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ham radio magazine

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Proven, Reliable HF Compact Transceiver

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BUILT-IN RECEIVE PREAMP

ONE MEMORY PER BAND

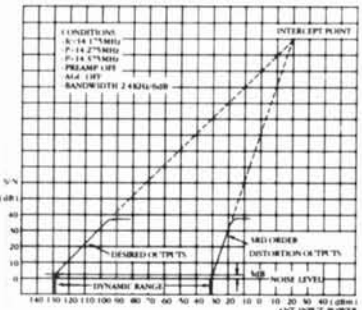
DUAL VFOs

TUNING KNOB LOCK

LARGE RIT TUNING KNOB

ICOM's IC-730 go-anywhere HF all-band SSB/CW/AM transceiver, the best value on the market, has a proven record of high performance, ease of operation and durability. Compact in size, yet full-featured, the IC-730 has gained an uncomparable reputation.

Receiver Performance. Utilizing ICOM's DFM (Direct Feed Mixer), the IC-730 obtains a dynamic range of 100dB and an intercept point of 19.5dBm.



Superior front-end receiver performance, coupled with a switchable preamplifier and IF shift or passband tuning (optional), gives the IC-730 receiver flexibility yet allows it to be easy to operate.

Compact. The IC-730 is sized to be used mobile — either in a car, airplane or boat — to be carried in a suitcase, or to be used as a base station. Only 3.7 inches high by 9.5 inches wide by 10.8 inches deep, the IC-730 is a very compact package. Still the IC-730 sports a large tuning knob, large RIT knob, and large bandswitching knob to make mobile operation easy. The RIT control is conveniently located in the lower right corner to make access by touch easy while operating the unit mobile.

Convenience Features. The IC-730 has important features that make the unit easy to operate in a mobile environment. Two VFOs are easily accessed at the push of a button. Normal or split operation and three separate tuning rates for fast QSY or slow tuning are available. The dial lock deactivates the main tuning knob for rock-solid stability without the possibility of moving off frequency. One memory per band is provided to allow storage of net frequencies or favorite frequencies at the push of a button.

Full-Featured. The IC-730 has additional features which make it a joy to operate. A full 200W PEP input transmitter provides a powerful signal on SSB and CW (40W carrier power on AM). Eighty through 10-meter coverage is provided including the bands at 10, 18, and 24MHz. A speech processor is included as standard. Popular features such as digital readout, selectable AGC, VOX, SWR meter and noise blanker are also included as standard in the IC-730.

Complete. The IC-730 comes complete with a handheld microphone and power cord. The IC-730 is ready to use and ready to go when you are.

Affordable. Dollar-for-dollar, the ICOM 730 packs more punch and performance into a small package than ever thought possible.

Listen to IC-730s on the air and hear the sound of ICOM quality. The IC-730 is your best buy for a second rig for mobile portable operation or for your main HF station. See the IC-730 at your local ham equipment supplier today!

✓ 152

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The World System

ICOM America, Inc., 2112-116th Ave NE, Bellevue, WA 98004 **(206)454-8155** / 3331 Towerwood Drive, Suite 307, Dallas, TX 75234 **(214)620-2780**

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Autorange	Audible continuity	Audible continuity
0.7% basic dc accuracy	Autorange/range hold	"Touch Hold" function
2000+ hour battery life	0.5% basic dc accuracy	Autorange/range hold
3-year warranty	2000+ hour battery life	0.3% basic dc accuracy
	3-year warranty	2000+ hour battery life
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		Multipurpose holster

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TR-2500

BIG performance, small size, smaller price!

The TR-2500 is a compact 2 meter FM handheld transceiver with every conceivable operating feature.

TR-2500 FEATURES:

- Weighs 540 g. (1.2 lbs). 66 (2-5/8) W x 168 (6-5/8) H x 40 (1-5/8) D, mm (inches).
- LCD digital frequency readout.
- Ten memories includes "MO" for non-standard split repeaters.
- Lithium battery memory back-up, built-in, (est. 5 year life).
- Memory scan.
- Programmable automatic band scan, and upper/lower scan limits; 5-kHz steps or larger.
- Repeater reverse operation.
- 2.5 W or 300 mW RF output. (HI/LOW power switch).
- Built-in tunable (with variable resistor) sub-tone encoder.
- Built-in 16-key autopatch encoder.
- Slide-lock battery pack.
- Keyboard frequency selection.
- Covers 143.900 to 148.995 MHz.

CONVENIENT TOP CONTROLS

- Optional MS-1 mobile or ST-2 AC charger/supply for operation while charging.
- Battery status indicator.
- Complete with flexible antenna, 400 mAH Ni-Cd battery, and AC charger.

Optional accessories:

- ST-2 Base station power supply/ charger (approx. 1 hr.)
- MS-1 13.8 VDC mobile stand/ charger/power supply.
- VB-2530 2-M 25 W RF power amps., (TR-2500 only).
- TU-1 Programmable CTCSS encoder (TR-2500 only).
- TU-35B Programmable CTCSS encoder (mounts inside TR-3500 only).
- PB-25H Heavy-duty 490 mAH Ni-Cd battery pack.
- DC-25 13.8 VDC adapter.
- BT-1 Battery case for AA manganese/alkaline cells.
- SMC-25 Speaker microphone.
- LH-2 Deluxe leather case.

TR-3500

70 CM FM Handheld

- Covers 440-449.995 MHz in 5-kHz steps.
- Hi-1.5 W, Low-300 mW.
- TX OFFSET switch, ±5 kHz tc ±9.995 MHz programmable.
- Auto/manual squelch control.
- Tone switch for opt. TU-35B
- Other outstanding features similar to TR-2500.

- BH-2A Belt hook.
- RA-3 2 m 3/8 λ telescoping antenna (for TR-2500).
- WS-1 Wrist strap.
- EP-1 Earphone.

TR-7950/7930

Big LCD, Big 45 W, Big 21 memories, Compact.

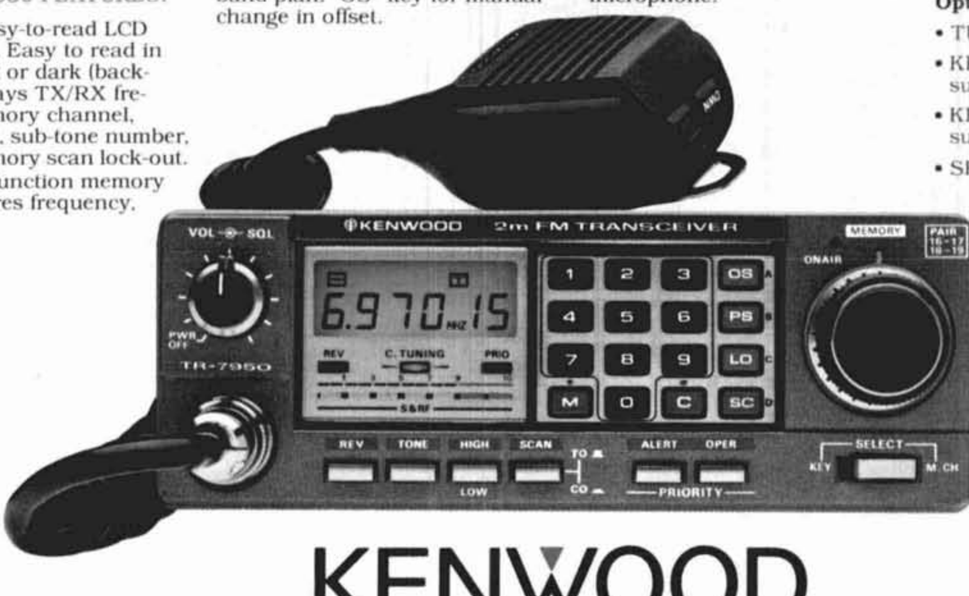
Outstanding features providing maximum ease of operation include a large, easy-to-read LCD display, 21 multi-function memories, a choice of 45 watts (TR-7950) or 25 watts (TR-7930), and the use of microprocessor technology throughout.

TR-7950/TR-7930 FEATURES:

- New, large, easy-to-read LCD digital display. Easy to read in direct sunlight or dark (back-lighted). Displays TX/RX frequencies, memory channel, repeater offset, sub-tone number, scan, and memory scan lock-out.
- 21 new multi-function memory channels. Stores frequency, repeater offset, and optional sub-tone channels. Memory pairs for non-standard splits. "A" and "B" set band scan limits. Lighted memory selector knob. Audible "beep" indicates channel 1 position.
- Lithium battery memory back-up. (Est. 5 yr. life.)
- 45 watts or 25 watts output. HI/LOW power switch for reduction to 5 watts.
- Automatic offset. Pre-programmed for simplex or ±600 kHz offset, in accordance with the 2 meter band plan. "OS" key for manual change in offset.
- Programmable priority alert. May be programmed in any memory.
- Programmable memory scan lock-out. Skips selected memory channels during scan.
- Programmable band scan width.
- Center stop circuit for band scan, with indicator.
- Scan resume selectable. Selectable automatic time resume-scan, or carrier operated resume-scan.
- Scan start/stop from up/down microphone.
- Programmable three sub-tone channels with optional TU-79 unit (encoder).
- Built-in 16-key autopatch encod with monitor (Audible tones).
- Front panel keyboard control.
- Covers 142.000-148.995 MHz ir 5-kHz steps.
- Repeater reverse switch. (Locking)
- "Beeper" amplified through speaker.
- Compact lightweight design.

Optional accessories:

- TU-79 three frequency tone uni
- KPS-12 fixed-station power supply for TR-7950.
- KPS-7A fixed-station power supply for TR-7930.
- SP-40 compact mobile speaker.



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REFLECTIONS

Meeting the Challenge of Volunteer Testing

The VEC program is now a reality – or it will be by the time this issue arrives in your mailbox. While it's not yet in place everywhere, proposals for volunteer exam programs have already been submitted to the FCC for at least three of the thirteen areas identified as the responsibility of a specific regional volunteer examiner coordinator (see *Presstop*, page 8). In addition, proposals for several other areas are expected in Washington very soon. Indeed, it appears likely that much of the country will again be enjoying regular and frequent opportunities for Amateur license exams before spring is very far along.

This is good news, because access to the examination process is essential to the survival of Amateur Radio. As of January 1, 1984, even major FCC field offices that had offered weekly examinations to walk-in applicants were cut back to only four one-week examination periods a year, with tests now scheduled by appointment only. Would-be Amateurs and those anxious to upgrade who live near the smaller FCC offices have even less opportunity.

Before January 1, Amateurs were taking exams at a rate of about 2000 a month. And even though a significant number of these were Novices (who were already being tested by Amateur volunteers), the fact remains that trying to cram all the rest of the applicants into a drastically reduced FCC-administered program would inevitably result in chaos. That's why it's so encouraging to find the Amateur community eager and – at least in some places – ready to take up the challenge of volunteer examination. All that's needed now is someone to accept that challenge in those areas as yet unclaimed.

What does it take to get a functioning VEC going in your area? Must a VEC be a part of a large, national organization with a full-time staff devoted only to Amateur Radio? *No.* Let's take a look at who has already seized the opportunity or who seems to be moving rapidly in that direction. One is a large but regional radio club (Alaska); another, a major repeater group (New York/New Jersey). There's a MARS organization taking responsibility for testing in the Virgin Islands and Puerto Rico; a local radio club that also sponsors the world's largest hamfest (8th call area); and an educational institution (9th call area). A diverse group, you'll notice, with one thing in common: a membership composed of dedicated, concerned Amateurs who saw the need and made the substantial effort necessary to get their organization involved!

Your area has many potential VECs. You can start with a strong local radio club, hamfest sponsor, or repeater group – or better yet, a regional Amateur organization such as a state or area repeater or radio club council. You might even seek support from outside Amateur Radio, from a school or business that has enough Amateurs to sponsor its own Amateur Radio club. Their corporate interest can be easily justified, since the VEC will perform a valuable public service, one that will earn the recognition and appreciation of the Amateur community and – if the Grenada experience is fresh in the public mind – of the larger community as well.

Once you've found your potential VEC, the first thing you'll need to do is get a copy of the FCC's Report and Order on PR Docket 83-27. It can be found in Volume 48, No. 195 – October 6, 1983 – of the Federal Register, available at many libraries and law offices; we'll also send you a copy for an SASE. (Enclose 71¢ postage.) Study it thoroughly, so you'll know precisely what responsibilities you're getting your group or organization into. If you're asking a school or corporation to become a VEC through its radio club, prepare a pursuasive sales pitch on the potential benefits of the program: public service, goodwill of present and future students, employees, neighbors, etc. Don't forget to tell them that their out-of-pocket expenses are (or soon will be) reimbursable up to $4 per exam; make it clear that you're asking for support, not charity.

After you've reached agreement with your future VEC, all that's left is making your VEC proposal to the FCC. Here's where careful study of that FCC Report and Order will pay off. If you've done your homework, you won't weaken your proposal by asking to do something the FCC has specifically forbidden. If you're really smart, you won't propose doing *anything* more than you need to do. Why? Because proposing more than delivery of the service required may lock you into something that may turn out to be impractical, unnecesssary, or simply more than your group can handle efficiently. The FCC knows that. All they really want from you is a reasonable, well-developed and clearly thought out proposal from a competent, qualified organization. Give them that, and you'll get the job!

The volunteer examination program may be the biggest and most important administrative challenge that Amateur Radio has ever faced. Let's show the FCC that its faith in Amateur Radio is well placed!

Joe Schroeder, W9JUV
Associate Editor

As a service to readers, *ham radio* will publish a continuously updated monthly listing of all VECs. We'll need your cooperation to do this; if you are affiliated with a group that has received VEC status, or is seeking approval as a VEC, please let us know.

Rich Rosen, K2RR
Editor-in-Chief

MFJ RTTY / ASCII / AMTOR / CW COMPUTER INTERFACES

RTTY/ACSII/AMTOR/CW INTERFACE CARTRIDGE FOR VIC-20/C-64

NEW

MFJ-1228
$ 69 95

Most versatile RTTY/ ASCII/AMTOR/CW Interface cartridge available for VIC-20 and Commodore 64. Gives you more features, more performance, more value for your money than any other interface cartridge available.

Same interface cartridge works for both VIC-20 and Commodore 64. Plugs into user's port.

Choose from wide variety of RTTY/ASCII/CW, even AMTOR software. You are not married to one on-board software package. Use MFJ, Kantronics, AEA plus most other software cartridge, tape or disk.

850 Hz and 170 Hz shifts on receive **and** transmit.

Has mark and space outputs for scope tuning.

Normal/Reverse switch eliminates retuning.

True dual channel mark and space active filters and automatic threshold correction gives good copy when one tone is obliterated by QRM or selective fading.

Easy, positive tuning with twin LED indicators.

Narrow 800 Hz active CW filter. Automatic PTT.

Exar 2206 sine generator for AFSK output.

Shielded XCVR AFSK/PTT interface cable provided. Plus or minus CW keyed output. FSK out.

Powered by computer (few mA.), no power adapter to buy or extra wire to dangle or pick up/radiate RFI.

Glass epoxy PCB. Aluminum enclosure. 4½x4½x1".

MFJ INTERFACE plus MFJ SOFTWARE CARTRIDGE

for VIC-20 or Commodore 64. MFJ-1228 PLUS MFJ-1250 or MFJ-1251 for one low price

$ 99 95 Save $20.00

SOFTWARE CARTRIDGE FOR VIC-20/C-64

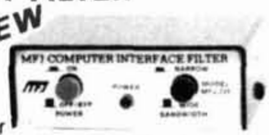
MFJ-1250/MFJ-1251
$ 49 95

Powerful MFJ software cartridge for VIC-20 (MFJ-1250, $49.95) and Commodore 64 (MFJ-1251, $49.95). Plugs into expansion port. Developed by MFJ.

Features RTTY/ASCII/CW send and receive, split screen display, type ahead buffer, message ports, status display, automatic CW speed tracking, parallel printer compatibility plus much more.

SUPER RTTY FILTER

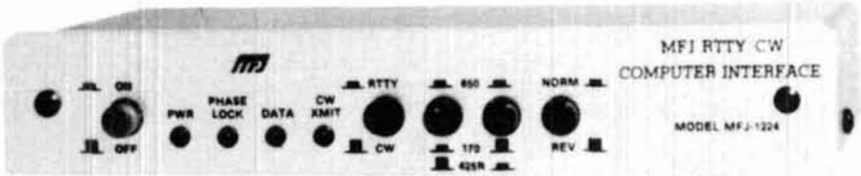
MFJ-725
$ 39 95 NEW



Super RTTY filter greatly improves copy under crowded, fading and weak signal conditions. Improves **any** RTTY receiving system. 8 pole bandpass active filter for 170 Hz shift (2125/2295 Hz mark/space). 200 or 400 Hz bandwidths. Automatic noise limiter. Audio in, speaker out jacks. On/off/bypass switch. "ON" LED. 12 VDC or 110 VAC with optional AC adapter, MFJ-1312, $9.95. 3x4x1 inch aluminum cabinet.

GENERAL PURPOSE RTTY/ASCII/AMTOR/CW COMPUTER INTERFACE

Lets you send and receive computerized RTTY/ASCII/AMTOR/CW. Copies all shifts and all speeds. Copies on both mark and space. Sharp 8 pole active filter for 170 Hz shift and CW. Plugs between your rig and VIC-20, Apple, TRS-80C, Atari, TI-99, Commodore 64 or most other personal computers. Uses MFJ, Kantronics software and most other RTTY/CW software.



MFJ Software plus MFJ Interface for VIC-20/C-64

Software cartridge alone, $49.95. Order MFJ-1250/MFJ-1224 for VIC-20, MFJ-1251/MFJ-1224 for Commodore 64. Includes cable to interface MFJ-1224 to VIC-20 or C-64. **$ 129 95**

MFJ-1224
$ 99 95

New MFJ-1224 RTTY/ASCII/AMTOR/CW Computer Interface lets you use your personal computer as a computerized full featured RTTY/ASCII/AMTOR/CW station for sending and receiving. Plugs between rig and VIC-20, Apple, TRS-80C, Atari, TI-99, Commodore 64 and most others.

Use MFJ (see MFJ-1250/1251 below) software for VIC-20, Commodore 64 and Kantronics for Apple, TRS-80C, Atari, TI-99 and most other software for RTTY/ASCII/AMTOR/CW.

Easy, positive tuning with twin LED indicators.

Copy any shift (170,425,850 Hz and all other shifts) and any speed (5-100 WPM RTTY/CW and up to 300 baud ASCII).

Copies on both mark and space, not mark only or space only, to improve copy under adverse conditions.

Sharp 8 pole 170 Hz shift/CW active filter gives good copy under crowded, fading and weak signal conditions. Automatic noise limiter suppress static crashes for better copy.

Normal/Reverse switch eliminates retuning. +250 VDC loop output drives RTTY machine. Speaker jack.

Automatic tracking copies drifting signal.

Exar 2206 sine generator gives phase continuous AFSK tones. Standard 2125 Hz mark and 2295/2975 Hz space. Microphone line: AFSK out, AFSK ground, PTT out and PTT ground.

FSK keying output. Plus and minus CW keying. CW transmit LED. External CW key jack.

Kantronics compatible socket.

Exclusive general purpose socket allows interfacing to nearly any personal computer with most appropriate software. Available TTL lines: RTTY demod out, CW demod out, CW-ID input, +5 VDC, ground. All signal lines are buffered and can be inverted using an internal DIP switch.

Use Galfo software with Apple, RAK with VIC-20, Clay Abrams with TRS-80C, N4EU with TRS-80 III, IV. Some computers with some software may require some external components.

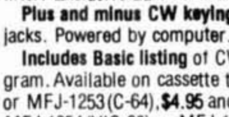
Metal cabinet. Brushed alum. front. 8x1¼x6 in. 12-15 VDC or 110 VAC with adapter, MFJ-1312, $9.95.

MFJ-1223, $29.95, RS-232 adapter for MFJ-1224.

CW INTERFACE CARTRIDGE FOR VIC-20/C-64

NEW

$ 39 95



MFJ-1226

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4 pole 100 Hz bandwidth active filter. 800 Hz center frequency. 3 pole active lowpass post detection filter. Exclusive automatic tracking comparator.

Plus and minus CW keying. Audio in, speaker out jacks. Powered by computer.

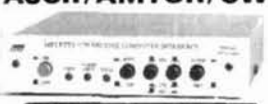
Includes Basic listing of CW transmit/receive program. Available on cassette tape, MFJ-1252 (VIC-20) or MFJ-1253 (C-64), **$4.95** and on software cartridge, MFJ-1254 (VIC-20) or MFJ-1255 (C-64), $19.95.

You can also use MFJ-1250 (VIC-20) or MFJ-1251 (C-64), $49.95 each, RTTY/ASCII/CW software cartridge. Or use Kantronics, AEA and others.

Also copy RTTY with single tone detection.

UNIVERSAL SWL RECEIVE ONLY COMPUTER INTERFACE FOR RTTY/ASCII/AMTOR/CW

MFJ-1225
$ 69 95



MFJ-1225 plus MFJ-1250 or MFJ-1251 $99.95.

Use your personal computer and communications receiver to receive commercial, military and amateur RTTY/ASCII/AMTOR/CW traffic.

Plugs between receiver and VIC-20, Apple, TRS-80C, Atari, TI-99, Commodore 64 and most other personal computers. Requires appropriate software.

Use MFJ (see this ad), Kantronics, AEA and most other RTTY/ASCII/AMTOR/CW software.

Copies all shifts and all speeds. Twin LED indicators makes tuning easy, positive. Normal/Reverse switch eliminates tuning for inverted RTTY. Speaker out jack. Includes cable to interface MFJ-1224 to VIC-20 or Commodore 64. 4½x1¼x4¼ inches. 12-15 VDC or 110 VAC with optional adapter, MFJ-1312, $9.95.

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presstop de W9JUV

<u>THREE REGIONAL VOLUNTEER EXAMINER COORDINATORS SHOULD HAVE FCC APPROVAL</u> by the time this reaches print, with several more close behind. First in with a satisfactory proposal was the Anchorage Radio Club, which will oversee Amateur exams for Alaska. Metroplex, a New York repeater group with over 1000 members, has volunteered to perform the VEC task in New York and New Jersey, and a MARS group in Puerto Rico has asked to serve the Caribbean. In the ninth call area DeVry, a highly respected technical school which does not teach Amateur Radio but has a very active Amateur club, has proposed not only acting as the VEC but also offering Amateur exams weekday evenings and Saturdays on its Chicago campus.

<u>Additional Proposals Are Also Expected From</u> the Dayton Amateur Radio Association, the Hamvention sponsor, for the eighth call area, while a Texas group is believed preparing to ask for the fifth district responsibility.

<u>The Reimbursement Of VEC Expenses Is Still In The Future</u>, waiting for the necessary change to be incorporated in Part 97. Though the ARRL filed a Request for Agency Action to have the $4 fee go into effect immediately, the Commission feels that justification for and accounting of the fees collected is needed. It appears likely that they'll want to have appropriate procedures and guidelines developed in response to a rule making procedure.

<u>THE FORMER WB6JAC WENT TO JAIL JANUARY 23</u> to begin serving an 18 month sentence for operating without a license. Richard A. Burton, who had earlier lost his license for transmitting obscene language, was back in court on four charges that he'd continued to operate after the FCC lifted his license. In his second appearance before U.S. District Court Judge Manuel Real, Burton was sentenced to 12 months in federal prison followed by six more months in "a jail type of facility." In addition, Judge Real also imposed five years of probation on Burton, during which he "shall not be found in any place in which any kind of broadcast is made by radio or otherwise."

<u>Burton Was Originally Indicted in May, 1982</u>, both for operating without a license and for transmitting indecent language. His license had been revoked earlier for his indecent transmissions. He was convicted on all but one count, though the convictions for indecent language were later thrown out by an appeals court. It appears Burton will be the first person to go to prison for violation of the Amateur Radio rules since the late 1940s.

<u>In An Unrelated Case, Out-Of-Band Operation Has Cost</u> two East Coast Amateurs healthy fines. KA2QMX and KA2GWV/4 were both caught operating outside the 40-meter band using false callsigns. Their repeated violations cost KA2QMX, a Technician class who refused an FCC request to inspect his station, $1100, while KA2GWV paid a $600 "monetary forfeiture." Such out-of-band operation is not uncommon, but only rarely practiced by licensed Amateurs.

<u>ACTION ON THE VOLUNTEER ENFORCEMENT PROGRAM</u>, at a standstill since last fall, may see some action soon. A draft of a "prototype" monitoring and enforcement training manual, developed under a joint FCC/ARRL effort, has been awaiting approval by the League Board of Directors since late last fall. However, it seems likely that the Commission, feeling the need to get some form of direct Amateur involvement in rules enforcement underway, will be proceeding soon, with or without any formal League sanction.

<u>PUBLICATION OF W5LFL'S STS-9 LOG DISAPPOINTED MANY</u> would-be space DXers. The third and ninth call areas fared the worst, with just a few QSOs each, while the fours, fives, and sixes dominated the roster of fortunates by logging three dozen or more contacts each. Outside the U.S., Canada (including VO) made the log 18 times, almost 40 European stations (including 11 Germans), nine VKs, eight from all of Latin America, and only one (JY1) from Asia; no one from Africa made the list. Further logging tape work could pull out a few more calls, but shouldn't change the proportions appreciably.

<u>The Excellent PR From W5LFL's Space Operation</u> and other Amateur Radio/media topics will be the subject of a Dayton Hamvention panel discussion. Joining moderator Jim Davis, KU8R, will be Steve Mendelsohn, WA2DHF (CBS), Bill Pasternak, WA6ITF (Metromedia and Westlink/ <u>Westlink Report</u>), Bob Hanson, W9AIF (Grey-North/Electra), Pete O'Dell, KB1F (ARRL, and Joe Schroeder, W9JUV (<u>ham radio</u>).

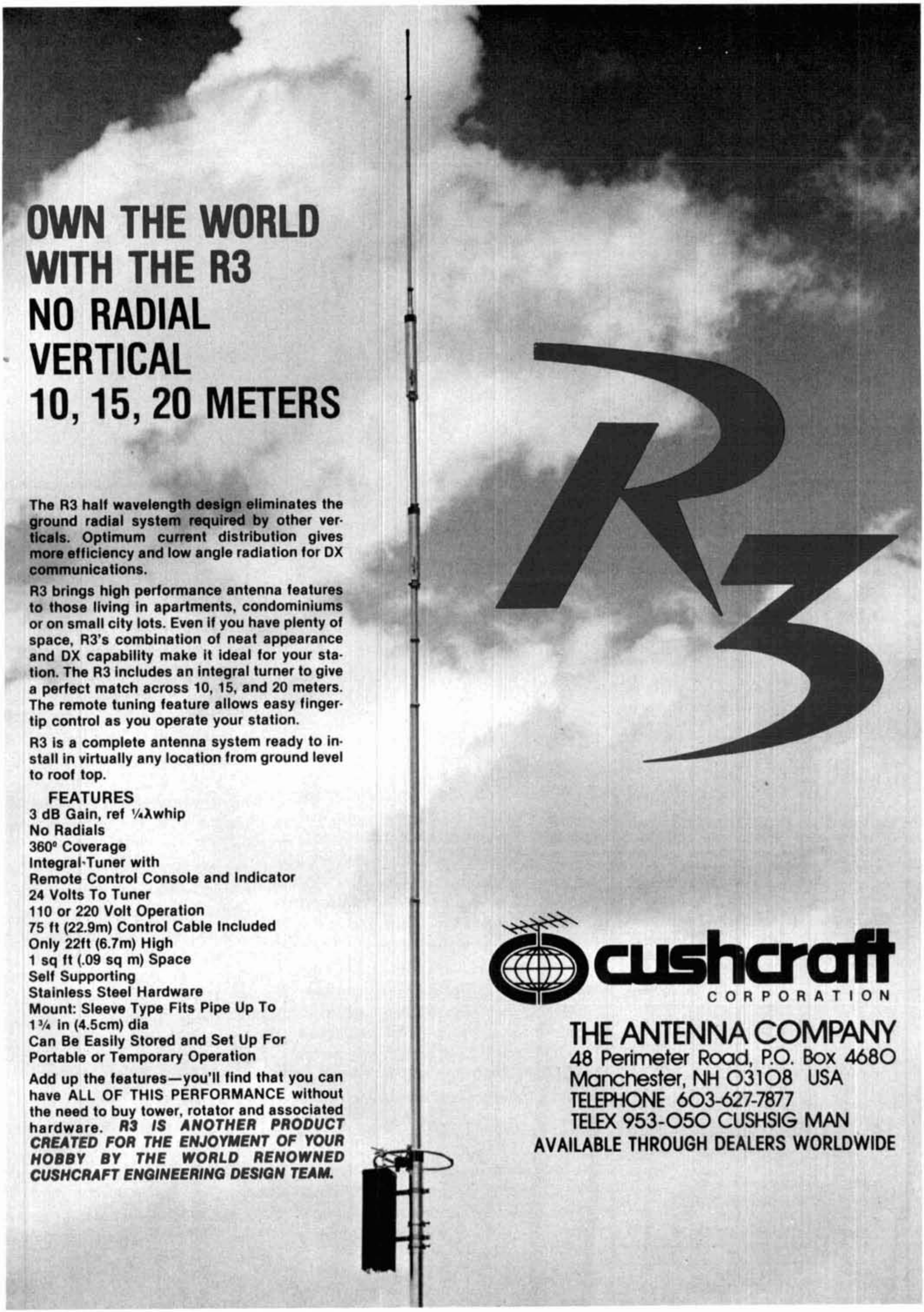
<u>NOMINATIONS FOR DAYTON HAMVENTION'S "HAM OF THE YEAR,"</u> "Special Achievement," and the new "Technical Excellence" Awards are due by the end of March. Nomination letters go to the Awards Committee, Dayton Hamvention, Box 44, Dayton, Ohio 45401.

<u>Europe's Hamvention Equivalent, The "Ham Radio" Convention</u> held in Friedrichshafen, Germany, expects over 10,000 Amateurs from throughout Europe June 22-24. Amateurs who'll be in Europe then can get details from the DARC, Box 1155, D3507 Vaunatal, West Germany.

<u>ADDITIONAL FREQUENCIES FOR RACES OPERATION</u> in the event of a major national emergency have been authorized by the FCC. Acting on PR Docket 83-524, the Commission added all the frequencies originally proposed plus both the old and new 2-meter repeater subbands to the frequencies that would be available if the President invoked his emergency war powers.

<u>Further Expansion Of The HF Amateur Phone Bands</u> is not likely in the near future. FCC staff limitations combined with decreasing MUFs and resultant lessened activity on 28 MHz will probably push any changes on that band off indefinitely.

<u>6-METER ACTIVITY FROM EUROPE WILL BE INCREASING</u> sharply in the near future. The RSGB reports the British government plans to increase special 50-MHz operating permits from the present 40 to 100 this year. Applications must be submitted before March 31.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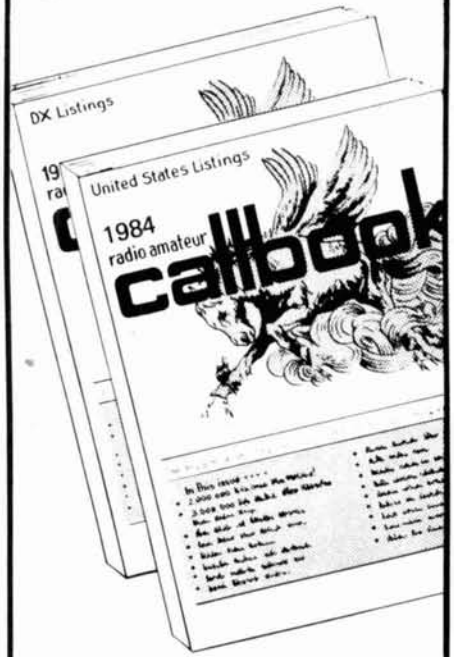

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comments

compact SSB

Dear HR:

I enjoyed Rick Littlefield's article on the compact SSB receiver (November, 1983). However, I do not agree with the use of No. 2 mix toroid cores for VFO use. No. 6 mix cores are much more temperature-stable than No. 2 mix cores. The most stable VFOs for HF oscillators are constructed with No. 6 mix toroid cores and NPO capacitors. Perhaps I am being a little picky about this, but using the right core material for oscillators can make a big difference in short and long-term drift.

Paul Montgomery, KAØGPE
Westcliffe, Colorado

phased verticals

Dear HR:

When I tried to design a 2-element vertical phased array, I ran into two problems. Where, electrically, did I feed the array and what was the velocity factor (VF) of my RG58U? Not sure what to do, I filed the matter.

Then good fortune appeared in the form of Forrest Gehrke's series of articles on the subject in *ham radio* (May, June, July, October, December, 1983). I have followed the series with great interest using an HP29C and a Smith Chart. The ABCD parameter analysis in the last article tied it all neatly together for me. I was more sure of what to do and why.

What to do with all this information?

1. In a narrow east-west back yard, I want to set up a 20-meter 2-element array cut for the low end of the CW band — and point it toward Quebec.
2. I know a 2-element Yagi would work, as I made one out of wood, aluminum, and old fence post insulators in 1959. I want to experiment.
3. In the spring, if the temperature ever gets above zero, I intend to put up the version of the array K2BT discusses in his October article. This is the array with the quarter-wavelength feeders and the 90-degree delay line.
4. Then I'll measure Z at the receiver with a noise bridge. Knowing the VF of my coax, I'll move with a Smith Chart toward the common feeder point — and see if K2BT's values are correct.

I'm weak on antenna theory, and for a change it's nice to know precisely where and why.

David Winter, W9OAM
Amboy, Illinois

short circuit

good news department: auto dialer

Readers who wish to construct the state-of-the-art auto dialer described in K2MWU's December, 1983 article may order the auto dialer in kit form from Tek-mation, Inc., 2618 North Stowell, Milwaukee, Wisconsin 53211, for $34.95 plus $2.50 postage and handling. (Note that the kit does not include the MD-22 chip; this is available from CES, Inc., P.O. Box 2930, Winter Park, Florida 32790.)

Printed circuit boards for the auto dialer are no longer available from Dynaclad, but may be ordered from Tek-mation or from Circuit Board Specialists, P.O. Box 969, Pueblo, Colorado 81002. The price per board — from either supplier — is $7.50 plus $1.50 postage and handling.

QSL cards

If you're still waiting for your free QSL cards from RCA (see August, 1983 issue, page 23), relax — they're on the way. Over half a million cards have been printed and shipped; more have been ordered to fill the remaining requests. — **Editor**

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More Details? CHECK—OFF Page 120

build your own "audio to microwave" amplifier

Readily available modular hybrid amplifiers provide extreme bandwidth, exceptional performance

How many times have you tried to build a wideband amplifier to cover the VHF or UHF bands only to find that you've constructed not a wideband amplifier, but a very poor oscillator or the world's most nonlinear active attenuator? At those frequencies, both careful design and close attention to physical configuration are mandatory. Individual component response must also be well characterized. The active devices must be particularly pampered to assure stability over all operating conditions. Although the design of input and output matching to assure stability is relatively straightforward, few of us have the necessary experience to make this a painless exercise with consistent results. It is here that the modular hybrid amplifiers provide the more critical elements of interfacing to the active devices.

In this article we will briefly review modular RF amplifiers with particular emphasis on some of the more critical aspects of their use. We will then go through the step-by-step construction of a modest RF amplifier using these components, which will perform quite well from audio into L-band. The devices specifically discussed are those with which I have had personal experience; many other manufacturers produce similar components that are equally as suitable.

the modular hybrid amplifier

Basically, the modular amplifier consists of one or more high-frequency active devices (usually bipolar transistors), mounted on a hybrid substrate with other discrete and deposited components. This completed substrate, which resembles a miniature PC board, is mounted in some type of header (a TO-12, for example) to provide a controlled physical environment as well as a simple means for connecting to the device. (A typical device is shown in **fig. 1**.) These devices are available in numerous circuit configurations, but in general they are all simple feedback amplifiers. Feedback helps stabilize the amplifier parameters and make them less sensitive to the characteristics of the active devices. This in turn helps lower cost and provides more consistent performance.

The simplest configuration is that of the devices similar to the Motorola MWA series of amplifiers. A simplified schematic of the MWA configuration is shown in **fig. 2**. Deceivingly simple, isn't it? This configuration requires the addition of input and output coupling capacitors, a collector load resistor, and a power supply decoupling capacitor. The external coupling capacitors allow the user to set the low frequency cutoff where desired. However, as the lower cutoff frequency is reduced, the physical size of the coupling capacitors increases, generally causing poorer RF performance. A practical limit is on the order of a few hundred Hertz. An external collector resistor allows tailoring the circuit to a wide range of supply voltages. The inductor L_C is part of the internal matching network. The MWA-type components are available with upper cutoff frequencies greater than 1 GHz.

A second popular configuration is that similar to the Avantek GPD 400 and GPD 1000 series of devices. A simplified schematic of the GPD 400 device is shown in **fig. 3**. These are very similar to the MWA type devices with the inclusion of the collector resistor and coupling capacitors. Since the collector resistor is fixed, these are basically fixed supply devices. Also, the coupling capacitors are reasonably small due to limited space in the package. This limits the lower cutoff to about 5 MHz. However, the GPD 400 and GPD 1000 series components are available without internal coupling capacitors. This allows the user to set the lower cutoff at almost any frequency within reason. As with the MWA devices, a few hundred Hertz

By Michael E. Gruchalla, 2450 Alamo Avenue, S.E., P.O. Box 9100, Albuquerque, New Mexico 87119

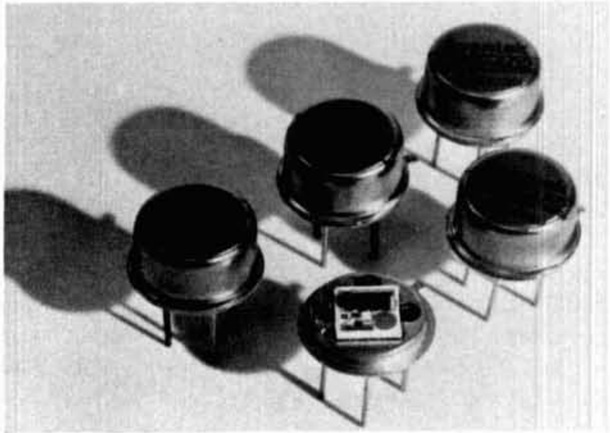

fig. 1. Hybrid modules are the basic building blocks around which the broadband amplifier is constructed.

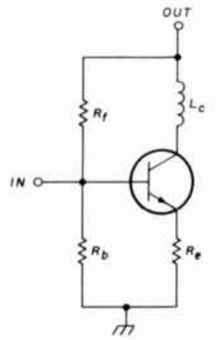

fig. 2. Simplified schematic of a 100 MHz bandwidth RF amplifier designed around the MWA module.

is a reasonable practical limit. Also, elimination of the internal coupling capacitors reduces the cost by about a factor of three. Components of the GPD configuration are available with cutoff frequencies exceeding 1 GHz.

Another configuration is that of the Avantek UTO devices (**fig. 4**).[1] Although it may not be obvious at first glance, these are very similar to the GPD 400/1000 configurations. The base resistor has been eliminated and a capacitor has been added in series with R_f. Next, a voltage regulator, U1, has been added to accurately control the operating point of Q1. This, in turn, offers more stable overall operation. These, however, may have a price more than a factor of 10 above a GPD type part with similar RF specifications. This component is useful in exacting applications with the more modest GPD type part serving very well in the majority of cases. Unlike the GPD parts, the UTO series is not available without the internal coupling capacitors. This is due to the added decoupling needed in the voltage regulator (two more pins would be needed on the package to allow for the addition of external capacitors). The lower cutoff is limited to 5 - 10 MHz. Upper cutoff frequencies as high as **2300 MHz** are available.

Finally, there are several configurations using transformer type feedback networks. This general configuration ideally has the potential for lossless, noiseless feedback. A typical configuration using a directional coupler is shown in **fig. 5**. The principal advantages of this feedback configuration over simple resistive feedback are the capability of providing lower noise figure and delivering higher power to the load. One disadvantage of this configuration is that the bandwidth is limited to about two or three *decades*. In the case of modular amplifiers, the lower cutoff is generally in the vicinity of 5 to 10 MHz because of the limited size of the transformers. Also, these units tend to be more expensive than simple resistive feedback devices because of their added complexity.

noise figure

A carefully designed and fabricated amplifier system using hybrid modular amplifiers can provide a noise figure on the order of 4 to 6 dB (about 400 degrees K to 900 degrees K). This is certainly not in the same class with typical LNA's (low noise amplifiers — typically 120 degrees K — Editor), but it is nevertheless reasonably good performance for an inexpensive general purpose amplifier. The total finished cost of the amplifier described below is perhaps a factor of two or three below the typical cost of just the input active device of an LNA! In many applications, a nominal 5 dB noise figure is quite adequate. Only the most exacting applications justify the cost associated with lower noise figures. Also, the modular amplifiers take all of the guesswork and "tweaking" out of amplifier construction. Few of us have the necessary equipment to accurately measure noise figure, particularly below 5 dB or so. Carefully designed and constructed amplifiers using the modular hybrids will yield very predictable and consistent performance. The noise figure will be at least that specified for the first stage amplifier and will generally be a little better if proper care is taken in the selection of components and construction.

The noise figure of the overall amplifier can, however, be compromised severely by the use of poor resistors in the amplifier assembly. Some resistors exhibit considerable excess noise. This noise, introduced particularly into the first stage, as well as all other stages, could increase the noise figure by as much as 5 dB. Also, a type of "popcorn" noise, or random spikes, often occurs in these resistors. The energy of the individual spikes is low, yielding an RMS component which gives the 5 dB noise figure degradation mentioned. However, the peaks of the spikes are quite high — perhaps a factor of 10 or 100 higher than the RMS level. If the noise figure is computed in a way that uses the peak amplitudes of these pulses, a noise

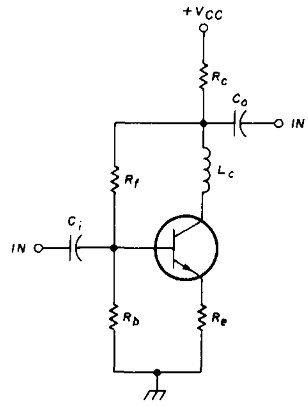

fig. 3. Simplified schematic of a wide bandwidth RF amplifier designed around the Avantek GPD series modules.

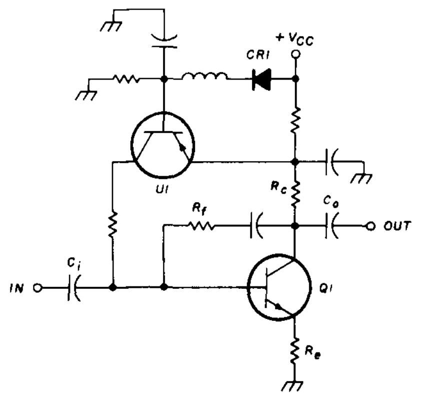

fig. 4. Schematic of a broadband amplifier that incorporates the Avantek UTO series of modules. More precise and stable operation is associated with slightly greater circuit complexity.

figure of 20 dB to 40 dB could easily be achieved. Such a computation, however, is not a correct mathematical exercise because a specific value of a noise spike cannot be computed, and specifying a "peak noise level" is generally meaningless. This is why noise is specified in terms of its RMS value (a statistical term) or its mean square value (square of the RMS value) proportional to noise power. So, the "popcorn" noise may exhibit a reasonably low mean square noise, while still having large amplitude spikes. Viewing this type of noise on an oscilloscope, one would see a low noise floor with high narrow spikes. If the displayed noise were set at about 0.1 division, the spikes could be as high as 1 to 10 divisions. These impulses exhibit a very wide spectrum and can destroy the usefulness of the amplifier at all frequencies. The best solution to this problem is to use high quality, name brand resistors; avoid the very inexpensive carbon film types. (An excellent review of noise considerations is available for those who wish to delve deeper into this subject.)[1]

do's and don'ts

Although the modular hybrid units are reasonably straightforward to use, there are a few do's and don'ts that are important to consider in order to avoid problems. The two most important considerations are proper mechanical mounting and good high-frequency bypassing of the power supply. Also, the use of a groundplane is an absolute *must*.

