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ICOM’s IC-730 goes 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.

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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.

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- 2.5 W or 300 mW RF output.
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- Built-in tunable (with variable resistor) sub-tone encoder.
- Built-in 16-key autopatch encoder.
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cover photo: Avantek

March 1984


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 persuasive 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, unnecessary, 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
SUPER RTTY FILTER

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March 1984
THREE REGIONAL VOLUNTEER EXAMINER COORDINATORS SHOULD HAVE FCC APPROVAL 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.

ADDITIONAL FREQUENCIES FOR RACES OPERATION 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 VHF Amateur phone bands.

FURTHER EXPANSION OF THE HF AMATEUR PHONE BANDS 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.

6-METER ACTIVITY FROM EUROPE WILL BE INCREASING 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.

THE FORMER WB6JAC WENT TO JAIL JANUARY 23 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."

Burton Was Originally Indicted in May, 1982, both for operating without a license and for transmitting indecent language. His license had been revoked earlier for his indecent transmissions but was reinstated 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.

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

THE REIMBURSEMENT OF VEC EXPENSES IS STILL IN THE FUTURE, 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.

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ACTION ON THE VOLUNTEER ENFORCEMENT PROGRAM, 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 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.

PUBLICATION OF W5LFL'S STS-9 LOG DISAPPOINTED MANY 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 VQ) made the log 18 times, almost 40 European stations (including ll Germans), nine VKs, eight from all of Latin America, and only one (JY1) from Asia. Calls from Africa after logging the liaison tests could pull out a few more calls, but shouldn't change the proportions appreciably.

The Excellent PR from W5LFL's Space Operation and other Amateur Radio/media topics will be the subject of a Dayton Hamvention panel discussion. Joining moderator Jim Davis, KB8R, will be Steve Mendelsohn, WA2DHF (CBS), Bill Pasteurnak, WA6ITF (Metromedia and Westlink Report), Bob Hanson, W9AIF (Grey-North/Electra), Pete O'Dell, KB1F (ARRL), and Joe Schroeder, W9JUV (Ham radio).

NOMINATIONS FOR DAYTON HAMVENTION'S "HAM OF THE YEAR," "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.

Europe's Hamvention Equivalent, The "Ham Radio" Convention 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.

ADDITIONAL FREQUENCIES FOR RACES OPERATION 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.

European VoA Transmission Of The Ham Radio Operation of the "Ham Radio" 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.

6-METER ACTIVITY FROM EUROPE WILL BE INCREASING 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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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, KA9GPE
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 theVF 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, W90AM
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 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
AEA Brings You The RTTY Breakthrough

**NEW MBATEXT™** $109.95 List/CALL FOR PRICE VIC-20 MBATEXT or C-64 MBATEXT

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More Details? CHECK—OFF Page 120

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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). 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
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-

---

¹ A detailed review of noise considerations is available for those who wish to delve deeper into this subject.

**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.

A 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
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Second 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 pF) 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°C to +85°C (B) case temperature; other specifications at 25°C.

<table>
<thead>
<tr>
<th>Avantek model</th>
<th>frequency response (MHz)</th>
<th>gain minimum (A)</th>
<th>noise figure (dB)</th>
<th>reverse isolation (dB)</th>
<th>power output for 1 dB gain compression (dBm) typical</th>
<th>3rd order intercept point (dBm) typical</th>
<th>2nd order intercept point (dBm) typical</th>
<th>maximum VSWR (50 ohms)</th>
<th>input power (volts, mA typ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPD-461</td>
<td>0.1-400</td>
<td>13</td>
<td>12</td>
<td>4.5</td>
<td>10</td>
<td>4.5</td>
<td>0.0</td>
<td>0.0</td>
<td>15, 10</td>
</tr>
<tr>
<td>GPD-462</td>
<td>0.1-400</td>
<td>13</td>
<td>12</td>
<td>6.0</td>
<td>20</td>
<td>6.0</td>
<td>0.0</td>
<td>0.0</td>
<td>15, 24</td>
</tr>
<tr>
<td>GPD-463</td>
<td>0.1-400</td>
<td>9</td>
<td>8</td>
<td>7.5</td>
<td>20</td>
<td>7.5</td>
<td>0.0</td>
<td>0.0</td>
<td>15, 24</td>
</tr>
<tr>
<td>GPD-464</td>
<td>0.1-400</td>
<td>9</td>
<td>8</td>
<td>7.5</td>
<td>20</td>
<td>7.5</td>
<td>0.0</td>
<td>0.0</td>
<td>15, 24</td>
</tr>
<tr>
<td>GPD-1061</td>
<td>0.1-1000</td>
<td>12</td>
<td>11</td>
<td>6.0</td>
<td>18</td>
<td>6.0</td>
<td>0.0</td>
<td>0.0</td>
<td>15, 15</td>
</tr>
<tr>
<td>GPD-1062</td>
<td>0.1-1000</td>
<td>12</td>
<td>11</td>
<td>7.0</td>
<td>18</td>
<td>7.0</td>
<td>0.0</td>
<td>0.0</td>
<td>15, 15</td>
</tr>
<tr>
<td>GPD-1063</td>
<td>0.1-1000</td>
<td>10</td>
<td>9</td>
<td>8.0</td>
<td>18</td>
<td>8.0</td>
<td>0.0</td>
<td>0.0</td>
<td>15, 15</td>
</tr>
</tbody>
</table>

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

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 avalanche, 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.

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, however,
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All IsoPole antennas yield the maximum gain attainable for their respective lengths and a zero degree angle of radiation. Exceptional decoupling results in simple tuning and a significant reduction in TVI potential. Cones offer greater efficiency over obsolete radials which radiate in the horizontal plane and present an unsightly bird’s roost with an inevitable “fallout zone” below. The IsoPoles have the broadest frequency coverage of any comparable VHF base station antenna. This means no loss of power output from one end of the band to the other when used with SWR protected solid state transceivers.

Outstanding mechanical design makes the IsoPole the only logical choice for a VHF base station antenna. A standard Amphenol 50 Ohm SO-239 connector is recessed within the base sleeve (fully weather protected). With the IsoPole, you will not experience aggravating deviation in SWR with changes in weather. The impedance matching network is weather sealed and designed for maximum legal power. All IsoPole antennas are D.C. grounded. The insulating material offers superb strength and dielectric properties, plus excellent long-term ultra-violet resistance. All mounting hardware is stainless steel. The decoupling cones and radiating elements are made of corrosion resistant aluminum alloys. The aerodynamic cones are the only appreciable wind load and are attached directly to the support (a standard TV mast which is not supplied).

IsoPole antennas have also become the new standard for repeater applications. They all offer low angle of radiation, low maintenance, easy installation, and low cost with gain comparable to units costing several times as much. Some repeater installations have even eliminated the expense of a duplexer by using two IsoPole antennas separated vertically by about twenty feet. This is possible because of the superior decoupling offered by the IsoPole antennas.

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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 swagging 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

* Spirit Electronics, 6560 N. Scottsdale Road, Suite E204, Scottsdale, Arizona 85253
** United Chemi-Con, 9801 West Higgins Road, Rosemont, Illinois 60018

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.

