the mini plug connected to the terminals. With S1 in the "Manual" position, both terminals are grounded, thereby keeping the recorder turned on regardless of the presence of audio.

The low on pin 3 of U1-b in the presence of audio is presented to pin 11 of U1-e and ends up at pin 8 of U1-d. That will pull pin 1 low in the absence of an audio signal from the microphone, making pin 2 high.

Diode D2 blocks the discharging of C5 through its original charging path, so C5 starts to discharge through R9 with a time constant of R9 × C5, or about 10.3 seconds. The turn-off time is determined by the relative turn-on voltage of the Schmitt inverter, which is about half of the supply voltage. That time works out to a delay of about 6 seconds. After that delay, the voltage at pin 3 rises above 3.2 volts, causing pin 4 to go low, thus removing the connection from terminal A to ground, and turning off the tape recorder. A continuous audio input to pin 1 will hold pin 4 high, but as soon as it ceases, the time-out process begins.

When power is applied to the circuit using switch S2, LED1 lights. However, if the ground connection to R11 is removed, and that end of the resistor is then connected to terminal X (pin 6 of U1-c), the LED will instead light only when the output of the circuit is active (more on that later).

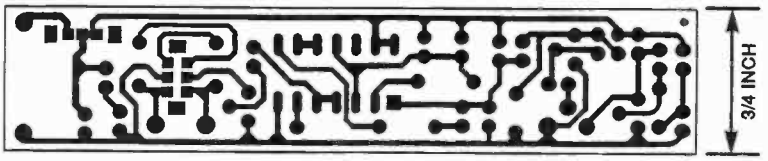

Fig. 2. Use this template to etch your own PC board for the Tape-Recorder Switch.

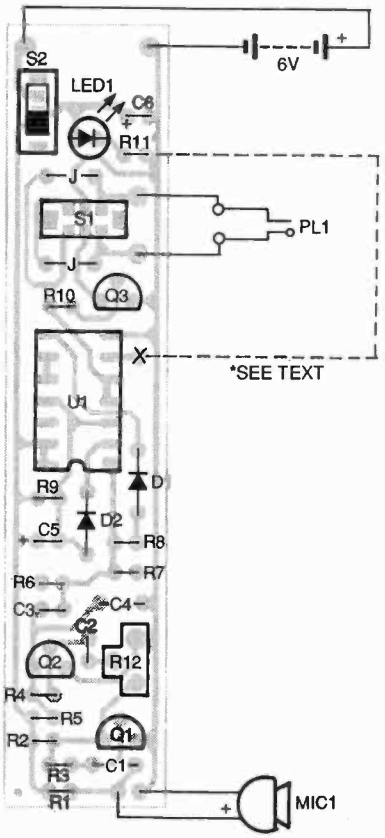

Fig. 3. This parts-placement diagram should make assembling the circuit easier. Fixed resistors must be mounted vertically. The orientation of Q3 might vary depending on the unit you use.

Construction and Checkout. The author's prototype for the Tape-Recorder Switch was built on a small PC board. You can build the circuit on a perforated construction board instead, but a PC board makes the project more compact. A pre-etched and drilled PC board is available as part of a complete kit of parts from the source mentioned in the Parts List. If you would like to etch your own PC board, a foil pattern is provided in Fig. 2.

For those using a PC board, a parts-

(Continued on page 79)

PARTS LIST FOR THE VOICE-ACTIVATED TAPE-RECORDER SWITCH

SEMICONDUCTORS

U1—74HC14 hex Schmitt trigger inverter, integrated circuit
Q1, Q2—BC547, NTE 123A, or equivalent NPN transistor
Q3—BC338, NTE123AP, or equivalent NPN transistor (see text)
D1, D2—1N4148 silicon diode
LED1—Light-emitting diode, any color

RESISTORS

(All fixed resistors are ¼-watt, 5% units, unless otherwise noted.)
R1—47,000-ohm
R2—10,000-ohm
R3—1-megohm
R4—2.2-megohm
R5—3900-ohm
R6, R7—1-megohm, ¼-watt, 1% metal-film
R8, R9—470,000-ohm
R10—470-ohm
R11—1000-ohm
R12—5000-ohm, PC-mount potentiometer

CAPACITORS

C1, C4—0.022-µF, Mylar
C2, C3—0.1-µF, ceramic-disc
C5—22-µF, 16-WDVC electrolytic
C6—47-µF, 16-WDVC electrolytic

ADDITIONAL PARTS AND MATERIALS

MIC1—Electret microphone
PL1—2.5-mm mini plug
S1—DPDT, PC-mount switch
S2—SPDT, PC-mount switch
B1—6-volt battery (4 AA cells in series)
Printed-circuit materials, 4-AA cell battery holder, 2-conductor wire, solder, hardware, etc.

Note: The following is available from Marlin P. Jones & Associates, Inc. (P.O. Box 12685, Lake Park, FL 33403-0685; Tel. 800-OK 2 ORDER or 407-848-8236; Fax: 407-844-8764): Voice-Activated Tape-Recorder Switch Kit (#6013-KT—includes everything specified in the Parts List, except batteries)—$12.95 plus $3.00 shipping and handling. Florida residents please add appropriate sales tax.

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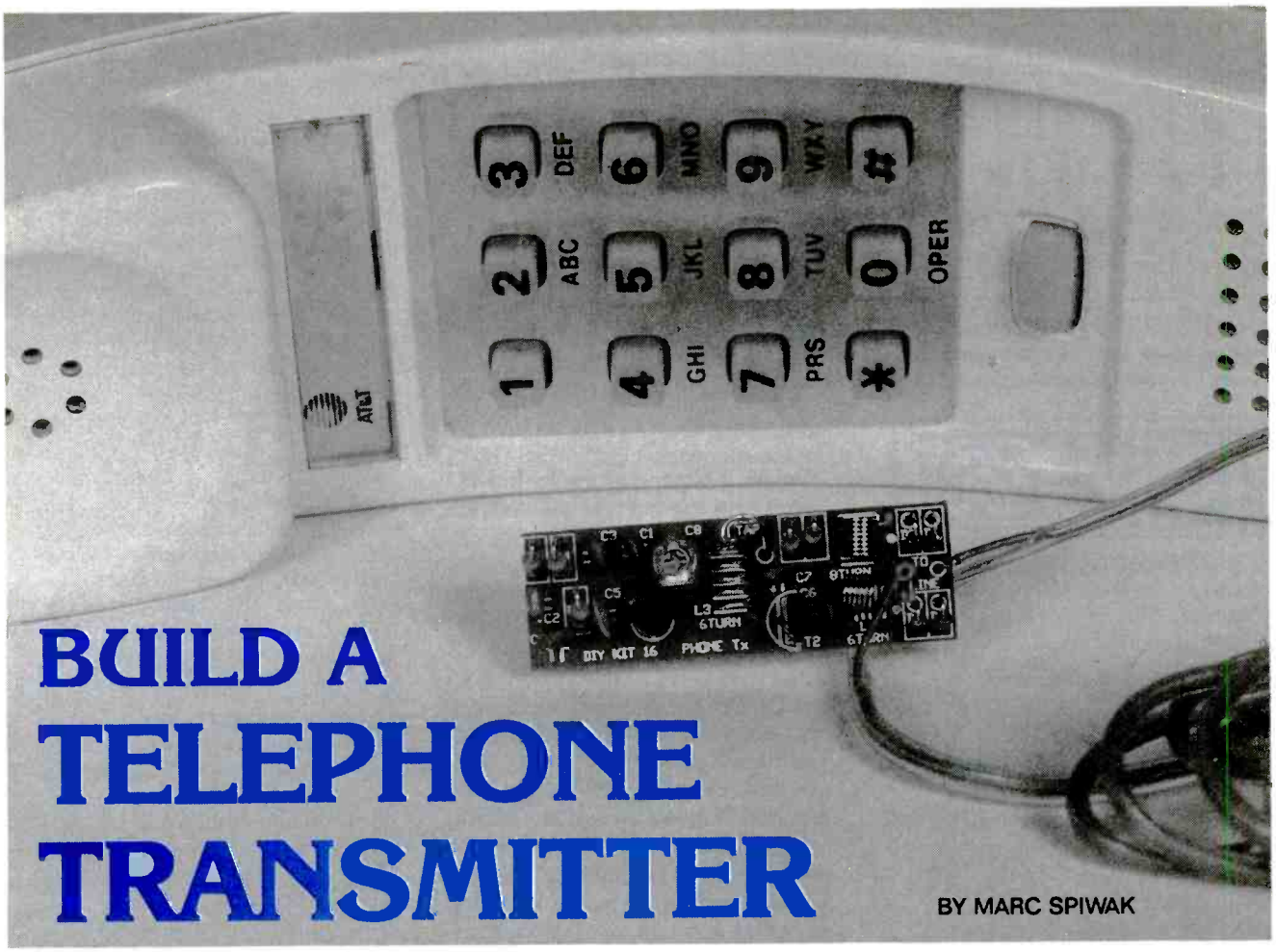

Receive telephone conversations on any FM radio with this neat little device.

Would you like to be able to amplify a phone call so everybody can hear it? Or perhaps you'd like a way to record a phone call to keep a record of it. If either idea sounds good to you, then you might want to build the *FM Telephone Transmitter* described in this article. It's a simple, yet ingenious device that connects in series with a phone line, "steals" power from the latter, and transmits both sides of a conversation to an FM radio tuned to between 90 and 95 MHz.

The circuit is built on a PC board that's so small it can easily be fitted inside the housing of a telephone, making it an instant pseudo-speakerphone. Keep in mind, though, that it is illegal to listen to or record a telephone conversation without informing all involved parties.

There are many legitimate reasons for wanting to broadcast a telephone call to an FM receiver. For one, maybe you are calling one of those "900" information or entertainment lines, and everybody wants to hear the message. Or perhaps when someone calls long distance he or she doesn't have the time or can't afford to stay on long, but everybody at home still wants to hear his or her voice. Or perhaps you want to record a phone call so that you have a record of, say, some electronic banking you did or a deal you made.

Besides being small in size, the Telephone Transmitter is also small in price. Only a handful of parts are needed to build the Transmitter, and everything you need (including a PC board) can be purchased as a kit for only $9.95. How's that for an inexpensive project?

Circuit Description. The schematic diagram for the Telephone Transmitter is shown in Fig. 1. That circuit connects in series with either the Tip or Ring (green or red) telephone line. Power for the circuit is full-wave bridge rectified from the phone line by diodes D1 through D4.

Transistor Q1, capacitors C1 and C8, and inductor L3 form an FM oscillator that operates at a frequency of around 93 MHz. Variable-capacitor C8 allows the oscillator frequency to be adjusted between 90 and 95 MHz. To move the tuning area up to the 98- to 105-MHz range, C1 must be replaced with a 10-pF capacitor.

Audio from the phone line is coupled through R3 and C2 to the base of Q1 where it frequency modulates the oscillator. Transistor Q3, inductor L1, and capacitor C6 form a power amplifier. The signal tapped off L3 in the oscillator circuit is fed to the base of transistor Q2 and the FM signal is transmitted from Q2's collector. Inductor L2 is a radio-frequency shunt that decouples power and audio from the amplifier circuit.

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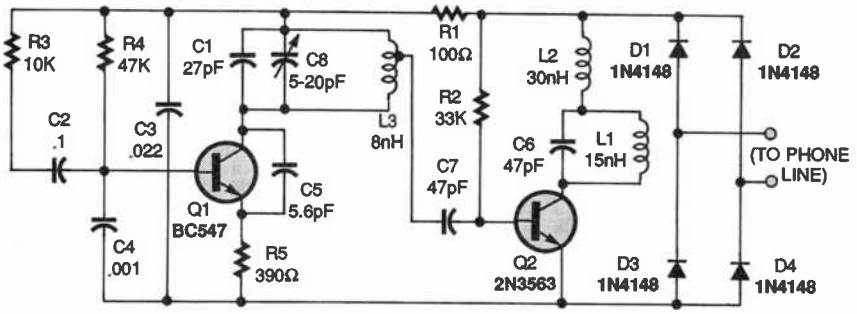

Fig. 1. Here's the FM Telephone Transmitter schematic. The circuit connects in series with a phone line, "steals" power from it, and transmits both sides of a conversation to an FM radio tuned to between 90 and 95 MHz.

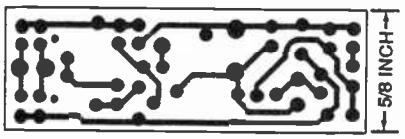

Fig. 2. If you'd like to etch your own board for the Transmitter, use this template.

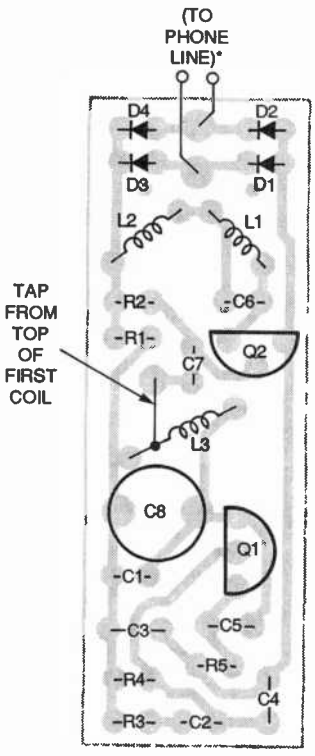

Fig. 3. Use this parts-placement diagram as a guide when mounting components to the board.

Construction. The circuit is simple enough to build on perforated construction board, but the tight design of the PC board shown in Fig. 2 is desirable. If you would like to use a PC board, you can either use the foil pattern provided in that figure to make your own PC board, or order a pre-etched and drilled board as part of a complete parts kit available from the source mentioned in the Parts List.

When mounting parts to the PC board, use the parts-placement diagram shown in Fig. 3 as a guide. Begin by installing the resistors and diodes; the board is so tight that those components must be mounted vertically.

The next step is to install the inductors. Coils L1 and L2 are 6 and 8 turns, respectively, of enameled copper wire. If you are winding your own coils, use approximately 22-gauge wire and a ⅛-inch drill bit as your winding form. Any enamel on the leads where the coils are to be soldered must be sanded, scraped, or burned off with a soldering iron before solder will adhere to them properly. Coil L3 is 6 turns of tinned copper wire in which the coils must be spread out with about 1 millimeter between each of them—none of the turns should be touching each other. A tap must be connected between the top of the first turn of L3 and the PC board. Go on to install the fixed capacitors and the variable one. Then you can solder the two transistors to their appropriate places.

The kit mentioned in the Parts List includes alligator leads for connecting the Transmitter to the phone line. However, the author opted to modify a modular phone cord and install the board in series with it. The Transmitter can then easily be swapped between different phones. Be certain to inspect the board for errors before connecting it to the phone line.

The range of the Transmitter is less than 100 feet. That distance can be increased, however, by soldering a wire antenna (about 150 cm of 26-gauge wire) to the collector of Q2.

Test And Tune. Connect the Transmitter to the phone line using whatever method you prefer. Turn on a nearby FM radio and tune to a quiet spot on the dial somewhere between 90 and 95 MHz. Pick up the phone; you should hear the dial tone right away on the FM radio. If that is not the case, adjust C8 until you do hear the dial tone. First adjust C8 for the best reception, and then fine tune the radio. If you have trouble finding a spot on the dial that is quiet enough, remember that the tuning area can be moved up to the 98- to 105-MHz range by replacing C1 with a 10-pF capacitor. ■

PARTS LIST FOR THE FM TELEPHONE TRANSMITTER

SEMICONDUCTORS

Q1—BC547, BC107, NTE 123A, or equivalent NPN transistor
Q2—2N3563, ZTX320, NTE 108, or equivalent NPN transistor
D1–D4—1N4148 silicon diode

RESISTORS

(All resistors are ¼-watt, 5% units.)
R1—100-ohm
R2—33,000-ohm
R3—10,000-ohm
R4—47,000-ohm
R5—390-ohm

CAPACITORS

C1—27-pF, ceramic-disc
C2—0.1-μF, ceramic-disc
C3—0.022-μF, ceramic-disc
C4—0.001-μF, ceramic-disc
C5—5.6-pF, ceramic-disc
C6, C7—47-pF, ceramic-disc
C8—5- to 20-pF, trimmer

ADDITIONAL PARTS AND MATERIALS

L1—15-nH, 6 turns of enameled copper wire (see text)
L2—30-nH, 8 turns of enameled copper wire (see text)
L3—8-nH, 6 turns of tinned copper wire (see text)
Printed-circuit materials, alligator clips, wire, solder, hardware, etc.

Note: The following is available from Marlin P. Jones & Associates, Inc. (P.O. Box 12685, Lake Park, FL 33403-0685; Tel. 800-OK 2 ORDER or 407-848-8236; Fax: 407-844-8764): FM Telephone Transmitter Kit (#6016-KT—includes everything specified in the Parts List)—$9.95 plus $3.00 shipping and handling. Florida residents please add appropriate sales tax.

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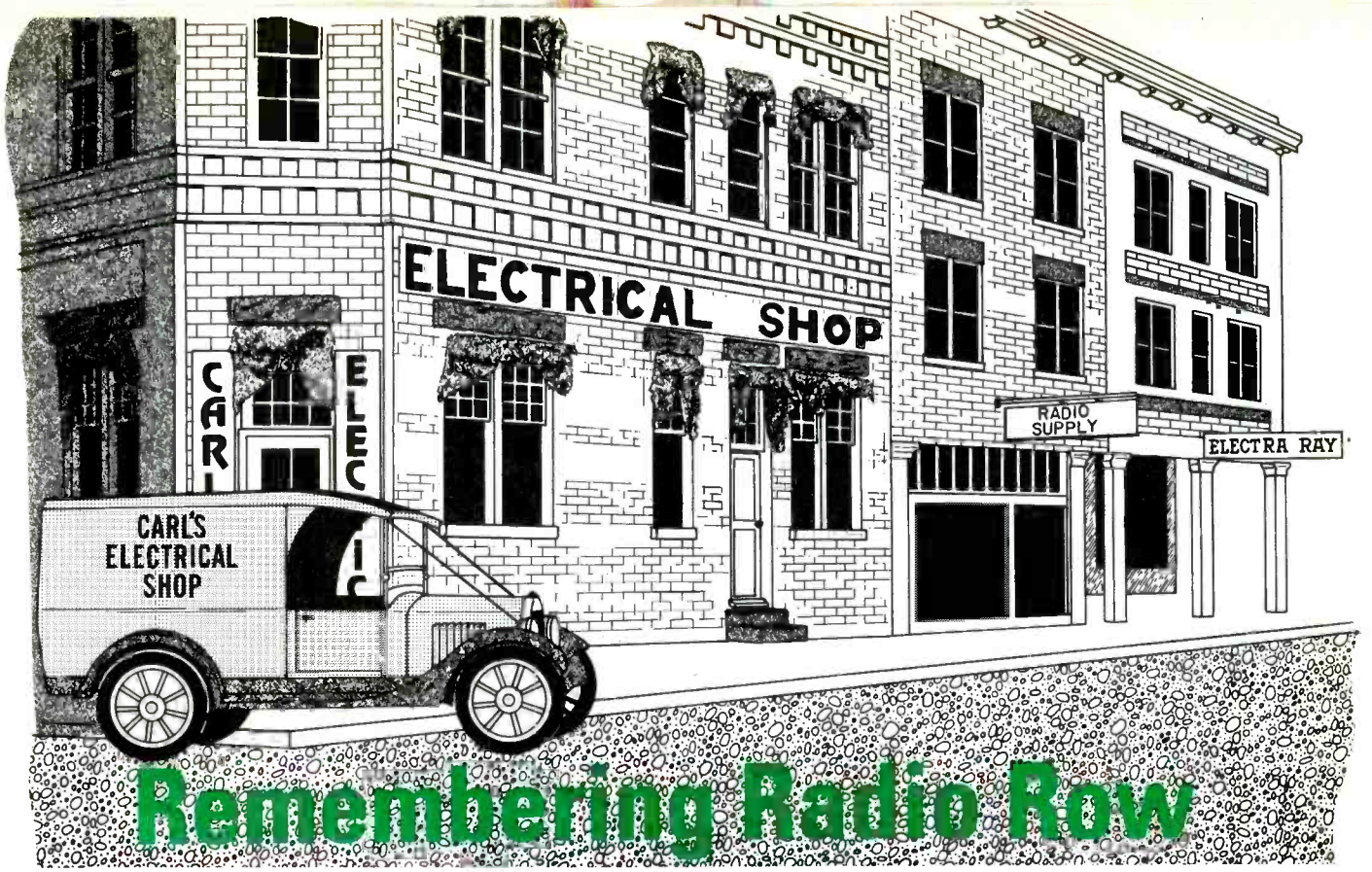

Remembering Radio Row

A look at where radio amateurs and other electronics hobbyists shopped in bygone days.

BY KARL T. THURBER, JR.

Where did one go for parts, components, and equipment in the 1940s, 1950s, and 1960s? There were few franchised radio outlets and few neighborhood Radio Shacks then. Most of the "ham stores" where you could work good trade-in and trade-up deals were situated in big cities.

The radio electronics world was much different then. Transistors and other solid-state devices were almost unknown. FM repeaters, exotic digital-communications modes, OSCAR satellites, CDs and CD-ROMs, cellular telephones, and—perhaps most significantly—personal computers (PCs), either didn't exist then or were little more than scientists' and engineers' dreams.

Amateur-radio stations and home electronics labs of the 1940s, 1950s, and 1960s were simple compared with the sophisticated equipment that today's hobbyists take for granted. Electronic experimenters used to build their own equipment to learn how the circuits worked, better appreciate improvements they could make, and of course, save money.

Mail Order. A large number of radio-electronics mail-order houses grew up in the dynamic post-World-War-II era to fill hobbyists' parts list and equipment-order requests. Those mail-order houses were the sources of many of the components radio beginners, amateurs, and builders needed. They were only necessary, of course, if one couldn't beg, borrow, or steal components from a sympathetic friend's junkbox or from piles of scrapped radio and TV sets often found in neighborhood repair shops.

Some of the biggest radio-electronics mail-order houses were Henry Radio (Los Angeles and St. Louis), World Radio Laboratories (Council Bluffs, Iowa), Walter Ashe (St. Louis), Lafayette Radio Electronics (New York), and Barry Electronics (New York). Other "postal parts magnets" were Burstein-Applebee and McGee Radio (both in Kansas City, Missouri), Arrow Electronic Supply (New York), Newark Electronics (Chicago), Concord Radio (New York), and Allied Radio (Chicago).

Only a few of those firms exist today. Others have merged into larger outfits and have lost their former identities. Still others went out of business, never to be heard from again, as the industry began to look to Japan in the 1960s and 1970s.

Radio Swap Meets. The radio hamfests of the 1940s and 1950s were not the slick, professionally organized amateur radio conventions of the 1990s. Most started out as regional swap meets. For the most part, those affairs were little more than radio flea markets, typically sponsored by local clubs for their own members.

The main activity at such radio swap meets was (and, in some cases, still is) the buying, selling, and swapping of radio and electronic parts and equipment. Sometimes an auction was held at a swap meet, often to dispose of all the remainder items so that they wouldn't have to be carted home by their owners.

In any case, one of the joys of radio flea markets has always been casual browsing. At a well-attended swap meet, there's an almost infinite variety

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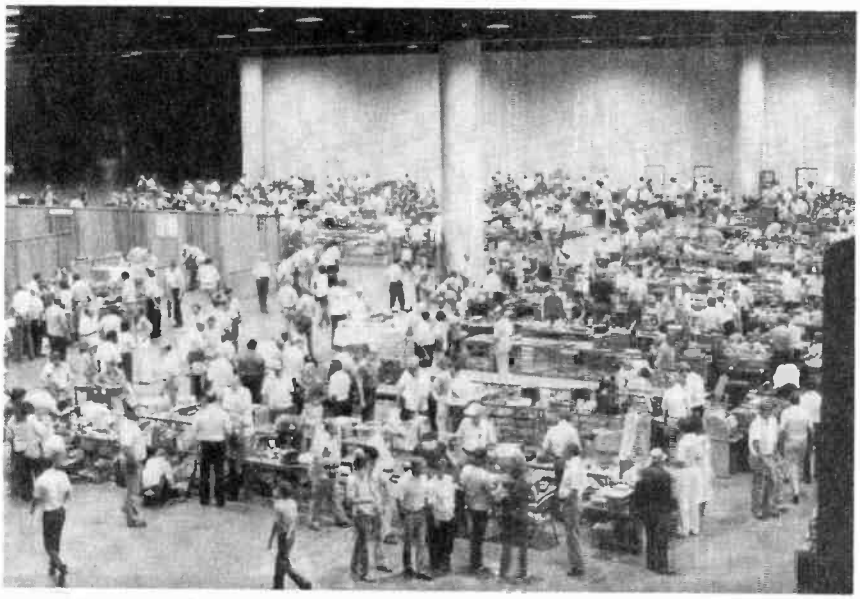

One of the joys of the radio marketplace always has been casual browsing through dusty, musty tables and parts bins. At a present-day swap meet, such as the one shown here, a shopper can equip his or her radio shack and workbench at minimum cost—with much the same result as a yesteryear Saturday morning trip to the nearest Radio Row.

of goodies to choose from, and the shrewd shopper can equip his or her radio shack and workbench at minimum cost—with much the same result as a Saturday morning trip to the nearest Radio Row in past years.

Postwar radio surplus played a big part in "stocking up" local swap meets and contributed to the development of a Radio-Row district in many American cities. The 1940s through the 1960s were the "good-old radio-surplus days" in which the amateur-radio and electronics magazines were full of ads from surplus houses touting their post-war (both World War II and Korean War) radio bargains.

Today, though, the glut (and usefulness) of World-War-II and Korean-War radio surplus has almost disappeared. In fact, radio "war surplus" is mostly a thing of the past. Up until at least the 1960s, however, many do-it-yourselfers and builders found that surplus goodies contained a wealth of usable meters, switches, capacitors, chokes, and other parts that could build up a junkbox for future projects.

Radio Rows, Coast-to-Coast. If you lived in or around large cities, a major source of parts and equipment used to be your city's "Radio Row" district of stores—radio meccas and emporiums that sold war surplus, wholesale and industrial equipment, components, and parts. Those stores were also places where many of the big mail-order houses and surplus dealers had an outlet—places where you often could buy things for even less than published in the company's own catalog.

Here's a photo of the author in his teens at the controls of his ham station, K2IKZ, circa 1957. Some of the equipment in this photo was purchased from the amateur-radio-equipment dealers who thrived in the Radio Row area.

Most of the Radio Rows around the country had their beginnings in the 1920s and 1930s as small shops selling radio wares clustered together—although some, like New York's fabled Radio Row, had their beginnings much earlier. What really got the Radio Rows off the ground was the big demobilization following the end of World-War II. In those days, considerable military-surplus radio equipment and components of every description were made available to civilians. Much of that stuff was given away, or it was sold for just a few cents on Uncle Sam's dollar.

The Reconstruction Finance Corporation (RFC) was one of the organizations created by the government in part to dismantle the big "war machine" that had been built up in World-War II. RFC and other government agents sold war surplus to manufacturing firms, radio jobbers, and wholesalers—and even to returning veterans in some cases. Much of that material ultimately was disposed of to the public "at retail" by small stores concentrated in metropolitan-area Radio Rows, or by the large mail-order houses.

Dealers were heavily clustered in such cities as New York, Los Angeles, Chicago, Boston, Miami, Dayton, St. Louis, Kansas City, Houston, and Seat-

Receivers, transmitters, VHF gear, test equipment—they're all found at the modern swap meet, just as in the "good-old Radio Row" days. If your budget is strained for the purchase of gear to get your station or listening post started, check out the used equipment tables.

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tle. The dealers often were located near military logistics depots where the large quantities of war-surplus materials were dispensed.

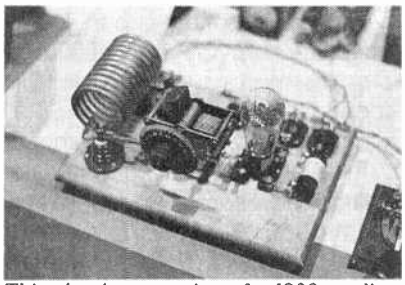
Over the years, the surplus market has changed considerably as military surplus has decreased in availability and usability. That, combined with urban renewal, has obliterated once-prosperous Radio Rows in most cities. Today surplus dealers are much more widely dispersed, and they tend to sell their wares primarily by mail.

New York's Radio Row. The biggest Radio Row in the country was New York City's sprawling Radio Row, located in lower Manhattan. To be sure, there were a few radio stores in midtown Manhattan and in the New York and New Jersey suburbs. But the one and only "original" Radio Row was situated in the Dey, Cortlandt, Fulton, Greenwich, Vesey, Warren, West, and Washington Street and lower Broadway areas and the adjacent districts. Through at least the 1940s and 1950s, you could buy almost anything you needed there to complete a radio-building project, and you could do it for little money, to boot.

Interestingly, much of what eventually became the New York Radio Row district was man-made land. In colonial times, for example, Greenwich Street, which roughly ran north and south, was on the shoreline, and what now is West Street was under water. Over the course of 200 years, the Hudson River was pushed back, making room for a thriving marketplace.

As new docks were built, property owners filled over the old structures. With people in the 1800s creating new land all the while, burying abandoned wharves and even ships, the bulkhead line marched 700 feet westward. By 1890, West Street had become the main thoroughfare of shipping and trade in New York.

The "Uncle Hugo" Era. While most of the Radio Rows around the country had their beginnings in the 1920s and 1930s, New York's Radio Row made its debut in the first decade of this century. One of the early pioneers and promoters of the radio hobby—especially among youngsters—was a 1904 immigrant from Luxembourg, Hugo Gernsback. He offered his first



This classic recreation of a 1930s radio rig speaks volumes about the opportunities for homebrewing radio equipment in bygone Radio Row days.

This 1972 Liberty Electronics ad shows that you could not only buy parts and equipment on Radio Row, but in some cases you also could sell your stuff back to a dealer for cash. Military electronics gear and test equipment were very popular items.

invention, a dry-cell battery, as well as a wireless transmitter and receiver, at his "great emporium of the amateur world, the Electro-Importing Company." Gernsback's five-story store was in what eventually came to be known as New York's Radio Row.

"Uncle Hugo's" radio-antenna-bedecked store featured wireless supplies, and it openly boasted that it carried "everything for the experimenter." The store was located in a five-story building at 233 Fulton Street in the heart of lower Manhattan. According to historians, Gernsback's shop probably was the first one in the United States to sell wireless apparatus directly to the public. The store also was a place where technically inclined youngsters could see wireless apparatus close-up, learn something about how to build their own radio sets, and meet other like-minded radio hobbyists.

Gernsback was a brilliant promoter of wireless as a hobby. His shop was so successful that he even published a catalog describing the electrical wares he offered, and in 1908 founded what is generally considered to be the first radio magazine, *Modern Electrics*. (Gernsback also was the founder of Gernsback Publications, which publishes **Popular Electronics** and *Electronics Now*. He's also considered by many science-fiction fans to be the "father" of modern science fiction.)

In his shop, Gernsback offered what arguably was the first commercially produced home radio receiver. It was the Telimco, the name of which was derived from his company, *T*he *E*lectro *I*M*p*orting *CO*mpany. The story is even told that he sold the Telimco receiver for so little that New York City officials received complaints about it, and the Mayor sent out some of "New York's Finest" officers to investigate him for possible fraud!

Hugo Gernsback's store began a hobbyist-friendly tradition that was still in existence in the 1950s and 1960s, long after the legendary Electro-Importing Company vanished. In stores like G&G Radio, Cortlandt Radio, Leeds Radio, Cantor the Cabinet King, Try-Mo Radio, Leotone Radio, Liberty Electronics, the Krantz Brothers, and Blan the Radio Man, proprietors welcomed youngsters and senior citizens with equal cordiality.

Gone Now. You'll no longer find most of the New York Radio Row stores today. They are almost all gone now, or they're dispersed geographically. Most of the shops got their walking papers when their sites were condemned to be bulldozed and paved over by the massive urban-redevelopment project that created the World Trade Center and its environs. In fact, some 164 buildings on the site had to be removed for the 110-story twin towers to be able to dominate the lower Manhattan skyline. The result is that urban redevelopment has displaced Radio Row in New York and in many other large cities, though there are a few vestiges of Radio Rows in some smaller towns and cities.

The problem of age also contributed to the demise of Radio Rows in New York and other cities. The young, back-from-the-war entrepreneurs, storekeepers, and proprietors who went heavily into radio and surplus sales in its heyday just following World War II have long since retired or even passed away.

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Despite all that, redevelopment has rejuvenated the area in some respects, and you might still find that New York's "downtown Manhattan" remains a bastion of the offbeat shopper. Shopping in the lower Manhattan area still can be rewarding, though not so much for radio, electronics, and surplus goods anymore.

Radio Rows as we knew them in the 1940s through the 1960s are almost nonexistent today. The closest you probably can come to experiencing the Radio Rows of earlier eras is by weekend shopping at a major hamfest's flea market or "bone yard." Or, if you can afford the cost of a trans-Pacific airline ticket, you can visit Tokyo's amazing Akihabara electronics district, perhaps the last real Radio Row. By some accounts, it was, and is, greater even than New York's at its peak.

Japan's Mega Radio Row. Akihabara is just two stops from the main Tokyo station on the Yamanote railroad line. In its multistory stores and tiny stalls you can buy almost any imaginable computer, radio, amateur transceiver, CD player, household appliance, TV, VCR, video camera, or electronic component.

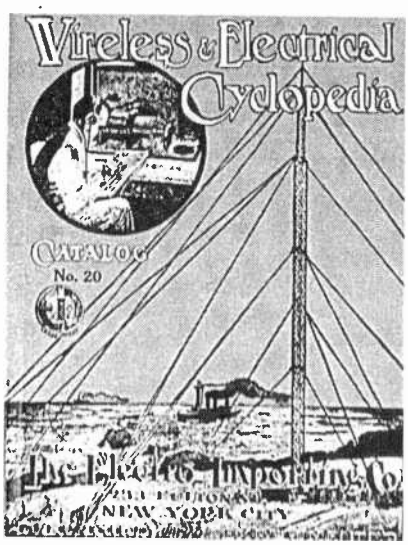
This freewheeling market probably is your best contemporary source for electronics parts and equipment anywhere. In fact, it's often said that if you visit even a large electronics store or radio emporium in the United States after shopping in Akihabara, you might feel as though you've just visited a Third World country's poorly stocked store in comparison with the electronics goodies found in Akihabara.