The mechanical mounting of the device must assure that the case is well grounded electrically. It must also provide good mechanical contact with the groundplane for proper heatsinking. Some manufacturers such as Avantek provide a mounting kit (**fig. 6**). Use it! A word of caution, though — you must mechanically mount the component *before* soldering its leads. If you solder the leads and do not have the package firmly against the groundplane, you may break the lead penetrations into the package and cause internal damage to the part when you tighten the mounting kit. When no mounting kit is available, it is a good practice to tack solder the flange of the package to the groundplane in two or three places. The index tab is an excellent place for one of these solder connections.

I have found one especially useful variation to the manufacturer's mounting. This concerns the ground lead. Normally, a plated through-hole from the groundplane to a trace-side pad would be provided for this lead. If the part is mounted in this manner, it is difficult to unsolder and remove the part without damaging the board, the part, or both, due to the heatsinking action of the groundplane. If the groundplane is relieved around the ground lead, as with the other leads, the removal problem is eliminated. However, a good electrical ground must still be provided. Good mechanical mounting will generally provide good electrical grounding, but to be sure, a pad configuration similar to that shown in **fig. 7** should be used. Adequate grounding is provided by the triangular ground pad. The two through-holes should either be plated through to the groundplane or should have short pieces of bus wire soldered in as feedthrough conductors. One screw of the mounting kit also ties to this pad, providing an additional ground path. The short conductors between the V_{CC} pin and ground pin provide a place to mount a high-frequency chip capacitor for V_{CC} bypassing with minimum inductance. I have found that up to 1 GHz and somewhat higher, this grounding configuration works quite well. Now, using this mounting technique, when you dig through your junk box for an old board with a good amplifier module on it, you will have no trouble removing the amplifier for use in some new project.

Good bypassing of the power supply pin is the sec-

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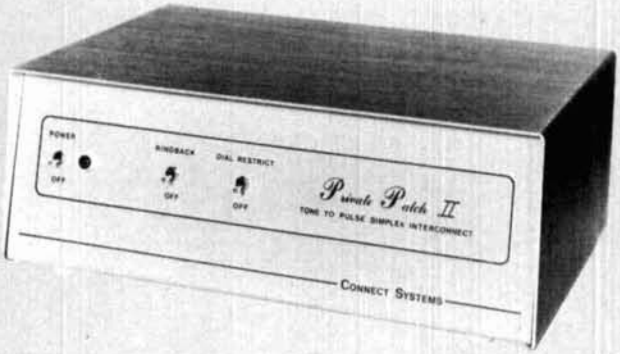

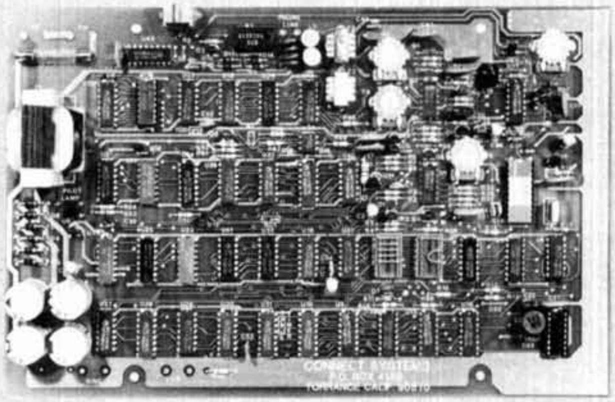

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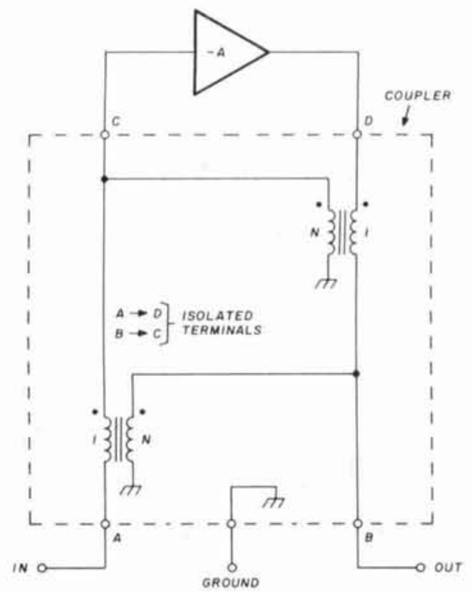

fig. 5. Transformer-type feedback networks provide lower noise figure and higher power to the load than the previous circuits.

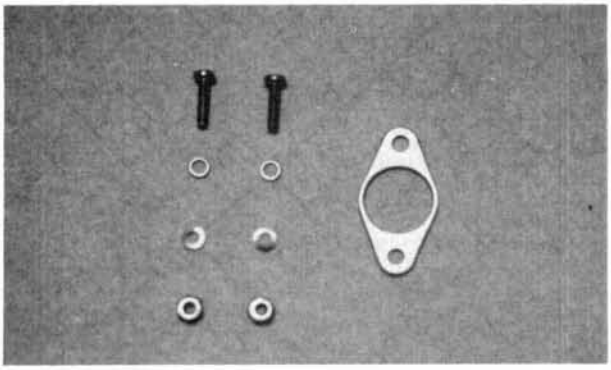

fig. 6. Use of mounting kit aids assembly.

ond thing one must carefully consider in the use of the modular amplifiers. If the pad configuration of **fig. 7** is used, the small chip capacitor (about 100 pF) will provide excellent high-frequency bypassing. However, a larger bypass capacitor (about 10 - 100 μF) is needed to provide low-frequency bypassing. If such a large capacitor is added in parallel with the chip capacitor, the chip may resonate with the lead inductance of the larger capacitor at some frequency. At that resonant frequency, the power supply impedance will vary, causing a glitch in the amplifier response similar to that shown in **fig. 8**. In some cases, this problem can be serious enough to cause oscillation. This problem is easily solved, however, by the addition of a medium-permeability ferrite bead (Ferroxcube 56-590-65/A46 or Amidon FB43101, for example). This bead acts as a lossy element at the resonant frequency. This spoils the Q of the resonant circuit and eliminates the problem. Use of ferrite beads is always a good practice whenever large and small bypass capacitors are paralleled. Be careful, however. Some types of beads are very conductive. These will short the power supply to the groundplane. It is best to use a low conductance bead similar to those above. If you use a highly conductive bead, be sure to insulate it from the lead on which it is placed.

Another point to be considered in bypassing is that of decoupling the supply lead of each module from all others in a cascade. Simple capacitive bypassing of each module with all the V_{cc} leads tied directly to a common supply bus may prove inadequate. A much more effective technique is to feed each module from the supply bus through a small resistance (about 10 ohms for currents up to approximately 100 mA). This resistance aids in decoupling and in providing additional Q spoiling of any resonant networks which may be lurking in long power supply conductors.

amplifiers can be cascaded

Many of the modular amplifiers are designed specifically for cascading. These are unconditionally stable for any combination of input and output VSWR. This eliminates the need for the design of matching networks to assure stability. The specifications are given for a conventional 50-ohm system and the device VSWR is reasonably good. This provides near optimum stage-to-stage matching without the need for matching networks. Several manufacturers offer a series of devices of graduated power capability to allow convenient cascading for both gain and output drive. We will be using two such series of devices manufactured by Avantek in this amplifier design.

A unique feature of these cascadable devices is that the frequency response of the devices is tailored by the manufacturer in such a manner that overall frequency response is preserved with cascading. Normally, if a number of amplifiers with an upper cutoff frequency of f_1, for example, are cascaded, the combined cutoff frequency would be well below f_1. Preservation of a bandwidth is done by a slight peaking of the response near the upper cutoff. The response flatness of a typical cascade will be about ± 2 dB. If very flat response is needed (better than ± 1 dB), gain may be traded for response flatness by adding compensating attenuator pads between stages as discussed below.

The manufacturers advertise foolproof cascading capability with simple power supply bypassing and direct stage-to-stage coupling. Nevertheless, experience has shown that using these parts in wideband cascaded amplifiers is somewhat more involved than that. This is particularly true for those who do not have the benefit of a machine shop to fabricate intricate enclosures. However, if you carefully follow the suggestions presented here, you should have no trouble.

table 1. Hybrid amplifier specifications.

Guaranteed specifications at 0-50°C (A), −54° to +85°C (B) case temperature; other specifications at 25°C.

Avantek model	frequency response MHz minimum	gain minimum A	gain minimum B	noise figure (dB) typical	reverse isolation (dB) typical	power output for 1 dB gain compression (dBm) typical	3rd order intercept point (dBm) typical	2nd order intercept point (dBm) typical	maximum VSWR (50 ohms) in	maximum VSWR (50 ohms) out	input power volts DC	input power current mA typ
GPD-461	0.1-400	13	12	4.5	20	−2	+9	+9	2.0	2.0	+15	10
GPD-462	0.1-400	13	12	6.0	20	+6	+18	+24	2.0	2.0	+15	24
GPD-463	0.1-400	9	8	7.5	20	+15	+25	+32	2.0	2.0	+24	65
GPD-464	0.1-400	9	8	7.5	20	+15	+26	+38	2.0	2.0	+15	70
GPD-1061	0.1-1000	12	11	6.0	18	+0	+12	+18	2.0	2.0	+15	15
GPD-1062	0.1-1000	12	11	7.0	18	+6	+16	+19	2.0	2.0	+15	27
GPD-1063	0.1-1000	10	9	8.0	18	+14	+24	+36	2.0	2.0	+15	55

Note: Three external capacitors (input, output coupling, and RF bypass) are required to establish low frequency roll-off.

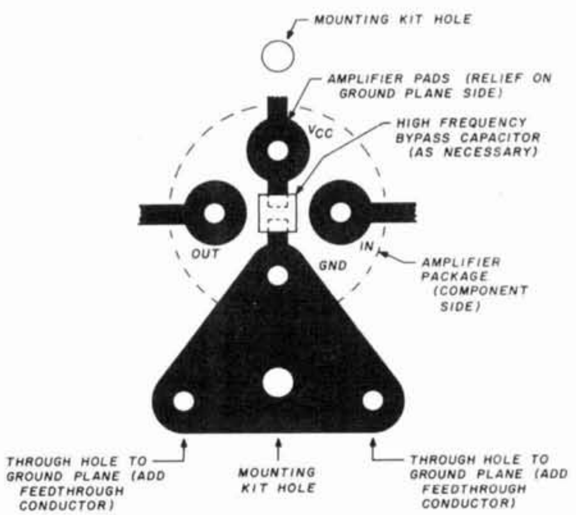

fig. 7. Ground pad configuration details by-pass capacitor, mounting and through hole locations.

design procedure

We are now ready to actually put together an amplifier using the modular hybrid devices. The first step is to choose the actual devices to be used. For the purpose of this project, I have chosen the Avantek GPD 461, 62, 64, and GPD 1061, 62, 63 devices. The actual specifications for these devices are given in **table 1**. The three devices in each series are of graduated power capability and are ideally suited for cascading. Note: there is a GPD 463, but it is a less convenient 24V part. Also, the "60" series parts have no internal coupling capacitors; considerably less costly than their counterparts with internal capacitors, they allow custom tailoring of the low-frequency cutoff. The 400 series parts have a minimum cutoff of 400 MHz and the 1000 series, 1 GHz. This bandwidth is preserved with cascading, and in general it will be found that the upper cutoff is somewhat above that specified. The combined response will be relatively flat, generally ±2 dB, but could be as poor as about ±3 dB. The amplifier design below will allow the purist with access to a network analyzer the means to tailor the bandpass to achieve flatness on the order of ±0.5 dB to beyond 400 MHz, using the GPD 46X parts, and greater than 1 GHz, using the GPD 106X parts.

The manufacturer recommends simple cascading with no matching networks. This technique works reasonably well, but the addition of a simple interstage pad produces a design that is somewhat more forgiving of less than ideal layout and packaging and, in general, is very stable. These pads also tend to reduce the effects of the impedance mismatches from one stage to the next. Furthermore, these pads also provide a very convenient place to add compensation for bandpass flattening. Padding, however, does trade gain for the desirable performance features provided.

I generally use a balanced 50 ohm Pi pad with special conductors on the PC board for "tweaking." A typical schematic (1 dB pad) and layout is shown in **fig. 9**. The additional conductors allow adding chip resistors and capacitors and even small inductors in parallel with the corresponding resistor to provide the frequency response desired. Since gain is traded for performance, it is desirable to keep these pads as small as possible. Typically, 1 dB is adequate if no response tailoring is used. That results in a total 4 dB gain reduction in a three-stage amplifier (two interstage pads, one input pad, and one output pad). That is not too high a price to pay for simplified construction and increased stability.

An input pad also provides some degree of input protection against overdrive. The active device of the modular amplifiers considered here is a bipolar unit. Therefore, it will tolerate a reasonably high current drive in the forward direction. However, in the reverse direction, the emitter-base junction would be avalanched, causing possible damage or degradation to the part (such as degradation of NF). The emitter-base junction may be protected from avalanche by adding a Schottky diode in parallel with the emitter-base junction, the diode anode at the emitter, and the cathode at the base. In normal operation, this diode is reverse-biased by the base forward drop, about 0.5V. At that bias, the diode impedance is much larger, even at 1 GHz, than the base impedance; it causes little performance degradation. The input pad now provides a well defined minimum source impedance to limit both forward base current and reverse diode current. Without the input pad, the source impedance could be essentially zero (from a capacitive discharge, for example) resulting in very high currents which could degrade performance.

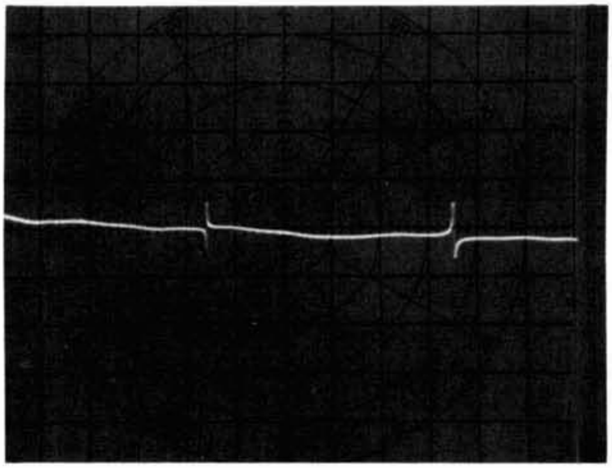

fig. 8. Varying power supply impedance causes glitch in amplifier response.

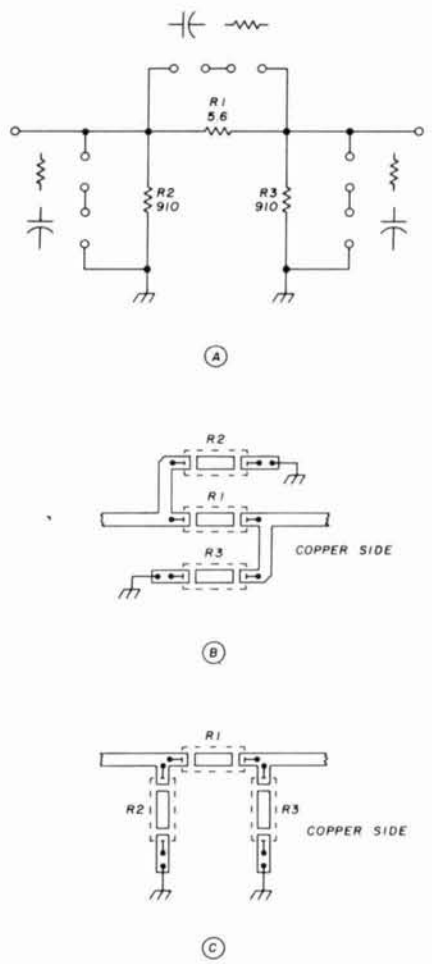

fig. 9. Typical interstage pads: (A) attenuator schematic; (B) input configuration; (C) interstage and output configuration.

The gain and bandpass of the modular hybrids are affected by the operating point. The GPD series parts selected for this project have internal collector load resistors. These basically set the supply potential required for the proper operating point. All the devices chosen are specified for operation at 15V. However, if the supply is varied slightly from 15V, the gain is varied without much degradation in bandpass. The supply potential should not be raised much above 15V due to increased dissipation, but it may be lowered to about 12V, which will reduce the gain of the three-stage amplifier by about 5 dB (**fig. 10**). In this design, a three-terminal regulator is included to allow simple internal regulation of the supply potential for gain stability in the finished amplifier.

packaging

One of the most difficult tasks in homebrew wideband amplifier design is how to package your product in a way that provides consistent performance. An enclosure machined specifically for the task would be ideal, but because few of us can afford such exotic packaging, I've come to favor the various die-cast aluminum boxes. You're probably familiar with these as being almost right for many uses, but never completely right for anything. Well, this application is no exception. The PC board must be solidly mounted with good groundplane continuity. Simply mounting the PC board on spacers from the bottom of one of these boxes is generally ineffective in RF designs. A better technique is to mount the PC board to a shelf at its periphery, but because this mounting is not provided in die-cast boxes, it must be added. **Fig. 11A** and **B** show a reasonably simple technique for mounting RF boards in these boxes. This technique provides good groundplane coupling to the box and good ground continuity from the RF connectors to the board.

It is very difficult to get perfect alignment of all the mounting components, especially with handmade parts. Therefore, give the mounting holes plenty of clearance to allow for adjustment.

where to obtain parts

Most of the components are standard items and can be obtained from almost any supplier. A few, how-

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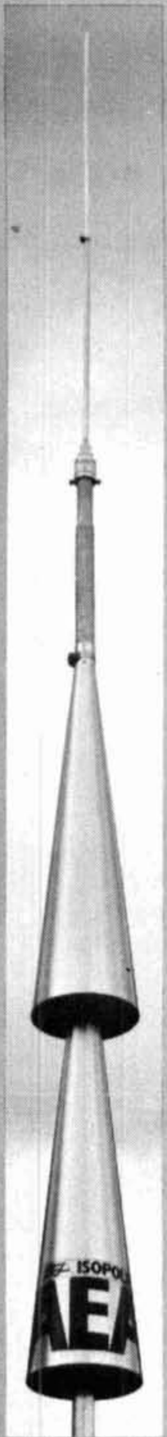

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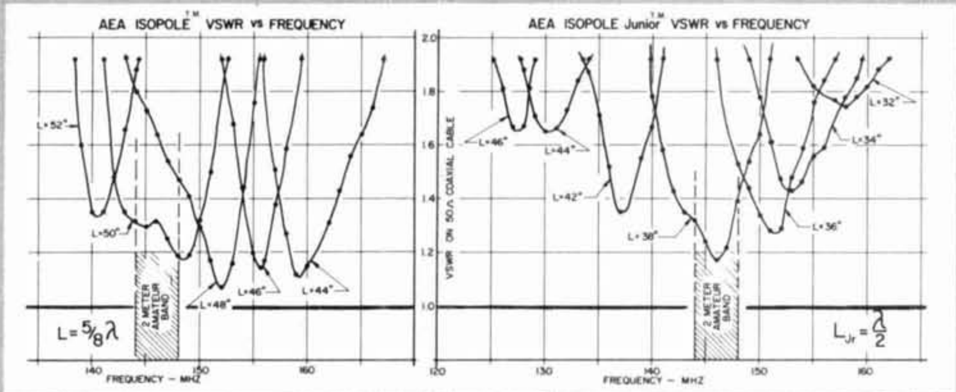

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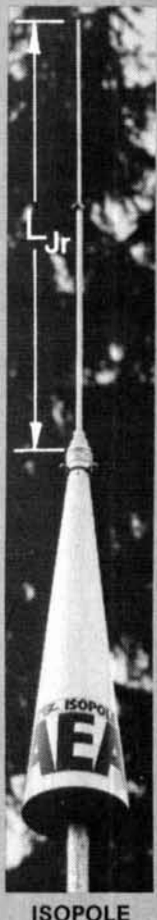

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ever, are somewhat troublesome to find because few distributors stock them. Fortunately, there are alternatives for those parts that prove impossible to get.

Obviously, the most critical special components are the RF amplifiers; these are available from Spirit Electronics* and other Avantek distributors. The chip tantalum capacitors are a particular problem. I used the Matsuo parts, but Matsuo has no retail distributor and no means of handling small orders. The Sprague 193D parts are equally as suitable and are available from some distributors. Another chip capacitor that works quite well is the Alchip-S unit by United Chemi-Con.** However, this part is an aluminum electrolytic. If you use this part, you must *not* clean the PC board in trichlorethylene because the solvent may ruin the capacitor; use 91 percent isopropyl alcohol only. If you cannot find any of those chip capacitors, the dipped tantalum (196D or equivalent) or the CK05 ceramic (with increased low frequency cutoff) can be used with almost as good a result.

The Schottky diode for input protection can be a problem. Almost any small signal RF Schottky diode is suitable. The Radio Shack 276-1124 is a good substitute. If a suitable diode cannot be found, just omit it, but this will make the input device more sensitive to reverse bias damage.

The swagged terminals are quite convenient and give the board a professional appearance, but are usually not available in small quantities. Proper swagging of these is essential; if they are too difficult to obtain or proper swaggging cannot be done, use pieces of wire as suggested below.

components

Because this is a high frequency design, performance is very sensitive to the particular components used. The components specified in the list of materials are the specific ones used for construction of the units presented in this article. While other components can be used with equal success, care must be exercised in their selection. Several points to take into consideration in selecting alternative parts are given below.

The components most easily substituted are the resistors. I specified Allen-Bradley brand carbon composition resistors mainly because of my particularly good experience with these parts. Most other name brands should perform equally well. However, some carbon film components are spirally cut to obtain the desired resistance; this could introduce added inductance, which could perturb performance. Also, some of the less expensive parts exhibit excess noise that could increase the noise figure of the amplifier. In general, try to avoid using the very inexpensive resistors and use brand name parts instead. In the 400 MHz amplifier (GPD 46X amplifiers), either carbon composition or quality carbon film resistors should be suitable, but in the 1000 MHz unit (GPD 106X amplifiers), try to use only carbon composition resistors.

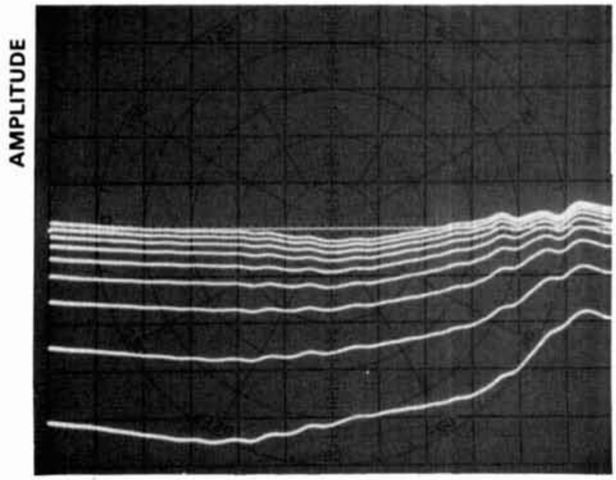

fig. 10. GPD106X gain variation with supply voltage (without regulator). Gain changes in 1 dB steps as V_{CC} is varied from +8 to +16 VDC.

The interstage coupling capacitors are also good candidates for substitution because the ones specified are somewhat difficult to find. If low frequency response (i.e., below about 100 kHz) is not a consideration, standard CK05 capacitors work quite well. These are not normally recognized as being good high-frequency capacitors, but up to 1 GHz or so they will work very well. (**Fig. 12** shows typical performance of the 1 GHz amplifier with 0.1 μF CK05 coupling capacitors.) One component almost guaranteed *not* to work for coupling is the tubular aluminum electrolytic capacitor, which generally exhibits high lead inductance and high stray capacitance because of its size; its use will probably result in a very unstable amplifier. The chip aluminum electrolytic capacitor manufactured by United Chemi-Con seems to work well, but is equally as difficult to obtain as the chip tantalum capacitors specified. With a little care, the dipped tantalum units — i.e., Sprague 196D or equivalent — can be used successfully for coupling. The general key to success with these parts is to stick to the ones of small physical size, about 1/8 inch in diameter, and keep leads short. An operating voltage greater than 6.8V is necessary. **Fig. 13** shows the response of the 1 GHz amplifier with 10 μF, 20V 196D capacitors.

The other capacitors in the circuit are not too critical, but some care should be taken in their selection. The low-value bypass capacitors should have relatively good high frequency properties. The CK05 units are recommended. Depending on their manufacturer, typical ceramic discs vary tremendously in performance and are not recommended. (The actual value

*Spirit Electronics, 6560 N. Scottsdale Road, Suite E204, Scottsdale, Arizona 85253

**United Chemi-Con, 9801 West Higgins Road, Rosemont, Illinois 60018

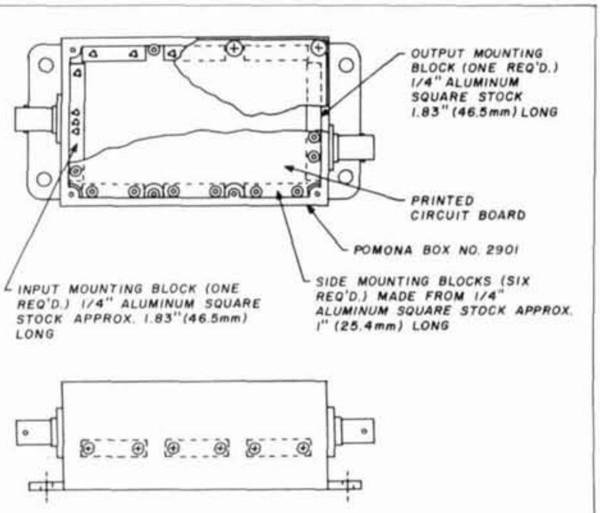

fig. 11A. Mounting shelves provide good ground plane coupling to box and good ground plane continuity between RF connectors and board.

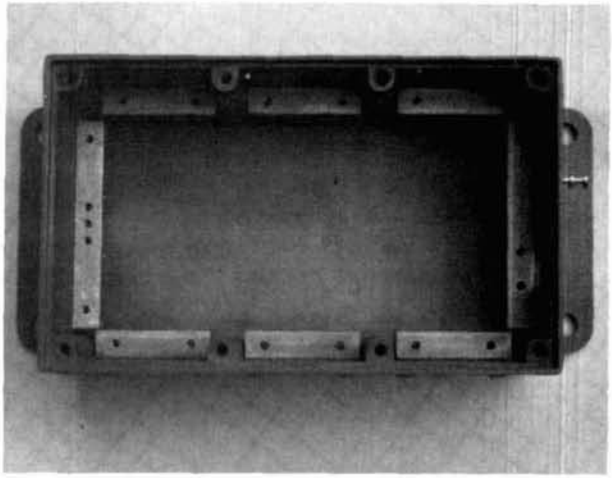

fig. 11B. Box detail with mounting blocks installed.

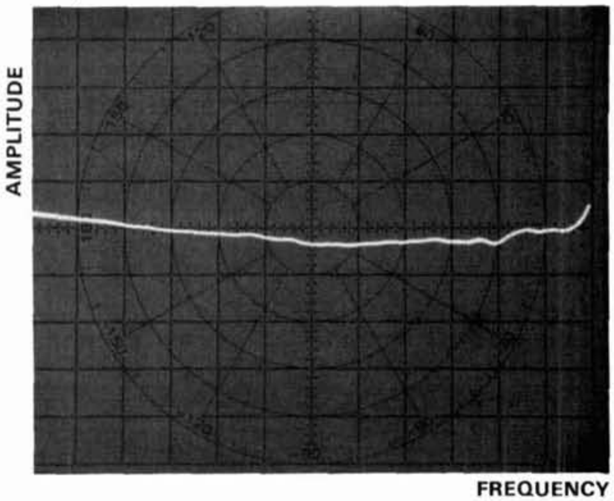

fig. 12. Typical performance of 1 GHz (0 - 1200 MHz, 5 dB gain variation) amplifier using 0.1 μF CK05 coupling capacitors.

is not too critical since they are basically used for high-frequency bypassing. Values between 100 and 1000 pF should be good.) The higher value bypass capacitors for both the amplifiers and the regulator should be dipped tantalum. Don't forget to bead the positive lead of the three amplifier bypass capacitors or you may have response anomalies similar to those shown in **fig. 8**. Aluminum electrolytics are too large to fit conveniently in the enclosure. Notice on the PC board that there are two ground pads for each of these capacitor positions; this allows easy mounting of both 0.2 and 0.25-inch lead formed capacitors. The actual value of these large bypass capacitors is not too critical. Variations by ± 20 percent should not be a problem, but it is better to go higher than lower. Also, observe the operating voltage. All the units except the supply input bypass capacitor should be 16V or greater. Try to stick with 16V capacitors since higher voltage units are larger and more expensive. The input capacitor should be a 35V unit to allow for large supply voltages without damage.

Another area that can prove troublesome is the swagged terminals. If you use terminals, they must be properly swagged and soldered into the board. If they are not properly swagged, the solder connection on the trace side could become a cold solder joint when the terminal is heated to attach leads. If you cannot properly swage the terminals, it is better to use pieces of wire in their place. A ¼-watt resistor lead works well for two RF connections (keep them as short as possible), and a lead from the power supply reverse polarity protection diode, CR2, works well for the power supply terminal. No ground terminal is really needed on the board; it's included only for checkout convenience. If you want to use terminals, almost any type will be adequate, but the PC board holes may have to be changed.

The ground terminal on the outside of the box may prove difficult to find. If you cannot find these, use a ¾-inch 4-40 brass or plated steel screw with a nut. Place the nut on the screw about ¼-inch from the end. Drive the screw into the box ground lug hole about ¼-inch and lock it in place with the nut. This will allow the screw to extend out about ½-inch for lead attachment.

Finally, the feedthrough filter could be a problem. While almost any filter will work, some type of feedthrough filter or feedthrough capacitor should be used; it must be a threaded type because it's difficult to solder to the box alloy. If you use a filter different from the one specified, be sure to drill and tap the mounting hole for the specific filter selected rather than for the filter shown in the list of materials.

PC board assembly

The assembly of the PC board is reasonably straightforward. (The schematic, component and PC

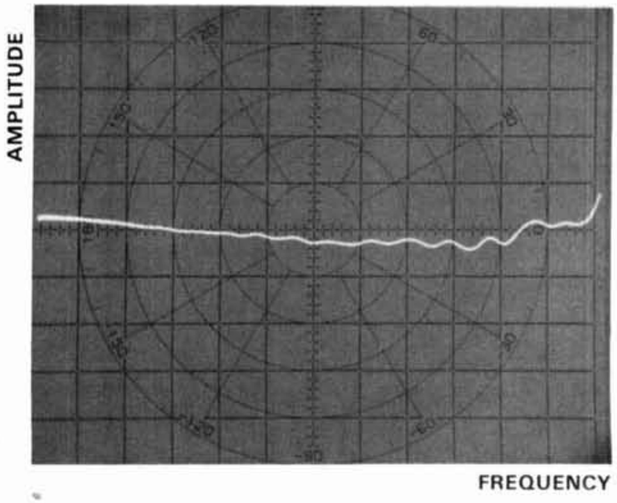

fig. 13. Response of 1 GHz (0-1200 MHz, 5 dB gain variation) amplifier using 10 μF, 196D capacitors.

boards are shown in **figs. 14, 15,** and **16.**) The first thing to do is mount the swagged terminals if you choose to use them. Next mount the three amplifiers with the mounting kits provided. Be sure to have the mounting kits completely installed and tight before soldering any of the amplifier leads. If chip tantalum coupling capacitors are to be used, it is easiest to mount those next. (These mount on the trace side of the PC board.) Now mount the remainder of the components on the groundplane side as shown on the assembly drawing, paying particular attention to the groundplane solder connections. Be sure to apply enough heat to the groundplane to get good solder flow on it.

When mounting the voltage regulator, allow about 1/16-inch space between the regulator body and groundplane. Mounting this part may be somewhat confusing because there are two sets of pads. The set closest to the board edge is for the general 78XXT and LM340T series parts. The other set is for the LM317T. (This allows the use of the LM317, 7805, 7812, 7815 or equivalent parts — the LM317 is preferred.) To mount the regulator, the leads must be bent as shown in **fig. 17**, which shows the lead bending for the LM317. If a 78XXT or LM340T series part is used, the leads should be bent behind the body to keep the mounting position of the tab at the proper location. Be careful to keep the tab electrically isolated from both the groundplane and the box. The two programming resistors in the regulator circuit are shown for the LM 317. If a 78XXT part is used, these resistors must be replaced with the appropriate values from the table on the schematic. These, however, are only approximate values. The supply potential at the amplifiers should be checked and the resistor values adjusted, if necessary, to set the output amplifier supply voltage between 15V and 16V. Usually only resistor R16 needs to be adjusted slightly. Increasing R16 lowers the output voltage, and decreasing R16 raises it.

fabricating the enclosure

Building the enclosure is probably the most difficult part of this project. Because the final performance will be as much a function of the enclosure as the actual PC board, considerable care should be invested in this task.

First the paint must be removed from the interior of the box to allow good grounding of the PC board. (The easiest way to obtain effective grounding is to buy the box unfinished, but this results in a finished unit that is less attractive than it could be.) If you start with a finished box, fill it with paint remover to within about one-half inch of the top. (Be sure to use proper

VR1	R10	R17
LM317 (PREFERRED)	330	3.9k
LM340T-5	470	620
LM340T-12	1k	200
LM340T-15	1k	24
LM7805	470	560
LM7812	1k	180
LM7815	1k	22

Except as indicated, decimal values of capacitance are in microfarads (μF); others are in picofarads (pF); resistances are in ohms. k = 1,000 M = 1,000,000

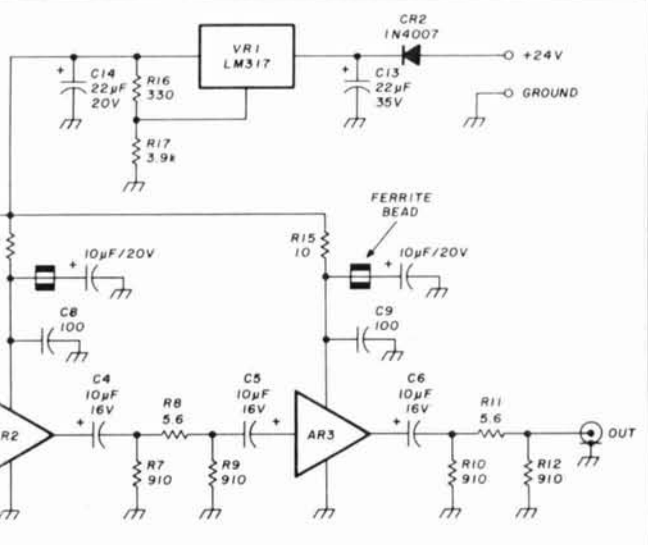

fig. 14. RF amplifier schematic.

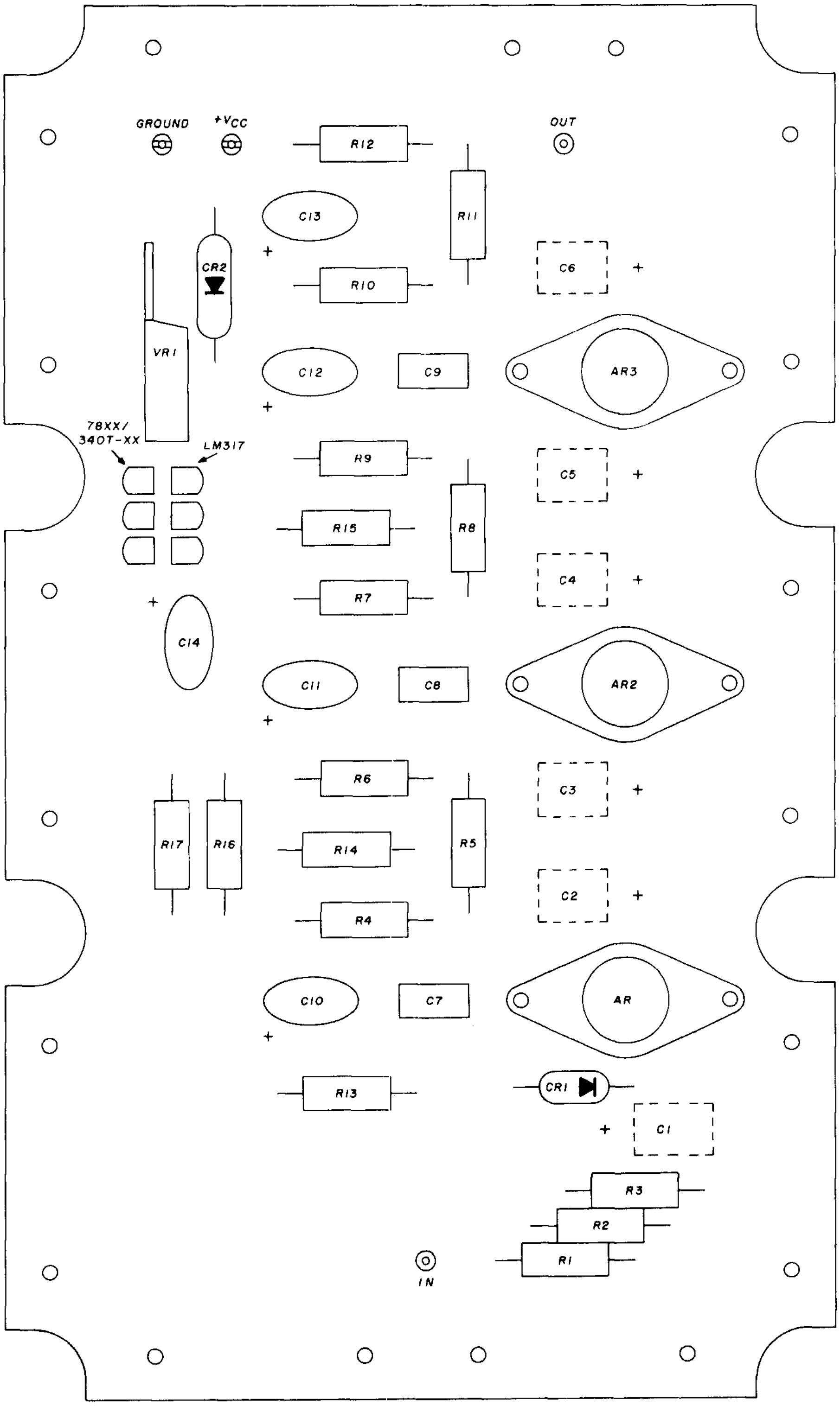

fig. 15. PC board component layout.

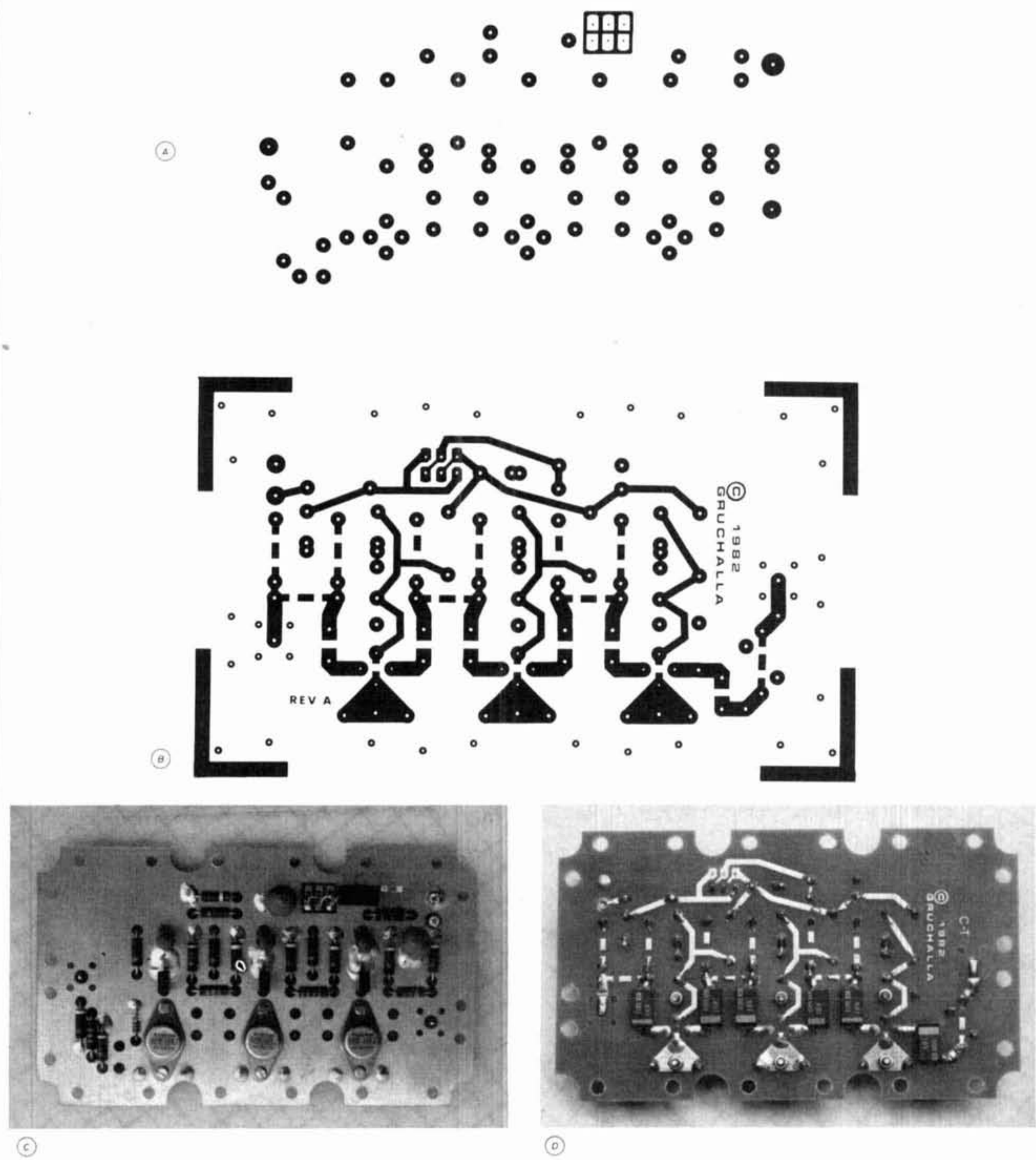

fig. 16. Double-sided PC board: (*A*) component side artwork, (*B*) ground plane side artwork, (*C*) completed assembly — component side view, and (*D*) completed assembly — ground plane side.

eye protection and gloves when handling paint remover.) Leave the paint remover in the box until it begins to attack the paint. Next, pour the paint remover out and *immediately* rinse the box in fresh paint thinner. Follow this with a thorough scrubbing with soap and water; a hard spray from a garden hose will help remove the loosened paint. Repeat the process until the paint has been removed. (If you prefer, you can remove the paint by sanding the interior walls of the box.)

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Materials list.

item	description
AR1	Avantek GPD 1061 (or GPD 461)
AR2	Avantek GPD 1062 (or GPD 462)
AR3	Avantek GPD 1063 (or GPD 464)
ferrite bead	Amidon FB 64-101 or Ferroxcube 56-590-65/4AG
C1-C6	10 μF/6.8V chip tantalum capacitor (may substitute CK05 ceramic or 196D dipped tantalum)
C7-C9	100 pF - 1000 pF, CK05 ceramic capacitor
C10-C12	10 μF/20V, dipped tantalum capacitor
C13	22 μF/35V, dipped tantalum capacitor
C14	22 μF/20V, dipped tantalum capacitor
CR1	1N5711 Schottky diode (may substitute Radio Shack 276-1124)
CR2	1N4001 Diode (may substitute 1N4002-1N4007)
filter	Erie 1221-001
R1,R3,R4,R6 R7,R9,R10,R12	910 ohm, 1/4 watt, 5 percent, RC07 resistor (Allen Bradley preferred)
R2,R5,R8,R11	5.6 ohm, 1/4 watt, 5 percent, RC07 resistor (Allen Bradley preferred)
R13-R15	10 ohm, 1/4 watt, 5 percent, RC07 resistor (Allen Bradley preferred)
R16	330 ohm, 1/4 watt, 5 percent, RC07 resistor (LM317 only)
R17	3.9K ohm, 1/4 watt, 5 percent, RC07 resistor (LM317 only)
VR1	LM317 regulator (may substitute as shown on schematic — R16 and R17 must also be changed)
box	Pomona 2901 (may substitute 2906)
terminal	(2) Cambion 160-2081-02-01-00 (input and output)
terminal	(2) Cambion 140-1385-02-01-00 (power and ground)
terminal	(1) H.H. Smith 2009 (box ground)
RF connector	UG447/U (may substitute UG290A/U with mounting holes drilled out to 7/64)
hardware for mounting regulator	
spacer	H.H. Smith 2341, 3/8 × No. 4 brass
insulator	(1) mica
shoulder washer	(1) fiber
screw	(1) 4-40 × 5/8, pan head steel
other hardware	
screw	(34) 2 × 56 × 3/16, pan head, steel (PC board and box)
screw	(8) 2 × 56 × 3/8, pan head steel (connector)
flat washer	(42) No. 2
flat washer	(1) No. 4
aluminum bar	12″ 1/4 × 1/4

The various holes must be added next. Use the PC board hole pattern (**fig. 16**) as a guide to hole placement in the mounting stock. For those who wish to precisely replicate hole locations, a detailed mechanical drawing is available from *ham radio* (enclose SASE with request). If you lay the holes out by hand, it is best to use a precision rule with both fraction and decimal graduations. Carefully mark all hole positions with a sharp scribe. Then check the dimensions to make sure all holes are in their correct locations. Be sure to center-punch all holes before drilling to prevent the drill from "walking." After drilling, deburr all the holes.