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

fig. 10. GPD106X gain variation with supply voltage (without regulator). Gain changes in 1 dB steps as Vcc is varied from +8 to +16 VDC.
Mounting shelves provide good ground plane coupling to box and good ground plane continuity between RF connectors and board.

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 ¼-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
boards are shown in figs. 14, 15, and 16. The first thing to do is mount the swaged 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 LM317. 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
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.

<table>
<thead>
<tr>
<th>item</th>
<th>description</th>
</tr>
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<tbody>
<tr>
<td>AR1</td>
<td>Avantek GPD 1061 (or GPD 461)</td>
</tr>
<tr>
<td>AR2</td>
<td>Avantek GPD 1062 (or GPD 462)</td>
</tr>
<tr>
<td>AR3</td>
<td>Avantek GPD 1063 (or GPD 464)</td>
</tr>
<tr>
<td>ferrite bead</td>
<td>Amidon FB 64-101 or Ferroxcube 56-590-65/4AG</td>
</tr>
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<td>C1-C6</td>
<td>10 μF/6.8V chip tantalum capacitor (may substitute CK05 ceramic or 196D dipped tantalum)</td>
</tr>
<tr>
<td>C7-C9</td>
<td>100 μF - 1000 μF, CK05 ceramic capacitor</td>
</tr>
<tr>
<td>C10-C12</td>
<td>10 μF/20V, dipped tantalum capacitor</td>
</tr>
<tr>
<td>C13</td>
<td>22 μF/35V, dipped tantalum capacitor</td>
</tr>
<tr>
<td>C14</td>
<td>22 μF/20V, dipped tantalum capacitor</td>
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<td>CR1</td>
<td>1N5711 Schottky diode (may substitute Radio Shack 276-1125)</td>
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<tr>
<td>C1-C6</td>
<td>10 pF 16.8V chip tantalum capacitor (may substitute CK05 ceramic or 196D dipped tantalum)</td>
</tr>
<tr>
<td>C1-C6</td>
<td>10 pF 16.8V chip tantalum capacitor (may substitute CK05 ceramic or 196D dipped tantalum)</td>
</tr>
<tr>
<td>CR2</td>
<td>1N4001 Diode (may substitute 1N4002-1N4007)</td>
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<tr>
<td>R1, R3, R4, R6</td>
<td>910 ohm, 1/4 watt, 5 percent, RC07 resistor (Allen Bradley preferred)</td>
</tr>
<tr>
<td>R7, R9, R10, R12</td>
<td>910 ohm, 1/4 watt, 5 percent, RC07 resistor (Allen Bradley preferred)</td>
</tr>
<tr>
<td>R2, R5, R8, R11</td>
<td>5.6 ohm, 1/4 watt, 5 percent, RC07 resistor (Allen Bradley preferred)</td>
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<td>R13-R15</td>
<td>10 ohm, 1/4 watt, 5 percent, RC07 resistor (Allen Bradley preferred)</td>
</tr>
<tr>
<td>R16</td>
<td>330 ohm, 1/4 watt, 5 percent, RC07 resistor (LM317 only)</td>
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<tr>
<td>R17</td>
<td>3.9K ohm, 1/4 watt, 5 percent, RC07 resistor (LM317 only)</td>
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<tr>
<td>VR1</td>
<td>LM317 regulator (may substitute as shown on schematic — R16 and R17 must also be changed)</td>
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<tr>
<td>box</td>
<td>Pomona 2901 (may substitute 2906)</td>
</tr>
<tr>
<td>terminal</td>
<td>(2) Cambion 160-2081-02-01-00 (input and output)</td>
</tr>
<tr>
<td>terminal</td>
<td>(2) Cambion 140-1385-02-01-00 (power and ground)</td>
</tr>
<tr>
<td>terminal</td>
<td>(1) H.H. Smith 2009 (box ground)</td>
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<td>RF connector</td>
<td>UG447/U (may substitute UG290A/U with mounting holes drilled out to 7/64)</td>
</tr>
<tr>
<td>spacer</td>
<td>H.H. Smith 2341, 3/8 x No. 4 brass</td>
</tr>
<tr>
<td>insulator</td>
<td>(1) mica</td>
</tr>
<tr>
<td>shoulder washer</td>
<td>(1) fiber</td>
</tr>
<tr>
<td>screw</td>
<td>(1) 4-40 x 5/8, pan head steel</td>
</tr>
<tr>
<td>screw</td>
<td>(34) 2 x 56 x 3/16, pan head steel (PC board and box)</td>
</tr>
<tr>
<td>screw</td>
<td>(8) 2 x 56 x 3/8, pan head steel (connector)</td>
</tr>
<tr>
<td>flat washer</td>
<td>(42) No. 2</td>
</tr>
<tr>
<td>flat washer</td>
<td>(1) No. 4</td>
</tr>
<tr>
<td>aluminum bar</td>
<td>12&quot; 1/4 x 1/4</td>
</tr>
</tbody>
</table>

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.

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 x 3/8 or 1/4 x 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
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 \( \pm 2 \) 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 \( \pm 2 \) 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-
A commercial 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


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A person can develop static levels of several thousand volts merely by walking across the floor. A discharge of this intensity can destroy or seriously degrade sensitive electronic components or circuit boards. Degraded boards may be prone to premature failure.

During routine maintenance and troubleshooting, the General Telephone Company of Wisconsin found evidence of degradation and premature failure of electronic telecommunication equipment due to static discharge in handling. It also found that circuits were being damaged during handling for storage. To eliminate the problem, General Telephone initiated an Electrostatic Discharge (ESD) program.

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.

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6-Band, 16 Channel No-crystal scanner


Tune Military, F.B.I., Space Stations, Police & Fire, D.E.A., Defense Department, AM Band, Aero Navigation Band, Fish & Game, Immigration, Paramedics, Amateur Radio, Justice Department, State department, plus thousands of other restricted radio frequencies no other scanner is programmed to pick up.

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Get a coupon good for a $50 rebate when you purchase a Bearcat 305, a $20 rebate on a Bearcat 210XLP, a $10 rebate on a Bearcat 1000, a $5 rebate on a Bearcat 260, or a $2 rebate on a Bearcat 1200. Mail in your completed coupon with your original dealer sales receipt and the Bearcat scanner number from the cast to Electra. You’ll receive your rebate in sixty to eight weeks. Offer valid only on purchases made between June 1, 1984 and March 31, 1984. All requests must be postmarked by April 15, 1984. Limit of one rebate per scanner. Bearcat least 10 orders to be eligible. Requests may not be reproduced. Offer good only in the U.S.A. Void where prohibited. Unless otherwise assigned by Electra Company, dealers and other Bearcat Scanner distributors are not eligible for rebates. Please be sure to send in the correct amount for your scanner. If the amount exceeds the rebate amount, the excess will be sent directly to you from Electra. Order cancellations and/or payments will not be processed and will be returned.

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Price $229.95/CE price $199.00

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Frequency range: 26-88, 144-512 MHz.