In many respects, parts of Akihabara are much like New York City's old Radio Row, but there surely are several times the number of stores in Akihabara than in Radio Row at its zenith. In Akihabara, block after block of stalls, small shops, and larger stores display new electronic wares, including many products that haven't yet jumped across the Pacific. And Akihabara is the place to see the newest technology. That forward-looking motif contrasts with the musty, dusty, surplus-like tone of most of the old New York Radio-Row stores.

It's no surprise that the 500 to 800 shops in the Akihabara area account for about 10 percent of all the electronics goods sold in Japan. In fact, each weekday roughly 75,000 people pass through the district, and they spend the equivalent of $4 to $5 billion a year on electronics purchases.

The Akihabara district has an interesting past. After World War II, many mom-and-pop merchants worked out of pushcarts parked in the narrow streets of the Sudacho district. That is an area about a mile from Akihabara and is close to what is now Tokyo Denki (Electric) University. At its peak, the Sudacho market reportedly had about 150 stalls.

In the late 1940s, General MacArthur's occupation authorities disbanded the street markets. They did so because the markets had grown too large, blocking traffic. That disruptive action caused the merchants to gravitate to the buildings around and under Akihabara's railroad tracks. Those became "the place" for electronic goods to be sold.



Shown here is a cover of one of the Electro-Importing Co.'s catalogs. Gernsback's company was probably the first one in the United States to sell wireless apparatus directly to the public.

One of the larger parts of Akihabara, and to many its very heart, is the Radio Center. There, hundreds of miniature shops are clustered close to the Akihabara station. The Radio Center is a veritable rabbit warren of tiny, one- or two-person booths mostly underneath the railroad. Those stalls are crammed with capacitors, transistors, diodes, switches, and other parts and components laid out in small bins, much like penny candy in an old-fashioned American candy store.

Customers can select their parts and place them in little plastic trays before paying. As you can probably determine so far, surplus and used equipment shops are the exception in the Radio Center and in the rest of Akihabara. Most parts are new.

Buying parts in Akihabara is considerably different from buying parts in the United States. Rather than finding large stores with many different kinds of components and devices, you instead find specialized, tiny shops grouped in large centers. One booth might sell only semiconductors, while the adjacent booth might stock only capacitors or resistors (but likely not both!). Still another stall might offer highly specialized test equipment, such as digital volt/ohm meters or certain computer connectors. Blister packs are infrequently encountered.

The prices in Akihabara are quite reasonable, even with the dollar's presently unfavorable exchange rate. That is especially true if you shop in the domestic (rather than the visitor-oriented duty-free) electronic stores—although many of the domestic store owners don't speak English. As a consequence of good selection, high availability, and low prices, Akihabara is crawling with electronics buffs from all over the world. About 20 percent of visitors to Akihabara are foreigners.

Another point: in Japan, unlike much of Asia, it's not customary to bargain over prices. But in Akihabara, you'll find one of the few places in the country where you can do so without embarrassment. In many shops, price tags might indicate both the list price and the shop's "discounted" price. But the price you actually pay often is still less, that amount being displayed on the shopkeeper's calculator after you inquire. Curiously, in some shops, that price might be shown to you rather than stated aloud.

Conclusion. So, as you can see, the days of Radio Rows in the United States are mostly gone now. While Japan might have its bargain hunter's electronic paradise, the nostalgic feel of American Radio Rows is not there.

But the memories of the various Radio Rows linger on in the minds of many radio amateurs and hobbysists. And those memories are pleasant ones. ■

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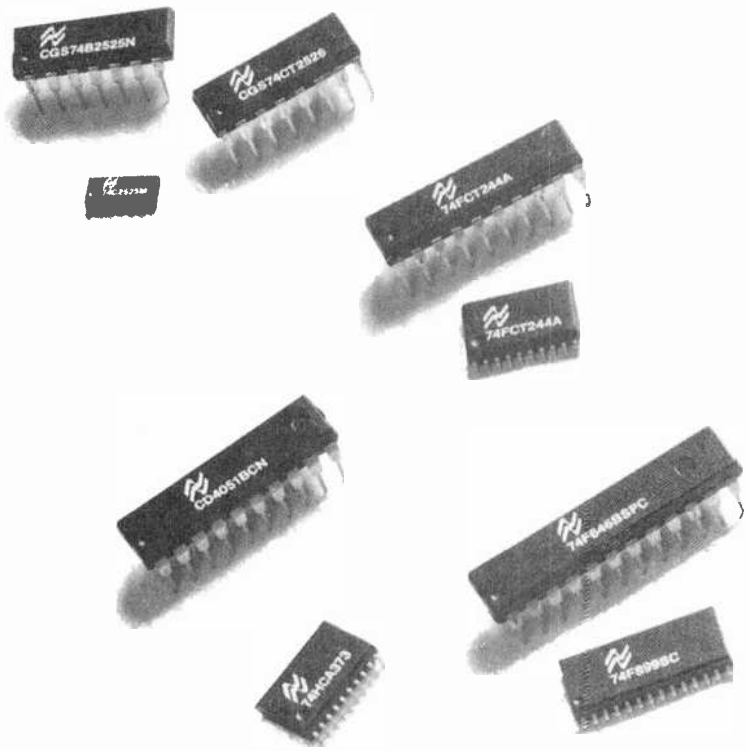

ALL ABOUT LOGIC FAMILIES

Learn about the characteristics of the different TTL and CMOS logic families, and the right way and time to use each.

BY STEPHEN J. BIGELOW

Ever since the very first digital integrated circuits reached the market, IC manufacturers have tried to optimize their devices through the use of improved gate designs and new manufacturing (IC-fabrication) techniques. In some cases, such optimization has resulted in digital ICs with excellent noise immunity or high-speed operation. In other cases, digital ICs have been refined for low power consumption or high output drive.

Each time a major improvement is perfected, a new family of logic is born. This article will show you the major TTL and CMOS logic families, explain their unique operating characteristics, and compare their important specifications.

A Data Sheet. Integrated circuits are remarkably involved devices. Because of that, dozens of operating parameters are needed to specify the characteristics of even the simplest IC. Those characteristics, or specifications, are fully detailed by the manufacturer on the device's data sheet (or "spec" sheet).

At first glance, a data sheet might seem overwhelming, but every data sheet can easily be broken down into four distinct areas: maximum ratings, recommended ratings, DC specifications, and AC specifications. Table 1 shows a typical breakdown of specifications for a 7400 TTL IC.

TABLE 1—SPECIFICATIONS FOR A TTL 7400 IC

Absolute Maximum Ratings		
Supply Voltage (V_{cc})	7	VDC
Input Voltage	5.5	VDC
Operating Temperature Range	0 to 70	°C
Storage Temperature Range	–65 to 150	°C
Recommended Operating Conditions		
Supply Voltage (V_{cc})	5	VDC
Logic 1 Input Voltage (V_{ih})	2	VDC min
Logic 0 Input Voltage (V_{il})	0.8	VDC max
Logic 1 Output Current (I_{oh})	–0.4	mA
Logic 0 Output Current (I_{ol})	16	mA
Electrical Characteristics (DC Specifications)		
Logic 1 Output Voltage (V_{oh})	2.4	VDC min
Logic 0 Output Voltage (V_{ol})	0.4	VDC max
Logic 1 Input Current (I_{ih})	40	µA max
Logic 0 Input Current (I_{il})	–1.6	mA max
Shorted Output Current (I_{os})	–55	mA max
High Output Supply Current (I_{cch})	8	mA max
Low Output Supply Current (I_{ccl})	22	mA max
Switching Characteristics (AC Specifications)		
Propagation Delay		
Low to High Output (t_{plh})	22	ns
High to Low Output (t_{phl})	15	ns

Maximum Ratings. This section is sometimes called "Absolute Maximum Ratings," and it is the first section of every data sheet. The ratings are considered "absolute" because the IC will likely suffer permanent damage and catastrophic failure if those ratings are exceeded. "Supply Voltage (V_{CC})" refers to the maximum voltage allowed to power the IC. "Input Voltage" is the maximum voltage allowed at any of the IC's logic inputs.

You generally do not need to be concerned with operating or storage temperature ranges because most project applications use ICs at or around normal room temperature (about 25°C). Keep in mind that an IC should **never** be operated at its absolute maximum ratings under normal conditions.

Recommended Ratings. The second section of a data sheet contains an IC's recommended ratings (or "Recommended Operating Conditions"). Recommended ratings specify the levels of voltage, current, and temperature at which the IC should be run under normal conditions. "Supply Voltage (V_{CC})" is listed again with

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the optimum value(s) of V_{CC}. The minimum voltage that must be applied to a logic input to be interpreted as a logic 1 is the "Logic 1 Input Voltage (V_{ih})." The maximum voltage that can be applied to a logic input and still be considered as a logic 0 is the "Logic 0 Input Voltage (V_{il})". The "Logic 1 Output Current (I_{oh})" is the amount of current provided by the output when the gate is in the logic-1 state. Note that I_{oh} is a negative number to indicate the fact that current is leaving the gate when it is logic 1. The "Logic 0 Output Current (I_{ol})" is the amount of current that can normally be absorbed by the gate when its output is logic 0; that is given as a positive number because current is flowing into the gate to ground.

DC Specifications. The static DC specifications (or "Electrical Characteristics") for a digital IC are listed in the third part of a data sheet. Electrical characteristics are often very similar to recommended operating conditions. The "Logic 1 Output Voltage (V_{oh})" is the minimum voltage level present at the gate's output when it is in the logic-1 state. The "Logic 0 Output Voltage (V_{ol})" is the maximum voltage present at the gate's output when it is in the logic-0 state. When a gate's input is logic 1, the "Logic 1 Input Current (I_{ih})" is being provided by the output of a previous gate or other circuitry. In the logic-0 state, the "Logic 0 Input Current (I_{il})" is being drawn from the input by a previous gate or other circuitry. Note that I_{il} is a negative number because current is leaving the gate's input.

There are a few varied current specifications. When an output is shorted to ground (which is NOT a recommended condition), a "Short Circuit Output Current (I_{os})" will flow out of the gate to ground. Note that I_{os} is a negative number because current is leaving the gate. Supply current (I_{CC}) varies somewhat depending on the particular conditions of each gate. The "Supply Current with Outputs High (I_{cch})" is typically less than the "Supply Current with Outputs Low (I_{ccl})."

AC Specifications. The AC specifications (or "Switching Characteristics") of a digital IC are usually focused on two important areas; propagation delays and clock rates. Whenever a change of input conditions cause a change in a gate's output, there is some certain amount of time needed for the change to take place (or "propagate") through the gate. That is the concept of propagation delay. The delay value will vary with the complexity of the logic device and whether TTL or CMOS technology is being used.

The time required to change a gate's output from a logic 0 to a logic 1 is the "Propagation Delay Low to High Output (t_{plh})." The time needed to change a gate's output from a logic 1 to a logic 0 is the "Propagation Delay High to Low Output (t_{phl})." Both propagation delays are typically measured in nanoseconds. More complex logic devices, such as multiplexers, flip-flops, or shift registers, will list additional propagation delays that consider the effects of clock, enable, and control inputs on the device.

Table 2 presents a number of additional specifications that could be listed with more complex logic devices. The "Maximum Clock Frequency (f_{max})" specifies the highest rate at which a signal might change when applied to the device. Devices such as flip-flops, counters, and shift registers rely on clock signals for proper operation. Signal frequencies that exceed f_{max} could result in erratic or unpredictable operation.

TABLE 2—ADDITIONAL IC SPECIFICATIONS

Maximum Clock Frequency (f_{max})	15 MHz
Input Pulse Width (t_w)	20 ns
Data Setup Time (t_{su})	15 ns
Data Hold Time (t_h)	5 ns

Data must be available on an input for a minimum amount of time before a clock pulse arrives. That is the "Data Setup Time (t_{su})". Also, data must be maintained for some minimum amount of time after the clock pulse passes. That is the "Data Hold Time (t_h)". Setup and hold times are usually quite brief—only a few nanoseconds. The "Input Pulse Width (t_w)" indicates the minimum time that a logic signal must be present at a gate's input to cause a reliable change in the gate's output. Timing parameters are generally not much of a problem if a gate is being operated at low speeds (a few hundred kHz). At high speeds, however, failure to obey a device's timing parameters can result in erratic or unpredictable circuit operation.

TTL vs. CMOS. Before you review the differences between specific logic families, you should understand some of the fundamental differences between TTL and CMOS devices.

TTL (transistor-transistor logic) is the oldest and perhaps the most recognized logic technology. TTL is a "bipolar" technology using conventional bipolar transistors (collector, base, and emitter) to create logical switching circuits. Today, such switching circuits are known as "gates". Throughout the late 1960s and into the 1970s, the trademark 7400 series accounted for a large share of the digital-IC market. TTL gates are reasonably easy to fabricate using simple IC-manufacturing methods, so IC manufacturers were able to produce logic ICs at low cost. Today, TTL ICs and their variations remain a staple of the digital IC market.

Figure 1A shows the internal structure of a classical TTL NAND gate; Fig. 1B shows the device's schematic symbol. Control of the gate's output is provided by a set of bipolar transistors (Q3 and Q4) arranged in what is known as a "totem-pole" output.

When the gate's output is logic 0, Q4 turns off to prevent current flow to the output, while Q3 turns on to effectively ground the output. Ideally, a logic 0 would force the output to 0-volts DC, but there will be some small saturation voltage across Q3 (0.4 VDC or less), which is the value of V_{ol}.

When the gate's output is logic 1, Q3 turns off to isolate the output from ground, and Q4 turns on to supply output current. Ideally, that pull-up would raise the output level to the value of V_{CC}, but the voltage drop across the 130-ohm resistor and the voltage drop across the saturated Q4 will reduce that value to as little as 2.4 VDC, which is V_{oh}.

Unfortunately, TTL devices consume a sizable amount of power—about 10 mW per gate. Although that allows TTL gates to supply plenty of current at their outputs, power dissipation will limit the number of gates that can be placed into a single IC package. TTL ICs run much hotter than their CMOS counterparts.

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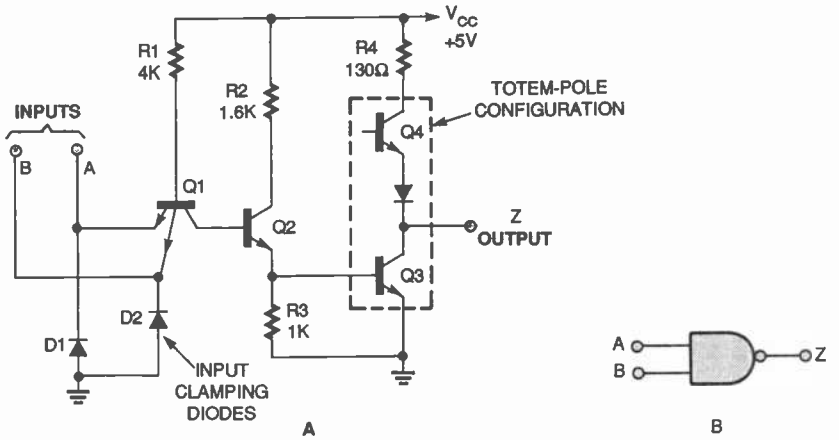

Fig. 1. The internal structure of a classical TTL NAND gate is shown in A; B shows the device's schematic symbol.

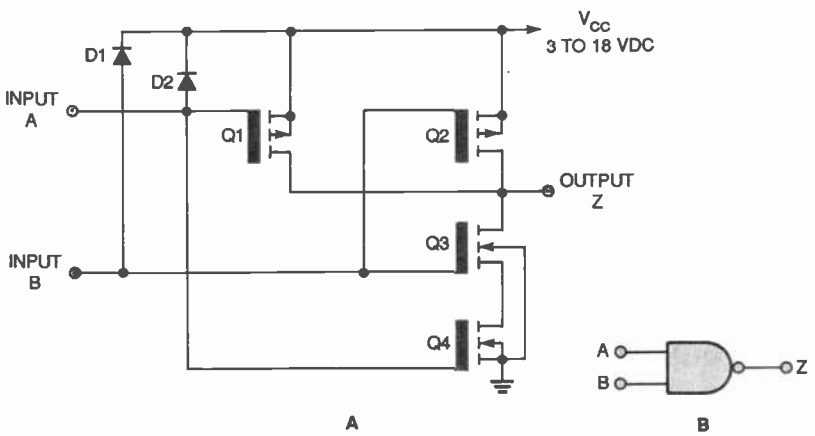

Fig. 2. A typical CMOS NAND gate is shown in A; the logic symbol for the gate is shown in B.

Also, bipolar transistors are somewhat slow devices, so propagation delay and operating speed are not usually acceptable for high-performance digital applications. On the plus side, bipolar transistors are highly tolerant of electrostatic discharge (ESD) damage, so TTL ICs are not subject to the same handling and use precautions that CMOS devices are.

CMOS (complementary metal-oxide semiconductor) devices are an offshoot of early MOS IC developments. The CMOS line was the only line of MOS ICs to be developed offering logic functions that are compatible with TTL functions. However, logic functions are the only aspect of CMOS devices that are compatible with TTL.

A typical CMOS NAND gate is shown in Fig. 2A; the logic symbol for the gate is shown in Fig. 2B. MOS transistors are physically much smaller and simpler than bipolar transistors and require almost no current in order to operate. At low frequencies, a CMOS gate dissipates very little power. As a result, CMOS logic gates are smaller than corresponding TTL gates, and many more CMOS gates can be fabricated onto an IC. That allows more complex CMOS ICs to be constructed. Classic CMOS gates suffer from very long propagation delays (over 100 ns), so operating frequencies are limited to less than a few MHz.

CMOS devices differ from TTL ICs in supply-voltage requirements and logic levels as well. Where TTL ICs are designed to run from a fixed supply voltage of 5 VDC, CMOS ICs will operate from a supply voltage between 3 and 18 VDC. The logic input levels of a CMOS gate will be proportional to the supply voltage. For example, a minimum logic-1 input must equal approximately ⅔ of the supply voltage. For a supply voltage of 15 VDC, a logic-1 input would be 10 VDC or more. A maximum logic-0 input must equal about ⅓ of the supply voltage. The maximum logic-0 input would be 5 VDC for a supply voltage of 15 VDC. A CMOS logic-1 output would approximately equal its supply voltage, and a logic-0 output would roughly equal 0 VDC.

As you might see, TTL input/output voltages and CMOS input/output voltages are very different. That has long been a source of incompatibility between TTL and CMOS devices. CMOS ICs do not provide enough current to drive TTL inputs, and TTL outputs do not guarantee enough voltage output to ensure the proper CMOS input levels. While there are methods of interfacing TTL and CMOS ICs, the two logic technologies have generally remained exclusive of each other—TTL designs rarely incorporate CMOS parts, and CMOS designs rarely incorporate TTL parts.

Special Logic Features. Now that you are familiar with some important logic specifications and have seen a comparison of basic TTL and CMOS technology, there are several special features often incorporated into logic devices that you should understand: Schmitt-Trigger inputs, three-state outputs, and open-collector/open-drain outputs.

You might have noticed that there is a substantial voltage gap between the maximum logic-0 input level (V_{il}) and the minimum logic-1 input level (V_{ih}). For a typical TTL gate, that voltage gap is usually 2.0 – 0.8 = 1.2 VDC. When a logic input falls within that gray area, it is virtually impossible to predict whether the gate will interpret the signal as a logic 1 or a logic 0. That circumstance can occur when an analog input or a slowly changing digital signal is applied to a TTL input. While the input exists between known logic levels, the gate might oscillate or behave erratically. To ensure that the gate will interpret a definite input, a signal conditioning circuit called a "Schmitt Trigger" is added to the input.

A typical Schmitt Trigger input circuit is illustrated in Fig. 3A; the schematic symbol for a gate with a Schmitt-trigger input is shown in Fig. 3B. In principle, the circuit is little more than a voltage comparator that switches on and off when the input voltage passes two different set points. The trigger's output remains at logic 0 until the input voltage reaches 1.7 VDC. At that point, the trigger's output becomes logic 1 and remains log-

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ic 1 while the input voltage increases further. The trigger's output will remain logic 1 until the input voltage is reduced to 1.2 VDC. Below 1.2 VDC, the trigger's output drops to logic 0 and remains there as the input drops to 0 VDC.

Notice that there is 0.5 VDC of overlap (called "hysteresis") between the point the trigger turns on and off. Hysteresis prevents the trigger from oscillating on and off. Because the Schmitt Trigger reacts almost instantly and will not oscillate, the input signal may change very slowly.

Schmitt Triggers add a certain amount of extra circuitry to a gate because each input requires an individual trigger circuit. As a result, only a few basic TTL devices incorporate Schmitt Triggers. If an input must be conditioned, a gate equipped with a Schmitt Trigger can be used to buffer the signal before being applied to the actual input. For example, a Schmitt Trigger NAND gate can be used to buffer a slow clock signal before being used to drive a flip flop.

Three-State Outputs. Some logic gates offer a selection of three output states; logic 1, logic 0, and a third state of high-impedance. A high-impedance state is created by turning off both totem-pole output transistors. That action would isolate the output from ground and the supply voltage. That effectively disconnects (or "floats") the output from the remainder of the circuit. Because a single logic input can only discern two states (logic 1 or logic 0), a control (or "enable") signal is needed to operate the gate's high-impedance state.

A typical three-state logic gate is shown in Fig. 4A; the schematic symbol for that gate is shown in Fig. 4B. When the enable line is at logic 1, the gate is disabled and its output is in the high-impedance state. When the enable line is at logic 0, the gate becomes active and its output will behave normally.

Three-state logic is often called "Tri-State" (a registered trademark of National Semiconductor) and is used extensively with digital signal buses. Signal busing allows logic devices to individually take control of a common set of signal lines without causing signal interference to other devices on the bus.

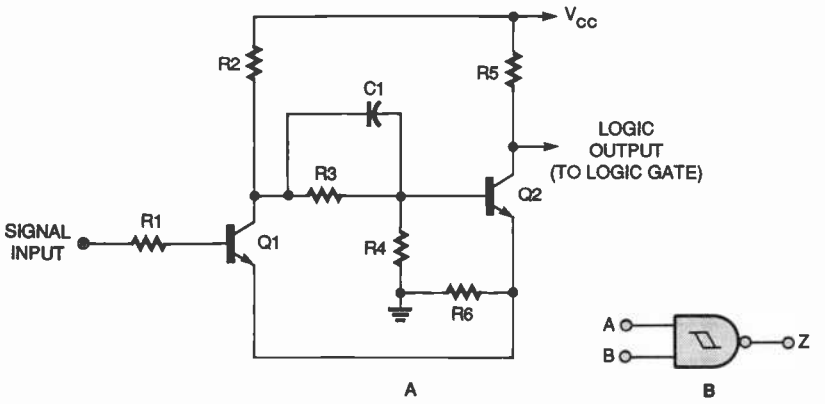

Fig. 3. To ensure that the gate will interpret a definite input, a signal-conditioning circuit called a Schmitt trigger, and shown in A, is added to the input. The schematic symbol for a gate with a Schmitt-trigger input is shown in B.

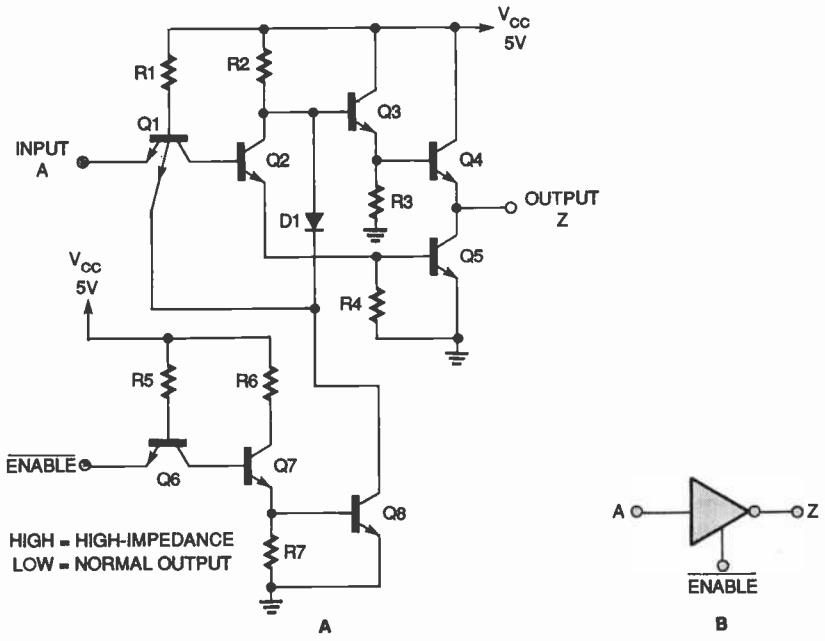

Fig. 4. In a typical three-state logic gate, like the one shown in A, when the enable line is at logic 1, the gate is disabled and its output is in the high-impedance state. When the enable line is at logic 0, the gate becomes active and its output will behave normally. The schematic symbol for that gate is shown in B.

CMOS ICs are also available for three-state logic operation. Although the internal gate design of CMOS three-state logic is different, the operating concepts are identical to TTL logic.

Open-Collector/Open-Drain Outputs. In all of the TTL- and CMOS-logic devices discussed so far, the output has been controlled by a totem-pole type of configuration. Most TTL and CMOS ICs are designed that way to simplify your final circuit and reduce your need for discrete components. In some cases, however, it is desirable to eliminate the active pull-up portion of the totem-pole and use external components to pull the output up to the supply voltage.

A typical open-collector TTL NAND gate is shown in Figure 5. Notice that only an active pull-down transistor is provided at the gate's output circuit. When the gate's output must be logic 0, the pull-down transistor saturates and grounds the output just as with a totem-pole configuration. When the output must be logic 1, the pull-down transistor shuts off normally. If the output were not pulled up, it would be effectively disconnected (or high-impedance). By connecting the output to the supply voltage through a resistor, the output can be pulled up to V_{CC} (or another voltage level).

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Use caution when determining a value of pull-up resistor. An extremely small value could allow excessive current flow through the pull-down resistor during a logic-0 output and cause permanent damage to the IC. An excessively large pull-up resistor might not allow enough current to drive subsequent logic inputs. In any case, an open-collector output must be pulled up to some potential in order for the gate to operate properly.

CMOS logic gates are also available in open-collector configurations, but such ICs are known as "open-drain" ICs. Remember that MOS transistor leads are source, gate, and drain. Those correspond to the bipolar transistors leads; emitter, base, and collector.

Family Specifics. So far, you have seen a brief comparison of simple TTL and CMOS logic, but there have been many advances in logic-gate designs and IC manufacturing techniques since the first version of saturating bipolar-transistor logic was introduced. A variety of both TTL and CMOS logic families are now available that offer characteristics of high-speed, low power consumption, low-voltage operation, or some combination of those factors. The sections below outline the specific characteristics of each logic family. Each logic family is characterized in Table 3.

74xxx Standard TTL. The 74 series was one of the first types of digital-logic IC to be introduced. Offering a broad selection of functions, moderate operating speeds, fair power consumption, and good output-drive capacity, the 74 series is still widely used. Standard TTL ICs dissipate about 10 mW of power per gate with an average propagation delay of 10 ns.

74Lxxx Low-Power TTL. A low-power TTL gate uses virtually the same circuit configuration as a standard TTL gate (which was shown back in Fig. 1). However, the gate's biasing and current limiting resistors are substantially larger. By reducing the amount of current flowing in the gate, the gate will dissipate less power. Integrated circuits in the 74L series typically dissipate 1 mW per gate—only 1/10 the power dissipated by standard TTL gates.

Unfortunately, low-power gates are a tradeoff of power versus performance. Propagation delays are longer because there is less current available to switch the bipolar transistors, so switching takes longer. Delays in 74L series gates can be greater than 30 ns. Low-power TTL ICs are best suited for low- to medium-performance circuits where power consumption and heat dissipation must be kept low.

74Sxxx Schottky TTL. The 74S series is designed to offer high switching speed. Propagation delays are greatly reduced by preventing a gate's transistors from saturating completely. To prevent full saturation, a Schottky barrier diode is incorporated into many of the gate's transistors. Schottky diodes work to bypass extra current that would otherwise saturate the transistor. Biasing and current-limiting resistor values are also reduced to about half the values used in standard TTL gates. That allows more current in the gate to force faster switching.

As with other gate designs, logic inputs are made directly to emitter inputs of the gate. The output is a totem-

TABLE 3—LOGIC FAMILY CHARACTERISTICS

Family	74	74L	74S	74LS	74AS	74ALS	74F	74C	4000B	74HC	74HCT	7AC	74ACT
Supply Voltage Range (V_{cc})	4.75 VDC to 5.25 VDC	4.75 VDC to 5.25 VDC	4.75 VDC to 5.25 VDC	4.75 VDC to 5.25 VDC	4.5 VDC to 5.5 VDC	4.5 VDC to 5.5 VDC	4.5 VDC to 5.5 VDC	3.0 VDC to 15.0 VDC	3.0 VDC to 18.0 VDC	2.0 VDC to 6.0 VDC	4.5 VDC to 5.5 VDC	3.0 VDC to 5.5 VDC	4.5 VDC to 5.5 VDC
Min. Logic-1 Input Voltage (V_{in})	2.0 VDC	2.0 VDC	2.0 VDC	2.0 VDC	2.0 VDC	2.0 VDC	2.0 VDC	2.0 VDC	2.3 V_{cc}	3.15 VDC	2.0 VDC	3.15 VDC	2.0 VDC
Max. Logic-0 Input Voltage (V_{il})	0.8 VDC	0.8 VDC	0.8 VDC	0.8 VDC	0.8 VDC	0.8 VDC	0.8 VDC	1.5 VDC	1.3 V_{cc}	0.9 VDC	0.8 VDC	1.35 VDC	0.8 VDC
Min. Logic-1 Output Voltage (V_{oh})	2.4 VDC	2.4 VDC	2.7 VDC	2.7 VDC	2.7 VDC	2.7 VDC	2.7 VDC	4.5 VDC	≈ V_{cc}	4.4 VDC	3.84 VDC	4.2 VDC	3.8 VDC
Max. Logic-0 Output Voltage (V_{ol})	0.4 VDC	0.4 VDC	0.5 VDC	0.4 VDC	0.4 VDC	0.4 VDC	0.5 VDC	0.5 VDC	≈0 VDC	0.1 VDC	0.33 VDC	0.5 VDC	0.5 VDC
Max Logic-0 Input Current (I_{il})	−1.6 mA	−0.18 mA	−2.0 mA	−0.36 mA	−0.5 mA	−0.1 mA	−0.6 mA	−0.5 nA	±1.0 µA	±1.0 µA	±1.0 µA	±1.0 µA	±1.0 µA
Max. Logic-1 Input tCurrent (I_{ih})	40.0 µA	10.0 µA	50.0 µA	20.0 µA	20.0 µA	20.0 µA	20.0 µA	5.0 nA	±1.0 µA	±1.0 µA	±1.0 µA	±1.0 µA	±1.0 µA
Max. Logic-0 Output Current (I_{ol})	16.0 mA	3.6 mA	20.0 mA	4.0 mA	20.0 mA	8.0 mA	20.0 mA	0.4 mA	3.0 mA	20.0 µA	20.0 µA	24.0 mA	24.0 mA
Max Logic-1 Output Current (I_{oh})	−400.0 µA	−200.0 µA	−1.0 mA	−400.0 µA	−2.0 mA	−400.0 µA	−1.0 mA	−0.36 mA	−3.0 mA	−20.0 µA	−20.0 µA	−24.0 mA	−24.0 mA
Propagation Delay (High to Low (t_{phl})	8.0 ns	30.0 ns	5.0 ns	8.0 ns	1.5 ns	7 ns	3.7 ns	90.0 ns	50.0 ns	20.0 ns	40.0 ns	3.0 ns	5.0 ns
Propagation Delay (Low to High) (t_{plh})	13.0 ns	60.0 ns	5.0 ns	8.0 ns	1.5 ns	5 ns	3.2 ns	90.0 ns	65.0 ns	20.0 ns	40.0 ns	3.0 ns	5.0 ns
Max. Operating Frequency (f_{max})	35 MHz	3 MHz	125 MHz	45 MHz	80 MHz	35 MHz	100 MHz	2 MHz	6 MHz	20 MHz	24 MHz	125 MHz	125 MHz
Power Dissipation Per Gate (mW)	10.0 mW	1.0 mW	20.0 mW	2.0 mW	4.0 mW	1.0 mW	4.0 mW	Note 1	Note 1	25.0 µW	80.0 µW	440 µW/ device	440 µW/ device

NOTE 1: VALUE IS FREQUENCY-DEPENDENT

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pole circuit, but the active pull-up portion of the totem pole uses a Darlington-transistor pair, while the active pull-down uses a "squaring network" to balance the totem pole circuit. Gates in the 74S series dissipate twice the power of corresponding 74-series gates. Power dissipations of 20-mW-per-gate is typical. Propagation delay is reduced to only 5 ns. 74S devices are best used in high-performance circuits where power dissipation and heat buildup are not important.

74LSxxx Low-Power Schottky TTL. By using an advanced IC-manufacturing technique, Schottky diodes and better Schottky-clamped transistors can be fabricated to build a gate with good switching times and low power consumption. Inputs are not multiple-emitter inputs. Instead, a discrete diode-transistor configuration is used to allow faster input responses. Schottky diodes clamp the major switching transistors to prevent full saturation. That ensures fast switching times. The totem-pole output of a 74LS gate uses a Darlington-transistor pair for active pull up and a squaring network for active pull down. The propagation delay for a 74LS gate is 8 ns, yet the power dissipation is only 2 mW per gate. Many medium- to high-performance logic circuits use 74LS series ICs to take advantage of their good speed and low-power-dissipation characteristics.

74ASxxx Advanced Schottky TTL. The 74AS series is designed to provide the fastest switching times that bipolar-fabrication technology can provide. Integrated-circuit-fabrication techniques allow Schottky diodes to be used more effectively than with corresponding 74LS components. Inputs are typically discrete diode-transistor circuits. A Darlington-transistor pair and a squaring network are used for the totem-pole output. Inputs and outputs are clamped by Schottky diodes to prevent transmission-line problems that can occur at very high switching speeds.