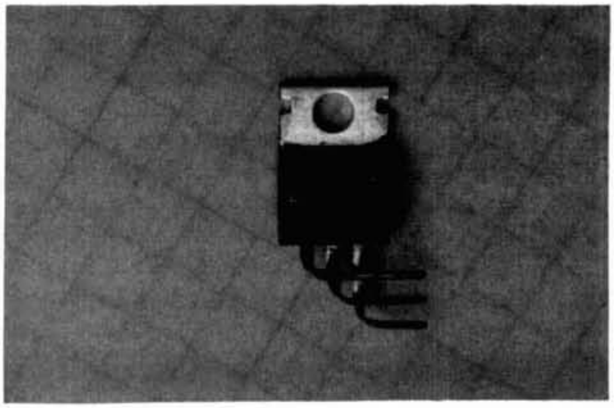


fig. 17. Regulator leads are bent for ease of mounting.

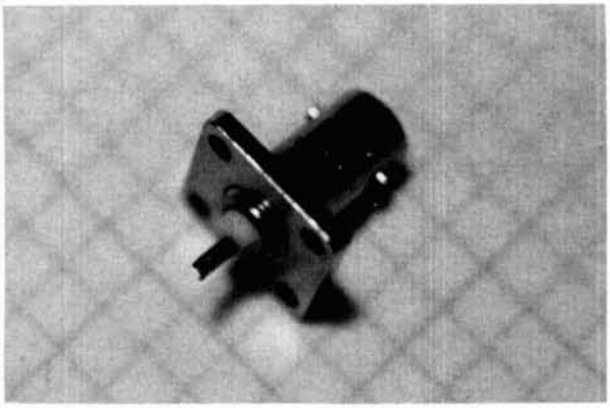
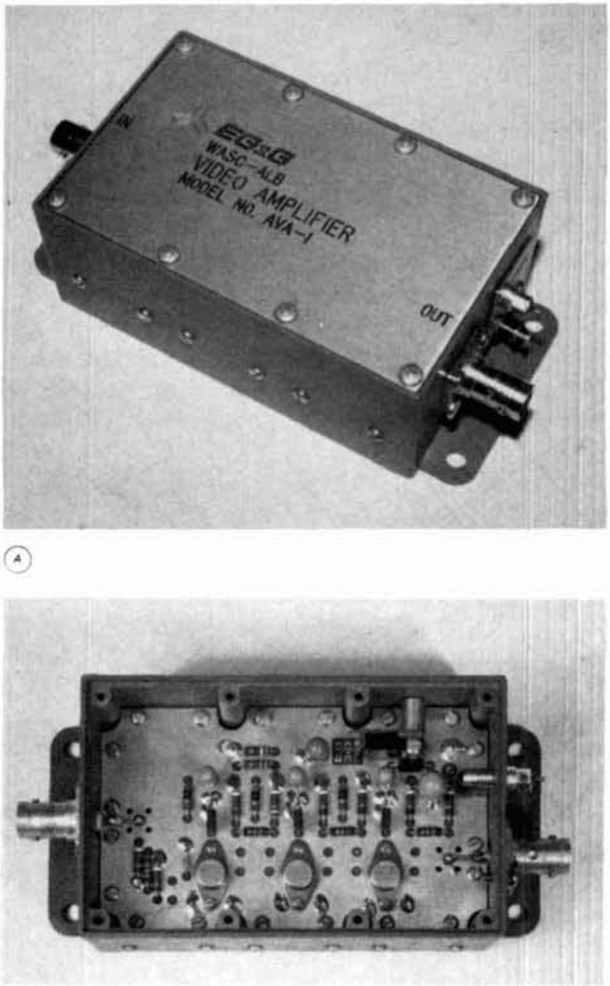


fig. 18. Dielectric ring of RF connector is modified to fit.

Now the mounting blocks must be made. The choice of material is not too critical. The 1/4-inch square material is specified, but 1/4 × 3/8 or 1/4 × 1/2 could also be used. Suitable mounting material — and the taps as well — should be available from your local hardware store. Carefully mark and cut each of the eight mounting blocks. Then mark, center-punch and drill each of the necessary holes. (Use motor oil or some other light oil to lubricate the bit.) Then tap each hole. Be *very* careful tapping. Use oil generously and back the tap out often to prevent jamming. This is particularly critical on the 2-56 holes.

final assembly

Now that all the pieces are finished, only final assembly remains. First, mount the eight mounting blocks with screws and washers inside the box, being sure to position each of the end pieces on the correct ends. Leave all screws just finger-tight to allow some adjustment. Place the PC board in the box on the mounting blocks. Again, make sure the orientation is absolutely correct. Insert all the PC board



(A)

(B)

fig. 19. Finished amplifier with lid (*A*) and without (*B*).

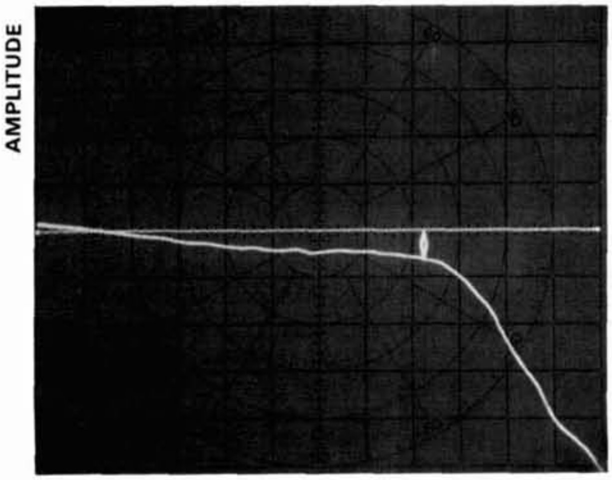


fig. 20. Swept frequency response of HF amplifier using GPD 460 series devices; the marker "birdie" is at 825 MHz (−3 dB point).

mounting screws and washers and tighten securely. Now tighten the mounting block screws.

The input and output connectors are next. First cut away the insulation to clear the PC board. (**Fig. 18** shows this modification.) Slide a knife along the solder tail into the insulation to the flange of the connector. Next, cut parallel with the flange to the solder tail and remove the piece of insulation. The connectors may now be mounted. Attach the conductors from the solder tails to the corresponding terminals. Then mount the ground terminal and power filter. Wire the power filter to the power terminal. Mount the lid and you're done.

performance

When you're finished, your amplifier should look like the one pictured in **fig. 19**. While having a machine shop available helps tremendously, the unit shown — except for the engraved lid — was build by hand exactly as described above.

Amplifiers were built using both the GPD 461/462/464 parts and the GPD 1061/1062/1063 parts. The first of these is the lower frequency unit. The bandpass of this amplifier is shown in **fig. 20**. Although the GPD 46X series parts are specified as 400 MHz devices, **fig. 20** shows that they perform far better. This unit was flat within ±2 dB from **500 Hz** to almost 900 MHz. The nominal gain of this unit was 34 dB. If you have a suitable network analyzer available, some of that gain could be traded off to allow compensation of the gain to flatten bandpass. The maximum output level of this amplifier at the 1 dB compression point was +14 dBm. The noise figure (NF) was measured roughly as 2.8 dB (260 degrees K). This is considerably better than that specified for the GPD 461 first stage, but this is not unusual because the specification value must be conservative enough to allow the manufacturer a reasonable yield. The overall dynamic range with a bandpass of 400 MHz, 2.8 dB noise figure, and +14 dBm 1 dB compression point, is then greater than 97 dB. This is reasonably high performance in any terms, but particularly good for a homemade unit.

If you think *that* was good, look at the performance of the high frequency amplifier that uses the GPD 1061/1062/1063 devices. **Fig. 21** shows the frequency response of this amplifier. This unit is flat within ±2 dB from 500 Hz to in excess of 1200 MHz, with a gain of +34 dB. The ripple above about 1000 MHz in **fig. 21** is actually due to the test system as shown in the measurement system response illustrated in **fig. 22**. The output at 1 dB compression was +13 dBm. The NF was measured to be about 3.3 dB (330 degrees K). The dynamic range is then greater than 91 dB.

Because these noise figure values seem quite good, one might suspect error in measurement; then too, the method used to measure the NF wasn't the best, but was convenient. To check the accuracy of the measurement system, the NF of an AWL-1200 com-

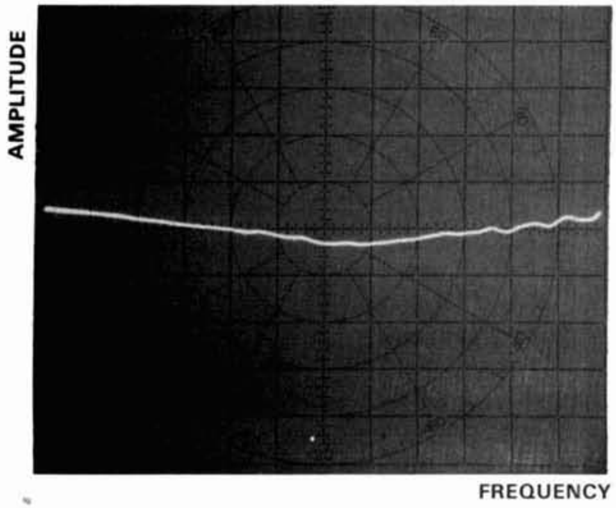


fig. 21. Swept frequency response of HF amplifier using GPD 1060 series devices.

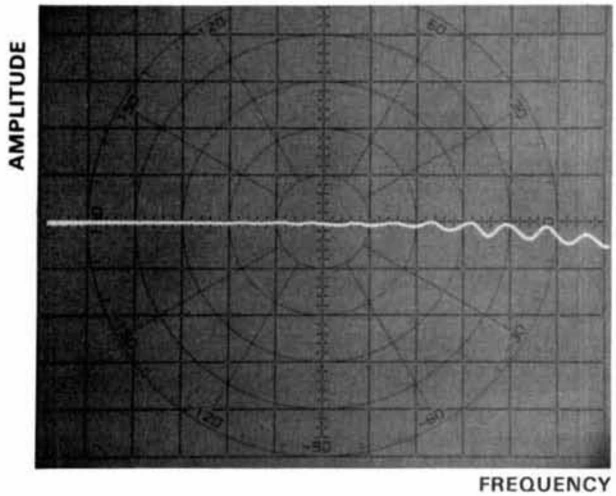


fig. 22. Test instrumentation actually introduces major ripple component.

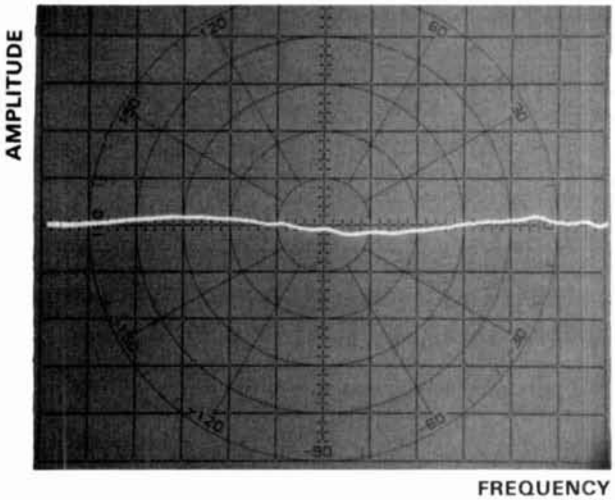


fig. 23. A wideband amplitude "flatness" of ±1 dB is achieved through the use of bandpass compensation.

mercial amplifier was measured. This unit was specified to have a NF of 5 dB and a value of 4.3 dB, was measured. This shows quite good agreement and that the results are reasonably accurate.

To demonstrate bandpass compensation, the high frequency unit was compensated to provide a flatness of ±1 dB. This is shown in **fig. 23**. About 4 dB of gain was traded for this performance. With enough patience, the bandpass could be flattened even further, but ±0.5 dB or so is about a practical limit.

Fig. 10 shows the gain variation of the high-frequency amplifier with operating voltage. For this example, the regulator output voltage was varied from 16V down to 8V in 1V steps with the highest gain corresponding to the highest voltage. This shows that some slight gain control can be provided with variation of supply voltage.

Performance of the high-frequency amplifier with CK05 0.1 μF coupling capacitors is shown in **fig. 12.** This raised the low frequency cutoff to about 50 kHz. Notice the slight peak in response at 1200 MHz in **fig. 12**. This could be attributed to stray coupling or the poorer impedance characteristics of the CK05. This peak was found to reach a +5 dB maximum at 1290 MHz beyond which the response dropped normally. **Fig. 13** shows the response with 196D, 10 μF, 20V dipped tantalum coupling capacitors. The low frequency cutoff was again 500 Hz and the high frequency characteristics were much the same as the CK05 — not perfect, but certainly acceptable.

conclusions

While constructing the amplifier described is not easy, it certainly should be within the capability of most readers. Once past the mechanical construction, the electronic assembly is simple. (This is quite the opposite of most RF amplifier construction projects.) Exercising care and patience in building this unit results in excellent performance; furthermore, the cost is quite modest compared to commercially available units offering similar performance.

I believe this project will demonstrate the simplicity and convenience of designing with modular hybrid amplifiers. This will be particularly obvious to those adventurous individuals who've spent many hours with plastic tweezers and razor blades, "tweaking" a discrete design. (Even when finished with those labor-intensive designs, you could not be sure of performance without a network analyzer.) If you build this amplifier carefully, its performance will almost certainly be similar to that documented above. And, if you follow the design hints given above, you should have little trouble using modular hybrids in your own designs.

reference

1. C.D. Motchenbacher and F.C. Fitcher, "Low Noise Electronic Design," *John Wiley & Sons*, New York, N. Y. 1973.

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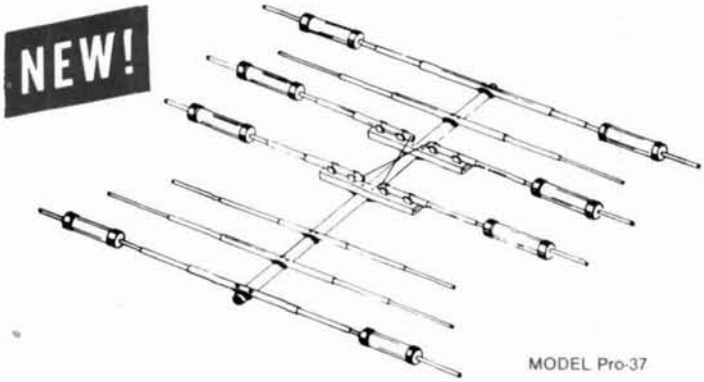

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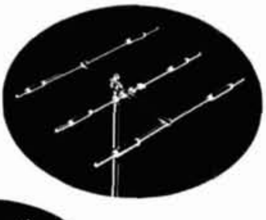

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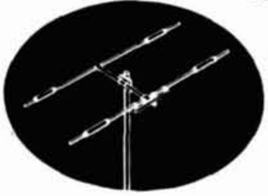

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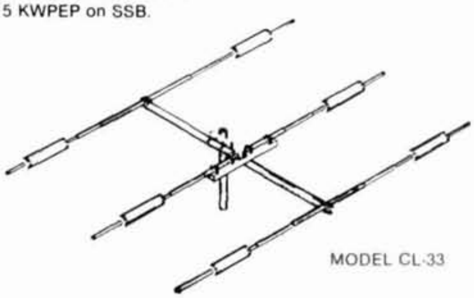

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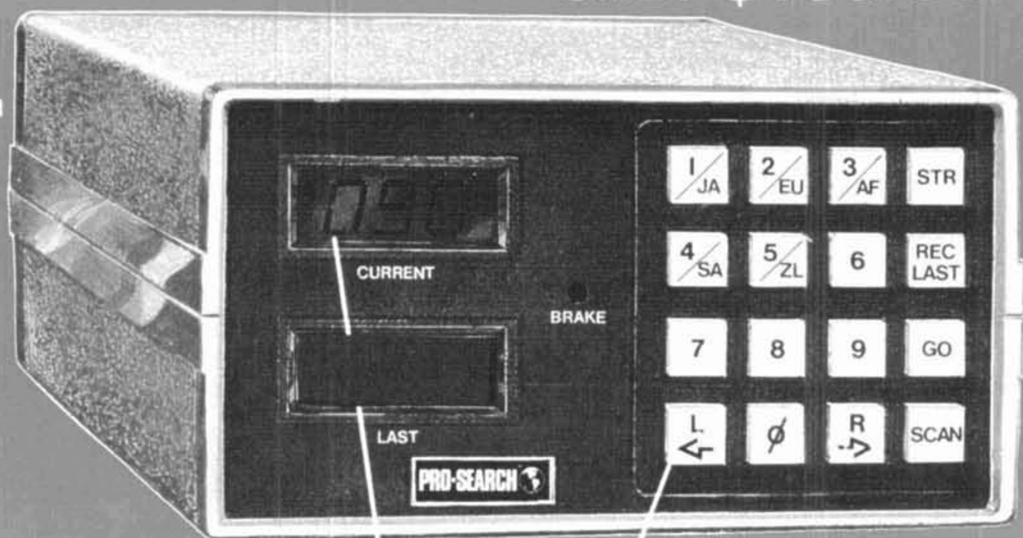

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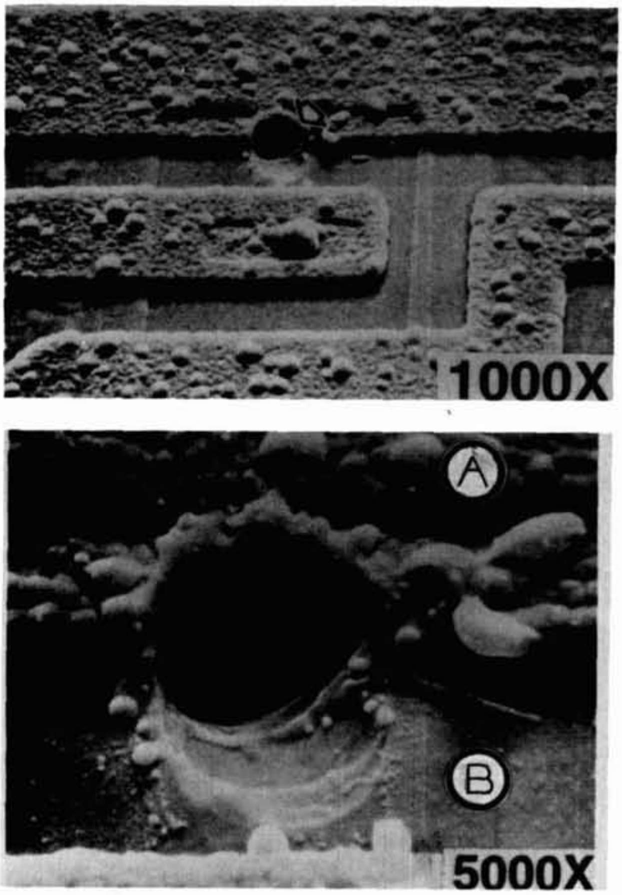

fig. 1. Enlarged, detailed views of a 6-micron (0.0002 inch) diameter hole created in aluminum metallization (A) and silicon dioxide substrate (B) by static electricity on an op amp integrated circuit.

By Morris H. Lundberg, K4KEF, 131 Burnett Way, Alpharetta, Georgia 30201

The integrated circuit is no exception to the familiar rule that says you can't get something for nothing. While the use of ICs has enabled manufacturers to reduce both size and power requirements of battery-operated radio equipment, there is a price for this increased portability and convenience. That price is extreme vulnerability to static electricity (**fig. 1**).

But are ICs really as sensitive to static damage as suggested in product packaging and literature?

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Bearcat® 300 Scanner	$349.00
Bearcat® 260 Scanner	$259.00
Bearcat® 250 Scanner	$279.00
Bearcat® 200 Scanner	$189.00
Bearcat® 210XL Scanner	$229.00
Bearcat® 20/20 Scanner	$289.00
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FB-W Frequency Directory for Western U.S.A.	$12.00
TSG "Top Secret" Registry of U.S. Government Freq.	$15.00
RRF Railroad Frequency Directory	$10.00
ESD Energy Services Directory	$10.00
ASD Frequency Directory for Aircraft Band	$10.00
SRF Survival Radio Frequency Directory	$10.00
TIC Techniques for Intercepting Comm. Manual	$12.00
CIE *Covert Intelligence, Elect. Eavesdropping Man.*	$12.00
B-4 1.2 V AAA Ni-Cad batteries (set of four)	$9.00
B-6 1.2 V AA Ni-Cad batteries (set of four)	$12.00
A-135c Crystal certificate	$3.00
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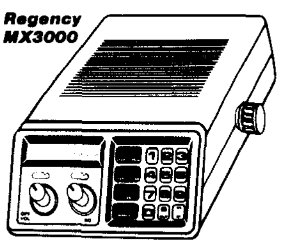

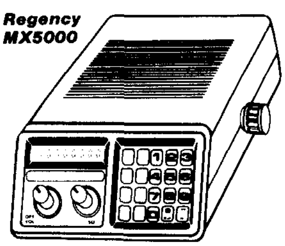

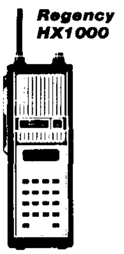

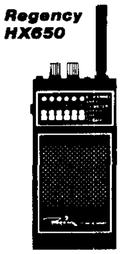

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fig. 2. Conductive wrist strap prevents damage to sensitive electronic circuitry by draining static buildup from worker. Humans can build up more than 8000 volts of static charge on themselves with normal activity. Some sensitive devices, however, can be destroyed or degraded by less than 100 volts of static charge.

fig. 3. Work stations, where delicate electronic parts and circuits are handled, should be protected against static electricity. Protection includes conductive table and floor mats, as well as wrist strap pictured in *fig. 2.* A blower also circulates a stream of negatively charged ionized air to neutralize static on non-conductive materials, such as plastic coffee cups, which cannot be grounded.

Semiconductor manufacturer Mostek also developed an ESD program in which it was able to reduce catastrophic ESD failures in the devices most susceptible to static damage by about two thirds on final test line production. In one Hewlett-Packard packaging plant, the yield went from 25 to 100 percent, with an overall improvement of 10 percent in IC lab yields after ESD procedures were instituted.[2] Tel-Matic Systems of Toledo, Ohio, reported a 60 percent reduction in the failure rate of newly installed electronic telephone systems after an ESD program was initiated.[3]

Although elaborate and costly, the ESD programs conducted by these companies consist primarily of static grounding of all personnel who handle sensitive devices, as well as the institution of improved handling, storage, and shipping methods. Several techniques of static grounding are used. Grounded wrist straps (**fig. 2**) and grounded, conducting workbench and floor mats (**fig. 3**) drain away static charge before any damaging voltage can develop.

Anti-static plastic pouches have been used for some

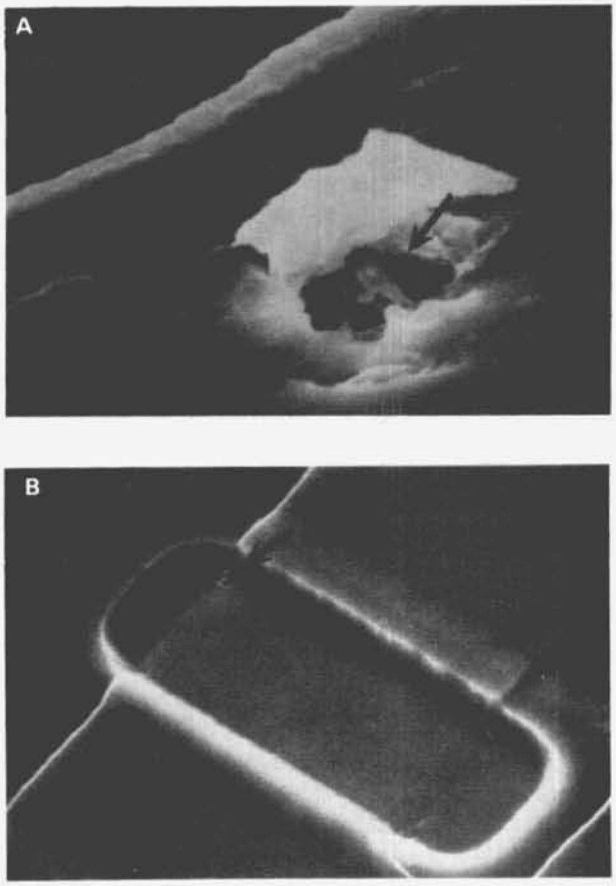

fig. 4. (A) shows static damage, magnified 7000 times, to a 3N157 MOSFET; (B) shows damage to an input pull-up resistor on a p-MOS character generator at 3000x magnification.

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(shown with 14K RAM and 8K ROM)

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- Can be customized for **LANS** and up to 56K RAM

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Manual only—credited with purchase (add $2.00 for shipping)	9.95
RTTY adapter board	12.95
Custom cabinet—includes installation of TNC, on/off switch, LED pwr indicator, reset button & pwr jack	24.95

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Pwr required: +12 VDC, approx. 200 ma.

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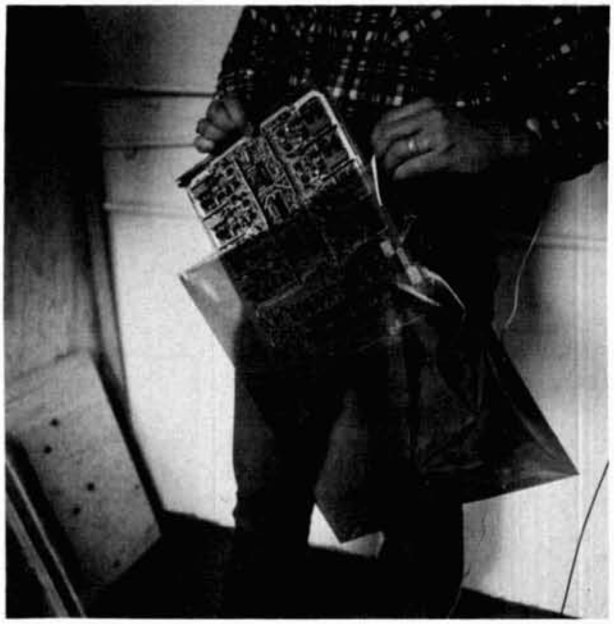
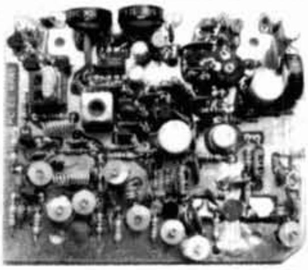


fig. 5. Three-layer bag protects circuit boards in shipping, storage, and handling. The outer surface is vapor coated with nickel to provide low surface resistivity to shield contents from external static fields. The middle layer provides strength, and the inner, heat-sealable layer prevents buildup of triboelectric (frictional) charge inside the bag.

AMATEUR TELEVISION



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time to protect devices in transit; recently, metal foil-lined plastic pouches have been found to be even more effective in eliminating static damage during handling, shipping, and storage (**fig. 4**). These containers also tend to eliminate penetration of electrostatic fields that may affect the contents, which are clearly visible through the foil liners (**fig. 5**).

So what does this mean to you and me? With more than half of the new ICs sensitive to damage at 100 volts, and several of the newer, more complex devices failing at as low as 30 to 40 volts, it's obvious that appropriate precautions must be applied.[4] This is particularly true with some of the new Ceramic Metal Oxide Silicon (CMOS) type of circuits. We should thoroughly ground ourselves before touching *anything* inside electronic enclosures. It's also a good idea to continuously drain off any static charge that might build up as we work.

Remember, it doesn't have to be a dry day — and you don't have to drag your feet across the carpet — to cause damage to sensitive components.

references

1-4. Publication #225-4S, 3M Static Control Systems Division, St. Paul, Minnesota 55144.

All photographs courtesy of 3M Static Control Systems Division.

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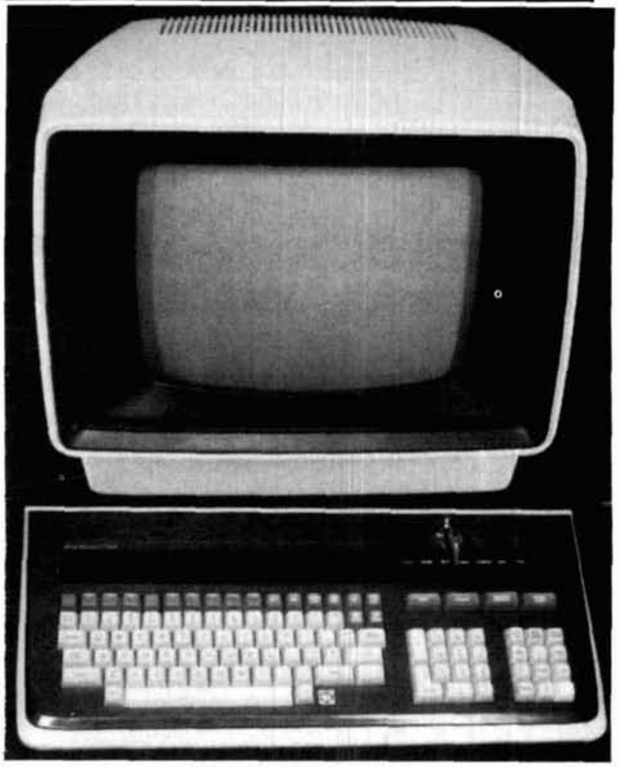
SELF STANDING COMPUTER TERMINALS

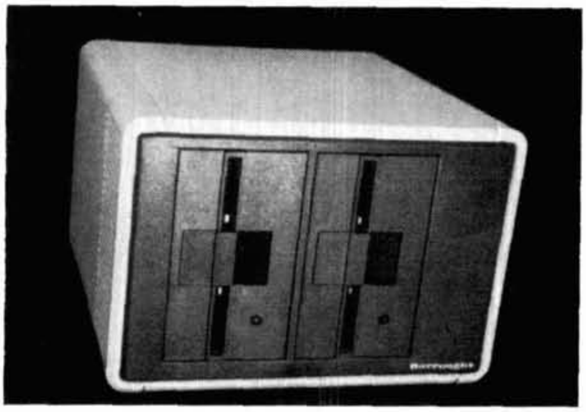


We acquired a small number of these beautifully made computer terminals which were made by a major U. S. manufacturer. We do not know all the details about them at press time, but we can tell you that someone lost over $2000 on each of them. They lose you win. The terminals feature 3 micro-processors for powerful capabilities, 106 key, Hall Effect ASCII keyboard, 10 user defineable keys, EAROMs, 16K RAM, 48K ROM, serial RS 232 asynchronous data communications, (synchronous optional), selectable baud rates of 75-38.4K BPS, high resolution, 12" green screen, composite video monitor, 80 X 25 line scrolling display, built-in reverse video option, self-contained, lightweight, tightly regulated switching power supply & more than can be fit in this space. The terminals were designed to be daisy chained around a central host computer and used as individual work stations. The host system could then selectively address any machine in the network for any message it may have. All units are visually inspected prior to shipment. An operators manual is provided w/ each unit. Shpg. wt. 55 lb. model no. MT 686 $289.00

With the addition of our TP 420 dual FDD system below, you can create your own office system.

We offer the following as options: schematic pac. 3 lb.	$ 10.00
USRT for synchronous data comm. w/ installation data	$ 10.00
25' RS 232 cable, 1 male & 1 female DB 25 connector	$ 20.00

TP 420 DUAL MINI-FLOPPY DISC SYSTEM



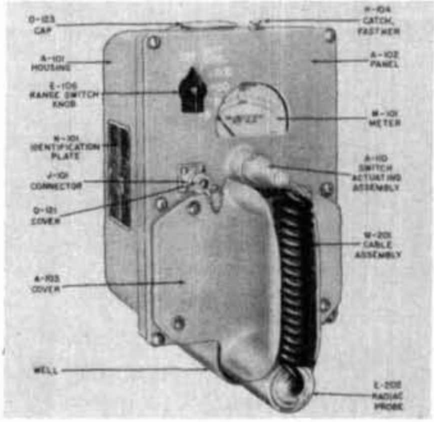
The TP 420 is an extremely versatile mini floppy disc drive system. It consists of 2 Shugart SA 400 5¼" floppy disc drives, associated logic, controller card, power supply, cooling fan, and case. The TP 420 has a built in controller card which features: Z 80 A CPU, Z 80A DMA, Z 80A CTC, Intel 8271 controller chip, 6K RAM, ROM, plus other goodies. We have been told that the serial interface controller card within the TP 420 will support up to 4 8" drives from the unused port on it. The con troller card can be easily removed should you wish to use it on some other system. Also built in is a tightly regulated, switching power supply which runs on 115/230 v 50/60 hz.. The TP 420 is shipped w/ the interface cable for the MT 686, data, & schematics. Shpg. wt. 22 lb. Stock no. TP 420 $300.00

PDR-27 NAVY RADIATION METER

Just released by the US Navy. They appear to be in excellent condition and include the fitted aluminum transit case. Batteries not furnished but are available in most electronic supply houses. 4 ranges 0.5 to 500 mr/hr. Removeable hand probe, detection of Beta and Gamma radiation. With todays world conditions and perhaps proximity to a nuke power station, it might provide a little insurance to own one of these instruments. With no facilities to check or test, we offer AS IS, visually OK Schematic provided with each. We have some accessories and offer as an option although not required for operation. Shipping wgt. 22 lb. PDR-27 Rad Meter $50.00

PDR-27 phones $7.00	Approx. 100 page Instr. Book $10.00
Hi Sensitivity GM tube $10.00	Low Sensitivity GM tube $5.00

The above listed tubes are already installed in the meter.
We are offering these as spares if desired.



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moon-tracking by computer

Determine azimuth and elevation with simplified computer program

table 1. Letter assignments of variables.

A = LATITUDE OF LOCAL STATION
B = LONGITUDE OF LOCAL STATION
C = GHA-1
D = GHA-2
E = DEC-1
F = DEC-2
G = GMT OF MOONRISE
H = (D-C)/48 INTERPOLATION INCREMENT GHA (0.25 HOUR)
I = (E-F)/48 INTERPOLATION INCREMENT DEC (0.25 HOUR)
J = B-C
K = COS(J/Z)
L = COS(A/Z)
M = COS(E/Z)
N = SIN(A/Z)
O = SIN(E/Z)
P = TAN(A/Z)
Q = ARCSIN(X) ELEVATION ANGLE
R = COS(Q/Z)
S = TAN(Q/Z)
T = ARCCOS(Y) AZIMUTH ANGLE
X = (K*L*M) + (N*O)
Y = (O/(R*L)) − (P*S)
Z = 57.2957795 RADIAN CONVERSION FACTOR.

THE PROGRAM IS ITERATED IN QUARTER HOUR INCREMENTS AND MAY BE STOPPED AT ANY DESIRED POINT.

A simple, user-friendly program of 58 steps to determine the position of the moon is now available for the TRS-80C* computer. Based on a more complex moon tracking program developed by the EIMAC division of Varian, Inc., this program computes and prints out the azimuth and elevation of the moon for every quarter-hour.

There's no list of rules to be followed and the entries are very short. Only six are required:

- LATITUDE OF LOCAL STATION (degrees, minutes, North or South)
- LONGITUDE OF LOCAL STATION (degrees, minutes, East or West)
- GHA-1 AT EVEN HOUR BEFORE MOONRISE† (degrees, minutes)
- GHA-2 12 HOURS LATER (degrees, minutes)
- DEC-1 AT EVEN HOUR BEFORE MOONRISE‡ (degrees, minutes, North or South)
- DEC-2 12 HOURS LATER (degrees, minutes, North or South)

Each function is assigned a letter; the long mathematical equations then become simple expressions of letters (see **table 1**). This reduces the chance of error considerably. The computations then require only about a dozen steps, using a straight-line interpolation of the GHA and DEC values over the twelve-hour period. The AZ-EL accuracy obtained by this simplification is adequate.

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*TRS-80C is a trademark of Tandy, Inc.
†Greenwich Hour Angle, equivalent to longitude on the Earth, is the angular distance of a celestial body west of the celestial meridian of Greenwich.
**Declination, equivalent to latitude on Earth, is the angular distance of celestial body north or south of the celestial equator. (Extension of plane of Earth's equator.)

