Deal yourself a winning hand in modern technology with ICOM's new micro-size 2-meter FM transceiver. The IC-μ2AT combines maximum performance, reliability and easy operation in a thin-styled handheld that's perfectly suited for today's active lifestyles.

The IC-μ2AT. A breakthrough that ends every amateur radio operator's quest for that one true, go-anywhere 2-meter handheld.

Miniaturization. The MICRO gives you all the advantages and performance of a larger handheld, in a package so small, so refined, so well-built that only ICOM could build it.

Measuring only 4.6" high by 2.3" wide by 1.1" deep, the MICRO fits in your pocket or purse as easily as a cassette tape.

This miniaturization doesn't compromise ICOM quality. It's exactly what you'd expect from ICOM: high performance in a micro package.

Full Featured. And ICOM hasn't compromised features for size. The IC-μ2AT DTMF version includes ten programmable memories, transmit offset capability from the back panel including odd offsets, an LCD readout on the top panel for easy readability, up to three watts of output (optional), 32 built-in subaudible tones AND wideband receive coverage from 138 to 162.995MHz in 5kHz steps for MARS and CAP operation plus weather broadcasts.

There's also a simple-to-use digital TouchStep Tuning System for fast shirt-pocket frequency adjustments. The MICRO also includes a band or memory manual scan function. An A version is also available without DTMF and PL tones.

Personalize your ICOM MICRO. The MICRO utilizes most existing ICOM handheld accessories, plus it hosts a new line of versatile accessories including the BP-24 2.6 watt high-power battery pack, BP-23 long-life 1.6 watt battery pack, BC-50 desktop rapid charger, and a variety of carrying cases.

See the ICOM MICRO at your local ICOM dealer. Play your cards right with ICOM!
Our Numbers Are Growing

Kantronics TUs & TNCs

UTU** UTU transmits/receives CW 6-99 WPM, RTTY 60, 67, 75, 100, and 132 WPM; ASCII 110, 150, 200, and 300 baud, and AMTOR modes A, B, and L. UTU features switched capacitance filters, and a ten-segment LED bargraph for extra easy tuning.
Suggested Retail $189.95.

UTU-XT/P** now operates HF PACKET along with CW 6-99 WPM, RTTY from 45-300 baud, and AMTOR A, B, and L. UTU-XT/P features user programmable parameters, such as MARK/SILENCE edges, multiple RTTY shifts, and a limiter/limiterless operation. UTU-XT/P utilizes a 6303 microcomputer, 8K RAM, NOVRAM, and 128K EPROM.
Suggested Retail $289.95.

KAM™ The Kantronics designed All Mode unit operates HF and VHF packet, CW 6-99 WPM, ASCII 45-300 baud, and AMTOR A, B, and L. KAM features HF and VHF radio ports, simultaneous HF and VHF packet connects and digipeating, HF/VHF gateway, bargraph tuning; and user programmable parameters, such as MARK/SPACE. KAM’s separate CW demodulator is also center frequency and bandwidth programmable.
Suggested Retail $319.00.

KPC-2400™ Fully compatible with all other TNCs, the KPC-2400 includes all the features of KPC-2 plus 2400 bps packet. KPC-2400 operates at 300, 1200, and 2400 bps, software selectable.
Suggested Retail $329.00.

Kantronics has also designed the 2400 TNC Modern™ for TNC-1s and TNC-2s. This add-on modem adds 2400 bps packet, while retaining 1200 bps operation.
Suggested Retail $149.00.

KPC-2™ This Kantronics designed AX.25 version 2 TNC features a built-in HF and VHF modem, full duplex operation, and multiple connects. The enhanced generic command structure fits any computer. KPC-2 includes 128K EPROM, 16K RAM - expandable to 32K, and 4K EEPROM.
Suggested Retail $169.00.

Kantronics Terminal Programs
Packet/UTU-Term™ for IBM and compatibles, C, 64, 128, TRS III, IV, IV/P, Operates KPC-2, KPC-2400, KAM, UTU-XT/P, and UTU. Disk $19.95, Cartridge $24.95, IBM disk $29.95.

Call or write Kantronics for a free catalog.

All Kantronics products are designed and manufactured in the U.S.A.

And There Are Good Reasons Why

Features and Support — Just a couple of reasons why so many amateurs are choosing Kantronics.
Take our packet units. Only Kantronics TNCs have always included the HF modem as standard equipment. And only Kantronics offers high-speed 2400 bps packet.
Our RS-232/TTL jumper makes all Kantronics "SMART" TUs and TNCs universally compatible. You won’t need special interfacing for Commodores when you choose Kantronics.