A typical 74AS gate dissipates 4 mW, and offers a very fast propagation delay of 1.5 ns.. Such characteristics make 74AS devices ideal in high-speed circuits where moderate power dissipation is allowed.

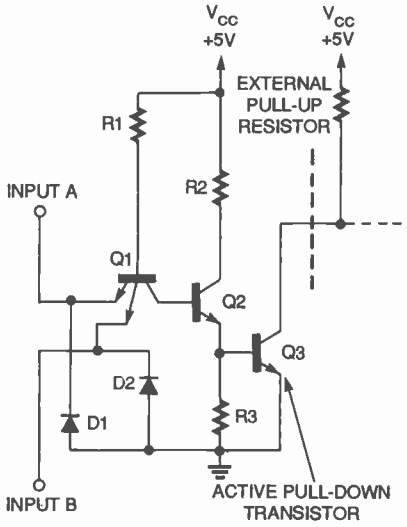

Fig. 5. In a typical open-collector TTL NAND gate, only an active pull-down transistor is provided at the gate's output circuit.

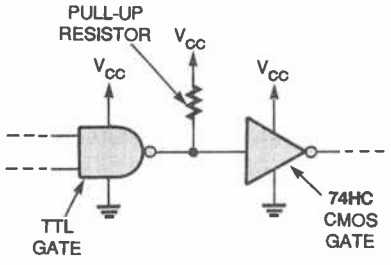

Fig. 6. To interface TTL and 74HC gates, a pull-up resistor should be added to the TTL gate's output to raise it enough to ensure at least 3.15 VDC.

74ALSxxx Advanced Low-Power Schottky TTL. The 74ALS family uses a fairly recent IC-fabrication process to provide gates that are twice as fast as 74LS devices, yet dissipate only half of the power. Internally, a 74ALS gate is remarkably similar to a 74LS gate. Inputs are usually the discrete diode-transistor type. The totem-pole output uses a Darlington-transistor pair for active pull up, and a transistor squaring network to handle active pull down.

Fabrication techniques used to manufacture the 74ALS family result in much smaller gate structures. Smaller gates allow more advanced functions to be placed on the same IC, but the gates are far more sensitive to electrostatic discharge (ESD) damage than other TTL families. To compensate for ESD sensitivity, additional clamping diodes are used at the gate's inputs to quickly quench any static charge.

A typical 74ALS gate will operate with a propagation delay of about 5 ns, yet the gate will only dissipate 1 mW of power. A 74ALS gate can operate at frequencies up to 35 MHz.

74Fxxx FAST ICs. FAST (a registered trademark of National Semiconductor) is an acronym for Fairchild Advanced Schottky TTL. FAST ICs are fabricated differently than 74ALS or 74AS ICs, but the 74F family provides similar operating characteristics. A typical 74F gate dissipates 4 mW, but it will operate with only 3 ns of propagation delay. FAST ICs can be used where high speed is needed and power dissipation is not a concern.

Low-Voltage TTL. The one constant factor in every logic family discussed so far has been the value of supply voltage. No matter what TTL IC you work with, you know it should run at 5 VDC. However, that constant will change as new, low-voltage logic families become available. Low-voltage logic is in demand because power requirements would be greatly reduced. Reducing the supply voltage from 5 VDC to 3.3 VDC could cut an IC's power dissipation in half. Such power reduction is very desirable to small-computer and portable-equipment manufacturers looking to extend battery life for their products.

A myriad of IC manufacturers are busy developing low-voltage ICs that offer various tradeoffs of speed and power. The low-voltage trend has already touched every type of logic (gates, memories, programmable logic, microprocessors, controllers, etc.), but it will take a bit of time before low-voltage logic becomes widely available to electronics hobbyists.

Logic levels within the various low-voltage logic families will likely remain compatible with current logic levels. Low-voltage gates will provide a maximum logic-0 output (V_{ol}) of .4 VDC, and a minimum logic-1 output (V_{oh}) of 2.4 VDC. Low-voltage logic will operate 5-volt TTL ICs properly, but 5-volt TTL might have difficulty operating low-voltage logic. Because the logic-1 output of 5-volt TTL can range from 2.4 VDC to 4.9 VDC, logic levels above 3.3 VDC can damage the low-voltage gate. That is only one of the quirks that IC designers are working to resolve.

(Continued on page 80)

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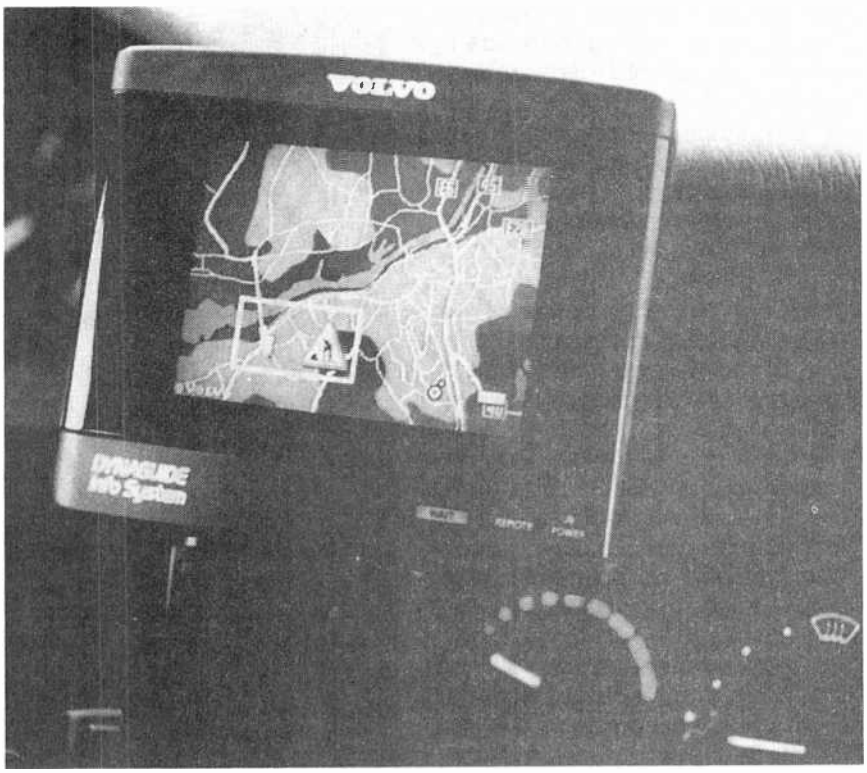
It's happened to many of us. We've been driving down the highway with our radio tuned to a local station giving traffic advisories. We've heard none and yet suddenly we come upon stopped traffic somewhere when it is too late to turn off on an alternative route. Or maybe we heard about an accident on the radio just as we pass the spot, only to find that everything has been cleared up long ago and traffic is now moving smoothly. Those common yet frustrating scenarios might soon be a thing of the past as in-vehicle navigation systems that also display traffic information in real-time are now coming to market.

One of the first of those systems to appear on the market comes from Sweden's Volvo. That example of Road Transport Informatics (RTI) technology is called the DYNAGUIDE Information System and uses the new pan-European RDS/TMC (Radio Data System/Traffic Message Channel) communication system. DYNAGUIDE will be available in Europe during 1995. According to Volvo, DYNAGUIDE will be comparable in price to a premium in-car sound system. The DYNAGUIDE system was also demonstrated recently in the New York metropolitan area. It could be on sale in the U.S. when the planned Intelligent Transportation System (ITS) infrastructure is in place here.

Cars equipped with the DYNAGUIDE system have a full-color video display mounted on the instrument panel. The display is controlled by a handheld remote control. By pushing the right button you can zoom in on the desired detail on the simplified map display—moving, for instance, from a map of Europe, to a particular portion of Europe, to a street-by-street map of a city center. You can pan around the map or change the pages using the remote control.

Other switches let you change the level of information displayed. Level-1 information includes red- or yellow-arrow icons at locations where there are delays. Red arrows indicate urgent information while yellow symbols designate less urgent situations. Switching to Level 2, you can obtain more detailed information such as the reason for the problem or, for example, information on parking availability at your destination. Further information in text form is available at Level 3. Designed for the European market, icons are based on international road signs and text messages are available in several different languages.



Traffic-Information Systems

Useful, up-to-the-minute traffic information whenever you need it is on the way.

BY BILL SIURU

Vehicle Navigation. As useful as traffic information is, the prime function of the DYNAGUIDE system is vehicle navigation. Instantaneous vehicle position and heading is pinpointed using Differential Global Positioning System (DGPS) supplied by Differential Corrections, Inc. (DCI) of Cupertino, CA. DGPS is needed because GPS broadcasts two sets of signals: a very accurate, encrypted Precise Positioning Service (PPS) signal for the military, and the Standard Positioning Service (SPS) for civilian applications. Because PPS is so accurate, the military does not want an enemy to use it, for example, to target weapons. While the civilian SPS can theoretically pinpoint current locations to within 15-25 meters (50-80 feet), that level of accuracy is not always available. To make it useless for military applications, the SPS signal is scrambled using "Selective Availability" to randomly reduce accuracy to 100 meters (328 feet), or about a sixteenth of a mile.

That is where DGPS services like those offered by DCI come to the rescue. Subscribers to DCI's DFGS services can choose its basic service, which provides 10-meter (33 feet) accuracy for minimum cost. Also offered are a more-expensive intermediate accuracy of 5 meters (16 feet) or a maximum accuracy of 1 meter (3 feet).

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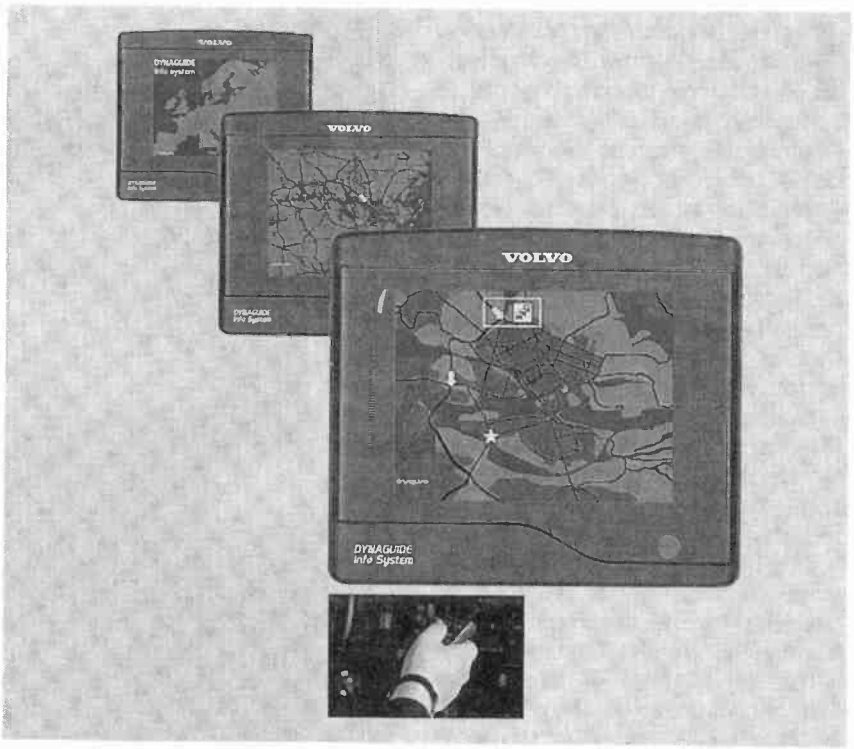
DCI already has DGPS networks in place and operating in Sweden, Finland, and Australia, and is setting up networks throughout Canada, the United Kingdom, Europe, and much of the Far East. DCI's networks in the United States should provide 99% coverage of the country by the end of 1995.

Traffic-Management Centers. Since DYNAGUIDE is both a navigation and dynamic traffic-management system, a "traffic-management center" is a key ingredient of the system. The center receives information on accidents, congestion, road construction, weather conditions, and so forth from a variety of sources. In Sweden, the traffic-management center is operated by the Swedish Road Administration.

In the Swedish system, traffic density and average speeds are measured by induction loops embedded in the roadbed. A signal is transmitted to the center whenever traffic flow deviates from the "normal" pattern. Weather stations placed at strategic locations provide up-to-the-minute information on air and road-surface temperatures, as well as wind conditions. Human inputs on traffic conditions are transmitted via special police and emergency-services channels by highway departments and even taxis. Individuals can input traffic and other information using regular or cellular phones.

RDS/RBDS Radio. After receiving, digesting, and analyzing all applicable traffic, weather, construction, and other data, the traffic-management center prepares the appropriate traffic advisory and encodes it for transmission to vehicles equipped with DYNAGUIDE or another equivalent system. Both traffic advisories and DGPS geographic information is transmitted by FM radio stations in digital format using the Radio Data System (RDS) standard and "piggy backed" on a FM subcarrier using a Traffic-Message Channel (TMC) message-coding system.



Volvo's DYNAGUIDE System provides real-time traffic information on a simplified, full-color display. The vehicle's current position is pinpointed by an arrow along with icons that indicate problems like congestion, accidents, road construction, etc. The system is operated via a hand-held remote-control unit.

With RDS, audio systems receive and decode a simultaneous digital broadcast information signal along with regular radio programs being broadcast by the station. RDS has been in use in Europe for several years and now 90% of the European FM radio stations are RDS compatible. An equivalent Radio Broadcast Data System (RBDS) was adopted as a North-American Standard in 1993 and is found in a growing number of FM receivers sold in this country.

As an aside, RDS and RBDS can be used without complex navigation systems to inform drivers of changing driving conditions, even while a cassette or CD is being played. An emergency alerting feature notifies the driver when weather or emergency information is being broadcast and interrupts cassette/CD operation and adjusts volume to a preset level during the announcement. Then, a brief message would be presented on the receiver's digital display screen. Future RDS/RBDS receivers could be programmed to turn on automatically when advisory bulletins are being broadcast. Other features of the system include selective seeking by station format—rock, country, easy listening, or talk.

Metro Traffic Control, Inc, headquartered in Houston, TX supplied traffic information for the recent DYNAGUIDE demonstration in New York City. Founded in 1978, Metro is the oldest and largest traffic reporting system in the U.S. It currently services more 50 American cities with some 50,000 traffic reports each week that reach an estimated 100-million people every day. Metro's traffic information comes from mobile units, cellular "hot lines," direct links to police and fire departments, a fleet of Bell Jet Ranger helicopters and fixed-wing aircraft for aerial surveillance, embedded loop detectors, and roadside CCTV cameras.

The demonstration showed that the technology is almost here for real-time traffic information in the U.S. as it is in Europe. When the system does arrive, it has the potential to significantly reduce the stress that is commonly associated with driving in congested urban areas. ■

FOR MORE INFORMATION

Volvo Cars of North America, Inc.
Rockleigh, New Jersey, 07647

Differential Corrections, Inc.
10121 Miller Avenue, Suite 201
Cupertino, CA 95014

Metro Networks—Metro Traffic Control
2700 Post Oak Boulevard, Suite 1400
Houston, TX 77056

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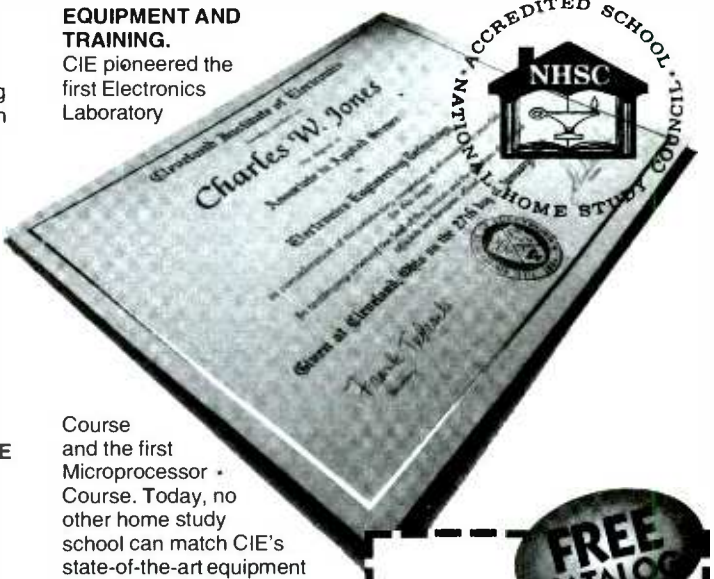

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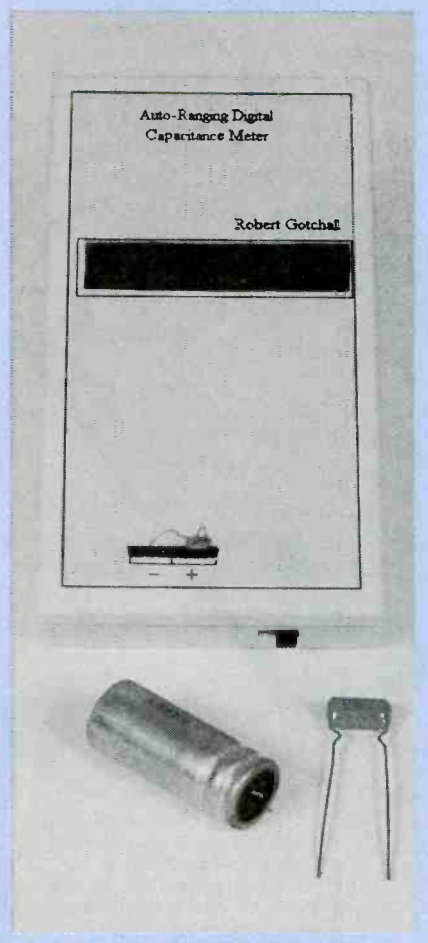

It's an accurate and useful addition to any hobbyist's workbench.

BY ROBERT GOTCHALL

When most hobbyists buy a number of similar-valued components, they keep them together. But what if they get mixed in with other parts? Well, in the case of resistors, you can use a multimeter or the color code to quickly determine their value. With capacitors, however, it isn't so easy. The big electrolytics are usually well labeled, but ceramic, Mylar, and old mystery types are frequently labeled with what appears to be random letters and numbers. When you separate those units from their labeled drawer or packaging, the only way to tell what they are is to use a capacitance meter that can determine the appropriate range on its own.

The *Auto-Ranging Digital Capacitance Meter* described in this article does just that. To use it, you simply insert the mystery capacitor's leads into the unit's test socket and wait about a second. The Meter automatically determines the range and displays the capacitance with the correct unit. That's all there is to it. There are no controls of any type, other than the power switch.

In addition to being extremely easy to use, the Meter is very accurate too. From 1 pF to 10 μF, the author's prototype differed less than 1% from its calibration unit. Typically, the Meter can measure up to about 1000 μF at a 5- to 10-percent error, and can estimate the value of capacitors up to approximately 5000 μF.

Another great feature of the Meter is its automatic compensation for stray capacitance. You see, before you connect a capacitor to the circuit, there is already as much as 35 pF present. When the meter is turned on, it measures and records that stray capacitance, and subtracts it from all subsequent readings. That feature allows you to measure very-small-value (1 or 2 pF) capacitors accurately.

Circuit Description. The schematic for the Meter is shown in Fig. 1. When switch S1 is closed, a 9-volt battery, B1, supplies power to a 78L05 regulator, U2, and to filter-capacitors C7 and C8. The result is a 5-volt DC supply for the rest of the circuit. Because the current draw is low, the 9-volt battery will provide close to 40 hours of usage.

A Microchip PIC16C57, U1, is at the heart of the circuit. That microcontroller has 2K of internal EPROM, which is programmed with the Meter's rather complex program (more on that later).

The circuit uses one of three 7555 CMOS timers, U3–U5, to generate a pulse train; the frequency of that pulse train has a strong linear dependence on the capacitor under test. That capacitor is inserted between ground and three relays, K1–K3. Microcontroller U1 turns on one of those relays to connect the capacitor to one of the three timing circuits.

The timer circuit made up of U5, R3, R4, R5, and C1 has the lowest resistance and impedance, while U4 and its surrounding components has a medium resistance and impedance, and U3's circuit has the highest. All the timer circuits have two nominally equal resistors; one of them is the series combination of a fixed resistor and a trimmer potentiometer. That variable combination is for calibration (which we'll look at later). The high-impedance (1-megohm) circuit is the default, and is used for small-valued capacitors, the medium-impedance (10,000-ohm) circuit is for medium-valued capacitors, and the low-impedance (100-ohm) circuit is for high-valued capacitors.

In other words, three timer circuits with low, medium, and high resistances are used to widen the effective measurement range and to allow the microcontroller to measure a frequency within certain easily managed limits (except at large capacitances). For instance, a 10-μF capacitor with the high-impedance circuit would oscillate imperceptibly slowly, while a 10-pF capacitor would cause the low-impedance circuit to oscillate far too high, and with a large amount of non-linear error.

When the capacitor under test is connected to the appropriate circuit, the microcontroller measures the frequency. Here's how that's accomplished: A 4-MHz crystal, XTAL1, gives U1 a 1-MHz internal-clock frequency. The microcontroller can therefore count the number of pulses from the appropriate timer circuit in a known period of time. It then goes on to convert the frequency to capacitance using 32-bit, floating-point arithmetic, and displays the results on a 16×1 LCD, DISP1, with the correct unit and decimal point.

Capacitor C9 is connected in parallel to the capacitor under test to aid in final calibration and for stability. Diodes D1–D3 protect the microprocessor from the back EMF of the relays' coils.

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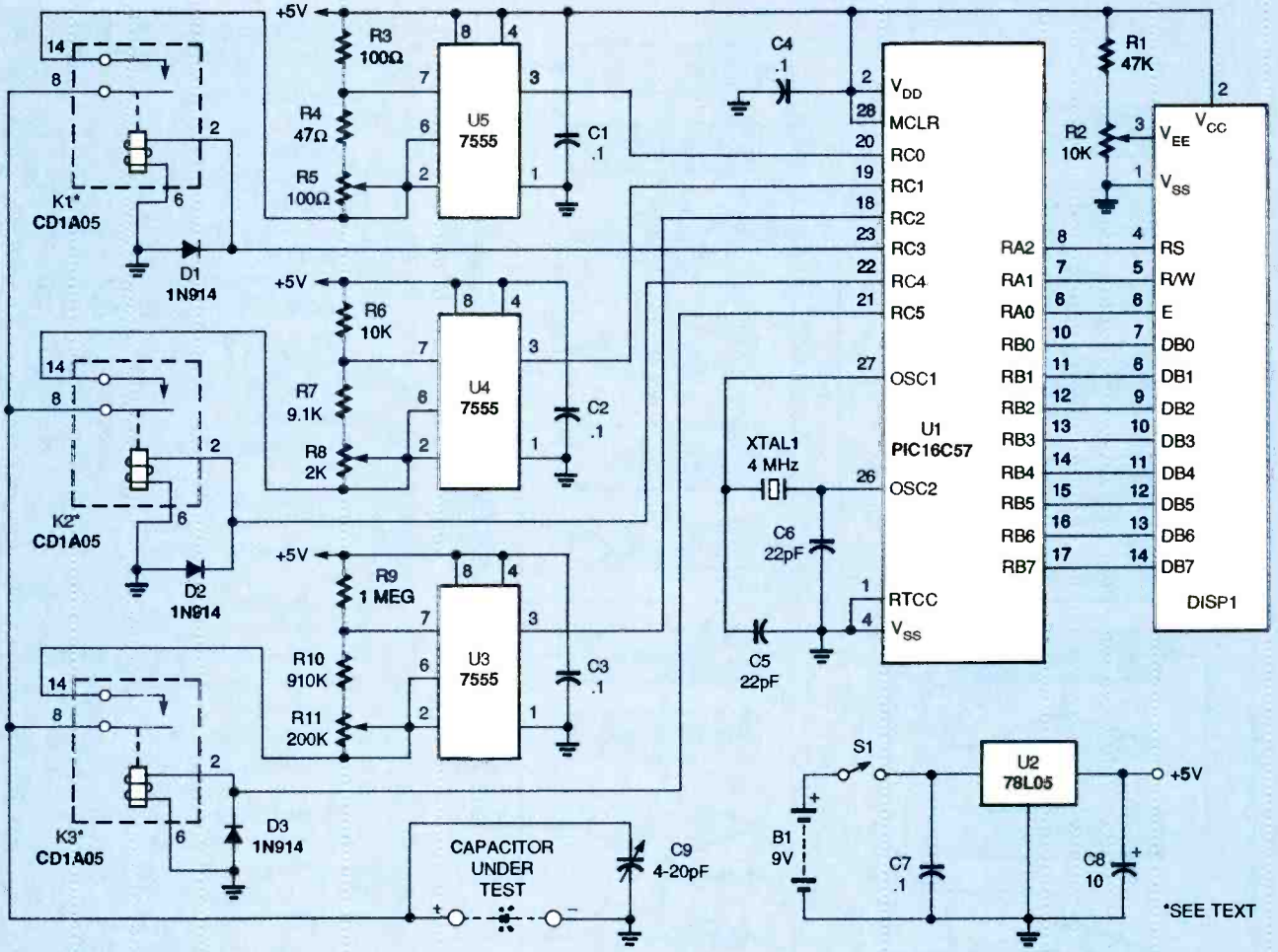

Fig. 1. Here's the schematic for the Digital Capacitance Meter. Most of the functions of the circuit are handled by U1, a PIC16C57 microcontroller. That chip's EPROM is programmed with the Meter's rather complex program.

Software Description. Before you can use the PIC microprocessor in the Meter, you have to program it. If you have the equipment to do that, you can obtain the software from the Gernsback BBS (516-293-2238). Otherwise, you can get a preprogrammed PIC from the source mentioned in the Parts List.

Here's how the program works: It counts the number of low-to-high edges on one of three input pins per second, thus determining the frequency. That frequency can be converted to capacitance via the formula:

$$C = 1.44/((R1 + 2)R2)f$$

where C is the capacitance in farads, R1 and R2 are the resistances in ohms in the selected timer circuit, and *f* is the frequency in hertz.

Figure 2 is a flowchart of the main program. For the purposes of explaining the flowchart, we'll refer to the 1-megohm timer as circuit C, the 10,000-ohm timer as circuit B, and the 100-ohm timer as circuit A.

The program assumes the capacitance will be quite small, and begins by examining the frequency of the high-impedance circuit, C. If the frequency is too high (above "initmin"), that means that no capacitor is in place, and "Ready" is displayed. If the frequency is too low (below CB, which stands for C to B), circuit B is activated and another frequency is measured. Circuits B and A do similar testing. The initmin, CB, BC, BA, AB, and max values are defined constants and can be changed to alter the circuit's behavior.

The mathematical calculations are done via floating-point routines. The capacitance is obtained using the formula given earlier, and the stray capacitance is subtracted from that value. The base-2, floating-point capacitance is converted to a usable form by multiplying it by ten as many times as possible without exceeding 8,000,000, which is the maximum a 24-bit signed-magnitude number can represent. The conversion is then finished using a binary (24 bit) to binary-coded-decimal (7 digit) conversion routine. The resulting BCD version is output to the LCD with the correct decimal point and unit as determined by the multiplier obtained in the conversion process.

Construction. To avoid possible stray capacitances, and for the sake of compactness, the Meter should be built on a double-sided circuit board. A pre-etched, drilled, and plated-through board is available from the source mentioned in the Parts List. Or, you can use the solder- and component-side patterns shown in Figs. 3 and 4, respectively to etch your own.

The screw holes for mounting shown on the boards were designed

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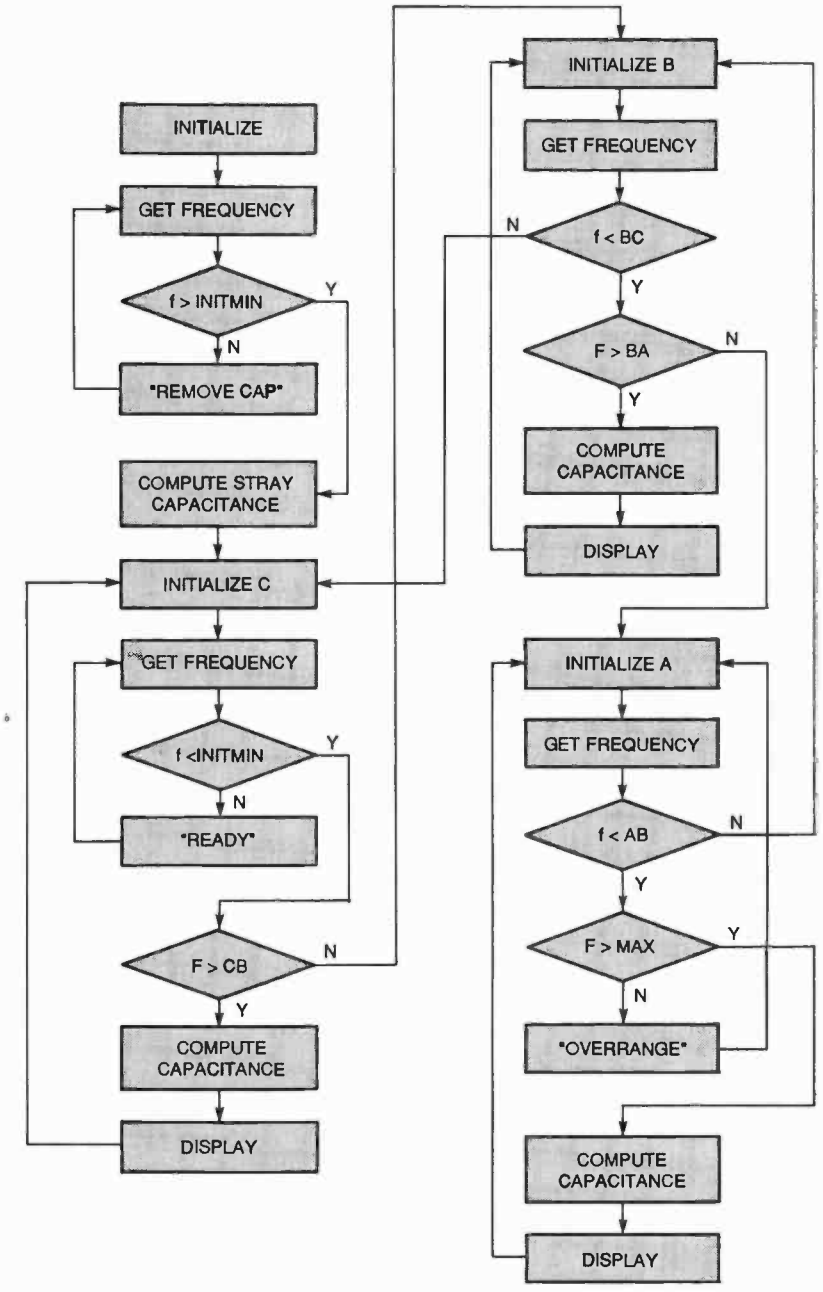

Fig. 2. This is a flowchart of the program used in the Meter's microcontroller. The 1-megohm timer circuit is referred to as C, the 10,000-ohm timer circuit is B, and the 100-ohm timer circuit is A.

to fit in a Digi-Key (P.O. Box 677, Thief River Falls, MN 56701-0677; Tel. 800-344-4539) 3- × 4- × 2-inch enclosure (#SR232 or equivalent). However, you can use any enclosure you want, as long as you allow for access to the switch and suitable room for a viewport for the LCD.

To make building the project easier, a parts-placement diagram is shown in Fig. 5. Begin by soldering sockets for U1, U3–U5, and the DIP relays. The relays used in the author's prototype have four pins that correspond to pin-numbers 2, 6, 8, and 14 in a 14-pin socket. You can simply snip off the other pins on 14-pin sockets and use the sockets for the relays. Don't insert the ICs or relays yet, however.

Next mount the fixed resistors and capacitors. To keep the board relatively small, the resistors are mounted vertically. Resistors R3–R11, and capacitors C1–C3 are "crowded in" near the timers; make sure that none of their leads are touching. Next mount trimmer-potentiometers R2, R5, R8, and R11, which are Bourns

PARTS LIST FOR THE CAPACITANCE METER

SEMICONDUCTORS

U1—PIC16C57 microcontroller, integrated circuit
U2—78L05 5-volt regulator, integrated circuit
U3–U5—7555 timer, integrated circuit
DISP1—16 × 1 alphanumeric LCD module (Optrex DMC-16117N, Epson EA-D16015AR-S, or equivalent)
D1–D3—1N914 silicon diode

RESISTORS

(All fixed resistors are ¼-watt, 5% units.)
R1—47,000-ohm
R2—10,000-ohm trimmer potentiometer (Bourns 3352W series, or equivalent)
R3—100-ohm
R4—47-ohm
R5—100-ohm trimmer potentiometer (Bourns 3352W series, or equivalent)
R6—10,000-ohm
R7—9100-ohm
R8—2000-ohm trimmer potentiometer (Bourns 3352W series, or equivalent)
R9—1-megohm
R10—910,000-ohm
R11—200,000-ohm trimmer potentiometer (Bourns 3352W series, or equivalent)

CAPACITORS

C1–C4, C7—0.1-μF, ceramic-disc
C5–C6—22-pF, ceramic-disc
C8—10-μF, 16-WVDC electrolytic
C9—4- to 20-pF trimmer (Sprague-Goodman GKG20011 or equivalent)

ADDITIONAL PARTS AND MATERIALS

XTAL1—4-MHz crystal
K1–K3—CD1A05 DIP-package relay, 500-ohm coil (All Electronics #DRLY-05 or similar)
B1—9-volt alkaline battery
Printed-circuit materials, project enclosure, IC sockets, battery connector with leads, wire, solder, hardware, etc.

Note: The following are available from Robert Gotchall (1781 Spyglass Dr. #280, Austin, TX 78746): preprogrammed PIC16C57—$13; pre-etched and drilled, double-sided PC board—$15; 16 × 1 alphanumeric LCD module—$12; kit of all parts except project case—$55. Please add $5 for shipping and handling. Texas residents please add appropriate sales tax.