By I.L. McNally, K6WX, 26119 Fairlane Drive, Sun City, California 92381

TRS-80C Moon-tracking program (LOAD "EME/BAS:0")

```
5 PRINT#-2,"PROGRAM FOR MOON TRACKING. INPUTS ARE IN DEGREES AND MINUTES."
10 INPUT "LATITUDE:DG,MN,N OR S";AA,AB,AC$
15 PRINT#-2, AA;AB;AC$,"LATITUDE IN DEGREES AND MINUTES."
20 IF AC$="S" THEN 25 ELSE 30
25 A=(AA+AB/60)*(-1):GOTO 35
30 A=AA+AB/60
35 PRINT#-2, A "LATITUDE IN DECIMAL DEGREES.(A)"
36 INPUT "LONGITUDE:DG,MN,E OR W";AD,AE,AF$
37 PRINT#-2, AD;AE;AF$, "LONGITUDE IN DEGREES AND MINUTES."
40 IF AF$="E" THEN 45 ELSE 50
45 B=(AD+AE/60)*(-1):GOTO 55
50 B=AD+AE/60
55 PRINT#-2, B "LONGITUDE IN DECIMAL DEGREES.(B)"
60 INPUT "GHA-1 AT EVEN GMT BEFORE MOONRISE:DG,MN";AG,AH
65 PRINT#-2,AG;AH, "GHA-1 IN DEGREES AND MINUTES."
70 C=AG+AH/60
75 PRINT#-2, C "GHA-1 IN DECIMAL DEGREES.(C)"
80 INPUT "GHA-2 12 HOURS AFTER MOONRISE:DG,MN";AI,AJ
85 PRINT#-2,AI;AJ,"GHA-2 IN DEGREES AND MINUTES."
90 D=AI+AJ/60
95 PRINT#-2,D "GHA-2 IN DECIMAL DEGREES.(D)"
100 INPUT "DEC-1 AT EVEN GMT BEFORE MOONRISE:DG,MN,N OR S";AK,AL,AM$
101 PRINT#-2,AK;AL;AM$,"DEC-1 IN DEGREES AND MINUTES."
102 IF AM$="S" THEN 105 ELSE 110
105 E=(AK+AL/60)*(-1):GOTO 115
110 E=AK+AL/60
115 PRINT#-2, E "DEC-1 IN DECIMAL DEGREES.(E)"
120 INPUT "DEC-2 12 HOURS AFTER MOONRISE:DG,MN,N OR S";AN,AO,AP$
125 PRINT#-2, AN;AO;AP$, "DEC-2 IN DEGREES AND MINUTES."
130 IF AP$="S" THEN 135 ELSE 140
135 F=(AN+AO/60)*(-1): GOTO 145
140 F=AN+AO/60
145 PRINT#-2,F "DEC-2 IN DECIMAL DEGREES.(F)"
150 INPUT "STARTING GMT"; G
160 Z=57.2957795
165 H=(D-C)/48
175 I=(E-F)/48
182 PRINT#-2, G "GMT"
185 J=B-C
190 K=COS(J/Z)
195 L=COS(A/Z)
200 M=COS(E/Z)
210 N=SIN(A/Z)
215 O=SIN(E/Z)
220 P=TAN(A/Z)
225 X=(K*L*M)+(N*O)
230 Q=Z*(ATN(X/SQR(-X*X+1)))
231 PRINT#-2,Q "ELEVATION ANGLE (Q)"
235 R=COS(Q/Z)
240 S=TAN(Q/Z)
245 Y=(O/(R*L))-(P*S)
250 T=Z*(-ATN(Y/SQR(-Y*Y+1))+1.5708)
255 PRINT#-2, T "AZIMUTH ANGLE.(T)"
260 U=360-T
265 PRINT#-2,U "AZIMUTH ANGLE WHEN GHA>LONGITUDE.(U)"
270 G=G+.25
275 E=E-I
280 C=C+H
285 GOTO 182
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R144 Shown

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- **R451 FM RCVR** Same but for uhf. Tuned line front end, 0.3 uV sens. Kit only $138.
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- **R110-259 SPACE SHUTTLE RECEIVER,** kit only $98.

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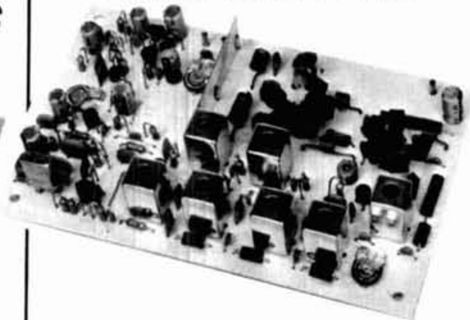

- **T51 VHF FM EXCITER** for 10M, 6M, 2M, 220 MHz or adjacent bands. 2 Watts continuous, up to 2½ W intermittent. $68/kit.

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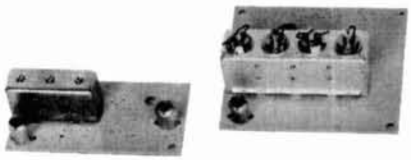

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Models LNA( ), P30, and P432 shown

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LNA 144	120-180	1.0 dB	18 dB	$39
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P432 also available in broadband version to cover 20-650 MHz without tuning. Same price as P432; add "B" to model #.

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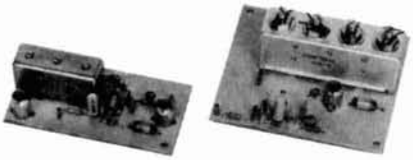

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50-52	28-30
50-54	144-148
144-146	28-30
145-147	28-30
144-144.4	27-27.4
146-148	28-30
144-148	50-54
220-222	28-30
220-224	144-148
222-226	144-148
220-224	50-54
222-224	28-30

UHF MODELS
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435-437	28-30
432-436	144-148
432-436	50-54
439.25	61.25

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Exciter Input Range	Antenna Output
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28-29	145-146
28-30	50-52
27-27.4	144-144.4
28-30	220-222*
50-54	220-224
144-146	50-52
50-54	144-148
144-146	28-30

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Exciter Input Range	Antenna Output
28-30	432-434
28-30	435-437
50-54	432-436
61.25	439.25
144-148	432-436*

*Add $20 for 2M input

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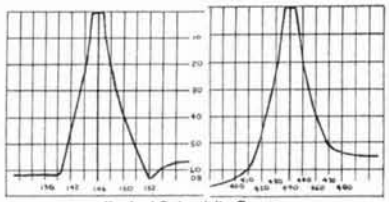

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VHF/UHF WORLD

Joe Reisert W1JR

VHF/UHF receivers

It's been some time since my last article on VHF/UHF receivers.[1] In many ways, the substance of that article still stands as written; however, technology marches on, and the state-of-the-art *has* improved: the development of GaAs FETs (gallium arsenide field effect transistors) and the proliferation of commercial transceivers for the VHF and lower UHF regions are just two examples of important changes that have taken place in recent years. This would be a good time, therefore, to take another look at the subject, review the material and circuitry discussed in my previous article, and bring some of it up to date in this month's column.

parameter review

Noise Figure. Noise figures have dropped dramatically over the last few years, largely because of improvements in devices available, but particularly because of the increased availability of inexpensive ($2.50-$15.00) MOS and GaAs FETs. New noise figure measurement equipment that yields extremely accurate numbers has made everyone "more honest" — and while it hasn't yet appeared in many ham shacks, it is readily available at most VHF/UHF conferences.

Modern state-of-the-art preamplifiers can now attain noise figures of 1 dB or better on any Amateur band below 1300 MHz, with gains up to 25 dB, using low-cost (under $15.00) GaAs FETs. In fact, 0.5 dB noise figures are not uncommon when slightly higher priced devices are used and special care is taken to use high *"Q"* components on the input matching networks.

IMD (intermodulation distortion) and blocking. IMD is getting to be a serious VHF/UHF problem as activity, power, and antenna gains are increased. On top of this, it is becoming common practice to place a very-low-noise preamplifier ahead of the receiver to improve sensitivity. Use of GaAs FETs has helped since they usually have high dynamic range and narrower bandwidth than their predecessors, the bipolar transistor, but they frequently have higher gain and hence *increase* the problem! Also, many converters still use mixers with poor dynamic range. To top it off, many VHF/UHF'ers who use converters/transverters have an IF exhibiting poor dynamic range.

How can you cope with these problems? Pay close attention to the gain distribution of the system and keep gain as low as possible ahead of the mixer. Typically speaking, 30 dB of gain ahead of a mixer is usually more than sufficient, even for low-noise and EME. Frequently only 10 to 15 dB of gain is required ahead of a mixer for normal operation such as tropo,* where 2 to 5 dB noise figures are adequate. As a rough rule of thumb, the gain of a preamplifier in a high *dynamic range* receiver should be approximately 6 dB greater than the noise figure of the receiver following it. In a low-noise setup a preamplifier should have about 10 dB more gain than the noise figure of the following receiver. For example, if a converter in a high dynamic range configuration has a 9 dB noise figure, only a 15 dB gain preamplifier is required, but 19 dB would be desired in a *low-noise* system (such as EME). Obviously, if you lower the noise

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*Tropospheric communications utilizes weather related changes in the atmosphere as opposed to ion concentrations found in the ionosphere to refract VHF/UHF signals. Using "tropo," reliable communications can be established several hundred miles beyond the horizon. — **Editor.**

figure ahead of the mixer with a moderate noise figure amplifier, less gain is required in the preamplifier. Examples of gain and cascaded noise figure calculations[2] are now found on some computer programs.[3]

Spurious responses. We live in an RF-polluted world. Signals are inundating the entire VHF/UHF spectrum; many of them are not even coming from normal transmitters, but are instead generated by scanners, computers, TV sets, and more recently, CATVI (Community Antenna Television Interference). The days of wide-open (little filtering) front-ends are limited. In order to cope with this situation we must pay more attention to RF filtering, selection of local oscillator frequencies (including the fundamental oscillator when frequency multipliers are used), and use high dynamic range circuitry. When using LO (local oscillator) multipliers for the higher frequency bands, try to use doublers wherever possible. Triplers and quadruplers have all kinds of problems including low output and more spurious products to be filtered. You'll be way ahead in the long run if you don't use them.

IF selection. Let me first reiterate some of the highlights of the earlier material about IF selection.[1] Try to use an IF frequency that is high enough to allow good image rejection but low enough to have good frequency stability. I prefer 28 to 30 MHz and use this range for all my converters through 2304 MHz. For converters from 144 MHz and above, use local oscillators with overtone crystals preferably in the 94 to 116 MHz range. Using a local oscillator with a fundamental frequency of 38.666 or 58 MHz for a 116 MHz local oscillator injection strip for 2 meters (28 MHz IF) is an open invitation for birdies. Furthermore, the lower cost of the crystal is often offset by the cost of the components in the extra multiplier required.

One other recommendation is to *not use even frequencies for the IF.* For example, it is common practice in commercial converters and transverters to use a 404 MHz LO for 432 MHz operation with a 28 MHz IF. This puts the weak signal region (432.0-432.1) between 28 and 28.1 MHz. This is a heavily used frequency range for HF, and IF leakthrough may place some HF signals right on top of a weak signal. If the local oscillator is slightly high in frequency (while still being well within specification), 432.0 MHz signals may be below the tuning range on the IF.

It is reassuring to be able to check frequency calibration accurately with an external frequency marker, but if the marker is a harmonic of a 1, 2, or 4 MHz calibration standard, the image frequency (376.0 MHz in this case), as well as the IF receiver (28 MHz), will pick up the marker. The net result will be a hopeless grouping of signals which must be sorted out before true frequency calibration can be determined. For best results, use an LO that will place the lowest frequency of interest at, for example, 28.1 MHz. (In this case the proper choice of the local oscillator would be 403.9 MHz.) The net result will be a cleaner sounding converter more removed from congestion and only one crystal clear marker to zero beat.

transceiver review

Commercial Amateur transceivers are now available for all VHF/UHF bands up to 1300 MHz. If you have one of these transceivers, there isn't much you can do to the innards without risking possible devaluation if you should ever decide to sell it. The modern rigs are complex and compactly constructed requiring skill, knowledge and complete documentation by anyone attempting to work on them. Real improvements — such as adding a low-noise preamplifier ahead of the receiver — usually have to be made externally.

An external preamplifier, especially a well designed GaAs FET type, will almost always yield a lower noise figure on an existing transceiver. However, most present-day commercial transceivers have low dynamic range "as is" and can generate IMD when any extra gain is placed ahead of them. This is not meant to imply that you won't have the same problem on a homebrew transverter or converter, as discussed earlier. However, in the latter case you will probably be able to lower the gain ahead of the mixer and at least partially compensate for the increase in gain of the extra preamplifier.

Another problem in modern solid-state equipment that has been plaguing Amateurs and commercial users alike is phase noise or noise sidebands present on the local oscillator. This is particularly true on rigs that use synthesized local oscillators. While this problem is not too obvious when listening, when a strong signal appears alongside or sometimes even some distance down the band from the station you are listening to, watch out! Before you tell said station that he has a dirty signal or is hitting it too hard, bypass your preamplifier or turn on the internal attenuator (if you have one) and see whether there is a dramatic drop in QRM or buckshot. Even if you build your own converter or transverter, your IF system can be a limiting factor in dynamic range. You may still have problems similar to the ones mentioned above, but now they may instead appear in the IF circuitry!

recommended circuits

Mixers. Many of the problems mentioned above can be eliminated or contained by using inexpensive ($10.00 or less) DBMs (double balanced mixers). My low-cost favorite is the Mini-Circuits Labs SRA-1. Their less expensive ($3.95 in quantities of 10 to 49) SBL-1 is also acceptable, but sometimes has a 1 to 3 dB poorer signal handling capability than the SRA-1. Recently I have seen many acceptable DBMs showing up at flea markets for some very attractive prices.

In order to use all of the capabilities of the DBMs, it's important to have each port properly terminated[4] and to provide adequate local oscillator power (5 to 10 milliwatts) at the mixer terminals. I have found that the easiest way to accomplish this is to use 3 dB attenuator pads on the local oscillator and RF ports and a simple diplexer on the IF port. The 3 dB pads will terminate the various undesired frequencies generated internally in the DBM and improve the impedance match to externally connected circuits. The diplexer will filter undesired outputs from the IF while providing a good match to the mixer and postamplifier. A

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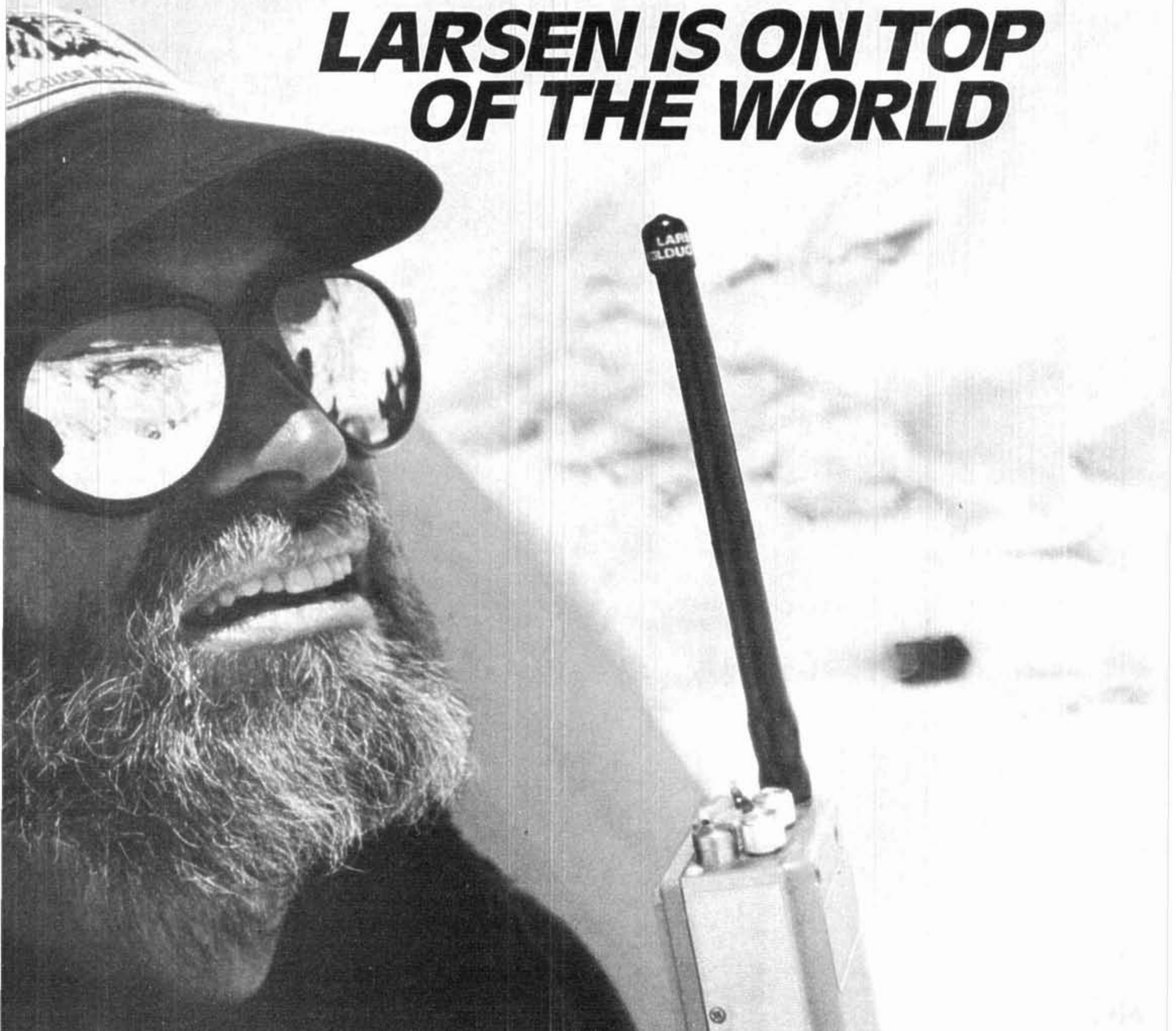

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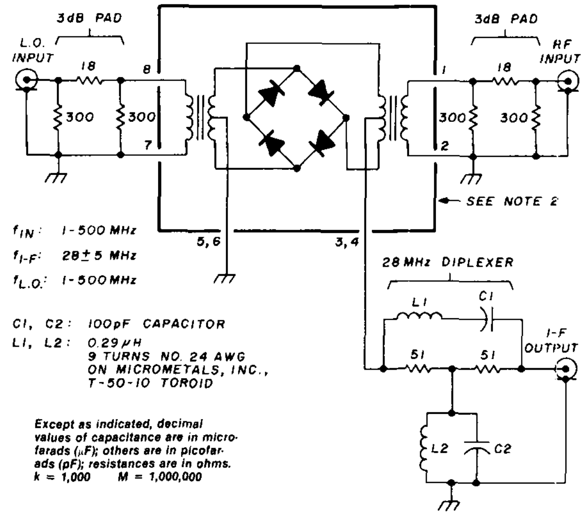
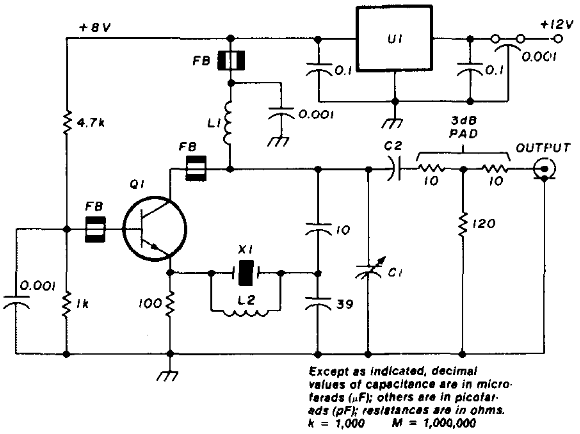
recommended circuit I've been using for over 10 years in shown in **fig. 1**. This circuit required 10 milliwatts of local oscillator power and will easily yield a 9 to 10 dB noise figure as is if followed by a low noise (1 dB) postamplifier. This mixer configuration with a single U310 JFET preamplifier ahead of same is more than adequate for a 2 to 3 dB noise figure high-dynamic-range converter on any Amateur band between 50 and 450 MHz.

Local oscillators. Remember that the local oscillator is also very important. It should be stable, have sufficient output power, and be free of strong (less than 25 dB down) harmonics and any spurious frequenices. My favorite oscillator circuit, an improved version of the one in my 1976 article, is shown in **fig. 2**. Several points still apply. The crystal should be a high-quality 5th or 7th overtone series-resonant type, preferably in an HC-18/U holder. *Capacitors or inductors should never be placed in series with the crystal* because this will dramatically lower the *Q* of the crystal *and hence the stability of the oscillator*. If you purchase a high quality, high accuracy crystal, it should be close to the desired frequency. If frequency deviations are needed, compensate for them by offsetting the frequency of the IF. One final point: a common crystal oscillator I sometimes see in use has the crystal connected from base to ground. This is an example of a poorly designed circuit because the crystal is operating in a low *Q* mode. Hence the oscillator is more likely to be less stable, operate on *spurious frequencies, and have high* phase noise. If you use such a circuit, try modifying it according to the circuit shown in **fig. 2**.



Notes:
(1) Keep all leads, especially grounds, as short as possible.
(2) Pin connections shown are for Mini-Circuit Labs SRA-1 or SBL-1 DBM. Other manufacturers' DBMs may use a different numbering system, but are usually physically located at the same place on a functional basis.

fig. 1. Recommended circuit for using commercial DBMs.



C1 2-20 pF small trimmer capacitor
C2 5 pF capacitor
FB ferrite bead - Ferroxcube No. 56 590 65/3B or equivalent
L1 8 turns No. 24 AWG enamelled wire close wound on 0.1 inch (2.5 mm) diameter
L2 0.39 μH RF choke or 10 turns No. 28 AWG on T-25-6 toroid core
Q1 2N5179, NE73432 or equivalent
U1 78L08 3-terminal 8-volt regulator
X1 5th or 7th overtone series resonant 90-125 MHz crystal (see text)

fig. 2. Recommended overtone crystal oscillator for 90-125 MHz. Output is approximately 10 milliwatts.

Multipliers. Some typical frequency doublers — improved versions of those illustrated in my earlier article — are shown in **figs. 3** and **4**. High quality tuning capacitors with short leads should be used so that the output power will be high and the spectrum as clean as possible. Properly duplicated, these circuits *do not require a spectrum analyzer for* alignment. All that is required is to peak all adjustments for maximum output power.

A few extra comments about the multiplier circuits are in order. I prefer to build these circuits with the components soldered or suspended above a piece of double-sided printed circuit board that is attached to the cover of a shielded box such as the Bud CU-124 (or equivalent) with the input/output (for example, BNC) connectors. This technique yields a good ground plane — especially for the bypassing capacitors, tuning capacitors, and inductors — while shielding the circuits from stray pickup. It also allows the unit to be easily connected to

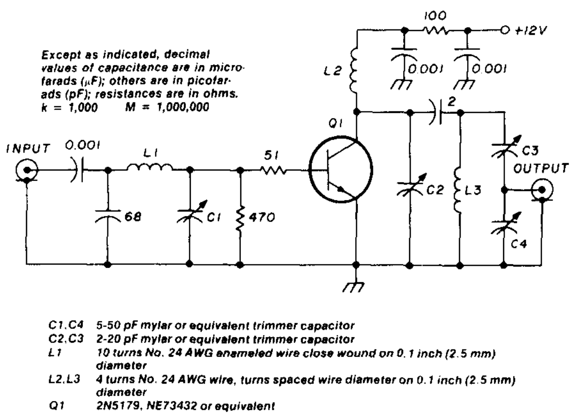


fig. 3. Frequency doubler: with a 95-110 MHz, 5-10 milliwatt input, a 190-220 MHz, 10-20 milliwatt output is produced.

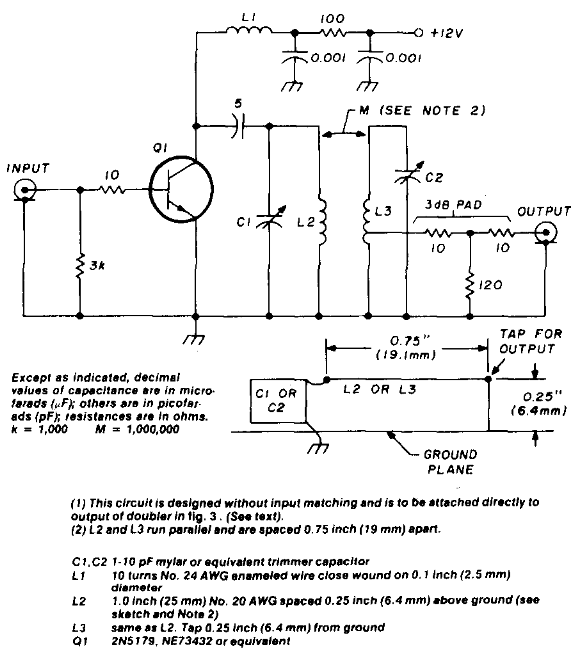


fig. 4. Frequency doubler: with a 190-220 MHz, 5-10 milliwatt input, a 380-440 MHz, 10-20 milliwatt output is produced.

the mixer with a short coaxial cable and facilitates testing if a spectrum analyzer is available.

The multiplier transistor choice will have a large effect on gain and hence the output power. Modern UHF transistors in TO-92 packages (such as the NEC NE73432 or the Fairchild FMT-1100, if available) are better and will have greater output than the older 2N5179. Also, as noted in **fig. 4**, if you use the second doubler, connect it directly after the circuit shown in **fig. 3**. The output tuning in the first multiplier performs the proper impedance matching.

testing

The easiest test of how your system is performing is to listen on the air, especially during activity nights or during contests. Sensitivity, generally related to noise figure, can be roughly estimated by listening for a distant station. Noise figures can often be tested and optimized at a VHF/UHF conference where noise figure meters are available. *Do not be tempted to retweak the input circuit in your low-noise preamplifier after it has been properly optimized on a good noise figure generator.* Optimum noise figure may frequently yield a lower gain preamplifier, and retweaking input circuits for more output when installed ahead of a converter may seriously degrade the overall noise figure.

You should also listen for unexpected spurious frequencies. Testing is best facilitated if you build your circuits in separate boxes or modules, a technique I have been advocating for many years. This will allow you to have your preamps and/or local oscillator chain easily tested if you have access to a noise figure meter or spectrum analyzer. It will also facilitate a rapid change if a device fails or if you want to substitute a new — hopefully improved — circuit.

final comments

Building your own receiving gear can be quite satisfying and one of the few ways we can get maximum performance with minimum compromise. In the months ahead, more details on high dynamic range and low noise figure preamplifiers will be forthcoming. Hopefully this column will inspire you to get out the soldering iron and put those devices you've been saving to work. In this fast-changing world, the devices we have today may be obsolete tomorrow. . .so let's use and enjoy them today instead of letting them gather dust in a corner of your work bench!

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4. P.Will, "Reactive Loads — The Big Menace," *Microwaves*, Volume 10, No. 4, April, 1971, pages 38-42.

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key to 3-element Yagi design

Find driving-point impedance, currents, gain and f/b using pocket calculator

During recent years an interesting series of articles on the Yagi-Uda dipole array antenna were written by the late James Lawson, W2PV.[1] In his first article of the series, he discussed the development of a practical Yagi array and briefly described its electrical parameters. To evaluate the system he employed a computer using a Fortran program which resulted in tabulated values and graphs.

But even after reading Lawson's evaluations and analyses of the Yagi, one intriguing question remained in my mind: could a design or evaluation be accomplished without a computer, using only a handheld programmable calculator?

The answer is *yes*. Such a project can be accomplished using a programmable calculator such as the Hewlett-Packard HP-41C or any non-programmable pocket calculator capable of performing conversions of complex numbers in either rectangular or polar forms. Using any of these calculators, it is possible for the Radio Amateur to determine a Yagi's input impedance, current ratio between dipole elements, free space radiation pattern, forward gain, front-to-back ratio, and the radiation pattern of the total array over smooth earth.

This article addresses the ways in which these parameters can be calculated using a step-by-step procedure. Although a program is provided,* it is recommended that the chapters on alternating currents and vectors in Nelson M. Cooke's *Basic Mathematics for Electronics*[2] (or any similar mathematical text) be reviewed by the reader before beginning the project.

*NOTE: Send SASE to *ham radio*, Greenville, NH 03048.

self-impedance of a dipole

Though several different expressions have been used to characterize a dipole's self-impedance,[3,4] one that is particularly simple to solve on a hand calculator is reproduced below.[5,6]

$$Z_{in} = [122.65 - 204.1\,bl + 110(bl)^2] - j\left\{120\left[\log\left(\frac{2l}{a}\right) - 1\right]\cot bl - 162.5 + 140bl - 40(bl)^2\right\} \quad (1)$$

where l = dipole length (normally close to half-wavelength long)

bl = "length" in radians of one leg of the dipole

a = radius of dipole element (same units as "l")

The determination of self-impedance for each Yagi (dipole) element is important because it is part of the total design calculation. Beam elements are assumed to be cylindrical in shape without any taper; elements exhibiting a taper have different current distributions with different input impedances. However, if the taper of the element is gradual, the values given in **table 1** can be used. Thick diameter dipole elements are resonant at lengths shorter than a (physical) half wavelength. The elements of a three-element Yagi are usually standardized in length with the driven element 0.475 wavelength long, the reflector 0.5 wavelength, and the director 0.450 wavelength. The element diameter is based on a size that is structurally sound and large enough to present a low Q — i.e. a slow reactance change with frequency.

The self-impedances and dimensions of a three-element Yagi tuned to 14.15 MHz are listed in **table 1**.

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table 1. Self impedance of dipole elements of different lengths and diameters.

		1.5 inch OD		1.0 inch OD	
length	**radian**	**R**	**X**	**R**	**X**
0.500	1.5708	73.0	+j41.0	73.0	+j41.3
0.494	1.5519	70.8	+j28.0	70.8	+j27.0
0.488	1.5331	68.3	+j14.8	68.3	+j12.9
0.484	1.5205	66.6	+j 6.0	66.6	+j 3.5
0.478	1.5017	64.2	−j 7.1	64.2	−j10.5
0.476	1.4954	63.4	−j11.5	63.4	−j15.2
0.475	1.4923	63.0	−j13.6	63.0	−j17.5
0.472	1.4828	61.9	−j20.2	61.9	−j24.5
0.466	1.4640	59.6	−j33.2	59.6	−j28.4
0.462	1.4514	58.1	−j41.9	58.1	−j47.7
0.456	1.4326	56.0	−j54.8	56.0	−j61.6
0.450	1.4137	54.0	−j67.8	54.0	−j75.5
0.444	1.3949	52.0	−j80.7	52.0	−j89.3

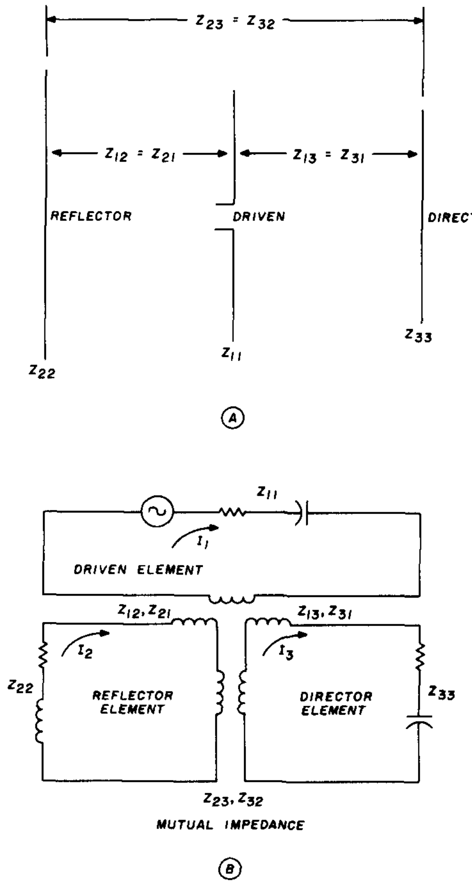

fig. 1A. Three-element Yagi antenna showing self- and mutual-impedance locations. fig. 1B. Network equivalent of three-element Yagi-Uda antenna.

dimension	director	driven	reflector
element diameter	1.5″ (38 mm)	1.5″	1.5″
length (full element)	31.3′ (9.54m)	33′ (10.06m)	34.8′ (10.61m)
length (one leg)	1.41 radians	1.49 radians	1.57 radians

mutual impedances between dipole elements

Mutual impedance is a term that relates current in one element to current in a different element of the same antenna. It's easy to understand if you consider the antenna as a circuit with several meshes or loops. In a circuit, if a voltage is generated in one branch, called a mesh, currents flow in other meshes. The coupling between meshes is through a transfer or mutual impedance common to both.

Many times a T network is used to explain mutual impedance action between two meshes. The T network shunt element is analogous to the mutual impedance displayed in a two-element Yagi antenna. Three-element Yagis require another type of illustration to show circuit relationships.

The circuit equivalent of a Yagi's self- and mutual-impedances are shown in **fig. 1**. Self-impedances are coupled to the other meshes by air core transformers. The transformers have a 1:1 ratio and are assumed lossless. The currents, both in magnitude and phase, can be determined using standard network techniques for each mesh. This is accomplished by writing the simultaneous equations that describe the electrical steady-state condition existing in the network.

$$\begin{aligned} &\text{driven element} && 1 = I_1 Z_{11} + I_2 Z_{12} + I_3 Z_{13} \\ &\text{reflector element} && 0 = I_1 Z_{21} + I_2 Z_{22} + I_3 Z_{23} \\ &\text{director element} && 0 = I_1 Z_{31} + I_2 Z_{32} + I_3 Z_{33} \end{aligned} \quad \textbf{(2)}$$

where I_1, I_2, and I_3 are the currents that flow in the driven, reflector, and director elements, respectively, and

Z_{11}, Z_{22}, Z_{33} are the same elements' self-impedances;

Z_{12}, Z_{13}, Z_{21}, Z_{23}, Z_{31}, and Z_{32} are mutual impedances between subscripted elements.

For example, Z_{12} = the mutual impedance between elements 1 and 2.

A list of mutual impedances[1] for different element spacing is given in **table 2**.

Notice from **eq. 2** how current magnitude and phase in each element is controlled by its self- and mutual-impedances. Once the element length and diameter is chosen, self-impedance becomes a fixed value. Therefore, the only means of controlling the current magnitude and phase in each element is by the mutual impedance values. Mutual impedance values change when different physical spacings between elements are used. The greater the element spacing, the less effect the mutual impedance has on the driving-point (input) impedance of the antenna. Consequently, changing the spacing changes the mutual impedances, which change the current ratio between elements. These currents in turn determine the radiation pattern of the antenna (gain and f/b). In a *driven* vertical array the current phase of each element is controlled by a phase delay line or network while the *parasitic* Yagi antenna relies on element spacing and length to diameter ratio to control current phase through self- and mutual impedances.

The solution to the unknown currents flowing in each of the three meshes is found by using determinants.

driven element

$$I_1 = \frac{(Z_{22}Z_{33}) - (Z_{32})^2}{\Delta}$$

reflector element

$$I_2 = \frac{(Z_{23}Z_{31}) - (Z_{33}Z_{21})}{\Delta} \qquad \textbf{(3A)}$$

director element

$$I_3 = \frac{(Z_{21}Z_{32}) - (Z_{31}Z_{22})}{\Delta}$$

$$\Delta = (Z_{11}Z_{22}Z_{33} + (Z_{12}Z_{23}Z_{31}) + (Z_{13}Z_{21}Z_{32}) - (Z_{31}Z_{22}Z_{13}) - (Z_{32}Z_{23}Z_{11}) - (Z_{33}Z_{21}Z_{12}) \qquad \textbf{(3B)}$$

The three currents may be given in rectangular form but it is more helpful to express them in polar form, because the latter shows whether the current phase is leading or lagging. Note this is very helpful to check to see if the solutions are correct. The reflector current phase should be positive (leading) while the director current phase should be negative (lagging). Each of the current characteristics denotes that the parasitic elements are either inductive or capacitive reactive.

calculating the driving-point impedance

One of the reasons for calculating currents in each element is to determine the driving-point impedance at the driven element of the Yagi antenna. Knowing this impedance, one can now match it to the transmission line. Wide spacing between elements usually produces higher driving-point resistance (first term of the complex impedance). This results in lower Q and wider bandwidths. The driving-point impedance equals:

$$Z_{in} = Z_{11} + (I_2/I_1)Z_{12} + (I_3/I_1)Z_{13} \qquad \textbf{(4)}$$

table 2. Mutual impedances between two elements.

spacing (in wavelengths)	R	X*
0.00	73	42
0.05	72	24
0.10	67	7
0.15	60	−7
0.20	51	−19
0.25	41	−28
0.30	29	−34
0.35	17	−37
0.40	6	−37
0.45	−4	−35
0.50	−12	−30
0.55	−19	−23
0.60	−23	−16
0.65	−25	−8
0.70	−25	−0.25
0.75	−22	6
0.80	−18	12
0.85	−13	16
0.90	−7	18
0.95	−1	19
1.00	4.0	18
1.05	9	15
1.10	12	11
1.15	14	7
1.20	15	2
1.25	14	−3
1.30	12	−7
1.35	10	−10

A three-element array is to be constructed with a reflector to driven element spacing of 0.1 wavelength and a director to driven element spacing of 0.15 wavelength. The element diameters are 1.5 inch and their self- and mutual-impedance values are taken from **tables 1** and **2**, respectively:

self impedances	mutual impedances
$Z_{11} = 63 - j15$	$Z_{12} = Z_{21} = 67 + j7$
$Z_{22} = 73 + j41$	$Z_{31} = Z_{13} = 60 - j7$
$Z_{33} = 54 - j70$	$Z_{23} = Z_{32} = 41 - j28$

Insert these values into **eqs. 3A** and **3B** to solve for the currents and then use **eq. 4** to solve for Z_{in}. This can be done manually or by use of a calculator. I used an HP-41C and a quad memory module. If you have this calculator, clear all registers, key in size 100, then key self- and mutual-impedance values into the proper memory storage registers. To obtain current magnitude and phase for each element current ratio and driving-point impedance, execute program "ZZ".

finding the determinant

Using this procedure one obtains the value for Δ and

*Though other sets of values exist, this procedure is the key feature of this article - Ed the values for driven, reflector, and director element currents I_1, I_2, and I_3 respectively.

$$\Delta = 95476 - j182530$$

driven element

$$I_1 = \frac{(Z_{22}Z_{33}) - (Z_{32})^2}{\Delta}$$

$$= \frac{(73+j41)(54-j70)-(41-j28)^2}{\Delta}$$

$$= 0.0159 + j0.0241$$

reflector element

$$I_2 = \frac{(Z_{23}Z_{31}) - (Z_{33}Z_{21})}{\Delta}$$

$$= \frac{41-j28)(60-j7)-(54-j70)(67+j7)}{\Delta}$$

$$= -0.0142 - j0.0027$$

director element

$$I_3 = \frac{(Z_{21}Z_{32}) - Z_{31}Z_{22})}{\Delta}$$

$$= \frac{(67+j)(41-j28)-(60-j7)(73+j41)}{\Delta}$$

$$= 0.0113 - j0.0154$$

current ratios between elements

$$I_2/I_1 = -0.3484 + j0.3611$$

$$I_3/I_1 = 0.2284 - j0.6213$$

driving-point impedance

These numbers when substituted into **eq. 4** give us the value of the input or driving-point impedance:

$$Z_{in} = Z_{11} + (I_2/I_1)Z_{12} + (I_3/I_1)Z_{13}$$

$$= (63-j15)+(0.3484+j0.3611)(67+j7)$$

$$+ (-0.2284-j0.6213)(60-j7)$$

$$= 19.0753 - j28.9239$$

The method outlined above is the simplest procedure that can be used to find the driving-point impedance of a monoband Yagi-Uda dipole array. It is hoped that this information will prove helpful to those Radio Amateurs considering designing and building their own three-element Yagi-Uda beam antennas on the high frequency Radio Amateur bands.

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Bill Orr, W6SAI

broadband 80/160-meter antenna

One of the very interesting advantages of writing this column is the feedback I get from readers. A case in point: in my October, 1983, column I discussed the problem of building a simple broadband antenna that would cover the whole of either the 80- or 160-meter bands with a reasonably low value of SWR on the feedline. Some of the newer solid-state transmitters are quite sensitive to an SWR other than 1.0:1, and they react by reducing the output power of the final amplifier stages at high values of SWR.

One of the antennas I discussed was the crossed-dipole array described by Mason Logan, K4MT, in the May, 1983, issue of this magazine. His basic antenna design is shown in **fig. 1**. The measured SWR curve of this antenna is shown in **fig. 2**. I suggested in my October column that a matching coil might be required at the antenna feedpoint to bring the impedance closer to 50 ohms.

Shortly after publication, I received a note from K4MT stating, in part, "Your statement that the antenna impedance is quite low and that a matching coil across the feedpoint is needed is not correct. With the stagger-tuned dipoles, each dipole acts as the network for the other. . .Nothing more is needed!"

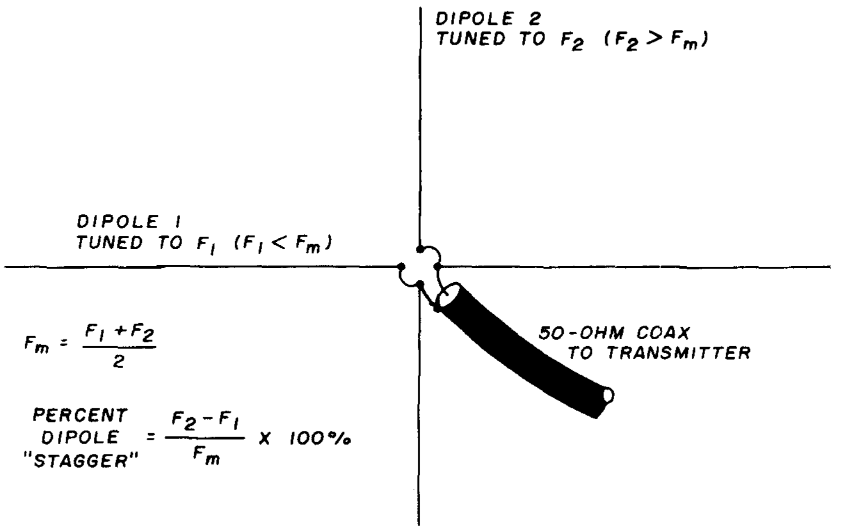


fig. 1. Top view of broadband stagger-tuned, crossed-dipole antenna.

Logan is correct and I am wrong, as his letter proves. He goes on to say that for the stagger-tuned dipoles, between the two chosen resonant frequencies, the reactances of the dipoles have opposite signs, forming a lossy, antiresonant circuit which can have an impedance maximum near the center frequency where the reactances are equal in magnitude. Near the band edges, at the resonant frequencies of the dipoles, the impedance is somewhat less than that of each dipole alone. Hence the W-shaped curve for the impedance as well as the SWR.

Mason goes on to say that height of the antenna above ground has a significant impedance effect and that when the resonant points are properly chosen, a satisfactory SWR curve can be achieved for heights of one-quarter wave or less. Great news for the "top-band" operator!

Paul Scholz, W6PYK, has worked with Mason to develop a computer program that determines the best design frequencies for the crossed-dipole antenna and provides im-

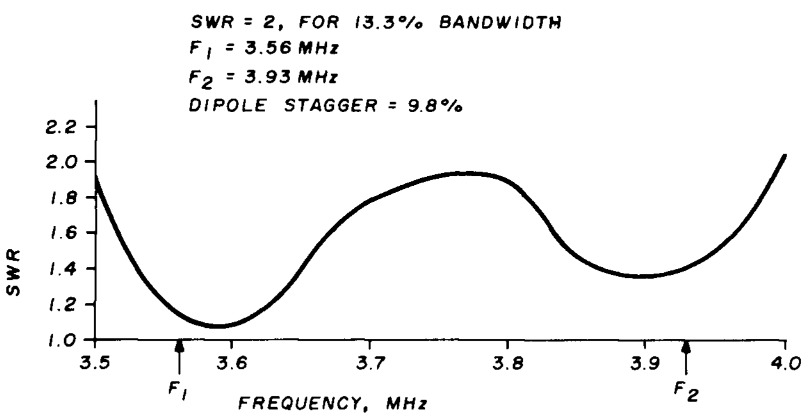


fig. 2. Measured SWR of broadband 80-meter stagger-tuned antenna using inverted Vs.

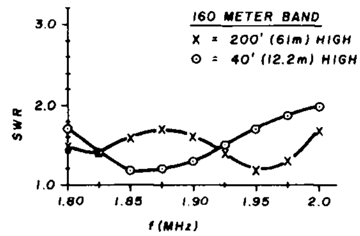


fig. 3. Computer-derived SWR curves for K4MT crossed-dipole antenna for 160-meter band. (Computer program by Paul Scholz, W6PYK.)

pedance and SWR readout. Two examples, given in **fig. 3** and **4**, show that even at low height, both the 80 and 160-meter designs exhibit a good match to a 50-ohm line; a better match, in fact, than if the antenna were suspended higher in the air.

The 160-meter design is summarized in **fig. 3**. The dipoles were cut by formula to 1.75 MHz and 2.1 MHz (outside both ends of the 160-meter band) in the case of the 40-foot high antenna, and to 1.8 MHz and 1.975 MHz in the case of the 200-foot high antenna.