Kantronics prices are compatible too! Check and see.

And what about support? — Kantronics full-time customer support departments have earned a reputation of excellence. From the time we answer your first call, our goal is to get you, and keep you on the air.
By providing updates and enhancements, Kantronics keeps you current too - like our 2.0 update.
Over 80% of our original Packet Communicator owners stayed current by updating to version 2.0.
We support our customers, and our products. And that’s why Our Numbers Are Growing.

Kantronics
RF Data Communications Specialists
1202 E. 23rd Street Lawrence, Kansas 66046
(913) 842-7745
The new TS-940S is a serious radio for the serious operator. Superb interference reduction circuits and high dynamic range receiver combine with superior transmitter design to give you no-nonsense, no compromise performance that gets your signals through! The exclusive multi-function LCD sub display graphically illustrates VBT, SSB slope, and other features.

• 100% duty cycle transmitter. Super efficient cooling system using special air ducting works with the internal heavy-duty power supply to allow continuous transmission at full power output for periods exceeding one hour.
• High stability, dual digital VFOs. An optical encoder and the flywheel VFO knob give the TS-940S a positive tuning "feel."
• Graphic display of operating features. Exclusive multi-function LCD sub-
May 1987
Volume 20, Number 5

Contents

8 Two-element HF beams:
Les Moxon, G6XN

35 Homebrew antenna mount
Howard A. Bowman, W6OIR

42 Yagi triangular array
John C. Cichowski, W2KIP

55 Ham radio techniques: an inexpensive base station antenna for 2 meters
Bill Orr, W6SAI

69 A no-compromise, multiband, low-VSWR dipole
Maurice C. Hately, GM3HAT

81 Practically speaking: grounding, shielding, and isolating — part 2
Joe Carr, K4IPV

87 Gamma matching programs for the C-64/128
Fred A. Sontag, N0CAO

92 VHF/UHF world: optimized 2- and 6-meter Yagis
Joe Reisert, W1JR

130 Advertisers index and reader service
110 Ham mart
114 New products
6 Comments
4 Reflections
105 DX forecaster
64 Short circuits
112 Flea market
it used to be . . .

It used to be one of the major considerations in planning any antenna installation. After the wish list (“How many?” “What kind?” “How high?” “What bands?”) was complete, reality entered the picture, raising such questions as “Can I really afford all this?” and “What kind of reception will I get?” This latter question often had less to do with performance and more to do with worrying about what the neighbors — and the zoning board — would say.

Radio Amateurs nationwide breathed (or should have breathed) a collective sigh of relief on February 12, 1987, when the courageous and persistent John Thernes, WM4T — who had taken on, at considerable personal expense, the city of Lakeside Park, Kentucky — won his case. In April, 1982, John had filed an application with the city zoning administrator for permission to erect a tower which was to include a triband beam at 70 feet and a two-element, 40-meter beam at 78 feet. (The specifics are important.) He was told, in effect, that the city’s zoning regulations excluded all antenna towers. His application was rejected.

The details can be found in all the major Amateur Radio news reports (HR’s Pressstop, The W5YI Report, The Westlink Report, and The ARRL Letter) and in the other ham magazines, but basically what happened is that John took his struggle right on up to the Federal Appeals Court. And on February 12, the city of Lakeside Park agreed to sign a full consent judgment. What this meant to him was that he could now install his tower, his antennas, and his guy lines. There was a compromise — instead of a total height of 78 feet, he had to “settle” for 73 feet overall. (I believe I read that 73 feet would have been acceptable to John at the very beginning, before the city turned him down for any height at all.)

The significance of this case isn’t that one Radio Amateur won his own personal antenna battle, but that we all did . . . because this was the first time that Memorandum Opinion and Order FCC 85-506, better known as PRB-1, was tested and supported in the higher courts. In its initial resolution, the Commission had declared that “local regulations which involve placement, screening or height of antennas based on health, safety or aesthetic considerations must reasonably accommodate amateur communications and represent the minimum practicable regulation to accomplish the purpose of the local authorities.” In other words, it maintained that local and state governments cannot arbitrarily rule against the installation of Amateur Radio antennas.

John’s legal fees, I believe, exceeded $20,000. In deciding in his favor, the court ordered the city of Lakeside Park to pay all John’s legal fees — almost $14,000 — incurred since the enactment of PRB-1. It now appears likely that any municipality that contests other proposed Amateur installations could very well lose and be held responsible for costs.