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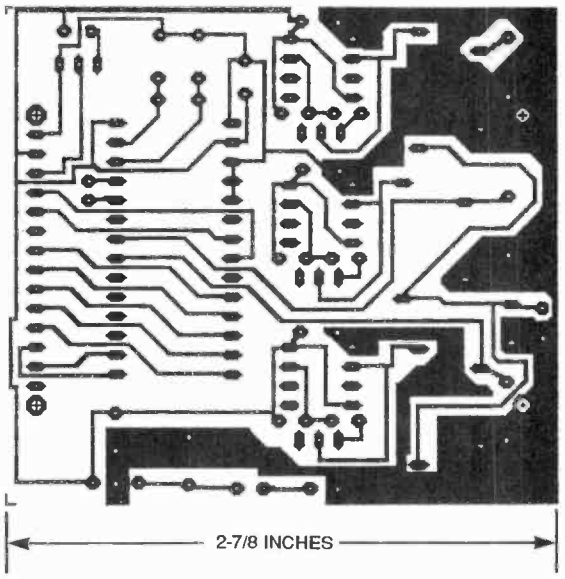

Fig. 3. Here's the solder side of the Meter's PC board.

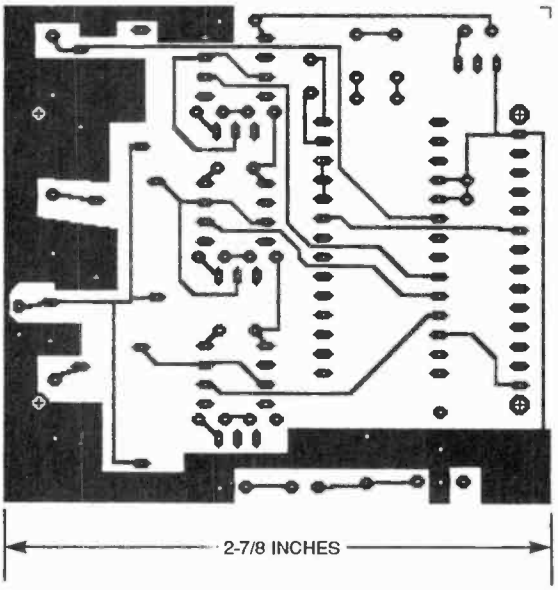

Fig. 4. This is the component side of the board.

3352W-series, vertical-PC-mount units (available individually from Digi-Key, as well as in a parts kit from the source mentioned in the Parts List). Try to get the exact units specified to ensure a perfect fit on the PC board.

Go on to install C9, the 4- to 20-pF trimmer capacitor (Sprague-Goodman GKG20011 or equivalent; available individually from Digi-Key as well as in the kit mentioned earlier). Be careful when soldering the trimmer, as it is placed somewhat close to K2.

Next mount XTAL1, the 4-MHz crystal. Be sure to leave a little length on the leads above the board, so that the case is not accidentally shorted to a trace. Then install diodes D1–D3. Make certain they are oriented properly, as shown in Fig. 5, or the circuit will not work and you might damage the microcontroller.

The row of 14 pads on the far-right side of the board is the off-board connector to LCD-module DISP1. Use ribbon cable to connect the board to the LCD, making sure that pin 1 on the LCD is connected to the top pin on the component side of the board.

There are three other off-board assembly steps that now need to be done. First, connect switch S1 to the board using two short leads. Next, solder the battery connector to the board, making sure the polarity is correct. Finally, Fig. 6 shows how to assemble the test socket using an 8-pin SIP socket. Solder a bit of wire to connect four pins on each side of the socket. That will make each group of four pins

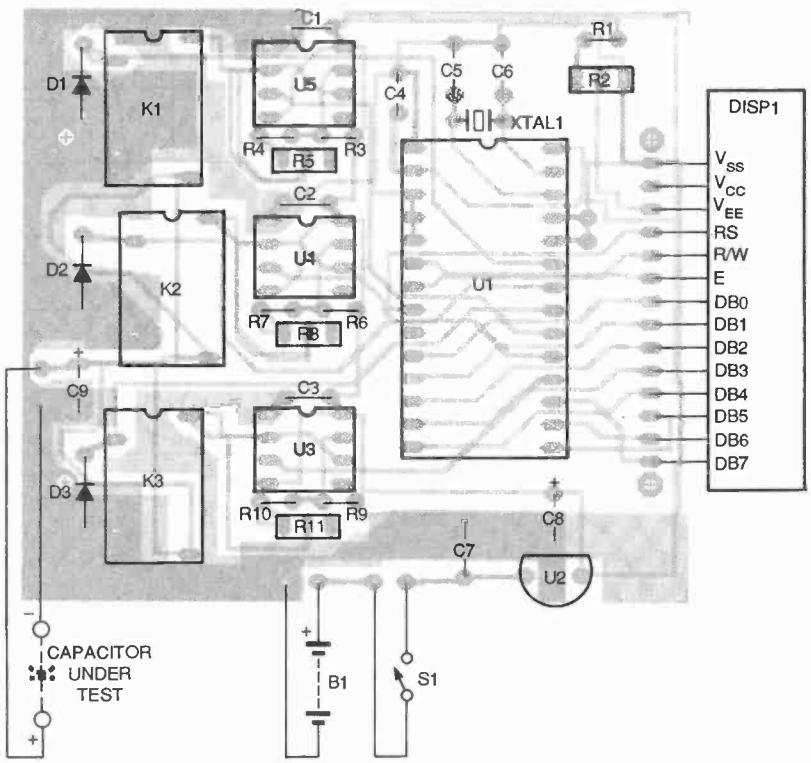

Fig. 5. When assembling the circuit, be sure to use this parts-placement diagram as a guide.

electrically equal, so that capacitors with different-size leads can all be accommodated. Solder a piece of 2-conductor ribbon cable (avoid using 2 ordinary wires) to each side of the socket, and solder the other end to the board as shown in the parts-placement diagram.

If you like, you can add external test leads to the board, so that you can measure capacitors that are still part of a circuit or that have leads that are too wide apart. Just keep them tightly wound up or otherwise immobile after turning the unit on, because any stray capacitance they add to the circuit will only be canceled out by the software when power is first applied. After that, any movement of the leads could result in error.

Checkout. After you're done build-

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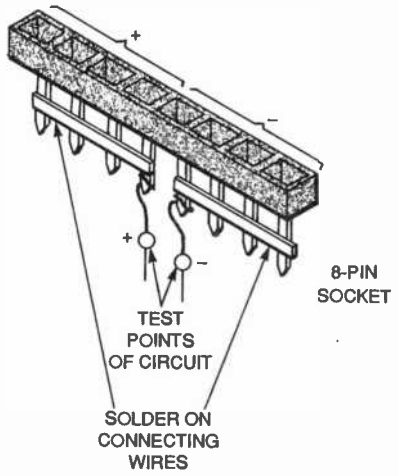

Fig. 6. By soldering a bit of wire to connect four pins on each side of the socket, you get two groups of pins, made up of four each, that are electrically equal.

if possible, verify that they are oscillating at output-pin 3. The 100-ohm circuit, "A," should be oscillating at the highest frequency.

Finally, turn off the power and insert U1, the microcontroller. Turn on the power again. The LCD might display black squares; if so, adjust R2 until the desired contrast is obtained. When correctly operating, the LCD will display "Please wait" upon power-up. After 1.3 seconds, the LCD will display "Ready" or "Remove capacitor." If it displays the latter, adjust C9 until the unit displays "Ready." Turn the Meter off, then on, so that it can re-calibrate with the new setting of C9. Ideally, you should have C9 set so that it is just low enough to give "Ready" upon power up, but no lower.

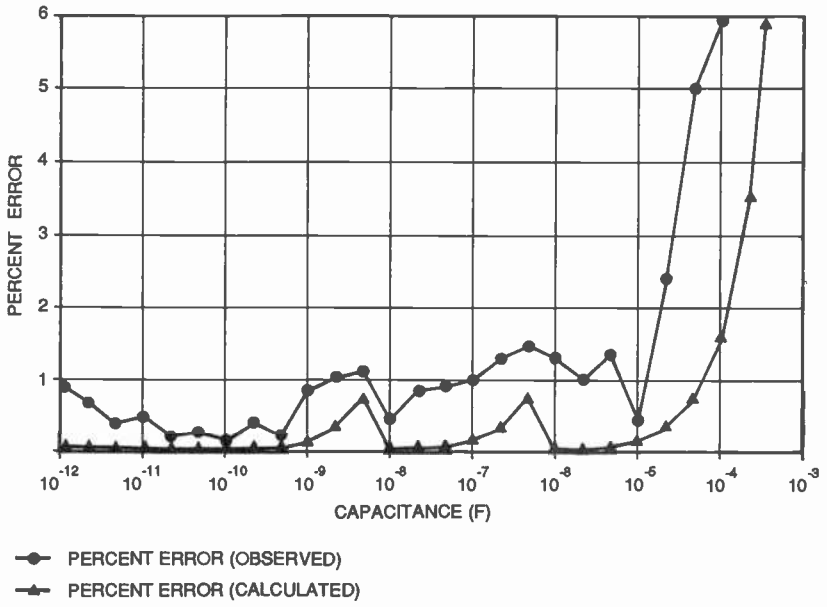

Fig. 7. This chart shows the error due to the quantization of the pulse counts from the timers in the Meter, and the author's measured results. Notice the error tends to shoot off to infinity for large-value capacitors, at least in theory.

ing the circuit, but before you insert the ICs and relays, check that you don't have a short between power (+5V) and ground. Connect a 9-volt battery to the battery connector, measure the voltage on the power rail, and verify that 5 volts is being supplied. If not, check for a short, and check that you have the orientation of the regulator correct.

Next, insert the relays and verify that there is an open circuit between pins 8 and 14 when pin 2 is grounded, and a closed circuit when pin 2 has +5V present. Then insert the timer ICs and,

Sources of Error. The microprocessor's software operates by assuming that R3 and the sum of R4 and R5 are exactly 100 ohms. The same is true for the other timer circuits, but with the substitution of 10,000-ohm and 1-megohm values. The discrete resistors are 5% tolerance, which translates to a source of 5% error.

Another source is in the timers—they are not all created equal. The internal circuit of a timer generates references at $\frac{1}{3}V_{CC}$ and $\frac{2}{3}V_{CC}$ using 3 resistors as voltage-dividers. Amazingly, those resistors are only 10% tolerance! Fortunately, those errors add to create one linear-error term, which can be effectively canceled out with calibration.

The primary source of error that remains is that associated with the quantization of the pulse counts from the timers. Figure 7 shows the error due to that phenomenon as well as the author's measured results. Notice the error tends to shoot off to infinity for large-value capacitors, at least in theory. The reason for that is the quantization error increases when the counts-per-second (frequency) approaches zero. For example, if a large-value capacitor, say 3407 μF, is generating a 1.408743-Hz pulse train, the Meter is likely to measure it as either 1 Hz (giving a 4800-μF reading) or 2 Hz (giving a 2400-μF reading). Those are 41% and 29% error rates, respectively.

To partially counter large error rates, there is a special section in the software to manage large-value capacitors. If you do measure a large-value (1000 μF or larger) capacitor, expect the time required to get a measurement to increase to as much as 13 seconds per reading. That extra time helps to minimize error in slow-frequency signals. Also, if you measure very-small-value capacitors (less than 47 pF), keep in mind the capacitance of long leads. A 1-pF capacitor with leads two-inches long and a half-inch apart will read 1.5 to 2 pF. To get an accurate reading, trim the leads and separate them 180° at the capacitor's package.

Calibration. There are two methods of calibrating your Meter. The first method is the more accurate, but it requires access to an accurate capacitance meter. Select a 100-pF, 0.01-μF, and 1-μF capacitor. Other values will do, but they must be close to those. Measure those capacitors as accurately as possible, keeping in mind that most commercial capacitors are 20% tolerance. Therefore, if you get a surprising reading, you can still probably trust the meter.

Place the 100-pF capacitor in your Meter. Adjust R11 until the value displayed on the LCD closely matches the known value. Repeat that with the 0.01-μF capacitor, adjusting R8, and the 1-μF capacitor, adjusting R5. That

(Continued on page 80)

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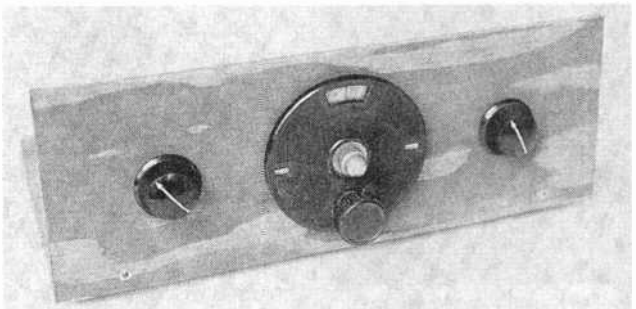
More on the 1930's Ham Receiver

By Marc Ellis

Preparing for two major late-summer antique radio meets—the Antique Radio Club of Illinois (at Elgin, IL) and the Antique Wireless Association (at Rochester, NY)—has definitely been seriously cutting into my workshop time. Nevertheless, I've managed to make at least a bit of progress on our 1930's ham set replica, and will be giving you a run-down later on in this column. But first, a word about Elgin and Rochester.



The front panel of the 1930's starter ham receiver. It doesn't look too authentic, so we'll spray it black by next time.

Rain and/or forbidding skies definitely put a damper on the first couple of days of the Elgin flea market. Normally seething with buyers and sellers, the Holiday Inn parking lot and surrounding open fields were a discouraging sight. The hardy souls who were trying to run around the raindrops found only 60 to 70 percent (an unscientific estimate) of vendors willing to take the tarps off their booths at any particular time.

However, with folks staying dry by patronizing the indoor activities, my own presentation on the history of this column was very well attended. And that was a lot of fun for me.

The sun finally came out on the third day (Friday), and I opened my Radio Collector subscription booth for the first time that morning. But by then many of the vendors had closed up their booths permanently. Friday being auction day, the crowd of potential buyers outside could be expected to thin out drastically.

Many of the vendors that I spoke with told me that their sets were selling briskly in spite of appearances to the contrary, and they certainly seemed to be asking (and getting) some very high prices. Possibly all of the business that was intended to get done at Elgin did get done, but it would have been much nicer if Mother Nature had cooperated a little more enthusiastically.

In a few days, I'll be leaving for the Rochester show, where the theme will be "100 Years of Radio." In a presentation to be given there, I'll be talking about the evolution of radio receivers during about 20 of those years (the "Golden Age" period spanning from the beginning of radio broadcasting in 1920 to the inception of World War II in 1941). But even if attendance at my talk suffers, I'm still hoping the weather will be a lot more benevolent than it was at Elgin!

CATCHING UP ON THE RECEIVER PROJECT

For those who might be just tuning in to this project, we're in the process of building a classical (and minimal) shortwave receiver of the type favored by beginning hams (and quite a few experienced ones) around 1930. Introduced in the October 1995 column, the set uses two 01-A tubes (as a regenerative detector and audio amplifier).

Many shortwave receivers of that era covered several bands through the use of plug-in coils. Our radio, being a simplified version, has a fixed coil. It does, however, cover two bands through the use of a tap-and-alligator-clip arrangement. As written up in the Amateur Radio Relay League's *How to Become a Radio Amateur* for 1930, the set covered 80 and 160 meters. I'm planning to modify the coil for 40 and 80 meter coverage in order to provide more listening opportunities.

In the November 1995 issue, I reported that I had done some junkbox scrounging and found that I had just about all of the parts on hand. I did go out and get a nice piece of ¾-inch clear pine to serve as the set's "breadboard," and—rather than mounting the controls on the board via brackets, as in the prototype set—I cut a piece of ¼-inch plywood to serve as a "control holder" and front panel.

I also found a spool of 20-gauge enamel-covered wire, which should be a good substitute for the 22-gauge double-cotton-covered wire called for in the parts list (particularly because I have to make some experimental adjustments to the coil dimensions anyway). To locate the required 2¾-inch-diameter coil form,

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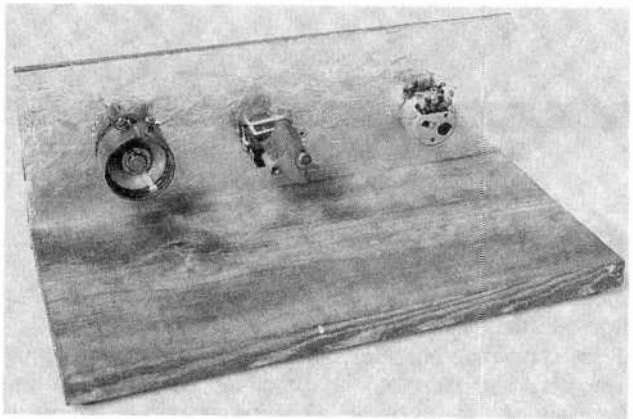
I paid a visit—ruler in hand—to our local supermarket, something I haven't done since tracking down the right Quaker Oats canister for the "NBS Crystal Set" project. Having had some prior experience, I wasn't quite as self conscious this time and, in due course, located a Pringles Potato Crisps canister (sour Cream 'n Onion flavor—my favorite) that was close to perfect.

CONSTRUCTION PROGRESS

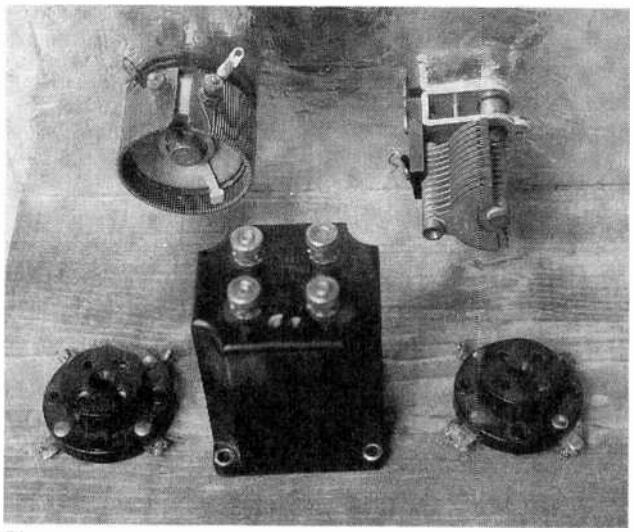
I began this month's brief workshop session by treating the pine breadboard with some walnut sealer/stain, just to protect the wood a bit and give it a little color. The front panel is supposed to be sprayed with some gloss black enamel—to simulate Bakelite or Vulcanite—but I haven't done that yet. For the time being, I just rubbed in some more of the sealer/stain.

As you can see, the front-panel controls certainly photograph more clearly this way than they would with a "black-on-black" color scheme, but I guess I'm not happy with the effect. I doubt that the experimenters in the 1930s had this type of plywood available to them, and certainly the panels on similar sets in period photos are almost invariably black. Next time you see our panel, it will undoubtedly have its coat of spray paint.

Many home builders of the period installed a metal shield plate behind the front panel to prevent "body capacity" effects from changing tuning adjustments as the operator's hand approached the controls. In fact, I've seen several examples of such a shield having been retrofitted to a factory-built set not originally equipped with one. So I decided that it would be a good idea to contact-cement a layer of household aluminum foil to the back of the panel. That will be connected to ground via the frame of the tuning capacitor, which is both at ground potential and installed in close contact with the back of the panel.



The rear view shows the foil-coated rear of the front panel and lots of empty breadboard awaiting mounting of components.



This is the preliminary positioning of the detector and audio-amplifier tubes, and the interstage transformer. The panel-mounted filament rheostat and tuning capacitor are in the background.

Next, I drilled appropriate mounting holes in the front panel and installed the controls, with their associated knobs and dials. The dial I'm using is a "Marco" brand that was widely advertised in the 1920s. That is the "three-window" model, and maybe one of you readers can throw some light on the function of the two subsidiary windows (the ones at 0 and 180 degrees on the dial face). Depending on the position of the dial, the scale numbers sometimes appear in those windows rather than in the main one. I might be missing some obvious point, but I don't understand how that helps the user!

With all of the parts in place on the panel, I fastened it to the pine baseboard using three short wood screws. With the panel installed, I could now experiment with the placement of the major board-mounted components and locate holes to be drilled for each of their mounting screws.

That's about all of the building progress I can lay claim to this month, folks. I'll try to have a lot more news for you next time!

NEW BOOKS

Sonoran Publishing Co. (116 N. Roosevelt, Suite 121, Chandler, AZ 85226), which has taken over the "radio books" division of Vestal Press, has released another work that very much embodies the high standards of quality established by Vestal over the years. *Crystal Clear, Volume 2* (ISBN 1-886606-03-X, 255 pages, soft cover, $29.95) is a sequel to the original volume that originally appeared in 1991. In *Volume 2*, author Maurice L. Sievers picks up where he left off, identifying an additional 172 crystal sets, 91 crystal detectors, and 26 crystals by manufacturer, model, year produced, description, and original selling price. The slick-paper book, which includes additional information on many of the sets covered in *Volume 1*, features over 350 photographs and 140 reproduced advertisements of crystal-radio products made in the U.S. between 1910 and 1960.

The information in *Crystal Clear, Volume 2* is presented via three media: a text discussing the major manufacturers and their products; collections of related photographs and advertising art; and easy-to-use reference tables listing manufacturer, model, case type, detector type, original selling price, and year made. The cumulative index covers both *Volume 1* and *Volume 2*.

Author Sievers is a medical doctor who has had many articles published in his field. He has been fasci-

(Continued on page 75)

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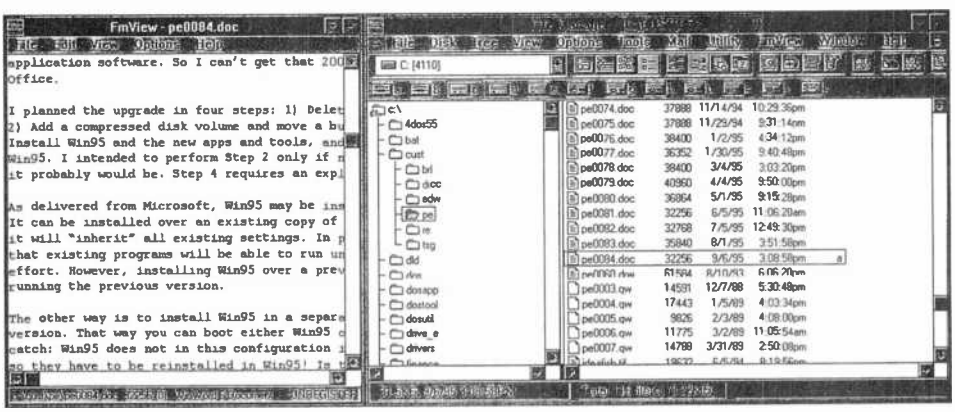
COMPUTER BITS

By Jeff Holtzman

Cleaning Up

Help! Gurgle, gurgle, gurgle! I'm being overwhelmed by junk! I just bought a 1-GB hard drive last year, and it's already 90% full. There's probably a lot of deletable junk on it, but probably not more than 10%. One more major application, and I'll essentially be out of space. The best option would be to buy a new machine, because my 486DX2-50 is about out of steam. But there's no budget for it yet. Second best would have been to add another hard disk—but I have the same budget problem. The only possible solution was better use of the existing space. Unfortunately, reclaiming that space has been a frustrating (and as yet incomplete) experience. Here's my tale of woe to date.



FmView is a shareware add-on for Windows' File Manager. It integrates itself directly into File Manager, so all you have to do is right-click on a file to view it. The Win 3.x version is shown here; a Win95 version should be out by the time you read this.

The most immediate problem is that I want to upgrade the machine to run Windows 95, including the complete MS Office Pro Suite for Win95, along with updates of several other applications, as well as some updated programming tools. I figured I'd need a minimum of about 200 MB. One catch is that the machine needs to be able to continue running Windows 3.1 and all the 16-bit application software. So I can't get that 200 MB by deleting Win 3.1 and Office.

I planned the upgrade in four steps: 1) Delete as much old junk as possible, 2) add a compressed disk volume and move a bunch of junk over to it, 3) install Win95 and the new apps and tools, and 4) migrate existing apps into Win95. I intended to perform step 2 only if necessary, but figured that it probably would be. Step 4 requires an explanation.

As delivered from Microsoft, Win95 may be installed in one of two ways. It can be installed over an existing copy of Windows 3.x, in which case it will "inherit" all existing settings. In practical terms, that means that existing programs will be able to run under Win95 with no additional effort. However, installing Win95 over a previous version prevents you from running the previous version.

The other way is to install Win95 in a separate directory from the previous version. That way you can run either Win95 or the old version. The only catch if you do that is that Win95 does not inherit your previous apps, so they have to be reinstalled in Win95! Is that intelligent, or what? Never mind. Suffice it to say that neither option appealed to me.

MANUAL LABOR

Another thing I did not want to do was go through all the files on the drive one by one. By typing "DIR /SUK" under shareware-gem 4DOS 5.5, I learned that I have 15,710 files and 3,651 directories. I also learned that those 15K files needed 691,082,934 bytes but were actually occupying 868,597,760 bytes. My mood sunk another notch at the 20% of wasted space. Most of the 200 MB I needed was sitting right there unused!

I had an idea about fixing that problem, but figured that disk grooming took top priority. And with all the file-removal programs on the market, I figured surely one could help. I had high hopes for a program called Remove-It, which seeks out unused flotsam and jetsam, optionally archives it, and then deletes it. Remove-It also comes with a Windows 95 "Upgrade Assistant" that helps migrate your apps from Win3 to Win95.

Unfortunately, my initial hopes have been at least partially disappointed. The program's removal features

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THINK TANK

By John J. Yacono
Technical Editor
Windows Magazine

Automotive Fun

Last month we discussed dielectrics and how they enhance capacitance. This month we'll continue by describing the characteristics and application of capacitors based on the properties of their dielectrics.

But first, I'd like to remind everyone about our recent contest: Send in enough quality circuits to fill a column, and you get a kit and a 1967 MCL1010 in addition to the usual book. Submissions with too few qualifying circuits will be printed one piece at a time, with the author getting a different book for each circuit displayed.

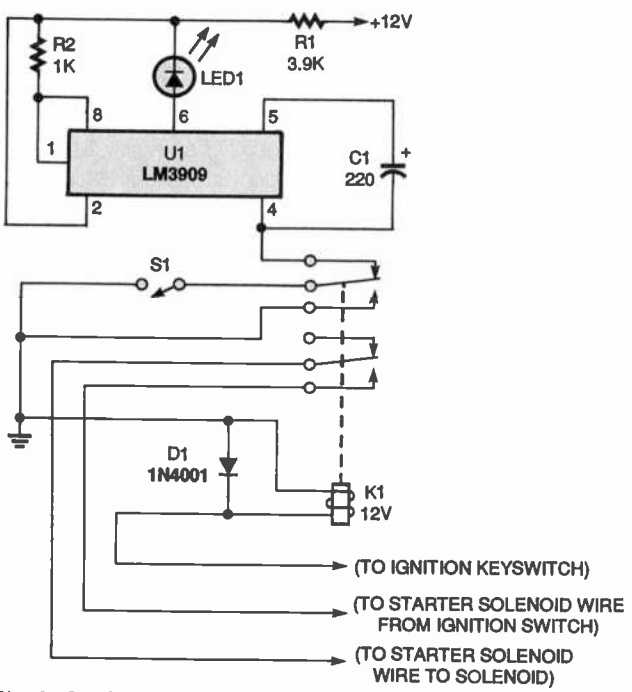

Fig. 1. Combining two functions in one, this circuit is both a passive cut-off device and a fake car alarm. Depressing S1 with the key in the run position disables the flasher, and allows the car to start.

Now, let's turn our attention back to the tutorial. The ceramic-disc capacitor is the most common unit in use today. As its name implies, it has a ceramic dielectric. The dielectric allows for higher capacitance than a vacuum or air, but not by much. So most ceramic-disc capacitors generally have values that range from 1 pF to less than 1 μF.

Their manufacturing technique does not produce high-tolerance units either. The value of simple ceramic-disc units can have a tolerance from 10 to 20 percent. Compounding that difficulty is the fact that their value changes with temperature. However, there are special ceramic discs called NPO's whose value drifts little, if at all, with temperature. Their tolerance ranges from 0.25 to 10 percent.

Another variant, called a ceramic-chip capacitor, is manufactured in a different way to yield higher tolerances and/or smaller packages. The tolerance of those units ranges from 5 to 20%, with typical values ranging from 10 pF to 0.18 μF.

It sounds like ceramic discs are pretty limited, so why are they so popular? Well, for one, many of them can be used at very high voltages. They can withstand from 3.3 volts to 6 kilovolts depending on the unit. Also, because the value of non-NPO units changes predictably with temperature, they can be used to compensate for other devices that change with temperature. The poor tolerance of the typical ceramic disc or NPO can also be compensated for by adjusting the surrounding circuitry once the component is in place. Furthermore, the typically small packaging of ceramic-disc capacitors makes them useful for miniature circuits.

Ceramic units are also popular because there are many circumstances where the value of a capacitor matters much less than its smallness. For example, ceramic-chip capacitors are often used to route unwanted transients on power traces to ground, protecting ICs from fluctuations that would make their operation erratic. That's a must for high-speed digital circuitry. On the analog side, ceramic-disc capacitors, especially NPO units, are often used to AC couple high-frequency stages in all kinds of devices.

A FLASH OF BRILLIANCE

Two Think Tank circuits (Figs. 4 and 5 of the October 1992 **Popular Electronics**), and your suggestions to replace K1 with a DPDT relay, brought to mind the expression about "killing two birds with one stone." So why not two circuits with one relay?

With most parts on hand I substituted an LM3909 flasher IC for the 555 timer and dug up the enclosed flasher and cut-off-switch circuit (see Fig. 1). The flasher operates when the ignition is off, establishing a ground for the circuit. The flasher rate can be adjusted by changing C1's value. For a more brilliant flash, I used a red, superbright LED (Radio Shack No. 276-087).

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With the ignition switch in the "run" position, pressing S1, a normally open, momentary contact switch, grounds and locks K1, allowing the car to start. When K1 locks on, ground is removed from the flasher.

In my spare parts I found a DPDT relay (Radio Shack No. 275-218). A plug-in socket (Radio Shack No. 275-217) allows for convenient mounting of K1.

Hope you can use the enclosed circuit.

— Herbert I. Byron, Jacksonville, FL

Gee, I wish I'd though of that. One thing I've always wondered is if a blinking LED would make a suitable false flasher. It wouldn't be as bright as your super LED, but placed prominently, it might dissuade a criminal. It'd also be really easy to wire up.

THIS CIRCUIT CRANKS

The enclosed circuit (see Fig. 2) is for measuring cranking voltage while starting an automobile engine. It is a negative-peak, holding voltmeter. The usable range is from 4 to 16 volts, the maximum being the highest voltage the ICs can withstand.

The circuit gets its power from the voltage that it is measuring. Resistors R1 and R2 divide the battery voltage by two to keep the input of U1 within its operating range. Op-Amp U1 and diode D1 act as a precision rectifier. Capacitor C3 is charged to half the battery voltage by pressing S1 before starting the engine, and is discharged to half the battery voltage by D1 while starting the engine. Op-Amp U2 is a buffer that drives the meter.

To calibrate the unit, connect the voltmeter to a known voltage. You could measure and use your car's battery for that. Hold S1 and adjust R4 for a proper reading.

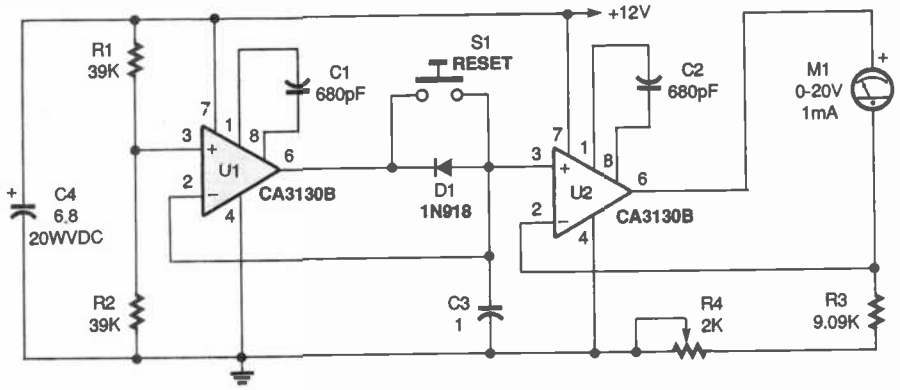

Fig. 2. Need to discover if your battery is weak or if your starter's windings are shorted? This meter will display how low your battery voltage drops during a start.

To use, connect the voltmeter to a switched battery source. Turn the ignition on and press S1. Start the engine. The voltmeter will read the lowest voltage.

Table 1 is a chart of minimum voltage versus electrolyte temperature. The reading might be less depending upon where you connect the voltmeter in the electrical system.

Please consider this circuit for your column. Thank you.

—Kenneth Hogg, Colorado Springs, CO

That's quite a good circuit. By measuring the cranking voltage at the battery's positive terminal and then at the starter, you can get a good idea of the power loss caused by poor cables or connections during starts.

TABLE 1

Temperature (degrees F)	Minimum Voltage
70 and up	9.6
60	9.5
50	9.4
40	9.3
30	9.1
20	8.9
10	8.7
0	8.5

HEAVY-METAL DETECTOR

Here's a springboard circuit idea that will, if calibrated carefully, detect the presence of a large metal object (see Fig. 3). Coil L1 is made by winding 50 turns of 26-gauge wire on a 50-inch form. If L1 is buried in the ground, the circuit can be used to detect any car or truck that is driven over the coil, which is what I think Mr. Eggelston could use based on his letter in the July 1995 issue of **Popular Electronics**.

Transistor Q1 and its surrounding components make up a Colpitts oscillator, operating at 10 kHz. The output is coupled to a Maxwell bridge through the secondary of T1, which is a 600-ohm to 600-ohm audio coupling transformer.

With R1, R2, and R3 set properly, the bridge is balanced when no metal is close to L1, producing a near-zero AC signal at the bridge's output (the R5/L1 junction and ground). Should a large-enough ferro-magnetic object pass over L1, the bridge is unbalanced producing a signal at the junction R5 and L1.

That signal is fed to the base of Q2, part of a common-emitter amplifier stage. Resistor R4 adjusts the gain of that stage. The signal from the amplifier is fed to the base of Q3, which drives a voltage doubler that supplies current to the relay driver, Q4.

The relay, K1, is a 1000-ohm, sensitive, 12-volt unit that can drive a normally open or closed alarm circuit to indicate the presence of a vehicle. Use shielded cable to attach L1 to the circuit, and do not bury L1 deeper than 8 inches for best results. Remember to weather-proof all components that will reside outside.