In each case, the resonant frequencies were chosen to provide a satisfactory value of SWR across the band (less than 2 to 1). The 40-foot high configuration is of most interest because it is a practical situation that can be duplicated by the average Amateur.

Only a portion of the "W" shape shows in the curve, as the higher design point was chosen outside the high frequency end of the band. Compare this curve with your ordinary 160-meter dipole located at a 40-foot elevation!

The "W" shape shows up in the 200-foot high antenna as the design points are closer together. But who can place an antenna at the 200-foot level? Not me.

Fig. 4 shows two crossed-dipole SWR curves for the 80-meter band. One antenna is 100 feet high and the design points are 3.55 MHz and 3.9 MHz. Note that the minimum SWR points do not correspond exactly to the design frequencies. The design points of the 40-foot high dipoles are 3.525 MHz and 3.975 MHz. Both of these antennas provide good SWR curves, with the lower antenna especially attractive for everyday operation across the band.

In summary, the K4MT crossed-dipole, broadband antennas do not exhibit critical design requirements and should be trimmed at the specific location for best match.

For those who want to write their own computer program for this antenna, the necessary information is given in **fig. 4** of K4MT's orignial article. (Thanks to K4MT and W6PYK for forwarding the computer data and additional design information to me.)

the K2GNC Y-doublet for 80 meters

Other hams have been experimenting with broadband antennas for 80 and 160 meters: Bill Pfaff, K2GNC, has come up with the interesting concept shown in **fig. 5**. He's had his Y-doublet up for over three years and it's worked quite well. The antenna is supported by a pole in the center, similar to that of an inverted-V. When properly constructed, it covers the entire 80-meter band (3.5 MHz to 4.0 MHz) with a SWR less than 1.5 to 1. This requires proper length and orientation of the three unequal-length elements.

The drawing shows connection of the three antenna wires to the feedline. Two wires (radials?) are attached to the shield of the line and a third antenna wire is attached to the center con-

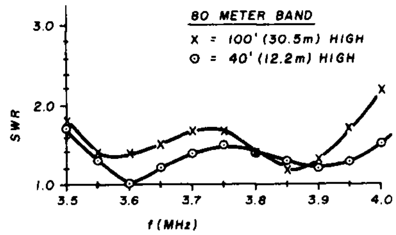


fig. 4. Computer-derived SWR curves for K4MT crossed-dipole antenna for 80-meter band. (Computer program by Paul Scholz, W6PYK.)

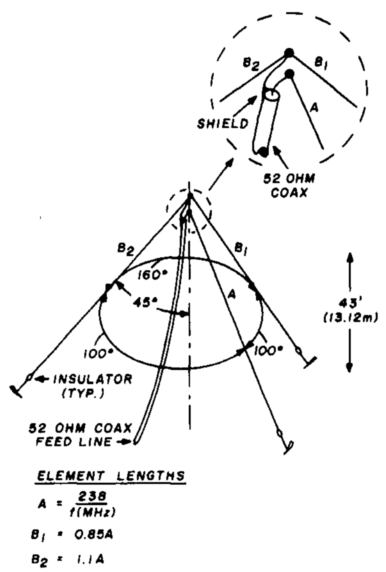


fig. 5. The K2GNC "Y-doublet" antenna for 80 meters. Antenna covers complete band with low SWR. It is supported from a single pole.

ductor. The wires form an angle of 45 degrees with respect to the 45-foot wooden support. The antenna wires also help guy the pole.

The two "radials" (marked B1 and B2 in the drawing) are located 100 degrees away from the radiator (marked A), as viewed in the horizontal plane. Minimum SWR frequencies are controlled by the B1 and B2 wire lengths. K2GNC has adjusted his wires so that the SWR of the antenna is below 1.5 to 1 from 3530 kHz and 3980 kHz. Outside these limits, the SWR rises sharply. SWR at the band edges can be reduced, but at the expense of high mid-band SWR.

design example

Choosing a design frequency of 3800 kHz generates the following element lengths:

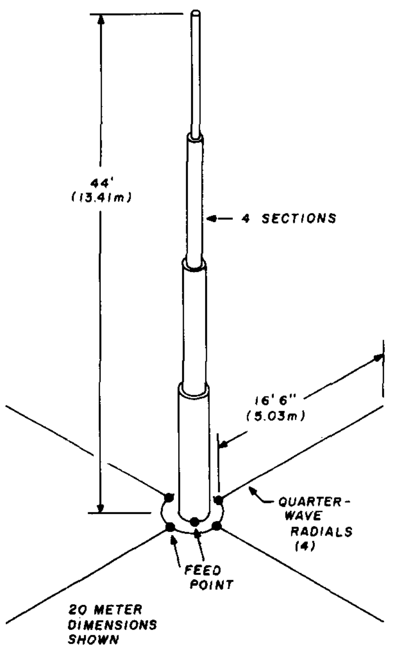
A: 62.63 feet or 62 feet 7 inches (=238/3.8)
B: 53.24 feet or 52 feet 3 inches (=0.85 × 62.63)
C: 68.89 feet or 68 feet 10 inches (=1.1 × 62.63)

The length and height of B1 and B2 can be varied.

A 10-meter model was assembled and placed on a rotator. Field strength measurements revealed a nearly-omnidirectional pattern, with narrow, deep nulls on each side of wires B1 and B2. K2GNC suggests these nulls may be due to the presence of nearby objects.

The feedline should come straight down to the ground underneath the antenna. The use of a balun did not affect measured SWR, nor antenna operation.

I spoke to Bill Pfaff on the phone about this interesting antenna and mentioned the K4MT crossed-dipoles. I asked him if he thought his antenna was a relative of K4MT's, and what would happen if he added a second wire to the A wire, running away from it, making it a four-wire configuration. Bill said he'd tried this idea and found that it didn't work as well as the present designs. So perhaps the K4MT and K2GNC antennas don't have that much in common, after all.



FREQUENCY (MHz)	WHIP	RADIAL
7.0	89' 0" (27.13m)	33' 5" (10.19m)
10.1	61' 9" (18.82m)	23' 2" (7.06m)
14.17	44' 0" (13.41m)	16' 6" (5.03m)
18.11	34' 5" (10.49m)	12' 10" (3.91m)
21.22	29' 4" (8.94m)	11' 0" (3.35m)
24.94	25' 0" (7.62m)	9' 4" (2.84m)
28.6	21' 9" (6.63m)	8' 2" (2.49m)

fig. 6. The 5/8-wave HF vertical antenna. "Whip" is made of four 12-foot telescoping sections of aluminum tubing. Taper ratio from bottom to top is 2:1.

the extended ground plane for HF operation

One of the long-standing jokes about the ground plane antenna is that because it's omnidirectional, it's equally poor in all directions! Maybe so, but an examination of DX QSLs reveals that a large percentage of overseas stations uses ground plane antennas, and some of these signals are quite powerful.

VHF operators have popularized a 5/8-wavelength vertical whip antenna which provides 3 dB gain over a simple 1/4-wave ground plane. It is possible to adapt such an antenna to a lower frequency just as it is done at VHF.

Originally, the 5/8-wave vertical antenna was designed some decades ago for use as an "anti-fade" antenna for the broadcast band.

A representative HF design is shown in **fig. 6**. Dimensions are shown for a center frequency of 14.17 MHz, using tubing for the element. Because the tubing is telescoping, there's a slight taper effect which must be taken into account. The final installation uses a 44-foot vertical section, and many quarter-wave radial wires beneath it. The general formula is:

length (feet) = 623.5/f (MHz)

The antenna must be tuned to resonance, and the easiest way to do this is to add enough inductance at the base to make the overall system resonant at an odd quarter-wavelength mode (three-quarter waves).

Three-quarter wave resonance is determined by adjusting the number of turns in the base coil until a dip meter coupled to the coil-antenna system indicates 14.17 MHz. The bottom end of the coil is attached to the radial wires, which fan out in a horizontal plane.

Once the antenna is resonant, the transmission line is tapped on a few turns above the bottom end of the coil and the tap varied until lowest SWR is achieved (**fig. 7**). It may be necessary to adjust the coil a fraction of a turn to drop the SWR to its lowest possible value.

Amateurs accustomed to the performance of a simple ground plane antenna will find this extended version to be a vastly improved design for both receivng and transmitting.

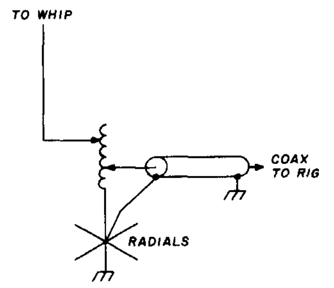


fig. 7. Single coil resonates whip to 3/4-wave mode and also permits match to coaxial line. For 14 MHz, coil is 12 turns of No. 12 wire, spaced twice wire diameter, wound on a ceramic form 2 inches in diameter. Adjust taps for best match as described in text.

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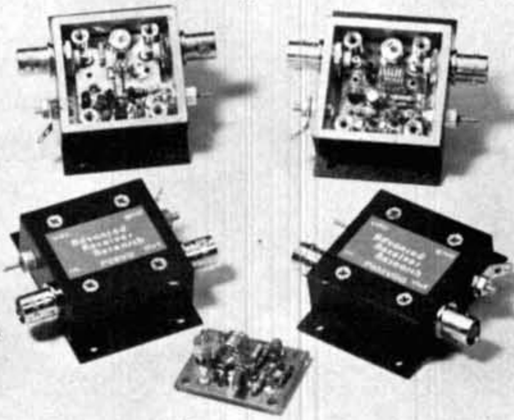

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f(MHz)	nominal attenuation RG-8/U, RG-8A/U, RG-213/U	(dB/100 feet) 9913
50	1.6	0.9
100	2.2	1.4
200	3.2	1.8
400	4.7	2.6
700	6.9	3.6
900	8.0	4.2
1000	8.9	4.5
4000	21.5	11.0

table 1. Comparison of Belden 9913 cable with RG-8/U, RG-8A/U and RG-213/U.

a coax "sleeper"

Reid Brandon, W6MTF, has pointed out an interesting coaxial cable listed in the new Belden wire and cable catalog. It may be 1984's replacement for the old RG-8/U, RG-8A/U, and RG-213/U. The cable is RG-8/U size, so the fittings for the old cable will work with the new one. It has a solid (not braided) center conductor and 61 percent coverage of the outer braid, plus a conductive, 100 percent coverage solid flexible metallic sheath beneath the braid. The dielectric is called "semi-solid polyethylene," which is not to be confused with foam dielectric. Instead, the new dielectric looks as if it is shaped to provide small air spaces (instead of foam bubbles) along the line. The velocity of propagation is 84 percent as opposed to 66 percent for the RG-8/U type line.

The attenuation of the Belden 9913 cable compared to some of the older varieties is listed in **table 1**. While the virtues of the cable are not apparent below 50 MHz, there's a big payoff in the VHF/UHF region. (Just check the 400 MHz figures!) And the newer cable is a lot less expensive than a power amplifier. For those interested in even less loss in the VHF/UHF region, Belden *9913* is suggested over the readily available forms of RG-8.

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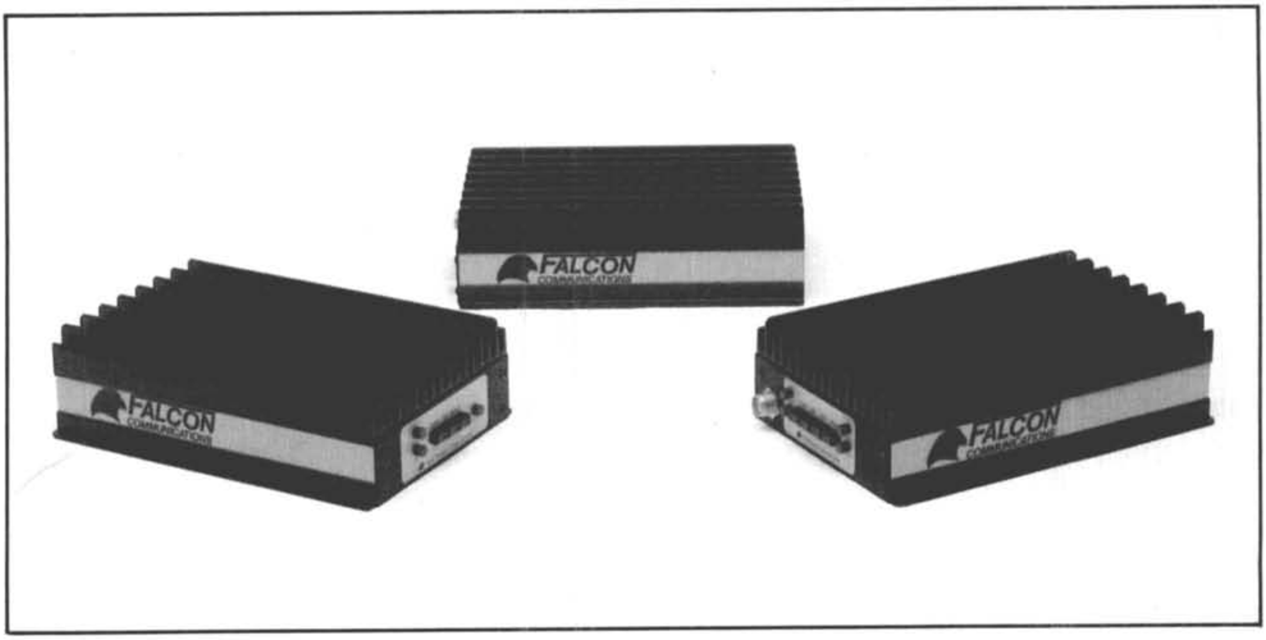

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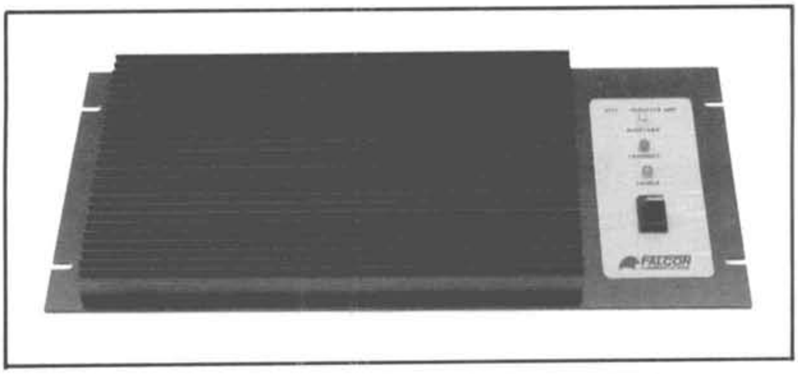

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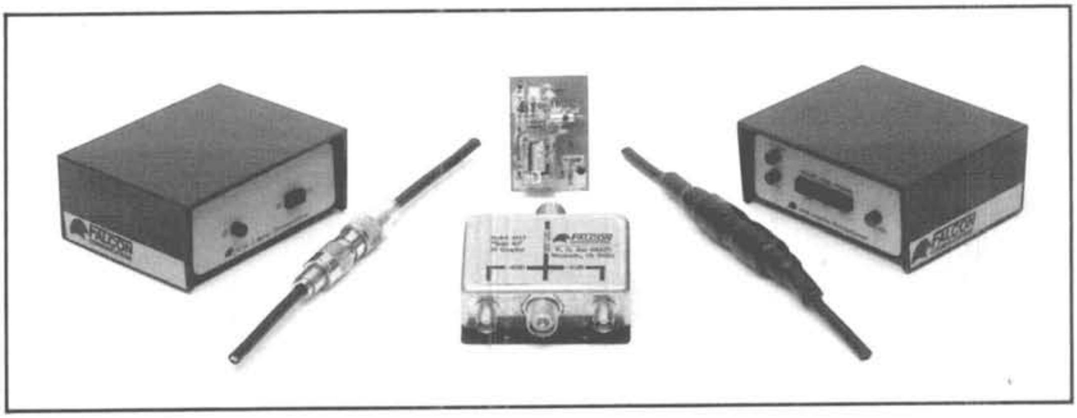

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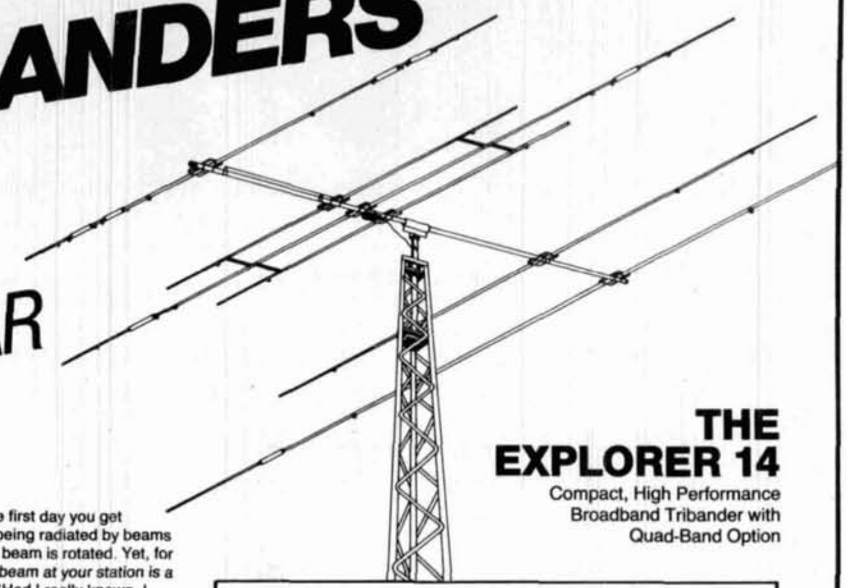

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The gain of a beam multiplies the effective radiated power of your transmitter just like an amplifier. More importantly, it amplifies the signal from the station being beamed. Off the sides and back of the antenna, the effective radiated power of those kilowatts on/near your frequency are reduced to manageable QRP levels.

A well-designed beam is by far the best performance buy you can make and it doesn't use any electricity. Further, if you buy a good one, it will last longer than some of the electronics gear in your shack. In terms of cost per hour of enjoyment, a beam antenna is among the least expensive major station components.

As sunspot cycle 21 winds down over the next few years the priority for a good beam shifts from "great to have" to "essential!" To maximize your station capability on the high bands choose one of these super broadband arrays.

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This is a broadband successor to the legendary TH6DXX. Five active elements on 10 meters and four elements on both 15-20 meters. The TH7DX represents the ultimate in high-performance arrays whether you're comparing other large tribander's or stacked monobander's. 76 lbs. (35 kg) with a surface area of 9.4 sq. ft. (.87 m), a 24 ft. (7.3 m) boom and a turning radius of 20 ft. (6.1 m). If you own a TH6DXX, a conversion kit is available which includes the second driven element, the completely new matching system, a full set of stainless steel hardware, and of course, step by step instructions. After conversion, your TH6DXX is a TH7DX, exactly.

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- BN 86 balun supplied as standard.
- Top quality stainless steel hardware supplied at no added cost.
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- Unique Hy-Gain die cast aluminum boom to mast bracket. Accepts mast diameters up to 2½" (63 mm).
- Twist and slip proof die formed heavy gauge aluminum element to boom brackets.
- All tubing deburred and cleaned for ease of assembly.
- Only one set of dimensions for complete coverage of all three bands below 2:1 SWR.
- Designed to survive winds of 100 mph (160 km/hr).

The value of a Directional Antenna was one of my early "discoveries". Over the years, I have built or bought numerous Quads and Yagis. I have never been so impressed as I am with my TH7DX. I enjoy QRP but now have a problem convincing folks that I am only running 5 watts! The TH7DX is a superb antenna, both from a performance and a structural point of view.

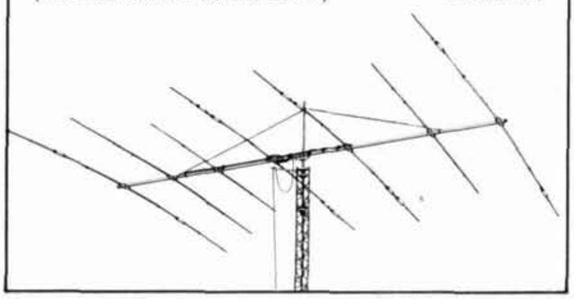
Congratulations!

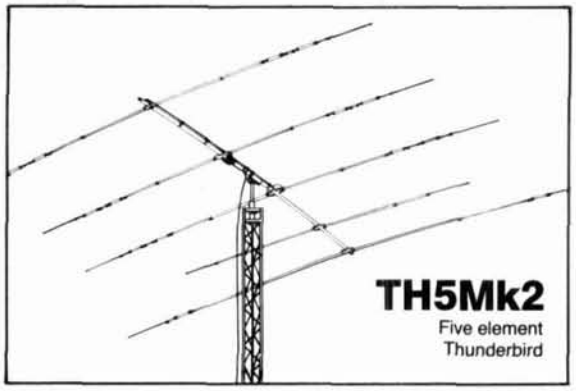
Jack Falker
W8KR

(W8KR has worked all countries but two!)

TH7DX

Seven element Thunderbird





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"Heavy Duty" is Relative!

In our lineup of rotators, the CD45 II is rated as medium duty. Some of our worthy competitors offer similar rotators which they rate as "heavy duty" and, within their product line, they are. But if you compare all rotators, it's a different picture. Here is a comparison of our CD45 II, our HAM IV and the Alliance HD73 (Specifications as stated by the manufacturer).

	HD73	CD45 II	HAM IV
Output Torque	400 in. lbs.	600 in. lbs.	800 in. lbs.
Gears	Plastic and Steel	All Steel	All Steel
Control Box Weight	3.8 lbs.	6.8 lbs.	6.8 lbs.
Rotor Unit Weight	6.5 lbs.	8.5 lbs.	10.5 lbs.
Direction Indicator Potentiometer	Carbon	Precision wire wound	Precision wire wound
Rotation Limiter	Mechanical stop only	Limit switches with mechanical stop	Limit switches with mechanical stop
Braking Power	1600 in. lbs. "Windmilling"	800 in. lbs. "Holding"	5000 in. lbs. "Holding"
Antenna Size Rating	10.7 sq. ft.	5 sq. ft.	15 sq. ft.

Wind load rating is an important specification too. Unfortunately, there is *no standard* method of measurement. For example, a long boom antenna with an unbalanced wind load is a much tougher problem than the calculated square area of the antenna would suggest. So we take a conservative "worst case" approach and rate the CD45 II at 5 square feet. Yet, the HD73, a lighter unit, is rated at 10.7 square feet. You be the judge.

Here is a complete listing of Hy-Gain rotators and the typical antenna systems that each will comfortably and reliably manage.

AR40—Primarily used for small to medium size VHF and UHF beams. Can also be used with a 10 or 15 meter, 3 element Yagi.

CD45 II—Recommended for a 3 element tribander such as our Explorer 14. Will also manage a medium sized VHF stack and is a good choice for the Azimuth rotator on a good sized satellite system.

HAM IV—A favorite for long boom tribanders such as our TH7DX. Would also be a good choice for an Explorer 14 stacked with a VHF DX antenna or a satellite system.

HAM SP—A modified Ham IV with a special control unit for a blind operator. Single knob directional control system includes a compass rose with braille markings. An audible beep indicates rotator start and stop.

T2X—The well-known Tail Twister manages combinations such as a TH7DX stacked with a small 2 element 40 meter beam. Also a great choice for a substantial VHF "weak signal" array. Of course, the ever popular stack of 3 or 4 element 10, 15, and 20 meter monobanders is a safe match for the T2X.

HDR300—This 5000 inch pound torquer is our idea of heavy duty. This is the choice for stacked HF "Long Johns" or the full sized 3 element 40 meter monsters. A favorite too for the giant VHF "weak signal" systems where the 1° rotator control and indicator accuracy is a must.

CHOOSING THE RIGHT MODEL—The mistake most commonly made is selecting a rotator for the antenna being installed at the time and not looking forward to the antenna system that you ultimately plan. A rotator that is not over-loaded will deliver many years of reliable service. So, when you choose yours, plan ahead and buy the model that will handle the ultimate load. If in doubt, drop us a note. We will share our experience with you. Long term, you will save money.

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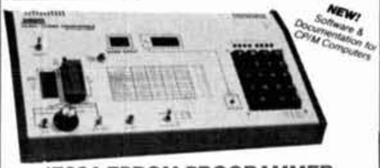
Part No.	Description	Price
JE520CM	For Commodore 64 & VIC-20	$114.95
JE520AP	For Apple II, II+, and //e	$149.95



NEW! Software & Documentation for CP/M Computers

JE664 EPROM PROGRAMMER
8K to 64K EPROMS — 24 & 28 Pin Packages

Completely Self-Contained — Requires No Additional Systems for Operation

• Programs and validates EPROMs • Checks for properly erased EPROMs • Emulates PROMs or EPROMs • RS232C Computer Interface for editing and program loading • Loads data into RAM by keyboard • Changes data in RAM by keyboard • Loads RAM from an EPROM • Compares EPROMs for content differences • Copies EPROMs • Power Input: 115VAC, 60Hz, less than 10W power consumption • Enclosure: Color-coordinated, light tan panels with molded end pieces in mocha brown • Size: 15⅝"L x 8⅝"D x 3⅞"H • Weight: 5⅝ lbs.

The JE664 EPROM Programmer emulates and programs various 8-Bit Word EPROMs from 8K to 64K-Bit memory capacity. Data can be entered into the JE664's internal 8K x 8-Bit RAM in three ways: (1) from a ROM or EPROM; (2) from an external computer via the optional JE665 RS232C BUS; (3) from its panel keyboard. The JE664's RAMs may be accessed for emulation purposes from the panel's test socket to an external microprocessor. In programming and emulation, the JE664 allows for examination, change and validation of program content. The JE664's RAMs can be programmed quickly to all "1"s (or any value), allowing unused addresses in the EPROM to be programmed later without necessity of "UV" erasing. The JE664 displays DATA and ADDRESS in convenient hexadecimal (alphanumeric) format. A "DISPLAY EPROM DATA" button changes the DATA readout from RAM word to EPROM word and is displayed in both hexadecimal and binary code. The front panel features a convenient operating guide. The JE664 Programmer includes one JM16A Jumper Module (as listed below).

JE664-A EPROM Programmer. **$995.00**
Assembled & Tested (Includes JM16A Module)

JE665 — RS232C INTERFACE OPTION — The RS232C Interface Option implements computer access to the JE664's RAM. This allows the computer to manipulate, store and transfer EPROM data to and from the JE664. A sample program listing is supplied in MBASIC for CP/M computers. Documentation is provided to adapt the software to other computers with an RS232 port. 9600 Baud, 8-bit word, odd parity and 2 stop bits.

FOR A LIMITED TIME A SAMPLE OF SOFTWARE WRITTEN IN BASIC FOR THE TRS-80* MODEL I, LEVEL II COMPUTER WILL ALSO BE PROVIDED.

JE664-ARS EPROM Prog. w/JE665 Option. **$1195.00**
Assembled & Tested (Includes JM16A Module)

EPROM JUMPER MODULES — The JE664's JUMPER MODULE (Personality Module) is a plug-in Module that pre-sets the JE664 for the proper programming pulses to the EPROM and configures the EPROM socket connections for that particular EPROM.

JE664 EPROM Jumper Mod. No.	EPROM	Programming Voltage	EPROM MANUFACTURER	PRICE
JM08A	2708	25V	AMD, Motorola, Nat., Intel, TI	$14.95
JM16A	2716, TMS2516 (TI)	25V	Intel, Motorola, Nat., NEC, TI, AMD, Hitachi, Mostek	$14.95
JM16B	TMS2716 (3-V's)	-5V, +5V, +12V	Motorola, TI	$14.95
JM32A	TMS2532	25V	Motorola, TI, Hitachi, OKI	$14.95
JM32B	2732	25V	AMD, Fujitsu, NEC, Hitachi, Intel, Mitsubishi, National	$14.95
JM32C	2732A	21V	Fujitsu, Intel	$14.95
JM64A	MCM68764 MCM68L764	21V	Motorola	$14.95
JM64B	2764	21V	Intel, Fairchild, OKI	$14.95
JM64C	TMS2564	25V	TI	$14.95

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• **Bright 4-digit 0.5" high display • 10 minute snooze alarm**
• **AM/PM indicator • Automatic display dimmer**

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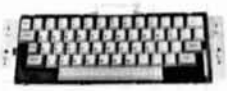
JE750 Alarm Clock Kit. $29.95



13⅛"L x 4¼"W x ¾"H

Misumi 54-Key Unencoded Matrix All-Purpose Keyboard

• SPST keyswitches • 20 pin ribbon cable connection • Low profile keys • Features: cursor controls, control, caps (lock), function, enter and shift keys • Color (keycaps): grey • Weight: 1 lb.

KB54. . . . . $14.95

18"L x 7⅝"W x 1½"H

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• 7 bit parallel ASCII with strobe • 11 key numeric keypad • SPST mechanical keyswitches • 15/30 card-edge connector • Features: escape, control, cursor controls, plus ten additional function keys • Color: white • Weight: 2 lbs. • Spec. included

KB1801. . . . . $29.95

21⅞"L x 9.8"W x 3⅛"H

106-Key 8-Bit Serial ASCII Keyboard

• Numeric and cursor keypad • 10 user definable keys • 7 LED function displays • Security lock • N-key rollover • Uses Intel 8048/8748 • Color: white w/black panel • Documentation included • Weight: 6½ lbs.

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Power/Mate Corporation REGULATED POWER SUPPLY +5VDC @ 3 Amp/ +6VDC @ 2.5 Amp

• Input: 105-125/210-250VAC at 47-63 Hz • Output: 5VDC @ 3.0 Amps/6VDC @ 2.5 Amps • Line regulation: 0.05% • Load reg.: 0.1% • Open frame mounts on any 1 of 3 surfaces • Size: 4⅞"L x 4"W x 2⅛"H • Weight: 2 lbs.

EMA5/6B. $29.95

Power/Mate Corporation REGULATED POWER SUPPLY +5VDC @ 6 Amp/ +6VDC @ 5 Amp

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Switching Power Supply for APPLE II, II+ & //e™

• Can drive four floppy disk drives and up to eight expansion cards • Short circuit and overload protection • Fits inside Apple computer • Fully regulated +5V @ 5A, +12V @ 3A, -5V @ .5A, -12V @ .5A • Direct plug-in power cord included • Size: 9⅞"L x 3½"W x 2¼"H • Weight: 2 lbs.

KHP4007. . . . . $79.95

8" FLOPPY DISK DRIVE

• Single-Sided
• 77 Tracks
• 400/800K Bytes Capacity
• Industry Standard

The **FDD100-8 8" Floppy Disk Drive** (Industry Standard) features single or double density. Recording mode: FM single, MFM double density. Transfer rate: 250K bits/sec. single density; 500K bits/sec. double density. The FDD100-8 is designed to work with the single-sided soft sectored IBM Diskette I, or eq. disk cartridge. Power: 115VAC @ 50-60Hz, +24VDC @ 1.7 amps max., +5VDC @ 1.2 amps max. Unit as pictured above (does not include case, power supply, or cables). Size: 8.55"W x 14"L x 4.5"H. Weighs 12 lbs. Incl. 96-pg. manual.

FDD100-8 . . $169.95 ea.

5¼" APPLE™ Direct Plug-In Compatible Disk Drive

• **Uses Shugart SA390 mechanics • 143K formatted storage • 35 tracks — compatible with Apple controller • Complete with connector and cable — just plug into your disk controller card • Size: 6"L x 3¼"W x 8-9/16"D • Weight: 4⅛ lbs.**

Part No. ADD-514 $195.95

5¼" TEAC DISK DRIVE
Single-Sided Half-Height 5¼" Drive

• **Single or double density • 48 TPI • 40 tracks • 6ms track to track • 5W power consumption • Brushless DC direct-drive motor • 160KBytes formatted storage • One year warranty parts and labor**
Double your work space with the TEAC 5¼ FLOPPY DISK DRIVE. Because the TEAC FD55A Drive is half the height of conventional drives, you can fit up to four TEAC drives in the same space where two conventional drives fit. Or, have room for two floppy disk drives and a hard disk drive. Includes operating manual. Requires: +5VDC @ .55A and +12VDC @ .3A. Size: 5¾"W x 1⅝"H x 8"D. Wt: 3 lbs.

FD55A. $249.95

5¼" SHUGART DISK DRIVE
Double-Sided Half-Height 5¼" Drive

• **Single or double density • 48 TPI • 40 tracks • 409KBytes formatted storage • 6ms track to track • Brushless DC direct-drive motor • One year warranty parts and labor • Media and interface compatible with the SA450**
Backed by the industry's largest and most experienced engineering sales and service organization, the SA455 is the smart solution for a wide range of desktop applications. Includes operating manual. Requires: +5VDC @ .7A and +12VDC @ .75A. Size: 5.88"W x 1.63"H x 8"D. Wt: 3.3 lbs.

SA455. . . . . $259.95

5¼" PANASONIC DISK DRIVE
Double-Sided Half-Height 5¼" DRIVE
Shugart SA455 Equivalent

• **Single or double density • 48 TPI • 40 tracks • 6ms track to track • 327KBytes formatted storage • One year warranty parts and labor**
The JA551 is perfect for word processors, personal and portable computers, small business computers and terminal add-ons. Includes operating manual. Requires: +5VDC @ .9A and +12VDC @ 1A. Size: 5.88"W x 1.63"H x 8"D. Wt: 3.3 lbs.

JA551-2. . . . . $239.95

DISKETTES AND ACCESSORIES

5¼" and 8" Diskettes

SSDD = Single Sided Double Density DSDD = Double Sided Double Density
SSQD = Single Sided Quad Density DSQD = Double Sided Quad Density

ULTRA MAGNETICS — 5¼" DISKETTES

Part No.	Description	Boxed	PRICE
UM51401	5¼" SSDD Soft Sector with Hub Ring and Envelope	10	$24.95
UM00096	5¼" SSDD Soft Sector with Hub Ring (Bulk)	100	189.95
UM52401	5¼" DSDD Soft Sector with Hub Ring and Envelope	10	32.95
UM00140	5¼" DSDD Soft Sector with Hub Ring (Bulk)	100	239.95
UM51801	5¼" SSQD Soft Sector with Envelope (96TPI)	10	34.95
UM00214	5¼" SSQD Soft Sector 96TPI (Bulk)	100	259.95
UM52801	5¼" DSQD Soft Sector with Envelope (96TPI)	10	41.95
UM00217	5¼" DSQD Soft Sector 96TPI (Bulk)	100	299.95

SK (ESKEI) — 5¼" DISKETTES

Part No.	Description	Boxed	PRICE
SK10	5¼" SSDD Soft Sector with Hub Ring and Envelope	10	20.95
SK10B	5¼" SSDD Soft Sector with Hub Ring (Bulk)	100	149.95
SK20	5¼" DSDD Soft Sector with Hub Ring and Envelope	10	26.95
SK20B	5¼" DSDD Soft Sector with Hub Ring (Bulk)	100	199.95

ULTRA MAGNETICS — 8" DISKETTES

Part No.	Description	Boxed	PRICE
UM81728	8" SSSD IBM-Compatible (128 B/S, 26 Sectors) and Envelope	10	34.95
UM00625	8" SSSD IBM-Compatible (128 B/S, 26 Sectors) Bulk	100	239.95
UM82728	8" DSDD Soft Sector (Unformatted) with Envelope	10	49.95
UM00640	8" DSDD Soft Sector (Unformatted) Bulk	100	299.95

All diskettes listed above are soft sectored. All have Hub Rings with the exception of the Quad Density and the 8" Series.

DISKETTE ACCESSORIES

Disk Minder

• Attractive, functional disk storage system • 50 (8") or 75 (5¼") disk storage capacity • Easy filing and retrieving • Protects disk from dust contamination • Molded from durable smoked plastic with front carrying handle • Size: 7"W × 6½"H × 9¼"D • Weight: 2 lbs.

Part No.	Description	Price
DM75	Stores 75 (5¼") Diskettes	$19.95 each
DM50	Stores 50 (8") Diskettes	$29.95 each

MINI-PAK

• Stores 10 (5¼") diskettes • Protects disk from dust contamination • Durable smoked plastic • Size: 6"L × 5¾"H × 1¼"D

Part No.	Description	Price
MP-10	Stores 10 (5¼") Diskettes	$2.95 each

Diskette Envelopes
Sleeves for Bulk-Purchased Diskettes

• Tear proof • Lint/contaminant free • Anti-static protect. • Wear resist.

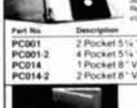
Part No.	Description	Price
MP5201	10 White 5¼" Envelopes	10 for $ 1.49
MP5201-100	100 White 5¼" Envelopes	100 for $10.95
MP8201	10 White 8" Envelopes	10 for $ 1.95
MP8201-100	100 White 8" Envelopes	100 for $17.95

Vinyl Pages
For 3-Ring Binders

Protects disks from dirt, scratches, dust, spills, and other contaminants. Reduces the risk of getting dirt near your disk drive head. Size: 8½" × 11".

Part No.	Description	Price
PC001	2 Pocket 5¼" Vinyl Page	10 for $7.95
PC001-2	4 Pocket 5¼" Vinyl Page	10 for $8.95
PC014	1 Pocket 8" Vinyl Page	10 for $7.95
PC014-2	2 Pocket 8" Vinyl Page	10 for $8.95

Mail Pak™



• Holds up to 3 diskettes
• Ideal for mailing and retail packaging
• Dust proof and durable
• Transparent sleeve allows easy identification

Part No.	Description	Price
MP-05	Holds 3 ea. 5¼" Diskettes	$2.49 each
MP-08	Holds 3 ea. 8" Diskettes	$3.95 each

DISK DRIVE CABLE CUSTOM

We stock a wide variety of signal cables and 3 power cable kits to meet your disk drive requirements. We also customize cable assemblies for many other applications. Call for a price quote.

IBM MEMORY EXPANSION KIT COMPAQ COMPATIBILITY

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the HP-IB greatly simplified

Test instruments communicate accurately and rapidly

The term GPIB (General Purpose Interface Bus), HP-IB (Hewlett-Packard Interface Bus), and IEEE-488 standard all mean the same thing: they describe a bus-oriented interface for instruments. For the sake of simplicity in this discussion, let's use the term HP-IB since Hewlett-Packard was instrumental in its adoption as an interface standard between lab instruments and calculators or minicomputers.

This article explains the bus concept, defines its signal groupings and individual signals, and provides an historical overview of how specific requirements prompted the development of this concept.

need for standardization

In 1972 Hewlett Packard, along with the United States Digital Instrumentation Committee for Standardization of Interfaces, developed the document that was adopted as a standard two years later by the IEC (International Electrotechnical Commission) by voting on a format ballot.

The decision to use automated, rather than manually controlled systems was based on four main advantages:

- Elimination of operator fatigue, yielding absolutely consistent results on repeated measurements.
- Greater throughput or faster processing speeds.
- More thorough testing resulting from this enhanced speed.
- Results expressed in scientific or engineering notation (i.e., powers of three such as *milli*, *micro*, *kilo*, and *mega*).

Table 1 lists key functional needs which are met by the system user who applies the HP-IB to his instrumentation.

how the HP-IB is used

The HP-IB provides a functional and electrical interface for up to sixteen laboratory instruments (DVMs, signal generators, and frequency counters, for example) daisy-chained or linked together in parallel with a controller such as a minicomputer or calculator (**fig. 1**). A controller's function is to designate which devices on the bus will be "listeners" (receivers) and which ones will be "talkers" (senders). The simplest possible system, then, would consist of two devices — a "talker" and a "listener" — without any need for a controller. One device could only "talk" while the other "listened". No interaction, however, would be possible. The maximum allowable distance between instruments is approximately 60 feet for serial digital data transmissions in the 1,000,000 bytes per second range.

Sixteen signal lines are required for the HP-IB. These are broken up into three distinct functional groups: (1) eight data lines; (2) five control lines; and (3) three handshaking lines. These terms will be explained shortly.

These three distinct functional groups are further divided into three component buses. A bus can be best thought of as a conduit through which only one type of signal flows. As an example, a control signal would never flow on a data bus and vice-versa (see **fig. 2**).

The eight bidirectional data bus lines are DI0 through DI7. These carry seven bits of coded interface messages in ASCII format and device-dependent

By Vaughn D. Martin, 114 Lost Meadows, Cibolo, Texas 78108

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I found the annoyance of my own "computer clutter" was even worse than the extra work the disorder created. And that is when I started looking for some practical furniture for my computer set up. Since I had already spent a lot of money on the system itself, I was really dismayed when I found out how much it would cost to get a decent-looking desk or even a data table for my equipment. $400 . . . $500 . . . even more for a sleasy unit that looked like junk! In fact, it was junk! And it took a long time for me to find something that was really worth the money . . . and more.

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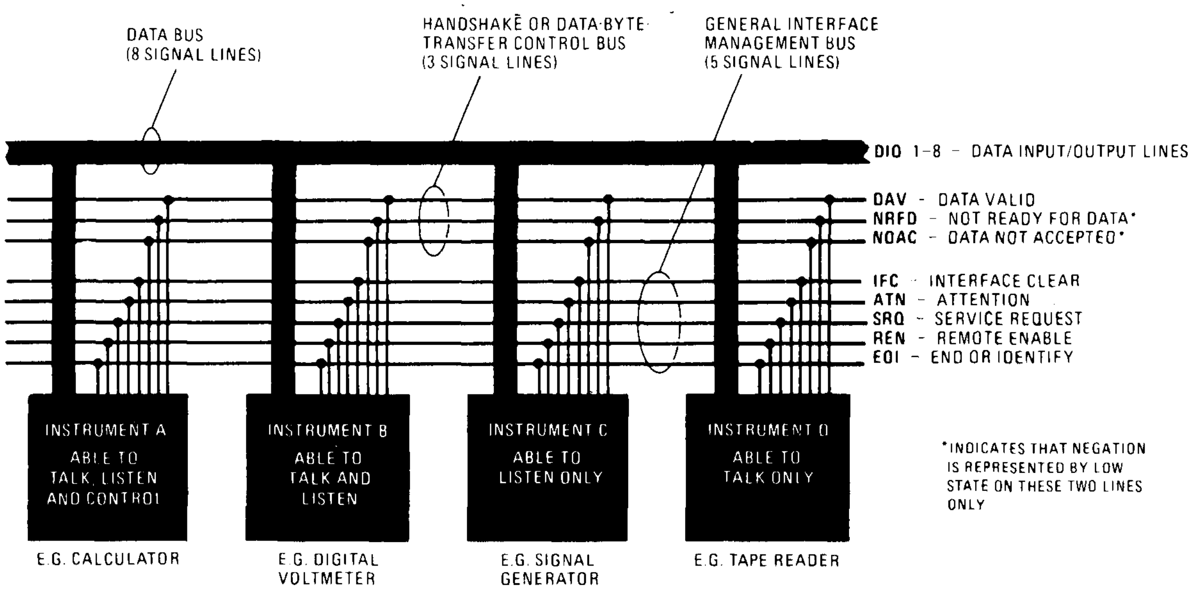

fig. 1. The HP-IB bus uses a 16-line cable to quickly link any instruments equipped with appropriate interface circuitry into a system. Data transfer is byte serial, bit-parallel at rates as high as 1 megabyte per second.

table 1. Key functional needs accommodated by HP-IB (IEEE 488).

basic need	concept	capability provided by
Unambiguous definition	Logical definition independent of implementation scheme	State diagram description of interface functions
Direct access to multiple asynchronous messages	Dedicated signal lines	IFC, ATN, SRQ, REN, EOI signal lines
Cost/performance flexibility	Optionality	Ten interface functions with allowable subsets
Multiple listeners independent of position or response rate	Three-wire handshake	DAV, NRFD, NDAC signal lines
Minimal hardware cost	Bus structure with minimal signal line count	Bi-directional bus for address, command, data, status messages
Standard method for accessing devices	Common code, easily generated and used	Address and universal command structure based on ASCII code
Slow speed status reporting	Device initiated service request	Common SRQ signal line, Serial Poll Mode with status byte reporting
High speed status reporting	Controller initiated status request	Parallel Poll Mode, one status bit for each of eight devices
Accommodation of other interface techniques	Hierarchical partitions	Terminal unit dedicated to interface conversion for cluster of local devices

messages from one to eight bits. But first, let's look at ASCII. **Table 2** shows what ASCII (American Standard Code for Information Interchange) codes are. Note that not all are printable or displayable; some are control characters — that is, carriage return, paper advance, backspace, etc.

The three handshaking signals are really signals that ask a question such as, "Is the serial transmission complete?" The queried device then answers with "yes" or "no." They are the status signals that give the box what appears to be an ability to think; therefore, many of these boxes are called "smart" boxes.

These three handshaking or interface lines (DAV, NRFD, and NDAC) effect the transfer of each byte of data on the data bus from an addressed talker (sender) to all addressed listeners (receivers). The source device, table 2. ASCII codes and characters.

ASCII & IEEE 488 (GPIB) CODE CHART

B7 B6 B5 BITS				Ø Ø Ø	Ø Ø 1	Ø 1 Ø	Ø 1 1	1 Ø Ø	1 Ø 1	1 1 Ø	1 1 1
B4	B3	B2	B1	CONTROL		NUMBERS SYMBOLS		UPPER CASE		LOWER	
Ø	Ø	Ø	Ø	0 NUL 0 (0)	20 DLE 10 (16)	40 SP 20 (32)	60 0 30 (48)	100 @ 40 (64)	120 P 50 (80)	140 \` 60 (96)	160 p 70 (112)
Ø	Ø	Ø	1	1 SOH GTL 1 (1)	21 DC1 LLO 11 (17)	41 ! 21 (33)	61 1 31 (49)	101 A 41 (65)	121 Q 51 (81)	141 a 61 (97)	161 q 71 (113)
Ø	Ø	1	Ø	2 STX 2 (2)	22 DC2 12 (18)	42 " 22 (34)	62 2 32 (50)	102 B 42 (66)	122 R 52 (82)	142 b 62 (98)	162 r 72 (114)
Ø	Ø	1	1	3 ETX 3 (3)	23 DC3 13 (19)	43 # 23 (35)	63 3 33 (51)	103 C 43 (67)	123 S 53 (83)	143 c 63 (99)	163 s 73 (115)
Ø	1	Ø	Ø	4 EOT SDC 4 (4)	24 DC4 DCL 14 (20)	44 $ 24 (36)	64 4 34 (52)	104 D 44 (68)	124 T 54 (84)	144 d 64 (100)	164 t 74 (116)
Ø	1	Ø	1	5 ENQ PPC 5 (5)	25 NAK PPU 15 (21)	45 % 25 (37)	65 5 35 (53)	105 E 45 (69)	125 U 55 (85)	145 e 65 (101)	165 u 75 (117)
Ø	1	1	Ø	6 ACK 6 (6)	26 SYN 16 (22)	46 & 26 (38)	66 6 36 (54)	106 F 46 (70)	126 V 56 (86)	146 f 66 (102)	166 v 76 (118)
Ø	1	1	1	7 BEL 7 (7)	27 ETB 17 (23)	47 ' 27 (39)	67 7 37 (55)	107 G 47 (71)	127 W 57 (87)	147 g 67 (103)	167 w 77 (119)
1	Ø	Ø	Ø	10 BS GET 8 (8)	30 CAN SPE 18 (24)	50 (28 (40)	70 8 38 (56)	110 H 48 (72)	130 X 58 (88)	150 h 68 (104)	170 x 78 (120)
1	Ø	Ø	1	11 HT TCT 9 (9)	31 EM SPD 19 (25)	51) 29 (41)	71 9 39 (57)	111 I 49 (73)	131 Y 59 (89)	151 i 69 (105)	171 y 79 (121)
1	Ø	1	Ø	12 LF A (10)	32 SUB 1A (26)	52 * 2A (42)	72 : 3A (58)	112 J 4A (74)	132 Z 5A (90)	152 j 6A (106)	172 z 7A (122)
1	Ø	1	1	13 VT B (11)	33 ESC 1B (27)	53 + 2B (43)	73 ; 3B (59)	113 K 4B (75)	133 [5B (91)	153 k 6B (107)	173 { 7B (123)
1	1	Ø	Ø	14 FF C (12)	34 FS 1C (28)	54 , 2C (44)	74 < 3C (60)	114 L 4C (76)	134 \ 5C (92)	154 l 6C (108)	174 | 7C (124)
1	1	Ø	1	15 CR D (13)	35 GS 1D (29)	55 – 2D (45)	75 = 3D (61)	115 M 4D (77)	135] 5D (93)	155 m 6D (109)	175 } 7D (125)
1	1	1	Ø	16 SO E (14)	36 RS 1E (30)	56 . 2E (46)	76 > 3E (62)	116 N 4E (78)	136 ∧ 5E (94)	156 n 6E (110)	176 ~ 7E (126)
1	1	1	1	17 SI F (15)	37 US 1F (31)	57 / 2F (47)	77 ? UNL 3F (63)	117 O 4F (79)	137 _ UNT 5F (95)	157 o 6F (111)	177 RUBOUT (DEL) 7F (127)