This is our annual antenna issue. Personally, I couldn’t have asked for a more appropriate time to acknowledge and discuss WM4T’s victory.

You can get a copy of the consent decree from the Northern Kentucky Tower Fund (P.O. Box 17721, Lakeside Park, Kentucky 41017; SASE appreciated). John, by the way, is reportedly still out approximately $7,000 of his own money; when you write for your copy of the decree, you may want to consider enclosing a donation to help minimize the impact.

Rich Rosen, K2RR
Editor-in-Chief

Amateurs interested in further developments in this and other cases may want to attend the Amateur Radio And The Law Forum conducted by attorney Jim O’Connell, W9WU, at 1 PM on Sunday, April 26, at this year’s Dayton Hamvention.
Ultimate Affordable HT!

TH-205AT
Affordable 5-watt hand-held transceiver. Ultimate Affordability!

It's here now! The affordable, "Kenwood Quality" hand-held transceiver. Standard features include a large, easy-to-read LCD display, wide-range power requirements (operates on 7.2 VDC-16 VDC), 3-channel memory, built-in battery saver circuit, and, when operated on 12 VDC, a robust five watts of power! The die-cast metal rear panel/heat sink assures cool, reliable operation. Receiver frequency coverage from 141-163 MHz is also standard—you can even listen to the "weather channels" at 162.40 or 162.55 MHz!

- Monitor switch—to check frequency when PL encode/decode switch is on.
- Extended frequency coverage for certain MARS and CAP operations.
- 3 memory channels store frequency and offset. And so easy to use! Simply press the memory channel number to recall your favorite channels!
- Night light, offset/reverse.
- 16-key DTMF pad for repeater autopatch is standard.

- NEW! Twist-Lok Positive-Connect battery case. A wide range of quick-change commercial duty battery packs are available.
- 12 VDC input terminal—allows direct mobile or external power supply operation. When 12 VDC is applied, power output increases to 5 watts!
- Heavy-duty final amplifier and heat sink. The die-cast rear panel assures reliable operation. With the optional 12-volt PB-11 battery pack, the TH-205AT provides 5 W output. The standard 8.4 volt PB-2 provides 2.5 W output. (300 mW low power).
- Large, easy-to-read LCD display. Frequency, offset, memory channel, TX, RX, and battery indicator.
- Frequency UP/DOWN keys. Used to select frequency or scanning direction.
- Scan function key.
- Automatic battery saver circuit extends battery life. No buttons to push!
- Supplied accessories include: Rubber flex antenna, belt hook. 8.4 V, 500 mAh NiCd battery pack, wall charger.

Optional Accessories:
1) PB-11 12 V 800 mAh NiCd batt pack (5 W output)
2) PB-2 8.4 V 500 mAH NiCd batt pack (2.5 W output)
3) PB-3 7.2 V 800 mAH NiCd batt pack (1.5 W output)
4) PB-4 7.2 V 1600 mAH NiCd batt pack (1.5 W output)
5) BT-5 AA manganese/alkaline battery case
6) BC-7 Rapid charger for PB-1, 2, 3, or 4
7) BC-8 Compact battery charger
8) SMC-30 Speaker microphone
9) SC-12, SC-13 Soft cases
10) RA-3, RA-5 Telescoping antennas
11) RA-6B StubbyDuk antenna
12) TSU-3 3C TTY encoder/decoder unit
13) VP2-2530 2 m, 25 W RF power booster
14) LB-4 LH-5 Leather cases
15) MJ-4 Mobile bracket
16) BH-5 Swivel mount
17) PG-2 2 V cable
18) PG-3C Filtered cigar lighter cord
VK4ZF did an admirable job, but I believe that certain deficiencies should be pointed out. (The same could probably be done about the program Jerry and I wrote.)

First, the initial input requirement for the number of elements in the antenna is irrelevant. The initial criterion should be the desired gain or the available boom length. (Coincidentally, the irrelevance of the number of elements is covered by Joe Reisert in his column in the same issue [page 103].) Furthermore, in an earlier paper, DL6WU stated that the minimum boom length for an antenna of this type is about two wavelengths; a 2.2-wavelength boom will accommodate eight directors. There is no restriction as to the minimum number of elements in the program.

Second, the diameter of the elements is limited to the discrete values for which data files have been made. This makes it impossible to compare the program results directly with the example antennas described by DL6WU, although the differences are slight.