I hope this is not an over simplification of Mr. Dwight Eggleston's problem.

— Michael E. Keller, Lancaster, PA

I'm sure your circuit will do nicely. By the way, Michael points out in his original drawing that C6–C10 are Mylar, and R1–R4 and R16 are linear units.

AUTOMATIC HEADLIGHT DIMMER

The circuit in Fig. 4 is designed to switch your car from its high beams to its low beams when traffic approaches. With Q1 in moderate darkness, the variable resistors should be adjusted to produce no base current through Q2. Even though Q2's emitter is negative with respect to point A, the base will be even more negative. So the

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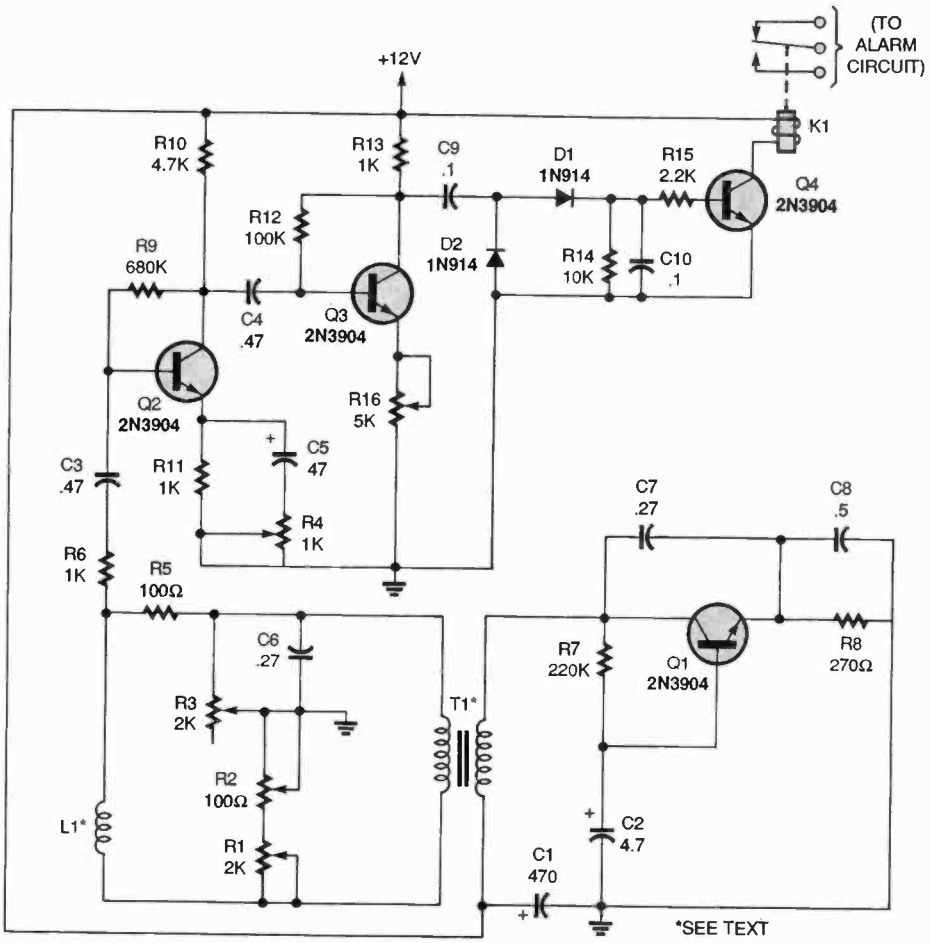

Fig. 3. This circuit, which detects the presence of cars, would be great to activate walkway lights lining a driveway.

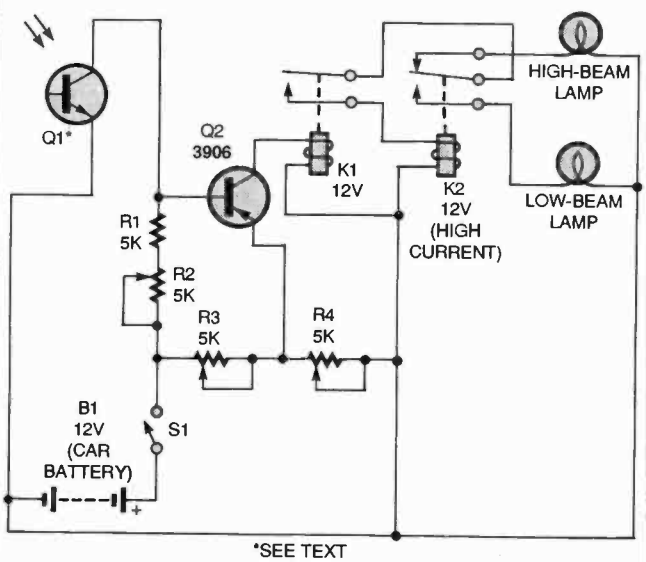

Fig. 4. Want maximum illumination from your headlights without disturbing on-coming drivers? This circuit will switch from your high beams to low beams when cars approach.

emitter is positive with respect to the base, which is okay.

When there are no approaching headlights to trigger the system, K1 is not energized and its contacts remain closed. Relay K2 is thus energized and the high-beam lights are on. When light from an approaching car shines on the phototransistor, the base current and collector current of the PNP transistor increases substantially and K1 is energized. That automatically de-energizes K2 (a power-type relay fed directly by the car battery) shutting off the high-beam headlights and turning on the low-beam lamps.

Switch S1 should be conveniently located on the dash of the vehicle. Keep the switch turned off during the day, so that the circuit will not leave your lights on in sunlight.

I used this automatic dimmer system on a 1969 Ford pick-up truck that I restored in 1980, so this might be a little out-dated. But, this system worked extremely well and it was working fine when I sold the truck in 1986. I'm presently working on an automatic dimmer system for my Harley-Davidson motorcycle, but in a simpler and smaller unit.

—Robert E. Davis, Huntsville, TX

Thanks, Robert. It should be mentioned that R3 must be adjusted to allow sufficient current to flow to K1. To adjust R3, set R2, R3, and R4 to their maximum values, and short the collector and emitter leads of Q2. Next turn S1 on, and reduce R3 till K1 trips, then turn it a little further. Remove the short and adjust R2 and R4 to produce zero-base bias in Q2 when no light strikes Q1. Readjust R3 as necessary to firmly trip K1 when light is present.

It should go without saying that all wiring sourcing or sinking of the high beams and low beams should be heavy enough to match the draw of the lights. Also, all connections should be well sealed against the harsh environment of a vehicle.

Well, that's it for now. As always, if you would like to take part in the fun you can send your circuits and suggestions to *Think Tank*, **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735. ■

"He's just testing his latest project."

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CIRCUIT CIRCUS

By Charles D. Rakes

LED Light Strings

While this is the January issue, as you read this we are fast approaching the holiday season. I can not think of a better way to celebrate this time of year than to use our shared interest and experience in electronics to build a few neat LED light strings. You can build up strings for tree decoration, outlining a display, or in a non-holiday application to bring attention to something all year round. The end use is your choice. So look over our six light-string circuits and see how you can fit them into your decoration scheme.

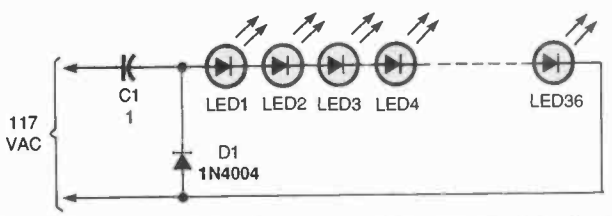

Fig. 1. This simple LED light string operates directly from the AC power line.

First, however, let's set a few ground rules. All light circuits will operate directly from the AC outlet. No transformers will be used. No voltage-dropping power resistors are allowed. And, above all, no component lead or bare wire may be exposed to the outside world. We want this to be fun and not a shocking experience.

A SIMPLE STRING

Our first LED light string, shown in Fig. 1, has 36 LEDs connected in series. The LEDs should be enclosed in a length of clear plastic tubing, and the two other components in an insulated enclosure. You might want to space the LEDs along the length of the tubing, using short lengths of small-gauge, insulated, stranded wire between the LEDs.

PARTS LIST FOR THE SIMPLE LIGHT STRING (Fig. 1)

D1—1N4004 silicon diode
LED1–LED36—Light-emitting diode, any color
C1—1-μF Mylar or similar capacitor
Wire, solder, plastic tubing, insulated enclosure, etc.

The circuit's operation is about as simple as can be. Capacitor C1, a 1-μF, 400-volt Mylar or similar unit operates in the circuit as a no-loss, AC-current-limiting component that's connected in series with the LED string. The capacitor's reactance acts like a resistor to the AC current without the losses found with a standard power resistor. The 1N4004 silicon diode protects the LEDs from reverse-voltage damage.

The circuit in Fig. 1 was tested with 36 red and green LEDs with an operating current of about 15 mA. Additional LEDs may be added in series if you wish, but that will reduce the brilliance of the LED string somewhat.

BRIDGE-FED STRING

Our next circuit, see Fig. 2, has a full-wave bridge rectifier feeding the LED string. With a 0.47-μF capacitor, as shown, the string's current was about 12 mA. If you substitute a 1-μF unit, the current will go up to about 20 mA, allowing you to add additional LEDs without suffering too severe a loss in brightness.

DUAL LIGHT STRING

Our third light circuit lets you light up two separate 15-light strings from a single power source. The circuit is shown in Fig. 3. On the positive half cycle of the 60-cycle AC waveform, LEDs 1 through 15 light and on

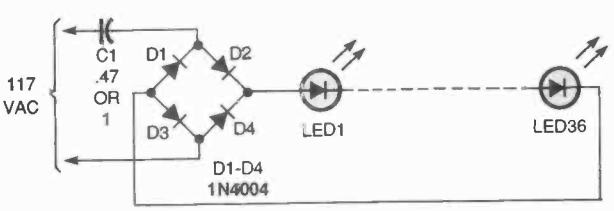

Fig. 2. This variation on the simple LED light string is fed by a basic bridge-rectifier circuit.

PARTS LIST FOR THE BRIDGE-FED LIGHT STRING (Fig. 2)

D1–D4—1N4004 silicon diode
LED1–LED36—Light-emitting diode, any color
C1—0.47-μF Mylar or similar capacitor
Wire, solder, plastic tubing, insulated enclosure, etc.

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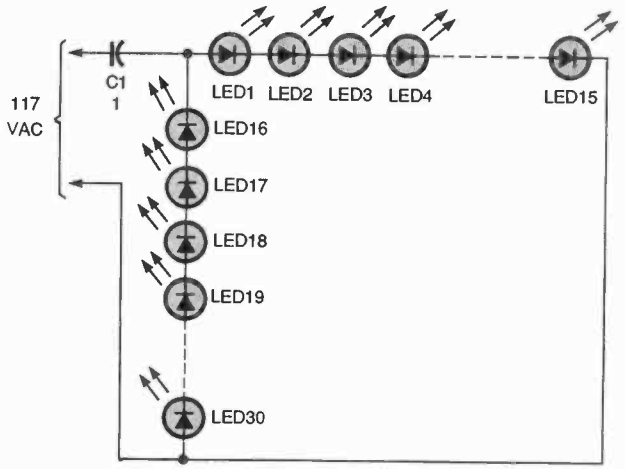

Fig. 3. If you are looking to run two separate LED light strings, they can be connected in parallel as shown here.

PARTS LIST FOR THE DUAL LIGHT STRING (Fig. 3)

LED1–LED30—Light-emitting diode, any color
C1—1-μF Mylar or similar capacitor
Wire, solder, plastic tubing, insulated enclosure, etc.

the negative half cycle LEDs 16 through 30 light. Because the eye's response time is much slower than 60 Hz, both strings appear to be on at the same time.

You can also add additional LEDs to this circuit, although with the same trade-off in brightness. However, you must be sure to add the same number of LEDs to each leg. To add more LEDs without suffering too much of a drop off in brightness, you could also increase the value of capacitor C1 or place another, similar capacitor in parallel with it.

DUAL-COLOR STRING

To make the light strings more eye catching, you can try the dual-color string shown in Fig. 4. That circuit uses 15 pairs of paralleled LEDs wired in series. On the positive half cycle LEDs 1 through 15 light and on the negative half cycle LEDs 16 through 30 light. Again, because the eye can not keep up with the 60-Hz rate, all LEDs appear to be on all the time. The number of LED pairs can be increased to 30 by doubling the value of C1.

PARTS LIST FOR THE DUAL-COLOR LIGHT STRING (Fig. 4)

LED1–LED15—Light-emitting diode, red
LED16–LED30—Light-emitting diode, green
C1—0.47-μF Mylar or similar capacitor
Wire, solder, plastic tubing, insulated enclosure, etc.

ALTERNATING-COLOR LIGHT STRING

Our next light string, shown in Fig. 5, adds some circuitry to the basic parallel scheme of the previous circuit to produce a string that alternates between red and green at steady 1-second rate, making it an attractive addition to any holiday display. Here's how the color switch is made. Two neon bulbs, NE1 and NE2, are connected in a relaxation-oscillator circuit that switches back and forth at about a 1-Hz rate. The values of R1, R2, and C3 set the switching rate. DC power for the neon oscillator circuit is supplied via C2 and D1. No DC filter capacitor is used or needed.

When NE1 turns on, current flows through the LED in U1, an optocoupler, turning on the SCR and grounding the anode of D2. When that happens, only the positive half cycle of the AC waveform passes to the LEDs, which lights only the red ones (LED1–LED15). After about one second, NE1 turns off and NE2 turns on, causing U2 to ground the cathode of D3. Now only the negative half cycle of

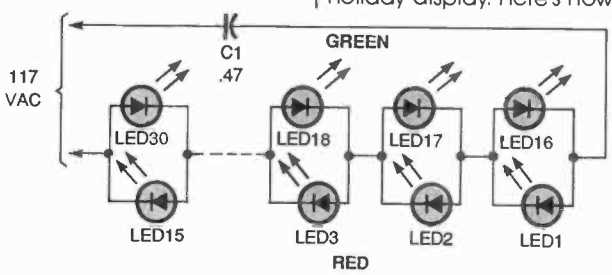

Fig. 4. The red LEDs are lit during the positive transition of the AC waveform, and the green ones during the negative one.

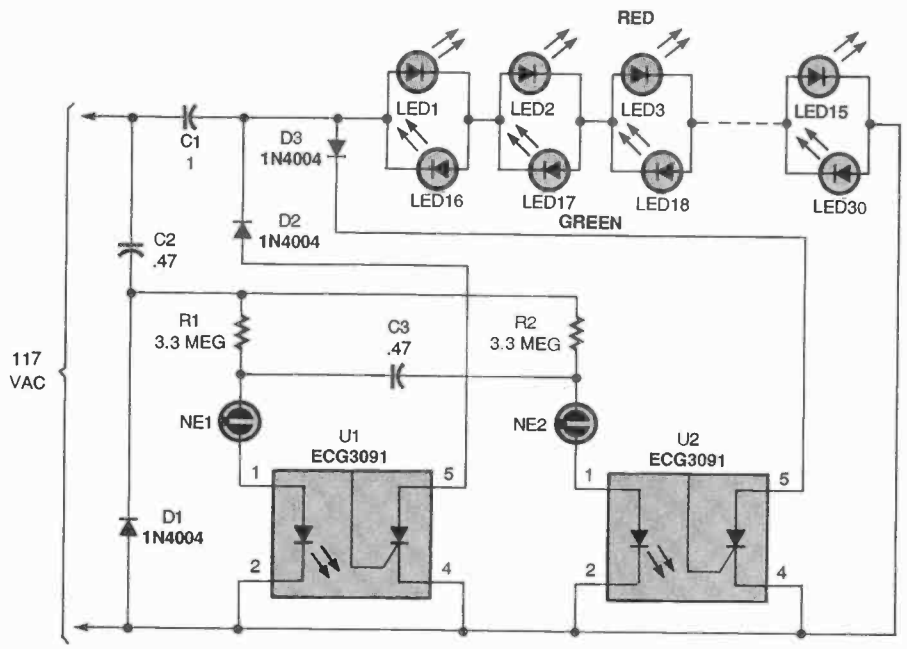

Fig. 5. The use of a relaxation oscillator lets you create an LED string that appears to change color from red to green.

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PARTS LIST FOR THE ALTERNATING-COLOR LIGHT STRING (Fig. 5)

SEMICONDUCTORS
U1, U2—ECG3091 or similar optocoupler, SCR output, integrated circuit
D1–D3—1N4004 silicon diode
LED1–LED15—Light-emitting diode, red
LED16–LED30—Light-emitting diode, green

ADDITIONAL PARTS AND MATERIALS
R1, R2—3.3-megohm, ¼-watt, 5% resistor
C1—1-μF Mylar or similar capacitor
C2, C3—0.47-μF Mylar or similar capacitor
NE1, NE2—NE-2 type neon lamp
Wire, solder, plastic tubing, insulated enclosure, etc.

PARTS LIST FOR THE MULTI-STRING LIGHT CIRCUIT (Fig. 6)

SEMICONDUCTORS
U1—4017 counter/divider, integrated circuit
U2—4011 quad two-input NAND gate, integrated circuit
U3–U5—MOC3010 optocoupler, Triac output, integrated circuit
D1, D2—1N4004 silicon diode
D3—12-volt, ½-watt, Zener diode
LED1–LED90—Light-emitting diode, see text

ADDITIONAL PARTS AND MATERIALS
R1—500,000-ohm potentiometer
C1, C2—0.47-μF Mylar or similar capacitor
C3—1-μF, 16-WVDC, electrolytic capacitor
C4—470μf, 16-WVDC, electrolytic capacitor
Wire, solder, plastic tubing, insulated enclosure, etc.

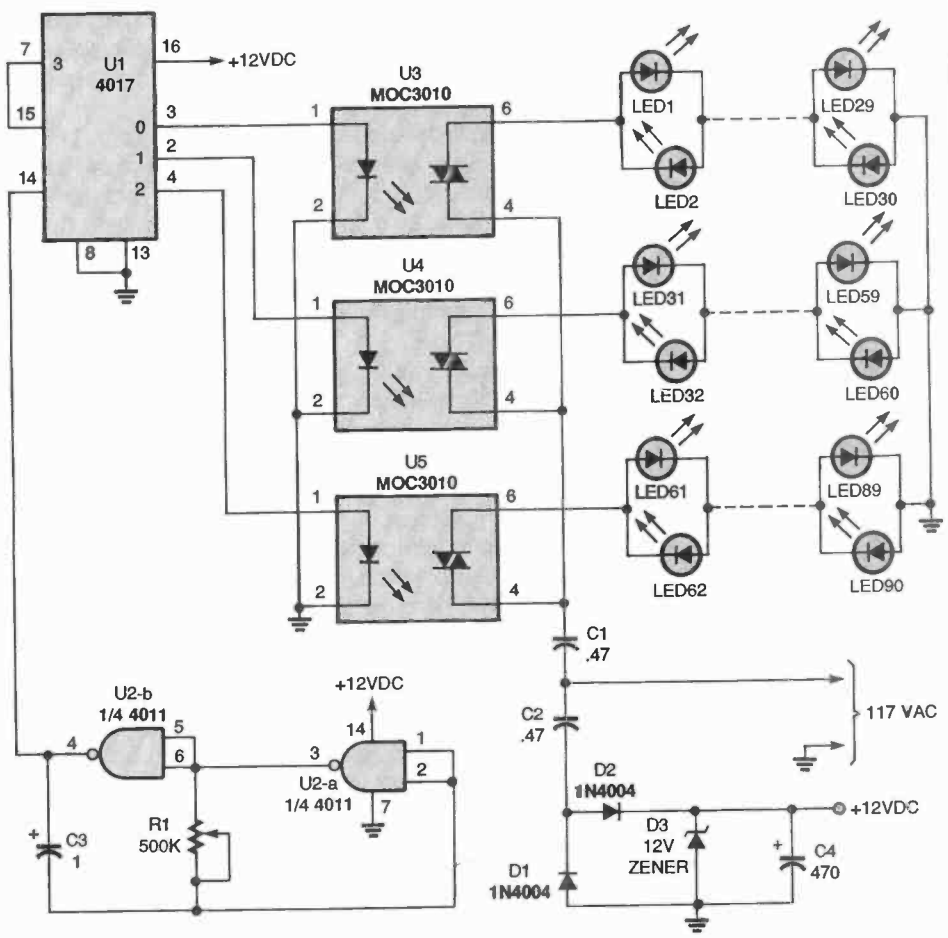

Fig. 6. If you want to create a display where LED light strings turn on and off in sequence, give this circuit a try. Though only three strings are shown for space and simplicity, up to ten can be used.

the AC waveform passes on to the LEDs, which lights only the green ones. If you'd like a change rate of less than 1 second, lower the values of R1 and R2, and to lengthen the rate, increase the value of capacitor C3.

MULTI-STRING LIGHT CIRCUIT

Our last light circuit, see Fig. 6, offers up to 10 strings of LEDs that turn on one row at a time in a sequential manner; for the sake of space and simplicity, only 3 strings are shown. The LED pairs could be all one color, mixed red and green, or any combination of colors.

Looking at the circuit, C2, C4, and D1–D3 make up a 12-volt DC power supply for the 5 ICs. Two gates of a 4011 quad two-input NAND gate, U2-a and U2-b, are connected in a low-frequency oscillator circuit. Resistor R1 controls the oscillator's frequency. The oscillator supplies a clock output to U1, a 4017 decade counter/divider, which operates as a counter that can be programmed to count from 0 to 9. Again, for the sake of simplicity, only 3 outputs are shown.

With each clock pulse, the 4017 makes a single step up in count from 0. The first output at pin 3 supplies voltage to the LED in U3, a 3010 optocoupler, turning on the IC's Triac and lighting the first string of LEDs. The next clock pulse steps the 4017 to the next output at pin 2 and repeats the sequence for that string. As each new light string turns on, the preceding string turns off giving the effect of a climbing string of lights. Changing the setting of R1 will change the rate at which the strings turn on and off.

If you want to add additional light strings beyond what is shown in Fig. 6, simply duplicate the circuitry for the light strings shown and connect to the appropriate output of the 4017, U1. You will also have to connect the first unused output to pin 15. If you use the maximum of 10 strings, pin 15 should be connected to ground. ■

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DX LISTENING

By Don Jensen

Radio Korea International

This year, *Radio Korea International* begins its 43rd year of broadcasting to the world in English on shortwave. Back when the station was founded, in 1953, a divided Korea had three years of war behind them and a shaky armistice in place. To emphasize its political status to the world, Seoul's shortwave broadcaster first called itself the "Voice of Free Korea." Its English-language programming amounted to just 15 minutes a day.

A Korean doll in traditional garb decorates this attractive QSL card.

In 1973, the station began calling itself "Radio Korea," and in 1994, Radio Korea International. The English program was extended to an hour in 1980.

Radio Korea International today broadcasts in eight other languages besides Korean and English: Japanese, Chinese, French, German, Russian, Spanish, Indonesian, and Arabic. It is on a total of 21 shortwave frequencies for a total of 114 broadcast hours each day.

Each English-language broadcast opens with the haunting and exotic melody, called "Dawn," which was composed specifically for Radio Korea International. It's followed by a 15-minute newscast, then, Monday through Thursday, a magazine-format program called "Seoul Calling," featuring music, features, and interviews.

The English programming continues on Monday with "Tales from Korea's Past;" on Tuesdays with "Korean Cultural Trails;" on Wednesdays with "Pulse of Korea," a look at modern Korea; and on Thursdays with the language feature, "Let's Learn Korean." Music is highlighted on Friday's "Let's Sing Together," which is a good way for the western ear to become familiar with Korean music. "Echoes of Korean Music" is featured on Sunday's English hour, along with "Shortwave Feedback," a special program for SWLers worldwide that features well-known U.S. DXer Bill Matthews.

Look for Radio Korea International beamed to eastern North American in English at 0100 UTC on 15,575 kHz, or at 0600 UTC on 11,945 or 15,155 kHz. Reception reports may be sent to Radio Korea International, Overseas Service, Korean Broadcasting System, 18 Yoido-dong, Youngdungpo-gu, Seoul 150-179, Republic of Korea.

To compare SW programming, you also might want to tune North Korea's Radio Pyongyang with its 50-minute long English program beamed to North America at 1100 UTC. Its frequencies, at this writing, are 6,576, 9,977, and 11,335 kHz.

WHAT TO BUY

Which shortwave receiver should I buy? That continues to be the most common question I receive from DX Listening readers. And it's not one I can readily answer because there is no single best answer. Which radio is right for you depends on a number of personal factors.

Larry Magne, editor/publisher of the respected shortwave annual, "Passport To World Band Radio," offers some guidance, however.

Don't be guided solely by price, he says. Surely you can begin your SWLing with a cheap model, costing, say, under $80. But, warns Magne, many of those sets are difficult to tune, and on many stations they sound terrible.

However, for many, those radios can open the door to the shortwave listening experience. But if you are at all serious about your SWLing, you'll quickly discover the limitations of cheapie radios, and will begin thinking about upgrading to better equipment.

You should ask yourself, what kind of stations do you want to hear? Just the most powerful worldwide broadcasters? Or do you want to

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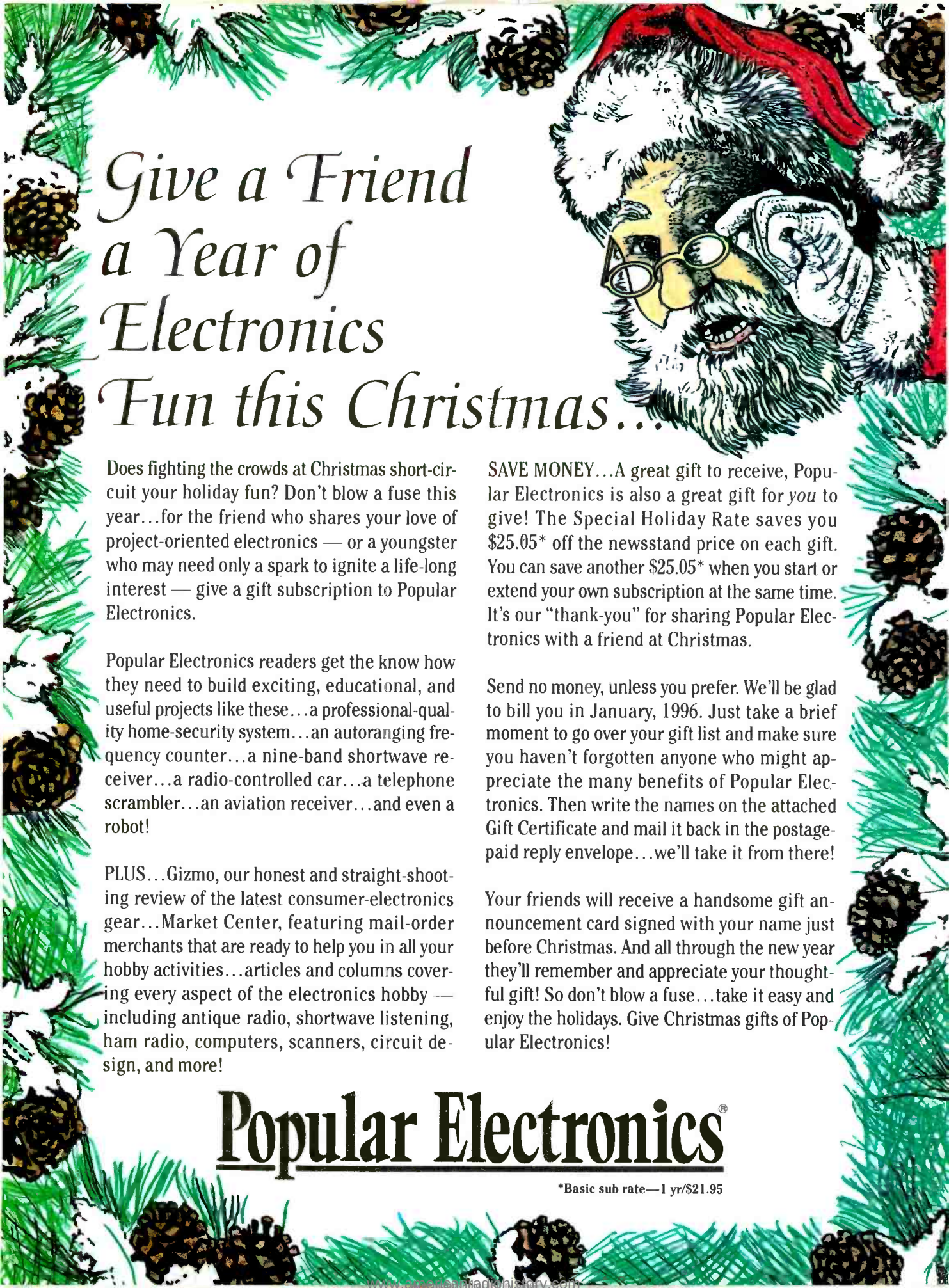

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try for the lower-powered, harder-to-hear exotic voices on SW?

If you intend to concentrate on the easier catches, the major international broadcasters, Magne says, the "sweet spot" in the price spectrum is $150–$250 for a compact or mid-sized portable receiver.

For tougher weak signals, or those in crowded, interference-ridden bands, one of the more expensive tabletop communications receivers might be needed. For that sort of set, expect to pay $500, $600, or more.

While that might seem expensive, compare it to the prices of other electronic entertainment "toys," like your PC or giant-screen projection TV, and it begins to look like a real "buy." Besides, maintenance is minimal and it should last for years, giving you plenty of DX-listening value.

Magne has more tips on buying a shortwave radio, and he reviews and rates specific makes and models. You can read them in "Passport To World Band Radio," available in most book stores.

IN THE MAIL

George Reilly of Chicago, IL, writes concerning radio pirates: "I've heard there are so-called pirates broadcasting on shortwave. What can you tell me about them and where can I get more information about when and where to hear these buccaneer stations?"

Pirate stations, simply, are unlicensed, that is, illegal, broadcasters that inhabit a few small areas of the shortwave spectrum. They air their own now-and-again homemade programming, mostly music and comedy sketches, which range from crude and sophomoric to downright hilarious.

Those buccaneer broadcasters thumb their noses at the FCC, which makes sporadic efforts to track down their transmissions. Such activities are not without danger; some pirate stations that have been closed down also have been fined thousands of dollars.

I neither condone nor condemn pirate radio. They do flout the law, but there's little evidence that they seriously interfere with other legitimate radio transmissions. They exist, and, further, there's nothing illicit about tuning them in.

One listeners' club that has covered the pirate-radio scene for more than a decade is the Association of Clandestine Radio Enthusiasts, or ACE. Its monthly bulletin is filled with information from others who regularly listen to the SW pirates. You can get a sample copy, and membership information, for $2 from ACE, P.O. Box 11201, Shawnee Mission, KS 66207-0201.

Questions? Comments? What are you hearing on the air these days? Drop us a line and let us know. The address is: "DX Listening," **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735.

DOWN THE DIAL

Here are some SW signals to test your tuning.

ANGOLA—4,950 kHz. *Radio Nacional* in Luanda was logged from about 0000 until 0115 UTC with non-stop music, mostly Portuguese versions of Beatle melodies and on-the-hour identifications and Portuguese news.

GHANA—4,915 kHz. Ghana Broadcasting's *Radio 1* has been noted at 0613 UTC with English-language news.

ITALY—11,905 kHz. *RAI*, Rome, signs on in English at 1935 UTC with its familiar bird-call signal and bells. It also can be heard at this time on 7,275 and 9,575 kHz.

LITHUANIA—9,530 kHz. *Radio Vilnius* has an English transmission at 2300 UTC. It was heard with interval signal, ID, news, and commentary.

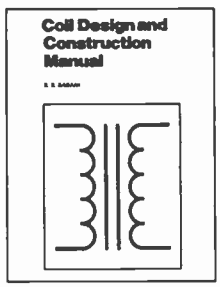
SWITZERLAND—10,461 kHz. *United Nations Radio* has been testing with an upper-sideband-mode transmission, via a Swiss transmitter, from 1757 to 1843 UTC sign off. Programming begins with a six-note interval signal, identification, and feature programming. The broadcast then ends with the station's address and fax number for receiving reports.

SYRIA—15,095 kHz. *Syrian Broadcasting Corp.* has been logged in Arabia at 1345 UTC, with Middle-Eastern and popular music, followed by Islamic religious programming and station identification.

USA—9,955 kHz. *WRMI*, Radio Miami International was heard at 0000 UTC broadcasting a program dealing with Florida's cultural attractions.

ZIMBABWE—3,306 kHz. Zimbabwe Broadcasting Company is "one up" on Ghana with its *Radio 2*, heard at 0400 UTC with news in an African language, station identification, and drum signal, then Afro-pops music. ■

CREDITS: Richard D'angelo, PA; Peter Grenier, NV; Rufus Jordan, PA; Marie Lamb, NY; Don Moore, IA; Ed Rausch, NJ; Brian Saade, CA; Giovanni Serra, Italy; North American SW Association (45 Wildflower Road, Levittown, PA 19057)



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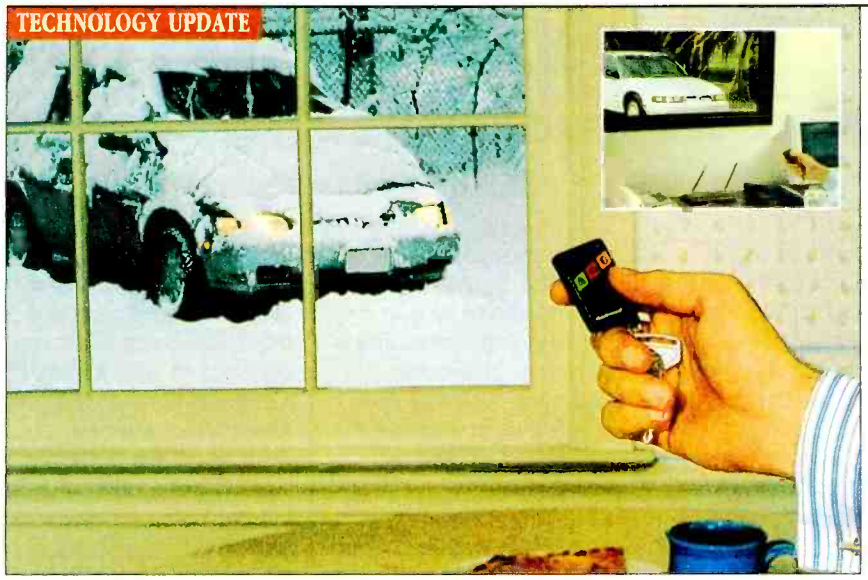

New microprocessor puts the brain of a $50,000 car under your hood...