Cover your choice of over 15,000 frequencies on 10 channels at the touch of your finger.

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We give you excellent service because CE distributes more scanners worldwide than anyone else. Our warehouse facilities are equipped to process thousands of scanner orders every week. We also exchange scanners to over 300 countries and military installations. Almost all items are in stock for quick shipment, so if you’re a person who prefers fact to fantasy and who needs to know what’s really happening around you, order your radio today from CE.
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.

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.

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. 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.

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
Now you can get in on the fun on packet radio!

- Ready to operate — wired & tested
- Low cost
- Easy to learn, easy to use
- Built-in packet modem
- Use with computers, terminals, time-sharing machines
- RS232 serial interface — 45 to 9600 baud
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- Over 60 commands
- Custom call sign option
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- Black/white mode for transferring computer data
- Operates as an unattended repeater
- Activates teletype motor to print messages
- Board accepts up to 14K of RAM
- Can be customized for LANS and up to 56K RAM

**MODEL PK-1 wired & tested w/4K RAM**

| Additional memory (up to 14K total) | $149.95 |
| Manual only — credited with purchase | 9.95 |
| (add $2.00 for shipping) |  |
| RTTY adapter board | 12.95 |
| Custom cabinet — includes installation of TNC, on/off switch, LED pwr indicator, reset button & pwr jack | 24.95 |
| Dimensions: 4.5 x 9.5 x 1.5 inches |  |
| Pwr required: +12 VDC. approx. 200 ma. |  |
| Contact GLB for additional info and available options. |  |

We offer a complete line of transmitters and receivers, strips, preselector preamps, CWID’ers & synthesizers for amateur & commercial use. Request our FREE catalog. MC & Visa welcome.

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**KPAS 1 WATT 70 CM ATV TRANSMITTER BOARD**

- **APPLICATIONS**: Cordless portable TV camera for races & other public service events, remote VCR, etc. Remote control of R/C airplanes or robots, show home video tapes, computer programs, remote SSTV to local ATVers, DX depends on antennas and terrain typ. 1 to 40 miles.
- **FULL COLOR VIDEO & SOUND** on one small 3.25x4" board.
- **RUNS ON EXTERNAL 13.8 VDC at 300 ma supply or battery.**
- **TUNED WITH ONE CRYSTAL** on 426.25, 4340, or 439.25 mHz.
- **2 AUDIO INPUTS** for a low Z dynamic and line level audio input found in most portable color cameras, VCR’s, or home computers.
- **APPLICATION NOTES & SCHEMATIC** supplied for typical external connections, packaging, and system operation.
- **PRICE ONLY** $159 delivered via UPS surface in the USA. Technician class amateur license or higher required for purchase and operation.

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**CALL OR WRITE FOR OUR COMPLETE CATALOG** & more info on ATV downconverters, antennas, cameras, etc., or who is on in your area.

**TERMS:** Visa, Mastercard, or cash only UPS COD by telephone or mail. Telephone orders & postal MO usually shipped within 2 days, all other checks must clear before shipment. Transmitting equipment sold only to licensed amateurs verified in 164.4 Callbook, Calif. include sales tax.

**(818) 447-4565 m-f 8am-6pm pst.**

**P.C. ELECTRONICS** 2522 Paxson Lane
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**AMATEUR TELEVISION**

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**references**


All photographs courtesy of 3M Static Control Systems Division.

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**ham radio**
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 definable 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 controller 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 m/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
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.

PHONE ORDERS accepted on MC, VISA, or AMEX
No COD's. Shpg. extra on above.
Send for free 72 page catalogue jam packed w/ bargains.
moon-tracking by computer

Determine azimuth and elevation with simplified computer program

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.

<table>
<thead>
<tr>
<th>table 1. Letter assignments of variables.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A = LATITUDE OF LOCAL STATION</td>
</tr>
<tr>
<td>B = LONGITUDE OF LOCAL STATION</td>
</tr>
<tr>
<td>C = GHA-1</td>
</tr>
<tr>
<td>D = GHA-2</td>
</tr>
<tr>
<td>E = DEC-1</td>
</tr>
<tr>
<td>F = DEC-2</td>
</tr>
<tr>
<td>G = GMT OF MOONRISE</td>
</tr>
<tr>
<td>H = (D-C)/48 INTERPOLATION INCREMENT GHA</td>
</tr>
<tr>
<td>(0.25 HOUR)</td>
</tr>
<tr>
<td>I = (E-F)/48 INTERPOLATION INCREMENT DEC</td>
</tr>
<tr>
<td>(0.25 HOUR)</td>
</tr>
<tr>
<td>J = B-C</td>
</tr>
<tr>
<td>K = COS(J/Z)</td>
</tr>
<tr>
<td>L = COS(A/Z)</td>
</tr>
<tr>
<td>M = COS(E/Z)</td>
</tr>
<tr>
<td>N = SIN(A/Z)</td>
</tr>
<tr>
<td>O = SIN(E/Z)</td>
</tr>
<tr>
<td>P = TANIA/Z</td>
</tr>
<tr>
<td>Q = ARCSIN(X) ELEVATION ANGLE</td>
</tr>
<tr>
<td>R = COS(Q/Z)</td>
</tr>
<tr>
<td>S = TAN(1/Z)</td>
</tr>
<tr>
<td>T = ARCCOS(Y) AZIMUTH ANGLE</td>
</tr>
<tr>
<td>X = (K<em>L</em>MI) + (N*O)</td>
</tr>
<tr>
<td>Y = (O/(R<em>LI)) - (P</em>S)</td>
</tr>
<tr>
<td>Z = 57.2957795 Radian CONVERSION FACTOR.</td>
</tr>
</tbody>
</table>

*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 "EMEIBI")

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):GO TO 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 A=(AD+AE/60)*(-1):GO TO 55
50 A=AD+AE/60
55 PRINT#-2, A "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):GO TO 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
170 I=(E-F)/48
180 PRINT#-2, G "GMT"
185 J=G-C
190 K=CO(S(J/Z))
195 L=CO(S(A/Z))
200 M=CO(S(E/Z))
210 N=SI(N(A/Z))
215 O=SI(N(E/Z))
220 P=TA(N(A/Z))
225 X=(K*L*M)+(N*O)
230 Q=Z*(ATN(X/SQRT(-X*X+1)))
231 PRINT#-2, Q "ELEVATION ANGLE (Q)"
235 R=CO(S(Q/Z))
240 S=TA(N(Q/Z))
245 Y=(O+(R*L)-(P*S))
250 T=Z*(-ATN(Y/SQRT(-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

March 1984
THE MOST AFFORDABLE REPEATER

ALSO HAS THE MOST IMPRESSIVE PERFORMANCE FEATURES

(AND GIVES THEM TO YOU AS STANDARD EQUIPMENT!)

JUST LOOK AT THESE PRICES!

<table>
<thead>
<tr>
<th>Band</th>
<th>Kit</th>
<th>Wired/Tested</th>
</tr>
</thead>
<tbody>
<tr>
<td>10M,6M,2M,220</td>
<td>$680</td>
<td>$880</td>
</tr>
<tr>
<td>440</td>
<td>$760</td>
<td>$990</td>
</tr>
</tbody>
</table>

Both kit and wired units are complete with all parts, modules, hardware, and crystals.