Third, the program is limited to 40 elements, which makes it impossible to compare the data for directors 39 through 47 of the 1296-MHz antenna described by DL6WU. There does not seem to be any valid reason for this limitation, since DL6WU states that his curves can be extrapolated almost indefinitely.

Fourth, the program limits the boom diameter to 0.05 wavelength, although this can be changed easily by modifying line 490. Without this change, it is impossible to use a boom diameter of 12.7 mm at 1296 MHz, which is the boom size used by DL6WU. Correspondence between DL6WU and KY4Z indicates that a minimum boom diameter of 0.075 wavelength is acceptable.

I have enclosed comparisons of the element lengths and spacings, showing DL6WU’s figures, those obtained from VK4ZF’s program, and those generated by the program written by KY4Z and me. A major discrepancy seems to be the length of the driven element in VK4ZF’s program; it is far too short at 432 MHz, but slightly long at 1296 MHz.

None of the limitations described above exist in the program written by KY4Z and me, although the program does not include calculation of beam widths or stacking distances. Furthermore, it is a great deal easier to keyboard because the 16 data files are not required (which also conserves disk space).

Our program was written in Microsoft BASIC and will run under GWBASIC and BASICA. Minor editing may be required to convert it to other species of BASIC.

The program exists, under the filename DL6WU-1.BAS, on most of the RCPM bulletin boards in the San Francisco Bay Area, including KY4Z’s AMPRO1 at 408-258-8128. I can also supply it in the following forms:

1. A listing, with a sample printout of results, for $1.00 (U.S.) plus a No. 10 (business-size) SASE. (Outside of the United States and Canada, send 10 IRCs.)

2. A 5.25-inch soft-sectored floppy disk for virtually any CPM computer (except Apple) or for any PC/MS-DOS computer. Be certain to specify the disk format desired (and an alternate, if possible) or the version of PC/MS-DOS that is used. The cost in the USA and Canada is $5.00 (U.S.), elsewhere, $7.00 (U.S.); this covers the cost of the disk, mailer, and postage. The same costs apply to either a disk or tape cassette for the Commodore 64.

Please address all requests to me.

Robert S. Stein, W6NBI
1849 Middleton Avenue
Los Altos, California 94022

any ideas?

Dear HR:

A friend installed a plastic owl on his beam to discourage birds. A real owl appeared and attempted to court the plastic owl. When the plastic owl failed to respond, it was attacked by the real owl, causing commotion and damage. Any ideas, anyone?

Berand Kirschner
Oceanside, California 92056
Kenwood Style!

**TM-3530A**
The first comprehensive 220 MHz FM transceiver

*Kenwood style!* Features include built-in 7-digit telephone number memory, auto dialer, direct frequency entry and big LCD. All this makes the TM-3530A the most sophisticated rig on 220 MHz!

- Big multi-color LCD and back-lit controls for excellent visibility
- Frequency lock switch
- Optional front panel programmable 38-tone CTCSS encoder includes 97.4 Hz
- High performance GaAs FET front end receiver

**TH-31BT/31A**
Kenwood's advanced technology brings you a new standard in pocket/handheld transceivers!

- 1 watt high, 150 mW low
- Super compact and lightweight (about 8 oz. with PB-21)
- Frequency range: 220-224.995 MHz in 5-kHz steps
- BT Series has built-in tune
- Repeat offset: -1.6 MHz, reverse, simplex
- Supplied accessories: rubber flex antenna, earphone, wall charger, 180 mAH NiCd battery and wrist strap
- Quick change, locking battery case

- 16-key DTMF pad, with audible monitor
- Center-stop tuning — another Kenwood exclusive!
- New 5-way adjustable mounting system
- Unique offset microphone connector — relieves stress on microphone cord
- Hi/Low power switch (adjustable LOW power)

**TM-3530A optional accessories:**
- TU-7 38-tone CTCSS encoder
- MU-1 DCL modem unit
- VS-1 voice synthesizer
- PG-2N extra DC cable
- PG-3B DC line noise filter
- MB-10 extra mobile bracket
- CD-10 call sign display
- PS-430 DC power supply

**TH-31BT/31A optional accessories:**
- HMC-1 headset with VOX
- SMC-30 speaker microphone
- PB-21 NiCd 180 mAH battery
- PB-21H NiCd 600 mAH battery
- DC-21 DC-DC converter for mobile use
- BT-2 manganese/alkaline battery case
- EB-2 external C manganese/alkaline battery case
- SC-8/8T soft cases with belt hook
- TU-6 programmable sub-tone unit
- AJ-3 thread-loc to BNC female adapter
- BC-6 2-pack quick charger
- BC-2 wall charger for PB-21H
- RA-9A Stubby Duk antenna
- BH-3 belt hook

*Complete service manuals are available for all Trio-Kenwood transceivers and most accessories.*

Specifications and prices are subject to change without notice or obligation.