Breakthrough remote control lets you start your car, turn on its headlights, sound a panic alarm and unlock the doors and trunk...from up to 400 feet away.

by Charles Anton

How many times have you had to bundle up and brave freezing weather to start your car? Or sit in a sticky car and touch a blistering-hot steering wheel to get your car started? What else can you do besides shiver while a defroster blows cold air in your face or roast in the scorching heat of your car?

A better way. The new AutoCommand keychain transmitter gives you the power to start your car from the comfort of your home or office. Simply press a button to start warming up or cooling off your car from up to 400 feet away. You can turn on the heater, air conditioner or defroster without leaving your seat.

The powerful microprocessor brain learns your car's starting pattern. It adjusts the starting routine based on the outside temperature, battery voltage and the amount of time since your car was last run to guarantee starting every time.

Why AutoCommand is better...

- **Range.** *Most remotes only work up to 100 feet away. AutoCommand gives you a range of up to 400 feet.*
- **Self-diagnostics.** *The unique feedback lights on AutcCommand confirm proper wire connections during and after installation, just like a car's on-board computer.*
- **Total security and convenience.** *AutoCommand gives your car the capability of remote car starting, keyless entry, panic alarm and car security. It also has built-in low temperature and low battery voltage start options.*

Give your car a brain. AutoCommand gives your car the same features as luxury cars, and even some they don't have, by adding this microprocessor brain. In addition to remote car starting, your car will have features such as keyless entry and built-in car security.

You can call for help or scare someone away with the panic alarm; locate your car with CarFinder; and have your car automatically turn on its headlights when it gets dark or turn them off 20 seconds after leaving your car. You can even leave your car running with the doors locked and no key in the ignition. If you forget your car is running, it will automatically shut off after 10 or 15 minutes, you choose.

Intelligent benefits. With AutoCommand, your car can't be driven until a key is put into the ignition. The AutoCommand immediately cuts off the engine if your vehicle's hood is raised, brake pedal is pressed or the vehicle is shifted out of gear without the key in the ignition, preventing theft or tampering.

AutoCommand also monitors your car while you are away. The built-in Vacation Option will automatically start and run your car for 10 minutes every four to six hours when the temperature drops below zero. On hot summer days, AutoCommand will also start your car when the interior reaches 140 degrees. If your battery drops below 11 volts, AutoCommand will start your car to recharge it.

Try it risk-free. At Comtrad, we back all our products with a risk-free home trial. Try AutoCommand in your car and if you're not completely satisfied with its value and performance, return it within 90 days for a full refund, "No Questions Asked." AutoCommand is also backed by a two-year manufacturer's limited warranty. Most orders are processed within 72 hours and shipped UPS.

UPGRADE OPTIONS.

You can replace your existing garage door remote control with the Garage Door Remote Control replacement system. This system can be added to any garage door that has an existing electrical garage lift unit. It will share the same transmitter as the AutoCommand, eliminating extra keychain remotes! You can also add the Shock Sensor option to the built-in car security system. It detects any impact on your car, giving you added protection.

The keychain transmitter works with all the available features.

Exclusive $50 installation discount

AutoCommand comes with an installation video and has patented self-diagnostic feedback lights which confirm wire connections step-by-step during installation. But for those who prefer to have AutoCommand professionally installed, we offer a $50 installation discount. Use the money for professional installation, or install it yourself and keep the money. Either way, AutoCommand makes it easy and affordable to add luxury car features to your automobile.

AutoCommand®	~~$349~~	$14 S&H
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add Shock Sensor to alarm	$49	$4 S&H

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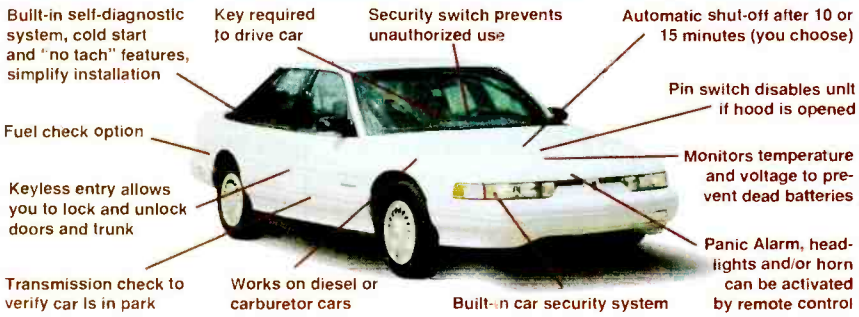

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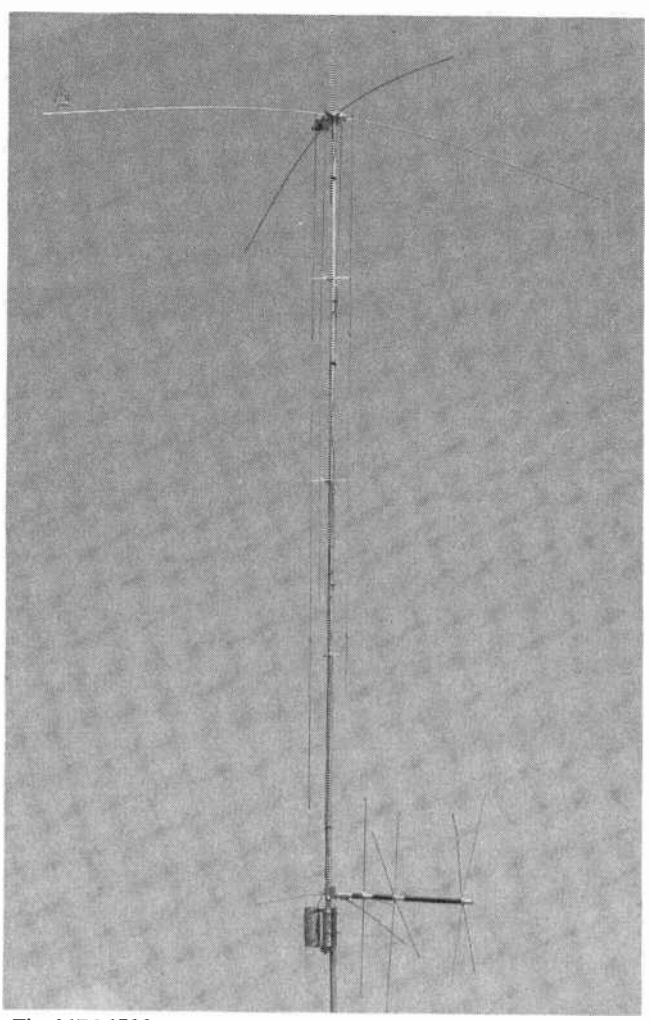
HAM RADIO

By Joseph J. Carr, K4IPV

Antenna Installation Safety

The depths of winter might not seem like the right time to consider installing a new ham-radio antenna, but that's when lots of folks like us start making plans for better weather. It's also a good time to reflect on the safety issues that relate to installing antennas. Over the past 35 years, I've seen and done enough antenna installations that have "gone wrong" to have first-hand experiences to share with newcomers. Fortunately, a badly wrenched back is my only memorable injury.



The MFJ-1798 antenna is a vertical designed to work on the 40-, 20-, 17-, 15-, 12-, 10-, 6-, and 2-meter bands.

The first issue to consider is electrical safety, and it comes in two flavors. First is the matter of electric-power lines. The electric-service lines in your area are likely to be above ground (unless you happen to live in a community with underground wiring). When installing an antenna, keep well away from those lines! **Don't ever toss a wire over power lines, no matter how hard other installation sites are!!!** Electric-power-line wires might look insulated, but that insulation is often old, and can be brittle, even on new lines. A length of antenna wire tossed over electric lines will often sever the insulation and bring you into direct contact with a lethal voltage.

When installing any kind of antenna, and especially when dealing with a vertical antenna, make sure that no part of it—mast, elements, guy wires, or whatever—can ever touch any power lines. That not only means keeping it away from the lines at the installation site, but also while carrying the assembled antenna across the yard to the installation site.

I remember one sad case when a CBer was carrying a 5/8-wavelength vertical across the yard, not realizing that its 18-foot height was greater than the height of the power lines! It touched the line and, according to the newspaper account, electrocuted the installer.

The second electrical-safety concern is what goes on in the shack. For example, when working on an antenna, make sure that the transmission line is disconnected from the rig! If someone turns on the transmitter while you are working on the antenna, you will get a nasty RF burn. In commercial-radio work, technicians carry around their own padlock and use it to lock the power switch off, before going out to work on any antenna.

Another major issue to consider when installing antennas is the physics of erecting the thing. That's how I got my wrenched back. Some years ago, I installed a 22-foot-high vertical antenna on a 20-foot telescoping mast. The two pieces were assembled on the ground, and then raised into place. Even though my strong-as-an-ox father-in-law was on his way, I decided to do it alone (vain pride will get you every time). The antenna didn't weigh very much, so I falsely assumed that it was a one-man job. Wrong! A slight breeze caught the antenna, and pulled it out of my hands. As I turned to grab the falling antenna, I felt that sickening "pop" that is Nature's signal that some damage had been done.

I also recall an incident back in the early 1960s when a shop I worked for sold a fellow a very-large "deep-fringe," all-channel television antenna. The fellow who bought the antenna had a home down on the Virginia side of Chesapeake Bay and was in the fringe-reception area for Richmond, Norfolk,

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Washington, and Baltimore TV stations. He wanted a rotatable antenna that could be used for all of those cities. We sold him a model with a 26-foot boom and about "50-gazillion" elements. The last thing I warned him about before he went out the door was to get help installing it, and to tether the antenna to the roof with a safety line while installing it.

He didn't listen to me. He went down to the Bay, and started installing the antenna on a 30-foot tower that was a few feet above the roof peak. He hadn't counted on the "sail area" of the antenna. While he was trying to lift it to the top of the mast onto the tower, a breeze blew in and caught the antenna. As a result, the poor fellow "hang glided" off the roof to the stone patio below . . . breaking a leg and his pelvis (about six month's worth of recuperation). He recovered, but the last time I talked to him he was still having trouble with both the leg and the hip . . . a fearsome price to pay for a little impatience.

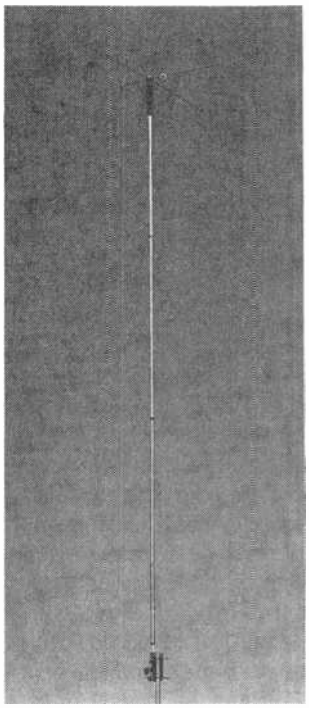
Big antennas are powerful things to handle. Always use enough people to do the job. Just about any antenna, regardless of how small it might be, is a two-person job. Don't let vanity or impatience get the better of you: be safe!

CODES AND INSTALLATION

One thing that we rarely talk about is finding out about the *local* mechanical and electrical codes required by your community that pertain to antennas. The FCC regulates the ham station, and according to the PRC-1 ruling, supported by Federal courts, the local government cannot keep you from installing an antenna (not so with homeowners associations, by the way). But the courts have also held that the local government can require "reasonable" mechanical- and electrical-installation codes.

The electrical requirements of most codes usually involve grounding for lightning protection. Typically, an eight-foot ground rod must be buried in the ground, and a heavy wire must be connected from the mast or antenna base to that grounding post, even if the mast is nominally grounded. The mechanical codes usually prescribe the method of installation, and sometimes the maximum height. In most jurisdictions, a permit is required, as is a final inspection before that permit is issued. In some cases, an interim inspection is also made, especially when a hidden, concrete foundation block is poured. In those installations, a typical requirement is to allow the inspector to see the hole you dug, and measure the depth of the gravel at the bottom. In most cases, the hole must be below the average frost line, and have four inches of gravel in the bottom. In my community, that means you would need to dig a 28-inch-deep hole.

So why is it important to keep in line with the codes? Besides the fact that you don't want the hassle of local authorities discovering that you've made an illegal installation, your homeowners-insurance policy is likely to disallow claims resulting from anything that is improperly installed, including radio antennas. I recommend that you keep the inspection certificates and the county permit on file so that any claims can be backed up.



For both 80- and 40-meter applications, try the MFJ-1792 antenna. It's some 33-feet tall, and requires guy wires for safe installation.

NEW ANTENNA NEWS

Here's a riddle for you: What's 20-feet tall, doesn't have any radials, and covers all 10 ham bands that most of us are likely to use? The answer is the MFJ Enterprises, Inc. (P.O. Box 494, Mississippi State, MS, 39762; Tel. 601-323-5869) Model MFJ-1798.

The MFJ-1798 is a vertical antenna that operates on the 75/80-, 40-, 30-, 20-, 17-, 15-, 12-, 10-, 6-, and 2-meter bands. On the higher bands, the MFJ-1798 provides full-size radiators with a unique "Elevated Top Feed" system that places the maximum radiation point high up where it will do the most good. On the lower bands (75/80, 40, and 30 meters), the antenna is end loaded, and offers a low angle of radiation (which is needed for long distance DX). MFJ Enterprises, Inc. offers the antenna with a one-year "no matter what . . . unconditional guarantee." The list price is $269.95.

Another MFJ antenna is the MJF 1792. That one is also a vertical, and is priced at $159.95. It operates on 80 and 40 meters. On the 40-meter band, it is a full-size radiator, *i.e.* an electrical quarter wavelength (33 feet). That is unusual for a 40-meter antenna intended for urban dwellers (many manufacturers prefer to use a shorter radiator, mated to a loading coil, even on 40 meters). On the 75/80-meter bands, the MFJ-1792 does use an end-loaded, high-Q coil, as well as a four-foot capacitance hat at the top of the 33-foot mast. For safety, that rather tall antenna must be guyed.

A companion antenna, the MFJ-1793, operates on 20, 40, and 75/80 meters ($179.95). It uses a full-size radiator on 20 meters, and loading coils or traps for the two lower bands.

Hope you've enjoyed our visit. See you again next issue with more ham-radio information. ■

One tree can make 3,000,000 matches.

One match can burn 3,000,000 trees.

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SCANNER SCENE

By Marc Saxon

A Portable for Newcomers

Look what Jack Frost's wintry wind blew in for 1996! It's *Radio Shack's* new *PRO-27* handheld portable, a nifty scanner that is easy to operate. It's fine for people who can use a basic scanner that brings in the action, but isn't decked out with all the advanced operating features.

The PRO-27 has 20 memory channels and covers 29–54, 137–174, and 406–512 MHz. There's instant access to the National Weather Service band, as well as the ability to do band searches. Standard scanner features such as delay, channel lockout, keyboard lock, low-battery alarm, a BNC antenna connector, and an earphone jack are part of the PRO-27. The unit scans at 10 channels per second.

The unit is powered by four AA-type NiCd batteries. An optional charger or mobile power cord is available.

The sensitivity is 0.4 μV below 54 MHz, 0.5 μV between 137 and 174 MHz, and 0.6 μV above 406 MHz. The IF frequencies are 10.85 MHz and 450 kHz. Selectivity comes in at −6 dB at ±10 kHz, and −50 dB at ±50 kHz.

The PRO-27 makes an excellent starter scanner for the newcomer. Alternatively, it is worth the consideration of anyone looking for a second or back-up handheld. You know, for those instances when you need a handheld, but are having second thoughts about bringing along the top-of-the-line rig for fear of damage or loss.

You can check out the PRO-27 at your local Radio Shack store.

Radio Shack's new PRO-27 handheld makes a great starter scanner for someone new to the hobby.

LET THE GAMES BEGIN

The frequencies are unusual, but we can state with certainty that the communications of the *Special Olympics World Games* have been monitored. Last summer the games were in Connecticut, although they are an ongoing endeavor. The games feature athletic competitions involving national teams consisting entirely of physically and mentally challenged young people.

Our friend Wes Peterson, of New Haven, Connecticut, was at the event. He wrote to mention that the communications related to operations, coordination, transportation, logistics, security, and all other activities were monitored in FM mode on 138.20, 138.45, 139.65, 139.675, 139.85, and 141.575 MHz. The busiest frequency was 139.675 MHz. All transmissions exhibited a CTCSS of 156.7 kHz, so repeaters were obviously in use. Wes has no idea whether he picked up repeater input or output frequencies.

LOOK, UP IN THE SKY!

Several readers wrote to observe that they have monitored occasional Russian-language FM-mode communications on 258.45 and 265.45 MHz, and asked if we could explain what that was all about. That inspired me to tune into those frequencies and hear the chatter, along with data transmissions also observed.

You probably know that 225–400 MHz is the UHF military aeronautical band. You'll hear plenty of military aero activity there, but those stations use AM mode. Keep in mind that there are also military communications satellites operating in portions of that band, and they *don't*

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use AM. They send data, and also voice traffic in NFM and WFM modes. Band segments rich in such downlinks include 243.845–244.21 and 249.55–269.85 MHz. When you search there in 50-kHz steps using NFM and WFM modes, you'll explore dimensions of the band that are completely different than those encountered during an AM mode search.

For best reception there, an outside-mounted antenna is suggested. We have had fine results using CRB's MAX-225 antenna, made for the 225–400-MHz band. Received signals get a healthy boost thanks to a GRE Super Amplifier. All sorts of intriguing outer-space signals and carriers show up, some with voice, others with data, or just warbles and whines.

According to records here, the two Russian station frequencies reported match up with downlink Channels 7A and 8B of the U.S. Navy FLTSATCOM satellite, positioned at 100° West longitude. That series of relay communications satellites uses dozens of frequencies. There's no way to exactly pinpoint the Russian stations monitored. One guess is that they are related to the MIR space laboratory, or its ground support.

Direct voice reception from MIR has been widely reported in WFM mode over the craft's primary frequency of 143.625 MHz. It's quite an experience to hear it for the first time. Other MIR voice (with data) frequencies reported also use WFM mode, and include: 121.125, 139.205, 142.00, 142.215, 142.42, 142.60, 143.145, 143.42, 143.825, 165.00, 165.875, 166.00, 166.13, 192.00, 231.0, 233.0, 417.00, and 463.00 MHz. MIR has also been monitored on these Amateur frequencies with NFM and packet communications: 145.40, 145.50, and 145.55 MHz.

WE ARE BAFFLED

A letter came in from Matthew W. (Brewster, MA) stating that he took his Bearcat 3000XLT to an auto store and made a frequency search from 1000 to 1020 MHz. The scanner was in "auto store" NFM mode. When he scrolled the frequencies, he tells us that he "heard people talking on some sort of phone." He didn't mention if it was one phone that kept switching to 12 different frequencies, or if there were a dozen different single-channel phones all going simultaneously.

The scanner had registered 12 frequencies lying between 1002.400 and 1014.520 MHz, including 1002.465, 1006.565, and others similar. He wants to know if those can be identified with any known communications service that would sound like a telephone.

Matthew didn't explain what motivated his trip to an auto store to investigate that particular frequency band. There's probably a grisly story somewhere in there that neither you nor I really want to know, anyway. No matter, because those frequencies do no belong to any phone-like service. We have no idea as to what they might be, but our readers might want to try searching that range to see if they hear anything.

Curiously, those signals are exactly 100-MHz higher than the 902–928-MHz band, which could conceivably hold signals from some newer UHF cordless phones. Is that sheer coincidence, or is there more to it all? We are throwing it open to discussion from any and all readers. Why not send your best guess, and maybe we can find one or more answers that sound reasonably logical.

Finally, Arn Schwartz, of Tampa, Florida, asks for the frequencies of the Goodyear blimps. Try 123.05 and 123.0 MHz for air/ground, while the handhelds use 151.625, 465.9125, 465.9375, and 465.9625 MHz.

Your input is always invited in the form of frequencies, ideas, and questions. Please address your comments to *Scanner Scene*, **Popular Electronics**, 500 Bi-County Blvd., Farmingdale, NY 11735. ■

ANTIQUE RADIO

(Continued from page 60)

nated with radios and crystal sets since childhood, and has been actively collecting since 1960.

Readers of this column who have antiquarian interests that include computers will be interested in an account of early computer development by an engineer who was deeply involved in the process. *Why Computers are Computers* (ISBN 1-885391-05-6, 178 pages, hardcover, $24.95; published by Wren Publishing, P.O. Box 1084, Philomath, OR 97370) was written by David Rutland, who authored *Behind the Front Panel*, a well-received volume covering the design and development of 1920's radios.

The home PC uses the same essential basic principle that early experimental computers employed some 50 years ago. Known as the "stored program concept," the principle was built into the very first computer constructed west of the Rockies: the National Bureau of Standards *SWAC* (which stands for "Bureau of Standards Western Automatic Computer").

Author Rutland served as an engineer on the SWAC project. In his book he describes in everyday language how the SWAC was designed and built. Using amusing anecdotes, Rutland leads the reader, step by step, from the early history of computers through the inventions and strange events that eventually produced today's computer revolution.

The bulk of the volume is devoted to the fascinating engineering history of the SWAC, which, when built at UCLA in 1950, was the fastest computer in the world. Built by designer Harry D. Huskey, working with three engineers over a period of less than 18 months, the device used over 2700 vacuum tubes and thousands of other parts. As the story unfolds, many of the parallels between the SWAC and the modern personal computer become very clear to the reader.

Rutland's work on the SWAC project in 1950 started him on a career in the design of digital computer hardware. He has served as President and founder of two electronic companies engaged in manufacturing computer graphics and image processing hardware and software. He has also had firsthand experience in the design of digital circuits, first with vacuum tubes and later with transistors and integrated circuits.

The book is available by mail from the publisher (add $3.00 for postage and handling). Also available in softbound (ISBN 1-885391-06-4).

That's all the room we have for now. We'll be back next month with more on the "ARRL Radio." ■

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ELECTRONICS LIBRARY

The ARRL Electronic Repeater Directory

from the American Radio Relay League

All of the information contained in the printed version of *The ARRL Repeater Directory* is now available on diskette for your PC. The disk allows you to call up data by band, state, city, call sign, frequency, sponsor, or repeater feature. You can quickly and easily find band plans, packet and ATV repeaters, beacons, frequency coordinators, and repeater user information. The electronic directory can be used on the road with a laptop or notebook computer. And you can print out any data you need.

The program is simple to install on your PC, and a handy README file describes its many features. It requires MS-DOS, 286 or higher processor, 360 kB of system memory, 1.3 MB of hard-drive space, and a VGA-compatible video-graphics adapter.

The ARRL Electronic Repeater Directory, 1995–96 Edition costs $14.95 and is published by The American Radio Relay League, 225 Main Street, Newington, CT 06111; Tel. 203-666-1541; Fax: 203-665-7531.

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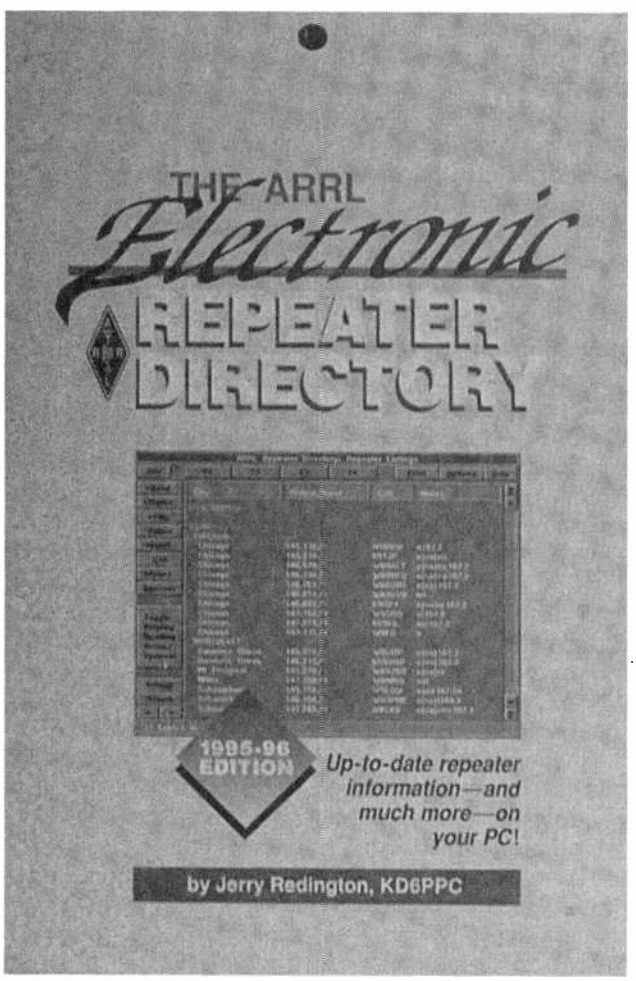
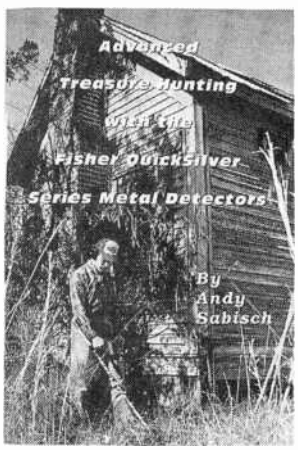


ADVANCED TREASURE HUNTING WITH THE FISHER QUICKSILVER SERIES METAL DETECTORS

by Andy Sabish

Although it is aimed primarily at users of Fisher Research Laboratory's CZ Quicksilver models of metal detectors, this book presents many tips and techniques that will be useful for just about any detector user.

The first several chapters introduce the reader to the specific features found on Quicksilver models, explaining how to get the best performance out of those detectors. Following chapters each deal with a particular type of treasure hunting, including coin hunting, relic hunting, and beach and water hunting. The book explains how to search neighborhood parks for rare coins, and how to hunt for lost coins and jewelry in the shallow water of local swimming holes, lakes, rivers, and the ocean. An entire chapter is devoted to competition treasure hunting. Convenient appendices include a recommended reading list, the "Treasure Hunter's Code of Ethics," and a listing of national treasure-hunting organizations.



Advanced Treasure Hunting with the Fisher Quicksilver Series Metal Detectors is available for $7 plus $2 shipping and handling from Fisher Research Laboratory, 200 West Willmott Road, Dept. EN, Los Banos, CA 93635; Tel. 209-826-3292; Fax: 209-826-0416.

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DON LANCASTER'S ACTIVE FILTER COOKBOOK

by Don Lancaster

The latest offering from this electronics expert and prolific writer of books and magazine columns—including *Electronics Now's* "Hardware Hacker"—is this comprehensive guide to lowpass, bandpass, and highpass active electronic filters. Such filters need no inductors, getting better results from op-amps, resistors, and capacitors. They are less expensive and offer easy tuning, simple design, and the advantage of modular design.

The book provides "Instant Design Charts" accompanied by real-life examples and clear explanations of the math behind the designs. It covers responses from Bessel to Chebychev to Elliptic, plus circuits from Sallen and Key through State Variable. The book is divided into chap-

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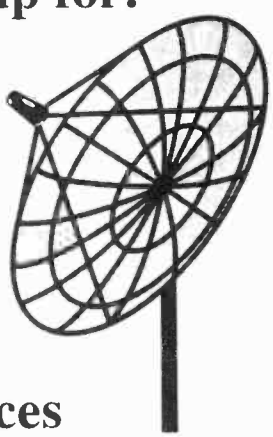

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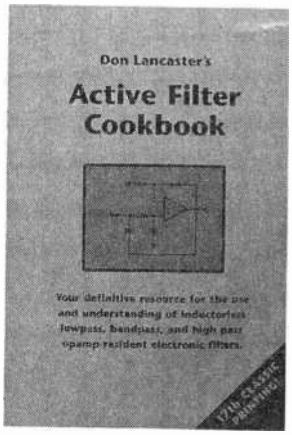


ters discussing active filter basics; op amps; first- and second-order networks; lowpass, bandpass, and highpass responses; lowpass, bandpass, and highpass circuits; tuning and voltage control; and real-world ideas and applications.

Autographed copies of Don Lancaster's Active Filter Cookbook are available for $28.59 plus $4.50 shipping and handling from Synergetics Press, 3860 West First Street, Thatcher, AZ 85552; Tel. 520-428-4073; e-mail: synergetics@genie.geis.com.

CIRCLE 82 ON FREE INFORMATION CARD

ELECTRONIC PRODUCTS ORDERING GUIDE

from 3M Electronic Products Division

Aimed at engineers, assemblers, and technicians, this 650-page catalog provides ordering information for more than 5000 products serving a wide variety of electronic applications. It includes board and wire-mount sockets, board stacking systems, "MIX" stacking connectors, PCB connectors, DIP connectors, cables, plugs, headers, tape-and-reel packaging, wire-marking products, assembly equipment, D-ribbon connectors, D-sub connectors, and heat-shrink tubing. The 100% recyclable catalog features product specifications, technical drawings, and black-and-white photographs.

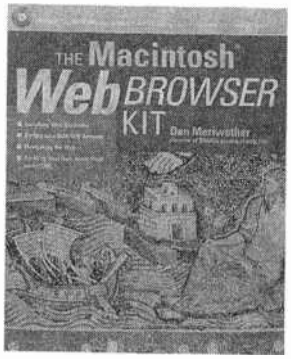
The Electronic Products Ordering Guide is free upon request from 3M Electronic Products Division, 6801 River Place Blvd., Austin, TX 78726-9000; Tel. 800-225-5373.

CIRCLE 83 ON FREE INFORMATION CARD

THE MACINTOSH WEB BROWSER KIT

by Dan Meriwether

This book-and-CD-ROM package shows Mac owners how to set up a Serial Line Internet Protocol or Point-to-Point Protocol (SLIP/PPP) graphical client interface and start navigating the Internet in just one day. It provides all the tips and software needed to order a SLIP/PPP connection from a service provider; install Web browsers and SLIP/PPP software on the Mac; build a multimedia Web Page using Hypertext Markup Language (HTML); and troubleshoot the SLIP/PPP connection and Web browser. The book provides pointers for cruising the Internet using Mosaic, Netscape, Lynx, and Mac WEB.



The included CD-ROM offers software and tutorials to help readers build a Web page, and provides Internet communications utilities and Web-browser utilities for viewing video, graphics, and sound. It also contains multi-player Internet games and Apple Remote Access software.

The Macintosh Web Browser Kit costs $29.95 and is published by John Wiley & Sons, Inc., 605 Third Avenue, New York, NY 10158-0012; Tel. 800-CALL-WILEY.

CIRCLE 84 ON FREE INFORMATION CARD

PROGRAMMABLE MICROCONTROLLERS CATALOG

from Blue Earth Research

This 28-page catalog describes various microcontrollers, peripherals, accessories, and development software. It also features an assortment of humidity, temperature, and pressure sensors that can be used with any of the controllers or with an analog interface module, and provides an overview of Blue Earth Research's custom design capabilities.

Highlighted product families are the Micro-440e, Micro-485, and Xplor Series of personal digital controllers. The Micro-440e programmable controller is a tiny microcontroller with standard features that include an advanced 8051-family CPU, 32K EPROM, 32K RAM, a real-time clock/calendar, and an 8-bit A/D converter. Similar to the Micro-440e, the Micro-485 adds several enhanced features and capabilities. The same software can be used for developing applications on both programmable controllers. The Xplor Series include a number of unique features not typically found in the subcompact price range. They are available as part of a complete starter package that also includes a cable, power supply, user's manual, and optional development software.

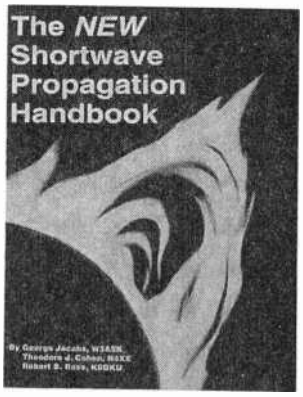
The Programmable Microcontroller Catalog is free upon request from Blue Earth Research, 165 West Lind Court, Mankato, MN 46001; Tel. 507-387-4001; Fax: 507-387-4008.

CIRCLE 85 ON FREE INFORMATION CARD

THE NEW SHORTWAVE PROPAGATION HANDBOOK
Third Edition

by George Jacobs, W3ASK, Theodore J. Cohen, N4XX, and Robert B. Rose, K6GKU

This book was written to help amateur-radio enthusiasts, SWLers, and CBers optimize their use and enjoyment of the HF spectrum regardless of the time of day, the season of the year, or the state of the sunspot cycle. So much has changed in the 13 years since the last edition was published that the book is more than just a revision—this comprehensive guide to mastering the art of shortwave propagation contains updates, expanded sections, and entirely new information.



The book features updated work on both solar phenomena and sunspot-cycle behavior. Lists of references and data sources have been expanded. New material has been added on the various PC programs available for use in developing customized ionospheric circuit analyses. There also is a summary of the sunspot-cycle predictions for Cycle 23 that have been developed by solar-physics professionals.

The New Shortwave Propagation Handbook (price N/A) is published by CQ Communications, Inc., 76 North Broadway, Hicksville, NY 11801. ■

CIRCLE 86 ON FREE INFORMATION CARD

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VOICE-ACTIVATED SWITCH

(Continued from page 36)

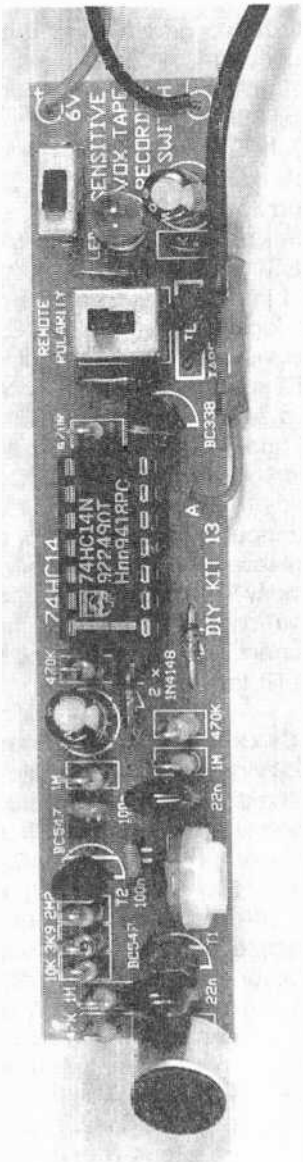
placement diagram is shown in Fig. 3. Begin assembly by mounting an IC socket for U1 (double-check the orientation with the parts-placement diagram). Then go on to install the fixed resistors; the board is small in size so the resistors must be mounted vertically.