CALL OR WRITE FOR COMPLETE DETAILS.

Also available for remote site linking, crossband, and remote base.

FEATURES:

- SENSITIVITY SECOND TO NONE; TYPICALLY 0.15 uV ON VHF, 0.3 uV ON UHF.
- SELECTIVITY THAT CAN'T BE BEAT! BOTH 8 POLE CRYSTAL FILTER & CERAMIC FILTER FOR GREATER THAN 100 dB AT ± 12KHz. HELICAL RESONATOR FRONT ENDS. SEE R144, R220, AND R451 SPECS IN RECEIVER AD BELOW.
- OTHER GREAT RECEIVER FEATURES: FLUTTER-PROOF SQUELCH, AFC TO COMPENSATE FOR OFF-FREQ TRANSMITTERS, SEPARATE LOCAL SPEAKER AMPLIFIER & CONTROL.
- CLEAN, EASY TUNE TRANSMITTER; UP TO 20 WATTS OUT (UP TO 50W WITH OPTIONAL PA).

HIGH QUALITY MODULES FOR REPEATERS, LINKS, TELEMETRY, ETC.

HIGH-PERFORMANCE RECEIVER MODULES

- **R144/R220 FM RCVRS** for 2M or 220 MHz, 0.15uV sens.; 8 pole xtal filter & ceramic filter in H, helical resonator frontend for exceptional selectivity, more than ~100 dB at ±12 kHz, best available today. Flutter-proof squelch. AFC tracks drifting xmtrs. Xtal oven avail. Kit only $138.
- **R451 FM RCVR** Same but for uhf. Tuned line front end, 0.3 uV sens. Kit only $189.
- **R76 FM RCVR** for 10M, 6M, 2M, 220, or commercial bands. As above, but w/o AFC or hel. res. Kits only $118. Also avail w/4 pole filter, only $98/kit.
- **R110 VHF AM RECEIVER** kit for VHF aircraft band or ham bands. Only $98.
- **R110-259 SPACE SHUTTLE RECEIVER**, kit only $98.

TRANSMITTERS

- **T51 VHF FM EXCITER** for 10M, 6M, 2M, 220 MHz or adjacent bands. 2 Watts continuous, up to 2½ W intermittent. $68/kit.
- **T451 UHF FM EXCITER** 2 to 3 Watts on 450 ham band or adjacent freq. Kit only $78.
- **VHF & UHF LINEAR AMPLIFIERS**. Use on either FM or SSB. Power levels from 10 to 45 Watts to go with exciters & xmtg converters. Several models. Kits from $78.
- **A16 RTIGHT BOX**. Deep drawn alum. case with tight cover and no seams. 7 x 6 x 2 inches. Designed especially for repeaters. $20.

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- **COR KITS** With Audio mixer, speaker amplifier, tail & time out timers. Kit only $38.
- **CWID KITS** 168 bits, field programmable, clean audio, rugged TTL logic. Kit only $68.
- **DTMF DECODER/CONTROLLER KITS**. Control 2 separate on/off functions with touchtones, e.g., repeater and autopatch. Use with main or aux. receiver or with Autopatch. Only $90.
- **AUTOPATCH KITS**. Provide repeater autopatch, reverse patch, phone line remote control of repeater, secondary control via repeater receiver. Many other features. Only $90. Requires DTMF Module.

- **HELIQUA RESONATOR FILTERS** available separately on pcb w/connectors.
  - **HRF-144** for 143-150 MHz $38
  - **HRF-220** for 213-233 MHz $38
  - **HRF-432** for 420-450 MHz $48

Tell 'em you saw it in HAM RADIO!
New low-noise microwave transistors make preamps in the 0.9 to 1.0 dB noise figure range possible without the fragility and power supply problems of gas-fet's. Units furnished wired and tuned to ham band. Can be easily retuned to nearby freq.

ECONOMY PREAMPS

Our traditional preamps, proven in years of service. Over 20,000 in use throughout the world. Tuneable over narrow range. Specify exact freq. band needed. Gain 16-20 dB. NF = 2 dB or less. VHF units available 27 to 300 MHz. UHF units available 300 to 650 MHz.

<table>
<thead>
<tr>
<th>Model</th>
<th>Freq Range</th>
<th>Gain</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>P30K</td>
<td>VHF Kit</td>
<td>$18</td>
<td></td>
</tr>
<tr>
<td>P30W</td>
<td>VHF Wired/Tested</td>
<td>$33</td>
<td></td>
</tr>
<tr>
<td>P432</td>
<td>UHF Kit less case</td>
<td>$21</td>
<td></td>
</tr>
<tr>
<td>P432W</td>
<td>UHF Wired/Tested</td>
<td>$36</td>
<td></td>
</tr>
</tbody>
</table>

P432 also available in broadband version to cover 20-650 MHz without tuning. Same price as P432; add “B” to model #.

SAVE A BUNDLE ON VHF FM TRANSCEIVERS!

FM-5 PC Board Kit – ONLY $178 complete with controls, heatsink, etc. 10 Watts, 5 Channels, for 2M or 220 MHz.

- Call or Write for FREE CATALOG
- (Send $1.00 or 4 IRC’s for overseas mailing)
- Order by phone or mail ● Add $3 S & H per order (Electronic answering service evenings & weekends) Use VISA, MASTERCARD, Check, or UPS COD.
VHF/UHF receivers

It's been some time since my last article on VHF/UHF receivers. 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

* 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 figures are now found on some computer programs. 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 Interface). 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. 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 38.606 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 leakage through 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 inners 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* 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.
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recommended circuit I’ve been using for over 10 years is 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 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 frequencies. 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.

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. 1. Recommended circuit for using commercial DBMs.**

---

**fig. 2. Recommended overtone crystal oscillator for 90-125 MHz. Output is approximately 10 milliwatts.**
available) are better and will have greater 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!

references

VHF/UHF coming events
EME perigee weekend: March 17-18.

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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. 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 (or any similar mathematical text) be reviewed by the reader before beginning the project.

self-impedance of a dipole

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

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

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.

By Walter J. Schulz, Jr., K30QF, 3617 Nanton Terrace, Philadelphia, Pennsylvania 19154

*NOTE: Send SASE to ham radio, Greenville, NH 03048.
table 1. Self impedance of dipole elements of different lengths and diameters.

<table>
<thead>
<tr>
<th>length (full element)</th>
<th>1.5 inch OD</th>
<th>1.0 inch OD</th>
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<tbody>
<tr>
<td>0.500</td>
<td>0.494</td>
<td>0.488</td>
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</table>

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.

\[
\begin{align*}
I &= I_1Z_{11} + I_2Z_{12} + I_3Z_{13} \\
0 &= I_1Z_{21} + I_2Z_{22} + I_3Z_{23} \\
0 &= I_1Z_{31} + I_2Z_{32} + I_3Z_{33}
\end{align*}
\]

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.

March 1984
A list of mutual impedances 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 efficiency).