ADDRESSED COMMANDS — UNIVERSAL COMMANDS — LISTEN ADDRESSES — TALK ADDRESSES — SECONDARY ADDRESSES OR COMMANDS

KEY TO CHART

octal — 25	PPU — GPIB code	
	NAK — ASCII character	
hex — 15	(21) — decimal	

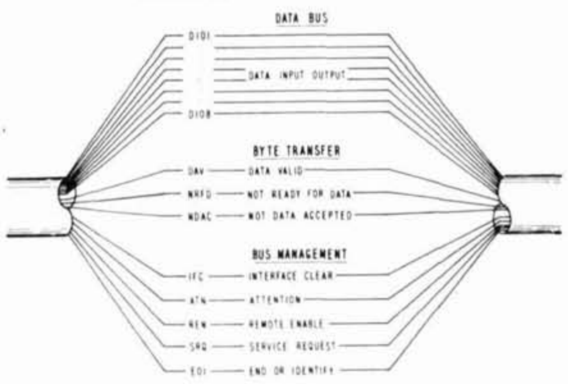

fig. 2. Party-line bus structure services 15 devices.

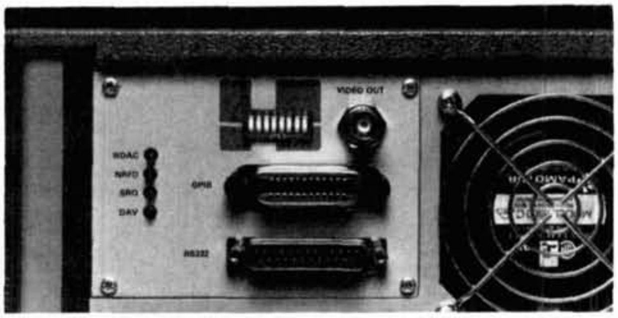

fig. 3. Rear panel switches allow HP-IB to be addressed by controller or operate in "talk only" mode.

whether controller or talker, drives the DAV (Data Valid) line which indicates the availability and validity of information on the data bus, while the acceptors (listeners) drive the NRFD (Not Ready For Data) and the NDAC (Not Data Accepted) lines.

Instruments often possess rear panel switches (**fig. 3**) that allow particular instruments to be addressable by a controller or operate simply in a "talk only" mode to another device such as a printer. If rear panel switches are not present, this switching function is probably accomplished by PC board jumper wires.

Five control or general management signal lines control the orderly flow of information across the interface as follows:

- The ATN (attention) line differentiates between data and control messages on the DIO lines.
- The EOI (End Or Identify) code indicates completion of a multiple byte transfer sequence and can also, together with ATN, activate a Parallel Poll.
- The IFC (Interface Clear) enables the interface system, placing all devices in a known quiet state prior to executing a bus transaction.
- The REN (Remote Enable) line selects between remote or local sources of device programming data.
- The SRQ (Service Request) is a call for service from one of the devices on the bus to the controller.

The three-wire (interlocked) handshake transfer scheme (DAV, NRFD, and NDAC) described above utilizes byte-serial, bit-parallel data travel on the eight DIO lines at typical speeds of 200 to 250 kilobytes per second (**fig. 4**). The maximum data transmission rate is 1 megabyte over extremely limited distances. The faster the data transmission, the shorter the allowable interconnecting cables can be; however, there is one way to overcome this limitation; see **fig. 5**. The HP37201A HP-IB Extender solves this problem by converting parallel data from the interface bus into a serial bit stream. This bit stream is suitable for transmission to a remote site

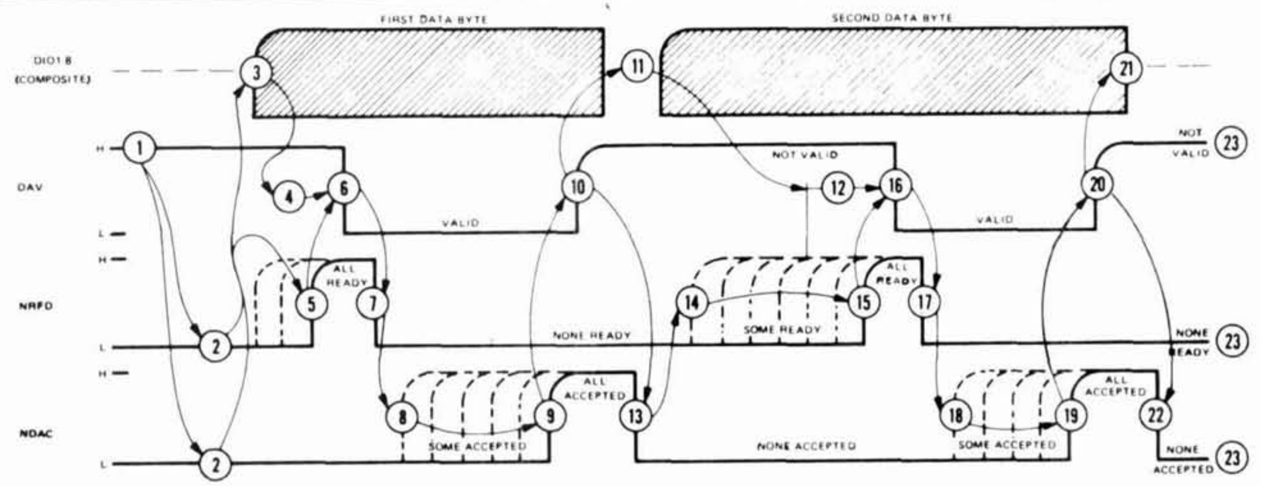

fig. 4. The interlocked handshake transfers data bytes asynchronously and unambiguously to one or more listeners.

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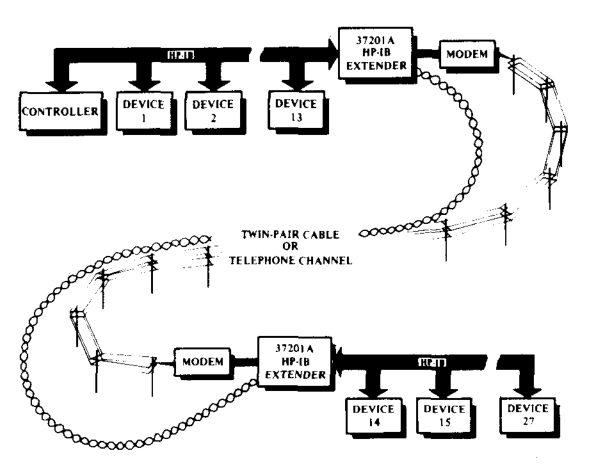


fig. 5. Point-to-point connection using twin twisted pair cable or full duplex modem link.

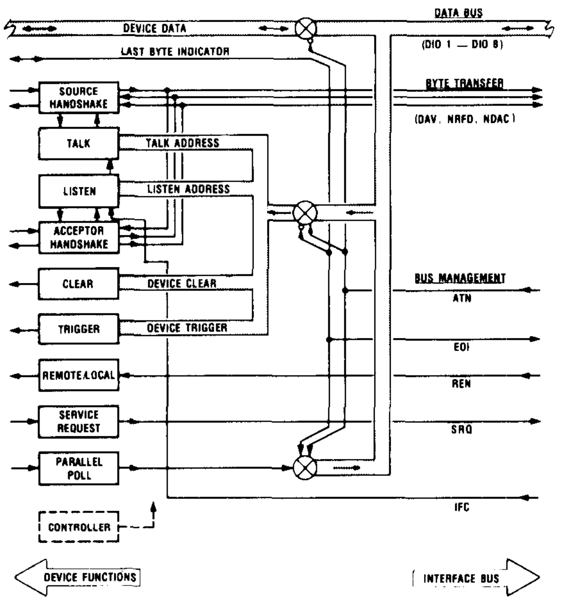


fig. 6. Ten interface functions serve to link the bus structure to the device functions.

and reconverts incoming serial data into the bit-parallel HP-IB format. This allows an HP-IB system to be split into two or more discrete parts separated by HP-IB extenders and a serial data link. A range of 0.6 mile (1 km) is possible if twin-pair cables are used for the transmission path, and virtually unlimited range is possible with a telephone modem hookup. Full duplex operation is also possible and allows for data to flow in both directions at the same time. Many HP-IB problems stem from glitches in this handshaking process. In part, this crisis results because the data transfer is asynchronous. A number of bus analyzers offer some means of detecting protocol violations in handshake activity.

The Hewlett-Packard Interface Bus, HP-IB INTERFACE functions (**fig. 6**) include:

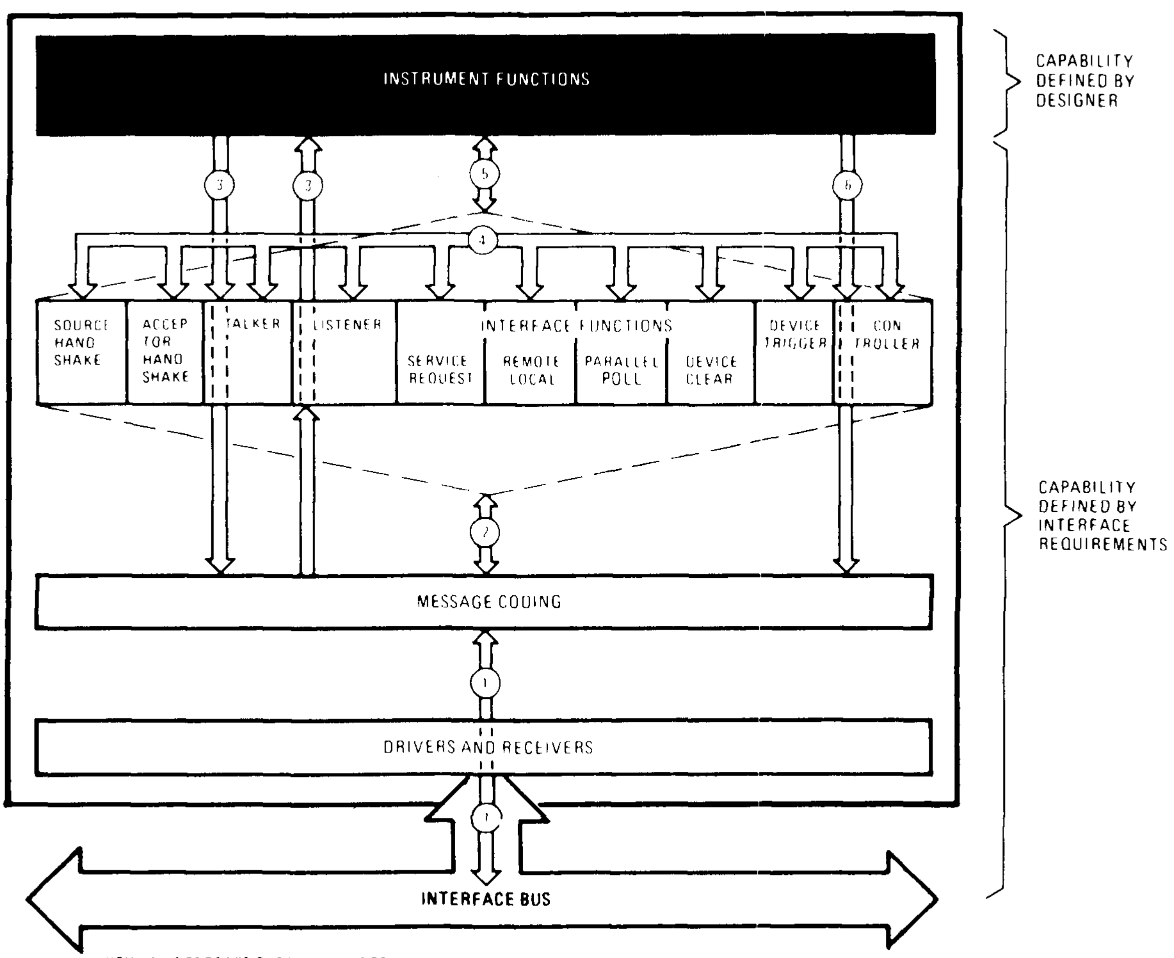
- Talker
- Listener
- Controller
- Source Handshake
- Acceptor Handshake
- SR or Service Report
- RL or Remote Local
- PP or Parallel Poll
- DC or Device Clear
- DT or Device Trigger

The first five functions exist in virtually every HP-IB System as primary functions. The last five, less frequently encountered, are found on the Hewlett-Packard Interface Bus. The detailed functions of these last five are defined as follows:

- **SR (SERVICE REPORT)** allows the device to ask the controller for attention asynchronously in relation to other messages.
- **RL (REMOTE LOCAL)** determines whether messages from the data bus (remote program) or from some local program source will receive the program data from a device in the system.
- **PP (PARALLEL POLL)** is a rapid simultaneous status report to the controller from several devices.
- **DC (DEVICE CLEAR)** enables an instrument (IFC enables the interface itself).
- **DT (DEVICE TRIGGER)** initiates a user-specified transaction within device functions and will synchronize similar actions for multiple measurements among a number of devices after programming.

For designers tackling the problem, the first design specification written is in terms of interface functions (not instrument functions), messages to and from the interface, and the behavior of each of these functions. This last item is traditionally accomplished with state diagrams in which signal flows and events happening are "tied together". **Fig. 7**, which probably best illustrates this process, will not only give you a feel for what goes into the process, but also a fuller appreciation of this clever interfacing scheme. Lastly, this is admittedly a complicated subject and if all of it is not totally clear, don't become frustrated. Once you begin working with them, the concepts will become second nature to you.

This has been an overview or summary of the HP-IB which you are certain to see much more of in the immediate future if you work with modern test equipment at all.



KEY
1 INTERFACE BUS SIGNAL LINES
2 REMOTE INTERFACE MESSAGES TO AND FROM INTERFACE FUNCTIONS
3 INSTRUMENT DEPENDENT MESSAGES TO AND FROM INSTRUMENT FUNCTIONS
4 STATE LINKAGES BETWEEN INTERFACE FUNCTIONS
5 LOCAL MESSAGES BETWEEN INSTRUMENT FUNCTIONS AND INTERFACE FUNCTIONS (MESSAGES TO INTERFACE FUNCTIONS ARE DEFINED. MESSAGES FROM INTERFACE FUNCTIONS EXIST ACCORDING TO THE DESIGNER'S CHOICE)
6 REMOTE INTERFACE MESSAGES SENT BY INSTRUMENT FUNCTIONS WITHIN A CONTROLLER

fig. 7. Instrument designs can be conceptualized as being partitioned into two areas: instrument functions and interface functions. But this division does not necessarily imply two separate physical layouts within the instrument.

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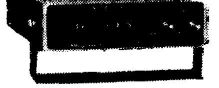

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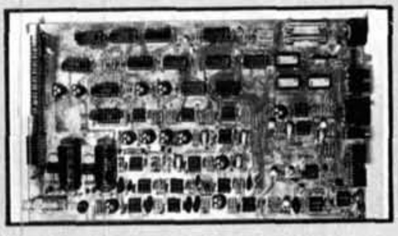

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the weekender

noise cancellation circuit

As an LF enthusiast, I've often encountered QRN and QRM on the 160 to 190 kHz (1750 meters) band. In years past, the situation was manageable, but in recent years, it seems that conditions have grown steadily worse. A plague of EMI in my area renders weak signal reception impossible, and the source of much of the QRN, at least, has been increasing use of electric light dimmer switches.

In trying to alleviate the interference, I did some experimenting with synchronous line blankers. I also used the noise blanker in my Yaesu FT-101E with my LF converter. Nothing worked.

Recalling previous experience with direction finders, I decided to approach the problem in a different way, using a loop antenna, a sense antenna, and some sort of an RF phasing scheme. But my ferrite rods lacked either the length or permeability necessary to make a practical 1750 meter loop, so I tried the two-antenna scheme shown in **fig. 1**. I was pleasantly surprised; at the first attempt, I could reduce a 20 dB over S9 QRN to S7.

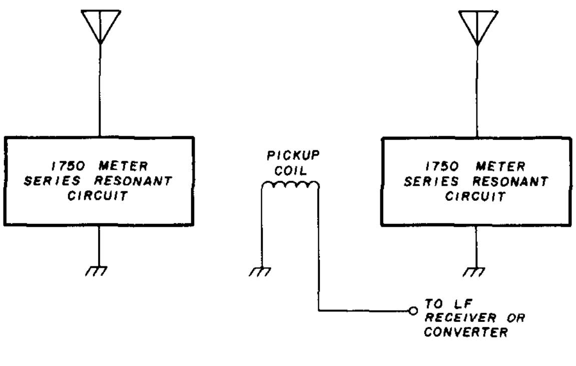

fig. 1. Two series-resonant circuits with a pickup coil gave surprising results.

By S.J. DeFrancesco, K1RGO, 17 Jeffrey Road, East Haven, Connecticut 06512

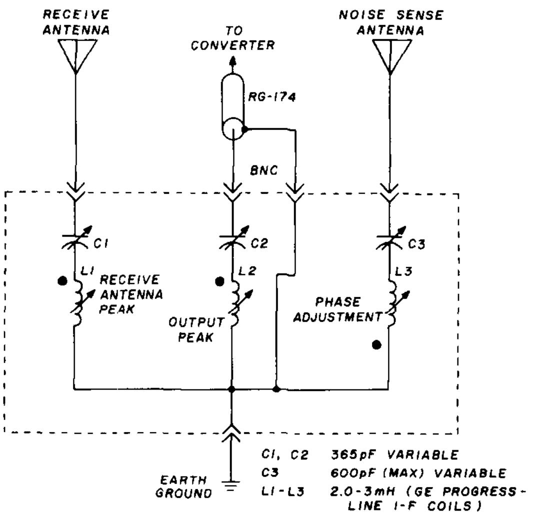

fig. 2. The 160-200 kHz RF phase cancelling circuit schematic. C1-C3 and L1-L3 can be increased or decreased in value to suit your frequency of interest. All coils are spaced 0.5 inch (12.7 mm) apart.

With a little further experimenting, I came up with a simple RF phase-cancelling circuit (**fig. 2**) that outperformed my Yaesu FT-101E noise blanker.

simple circuit layout

Three coils obtained from old General Electric two-way radio progress line IF transformers are mounted side by side in an enclosed metal minibox. The coils are approximately 0.5 inch (12.7 mm) apart; L1 and L3 are out of phase with each other. C1, C2, and C3 can be variable capacitors for wider frequency coverage, but for the 1750 meter band, I obtain adequate coverage by slug tuning the mutually coupled coils. Adjusting around the resonant frequency of both tuned circuits at the frequency of interest will result in phase cancelling of the unwanted noise with very little attenuation of the received signal.

cancelling noise

A careful adjustment can reduce 20 over 9 light dimmer noise to a noise level of S3 or less. Connect your "noise" antenna to the noise antenna input, then connect your LF receiver or LF converter to the output of the noise canceller. Leave the receive antenna off. Now tune the "phase" or noise antenna coil, L3, for maximum noise at the frequency of interest. Disconnect the noise antenna and connect the receive antenna. Peak the receive antenna coil, L1, for maximum noise at the frequency of interest. Connect both receive and noise antennas and adjust both coils carefully till your noise is nulled out. Repeak L2 for maximum signal.

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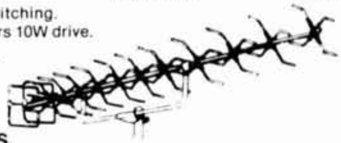

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The light dimmer in my house was the only noise source that the noise canceller couldn't phase out, but my easy access to the dimmer switch cured that problem. I simply replaced it with a conventional switch. Power line noise and light dimmer noise are no longer a problem to me, and 1750 meters is now fun to operate again.

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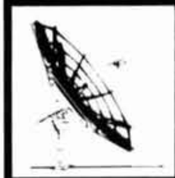

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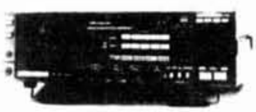

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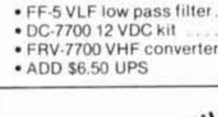

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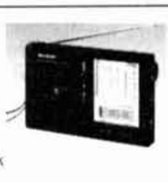

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speech synthesis for repeaters

Today's synthesizers are smaller, faster, smarter, cheaper

In the late 1960's a machine containing 60 endless loop tape cartridges was required for a human voice announcement of time. The device measured three feet high by nineteen inches wide. Today the same function is accomplished with a unit the size of a wrist watch, with all the electronics manufactured on a single wafer.

In the mid 1970's, the electronic industry began introducing electronic voice generating devices known as voice synthesizers. The initial versions, which the home experimenter could afford, fit on a 10 × 7-inch PC board and contained a limited vocabulary. But unlike its mammoth predecessor, it could be easily controlled by a computer or digital controller.

In the early 1980's, chip technology had advanced and the 10 × 7 inch module was reduced to a single device. Several manufacturers are now producing these devices and their use is commonplace in repeaters as well as the phone company. Amateur Radio manufacturers have started using these devices. The Kenwood TW-4000A 2 meter and 440 MHz transceiver features a voice option in both English and Japanese. Two Amateur repeater-controller manufacturers, Micro Security and Advanced Computer Controls (ACC)* also provide speech synthesis features.

If you dial Telephone Information for a phone number, you first speak with a human assistant. After taking your request, the assistant departs and your requested phone number is given by an electronic voice unit. Some expensive voice generators sound so much like human speech that only a musically-tuned ear can detect any difference. However, some less expensive units sound very good and are adequate for use in repeaters. One such unit is the National Semiconductor's "DT-1050 Digitalker."

DT-1050 voice synthesizer

The DT-1050 contains a voice control processor and two 8K Byte ROMs. The control processor is a 40-pin IC which controls voice generation as instructed by the commands in the ROMs. The ROMs contain 143 characters; an outside controller can instruct the control processor to pronounce these characters via an 8-bit input latch. Each character is assigned an 8-bit combination that forces the processor to fetch the character data from ROM and execute the speaking of the chosen character. If a new character command is given, the processor will stop what it is doing and start with the new character. This feature allows forming words not in the existing vocabulary by using combinations of characters. An example is the word "repeater" which is very close to "re meter" pushed together. (I've even produced a reasonable "Cincinnati, Ohio" using *Cent, C, N, At, E, O, High*, and *O* pushed together.)

Table 1 provides a list of the DT-1050 master word list along with the character 8-bit data word commands. The first character, "This is Digitalker," is spoken in a "female" voice, but the remainder is spoken in a "male" voice. Note that the one through twenty character commands are 1 through 20 decimal. To force the character sixteen, the controller simply sends 16 decimal or 10 hexdecimal. Also, commands above 142 decimal or 8F hexdecimal are invalid. These commands will return garbage.

To control the DT-1050, one first places the character command on the 8-bit latched inputs SW1 (LSB) through SW8, and produces a low to high TTL signal on the "write" line (pin 4 of the processor). The processor then latches the 8 bits and starts the character speech sequence. It continues until finished or until a new command is entered, whichever comes first. When the processor is busy it produces a TTL low on the introduction

By Ron Wright, N9EE, Micro Security, 9307 Meadow Lane, Greenfield, Indiana 46140

*Advanced Computer Controls (ACC), 10816 Northridge Square, Cupertino, California 95014.

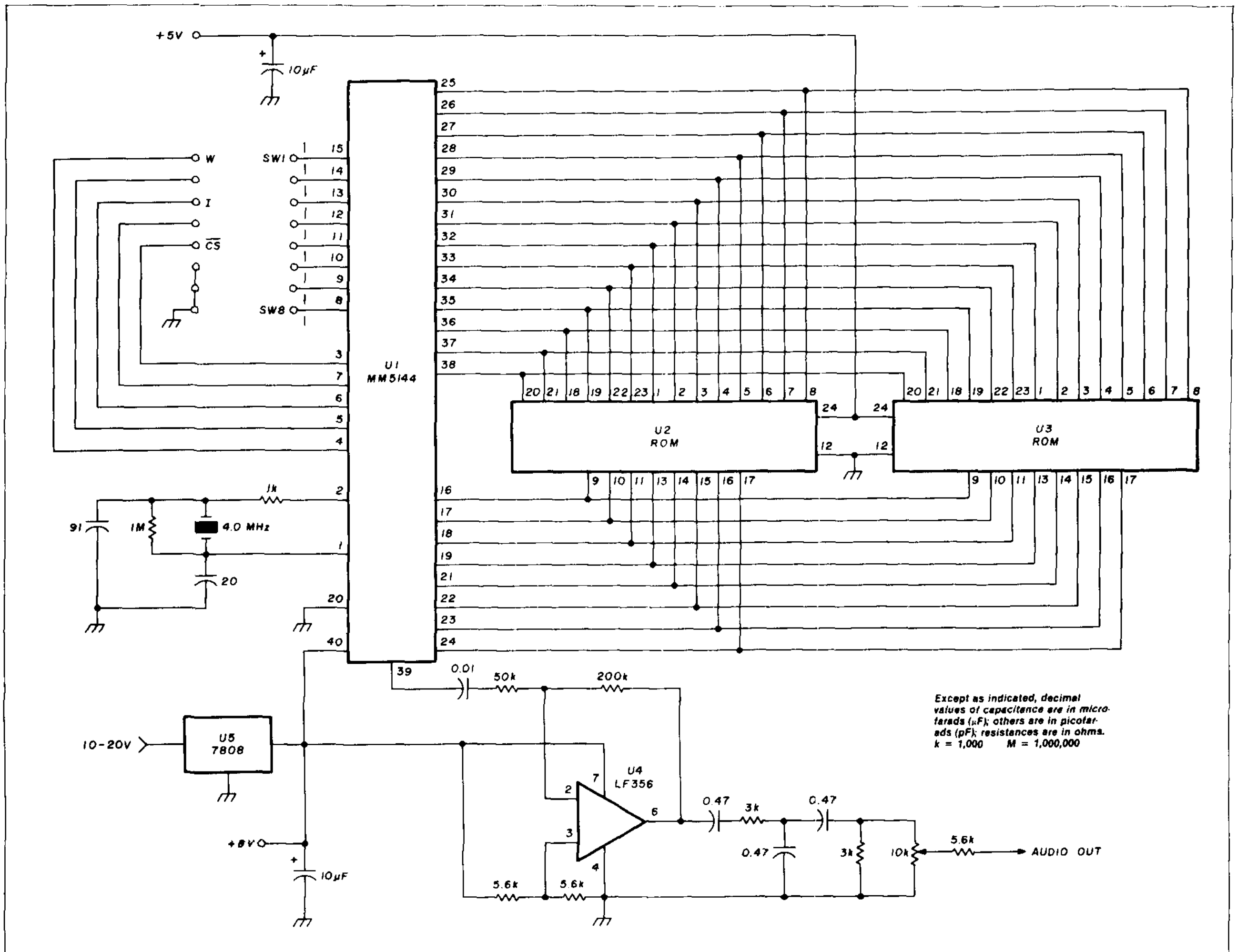


fig. 1. Voice generator DT-1050, audio filter and amplifier schematic.

(pin 6). When the character is complete, this line will go high. The external controller can use this line for "handshaking" with the voice processor.

The control processor can be tied directly to a microprocessor data bus with the Chip Select (pin 3) enabling the input latch. However, in the case of a hardware controller, this pin can be tied low. This pin controls only the input latch, enabling it when a command is to be entered. While the processor is speaking, the CS may be high or low.

the voice generator

Fig. 1 is a schematic of the DT-1050 and the needed audio filter and amplifier. The amplifier drives a 1 kilohm load. The voice processor controller operates on 7 to 11 volts and the ROMs require 5 volts. The 4 MHz crystal is the master clock and determines the speed at which the characters are pronounced. It is recommended that a 4 MHz crystal be used rather than the easy-to-find 3.58; there is a definite difference.

Fig. 2 is a schematic of a hardware controller for forming a list of phrases. The 2716 EPROM contains the character sequence. By programming the desired characters in the 2716 with each set in 16-byte blocks, one can produce and select desired character sequences. This controller uses only eight sets of the 16-byte blocks. The block addresses, which must be programmed with the desired voice sequence corresponding to the message input, are given in the inset table. If one wishes to expand the number of messages, a more detailed 2716 address control is required.

The 74374 latches the input command when the start line goes from low to high. This also presets the 7474 latch, which allows the 74123 to run clocking through the 2716 selected addresses, forcing the desired table to be outputted to the voice control processor. To start a voice sequence, first ground the desired 74374 "message input" line (M1 through M7). Then ground the "start" line, making sure it returns high prior to the message finish. The grounding of the "start" line and leaving the message lines high forces the table stored in 7F0 through 7FF to be sent. When a new byte is sent to the table 1. DT-1050 master word list.

Word	8-Bit Binary Address SW8 SW1		8-Bit Binary Address SW8 SW1		SW8 SW1
THIS IS DIGITALKER	00000000	Q	00110000	IS	01100000
ONE	00000001	R	00110001	IT	01100001
TWO	00000010	S	00110010	KILO	01100010
THREE	00000011	T	00110011	LEFT	01100011
FOUR	00000100	U	W0110100	LESS	01100100
FIVE	00000101	V	00110101	LESSER	01100101
SIX	00000110	W	00110110	LIMIT	01100110
SEVEN	00000111	X	00110111	LOW	01100111
EIGHT	00001000	Y	00111000	LOWER	01101000
NINE	00001001	Z	00111001	MARK	01101001
TEN	00001010	AGAIN	00111010	METER	01101010
ELEVEN	00001011	AMPERE	00111011	MILE	01101011
TWELVE	00001100	AND	00111100	MILLI	01101100
THIRTEEN	00001101	AT	00111101	MINUS	01101101
FOURTEEN	00001110	CANCEL	00111110	MINUTE	01101110
FIFTEEN	00001111	CASE	00111111	NEAR	01101111
SIXTEEN	00010000	CENT	01000000	NUMBER	01110000
SEVENTEEN	00010001	400HERTZ TONE	01000001	OF	01110001
EIGHTEEN	00010010	80HERTZ TONE	01000010	OFF	01110010
NINETEEN	00010011	20MS SILENCE	01000011	ON	01110011
TWENTY	00010100	40MS SILENCE	01000100	OUT	01110100
THIRTY	00010101	80MS SILENCE	01000101	OVER	01110101
FORTY	00010110	160MS SILENCE	01000110	PARENTHESIS	01110110
FIFTY	00010111	320MS SILENCE	01000111	PERCENT	01110111
SIXTY	00011000	CENTI	01001000	PLEASE	01111000
SEVENTY	00011001	CHECK	01001001	PLUS	01111001
EIGHTY	00011010	COMMA	01001010	POINT	01111010
NINETY	00011011	CONTROL	01001011	POUND	01111011
HUNDRED	00011100	DANGER	01001100	PULSES	01111100
THOUSAND	00011101	DEGREE	01001101	RATE	01111101
MILLION	00011110	DOLLAR	01001110	RE	01111110
ZERO	00011111	DOWN	01001111	READY	01111111
A	00100000	EQUAL	01010000	RIGHT	10000000
B	00100001	ERROR	01010001	SS (Note 1)	10000001
C	00100010	FEET	01010010	SECOND	10000010
D	00100011	FLOW	01010011	SET	10000011
E	00100100	FUEL	01010100	SPACE	10000100
F	00100101	GALLON	01010101	SPEED	10000101
G	00100110	GO	01010110	STAR	10000110
H	00100111	GRAM	01010111	START	10000111
I	00101000	GREAT	01011000	STOP	10001000
J	00101001	GREATER	01011001	THAN	10001001
K	00101010	HAVE	01011010	THE	10001010
L	00101011	HIGH	01011011	TIME	10001011
M	00101100	HIGHER	01011100	TRY	10001100
N	00101101	HOUR	01011101	UP	10001101
O	00101110	IN	01011110	VOLT	10001110
P	00101111	INCHES	01011111	WEIGHT (Note 2)	10001111

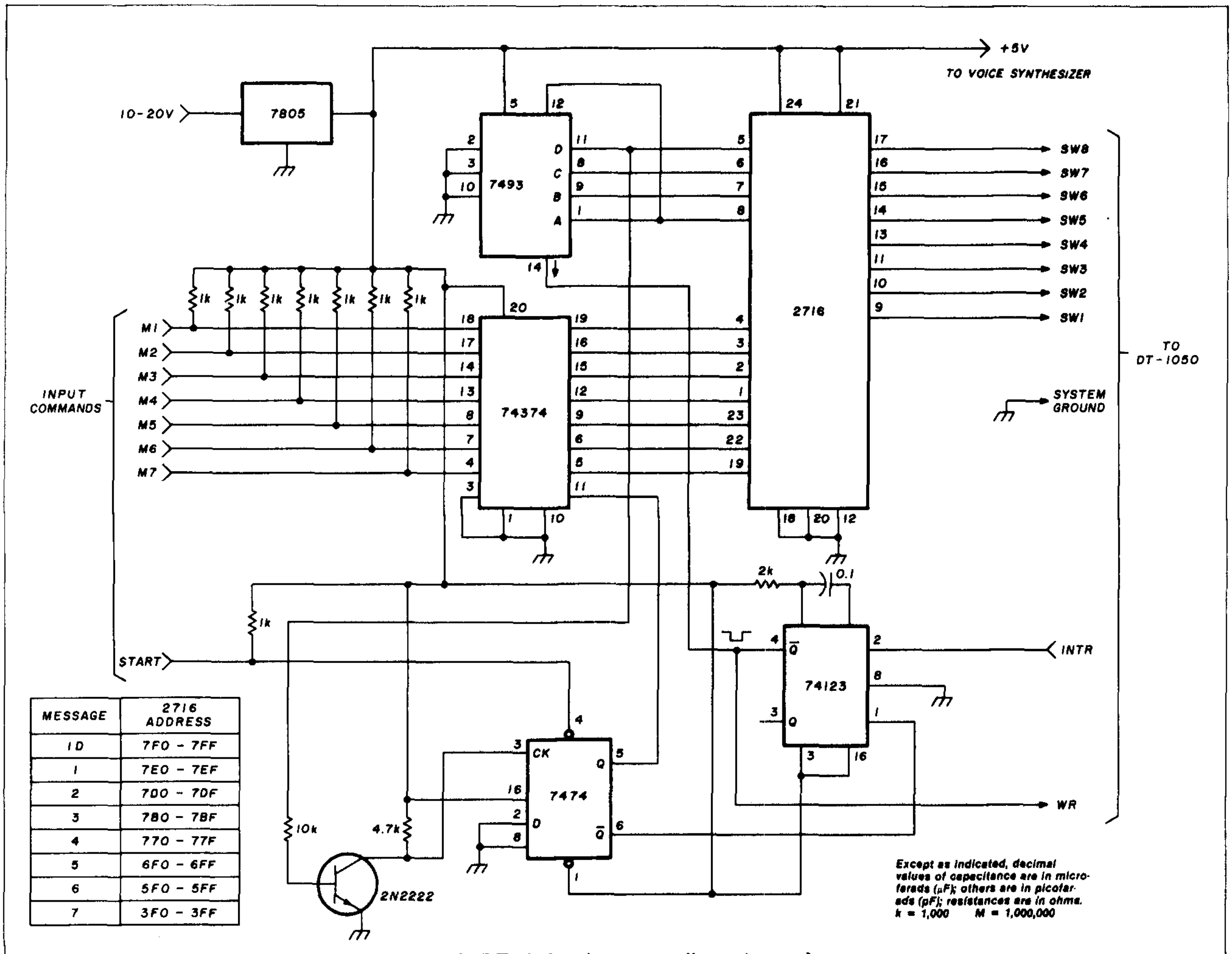
Note 1: "SS" makes any singular word plural

Note 2: *Address 143 is the last legal address in this particular word list. Exceeding address 143 will produce pieces of unintelligible invalid speech data.*

processor, the controller strobes the "write" line, beginning the character sequence. When the character is complete, the processor returns a low to high signal on the "intr" line, clocking the 74123, clocking the 7493, and selecting the next byte. This sequence continues until the 7493 reaches all ones (1111) and receives an additional strobe. This last strobe now forces a 0000 output and clocks the 7474, producing a stop command.

voice applications

Voice generator applications are many. The most obvious is the voice ID of a repeater. Other applications are "10 seconds time out" for repeater and autopatch time out warning; "you timed it out" on time out recovery; "2 meters on" for remote bases; and many more. If one has a microprocessor-based controller, one can add software with a minimal amount of hardware to produce



MESSAGE	2716 ADDRESS
ID	7F0 - 7FF
1	7E0 - 7EF
2	7D0 - 7DF
3	7B0 - 7BF
4	770 - 77F
5	6F0 - 6FF
6	5F0 - 5FF
7	3F0 - 3FF

fig. 2. DT-1050 voice controller schematic.

features such as a talking clock, which is touch-tone settable, or a touch-tone pad tester (the voice generator says "star" and "pound" as well as the remainder of the touch-tone digits). The list is limited only by our imaginations.

National is now marketing the DT-1057, a second set of ROMs without the voice processor, containing another set of characters. The voice synthesizer can be expanded, using all four ROMs. National is also trying to market software that will allow development of one's own character set, but rumor has it that the cost may be about $1000. National is also said to be willing to develop words for about $200 each, but the present set is certainly adequate for many repeater applications.

The DT-1050 can be purchased from any supply store that carries National Semiconductor products, though you may have to wait a few weeks for delivery.

conclusion

The rapid progress in this field has brought consumer products incorporating memory speech synthesis into nearly every American home. One can now buy a wrist watch with a built-in storage unit that will allow its owner to enter an 8-second message to be read back at a selected time; the message can remind the wearer of an appointment or simply remind him or her of some timely piece of information. Votan* is marketing a voice-recognition and generation unit for taking orders over the phone, in which the caller follows computer-generated instructions and the computer enters account codes and part numbers using the caller's voice. "You are the XYZ company," says the computer. "You have ordered fifteen items . . . shipment will be in four days." Next, an automatic stock-fetching unit collects the ordered items, boxes them up, weighs the package, places the correct amount of postage on it, attaches the mailing label, and sets it on the loading dock for shipment.

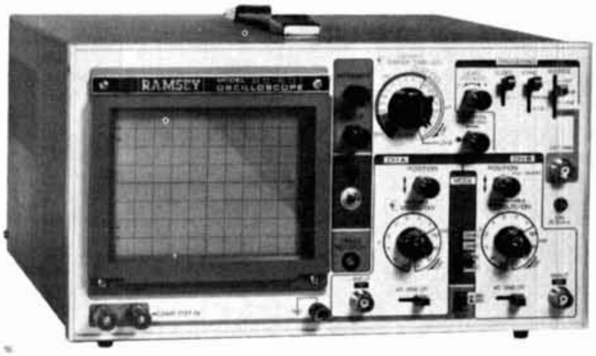
Speech synthesis has come a long way in a very short time. The technology is here and fully accessible for applications in Amateur Radio.

ham radio

*Votan, 4487 Technology Drive, Fremont, California 95438.

RAMSEY — THE FIRST NAME IN ELECTRONIC TEST GEAR

NEW FROM RAMSEY 20 MHz DUAL TRACE OSCILLOSCOPE



Unsurpassed quality at an unbeatable price, the Ramsey oscilloscope compares to others costing hundreds more. Features include a component testing circuit that will allow you to easily test resistors, capacitors, digital circuits and diodes • TV video sync filter • wide bandwidth & high sensitivity • internal graticule • high quality rectangular CRT • front panel trace rotator • Z axis • high sensitivity x-y mode • very low power consumption • regulated power supply • built-in calibrator • rock solid triggering • high quality hook-on probes • 5" CRT • 5 MV/DIV vertical sensitivity • 120/220 VAC pwr. • 15 lbs. • 6.4" (H) × 11.6" (W) × 13.9" (L)

$399.95 high quality hook-on probes included

RAMSEY D-1100 VOM-MULTITESTER

Compact and reliable, designed to service a wide variety of equipment. Features include • mirror back scale • double-jeweled precision moving coil • double overload protection • an ideal low cost unit for the beginner or as a spare back-up unit.

$19.95

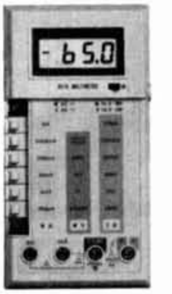
test leads and battery included

RAMSEY D-2100 DIGITAL MULTITESTER

A compact easy to use unit designed to operate like a pro. Featuring • 3½ digit LCD • low BAT indicator • all range overload protection • overrange indication • auto-polarity • transistor tester • dual-slope integration • vinyl carrying case

$54.95

h_{FE} test leads, battery & vinyl carrying case included

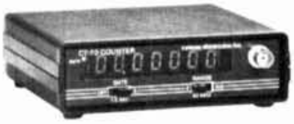


RAMSEY D-3100 DIGITAL MULTIMETER

Reliable, accurate digital measurements at an amazingly low cost • In-line color coded push buttons, speeds range selection • abs plastic tilt stand • recessed input jacks • overload protection on all ranges • 3½ digit LCD display with auto zero, auto polarity & low BAT. indicator

$59.95

test leads and battery included



CT-70 7 DIGIT 525 MHz COUNTER

Lab quality at a breakthrough price. Features • 3 frequency ranges each with pre amp • dual selectable gate times • gate activity indicator • 50mV @ 150 MHz typical sensitivity • wide frequency range • 1 ppm accuracy

$119.95

includes AC adapter

CT-70 kit $99.95
BP-4 nicad pack 8.95

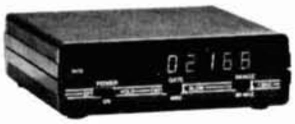
CT-90 9 DIGIT 600 MHz COUNTER

The most versatile for less than $300. Features 3 selectable gate times • 9 digits • gate indicator • display hold • 25mV @ 150 MHz typical sensitivity • 10 MHz timebase for WWV calibration • 1 ppm accuracy

$149.95

includes AC adapter

CT-90 kit $129.95
OV-1 0.1 ppm Oven Time base 59.95
BP-4 nicad pack 8.95



CT-125 9 DIGIT 1.2 GHz COUNTER

A 9 digit counter that will outperform units costing hundreds more. • gate indicator • 24mV @ 150 MHz typical sensitivity • 9 digit display • 1 ppm accuracy • display hold • dual inputs with preamps

$169.95

includes AC adapter

BP-4 nicad pack 8.95

CT-50 8 DIGIT 600 MHz COUNTER

A versatile lab bench counter with optional receive frequency adapter, which turns the CT-50 into a digital readout for most any receiver • 25 mV @ 150 MHz typical sensitivity • 8 digit display • 1 ppm accuracy

$169.95

wired

CT-50 kit $139.95
RA-1 receiver adapter kit 14.95

DM-700 DIGITAL MULTIMETER

Professional quality at a hobbyist price. Features include 26 different ranges and 5 functions • 3½ digit, ½ inch LED display • automatic decimal placement • automatic polarity

$119.95

includes AC adapter

DM-700 kit $99.95
MP-1 probe set 4.95

PS-2 AUDIO MULTIPLIER

The PS-2 is handy for high resolution audio resolution measurements, multiplies UP in frequency • great for PL tone measurements • multiplies by 10 or 100 • 0.01Hz resolution & built-in signal preamp/conditioner

$49.95

wired

PS-2 kit $39.95

PR-2 COUNTER PREAMP

The PR-2 is ideal for measuring weak signals from 10 to 1,000 MHz • flat 25 db gain • BNC connectors • great for sniffing RF

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includes AC adapter

PR-2 kit $34.95

PS-1B 600 MHz PRESCALER

Extends the range of your present counter to 600 MHz • 2 stage preamp • divide by 10 circuitry • sensitivity: 25mV @ 150 MHz • BNC connectors • drives any counter

$59.95

includes AC adapter

PS-1B kit $49.95

ACCESSORIES FOR RAMSEY COUNTERS

Telescopic whip antenna—BNC plug	$ 8.95
High impedance probe, light loading	16.95
Low pass probe, audio use	16.95
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Tilt bail, for CT-70, 90, 125	3.95

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RAMSEY

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MINI KITS - YOU HAVE SEEN THESE BEFORE NOW HERE ARE OLD FAVORITE AND NEW ONES TOO. GREAT FOR THAT AFTERNOON HOBBY.

FM MINI MIKE

A super high performance FM wireless mike kit! Transmits a stable signal up to 300 yards with exceptional audio quality by means of its built in electret mike. Kit includes case, mike, on-off switch, antenna, battery and super instructions. This is the finest unit available.

FM-3 Kit **$14.95**
FM-3 Wired and Tested **$22.95**

Color Organ

See music come alive! 3 different lights flicker with music. One light each for high, mid-range and lows. Each individually adjustable and drives up to 300 W, runs on 110 VAC.

Complete kit, ML-1 **$8.95**

Video Modulator Kit

Converts any TV to video monitor. Super stable, tunable over ch 4-6. Runs on 5-15V accepts std video signal. Best unit on the market! Complete kit VD-1 **$8.95**

Led Blinky Kit

A great attention getter which alternately flashes 2 jumbo LEDs. Use for name badges, buttons, warning panel lights, anything! Runs on 3 to 15 volts.
Complete kit BL-1 **$2.95**

Super Sleuth

A super sensitive amplifier which will pick up a pin drop at 15 feet! Great for monitoring baby's room or as general purpose amplifier. Full 2 W rms output, runs on 6 to 15 volts, uses 8-45 ohm speaker.
Complete kit, BN-9 **$5.95**

CPO-1

Runs on 3-12 Vd... SOLD OUT ...good for CPO, Alarm, Audio O... ...mplete kit **$2.95**

CLOCK KITS

Your old favorites are here again. Over 7,000 Sold to Date. Be one of the gang and order yours today!

Try your hand at building the finest looking clock on the market. Its satin finish anodized aluminum case looks great anywhere, while six .4" LED digits provide a highly readable display. This is a complete kit, no extras needed, and it only takes 1-2 hours to assemble. Your choice of case colors: silver, gold, black (specify).

Clock kit, 12/24 hour, DC-5 **$24.95**
Clock with 10 min. ID timer, 12/24 hour, DC-10 **$29.95**

For wired and tested clocks add $10.00 to kit price.
SPECIFY 12 OR 24 HOUR FORMAT

FM Wireless Mike Kit

Transmits up to 300' to any FM broadcast radio, uses any type of mike. Runs on 3 to 9V. Type FM-2 has added sensitive mike preamp stage.

FM-1 kit **$3.95** FM-2 kit **$4.95**

Whisper Light Kit

An interesting kit, small mike picks up sounds and converts them to light. The louder the sound, the brighter the light. Includes mike, controls up to 300 W, runs on 110 VAC.
Complete kit, WL-1 **$6.95**

Tone Decoder

A complete tone decoder on a single PC board. Features: 400-5000 Hz adjustable range via 20 turn pot, voltage regulation, 567 IC. Useful for touch-tone burst detection, FSK, etc. Can also be used as a stable tone encoder. Runs on 5 to 12 volts.
Complete kit, TD-1 **$5.95**

Universal Timer Kit

Provides the basic parts and PC board required to provide a source of precision timing and pulse generation. Uses 555 timer IC and includes a range of parts for most timing needs.

UT-5 Kit **$5.95**

Mad Blaster Kit

Produces LOUD ear shattering and attention getting siren like sound. Can supply up to 15 watts of obnoxious audio. Runs on 6-15 VDC.

MB-1 Kit **$4.95**

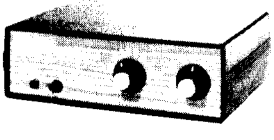
Siren Kit

Produces upward and downward wail characteristic of a police siren. 5 W peak audio output, runs on 3-15 volts, uses 3-45 ohm speaker.
Complete kit, SM-3 **$2.95**

60 Hz Time Base

Runs on 5-15 VDC. Low current (2.5ma). 1 min/month accuracy. TB-7 Kit **$5.50**

SATELLITE TV KIT



THE POPULAR SAT-TEC RECEIVER IN KIT-FORM!

image rejection, fully tunable audio to recover 'hidden' subcarriers, divide by two PLL demodulator for excellent threshold performance, tight tracking AFC to assure drift free reception, and of course, full 24 channel tunable coverage.

Build your satellite TV system around the R2B, close to ten thousand others already have and now it's available in kit form at a new low price. Order yours today.

NEW, LOWER PRICES!

Featured in a Radio Electronics magazine cover story (May 82), the reliable R2B Sat-tec TV receiver is now operating in thousands of locations. The R2B is easy to build: pre-etched plated boards with screened component layout assures accurate component placement and the critical IF section and local oscillator are pre-assembled and aligned! ... are included for the R2B: ... case, power supply, descriptive operating manual as well as complete assembly instructions. Features of the receiver include; dual conversion design for best

SOLD OUT

A complete Satellite TV System requires a dish antenna, LNA (low noise amplifier), Receiver and Modulator.

R2B Receiver Kit	**$295.00**
R2B Receiver, Wired and Tested	**$395.00**
120°K LNA	**$295.00**
RM3 RF Modulator	$49.95

Prices include domestic UPS shipping and insurance.

PARTS PARADE

IC SPECIALS

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301	$ .35
324	$1.50
380	$1.50
555	$ .45
556	$1.00
567	$1.25
741	10/$2.00
1458	$ .50
3900	$ .50
8038	$2.95

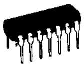
TTL

74S00	$ .40
7447	$ .65
7475	$ .50
7490	$ .50
74196	$1.35

SPECIAL

11C90	$15.00
10116	$ 1.25
7208	$17.50
7207A	$ 5.50
7216D	$21.00
7107C	$12.50
5314	$ 2.95
5375AB/G	$ 2.95

CMOS



4011	.50
4013	.50
4046	$1.85
4049	.50
4059	$9.00
4511	$2.00
4518	$1.35
5639	$1.75

FERRITE BEADS

With info and specs **15/$1.00**
6 Hole Balun Beads **5/$1.00**

READOUTS

FND 359 .4" C C	$1.00
FND 507/510 .5" C A	1.00
MAN 72/HP7730 .33" C A	1.00
HP 7651 .43" C A	2.00

Sockets

8 Pin	10/$2.00
14 Pin	10/$2.00
16 Pin	10/$2.00
24 Pin	4/$2.00
28 Pin	4/$2.00
40 Pin	3/$2.00

TRANSISTORS

2N3904 NPN C+F	15/$1.00
2N3906 PNP C+F	15/$1.00
2N4403 PNP C+F	15/$1.00
2N4410 NPN C+F	15/$1.00
2N4916 FET C+F	4/$1.00
2N5401 PNP C+F	5/$1.00
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Power Tab NPN 40W	3/$1.00
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NPN 3904 Type T+R	50/$2.50
PNP 3906 Type T+R	50/$2.50
2N3055	$.80
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Diodes

5.1 V Zener	20/$1.00
1N914 Type	50/$1.00
1KV 2Amp	8/$1.00
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25 AMP 100V Bridge **$1.75 each**

Mini-Bridge 50V 1 AMP 2 for $1.00

Resistor Ass't

Assortment of Popular values - ¼ watt. Cut lead for PC mounting, ½" center, ⅛" leads, bag of 300 or more **$2.00**

Crystals

3.579545 MHZ	$1.50
10.00000 MHZ	$5.00
5.248800 MHZ	$5.00

Switches

Mini toggle SPDT **$1.00**
Red Pushbuttons N.O. **3/$1.00**

AC Adapters

Good for clocks, nicad chargers, all 110 VAC plug one end

8.5 vdc @ 20 mA	$1.00
16 vac @ 160mA	$2.50
12 vac @ 250mA	$3.00

Earphones

3' leads, 8 ohm, good for small tone speakers, alarm clocks, etc.
5 for $1.00

Mini 8 ohm Speaker

Approx 2¼" diam. Round type for radios, mike etc.
3 for $2.00

Solid State Buzzers

small buzzer 450 Hz 86 dB sound output on 5-12 vdc at 10-30 mA. TTL compatible **$1.50**

Slug Tuned Coils

Small 3/16" Hex Slugs turned coil 3 turns 10 for $1.00

AC Outlet

Panel Mount with Leads **4/$1.00**

CAPACITORS

TANTALUM Dipped Epoxy	ALUMINUM Electrolytic		DISK CERAMIC	
1.5 uF 25V 3/$1.00	1000 uF 16V Radial	$.50	.01 16V disk	20/$1.00
1.8 uF 25V 3/$1.00	500 uF 20V Axial	$.50	.1 16V	15/$1.00
.22 uF 25V 3/$1.00	150 uF 16V Axial	5/$1.00	.001 16V	20/$1.00
	10 uF 15V Radial	10/$1.00	100 pF	20/$1.00
			.047 16V	20/$1.00

DC-DC Converter

•5 vdc input prod. -9 vdc @ 30ma
•9 vdc produces -15 vdc @ 35ma **$1.25**

Ceramic IF Filters

Mini ... 7 kHz B.W. ... SOLD OUT ... $1.50 ea.

25K 20 Turn Trim Pot **$1.00**
1K 20 Turn Trim Pot **$ .50**

Trimmer Caps

Sprague - 3-40 pf Stable Polypropylene **.50 ea.**

Crystal Microphone

Small 1" diameter ¼" thick crystal mike cartridge **$.75**

Mini RG-174 Coax **10 ft. for $1.00**

Coax Connector

Chassis mount BNC type **$1.00**

9 Volt Battery Clips

Nice quality clips **5 for $1.00**
⅜" Rubber Grommets **10 for $1.00**

Parts Bag

Asst. of chokes, disc caps, tant., resistors, transistors, diodes, MICA caps etc.
sm. bag (100 pc) **$1.00** lg. bag (300 pc) **$2.50**

Connectors

6 pin type gold contacts for mA-1003 car clock module price **.75 ea.**

Leds - your choice, please specify
Mini Red, Jumbo Red, High Intensity Red, Illuminator Red **8/$1**
Mini Yellow, Jumbo Yellow, Jumbo Green **6/$1**

Varactors

Motorola MV 2209 30 PF Nominal cap 20-80 PF - Tunable range - **.50 each or 3/$1.00**

Audio Prescaler