If resistor R11 is installed as shown in Fig. 3, LED1 will light when power is applied to the circuit, as mentioned before. However, again as mentioned earlier, if the ground connection to R11 is lifted, and that end of the resistor is then jumpered to pad X (as indicated by the dashed line), the LED will light when the output of the circuit is active. You might want to go with that option because it makes the circuit's sensitivity a little easier to adjust, and prevents the LED from wasting power.

Continue the assembly process by soldering the capacitors to the board. Make sure to check the polarity of the electrolytics. Then mount the transistors, diodes, and LED. While the two devices mentioned in the Parts List as suitable for Q3 are functionally equivalent, they are housed in different packages. Hence, if you use the second device mentioned, a NTE123AP, it will have to be rotated 180° prior to installation.

Next install the electret microphone, MIC1; check the parts-placement diagram for proper orientation. The unit's negative lead is the one that is grounded to its metal case. Due to the small size of the PC board, and depending on the microphone you use, the leads might have to be inserted and soldered from the bottom side of the board and the microphone bent up over the edge of the board. Otherwise the microphone might physically interfere with the capacitor next to it. Alternatively, you can connect the microphone to the board with a short length of shielded cable.

Go on to install a four-AA-cell battery holder to the board, as shown in Fig. 3. Then use a length of 2-conductor wire to connect to the board a 2.5-mm plug (PL1)—that will plug into the remote jack of a tape recorder (the polarity of the plug is unimportant). Finally, insert the IC into its socket to complete the construction process.



As shown here, the microphone leads might have to be inserted and soldered from the bottom side of the board with the microphone bent up over the edge of the board.

Now it is time to checkout and adjust the switch. After carefully inspecting the board for soldering errors, install four AA batteries or connect a 6-volt supply and turn on power. Connect plug PL1 to the remote jack of a tape recorder set to record. Any noise should activate the circuit, and adjusting R12 will vary its sensitivity.

Assuming all is well, the circuit is now ready to control a tape recorder. With the Voice-Activated Tape-Recorder Switch, you can enjoy remote audio recording without having to worry about taping the annoying sounds of silence. ■

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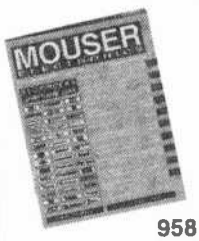

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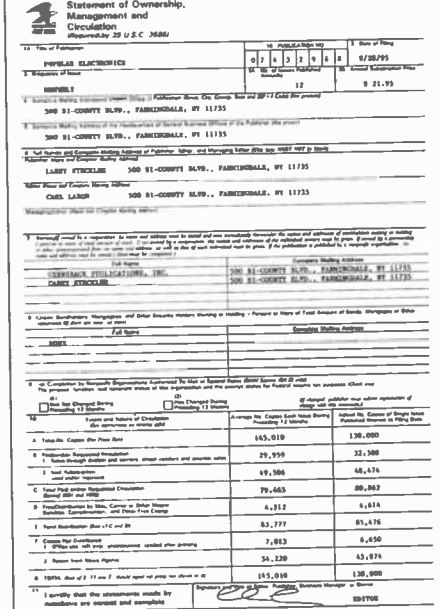
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LOGIC FAMILIES

(Continued from page 48)

74Cxxx Standard CMOS. The 74C series is a direct descendant of the 4000 and 40H00 metal-gate CMOS families. Supply voltages can vary from 3 VDC to 15 VDC. Two distinguishing characteristics set 74C gates apart from their predecessors. First, 74C pinouts are laid out to correspond to their TTL counterparts. For example, a 74C00 CMOS NAND gate has the same pin layout as the 7400 TTL NAND gate. Such pin-to-pin compatibility allows CMOS parts to be used instead of TTL parts without major redesign of a circuit. The 74C family also has a substantially smaller current output capacity than either the 4000 or 40H00 families.

Even with such improvements, the 74C series retains many undesirable characteristics of older CMOS devices. Propagation delays are long for metal-gate CMOS gates. Delays of 90 ns are common for 74C gates. Such low performance limits the gate to operating frequencies below 2 MHz. Power dissipation in metal-gate CMOS depends on the operating frequency. At DC or low frequencies, CMOS gates dissipate almost no power. At higher frequencies, gate power can exceed 10 or 15 mW.

74HCxxx/74HCTxxx High-Speed CMOS. High-speed CMOS is designed to overcome some of the disadvantages that have plagued older CMOS families. The 74HC family is designed to operate from a supply voltage of 2 VDC to 6 VDC—ideally 5 VDC to coincide with TTL levels. Gate speed is substantially reduced. A 74HC gate offers about 20 ns of propagation delay. A 74HCT gate works in about 40 ns. Both high-speed families dissipate far less than 1 mW of power-per-gate.

An important difference between 74HC and 74HCT families is input compatibility. High-speed CMOS (74HC) gates running at 5 VDC require a logic-1 input to exceed 3.15 VDC. TTL gates only guarantee a logic-1 output of 2.4 VDC. As a result, a logic-1 output from a TTL gate will not guarantee a logic-1 input to a 74HC gate. TTL and 74HC gates are not considered compatible for that reason. However, a pull-up resistor added to the TTL gate's output as shown in Fig. 6 should raise the TTL output level enough to ensure at least 3.15 VDC.

A 74HCT CMOS gate IS fully compatible with TTL outputs. The "T" attached to HCT indicates TTL compatibility. At a supply voltage of 5 VDC, a 74HCT gate requires a minimum logic-1 input of 2 VDC, and a maximum logic-0 input of 0.8 VDC. Because those requirements coincide with TTL specifications, a TTL gate will drive a 74HCT gate directly. Both the 74HC and 74HCT families will provide a logic-1 output of about 4.0 VDC, and a logic-0 output of below 0.4 VDC. Such output characteristics will drive at least several TTL inputs properly. Just how many TTL inputs a 74HC or 74HCT gate will drive depends upon the input-current requirements of the particular TTL family.

74ACxxx/74ACTxxx Advanced CMOS. Advanced CMOS logic provides the ultimate in CMOS-gate performance. When operated from a supply voltage of 5 VDC, a 74AC gate has about 3 ns of propagation delay, and a 74ACT gate has 5 ns of delay. Both families can operate at frequencies beyond 100 MHz, yet dissipate less than 0.5 mW of power-per-gate. Such characteristics make advanced CMOS logic ideal for high-performance, low-power circuits. Gates, flip-flops, buffers, registers, multiplexers, and simple memories are available in the 74AC and 74ACT families.

Parts in the 74AC family are not necessarily compatible with TTL outputs. A 74AC gate requires a minimum logic-1 level of 3.15 VDC. Because TTL outputs are only guaranteed for a logic-1 output of 2.4 VDC, the CMOS gate might not respond properly. TTL and 74AC gates are said to be incompatible for that reason. By adding a pull-up resistor to the TTL gate's output, the output voltage can be increased enough to drive the 74AC gate input.

A 74ACT gate is designed to be fully TTL compatible. A 74ACT requires a minimum logic-1 input of 2.0 VDC and a maximum logic-0 input of 0.8 VDC, so the output from a TTL gate will drive a 74ACT gate properly. Both the 74AC and 74ACT families provide logic-1 outputs well above 3 VDC and logic-0 outputs below 0.8 VDC, so both families can drive TTL gates directly. ■

CAPACITANCE METER

(Continued from page 58)

will give you the best calibration, subject of course to the accuracy of the meter you used.

The other method you can use will give acceptable results in the absence of another capacitance meter. Carefully measure R9, which is nominally 1 megohm, and R10, which is nominally 910,000 ohms. Then, adjust R11 until it satisfies this equation:

$$R11 = ((3{,}000{,}000 - R9) - R10)/2 \approx 90{,}000 \text{ ohms}$$

Continue by adjusting R8 and R5 until they satisfy these equations:

$$R8 = ((30{,}000 - R6) - R7)/2 \approx 900 \text{ ohms}$$

$$R5 = ((300 - R3) - R4)/2 \approx 53 \text{ ohms}$$

That procedure will relieve you of the resistor's 5% error, but not the 10% error of the timer's resistors.

Using the Meter. As I've said, the Capacitance Meter is user friendly. When calibrated and turned on, the Meter displays "Please Wait." During that time it measures and records any stray capacitance present. That value will vary from meter to meter, and from day to day on the same unit. After about 1.3 seconds, the Meter will display "Ready." If you have a capacitor in the test socket when turned on, the meter will read "Remove capacitor" instead of "Ready." Simply remove the capacitor and wait another 1.3 seconds for "Ready."

To use the Meter then, place a capacitor in the unit's test socket. Note which side of the test socket is the circuit ground. You should always place the negative terminal of electrolytic capacitors in the ground side. The Meter automatically detects the capacitor's presence, selects the appropriate range, and displays the result; the unit will also update the reading every 1.3 seconds. When you remove the capacitor, the display should return to "Ready."

If you measure large capacitors, the time between readings will increase. If you really test the Meter's limits, it will display "overrange" for capacitances larger than about 5000 µF, or if you accidentally place a resistor in the socket. ■

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COMPUTER BITS

(Continued from page 61)

are all but unusable, so I haven't yet had the chance to try the Upgrade Assistant. When using the program, I keep asking myself whether the developers ever used it. If they had, it seems highly unlikely they would have done certain things the way they did.

In short, Remove-It's file-selection mechanism is about as user-friendly as a crocodile in heat. You can't simply arrow your way through a list of files and toggle a selection on or off. Instead, you must go through a convoluted series of nested dialog boxes for *every* file you select individually, delete the file, and then get unceremoniously dumped right back at the top of the list so you can start over. In its defense, Remove-It has a handy file viewer that, if the selection mechanism weren't so ridiculously awkward, would be quite useful in determining the fate of various files. (Actually, you don't have to go through the convoluted approach. There's an express mode that, from what I could tell, does the equivalent of "FORMAT C:". Not terribly appealing.)

So I'm still stuck on step 1. To deal with that task, it seems best to use good old File Manager, along with a couple of shareware programs. One is WinZip, a Windows-based front end for the PKZIP/PKUNZIP utilities. WinZip is a great program for examining the contents of Zip files. The other is a program called FmView. It is a File Manager add-on that gives you file-viewing capabilities simply by right-clicking on targets in File Manager. FmView supports tons of file formats, but you must register the program to view graphics files. However, registration runs a mere $15–$30. FmView is a quality piece of work that I ran across on CompuServe. It has no fancy packaging, nor testimonials from a half-dozen computer magazines about how wonderful it is. (That's in marked contrast to another program discussed here.)

Anyway, I still have hope for Remove-It's Win95 Upgrade Assistant. I'll let you know how it goes in a future issue. ■

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MULTIMEDIA WATCH

(Continued from page 23)

package lets you quickly fill out paper forms on your computer. Formbuster lets you convert existing forms into electronic forms by importing them with a fax machine or scanner. Then you simply fill in the form using your keyboard or with information stored in a database. You can also edit the form image as well as the text, and add custom graphics, logos, signatures, and more. Formbuster costs $99.95.

If you're planning a road trip, the *Microsoft Automap Road Atlas* version 4.0 will be helpful. That latest version of the popular trip-planning software calculates trip directions, refueling stops, and more. The computerized road atlas asks for a starting point, destination, and some traveling preferences, and then calculates a route to any one of nearly 150,000 places in the United States, Canada, and Mexico. It will also point out places of interest along the way. Driving preferences include such things as how many hours per day of driving, average speed, and the preferred types of roads. If you're in a hurry you'll want to stick to the highways while others might elect for more scenic routes with many stopping points. Road Atlas provides printed copies of maps and driving instructions. A database includes information on states and cities, ski resorts, national parks, mountains, forests, rivers, historic sights, and more. Road Atlas will set you back $39.95.

Star Trek fans will love Simon & Schuster's *Star Trek The Next Generation Interactive Technical Manual* on CD-ROM for the U.S.S. Enterprise NCC-1701-D; it's not the original one, but it's the most powerful Enterprise ever. The disc lets you assume command of an inspection tour and move throughout the ship without restriction. You can walk the corridors, command the bridge, explore the holodeck, and check out engineering. This disc will probably become a collector's item.

IVI Publishing lets you go fly fishing from the comfort of your own home with its *Fly Fishing: Great Rivers of the West* CD-ROM. The disc lets anyone take an interactive journey to the best fly-fishing waters west of the Mississippi, accompanied by six of the nation's top fly-fishing guides. Beginners can learn the sport from the water up and veterans can pick up a few tips from the pros. Fly Fishing sells for about $35.

Johnny Mnemonic is not only a movie, it's also a game based on the movie. The CD-ROM from Sony Imagesoft takes the player into a cyberpunk world of the near future where Johnny the data courier must transport a vital package of information stored in memory chips implanted in his brain. But the package exceeds his own storage capacity and he must therefore download the information quickly or risk suffering a fatal overload. ■

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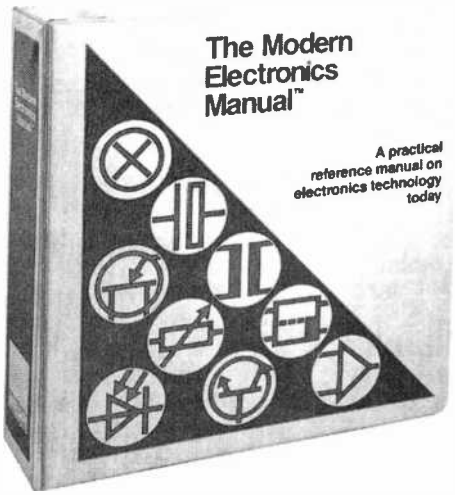

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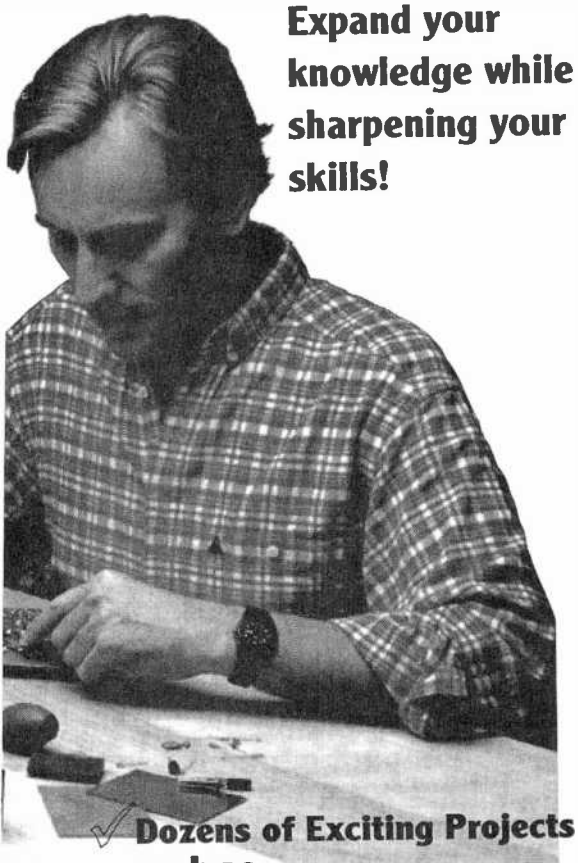

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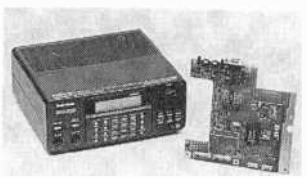
NEW PRODUCTS

(Continued from page 6)

The interface also makes it easier and less confusing to use the PRO-2035. Even when you're away from the scanner, the computer can continue to search out the frequencies you want to monitor and record them into virtually unlimited numbers of memory locations.



The unit also comes with two built-in CI-V-interface converter jacks, eliminating the need for an external converter box. It provides signal decoding of CTC22 tones, DCS codes, and DTMF characters. The OptoScan535 is supported by such software programs as Probe, Scanstar, Scancat, Scanner Ware for Windows, Radio Manager for Windows, and Wave for Mac.

The OptoScan535 can also be used with Optoelectronics' Scout to achieve the company's patented Reaction Tuning. The Scout will automatically tune the PRO-2035, equipped with an OptoScan535, to the frequency recorded. The frequencies can also be recalled from any one of the 400 memories in the scout to tune the receiver by Memory Tune.

The OptoScan535 has a suggested list price of $299. For more information, contact Optoelectronics, 5821 NE 14th Avenue, Ft. Lauderdale, FL 33334; Tel. 305-771-2050; Fax: 305-771-2052.

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VOICE-OPERATED SWITCH

Azden Corporation's Model PTT-02 voice-operated (VOX) switch can give any radio the advantages of remote manual or voice-triggered transmission. Variable microphone gain, adjustable frequency equalization, and VOX gain are included. It can be used with all types of

microphones including dynamic and electret. A removable belt clip, Velcro tape, and a soft desk pad allow the device to be mounted just about anywhere.

An OFF/PTT/VOX switch allows either normal push-to-talk or VOX operation. An adjustable (from 0 to +8 dB) 2-kHz gain control, coupled with an overall gain control (0 to +10 dB), provides matching of most microphones to most radios, as well as shaping the frequency response for improved DX operation.

The PTT-02 VOX switch costs $50. For additional information, contact Azden Corporation, 147 New Hyde Park Road, Franklin Square, NY 11010; Tel. 516-328-7500; Fax: 516-328-7506.

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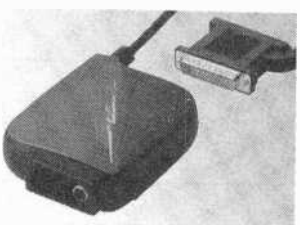
PORTABLE FRAME GRABBER

Intended for use with notebook and laptop computers, *VideoLabs' VideoShot* is a palm-sized, stand-alone frame grabber. The device plugs right into the parallel port, so there's no need to open the PC. The VideoShot will work using three AAA batteries, capturing 500 true-color frames when working with notebooks.



VideoShot can capture an image at 640 × 480 resolution in 16-million colors in one-thirtieth of a second. It is TWAIN compatible and works with all image-processing software, including PhotoStudio, Photoshop, and Corel Draw. For easy-to-use image editing, each unit ships with PhotoStudio software.

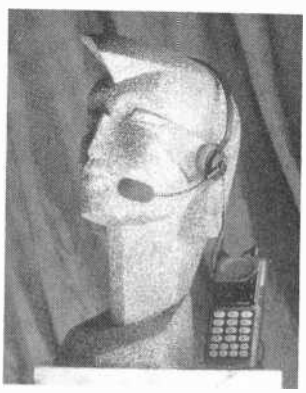
Video input is accomplished using VideoLabs' FlexCam, a camcorder, a VCR, or any other video source. It accepts both composite and S-video inputs. Depending upon the capabilities of the user's computer, a preview display rate of 8 to 12 frames per second is possible.

The VideoShot frame grabber has a manufacturer's suggested retail price of $229. For further information, contact VideoLabs, Inc., 10925 Bren Road East, Minneapolis, MN 55343; Tel. 612-988-0055; Fax: 612-988-0066.

CIRCLE 92 ON FREE INFORMATION CARD

CELL-PHONE HEADSET

The *ACS Stratus On-the-Go* headset for wireless and cellular phones combines a noise-canceling microphone and earphone in a lightweight, comfortable package that frees the user's eyes and hands, relieves fatigue, and increases productivity. It connects to compatible cordless and cellular phones by way of a 2.5-mm audio-type plug and includes an adapter for 3.5-mm applications. Available in both patented Ear Capsule and Headband models, the headset weighs just half an ounce and features a unique cable configuration that prevents the cable from looping. That feature, along with hands-free operation, eliminates some of the safety hazards associated with using a cellular phone while driving.



The Stratus On-the-Go features a noise-canceling microphone that reduces background noise by 12 decibels. Wind and road noise are practically eliminated, making mobile calls sound as if they were being placed from an office. The microphone is attached to the headset on a flexible boom.

The Stratus On-the-Go headset has a suggested retail price of $79.95. For more information, contact ACS Wireless, Inc., 10 Victor Square, Scotts Valley, CA 95066-3518; Tel. 408-438-3883; Fax: 408-438-7730.

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CAR NAVIGATION GUIDE

The *EtakGuide for Florida and Georgia*, bundled with the Sony NVX-F160 navigation system, allows motorists to navigate every road and highway throughout the states of Florida and Georgia. They can select actual street addresses or key landmarks, restaurants, hotels, vacation sites, and other categories from a menu on the dashboard-mounted display.

The Sony system consists of the dashboard-mounted display, a CD-ROM player, and a global-positioning-system (GPS) receiver for precise navigation. The Florida/Georgia EtakGuide is the second CD-ROM guide to be released by *Etak* for the NVX-F160, following the California/Nevada guide.

The EtakGuide features "moving maps"—accurate, detailed road maps that show virtually every street in both states. Clear text and graphics identify and distinguish between interstate highways, toll roads, local streets, scenic routes, exit numbers, and ramp details. Available services at highway interchanges are noted by icons that indicate gas, food, lodging, and camping facilities. The multimedia map combines audio prompts and help screens, text descriptions, icons, colorful screen menus, photographs, illustrations, and music.

In Florida and Georgia, and California and Nevada, the appropriate EtakGuide CD-ROM is included in the purchase price (less than $3000) of the Sony NVX-F160 GPS system. The EtakGuides are available separately for $150 each. For more information, contact Etak, Inc., 1430 O'Brien Drive, Menlo Park, CA 94025; Tel. 800-773-5564. ■

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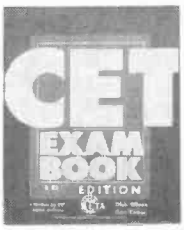

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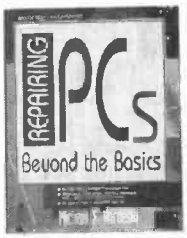

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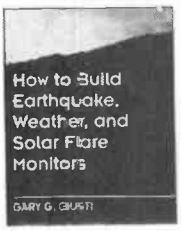

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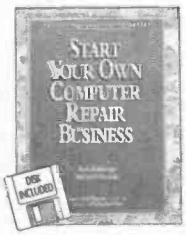

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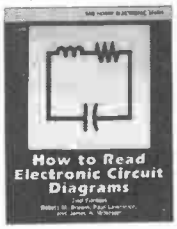

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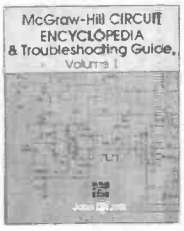

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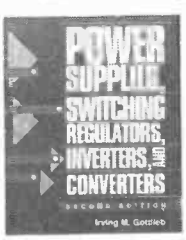

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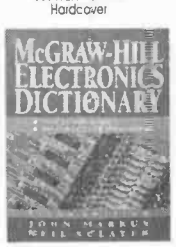

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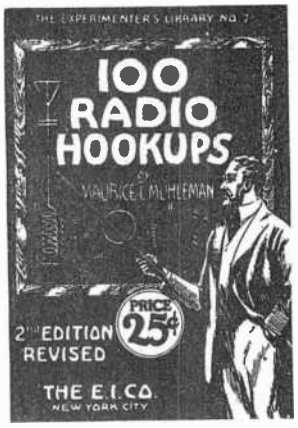

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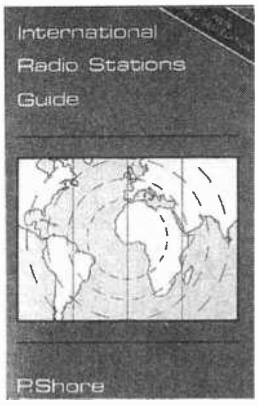

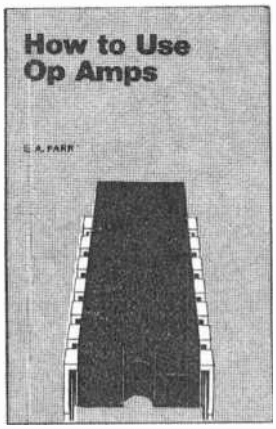

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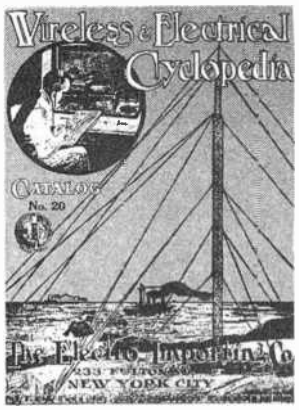
The engineer's best friend is the op amp. This basic building block is found in many circuits, analog and digital alike. The op amp finds many useful purposes such as: oscillators, inverters, isolators, high- and low-filters, notch and band-pass filters, noise generator, power supplies, audio, MIDI, and much more. Prepared as a designer's guide, some limited math is used, however engineers and hobbyists alike find it a useful text for their design needs.



☐ WIRELESS & ELECTRICAL CYCLOPEDIA —ETT1—$5.75

A slice of history. This early electronics catalog was issued in 1918. It consists of 176 pages that document the early history of electricity, radio and electronics. It was the "bible" of the electrical experimenter of the period. Take a look at history and see how far we have come. And by the way, don't try to order any of the radio parts and receivers shown, it's very unlikely that it will be available.

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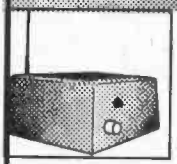
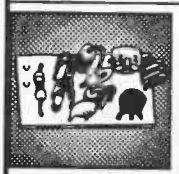
RAINBOW KITS



FM STEREO TRANSMITTER

Own your own FM radio station. Any stereo signal you plug into the FMST-100 will be transmitted to any FM radio tuneable from 76 to 108MHz FM. Transmit a wireless link through an auditorium, from your car to your camper, listen to your CD's while mowing the lawn, Play music on one channel sing on the other. Clarity is excellent, aprox. 40dB stereo separation. Length of antenna determines the distance of transmission. Complete with stereo input level controls & crystal for stereo separation. 9v battery operation. SIZE: 1.5" x 2.5" x 3"

FMST-100 KIT **$29.95** / Cabinet **$8.95**



PHONE TRANSMITTER

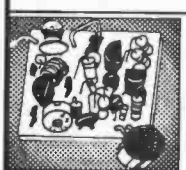
Small but mighty,it fits anywhere. Phone line powered, never needs batteries. Transmits both sides of a phone conversation loud and clear, wireless, to any FM radio at great distances. Variable tunes from 70MHz to 130MHz FM. You can also use it as a speaker phone. SIZE:1.25" x .6".

TEL-B1 KIT **$12.95** BUILT **$29.95**

SUPER SNOOPER BIG EAR

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"

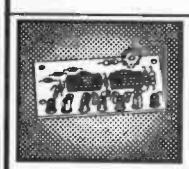
AA-1 KIT **$10.95** BUILT **$29.95**



WIRELESS FM MICROPHONE

Small but mighty this little jewel will out perform most units many times its price. It really stomps out a signal. The WM-1 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-1 KIT **$14.95**

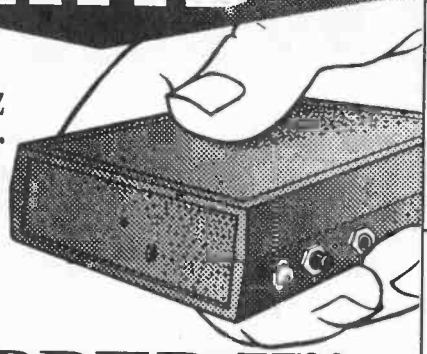


DC VOLTAGE MONITOR

If battery status is important, you need this kit. This kit uses 7 LEDs to monitor 12v DC in 1v, 1/2v, or 1/4v steps. Monitor 8v or 5v in 1/4v steps. Great for boats, motor homes, model planes or race car ni-cads. All parts and instructions are included. SIZE: 1.3" x 2.7".

VM-1 KIT **$7.95**

The 10GHz Transmitter is back...



The "ZAPPER II"

With it's new and improved design it will not only test your radar detector... BUT it's tuned to the amateur radio band.

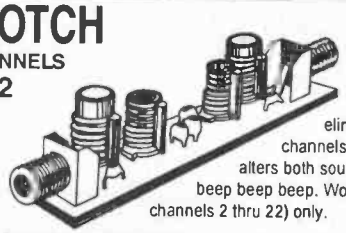
- While your out on American highways personally test yours and your fellow travelers radar detectors.

The "ZAPPER II" is a 10.450 GHz to 10.550 CW oscillator. It has a code key jack installed for those who want to send Morse code.

BUILT **$49.95** KIT **$39.95**

TV NOTCH FILTERS

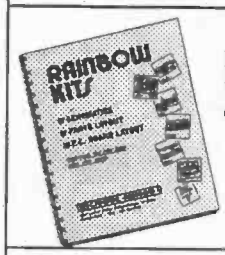
FOR CHANNELS 2 thru 22 ONLY



Our TV filters eliminate unwanted TV channels or interference that alters both sound and video with a beep beep beep. Works on cable channels 2 thru 22) only.

NOTE: All TV Filter Kits are sold for educational purposes only. You must obtain permission from your local cable company before using these filters on your cable system.

DF-222 KIT **$14.95**



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

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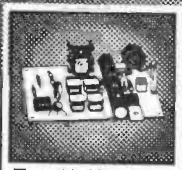
5K



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"

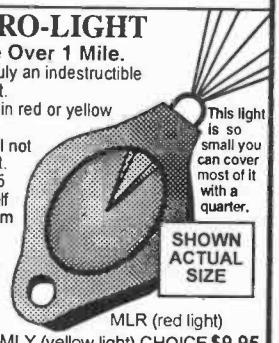
ST-1 KIT **$9.95**

MICRO-LIGHT

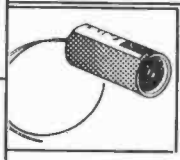
Visible Over 1 Mile.

This is truly an indestructible flash light.

- Comes in red or yellow light.
- Bulb will not burn out.
- Uses a 5 year shelf life lithium battery.
- Case made of tough ABS.



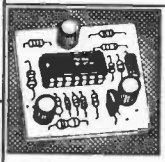
MLR (red light)
MLY (yellow light) CHOICE **$9.95**



4.0 mW Laser Diode

Great for making a gun sight, use as a transit, makes a super experimenters project. The beam is visible with a wavelength of 670 nm. Size of beam is 6mm at 5 meters. Power requirement 3 volts DC at 85mA. Size: 10.5mm x 18.5mm

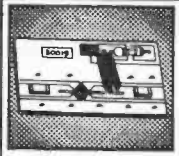
LDM-5 New Low Price **$59.95**



VOICE ACTIVATED SWITCH

This VOX circuit can be used to operate a tape recorder, ham radio, CB radio, or turn on an alarm. The VOX-1 kit has 100MA of output that operates a relay, light, motor, ? What could you do with a sound activated switch?Power requirement 7.5 TO 18vDC. SIZE: .1.5" x 1.3"

VOX-1 KIT **$6.95**



WIDE BAND PREAMP

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WBA-6 KIT **$19.95**

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3 fully regulated supplies; 1.5-15V @ 1A, -1.5 to -15V @ 1A or 3-30V @ 1A & 5V @ 3A **Kit XP-620K $49.95**

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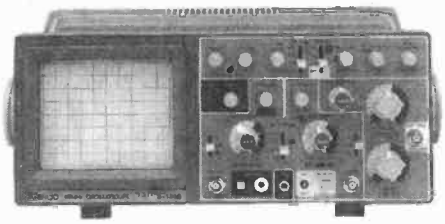


60MHz

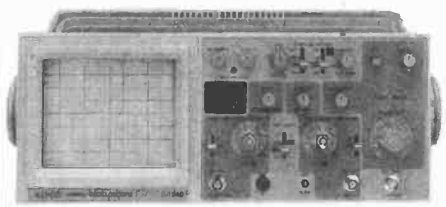
S-1360 $775

Delayed Sweep

S-1365 $849

Cursor Readout

- Voltage, Time
- Frequency differences displayed on CRT



40MHz

S-1340 $495

2- Channel

S-1345 $575

Delayed Sweep

- Beam Find
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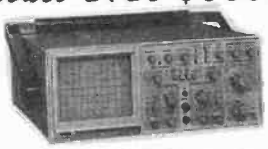
Model 2120 $389.00



Delayed Sweep

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- Video sync separators
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- Single sweep
- V mode-displays 2 signals unrelated in frequency

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- Sweep to 5ns/div
- Dual time base
- Signal delay line
- Component tester
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- Sweeps to 2ns/div
- Dual time base
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- 19kV accelaerating voltage
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- 2k memory per channel
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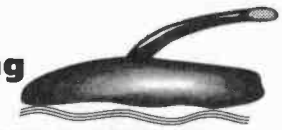
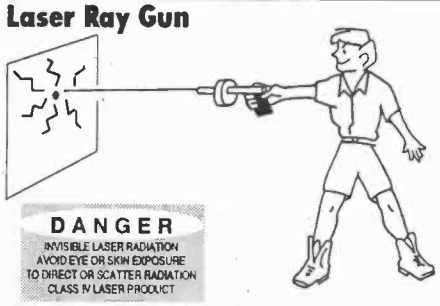


Remember War of the World? Objects float in air and move to the touch. Defies gravity, amazing gift, conversation piece, magic trick or great science project.

ANT1K Easy to Assemble Kit / Plans $19.50

Laser Ray Gun



Advanced project produces a burst of light energy capable of burning holes in most materials. Hand-held device uses rechargeable batteries. 500 joules of flash energy excite either a neodynium glass, yag or other suitable 3" laser rod. This is a dangerous CLASS IV project (individual parts/assemblies available). LAGUN1 Plans $20.00

LAGUN1K Kit / Plans ..... Price on Request

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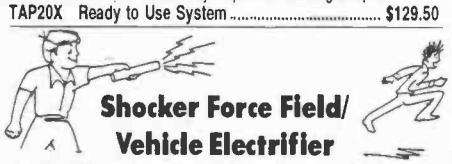
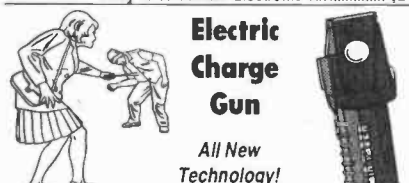


Neat little device allows you to make hand and shock balls, shock wands and electrify objects, charge capacitors. Great payback for those wise guys who have wronged you!