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.

\[
\begin{align*}
I_1 &= (Z_{22}Z_{33} - Z_{32}^2) / \Delta \\
I_2 &= (Z_{23}Z_{31} - Z_{33}Z_{21}) / \Delta \\
I_3 &= (Z_{21}Z_{32} - Z_{31}Z_{22}) / \Delta \\
\Delta &= (Z_{11}Z_{22}Z_{33} + (Z_{12}Z_{23}Z_{31}) + (Z_{13}Z_{21}Z_{32}) \\
&- (Z_{31}Z_{22}Z_{13}) - (Z_{32}Z_{21}Z_{12}) - (Z_{33}Z_{21}Z_{12})
\end{align*}
\]

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:

\[
Z_{in} = Z_{11} + (I_2/I_1)Z_{12} + (I_3/I_1)Z_{13}
\]

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:

<table>
<thead>
<tr>
<th>self impedances</th>
<th>mutual impedances</th>
</tr>
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<tbody>
<tr>
<td>(Z_{11} = 63 - j15)</td>
<td>(Z_{12} = Z_{31} = 67 + j7)</td>
</tr>
<tr>
<td>(Z_{22} = 73 + j41)</td>
<td>(Z_{31} = Z_{13} = 60 - j7)</td>
</tr>
<tr>
<td>(Z_{33} = 54 - j10)</td>
<td>(Z_{23} = Z_{32} = 41 - j28)</td>
</tr>
</tbody>
</table>

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 \(\Delta\) and...
the values for driven, reflector, and director element currents $I_1$, $I_2$, and $I_3$ respectively.

\[ \Delta = 95476 - j182530 \]

**driven element**

\[
I_1 = \frac{(Z_{22} Z_{33}) - (Z_{33})^2}{\Delta} = \frac{(73 + j41)(54 - j70) - (41 - j28)^2}{\Delta} = 0.0159 + j0.0241
\]

**reflector element**

\[
I_2 = \frac{(Z_{23} Z_{33}) - (Z_{33} Z_{23})}{\Delta} = \frac{41 - j28(60 - j7) - (54 - j70)(67 + j7)}{\Delta} = -0.0142 - j0.0027
\]

**director element**

\[
I_3 = \frac{(Z_{21} Z_{32}) - Z_{31} Z_{22}}{\Delta} = \frac{(67 + j41 - j28)(60 - j7)(73 + j41)}{\Delta} = 0.0113 - j0.0154
\]

**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.

**references**

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March 1984
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!”

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

---

**eq.**

$$F_m = \frac{F_1 + F_2}{2}$$

$$\text{PERCENT DIPOLE “STAGGER”} = \frac{F_2 - F_1}{F_m} \times 100\%$$

---

March 1984 53
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-

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 original 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

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.

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:

\[
\text{length (feet)} = 623.5/f (\text{MHz})
\]

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 receiving and transmitting.

**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.**

**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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**Samir, Boston, MA**

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 braid) 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 other 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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Congratulations!
Jack Falkner
WB5K (WB5K has worked all countries but two)
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).

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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 Tall Twister manages combinations such as a TH7DX stacked with a small 2 element 40 meter beam. Also a good 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 torque 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.
- **CHOOSEING 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.

More Details? CHECK-OFF Page 120 March 1984 61
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- MICROCOMPUTER CONTROL: At the forefront of technology!

- UP TO 8 NONSTANDARD SPLITS: Ultimate versatility. COMPARE!

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- FREQUENCY REVERSE: The touch of a single button inverts the transmit and receive frequencies, no matter what the offset.

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- BRIGHT GREEN LED FREQUENCY DISPLAY: Easily visible, even in direct sunlight.

- DIGITAL S/RF METER: Shows incoming signal strength and relative power output.

- BUSY-CHANNEL AND TRANSMIT INDICATORS: Bright LEDs show when a channel is busy and when you are transmitting.

- FULL 16-KEY TOUCHTONE® PAD: Keyboard functions as autopatch when transmitting (except in PCS-4800).

- PL TONE: Optional PL tone unit allows access to private-line repeaters. Deviation and tone frequency are fully adjustable.

- TRUE FM: Not phase modulation. Unsurpassed intelligibility and audio fidelity.

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- 1800 bytes
- Diskettes Capacity
- Industry Standard

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- 16KB buffer
- No computer power required
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- No computer power required
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The FDD100-8 "Floppy Disk Drive (Industry Standard)" features 8" double-sided floppy drives with 1800 bytes density. Transfer rate: 50KB/s, single-density, 1800 bytes density. It is designed to work with the single-sided 5.25" floppy drives. The drive can be used with any computer that has a dedicated 5.25" floppy drive port. The cables are available in various sizes. 8" floppy drives require 14.4" x 14.4" x 2.5" space. 1000 drives cost $195.95 ea.

**5 1/4" PIONEER DISK DRIVE**

Double-Sided Half-Hight 5" Drive

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- Formatted: 1.2MB/2.4MB
- 16KB buffer
- No computer power required
- 5/8" capacity

Customers can purchase TEAC 5.25" drives. The conventional drive is priced at $995.00. The 5.25" drive is priced at $995.00. Both drives require a minimum order of 1000 drives.

The FDD100-8 "Floppy Disk Drive (Industry Standard)" features 8" double-sided floppy drives with 1800 bytes density. Transfer rate: 50KB/s, single-density, 1800 bytes density. It is designed to work with the single-sided 5.25" floppy drives. The drive can be used with any computer that has a dedicated 5.25" floppy drive port. The cables are available in various sizes. 8" floppy drives require 14.4" x 14.4" x 2.5" space. 1000 drives cost $195.95 ea.

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The FDD100-8 "Floppy Disk Drive (Industry Standard)" features 8" double-sided floppy drives with 1800 bytes density. Transfer rate: 50KB/s, single-density, 1800 bytes density. It is designed to work with the single-sided 5.25" floppy drives. The drive can be used with any computer that has a dedicated 5.25" floppy drive port. The cables are available in various sizes. 8" floppy drives require 14.4" x 14.4" x 2.5" space. 1000 drives cost $195.95 ea.
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 D0 through D7. These carry seven bits of coded interface messages in ASCII format and device-dependent

By Vaughn D. Martin, 114 Lost Meadows, Cibolo, Texas 78108
Clean up the radio/computer clutter.

For less than $250 you can make your investment in yourself pay off!

Chances are you have spent a couple thousand dollars on setting up a computer system that gets a lot of your work done. But sometimes it gets to be work to work at it.

I know that when I have to move two program manuals and a pencil holder to boot up the disk drive, it is work. When there is an unlabeled floppy (that I am going to identify some day) on top of the monitor and the business checkbook is on top of the printer and I will remember (I hope) before the next “report” comes through that is work.

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 sleazy 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.

A lot of my working day is spent with my computer, and I will bet a lot of your time is too. So I figure a “home” for my system—a housing that is good looking as well as efficient to work at—will pay off in two ways:

1. Less work: an efficient and orderly layout will save me time and energy.
2. Personal satisfaction: good quality furnishings look better... they just plain feel better to work at too.