Make high resolution audio measurments, great for musical instrument tuning, PL tones, etc. Multiplies audio UP in frequency, selectable x10 or x100, gives .01 HZ resolution with 1 sec gate time! High sensitivity of 25 mv, 1 meg input z and built-in filtering gives great performance. Runs on 9V battery, all CMOS.

PS-2 kit **$39.95**
PS-2 wired **$49.95**

600 MHz PRESCALER

Extend the range of your counter to 600 MHz. Works with all counters. Less than 150 mv sensitivity, specify -10 or -100

Wired, tested, PS-1B **$59.95**
Kit, PS-1B **$49.95**

30 Watt 2 mtr PWR AMP

Simple Class C power amp features 8 times power gain. 1 W in for 8 out, 2 W in for 15 out, 4W in for 30 out. Max output of 35 W, incredible value, complete with all parts, less case and T-R relay.

PA-1, 30 W pwr amp kit **$24.95**
TR-1, RF sensed T-R relay kit **$6.95**

MRF-238 transistor as used in PA-1 8-10db gain 150 mhz **$15.95**

RF actuated relay senses RF (1W) and closes DPDT relay. For RF sensed T-R relay
TR-1 Kit **$6.95**

Power Supply Kit

Complete triple regulated power supply *provides variable 6 to 18 volts at 200 ma* and +5 at 1 Amp. Excellent load regulation, good filtering and small size. Less transformers, requires 6.3 V @ 1 A and 24 VCT.
Complete kit, PS-3LT **$6.95**

OP-AMP Special

BI-FET LF 13741 - Direct pin for pin 741 co... but 500,000 MEG input z, super low 50 pa input curr... power drain SOLD OUT
50 for only $9.00 **10 for $2.00**

Regulators

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723	$.50
309K	$1.15
7805	$1.00
7812	$1.00
7815	$1.00
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7912	$1.25
7915	$1.25

Shrink Tubing Nubs

Nice precut pces of shrink size 1" x ⅛" shrink to ⅛". Great for splices **50/$1.00**

Mini TO-92 Heat Sinks

Thermalloy Brand **5 for $1.00**
To-220 Heat Sinks **3 for $1.00**

Opto Isolators - 4N28 type **$.50 ea.**
Opto Reflectors - Photo diode + LED **$1.00 ea.**

Molex Pins

Molex already precut in length of 7. Perfect for 14 pin sockets. **20 strips for $1.00**

CDS Photocells

Resistance varies with light. 250 ohms to over 3 meg **3 for $1.00**

More Details? CHECK—OFF Page 120 ✓ 183

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Tested and Proven 15 Meter Mobile Transceiver USB and CW
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All this PLUS the freedom of DXing

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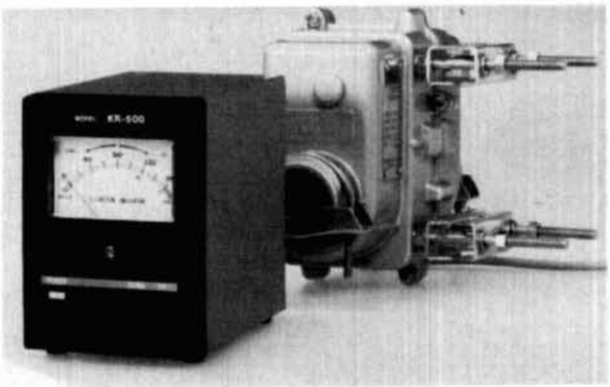

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the effects and treatment of electric shock

Still checking for live circuits with your fingers? Read this

Even in this day of solid-state equipment, Amateurs need to be especially aware of the hazards of electric shock. We all know what causes shock, but not all Amateurs know just why an electric shock can be so dangerous.

Some people believe that an electric shock burns a victim to death. Yet, medical evidence suggests that currents strong enough to burn actually kill less often than do much lower voltages. Others think that the electric current "shorts out" a victim the same way that lightning may short out an electric circuit. While far from accurate, this latter belief is closer to what really happens than the former.

Our nervous system is a complex electrochemical system "masterminded" by the brain. Our various motor functions are controlled by minute electric signals sent along the complex network known as the nervous system; an electric current generally kills by overriding the controlling influence of this system.

The minute electrical impulses circulating in the nervous system lose control of body functions whenever they are overridden by an outside current. By applying small potentials to the brain, researchers have been able to induce the movement of limbs and also the stimulation of mental images. This electrical prodding has helped them learn much about the brain and its effects on human behavior. Not so helpful, however, are the uncontrolled currents that flow during an electric shock, for these currents can affect the brain's signals to vital body parts. Currents entering the heart and respiratory centers are especially dangerous; the key to surviving electric shock appears to lie not in how much current there is, but rather where it travels.

shock kills two ways

Death due to electric shock is generally caused by one of two effects: ventricular fibrillation or respiratory center paralysis. Ventricular fibrillation is irregular, arhythmic contraction of the muscles of the heart. The heart is a pump that forces blood throughout the body according to a rhythmic stimulus established in the right auricle or sinus node. This stimulus is a minute periodic electric current that flows to all sections of the heart and regulates the contractions of its muscles. If the system is upset — say by an outside current —

(continued on page 88)

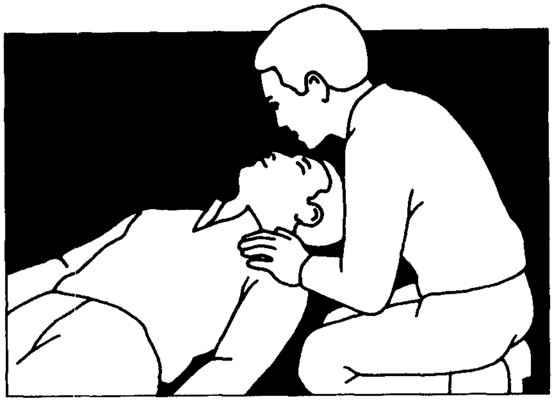
By Daniel Peters, Falcon Communications, P.O. Box 620625, Woodside, California 94062

YOU CAN LEARN CPR

When a person's heart and lungs stop functioning because of a heart attack, shock, drowning or other causes, it is possible to save that life by administering CPR, or cardiopulmonary resuscitation.

CPR provides artificial circulation and breathing for the victim. External cardiac compressions administered manually are alternated with mouth-to-mouth resuscitation in order to stimulate the natural functions of the heart and lungs.

This brochure contains an overview of CPR training and is not intended as a complete guide. Contact your local chapter of the AMERICAN RED CROSS for further information on how you can learn this life-saving procedure.

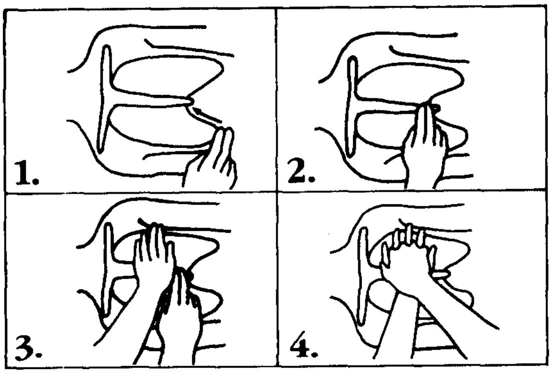


1. DETERMINE IF VICTIM IS UNCONSCIOUS

Tap or gently shake the victim's shoulder. Shout, "Are you O.K.?" If no response shout "HELP!" (Someone nearby may be able to assist.) Do the AIRWAY step next.

4. CHECK STEP

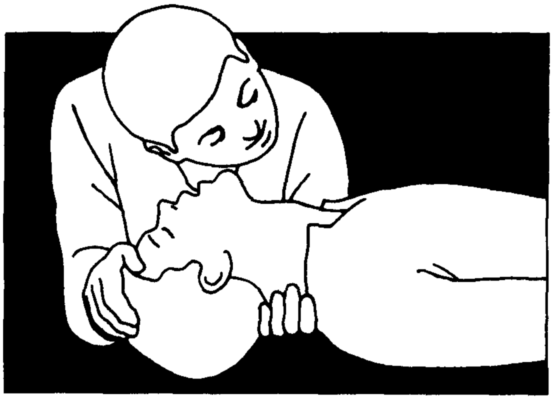
CHECK the pulse and breathing for at least 5 seconds but no more than 10. To do this, keep the head tipped with the hand on the forehead. Place the fingertips of your other hand on the adam's apple, slide your fingers into the groove at the side of the neck nearest you. If there is a pulse but no breathing give one breath every 5 seconds. If no pulse **or** breathing is present send someone for emergency assistance (dial 911 or operator) while locating proper hand position.
Begin Chest Compressions.



5. HAND POSITION FOR CHEST COMPRESSIONS

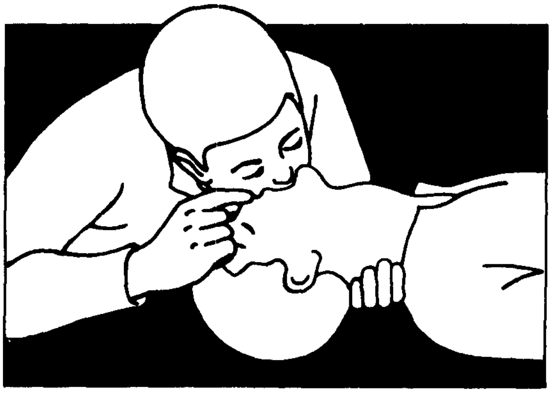
1. With your middle and index fingers find the lower edge of the victim's rib cage on the side nearest you.
2. Trace the edge of the ribs up to the notch where the ribs meet the breastbone.
3. Place the middle finger **on** the notch, the index finger next to it. Put the heel of the other hand on the breastbone next to the fingers.
4. Put your first hand on top of the hand on the breastbone. Keep the fingers off the chest.

fig. 1. CPR saves lives, but requires training and practice.



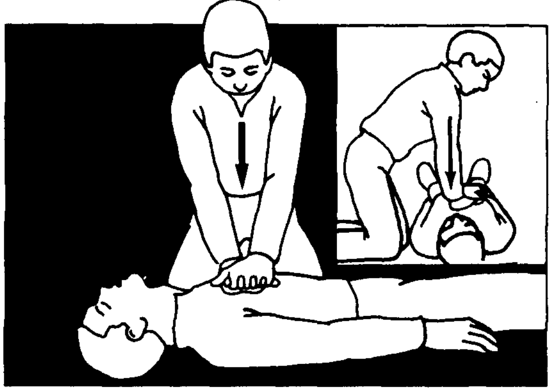
2. AIRWAY STEP

Place one hand on the forehead and push firmly backward. Place the other hand under the neck near the base of the skull and lift gently. Tip the head until the chin points straight up. This should open the airway. Place your ear near the victim's mouth and nose. LOOK at the chest for breathing movements, LISTEN for breaths and FEEL for breathing against your cheek. If no breathing occurs do the QUICK step next.



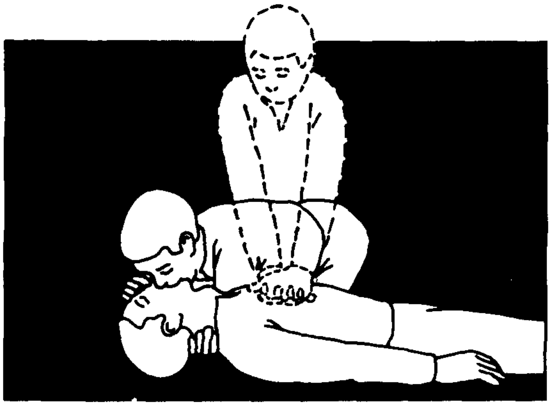
3. QUICK STEP

Give 4 QUICK full breaths, one on top of the other. To do this keep the head tipped and pinch the nose. Open your mouth wide and take a deep breath, making a good seal. Now, give the 4 breaths without waiting in between. Do the CHECK step next.



6. CHEST COMPRESSIONS

PUSH straight down without bending your elbows while maintaining proper hand position. Keep knees shoulder width apart. Shoulders should be directly over victim's breastbone. Keep hands along midline of body. Bend from the hip not the knees. Keep fingers off the chest. Push down about *1½ to 2 inches. Push smoothly. Count,* "1 and, 2 and, 3 and, etc.".



7. PUSH 15—BREATHE 2

Give 15 compressions at a rate of 80 per minute. Tip the head so the chin points up and give 2 quick full breaths. Continue to repeat 15 compressions followed by 2 breaths. Check the pulse and breathing after the first minute and every few minutes thereafter.
NOTE: **Do not practice** chest compressions on people as it could cause internal injuries.

THIS INFORMATION DOES NOT TAKE THE PLACE OF CPR TRAINING. CONTACT YOUR LOCAL RED CROSS CHAPTER ON HOW YOU CAN LEARN THIS LIFE-SAVING PROCEDURE.

Reprinted with permission from the American Red Cross.

the muscles of the heart may respond in an irregular fashion, rendering the organ useless as a pump. Without immediate trained medical attention, recovery from ventricular fibrillation is unusual.

Respiratory center paralysis is the second most lethal effect of electric shock. Normal breathing is controlled by the hindbrain; the stimulus travels from the brain through the nervous system to the lungs. An outside electric current can easily cause breathing to stop.

low voltage more dangerous?

Just how much current will cause death is difficult to determine. Much research has been done, but rather than list data that could be erroneously interpreted as a guideline of what constitutes safe levels, let's just say that under the wrong conditions, just a few thousandths of an ampere can do you in. But how does this equate to voltage?

I have tested the electrical resistance of my body under various conditions. One warm day, when I was perspiring freely, the resistance of my body (measured between two small pieces of pipe held in my hands) was low enough that a voltage as low as 25 volts would have caused a current generally considered lethal to a healthy adult. (Back in the days of 32-volt farm lighting systems, death from these systems was not unknown.)

At times shock from 1000 volts or more may be less dangerous than shock from lower voltages. The reason for this is that the high voltage, and attendant higher currents, cause all muscles — including those of the heart — to contract suddenly and violently. Sometimes the heart muscles may contract to such an extent that fibrillation can't occur; in such cases the heart may resume normal action if the current is stopped within three or four minutes. One report indicated a recovery rate of 62 percent among persons who were "knocked out" by voltages above 1000. The corresponding recovery rate at much lower voltages was only 39 percent.

People say a charged conductor "holds" its victim. It does this by contracting and paralyzing muscles. But in some cases muscles contract with enough force to "throw" the victim; this, of course, may cause secondary injuries if the victims's body strikes an obstruction as it falls.

watch out for that left hand

Current paths are extremely important in determining the effects of electric shock. Any route involving the heart or brain is particularly dangerous; leg-to-leg paths are considered less threatening.

In a study of cases involving fatal shock at voltages below 250, 90 percent of the victims had burns on their left hands. This suggests that shocks received through the left hand may kill more often than those through the right hand. (This statistic is even more noteworthy when you consider the predominance of right handed people in the general population.) So if you follow the rule of keeping one hand in your pocket while working on live circuits, make it your left hand. Better yet, *don't work on live circuits — ever.*

delayed results

If you receive a shock and suffer no apparent injury, your troubles are not necessarily over. Electric shock often damages delicate nerve cells in the spinal cord, which can cause a "wasting away" of muscle in one or more limbs. This is a slow, progressive, and intractable disturbance whose effects may not appear for weeks or even months after experiencing the shock. Other delayed effects may include insanity, personality changes, amnesia, mental inertia, blood-vessel diseases, cataracts, nerve disturbances, destruction of pancreatic tissue, and disruptions of the heart's conduction system.

how to help

If you are present when someone is rendered unconscious by an electric shock, the first thing to do is to ***stop the current flow.*** If possible, do so by turning off the power at the nearest switch. If you can't do that, or if getting to the switch will take too long, the next best thing is to ***separate the victim from the source of current.*** This can be dangerous. Use a wooden board or other nonconducting object. As soon as you can touch the victim safely, begin cardiopulminary resuscitation (CPR) — but only if you've been trained in the technique. *Anyone who works near live circuits owes it to his or her colleagues to take a course in CPR, master the technique, and make sure the skills are practiced at regular intervals, or as needed. (See **fig. 1.**)*

Speed is essential. Any delay at all greatly reduces the chances of recovery. Of some 600 cases studied, over 70 percent of those receiving treatment within three minutes recovered. Just one more minute dropped the percentage of recovery to 58 percent. If there is no heart or respiratory action and treatment is delayed by five minutes, death is inevitable.

If you are alone, do not take the time to go for help. Start treatment immediately. If the victim can be saved, you are the one who will do it. ***Don't stop treatment — not even if the victim appears to be dead;*** in one case, eight hours passed before a victim responded. Only a physician can judge whether a victim is really dead.

ham radio

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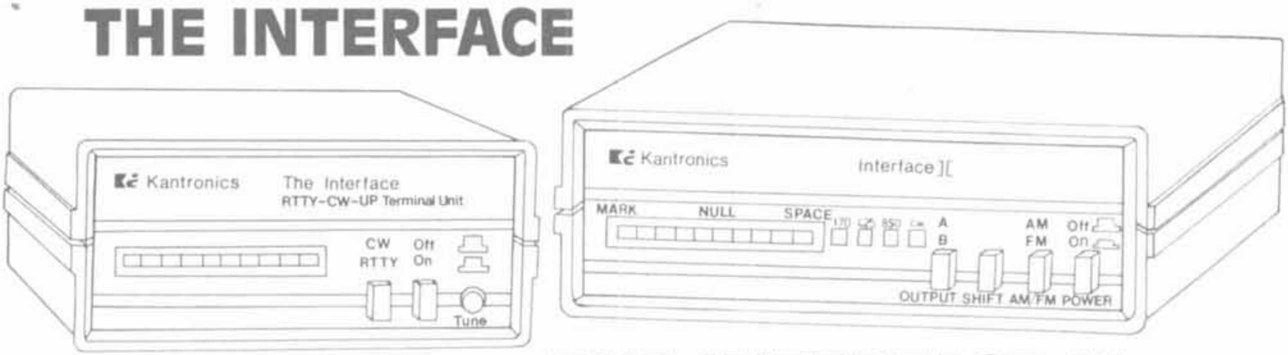
THE INTERFACE



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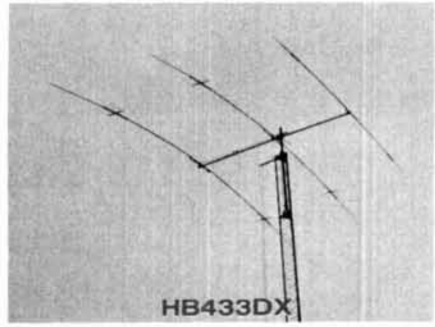

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Power	1KW CW		1KW CW
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7.1 - 7.25		2.0:1 or better adjustable	
14.0 - 14.5 21.0 - 21.45 28.0 - 29.0		1.5:1 or better	
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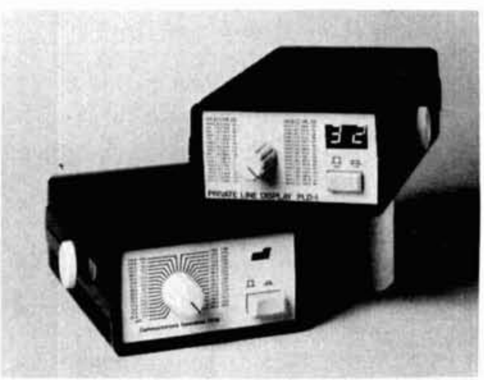

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performance by design

Folding Meters are Better

Not all multimeters fold. There's a reason. While other manufacturers were busy copying each others designs, BBC looked at where portable meters were used and how they could be improved.

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In multimeters "hands free" is significantly better than "handheld." You need three hands to operate the typical "handheld" meter in the field. One for the meter and two for the probes. BBC's folding design lets you use a neck strap for the meter. This frees your hands for the probes.

On the bench, the large, adjustable displays pay off. It's a sensible design that lets you make measurements faster and more easily.

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BBC's track record of expertise in precision engineering spans eight decades. All our meters are built to tough VDE and DIN safety standards. The 3½-digit DMM's feature 0.1% basic dc accuracy and externally accessible fuses for overload protection.

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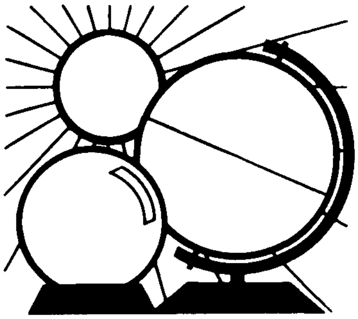

DX FORECASTER

Garth Stonehocker, K0RYW

equinox DX

The ionospheric structure that affects radio propagation changes rapidly during the two months of equinox (March and April). A second equinoctial ionospheric effect is related to the alignment of the equatorial planes of both the earth and the sun. This alignment allows more direct entry by solar wind particles to the earth's polar regions. The geomagnetic field modulated by these solar wind particles cause ions in the ionosphere to move. A signal ray traced through the ionosphere (see October, 1983, *DX Forecaster*) follows the ion's irregular path. The ray alternately focuses and defocuses its energy at the receive location. This is one cause of QSB, signal strength variability of a relatively short time (seconds to period minutes). Expect more intense and greater numbers of these geomagnetic-ionospheric disturbances this time of year.

Gray line DX, a very efficient type of twilight propagation for QRP work or at any power level, is aligned across the pole at this season. Look for this mode of propagation to occur within half an hour on either side of sunrise and sunset. (A beam bearing visualization aid, timing chart, and propagation descriptions can be found in *The Shortwave Propagation Handbook* by T. Cohen and G. Jacobs. This excellent book is available from Ham Radio's Bookstore, Greenville, New Hampshire 03048, for $9.95 postpaid.)

spring thunderstorm QRN

Winter has been very quiet; now noise — QRN — is here again. March and April are months in which the weather often consists of a series of spring storms bringing rain to much of our country. These storms are usually fronts of warm and cold air that generate the year's first major thunderstorms. These thunderstorms produce noise (static) that reduces the signal-to-noise ratio of received signals, worsening readability.

The cumulative effect of thunderstorm static worldwide is the main cause of high noise levels on lower frequency HF bands, mainly in summertime. However, as a specific storm front approaches, a significant increase in the noise level is heard. One first notices this increase in noise at a one-hop distance away, about 600 to 1200 miles (960 to 1920 km) when the storm front is about one day west of your location. Next, the noise level usually decreases as the storm moves closer. When the storm is within a ground-wave's distance (50 to 60 miles or 80 to 96 km), the noise level becomes more intense. Individual discharges can be heard. As the storm draws nearer, its sounds become part of the "local noise"; as it moves away, a similar decrease in noise occurs. An increase is heard again approximately one day later as the front reaches the one hop distance away. (You can check this out for your location by correlating information on storm movement given on the local television weather report with your operating and listening experience.) In looking for the rare DX, you may want to save time by tracking storms in order to determine the most favorable operating conditions.

last-minute forecast

The higher HF bands (10 to 30 meters) are expected to be excellent the first and last weeks of March. During the second and third weeks, the lower bands (30 through 160 meters) will be at their best. Disturbed geomagnetic and ionospheric conditions can be expected about March 7, 12, 17, 21, 26 and 31st. Spring equinox occurs on March 20th at 1024 UT. The moon is full on the 17th and at perigee on the 16th.

band-by-band summary

Ten, fifteen, and twenty meters will be open from morning to early evening almost every day, and to most areas of the world. The openings on the higher of the bands will be shorter and will occur more frequently near local noon. Transequatorial propagation on these bands will be more likely towards evening during conditions of high solar flux and a disturbed geomagnetic field. Noise effects are not too noticeable.

Thirty meters will be useful almost twenty-four hours a day. Daytime conditions will resemble those on 20 meters, although signal strength may decrease during midday on some days — days coinciding with high solar flux values. Nighttime use will be good except after days of very high MUF conditions. Generally the usable distance is expected to be greater than that achieved on 80 at night, but less than that on 20 meters during the day.

Forty, eighty, and one-sixty meters are the nighttime DXer's bands. The bands open just before sunset and last until the sun comes up on the path of interest. Except for daytime short-skip signal strengths, high solar flux values don't affect these bands much. Geomagnetic disturbances, however, which will be more evident near the equinox, cause signal attenuation and fading on polar paths. Noise will be sporadic and very noticeable on these lower frequency bands.

ham radio

MARCH

WESTERN USA

GMT	PST	N (Asia Far East)	NE (Europe)	E (S. Africa)	SE (S. America)	S (Antarctica)	SW (New Zealand)	W (Oceania Australia)	NW (Japan)
0000	4:00	20	20	15	10	15	10	10	20
0100	5:00	20	20	15	10	15	10	10	20*
0200	6:00	20	20	15	10	15	10	10	15
0300	7:00	20	20	15	10	15	10	10	15
0400	8:00	20	20	20	10	15	10	10	15
0500	9:00	20	20	20	10	15	10	10	15
0600	10:00	20*	30	20	10	20	10	10	20
0700	11:00	20*	30	20	10	20	10	15	20
0800	12:00	20	30	20	15	20	15	15	20
0900	1:00	20	30	20	15	20	15	15	20
1000	2:00	20	30	20	15	20	15	20	30
1100	3:00	20	30	20	20	30*	20	20	30
1200	4:00	30	30	20	20	30*	20	20	30
1300	5:00	30	30	15	20	20	20	20	30
1400	6:00	30	20	15	20	20	20	20	30
1500	7:00	30	20	15	20	20	20	20	30
1600	8:00	30	20	15	20	20	20	20	30
1700	9:00	30	20	10	20	15	15	20	30
1800	10:00	40*	20	10	15	15	15	15	20
1900	11:00	30	20	10	15	15	15	15	20
2000	12:00	30	20	10	15	15	10	15	20
2100	1:00	20	20	10	10	15	10	10	20
2200	2:00	20	20*	10	10	15	10	10	20
2300	3:00	20	20*	15	10	15	10	10	20

MID USA

GMT	MST	N (Asia Far East)	NE (Europe)	E (S. Africa)	SE (S. America)	S (Antarctica)	SW (New Zealand)	W (Oceania Australia)	NW (Japan)	CST
0000	5:00	30	20	15	15	15	10	10	20	6:00
0100	6:00	30	20	15	15	15	10	10	20	7:00
0200	7:00	30	20	15	15	15	10	10	20*	8:00
0300	8:00	30	20	15	15	15	10	10	20*	9:00
0400	9:00	30	20	20	20*	15	10	10	20*	10:00
0500	10:00	30	20	20	20	15	10	10	20	11:00
0600	11:00	30	30	20	20	20	10	15	20	12:00
0700	12:00	30	30	20	20	20	15	15	20	1:00
0800	1:00	30	30	20	20	20	15	15	20	2:00
0900	2:00	20	30	20	20	20	15	20	20	3:00
1000	3:00	20	30	20	20*	20	20	20	30	4:00
1100	4:00	20	30	20	15	20	20	20	30	5:00
1200	5:00	20	30	20	15	20	20	20	30	6:00
1300	6:00	20	30	15	15	20	20	20	30	7:00
1400	7:00	20	20	15	10	20	20	20	30	8:00
1500	8:00	20	20	15	10	20	20	20	30	9:00
1600	9:00	20	20	10	10	20	20	20	30	10:00
1700	10:00	20	20	10	10	15	15	20	30	11:00
1800	11:00	20	20	10	10	15	15	15	20	12:00
1900	12:00	20	20	10	10	15	15	15	20	1:00
2000	1:00	20	20	10	10	15	15	15	20	2:00
2100	2:00	30	20	10	10	15	10	10	20	3:00
2200	3:00	30	20	10	15	15	10	10	20	4:00
2300	4:00	30	20	15	15	15	10	10	20	5:00

EASTERN USA

GMT	EST	N (Asia Far East)	NE (Europe)	E (S. Africa)	SE (Caribbean S. America)	S (Antarctica)	SW (New Zealand)	W (Oceania Australia)	NW (Japan)
0000	7:00	30	20	15	15*	10	10	10	20
0100	8:00	30	20	15	15	15	10	10	20
0200	9:00	30	20	15	15	15	10	10	20*
0300	10:00	30	20	15	15	15	10	10	20*
0400	11:00	30	20	20	20*	15	10	10	20*
0500	12:00	30	30	20	20	15	10	15	20
0600	1:00	30	30	20	20	20	15	15	20
0700	2:00	30	30	20	20	20	15	15	20
0800	3:00	30	30	20	20	20	15	20	20
0900	4:00	30	40*	20	20	20	20	20	30
1000	5:00	20	40*	20	15	20	20	20	30
1100	6:00	20	30	20	15	20	20	20	30
1200	7:00	20	30	15	15	20	20	20	30
1300	8:00	20	20	15	15	20	20	20	30
1400	9:00	20	20	15*	10	20	20	20	30
1500	10:00	20	20	10	10	20	20	20	30
1600	11:00	20	20	10	10	20*	20	20	30
1700	12:00	20	20	10	10	15	15	20	30
1800	1:00	20*	20	10	10	15	15	15	20
1900	2:00	20	20	10	10	15	15	15	20
2000	3:00	20	20	10	10	15	10	15	20
2100	4:00	30	20	10	10	15	10	10	20
2200	5:00	30	20	15	15	15	10	10	20
2300	6:00	30	20	15	15	15	10	10	20

The italicized numbers signify the bands to try during the transition and early morning hours, while the standard type provides the MUF during 'normal' hours.
*Look at next higher band for possible openings.

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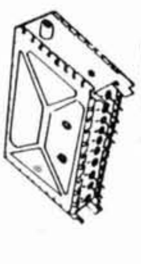

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Coming Events

ACTIVITIES

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COLORADO: The Grand Mesa Repeater Society's fifth annual Western Slope Hamfest, Saturday, March 31, 10 AM to 4 PM, Plumbers and Steamfitters Union Hall, 2384 Highway 6 and 50, Grand Junction. Free admission. Swap tables $5.00 each. Novice exams, tech sessions, auction and refreshments. Talk in on 146.82 and 449.20. For information or swap tables SASE to Larry Brooks, WB0ECV, 3185 Bunting Avenue, Grand Junction, CO 81504. (303) 434-5603.

ILLINOIS: LAMARSFEST 1984, Sunday, March 25, Lake County Fairgrounds, Grayslake, Rts. 45 and 120. Setup 6 AM. Public admitted 8 AM. Tickets $2.00 advance. $3.00 at door. 8 ft. tables $5.00 each — reservations encouraged. Talk in on 147.63-03 or 146.94 simplex. For information, tickets, reservations: SASE to LAMARS, PO Box 751, Libertyville, IL 60048.

ILLINOIS: The Sterling-Rock Falls Amateur Radio Society's 24th annual Hamfest, March 18 at the Sterling High School Fieldhouse, 1608 Fourth Avenue, Sterling. Commercial distributors, dealers and a large flea market. Doors open 7:30 AM. Tickets $2.00 advance, $3.00 at door. Flea market tables requiring electricity and all commercial tables $5.00. All others $3.00. Concession stand and accommodations for overnight self-contained campers available. For tickets, tables or information: Sue Peters, KA9GNR, PO Box 521, Sterling, IL 61081 or call (815) 625-9262. Talk in on W9MEP 146.25/85.

ILLINOIS: The 18th annual Rock River ARC Hamfest, Sunday, April 8, Lee County 4-H Center. Advance ticket donation $2.00. $3.00 at gate. Tables available for $5.00 (8 ft). Camping space available for nominal charge. Breakfast and lunch will be served and an auction for amateur related gear. Talk in on 37/97 repeater. Doors open 8 AM. For information, tickets, tables write or call Shirley Webb, KA9HGZ, 618 Orchard St., Dixon, IL 61021. (815) 284-3811.

INDIANA: The Morgan County Repeater Association Club's Martinsville Hamfest, March 11, Indiana State Fairgrounds Pavilion Building, Indianapolis. Admission $4.00 at the door. Tables: premium $30.00, flea market $8.00. Flea market space/no table $1.00. All tables advance reservations. Talk in on 147.21 and 146.52 simplex. For information and table reservations SASE *before March 1 to Aileen Scales, KC9YA, 3142 Market Place,* Bloomington, IN 47401.

INDIANA: The Putnam County Amateur Radio Club's second Amateur Radio and Electronics auction, April 7, Putnam County Fairgrounds, north of Greencastle. Doors open at 8 AM, auction at 10 AM. 5% commission on sales. Food available. Talk in on 147.93/.33. For information: John Underwood, K9IIB, RFD 1, Box 10, Fillmore, IN 46128.

MASSACHUSETTS: The Framingham ARA's annual Spring Flea Market, Sunday, April 1, Framingham Civic League Bldg., 214 Concord St. (Rt. 126) downtown Framingham. Doors open 10 AM, sellers setup 8:30. Admission $2. Tables $10 — pre-registration required. Radio equipment, computer gear, bargains galore! Talk in on 147.75/15 and 52. Contact Jon Weiner, K1VVC, 52 Overlook Dr., Framingham, MA 01701. (617) 877-7166.

MASSACHUSETTS: The Wellesley Amateur Radio Society's annual Auction, Saturday, April 14, First Congregational Church of Wellesley Hills, 207 Washington Street, Wellesley. Doors open 10 AM and the auction begins at 11 AM. Talk in on 63-03, 04-64 and 52. Contact: Kevin P. Kelly, WA1YHV, 7 Lawnwood Place, Charlestown, MA 02129.

MICHIGAN: The 23rd annual Michigan Crossroads Hamfest, sponsored by the Southern Michigan Amateur Radio Society and the Marshall High School Photo-Electronics Club, Saturday, March 24 from 8 AM to 3 PM, at the Marshall High School. Tickets $2.00 at the door; $1.50 advance. Table space 50¢ per ft., min. 4 ft., reserved til 8 AM. Snack bar and full food service. For reservations SASE to: SMARS, PO Box 934, Battle Creek, MI 49016 or call Wes Chaney, N8BDM (616) 979-3433. Talk in on 146.52 and 146.07/67.

MICHIGAN: The South Eastern Michigan Amateur Radio Association (S.E.M.A.R.A.) 26th annual Hamfest Swap and Shop, April 8, 8AM to 3 PM, Grosse Pointe North High School, Vernier Rd. between Mack and Lakeshore. Advance admission $1.00, $2.00 at door. Talk in on S.E.M.A.R.A. repeater 147.75/15. For further information SASE to S.E.M.A.R.A., PO Box 646, St. Clair Shores, MI 48083, or call WD8QVL (313) 445-8651.

MISSOURI STATE ARRL Convention, Kansas City, April 7-8, 1984. For information write or call PHD Amateur Radio Association, PO Box 11, Liberty, MO 64068-0011. (816) 781-7313.

NEW JERSEY: The Delaware Valley Radio Association's 12th annual Flea Market and Computer Show, Sunday, April 1, 8 AM to 4 PM, New Jersey National Guard 112th Field Artillery Armory, Eggerts Crossing Road, Lawrence Township, Trenton. Advance registration $2.50 or $3.00 at door. Indoor/outdoor flea market. Dealers and refreshments. Sellers bring own tables. Talk in on 146.52 and 146.07-.67. For tickets and space reservations SASE to KB2ZY, 140 Susan Drive, Trenton, NJ 08638.

NEW JERSEY: Ham Radio Flea Market sponsored by the Chestnut Ridge Radio Club, Saturday, March 24, Education Building, Saddle River Reformed Church, East Saddle River Road and Weiss Road, Upper Saddle River. Tables $10.00 for first, $5.00 each additional. Tailgating $5.00. Free admission. Food and soda available. Contact: Jack Meagher, W2EHD (201) 768-8360 or Roger Soderman, KW2U (201) 666-2430.

NORTH CAROLINA: The Raleigh Amateur Radio Society's 12th annual Hamfest and Flea Market, Sunday, April 15, Crabtree Valley Shopping Mall, intersection of US70 west and US 1&64. Starts 8 AM. Admission $4.00 at gate, no extra charge for tailgaters. Tables available for rent. There will be special interest meetings, CW and homebrew contests. Plenty of nearby hotels, restaurants, etc. Talk in on W4DW 146.04/146.64 and K4ITL 146.28/146.88. For more information: Pete Thacher, N4HQZ (919) 876-4073 or Jim Bradley, WA4AOO (919) 851-2437 6-8 PM weekdays or weekends or write RARS, PO 19127, Raleigh, NC 27619.

OHIO: The Lake County Amateur Radio Association's fifth annual Lake County Hamfest and Computerfest, Sunday, March 25, Madison High School, Madison. Open for exhibitors at 5:30 AM and for the public 8 AM to 4 PM. Admission $3.00 advance and $3.50 at door. Tables $5.00 per 6 ft. and $6.50 per 8 ft. Check in and talk in on 147.81/.21. For information and reservations SASE to Lake County Hamfest Committee, PO Box 150, Mentor, Ohio 44061. (216) 953-9784.

TEXAS: The San Antonio Area Radio Club's FIRST annual Swapfest and Bar-B-Q, April 7 at Comanche Park, 7 AM to 5 PM. Talk in on 147.36 MHz. For details: Melvin Anderson, 8932 Saddle Trail, San Antonio, Texas 78255.

TEXAS: The Midland Amateur Radio Club's annual St. Patrick's Swapfest, Saturday, March 17 at 10 AM to 6 PM and Sunday, March 18, 8 AM to 2:30 PM, Midland County Exhibit Building east of Midland. Pre-registration $5, $6 at door. Tables $6 each. Refreshments available. Talk in on 16/76 and 33/93. For information or reservations contact Midland ARC, PO Box 4401, Midland, Texas 79704.

WISCONSIN: The Madison Area Repeater Association (M.A.R.A.) will hold its 12th annual Swapfest, Sunday, April 8, Dane County Exposition Center Forum Bldg. in Madison. Doors open at 5 AM for commercial exhibitors, 8 AM for flea market sellers and 9 AM for general public. Equipment and components for hams, computer hobbyists and experimenters. Admission $2.50 advance and $3.00 at the door. Children twelve and under admitted free. Flea market tables $4.00 each in advance and $5.00 at the door. An all-you-can-eat pancake breakfast and a Bar-B-Q lunch will be available. Talk in on WB9AER/R, 146.16/.76. For reservations or information: M.A.R.A., PO Box 3403, Madison, WI 53704.

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MARCH 24 TO 26: B.A.R.T.G. Spring RTTY Contest, 0200 GMT Saturday until 0200 GMT Monday. Total contest period is 48 hours but not more than 30 hours of operation is permitted. Bands: 3.5, 7.0, 14.0, 21.0, and 28 MHz. Stations may not be contacted more than once on any one band but additional contacts may be made with the same station if a different band is used. Messages: Time GMT, RST and contact number. All logs must be received by May 31, 1984 to qualify. Summary and log sheets available from contest manager for two IRC's: Peter Adams, G6LZB, 464 Whippendell Road, Watford, Herts, England WD1 7PT.

CONNECTICUT QSO PARTY sponsored by the Candlewood ARA from 2000Z March 31 until 0200Z April 1 with a rest period from 0500 to 1200Z. Suggested frequencies: Phone — 3927, 7250, 14,295, 21,370, 28,540. CW — 40 kHz from low end. Novice — 3725, 7125, 21.125, 28.125. Mail by April 30, 1984 to CARA, c/o R. Dillon, N2EFA, PO Box 954, Danbury, CT 06810.

TIDBITS

MORSE CODE, BREAKING THE BARRIER

by Phil Anderson, WØXI

Learning the Morse Code does not have to be the painful experience many folks make it out to be. This little booklet is chockfull of helpful and highly recommended hints and tips on how to learn the Morse Code. Uses the high/low method to eliminate the dreaded 10 wpm plateau. ©1982, 1st edition.

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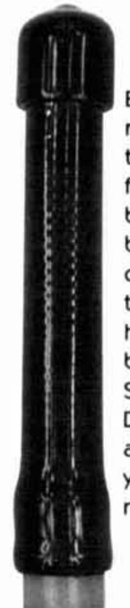

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Speaker Builder can save up to **two thirds of the cost of the speakers**—which translates to almost one third of your outlay for your stereo system. Over 110,000 Americans will build their own enclosures this year—and you can too! Your dream speaker is probably well within reach if you build it yourself. There's a lot of help around already and now, ***Speaker Builder*** brings it all together in an assortment of articles that are comprehensive and a mix of both simple and advanced projects to help you choose and build the best type for your listening room.

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- **★ Transmission Lines**
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There will be reports on building the many kit speakers and enclosures now available, and a roundup of suppliers for drivers, parts, and kits. Articles range from the ultimate (650 lbs. each) to tiny plastic pipe extension speakers. From time delayed multi-satellites to horn loaded subwoofers, as well as modifications of many stock designs.

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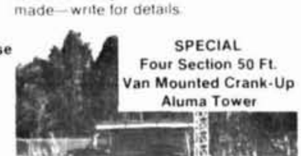

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NEW products

TC-1 plus ATV transmitter/downconverter

P.C. Electronics has upgraded its TC-1 420-450 MHz full color ATV unit with some new features plus many options that were once offered at an additional cost now standard, at no increase in price.

With more Amateurs using computers and VCRs on ATV, separate video and audio inputs were added to the existing camera and mic inputs. This allows front-panel switching back and forth between the camera and computer, or transmitting both the VCR audio along with voice over commenting using a microphone. It has made learning Basic over the air, as well as retransmitting space shuttle video and audio, *easy*.

Capability for external 13.8 VDC in addition to the built-in AC supply has been provided for those who want to go mobile or portable on battery power during field day, emergency services, CAP searches, parades, marathons, or other public service events.