SHK1KM Easy to Assemble Electronic Kit $24.50

Electric Charge Gun



All New Technology!

Stuns/immobilizes attackers up to 15 feet away! •Legal in most state (not in NY, NJ, MA, WI) • More knock-down power than most handguns • No permanent injury • ID coded • Free 80KV stun gun with every purchase.

ECG1 Data Packet, Creditable toward purcase $10.00

ECG10 Charge Gun, Ready to Use, w/Free 80KV Gun $249.50

Homing / Tracking Transmitter

Beeper device, 3 mile range.

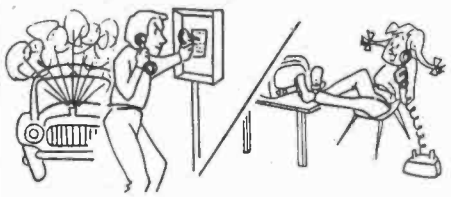
HOD1 Plans ..... $10.00 HOD1K Kit / Plans $49.50

Listen Through Walls, Floors

Highly sensitive stethoscope mike.

STETH1 Plans..... $8.00 STETH1K Kit/Plans $44.50

Infinity Transmitter ++



Telephone Line Grabber/ Room Monitor / Controller

All New - The Ultimate in Home/Office Security & Safety!

Simple to use! Call your home or office, push a secret tone on your telephone keypad to access: • On premises sounds and voices • Ongoing phone conversation w/break-in capability • Up to 10 external electrical functions, lights, TV, alarms, coffee pots, heater, etc. CAUTION! Check legality with your state's attorney general's office before use for monitoring of voices.

TELECOM2 Kit, includes PC Board $149.50

TELECOM2 Ready to Use $199.50

Visible Beam Laser

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 200,000 volts of crackling, sizzling plasma. Stuns and immobilizes most attackers

STUN40 Ready to Use $69.50

STUN10 Smaller Unit $39.00

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. IOG3 Plans $8.00

IOG3K Kit/Plans $69.50

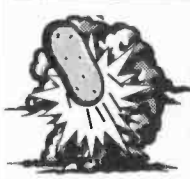
Invisible Pain Field Generator

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!

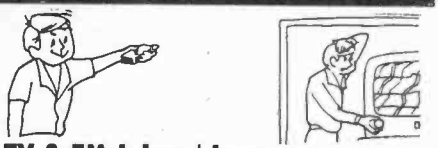
POT1 Plans..... (Dangerous Product)..... $10.00

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

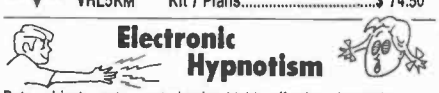
LWB30 Ready to Use, includes Laser Gun Sight $199.50

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

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

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

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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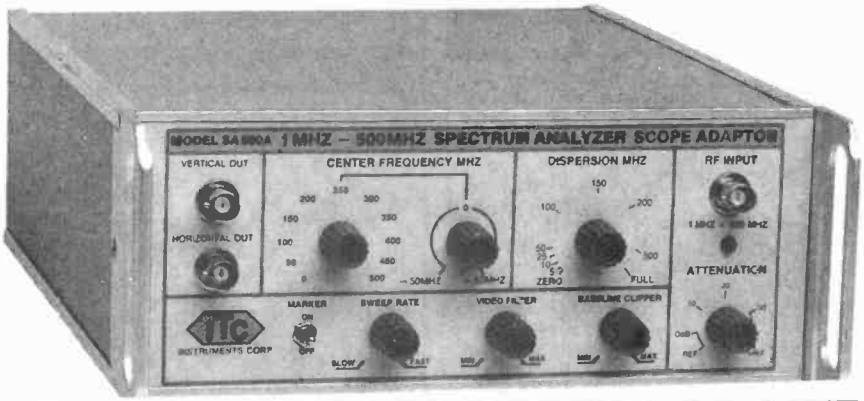
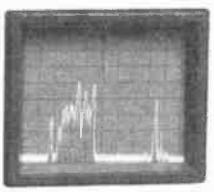
SPECTRUM ANALYZER SCOPE ADAPTER



1 MHz TO 500MHz SPECTRUM ANALYZER



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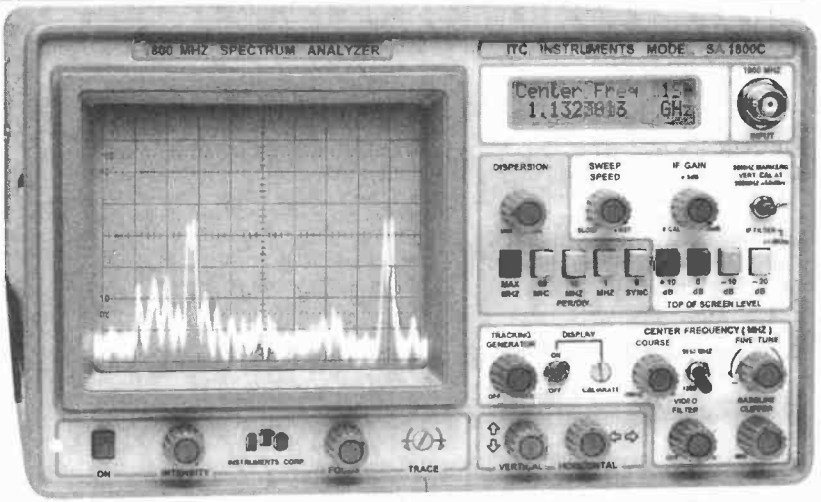

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MADE IN THE USA

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SA1800C Shown $2395.00

Model SA1300B **1-1300 MHz** ***In One Sweep*** **$1995.00** Options 1.3.5.6

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SA1800C 1-1300 & 850-1850MHz **$2395** With Opt. 1,3,5,6

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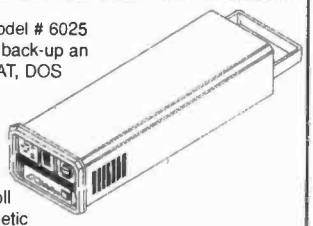
EXPERIMENTERS DELIGHT 20 MB TAPE BACK-UP SYSTEM



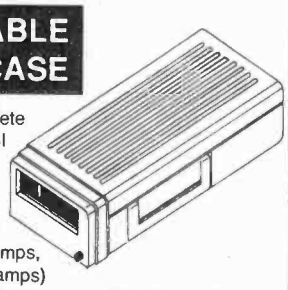
Interdyne Model # 6025 Designed to back-up an IBM PC/XT/AT, DOS 2.0 or later. These units were designed to do back-ups on a small roll of 1/4" magnetic tape. The units are 14.6" x 4.75" x 2.9" and weigh 10 lbs. The heavy-gauge metal chassis box contains a tape drive, power supply with fan and other components. Also includes IEC power cord, data cable and 2 rolls of back-up tape. Although these are new units, we do not wish to represent these as useable units.

CAT# TBS-2

We are selling them "AS-IS" for parts and experimentation.

$12.00 each

PORTABLE SCSI CASE



Nearly complete case for SCSI device. Includes 40 watt power supply (5 Vdc @ 3 amps, 12 Vdc @ 2 amps) with cooling fan, power switch, fuse holder, LED socket, power input receptacle, two standard 50 pin SCSI interface jacks, molex-type power connectors, interior cable with 50 pin socket connector and interior mounting rails. Front face plate is an aftermarket piece that doesn't quite go with the box but serves the purpose pretty well. Absent from the case is the switch in back which specifies the device's position in the chain. This can be easily bypassed with a few 0.1" shorting jumpers (our CAT# SJ-1). Also not included is a standard IEC power cord (our CAT# LCAC-60). Off-white case is 14.25" X 7.38" X 3.26" and has a folding handle for easy carrying.

$19.95 each

CAT# SCSI-1

2 for $36.00

FORCE SENSING RESISTANCE PAD

Interlink 7.5" x 11.5" x 0.03" thick plastic pad with two separate force sensing resistor circuits embedded in the pad. We have no factory specs or information on the intended application for the product. It was probably designed for some sort of touch sensitive apparatus. The resistance circuits read between 1.5 Meg and 0.5 Meg when nothing is touching the pad. The resistance decreases to as low as 1.5K ohms when pressure is applied to the pad and appears to be dependent upon force and the amount of surface area acted upon. An interesting device for experimentation.

CAT# FSR-1

$4.50 each

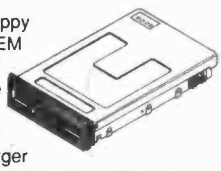
MERCURY TILT SWITCH

SPST mercury tilt switch. Glass bulb is 0.25 "dia. X 0.67" long. Circuit is closed in vertical position. Rated 750 ma.

CAT# MS-15

$1.00 each

720K 3.5" INTERNAL FLOPPY DRIVE



Sony # MP-F11W-2Z Brand new 720 KB floppy drives. Built for an OEM product, these are, in every way, compatible with PC/XT/AT computers except that the faceplate is slightly larger than those on exact replacements. The faceplate size on these is 4.04" X 1.23". (Normal size is 4" X 1"). The faceplate is removable and can be trimmed if desired. In some cases it may work without trimming. Also, we have found that, when used in 5.25" bays with the adapter kit below, the adapter can easily be modified to accommodate the unit. Because of this slight inconvenience, we are selling these drives at an incredibly low price.

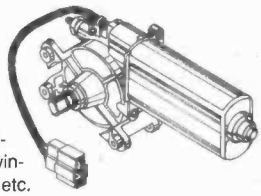
$14.00 each

10 for $120.00

CAT# MPF-11SF

INSTALLATION KIT for MPF-11SF allows for installation into 5.25" drive bays. Simply cut and remove three plastic gussets to

12 Vdc GEAR MOTOR

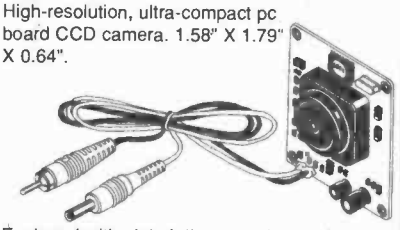


ASMO brand 12 Vdc, reversible gear-head motor. Right-angle motor for automotive applications, power windows, sun-roofs etc. Great for robotics, winches and other hi-torque applications. 175 RPM @ 12 Vdc, 1.5 amps (no load). Works well from 6 to 24 Vdc. 10mm diameter X 15mm long dual flatted threaded shaft (thread pitch 1mm). Overall dimensions: 6.5" long X 2.75" X 3.5". 7" wire leads with molex-type connector.

CAT# DCM-61

$17.50 each

MINIATURE BLACK AND WHITE CAMERAS



High-resolution, ultra-compact pc board CCD camera. 1.58" X 1.79" X 0.64". Equipped with pinhole lens which can view objects from 2" to infinity in extremely low light (.5 Lux @ F 1.6). Infrared sensitive - works in total darkness with an infrared light source. Auto-iris for automatic light compensation. 18" shielded cable with RCA plug for video output. 20" cable with co-ax DC power plug (2.1mm center positive) 12vdc @ 150 ma. operation.

CAT# VC-200P

$159.00 each

B/W CAMERA with AUDIO

Above camera with electret mike, audio board and 20" audio output cable with RCA plug. Same dimensions as above, but audio board adds 0.2" thickness to the assembly.

CAT# VC-200PA

$169.00 each

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	HR250	$CALL*
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	HH70	$109.95
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- Here is what you need to start truly enjoying your scanner hobby; (1) Scout 40 (2) Scanner AR2700 or AR8000 (3) EEB modification to scanner including interconnect cable (CB-RT)

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Scout 40, EEB mod w/cable and AR2700 ($839.95) or AR8000 ($1039). One year warranty on system included. Optional extended 3 year total system warranty $79.95

!!REMEMBER!!

The AR8000 is the only portable on today's market that has true USB/LSB/SSB with 50 Hz steps. Listen to easy to tune true SSB.

AR2700 & AR8000 are cellular block per FCC. Unblocked units available to qualified users.

• AR2700	list $499.95	EEB $399.95
• AR8000	list $799.95	EEB $599.95
• Mods & system check		EEB $50
• Cable CB-RT		EEB $20
• Scout 40	list $449.95	EEB $399.95

CYBER SCAN AOR AR5000

NEW AR5000 AOR

The new AOR AR5000 is on it's way. At this writing (mid Sept) details are sketchy. *Internet* is buzzing and here are some of the tentative specs.

•10KHz-2600 MHz •1000 memories •All mode AM/FMN/ FMW/LSB/USB/CW •IF band width 3 to 200KHz (7 filters) •12VDC computer control 10.7 MHz IF output

Watch our next ad for more detailed information

Price in the $2000 class

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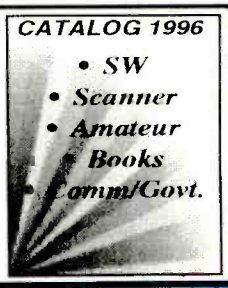
All new expanded 1996 catalog. Hundreds of new items, you should have a copy by now...if not...get one!



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DMM 20 $74.95

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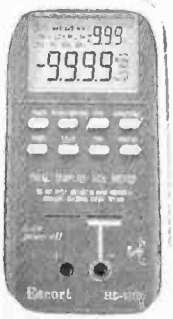
Fluke 87	$287
Fluke 97 Scope Meter	$1785



LCR Meter 131D $229.95

Most Advanced LCR

Dual display:L/Q or C/D
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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

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Inductance: 0.1µH-200H
Capacitance: 0.1pF-20,000µF
Resistance: 1mΩ-20MΩ
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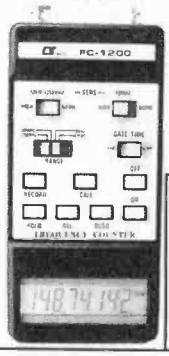

Frequency Counter FC-1200 $129.95

Frequency:0.1Hz-1.25GHz
Display: 8 digit LCD
Period: 0.1µs-0.1s
Records Max/Min/Average
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Deluxe case $5.00

Also Available:
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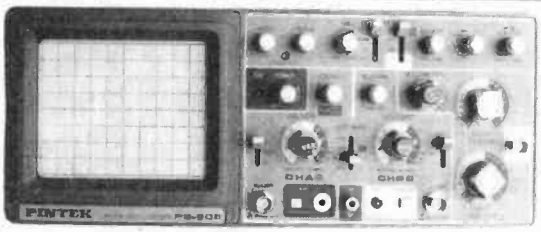

20 MHz Oscilloscope with Delay Sweep PS-205 $429.95

Dual Trace, Component test, 6" CRT, X-Y Operation, TV Sync, Z-Modulation, CH2 Output, Gratlcule 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

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DS-203 20MHz, 10M Sample/sec $729.95
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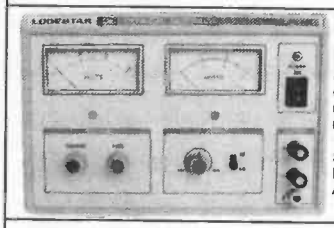

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0.02% + 3mV load regulation
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PS-8200 with digital voltmeter $179.00
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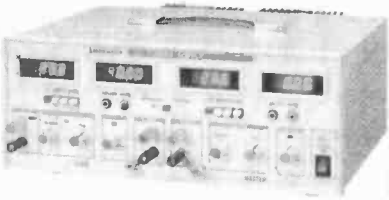

DC Power Supply Triple Output PS-8202 $499.95

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One fixed 5VDC, 3A output
Capable of independent or tracking operation
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Short circuit and overload protected
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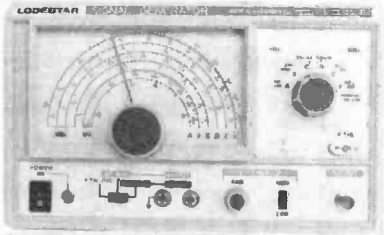
Dual tracking 30V/3A, 30V/5A, 60V/3A, 60V/5A



RF SIGNAL GENERATOR SG-4160B $119.00

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RF Output 100mVrms to 35 MHz
Internal 1kHz, External 50Hz-20kHz AM modulation
Audio output 1 kHz, 1 Vrms

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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 $119.00

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

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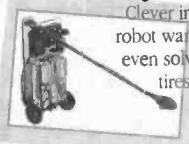

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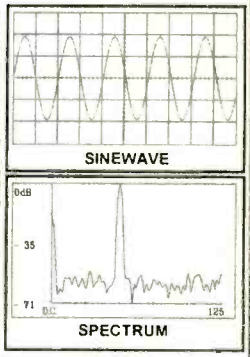

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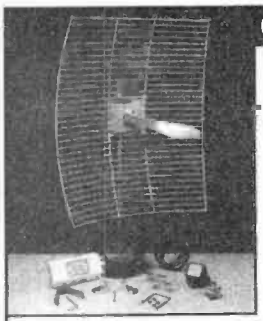

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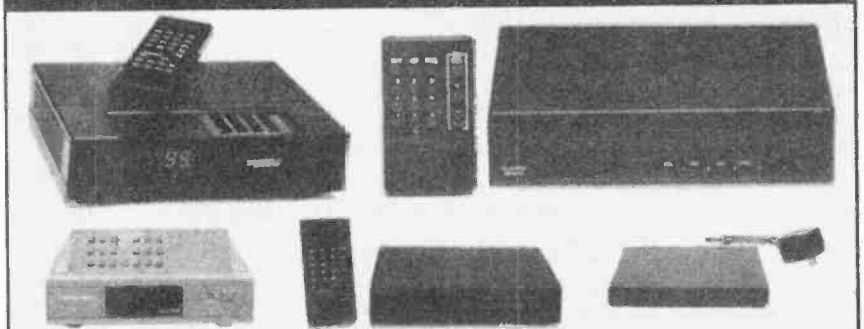

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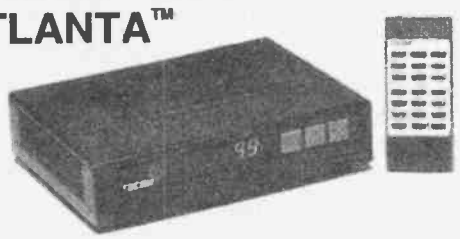

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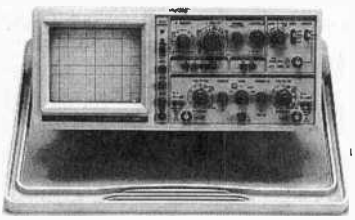

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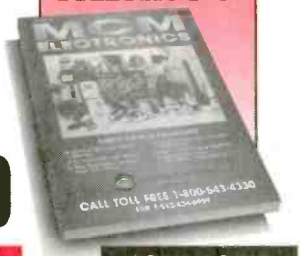

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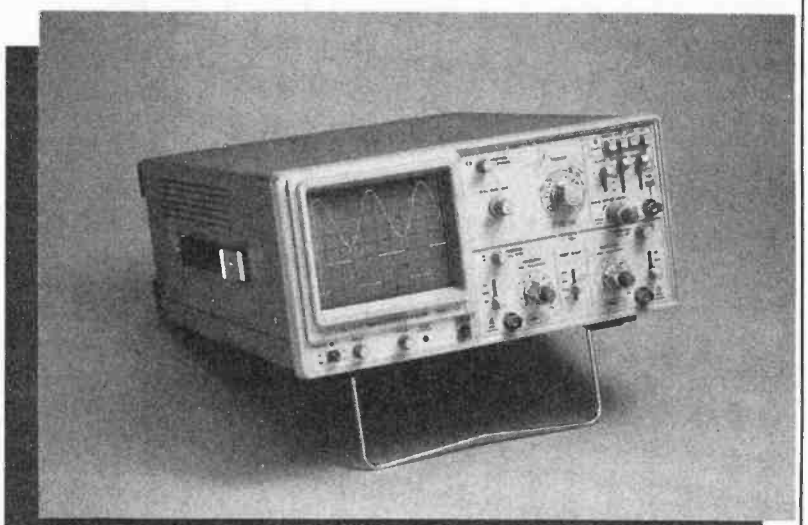

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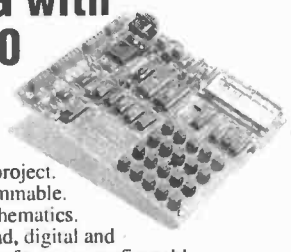

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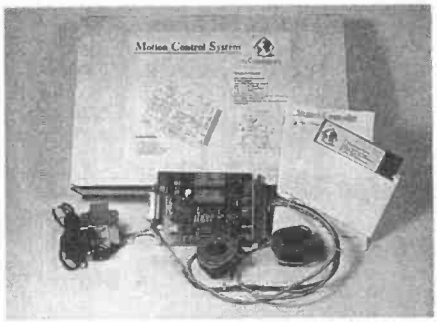

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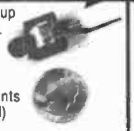

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- Works with any FM broadcast receiver.

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CSD 9225-12	8.95	6.14	5.29	4.59
CSD 1225-12	11.45	8.96	7.82	6.85

Specifications

CAT NO	DIMENSIONS (MM)	RATED VOLTAGE (V)	START VOLTAGE (V)	INPUT CURRENT (A)	AIR FLOW (CFM)	STATIC PRESSURE (INCH-H_2O)	SPEED (RPM)	NOISE LEVEL (dB)	WEIGHT (g)
CSD 4010-12	40x40x10mm	12	7	0.06	5.1	0.19	5,500	26	20
CSD 6025-12	60x60x25mm	12	5	0.13	13.7	0.165	4,500	28	65
CSD 8025-12	80x80x25mm	12	5	0.16	37.8	0.177	3,000	31	80
CSD 9225-12	92x92x25mm	12	5	0.32	42	0.18	2,800	37	95
CSD 1225-12	120x120x25mm	12	5	0.35	62	0.180	2,500	42	135

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Weight: 370±10gm (0.82lb.)
Frame/Housing: Aluminum
Impeller: Glass reinforced thermoplastic UL94V-O
Bearing Type: Ball Bearing
Dielectric Strength: 1 minute at 1,500VAC/50-60Hz
Operating Temp: -20°~+85°C
Life Expectancy: 50,000 Hrs (at 25°C, 65%RH)
Motor Protection: Impedance Protected
Safety Approvals: Meets UL, CSA, VDE Standards

CAT NO	PRICE EACH 1	10	25	100
CSA8038AC	$15.26	$12.92	$10.98	$9.73

Size: 120 x 120 x 25.5mm (4.71 x 4.71 x 1.00")
Weight: 390±10gm (0.86lb.)
Frame/Housing: Aluminum
Impeller: Glass reinforced thermoplastic UL94V-O
Bearing Type: Ball Bearing
Dielectric Strength: 1 minute at 1,500VAC/50-60Hz
Operating Temp: -20°~+85°C
Life Expectancy: 50,000 Hrs (at 25°C, 65%RH)
Motor Protection: Impedance protected
Safety Approvals: Meets UL, CSA, VDE Standards

CAT NO	PRICE EACH 1	10	25	100
CSA1225AC	$15.28	$12.94	$11.01	$9.88

Specifications

CAT NO	DIMENSIONS (MM)	NOMINAL VOLTAGE (V)	FREQUENCY (HZ)	SPEED (RPM)	INPUT POWER (W)	AIR FLOW (M3/MIN)	STATIC PRESSURE (MM)	NOISE LEVEL (dB)
CSA8038AC	80x80x38.5	110/120	50/60	2300/2600	9/7	0.63/0.72	3.5/4.5	31/34
CSA1225AC	120x120x25.5	110/120	50/60	2000/2300	12/10	1.56/1.70	4.6/4.8	23/36

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CAT NO	DESCRIPTION	PRICE EACH 1	10	25	50
GRM 60	Plastic Fan Filter Kit for 60mm Fans	$1.76	$1.42	$1.20	$ .98
GRM 80	Plastic Fan Filter Kit for 80mm Fans	2.20	1.75	1.48	1.28
GRM 92	Plastic Fan Filter Kit for 92mm Fans	2.60	2.05	1.74	1.40
GRM 120	Plastic Fan Filter Kit for 120mm Fans	2.92	2.19	1.84	1.56

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2' Length, SPT-1, AWG18 x 2C, UL/CSA

CAT NO	DESCRIPTION	PRICE EACH 1	10	25	50
C180	Fan Power Cord	$1.28	$1.14	$ .94	$ .78

Metal Fan Filter Assemblies

For use with tubeaxial fans. These wire formed fan guards provide extra safety.

CAT NO	DESCRIPTION	PRICE EACH 1	10	25	50
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FG60-4	Wire Formed Fan Guard for 60mm Fans	1.92	1.44	1.19	.96
FG80-5	Wire Formed Fan Guard for 80mm Fans	2.00	1.50	1.24	.99
FG92-5	Wire Formed Fan Guard for 92mm Fans	2.28	1.71	1.39	1.14
FG120-15A	Wire Formed Fan Guard for 120mm Fans	2.52	1.89	1.57	1.26

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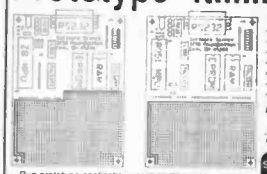

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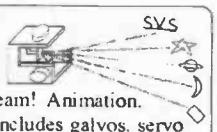

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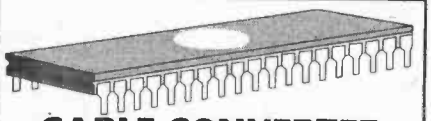

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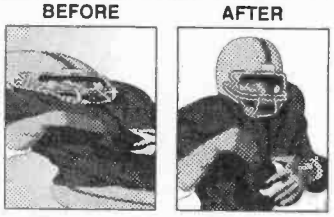

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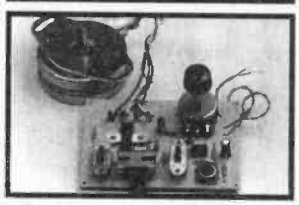

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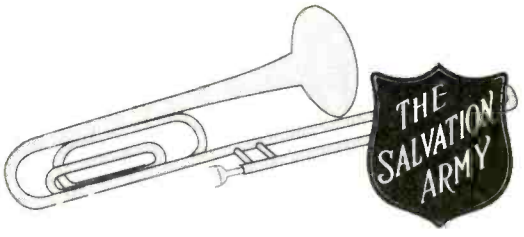

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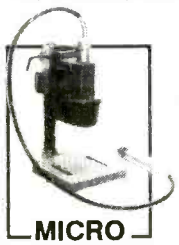

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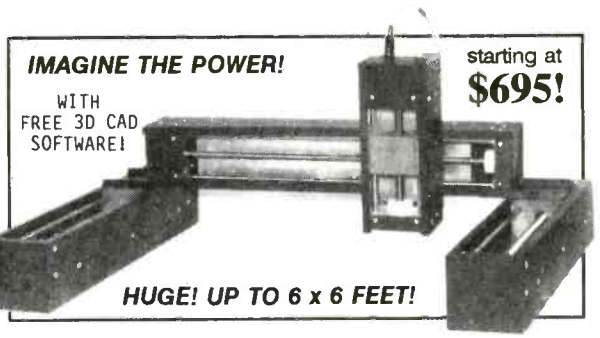

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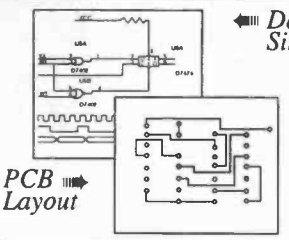

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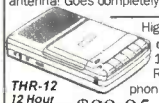

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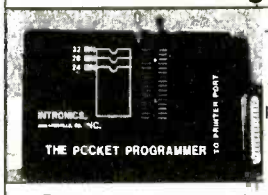

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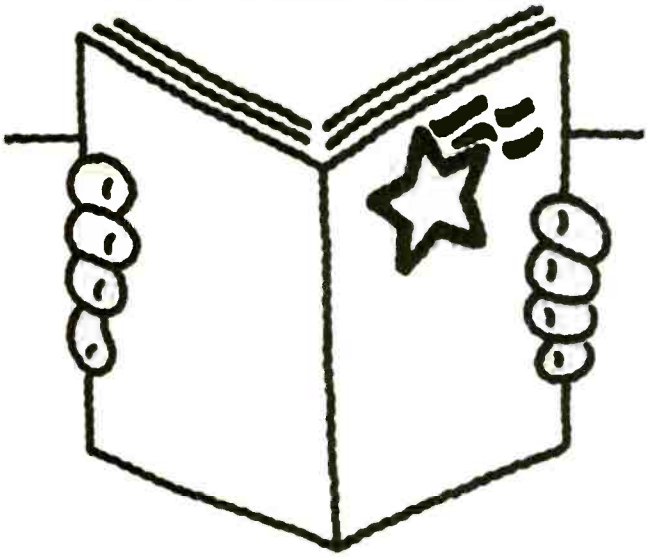

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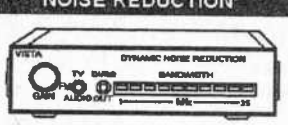

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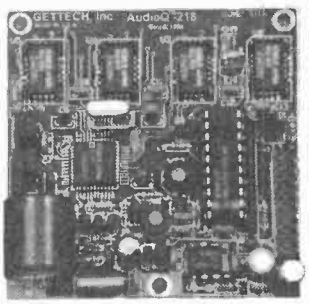

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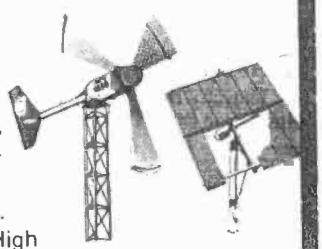

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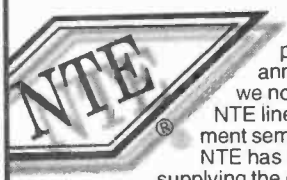

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AmericanRadioHistory.Com

New breakthrough clones TV signals and sends them to any other TV in your home

Recoton's new development duplicates cable, TV, VCR and satellite signals and transmits them...without any wires!

by Charles Anton

Today, television choices are virtually unlimited. Between cable, satellite TV, videos and network programming, it's almost a full-time job trying to keep up with all the alternatives. And it promises to get more complicated in the future. Breakthroughs in fiber optic technology will bring over 500 channels into your home.

Home broadcasting breakthrough. The problem with all this technology is the expense required to maintain your system and keep it up-to-date. Now, a wireless video broadcasting system from Recoton gives you the power to utilize this technology without the hassle and expense of re-wiring your entire home.

Today, Recoton introduces the next generation in wireless broadcasting. The wireless video broadcaster transmits (re-broadcasts) cable, TV, VCR or satellite programs to any other TV in your home...wirelessly!

Wave of the future. Never drag your VCR from room to room again: Recoton's wireless video broadcasting system transmits video or TV signals to any other TV in your home.

Because the system is totally wireless, you won't have to worry about running miles of wires. Besides, who wants to install cable in every room of their home? With Recoton's wireless video broadcasting system, you won't have to. You can even watch one program on your main TV while someone else watches something different on another TV. It's just like having a personal broadcasting system in your home—and it's legal in every state.

Hi-tech home broadcast. Recently, the *Federal Communications Commission* allocated a band of radio frequencies specifically for wireless, in-home product applications. Recoton took advantage of the FCC ruling by creating and introducing wireless equipment that can transmit within the prescribed frequency over distances of up to 150 feet.

Wireless Video Breakthrough...

Cable *Broadcast cable channels, even premium channels, to other TVs in your home that are not wired for cable.*

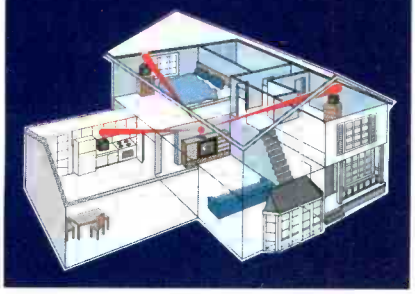
Videos *Transmit signals from one VCR to any room, even if someone is watching TV in the room that the VCR is in.*

Satellite programs *Watch satellite programs throughout your home without stringing miles of cable everywhere.*

Live video *View home videos as you film them or turn your camcorder into a security camera.*

Network programs *If the main TV is hooked up to an antenna, you can broadcast its clear signal to all the others.*

Recoton's video broadcasting system clones the accessories (cable, satellite, VCR, etc.) of one TV and broadcasts it to any other TV in your home...without wires!



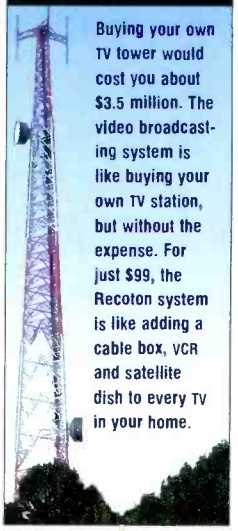
One transmitter, unlimited receivers. One transmitter will operate an unlimited number of receivers. This means that a transmitter in the den can send signals to a TV in the living room, kitchen, bedroom and anywhere else you may have a TV. Recoton puts your favorite programs where you want them most.

Unlimited choices. Since the broadcasting system uses the latest in 900 MHz frequency signals, there is no time-consuming or complicated wiring. The receiver can be easily moved from one television to another.

The transmitter will also broadcast to multiple receivers, so you can watch the same program on multiple TVs simultaneously. The transmitter connects to the source TV; the receivers simply connect to the others.

Exclusive factory-direct offer. With this breakthrough in home video broadcasting technology, you can have the convenience of your own personal wireless broadcasting system for a fraction of the cost of owning your own TV station. For a limited time only, we are offering Recoton's wireless video broadcasting system (one transmitter and one receiver) for the low price of $99. You can order additional receivers for other TVs for just $59 each.

ADD A TV TOWER?



Buying your own TV tower would cost you about $3.5 million. The video broadcasting system is like buying your own TV station, but without the expense. For just $99, the Recoton system is like adding a cable box, VCR and satellite dish to every TV in your home.

Risk-free offer. The wireless video broadcasting system by Recoton is backed by Comtrad's exclusive risk-free home trial. Try it, and if you are not completely satisfied, simply return it within 30 days for a full "No Questions Asked" refund. It also comes with a 90-day manufacturer's limited warranty. Most orders are processed within 72 hours and shipped UPS.

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