So imagine how good I felt to find the “Micro-Office” Work Center! These are fine pieces of computer system furniture that make my office-at-home as pleasant a place to work as it ought to be. And the biggest and best surprise is the low, low price for such good quality.

Here is what you get—all for only $249.50 plus shipping:
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- There is no risk in buying from us either. We will make a full refund of purchase price plus shipping charges if you return the work center within 30 days for any reason whatsoever. In addition, the product is warranted for any defects in materials or construction for a full year from date of purchase. This is a no-risk investment in your own productivity and work efficiency that will pay off for years to come—even if your work station is not yet a microcomputer of your own.
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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

<table>
<thead>
<tr>
<th>BITS 87 B6 B5</th>
<th>00 00 00</th>
<th>00 01 01</th>
<th>01 10 10</th>
<th>01 11 11</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONTROL</td>
<td>NUL</td>
<td>00</td>
<td>SP</td>
<td>01</td>
</tr>
<tr>
<td>NUMBERS</td>
<td>00</td>
<td>01</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>SYMBOLS</td>
<td>00</td>
<td>01</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>UPPER CASE</td>
<td>00</td>
<td>01</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>LOWER</td>
<td>00</td>
<td>01</td>
<td>10</td>
<td>11</td>
</tr>
</tbody>
</table>

ADDRESS COMMANDS

SECONDARY ADDRESSES OR COMMANDS

UNIVERSAL COMMANDS

LISTEN ADDRESSES

TALK ADDRESSES

KEY TO CHART

octal = 25
hex = 15

NAK = ASCII character

GPIB code = FF

decimal = 21

---

68 March 1984
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 D10 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 D10 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.
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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.
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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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-101 E 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.

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.
I've had exceptional results. I've nulled out 20 over 9 light dimmer noise and managed to receive very weak LF experimental beacons, one from 67 miles away and another from 90 miles away. Even with my noise blanker on, I was never able to receive either of these before.

In some instances the noise blanker and noise canceller can be used together to cancel noise. I use a 260 foot wire for my receive antenna and a 50 foot inverted L configuration for my noise antenna. For best results, you may have to do some experimenting with your noise antenna configuration; it should be fairly long (at least 40 feet), with a good portion of its length running vertically.

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.

For those interested in 1750 meters The Lowfer Letter is available free (send SASE) from Vincent J. Pinto, 2 Fairview Terrace, Suffern, New York 10901 - Editor

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9 MHz CRYSTAL FILTERS

<table>
<thead>
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<th>Bandwidth</th>
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When you have finished your experiment, please let me know the results. Thank you.

antennas

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<td>1650-1750 MHz</td>
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<td>Type 14A</td>
<td>SMA $5.95</td>
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speech synthesis
for repeaters

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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 x 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 x 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 (ACCI)* 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 hexadecimal. Also, commands above 142 decimal or 8F hexadecimal 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

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

By Ron Wright, N9EE, Micro Security, 9307 Meadow Lane, Greenfield, Indiana 46140
When the character is complete, this line will go high. The external controller can use this line for "hand-shaking" 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 7FO through 7FF to be sent. When a new byte is sent to the
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
features such as a talking clock, which is touch-tone set-
table, 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 select-
ted time; the message can remind the wearer of an ap-
pointment or simply remind him or her of some timely
piece of information. Votan* is marketing a voice-rec-
ognition 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 fif-
teen 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 ap-
plications in Amateur Radio.

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**More Details? CHECK-OFF Page 120**

**SATELLITE TV KIT**

**THE POPULAR SAT-TEC RECEIVER IN KIT FORM!**

**NEW, LOWER PRICES!**

**Audio Preamp**

Make high resolution audio measurements, great for musical instrument testing. PL tones, etc. Multiplies audio output in frequency detectable at 1000 and above 0.1 Hz resolution with 1 sec gate. Super low sensitivity of 25 mV for megapixels and 2000 for CD. Gekit functions perfectly. Get full service and complete assembly instructions. Features of the receiver include, digital conversion for best image reaction, fully tuneable audio to recover hidden subcarriers, RF demodulation, RF discriminator, threshold measurement, tight locking AIC, adaptive demodulator, three PLL’s, and a subcarrier tunable encoder. Build your satellite TV system around the R20, close to wining the game and there is a winner in kit form at a low price. Order today.

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Extend the range of your TV system to 200 MHz works with all-counters. Less than 150 mV sensitivity specify 10 or 100. Wired, tested PS-1B $39.95

**600 MHZ PREScALER**

$49.95

**30 Watt 2 m PWR AMP**

Simple Class C power features 8 times power gain. 1 W for 8W, 2 W in 15 W, 4W in 350 W. Max output of 55 W, incredible value, complete with all parts, less case and T-relay PA-1, 30 W pwr amp kit $24.95

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(1W) and closes DPOT relay. For RF sensed T-relay TR-1 $6.95

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*Note: All prices are subject to change without notice.*

**SOLD OUT**

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7812 $1.00
7815 $1.00
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**Mini TOK-92 Heat Sinks**

One color 114°F 7-1/4" x 1-1/4" x 2-1/8" fits 1/4" resin. Great for spaced $0.10/1 each $1.00/10 each $10.00/30 each $20.00/60 each $30.00/100 each $50.00/200 each $75.00/300 each $100.00/500 each $150.00/1000 each $200.00/2000 each $300.00/3000 each $500.00/5000 each $750.00/7500 each $1000.00/10,000 each

**Opto Isolators - 4N28 type**

OPT-1 $5.00 ea.
OPT-2 $10.00 ea.

**Moles Pins**

Moles pins are in place in 10 levels of 10 each. For 10 pins sockets 30 each for 100 each $25.00

**CDS Photocells**

Resistance varies with light, 250 ohms to over 1 meg.

March 1984 Pg 83
NCG WORLD BAND COMMUNICATIONS

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Power-High 10 watts, Low 2 watts
VFO Tuning, Noise Blanker
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13.8 VDC @ 3A Neg. Ground
9.5" L x 9" W x 2.5" H
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USB-LSB CW (Narrow CW filter optional).

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40-15 & 6 Meter
26 Watts PEP. Built-in AC/DC Power Supply

MICROWAVE VIDEO RECEIVER
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HMR XI
34+ dB GAIN • FREQUENCY 2.1 to 2.6 GHz
ABSOLUTELY WATERPROOF
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PHOENIX, ARIZONA 85009

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INDIVIDUAL COMPONENTS AVAILABLE
FAST-EXPERT REPAIR ON ALL TYPES
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 1 1/2 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 victim’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 cardio-pulmonary 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
The INTERFACE is the original Kantronics terminal unit that broke through the barrier of multi-computer compatibility. The INTERFACE is an amateur modem for transceiver-to-computer communication. With the INTERFACE and Hamsoft or Hamtext for your computer you can send and receive Morse Code, Radiotele-type, and ASCII. The INTERFACE is also compatible with our new software for AMTOR communication, AMTORSOFT. The INTERFACE is our most popular unit combining active filtering, easy tuning, six-computer compatibility, and low price for an unbeatable package.