The TC-1+ has the new TXA5-5 exciter/modulator which features two-frequency plug-in crystal switching with just the addition of a SPST switch. The built-in sync stretcher and high/low power switch capability enable superior stable color video if a higher power linear

amplifier, such as the Mirage 100 watt D1010N, is added later or run barefoot at its greater than 10 watt PEP RF output.

The 420-450 MHz tuneable downconverter has the low-noise NE64535 preamp stage to dig out the weak signals. It acts like a super hot UHF TV tuner, but covering only the 70 cm ham band, when connected to your TV set antenna input and set for channel 3 or 4. Both color video and sound live action Amateur television (ATV) are available on your TV set just as the broadcast stations provide. The standards are the same. A Technician class or higher Amateur Radio license is required for operation and purchase from P.C. Electronics.

More information and a complete catalog of ATV equipment, antennas, cameras, modules, and accessories are available from P.C. Electronics, 2522 South Paxson, Arcadia, California 91006.

Circle #301 on Reader Service Card.

parabolic antenna

The enlarged surface of the X-16 Parabolic Satellite Antenna by KLM Electronics, Inc., gives greater signal gain to compensate for weaker signal strength in locations on the fringe of satellite footprints — generally, areas outside of the continental U.S. Its modular aluminum construction permits assembly by Amateurs using ordinary tools. It is easily attached to its gold-anodized steel X-11 Polar-Trak mount with precision motor for accurate satellite tracking. Remote control is provided by a standard Polar-Trak with east-west pushbutton control or by KLM's programmable Memory Trak Dish Control Console which remembers fifty satellite locations.

The X-16 is available in "decorator" colors including forest green, desert tan, and brown, and can be ordered in other hues. Suggested retail for the X-16 and mount is $2,195; for an entire system, $4,795.

For details, contact KLM Electronics, Inc., 16890 Church Street, Morgan Hill, California 95037.

Circle #302 on Reader Service Card.

30-channel programmable scanner

Regency Electronics now offers a computer-controlled 30-channel programmable scanner loaded with advanced features for monitoring the action on more than 15,000 frequencies. Manufactured in the United States (Regency is the only American-made scanner), the Regency Model DX 3000 is available for $269.95 at participating Regency Electronics dealers.

The Regency DX 3000 covers six bands: low and high VHF (30-50 and 148-174 MHz), UHF (450-470 MHz), UHF "T" (470-512 MHz) and two FM ham bands (144-148 and 440-450 MHz); no crystals are required, and a CMOS memory with battery back-up saves frequencies for up to six months in the event of a power outage or if the scanner is stored.

Any selected frequency can be programmed into any selected channel with a few keys. The DX 3000 can search automatically (every 5 kHz on VHF, 12.5 kHz on UHF) for an active frequency; when it finds one, it pauses for four seconds to allow time for the operator to either enter it into memory or jot it down for reference.

The DX 3000 searches at the rate of 400 VHF frequencies (2 MHz) in about 34 seconds and 400 UHF frequencies (5 MHz) in about 30 seconds. Scan rate for the 30 programmed channels is about 15 channels per second. A channel lockout feature can exclude any selected channel(s) from being scanned; this keeps generally busy channels programmed into the scanner while preventing them from "locking in" on each scan. A selected *priority channel* is sampled every two seconds. If active, it automatically overrides any other signal. The scan delay feature holds the channel open for approximately two seconds at the end of a transmission to wait for any reply; if scan delay is not selected, scanning resumes in about six-tenths of a second.

Programming the DX 3000 is simplified by a series of plain-language messages that appear on its vacuum fluorescent digital display. These messages identify its current status and prompt appropriate actions. Operation is made easy with up-front controls for on-off/volume and squelch. Dual built-in power supplies permit plug-in AC operation, and 12 volt DC operation where not prohibited by law. UL listed and FCC certified (Part 15, Subpart C), the DX 3000 measures 10 1/3 × 3 1/3 × 7 inches.

For additional information, contact Regency Electronics, Inc., 7707 Records Street, Indianapolis, Indiana 46226-9986.

Circle #303 on Reader Service Card.

AMTOR converter

The new Info-Tech M-44 AMTOR convertor allows most RTTY terminals to be used on the recently approved AMTOR RTTY mode. Interface to the terminal is via serial TTL or RS-232 levels, and either ASCII or Baudot terminals may be used.

The unit also features a built-in modulator and demodulator with pre-filter, full time ATC, and two transmit buffers. All control of the M-44 and transceiver are simple commands entered via the terminal keyboard.

Priced at $379.95, this converter is American designed and manufactured and will operate in the ARQ, FEC, and ARQ monitor modes.

For information, contact Digital Electronics Systems, 1633 Wisteria Court, Englewood, Florida 33533.

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IC-27A two-meter mobile

The ICOM IC-27A measures only 1-1/2 inches wide by 5-1/2 inches high and contains an internal speaker, making it easy to mount. Although the IC-27A is the most compact two-meter mobile unit on the market, no features have been sacrificed. Standard features include 25 watts of output power, 32 PL frequencies, ten full-function tunable memories, scanning of memories and the band, priority scan and a microphone which includes a 16-button touchtone pad for easy access to a repeater or dialing through to an autopatch. An optional speech synthesizer is also available to verbally announce the receiver frequency of the transceiver through the simple push of a button.

The IC-25A, measuring 2 inches wide by 5-1/2 inches high, will continue to be available for those individuals preferring a 25-watt two-meter mobile unit with larger operating knobs.

For more information, contact ICOM, 2112 116th Avenue, N.E., Bellvue, Washington 98004.

Circle #305 on Reader Service Card.

new triband beams

Two triband beams previously unavailable in the U.S. are now available from Palomar Engineers. Long a favorite of European DX'ers, the Model DX-33 (with three elements on 10, 15, and 20 meters) and DX-43 (with four elements) were designed for use with solid-state transceivers. The antennas feature low SWR, wide bandwidth, and particularly good gain and front-to-back ratio. Each trap is individually sweep-tested at the factory for uniform performance. Stainless steel "U" bolts are used throughout.

For more information, contact Palomar Engineers, 1924-F West Mission Road, Escondido, California 92025.

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low-attenuation coax

Belden Electronic Wire and Cable has available three 50-ohm low-attenuation, flexible coax cables (Belden 9913, 9914, 9915) for cellular radio, satellite communications, microwave and other two-way communications. Designed as flexible alternatives to semi-rigid cable to allow for ease of installation while maintaining similar electrical parameters, the cables will fit standard connectors.

Belden 9913, an RG-8/U type air dielectric coax, has an attenuation of 4.5 dB at 1 GHz, 11

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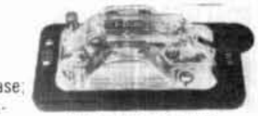

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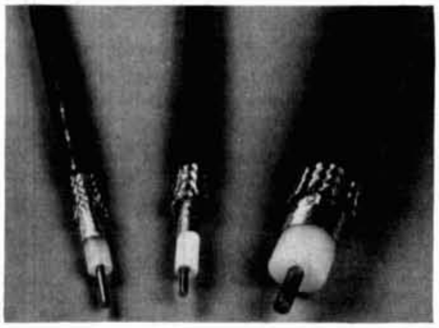
NEW products

dB at 4 GHz, and 21 dB at 10 GHz. Nominal capacitance is 24 pF per foot. Overall diameter is 0.405 inch. Standard put-ups are 100, 250, 500, and 1000 feet. Representative price is $417.75 for 1000 feet.

Belden 9914, an RG-8/U type foam dielectric coax, has an attenuation of 1.6 dB at 100 MHz, 3.1 dB at 300 MHz, 4.1 dB at 500 MHz, 5 dB at 700 MHz, 6 dB at 1 GHz, 13 dB at 4 GHz, and 25 dB at 10 GHz. Nominal capacitance is 26 pF per foot. Overall diameter is 0.405 inch. Standard put-ups are 100, 250, 500, and 1000 feet. Representative price is $414.15 for 1000 feet.



Belden 9915, an RG-218/U type solid polyethylene insulated coax, has an attenuation of 0.83 dB at 100 MHz, 1.6 dB at 300 MHz, 2.4 dB at 500 MHz, 2.7 dB at 700 MHz, 3.5 dB at 1 GHz, and 10 dB at 4 GHz. Nominal capacitance is 30.8 pF per foot. Overall diameter is 0.870 inch. Standard put-ups are 250 and 500 feet. Representative price is $1,186.50 for 500 feet.

For additional information, contact Belden Electronic Wire and Cable, 2000 South Batavia Avenue, Geneva, Illinois 60134.

Circle #307 on Reader Service Card.

MR4 receiver

The new Micro Control Specialties MR4 receiver uses seven helical resonators in the front end and twelve poles of IF filtering to achieve a dynamic range greater than 100 dB. By using a first IF of 21.4 MHz and extensive shielding, it also rejects images by 120 dB. Other features of the MR4 include automatic slow/fast squelch, squelch hysteresis, and metering circuitry for signal strength, peak deviation, and discriminator.

The MR4 is intended for fixed frequency applications in the VHF and UHF bands, especially at multi-transmitter sites where RF interference is severe. The receiver is available in both modular and rack-mounted versions. The rack-mounted version includes full metering plus a local audio speaker.

For more information, contact Micro Control Specialties, 23 Elm Park, Groveland, Massachusetts 01834.

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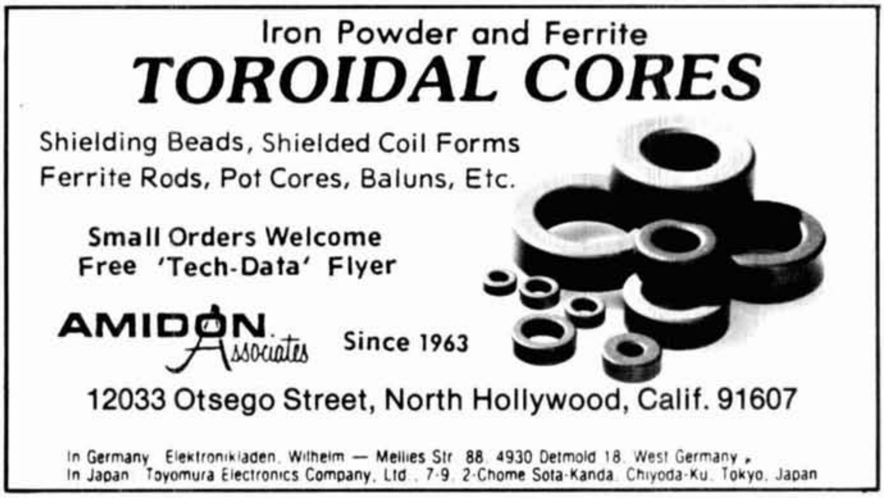

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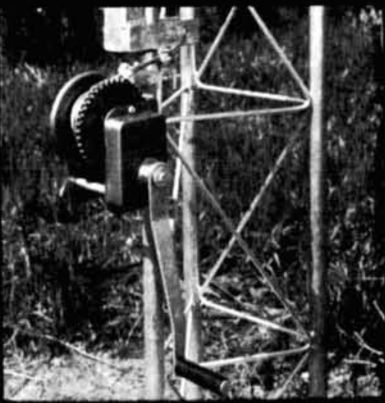


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NEW products

PLL-synthesized VHF FM receiver

FDK International Corporation has developed a PLL-synthesized VHF FM receiver, the RX-40, covering 141 MHz to 180 MHz band-range or virtually all main VHF FM frequencies. Designed for use in Amateur, commercial, and marine band communication, it uses PLL-synthesized circuitry to provide accurate frequency selection of 15,600 channels between 141-180 MHz in 2.5 kHz steps. Its light weight (11 ounces; 315 g.) and miniature size (6-5/8 × 2-3/8 × 1-5/8 inches; 169 × 58 × 43 mm) allow maximum portability. Supplied with Ni-Cd battery pack, flex rubber antenna, AC charger and earphone, the RX-40 features an adjustable squelch level to eliminate background noise on the AM mode and offers extremely low battery consumption providing continuous operation for ten hours. A BNC aerial connector, DC charger and shoulder case are also available as operational accessories.

For further information, contact FDK International Corporation, 10-2, Kaji-cho 2-chome, Chiyoda-ku, Tokyo 101, Japan.

Circle #309 on Reader Service Card.

antenna analysis software

"Annie" antenna analysis software, available for the Apple II+ and IIe with DOS 3.3, can calculate the patterns of nearly any wire antenna including dipoles, verticals, inverted vees, slopers and arrays of any length, orientation, position, power, phase or combination. "Annie" even includes the effects of real ground — conductivity and dielectric constant. It plots horizontal, vertical, or total gain in any direction; the plots may be drawn at any magnification or with any aspect ratio (for truly round circles). Any number of patterns may be drawn on each grid. The patterns can be drawn with solid, dotted, dot-dashed or dashed lines. The plot can be printed at an FX-80 printer — the graphics dump source is included for modification for use of other printers.

In addition to horizontal, vertical, and total gain, "Annie" will calculate and tabulate polarization sense, axial ratio, tilt and phase. Any quantity may be printed in any column.

Written in assembly language for speed, the software comes with a 54-page illustrated user's manual and a 5-1/4-inch disk for $49.95 plus $2.00 postage. (If you don't have an Apple, you can still benefit from "Annie's" analysis. For a small charge, an analysis of your antenna or array will be performed and the results mailed back to you.)

For more information, contact Sonnet Software, Dept. HR, 4397 Luna Course, Liverpool, New York 13088.

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CAT technology

A new generation of CATs (computer aided transceivers) — the FT-757GX line — is available from Yaesu Electronics.

Controlled by three 8-bit microprocessors, the FT-757GX is a full QSK synthesized transceiver offering general coverage on receive and ham band transmit capability, with expanded coverage available for MARS operators. The transmitter section is specified for up to 30 minutes of continuous operation at a nominal output of 100 watts. For maximum operating flexibility, the FT-757GX performance package includes dual VFOs, eight memories, all-mode squelch, and a variety of scanning features. A 600 Hz CW filter, electronic keyer module, AF speech processor, and FM capability are all included in the purchase price.

Among the high-performance options available for the FT-757GX line are the FC-757AT automatic antenna tuner with band/antenna memory, the FP-757GX compact switching regulator power supply, the FP-757HD heavy-duty power supply (for continuous duty applications), the FP-700 standard power supply, and the FTV-700 transverter.

For further information on the FT-757GX line or other Yaesu transceivers designed for computer interface, contact Yaesu Electronics Corporation, P.O. Box 49, Paramount, California 90723.

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color-coded A/V cable boots

Cole-Flex has announced the availability of a new color-coded insulating connector boot designed to fit many standard connectors. These heat-shrinkable boots are designed for use on audio and video cables and connectors to provide quick visual identification and interconnection. The boots also provide increased strain relief for cable assemblies and extra protection of connectors from rough handling.

Constructed of irradiated polyolefin, the boots have a 2:1 shrink ratio and can be installed with any standard industrial heat gun. They are available in a standard 1-3/4-inch length and can cover a standard 3/4-inch audio connector such as an XLR type. Colors available include black, white, red, yellow, blue, and clear. Hot stamping with special lettering or logos is also available.

For details, contact Cole-Flex Corporation, 91 Cabot Street, West Babylon, New York 11704.

Circle #312 on Reader Service Card.

Dressler 2-meter amplifier

The typical 2-meter transceivers available today often have noise figures of 6 to 8 dB. Adding a low-noise preamplifier ahead of the receiver will usually make a dramatic improvement in sensitivity. However, we must also consider the typical installation with a 1 to 2 dB transmission line loss from the antenna system, which further attenuates signals even before they reach the preamplifier. In particular, OSCAR 10 users have been experiencing such problems hearing downlink signals since this satellite may be up to 23,000 miles (38,000 km) distant instead of 900 miles (1500 km) as previous satellites were.

Several low-noise preamplifiers have recently become available, but they are primarily meant to be installed directly in the receiver at the shack and hence cannot overcome feedline losses. Dressler of West Germany has solved this problem by designing a preamplifier that can not only be easily mounted at the antenna but also remotely bypassed so that you can transmit around it with up to 1000 watts PEP.

This preamplifier is built on a high quality glass epoxy board and housed in a sealed metal enclosure. It is mounted in a waterproof ABS plastic outer housing complete with an adjustable clamp that will accommodate a mast up to 2 inches (51 mm) in diameter. Input/output connectors are type "N." The preamplifier features a low-noise dual gate GaAs (gallium arsenide) FET followed by a low-noise J-FET, thus yielding excellent noise figure as well as dynamic range. The input tank is a silver plated inductor. The overall bandwidth of the amplifier is filtered to 4 MHz so as to not respond to out of band signals, etc. Low insertion loss, high isolation coaxial relays perform the bypassing function and are mounted right on the preamplifier circuit board in order to take advantage of the low noise figure of the devices and protect them from burnout during transmit. Protection diodes are also

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NEW products

located on both the input and output of the preamplifier to further protect the circuitry.

Its performance is outstanding. The measured noise figure on an HP 8970A noise figure generator was below 0.75 dB and gain is typically 18 dB. Typical receive operating current is 180 mA at a nominal 12 volts. No power is required during transmit. To energize the preamplifier, connect 12 to 15 volts to the feedthrough capacitor on the housing. For remote powering, the supply voltage may be applied directly to the antenna feedline with a bias inserter or through the Dressler model VV-INTERFACE remote power unit.

A 70 cm (432 MHz) unit will be available shortly. The 2-meter units are available in the United States from International Media Service, Box 26, Tewksbury, Massachusetts 01876. Price on the model EVV-2000 GaAs preamplifier is $109.95 plus $5 shipping; the model VV-INTERFACE is $29.95 plus $2.50 shipping.

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cordless phone protection

The Kleen Line Protection System for cordless phone base stations is designed to suppress damaging telephone and power line spikes caused by lightning, spherics or phone office switch gear. The security system uses modern semiconductor, gas discharge tube and metal oxide varistor suppression techniques. Model PDS-11/SUP, priced at $81.95, has suppression on red and green phone lines (pins 3 and 4), with yellow and black lines brought straight through. A 6500 ampere suppressor protects the AC power line. Standard modular 4-pin telephone connectors provide simple, trouble-free hook-up.

For details, contact Electronic Specialists, Inc., 171 South Main Street, P.O. Box 389, Natick, Massachusetts 01760.

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new satellite receiver

A new satellite receiver — the System 70 — features detent tuning, polarity control, a signal strength meter, a built-in modulator, scan tuning and both wide and narrow audio filters. It is available in two versions, the standard model 70X or the stereo version, model 70S, which decodes both matrix and discrete stereo sound and features simplified stereo tuning. Both models carry a full one year warranty.

For details, contact Lowrance Electronics, Inc., 12000 E. Skelly Drive, Tulsa, Oklahoma 74128.

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dual heat soldering iron

The new Archer® Switchable Dual Heat Soldering Iron (No. 64-2055) from Radio Shack, a division of Tandy Corporation, completes small or medium-size jobs that would normally require two separate irons.

A convenient handle-mounted wattage switch allows the user to select 15 or 30 watts, depending on the size of the job, with no need to change the iron. The sculptured handle assures comfortable soldering. The U.L. listed dual-heat iron, 8-1/4-inches long, is available at participating Radio Shack Stores and sells for $6.95. Replacement tips (No. 64-2065), rated up to 30 watts, are priced at 89 cents each.

For information, contact Tandy Corporation/Radio Shack, 1800 One Tandy Center, Fort Worth, Texas 76102.

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battery/button cell tester

While there are plenty of battery testers on the market, not all will test button cells — and some won't even accommodate the popular "N" size battery. The new CEC-1 Battery Tester and Button Cell Checker from Century Electronics tests all standard sizes plus all button types. Special compartments accommodate each battery size, and all batteries are automatically connected across a load resistor, for accurate readings on the unit's colorful, easy-to-read scale. The CEC-1 is priced at $7.95.

For more information, contact Century Electronics Corporation, 3511 North Cicero Avenue, Chicago, Illinois 60641.

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buyers' guide

The Buyers' Guide To Radio And Electronic Parts is written so the hobbyist can easily locate a wide variety of electronic and mechanical parts for construction projects. It lists radio, antenna, computer, microwave, electronic, and mechanical parts sold by over 70 companies.

The Guide has two main sections: a directory of parts and a supplier information section. The directory lists the parts alphabetically by generic name with a part number and a description. A number is included on each line that tells the user the variety of parts that are stocked by the supplier for that listing, and is an indication of how complete a supplier's offering is for that part.

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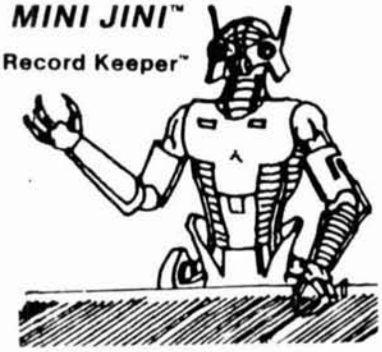

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This book is available for $6.95 postpaid from Ham Radio's Bookstore, Greenville, New Hampshire 03048.

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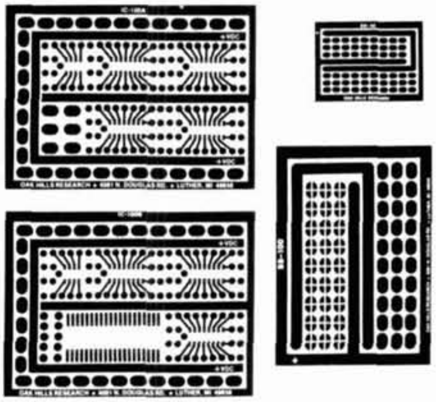
breadboards

The hard work of converting a raw piece of circuit board into a breadboard has been eliminated by Oak Hills Research with its new line of G-10 epoxy breadboards.

If soldering temperatures are kept low, these boards can be used repeatedly. (A 30-or 40-watt maximum rating is recommended for the pencil iron used; in many instances a 25-watt iron will be sufficient.) They are also excellent for finished, permanent projects. Double-sided versions of these boards are available on special order for those who require a ground plane surface opposite the etched foils.



Two general-purpose breadboards are available. They are the BB-50 for small projects (2-1/4 × 1-3/4 inches) and BB-100 (3-1/4 × 4-3/4 inches). While both units have the same pattern, the BB-100 includes isolated pads on one side of the board divided into four equal segments to accommodate transistors with as many as four leads.

Two IC breadboards are also available. They are the IC-100A (4 × 5-1/4 inches) and IC-100B (4 × 5-1/4 inches). The 100A contains sites for four 16-pin DIP ICs, plus one 8-pin DIP. Numerous isolated pads are included for mounting additional components. The IC-100B will accommodate three 16-pin DIP ICs, one 8-pin DIP and an LSI chip with as many as 40 pins. Each IC site is marked for drilling, should the user desire to install IC sockets.

All feature ground and plus voltage buses routed through to provide short connections to these conductor lines. The outer borders of the boards are copper, and they are common to the ground bus of the board. This aids grounding when mounting the breadboards to a metal mainframe. All conductors are tin plated to retard corrosion.

Prices are: BB-50, $2; BB-100, $3; IC-100A and B, $4. (Include $1 for handling and postage for orders under $10; postage on orders greater than $10 is paid by Oak Hills Research. Michigan residents include sales tax.)

For information or orders, contact W1FB, Oak Hills Research, 4061 N. Douglas Road, Luther, Michigan 49656.

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new Larsen® catalog

The redesigned, simplified-format Larsen Electronics catalog offers more thorough explanations of products, electrical types, and frequencies, thereby making ordering easier. Now available, the catalog includes all of the latest developments in both antennas and accessories at prices unchanged since August, 1982.

For more information, contact Larsen Electronics, P.O. Box 1799, Vancouver, Washington 98668.

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beacon guide

The new edition of *The Beacon Guide* — updating the first edition, published in 1974 — is now available by mail or through selected retailers. Compiled by H. John Clements, WA6RXN, and edited by Ken Stryker, the volume is distributed exclusively by the Century Print Shop, 6059 Essex Street, Riverside, California 92504. The price of the 100-page book is $7; club and other quantity discounts are available.

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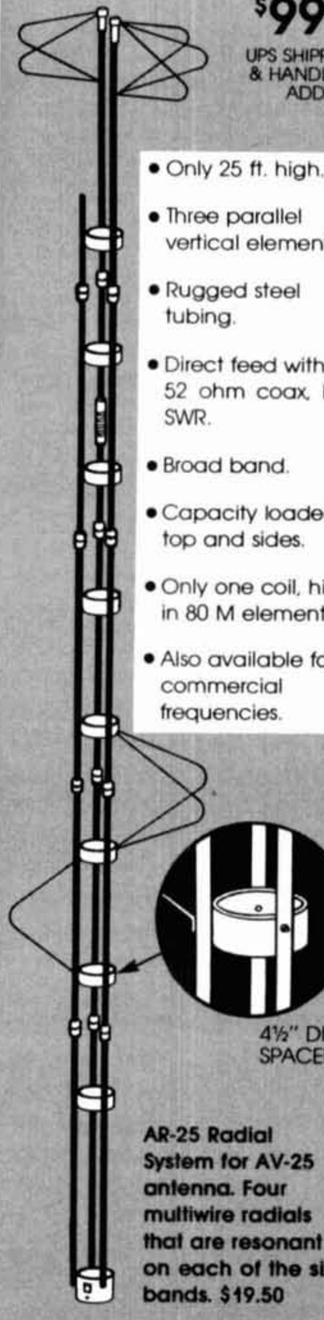

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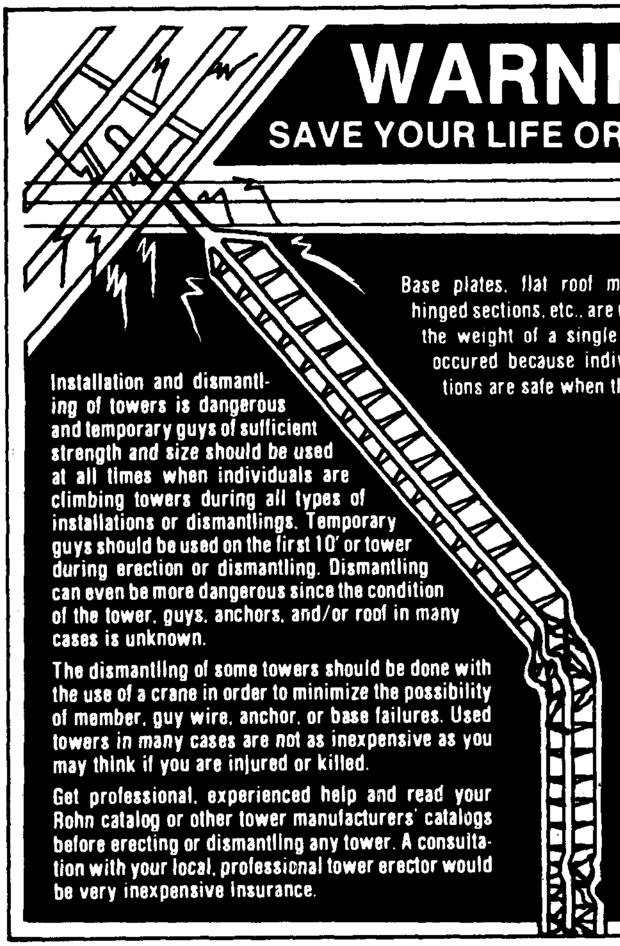

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book REVIEW

The UHF Compendium: Part 1 and 2

Even though we are communications hobbyists, many of us are relatively unaware of technical progress in other areas of the world. In the field of UHF and VHF communication, Europeans have long been at the forefront of technical development. The first real insight for many of us on some of Europe's exciting developments can be found in *The UHF Compendium* by Kurt Weiner, DJ9HO. First written in German in 1975, *The UHF Compendium* firmly established itself as one of the best sources of UHF and VHF information available; consquently, it was decided that an English edition would further expand its appeal. So DK7LF, in cooperation with the author, set about the complex task of translating the manuscript into English, in hopes of rekindling interest in some of the more technical aspects of Amateur Radio. Of particular interest to VHF/UHF operators is that all designs, ideas and projects have been built and debugged using the latest state-of-the-art test equipment to ensure that they will in fact operate.

content

The UHF Compendium is divided into two basic sections: theoretical background and building instructions. To enhance the usability of the book, sections are cross-tabbed for reference; should a question arise, an explanation can be easily found.

The theory sections of *The UHF Compendium* contain sufficient material and explanations to help the reader fully understand many of the state-of-the-art concepts and projects to be found inside.

As you would expect, heavy coverage is given to the use of GaAs FET devices in preamplifiers and converters. You will also find a number of power amplifier circuits for both the 70 and 20 cm bands. Antennas are fully discussed, with detailed construction information provided in order to ensure optimum results. One area only superficially covered in other VHF/UHF books is the design, construction and use of alignment tools, power measuring equipment, signal generators, UHF antenna dippers, panoramic receivers, and swept-frequency generators. These areas are all fully discussed so as to ensure that the reader will derive maximum use from these handy and most necessary tools and pieces of equipment. As I mentioned earlier, the author and his collaborators went to great lengths to fully test and verify each project. They also worked hard to optimize performance.

At over two pounds, this is quite a hefty book. It sells for $23.95. I am only beginning to get involved in VHF/UHF communications, so I frequently find myself confused about the quirks of getting equipment to operate above 30 MHz. I have found, however, that *The UHF Compendium* gives detailed and understandable explanations that make comprehension much easier. (Joe Reisert, W1JR, *ham radio's* VHF/UHF columnist, has told us that *The UHF Compendium* is an invaluable tool for all levels of VHF/UHF knowledge.)

If you have any interest at all — casual or "dyed in the wool" — in VHF or UHF communications, *The UHF Compendium* is an absolute necessity for your library.

The UHF Compendium is available from Ham Radio's Bookstore, Greenville, New Hampshire 03048, for $23.95 plus $2.50 shipping and handling.

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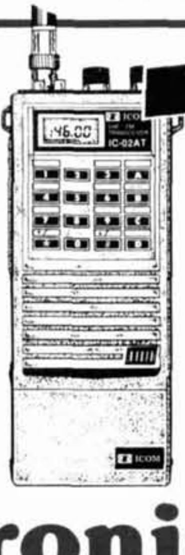

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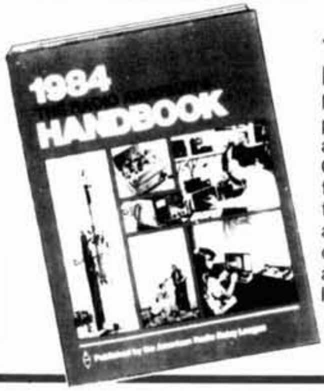

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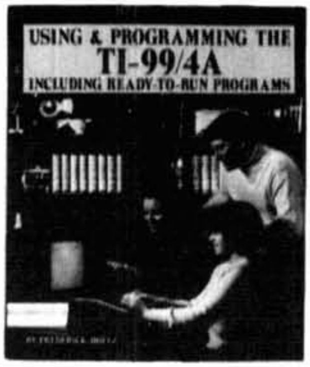

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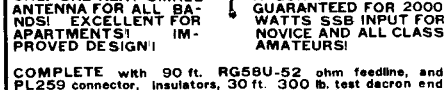

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- Separate level adjust pots and output connections for each tone Group.
- Immune to RF
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- Low impedance, low distortion, adjustable sinewave output, 5v peak-to-peak
- Instant start-up.
- Off position for no tone output.
- Reverse polarity protection built-in.

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67.0 XZ	91.5 ZZ	118.8 2B	156.7 5A
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79.7 SP	103.5 1A	136.5 4Z	179.9 6B
82.5 YZ	107.2 1B	141.3 4A	186.2 7Z
85.4 YA	110.9 2Z	146.2 4B	192.8 7A
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2805			1800	2100	2350	

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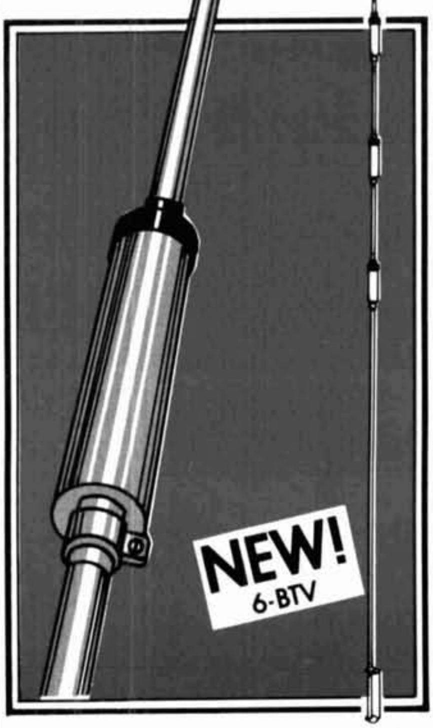

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Answering the call for an HF rig that goes everywhere, sounds great, and is cost-effective, Yaesu proudly introduces the FT-77 Compact HF Transceiver System.

Computerized Design and Manufacture

The FT-77 design engineers utilized the latest computerized circuit board layout methods, resulting in a compact, reliable transceiver with maximum utilization of available space. Automated insertion techniques are used in assembly, providing improved reliability and quality control over earlier designs.

Operating Versatility

The FT-77 is equipped for operation on all amateur bands between 3.5 and 29.7 MHz, including the three new WARC bands. Fully operational on SSB and CW, the FT-77 includes a dual width noise blanker (designed to minimize the "Woodpecker" or ignition noise), full SWR metering, R.I.T., and optional CW filter with wide/narrow selection. The optional FM-77 permits operation on the FM mode, with front panel squelch sensitivity control.

Expandable Station Concept

Ideal for mobile operation because of its compact size and light weight, the FT-77 forms the nucleus of a versatile base station. Available as options for the FT-77 are the FP-700 AC Power Supply, FV-700DM Synthesized External VFO and Memory System, FTV-707 VHF/UHF Transverter, and FC-700 Antenna Coupler, providing top performance at an extraordinarily low price.

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TS-430S

The TS-430S combines the ultimate in compact styling with advanced circuit design and performance. An all solid-state SSB, CW, and AM transceiver, with FM optional, covering the 160-10 meter Amateur bands, it also incorporates a 150 kHz-30 MHz general coverage receiver having a superior dynamic range, dual digital VFO's, 8 memories, memory scan, programmable band scan, IF shift, notch filter, all-mode squelch, and built-in speech processor.

TS-430S FEATURES:

- **160-10 meter operation, with general coverage receiver**
  With 160-10 meter Amateur band coverage, including WARC 30, 17, and 12 meter bands, it also features a 150 kHz-30 MHz general coverage receiver. Innovative UP-conversion digital PLL circuit, for superior frequency stability and accuracy. UP/DOWN band switches for Amateur bands or 1-MHz steps across entire 150 kHz-30 MHz range. Two digital VFO's continuously tuneable from band to band. Band information output on rear panel.
- **USB, LSB, CW, AM, with optional FM**
  Operates on USB, LSB, CW, and AM, with optional FM, internally installed. AGC time constant automatically selected by mode.
- **Compact, lightweight design**
  Measures only 10-5/8 (270) W x 3-3/4 (96) H x 10-7/8 (275) D, inches (mm), weighs only 14.3 lbs. (6.5 kg.).
- **Superior receiver dynamic range**
  Use of 2SK125 junction-type FET's in the Dyna-Mix high sensitivity, balanced, direct mixer circuit provides superior dynamic range.
- **10-Hz step dual digital VFO's**
  10-Hz step dual digital VFO's operate independently, include band and mode information. Different band and mode cross operation possible. Dial torque adjustable. STEP switch for tuning in 10-Hz or 100-Hz steps. A=B switch quickly shifts "B" VFO to the same frequency and mode as "A" VFO, or vice-versa. VFO LOCK switch provided. RIT control tunes VFO or memory. UP/DOWN manual scan possible using optional microphone.
- **Eight memories store frequency, mode, and band data**
  Memories store frequency, mode, and band data. Eighth memory stores receive and transmit frequencies independently. M.CH switch for operation of memory as independent VFO, or fixed frequency.
- **Lithium battery memory back-up**
  Estimated five-year life.
- **Memory scan**
  Scans memories in which data is stored.
- **Programmable automatic band scan**
  Scans programmed band width. Scan speed adjustable. HOLD switch interrupts band or memory scan.
- **IF shift circuit for minimum QRM.**
  IF passband may be moved to place interfering signals outside the passband, for best interference rejection.
- **Tuneable notch filter built-in**
  Deep, sharp, tuneable, audio notch filter.
- **Narrow-wide filter selection**
  NAR-WIDE switch for IF filter selection on SSB and CW when optional filters are installed. (2.4 kHz IF filter built-in.)
- **Speech processor built-in**
  Improves intelligibility, increases average "talk-power."
- **Fluorescent tube digital display**
  Indicates frequency to 100 Hz (10 Hz modifiable).
- **All solid-state technology**
  Input rated 250 W PEP on SSB, 200 W DC on CW, 120 W on FM (optional), 60 W on AM. Built-in cooling fan, multi-circuit final protection. Operates on 12 VDC, or 120/220/240 VAC with optional PS-430 AC power supply.
- **All-mode squelch circuit, built-in**
- **Noise blanker, built-in**
- **RF attenuator (20 dB)**
- **Vox circuit, plus semi break-in with side-tone**

Optional AT-250 Automatic Antenna Tuner
Designed to match the TS-430S in size, color, and appearance. Functionally compatible with any HF transceiver of 200 watts PEP or lower. (Requires manual bandswitching.)
- Covers 160-10 meter incl. WARC
- ABC Automatic Band Changing System (when used with TS-430S) • SWR/Power meter • 4 antenna terminals • Built-in AC Power Supply.

Other optional accessories:
- PS-430 compact AC power supply.
- PS-30 or KPS-21 AC power supplies.
- SP-430 external speaker.
- MB-430 mobile mounting bracket.
- AT-130 compact antenna tuner, 80-10 m incl. WARC.
- FM-430 FM unit.
- YK-88C (500 Hz) or YK-88CN (270 Hz) CW filters.
- YK-88SN (1.8 kHz) narrow SSB filter.
- YK-88A (6 kHz) AM filter.
- MC-42S UP/DOWN hand microphone.
- MC-55 (8P) mobile microphone.
- MC-60A deluxe desk microphone.
- MC-80 UP/DOWN desk microphone.
- MC-85 multi-function desk microphone.

More information on the TS-430S is available from all authorized dealers of Trio-Kenwood Communications, 1111 West Walnut Street, Compton, California 90220.

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