Suggested Retail $139.95

INTERFACE II is the new Kantronics transceiver-to-computer interface. INTERFACE II features a new highly sensitive front end with mark and space filtering and a unique new tuning system. Even the most discerning operator will be surprised with the INTERFACE II's ability to dig out signals in poor band conditions, and our new tuning system even displays signal fading.

X-Y scope outputs and dual interface outputs for VHF and HF connections make INTERFACE II compatible with almost any shack. All three standard shifts are selectable and INTERFACE II is compatible with the industry standard Kantronics programs: Hamsoft, Hamtext, and Amtorsoft. Step up to state of the art in computer-amateur communications with INTERFACE II.

Suggested Retail $269.95

For more information see your Kantronics dealer, or contact:

Kantronics 1202 E. 23rd Street Lawrence, KS 66044
QUAD BAND BEAMS
7-14-21-28 MHz
THE NEWEST INNOVATIVE ADDITIONS to the TET LINE
FEATURE TRUE MULTI-ELEMENT PERFORMANCE ON 4, NOT 3, BUT 4 BANDS.
ALL ON A SINGLE BOOM!!

All the usual TET multi-band beam features are included in these two models, including wide bandwidths, increased gain, low SWR, light weight and superior mechanical construction and easy assembly.

Preliminary Specifications:

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Available from local dealers including:

Electronic Equipment Bank
516 Mill St.
Vienna, VA
(600) 368-3270

Jun's Electronics
460 E. Plumb Lane
Reno, NV
(800) 648-3962

Sutronics
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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 other's designs, BBC looked at where portable meters were used and how they could be improved. The result is a unique approach. Folding meters with large displays (18 mm LCDs) and adjustable viewing angles. Now you can have high performance in a meter that excels in the field and on the bench.

Hands Free vs Handheld

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.

A Heritage of Precision

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.

Compact, Rugged and Affordable

To design the impact resistant case that protects these DMM's, BBC relied on the industrial design skills of the Porsche Design Studios.

When open, the display angle is easily adjustable. When closed, the display and the controls are protected, and the meters turn off automatically.

Competitive pricing is another feature of BBC meters. Prices start at $193.00.

Available Locally

BBC meters are available throughout the U.S. If your instrumentation supplier doesn't carry BBC yet, we'll gladly tell you who does. Call toll free:

1-800-821-6327
(In CO, 303-469-5231)

BBC - METRAWATT/GOERZ
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Broomfield, CO 80020, Telex 45-4540

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45 Watts! Multi-featured.

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25 watts on both bands.

Call for YOUR Low Price!

**TR 2500**
Full Featured 2M Handheld

UPS Brown Paid on TR 2500

---

**MICA COMMUNICATIONS CONSOLES**

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<td><strong>$3,295</strong></td>
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**OPTIONAL ITEMS:**
- **Enhanced Cooling Fan:** Thermo-controlled wire duct, wire labels, etc.
- **Flat Panel Screen:** Recessed for keyboard, graden fixed at 26 degrees.

**Break Communications Systems, Inc.**
5817 S.W. 21st Street, Dept. HRM - Hollywood, Florida 33023
Phone (305) 989-2371

**AMAZING SCIENTIFIC AND ELECTRONIC DEVICES**

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<tr>
<th>Device</th>
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**UP YOUR ERP**

For HT owners operating inside a vehicle and wanting increased T/R range, RF PRODUCTS has the low cost solution. To remove your BNC antenna from the HT and mount on the RF PRODUCTS BNC magnet mount, install the magnet mount on the roof top and connect the BNC coaxial connector. The magnet mount (part no. 199-445) has 10 feet of cable (5/32") coax with BNC connector attached and is priced at $15.95 (including shipping by UPS to 46 states). TO ORDER: send $15.95 money order or cashiers check only; 3% sales tax, for air UPS add $1.50.

The RF PRODUCTS Magnet Mounts are one of the few magnetic antenna mounts available that can be repaired should the coaxial cable be damaged. The coaxial cable connector includes a shrin tubing strain relief for long life at the connector cable flex point (an RF PRODUCTS exclusive on all cable assemblies). Eight other models available with three each choice of antenna connectors, coax types and transceiver connectors (BNC, 1-1/8-18, 5/16-24 & RG-122U, RG-58A/U, mini-8X & BNC, PL-259, type N).

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**RF PRODUCTS**
P.O. Box 33, Rockledge, FL 32955, U.S.A. (305) 631-0775
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 causes 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 visualizing 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 summer-time. 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.

Garth Stonehocker, KØRYW
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*Note: The table provides local time equivalents for the Western USA, Mid USA, and Eastern USA. The times are for standard operating hours.
This tower is ready for shipment to one of our customers, or is it? If we were an ordinary tower company, this tower would have already been sent.

We are not an ordinary tower company and that is why this tower did not go out. We have the best quality control in the business and we are not afraid to say so. That is why when John Pasillas found a 1/8" clearance on the swaged guide, he placed a red tag of rejection on this tower and made sure it was corrected to 1/16" before he stamped his final approval for shipment.

Every employee at Tri-Ex knows that the reputation you establish in an industry is what will make or break his company. That is why Tri-Ex has been in business continually since 1955.

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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 8AM to 3PM, at the Marshall High School. Tickets $2.00 at the door. $1.50 Advance. Table space $5.00 per ft., min. 1 ft. reserved. $2.50 for Shall service. For reservations SASE to: SMAR, P.O. Box 934, Battle Creek, MI 49016 or call Wes Chaney, N8BDM (616) 979-3433. Talk on in 146.52 and 146.9767.

MICHIGAN: The Southern Michigan Amateur Radio Association (S.E.M.A.R.A) 26th annual Hamfest Swap and Shop, April 18, 9AM to 3PM. Grosse Pointe North High School, Verner Rd. between Chadsey and Lakeshore. Advance admission $1.00, $2.00 at door. Talk on 147.95/15 and 52. Contact Joe Weiner, K1VUC, 52 Overlook Dr., Farmington, MA 01701, (617) 937-7166.

MISSOURI STATE ARRL Convention, Kansas City, April 7-8, 1984. For information or call PHD Amateur Radio Association, P.O. Box 11, Liberty, MO 64068-0011. (816) 781-7133.

NEW JERSEY: The Delaware Valley Radio Association’s 12th annual Flea Market and Computer Show, Sunday, April 8, 8AM to 4PM. 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. Seller’s bring own tables. Talk in 146.55 and 146.07-67. For tickets and space reservations SASE to: KB2ZY, 140 Susan Drive, Trenton, NJ 08638.

NEW JERSEY: Radio Flea Market sponsored by the Chestnut Ridge Radio Club, Saturday, March 24, Education Building, Sussex River Reformed Church, East Sussex River Road and Weiso Road, Upper Saddle River. Tables $10.00 for first, $5.00 each additional. Tailgating $5.00. Free admission. Food and social area available. Contact Jackie Melander, WE2QD (201) 768-3850 or Roger Soderman, K2WU (201) 666-2430.

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And speakers are easy to make—and very difficult to design. Speaker Builder, a new quarterly from the publishers of Audio Amateur, has all the design answers you novice-to-experts need to dramatically improve the quality of sound you're getting from your stereo system. The drivers are relatively cheap and the sources for them are all listed in Speaker Builder's pages. As an experienced ham, you probably know your way around your audio system already. Here's an easy way to make what you have sound a whole lot better at minimum cost.

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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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 strengths 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 a 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.

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 149-174 MHz), UHF (450-470 MHz), UHF “T” (470-512 MHz) and two FM ham bands (144-146 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.

AMTOR converter

The new Info-Tech M-44 AMTOR converter 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 AQR monitor modes.

For information, contact Digital Electronics Systems, 1633 Wisteria Court, Englewood, Florida 33633.

Circle 304 on Reader Service Card.
IC-27A two-meter mobile

The ICOM IC-27A measures only 1-1/12 inches wide by 5-1/12 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.

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

Circle 1305 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.

Circle 1306 on Reader Service Card.

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.

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

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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, 5.0 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 1000 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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**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 bandrange 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 15,000 channels between 141-180 MHz in 2.5 kHz steps. Its light weight (11 ounces; 315 g.) and miniature size (6-5/8 x 2-3/8 x 1-5/8 inches; 169 x 56 x 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 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, "winnie" will calculate and tabulate polarizaton 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 $45.95 plus $2.00 postage. (If you don't have an Apple, you can still benefit from "winnie" analyses. For a small charge, an analysis of your results may be printed in any column.

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

Circle 1310 on Reader Service Card.

**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 transmit capability, with expanded coverage available for use of other printers. 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 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-75770 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.

Circle #11 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 the shack often have noise figures of 6 to 8 dB. Additional low-noise preamplifiers that are particularly useful are the Cole-Flex preamplifiers.

For details, contact Cole-Flex Corporation, 91 Cabot Street, West Babylon, New York 11770.

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<th>Gain (dB)</th>
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<td>164 MHz</td>
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<tr>
<td>10 GHz</td>
<td>12 GHz</td>
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<td>6 GHz</td>
<td>12 GHz</td>
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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 Dszer 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.

Circle #13 on Reader Service Card.

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.

Circle #14 on Reader Service Card.

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.

Circle #15 on Reader Service Card.
dual heat soldering iron

The new Archer® Switchable Dual Heat Soldering Iron (No. M-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.
Circle 1316 on Reader Service Card.

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.
Circle 1317 on Reader Service Card.

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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Once the desired part is found in the directory and a supplier chosen, the user refers to the supplier information section, where company information is given. Included is the supplier's address and phone number, cost to obtain a catalog, minimum order information, and whether their parts are new or surplus. (To be included in the Guide, a supplier must have a mail order operation and be willing to sell in small quantities to individuals.)

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

Circle #18 on Reader Service Card.

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 x 3-1/4 inches) and BB-100 (3-1/4 x 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 x 5-1/4 inches) and IC-100B (4 x 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 WIFB, Oak Hills Research, 4061 N. Douglas Road, Luther, Michigan 49666.

Circle F319 on Reader Service Card.

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 98666.

Circle F20 on Reader Service Card.

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, W46RXN, 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.

For information, contact the Century Print Shop, 6059 Essex Street, Riverside, California 92504.

Circle F21 on Reader Service Card.

CMOS keyer kit

BEL-TEK has introduced an inexpensive CMOS keyer kit incorporating state-of-the-art circuitry. Power consumption is kept to a minimum by the use of low power CMOS digital integrated circuits.

The keyer uses a triggered clock to completely eliminate the possibility of having the first dot or dash any longer than the characters that follow. The instant you push the key, the character starts, eliminating the delay often encountered in keyers with free-running clocks. The digital circuitry of the CMOS keyer provides an exact 3:1 weight ratio for perfect CW. The keyer also provides jam-proof spacing which eliminates

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The dismantling or some towers should be done with the use of a crane in order to minimize the possibility of member, guy wire, anchor, or base failures. Used towers in many cases are not as inexpensive as you may think if you are injured or killed.

Get professional experience help and read your Rohn catalog or other tower manufacturer's catalog before erecting or dismantling any tower. A consultation with your local professional tower erector would be very inexpensive insurance.

the chance of placing dots and dashes too close together. After a dot or dash is completed, a space is automatically inserted before the next character begins, even if the key was pushed before the completion of the space. If both the dot and dash keys are sent simultaneously, the dash will dominate until it is released.

The keyer can be powered by any voltage between 5 and 12 volts DC. The circuit is protected against accidental polarity reversal of the supply voltage. The keyer can be operated at any speed between 5 and 50 WPM by adjusting the speed control to your desired operating speed. The built-in 800 Hz sidetone has an adjustable volume control.

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The CMOS keyer kit comes with a printed circuit board and all components necessary for assembling. The price is $9.95 plus $1.50 shipping.

For more information, contact BEL-TEK, P.O. Box 125H, Beloit, Wisconsin 53511.

Circle #322 on Reader Service Card.

THE RADIO AMATEUR ANTENNA HANDBOOK
by William L. Orr, W6SAI and Stuart Cowan, W2LX
Contains lots of well illustrated construction projects for vertical, long wire, and HF/UF beam antennas. There is an honest judgment of antenna gain figures, information on the best and worst antenna locations and heights, a long look at the quad vs. the yagi antenna, information on baluns and how to use them, and new information on the popular Sloper and Delta Loop antennas. The text is based on proven data plus practical, on-the-air experience. The Radio Amateur Antenna Handbook will make a valuable and often consulted reference. 190 pages. ©1978.

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The cubical quad antenna is considered by many to be the best DX antenna because of its simple, lightweight design and high performance. You'll find quad designs for everything from the single element to the multi-element monster quad, plus a new, higher gain expanded quad (X-Q) design. There's a wealth of supplementary data on construction, feeding, tuning, and mounting quad antennas. 112 pages. ©1977.

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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; consequently, 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 VHFIUHF 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 VHFIUHF 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 col-umnist, 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. Circle #226 on Reader Service Card.

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<table>
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High Gain Matched Quads Available

**MISC. 2-30 MHz**

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</tbody>
</table>

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**March 1984**

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**MISC. 2-30 MHz**

<table>
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- Frequency accuracy, ± 1 Hz maximum - 40°C to + 85°C
- Frequencies to 250 Hz available on special order
- Continuous tone

Group B

<table>
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<tr>
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<th>BURST TONES:</th>
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<td>2805</td>
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</tbody>
</table>

- Frequency accuracy, ± 1 Hz maximum - 40°C to + 85°C
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Model TE-64 $79.95
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With the most experience in transceiver design and manufacture, the Yaesu trademark is your guarantee of quality and durability. We’ve got all-new technology and an all-new warranty policy to back it up.

See the FT-77 and the all new line of Yaesu HF, VHF, and UHF transceivers, receivers and accessories at your Yaesu Dealer today! It's time you tried a Yaesu!
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 tunable 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 x 3-3/4 (96) x 10-7/8 (273) 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 provides 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/PWR 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 band 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, 1101 West Walnut Street, Compton, California 90220.