KENWOOD
TRIO-KENWOOD COMMUNICATIONS
1111 West Walnut Street
Compton, California 90220
two-element hf beams

Tune these medium-sized high performance antennas right from the shack

Physically small beam antennas that represent the least compromise in gain and directivity have been discussed in the literature. Large antennas, for those for whom size is no problem, have received widespread coverage; the W2PV series of articles, for example, includes a wealth of material on large Yagis. Yet the topic of medium-sized antennas — which includes the majority of Amateur beams — remains an area of uncertainty, about which many have sought without success for more information. The quad-versus-Yagi controversy continues unabated; conflicting claims are made for what might appear to be a bewildering variety of different beams, and an imperfect grasp of essentials has turned an inherently simple situation into one of needless complexity, with two-element beams deprived of their rightful status.

how small two-element beams work

In fig. 1, we have a bird's-eye view of two identical vertical elements carrying equal currents and spaced by a small fraction of a wavelength, with the plus and minus signs indicating that they are initially fed in opposite phase, thus tending to cancel each other. At this point it’s not important to know how the currents got there. Energy arriving at a specific point in space travels a different distance from each vertical element. This difference in path length and the opposite polarity of each vertical causes the maximum radiation from the array (two elements) to be along a line that goes through the elements. The two fields combine vectorially as shown in fig. 1B. For small angles, \( \phi_0 \) halving the angle halves the field. As one moves around the antenna, the difference is reduced; therefore the angle reduces, producing the directional pattern shown in fig. 1C, which is independent of spacing as long as the angle remains small. It follows that because energy remains similarly distributed throughout space, signal strengths must also be independent of spacing — provided there are no losses. Usually one introduces an electrical phase shift, \( \phi \). If this is equal to the spatial phase shift, \( \phi_0 \), cancellation takes place in the reverse direction, producing the well-known cardioid pattern of fig. 1D. As the electrical phase shift, \( \phi \), is reduced, the null in the back direction splits into two. It gradually shifts around, with the back lobe increasing in strength until we arrive back at fig. 1C. However, for a given ratio of \( \phi/\phi_0 \), the pattern remains independent of spacing.

In the case of horizontal beams the directional pattern of the individual elements is superimposed on the beam patterns derived in accordance with fig. 1, but the principles are the same. Because no dimensions are mentioned, it follows that for two elements the directive pattern — and therefore the gain — depend only upon the phase shift ratio, \( \phi/\phi_0 \), and are independent of the size, shape, or spacing of elements, provided the dimensions are not excessive. This rule is reasonably accurate for element lengths up to about 0.7\( \lambda \), and as shown in fig. 2, for spacings up to 0.2\( \lambda \). It starts to break down if there are regions of high current that are separated by a substantial fraction of a wavelength, the \( \lambda/4 \) separation between top and bottom of a quad loop not being appreciable in this context. In this case, a directive pattern results through the addition of fields — a completely different mechanism that is the basic principle of large arrays. Figure 2 shows the effect that element spacing has on gain and, from another source, a very similar curve for three elements.

The basic statement emphasizing gain as primarily a function of the phase shift ratio rather than spacing — though it seems physically obvious — is in flat contradiction of widely published figures. These figures, derived mathematically for parasitic arrays, show gain and directivity to be critically dependent upon spacing and whether an element is tuned as a director or reflector. But although the calculations are indeed correct, they happen to be the wrong ones! More accurately stated, perhaps it’s the designs to which they relate that are faulty, since I have assumed equal currents, whereas normally performance is sacrificed if the elements are straight. As can be inferred from fig. 3, this is the worst possible shape because it minimizes coupling, consequently precluding the possibility of the presence of equal currents, except with very close

Les Moxon, G6XN, Gorse Hill, Tilford Road, Hindhead GU26 6SJ Surrey, England
Nulls in the directional pattern are filled in and gain is also adversely affected. Coupling between straight elements can be increased by moving them closer together. But for this to be effective, spacing has to be reduced to about 0.05X, which is normally regarded as unacceptable because of reduction in bandwidth and efficiency. For this spacing, my calculations and those of W2PV are in close agreement. In my case, however, due to the assumption of equal current amplitudes, dependence on physical dimensions has been eliminated.

Inductive coupling (fig. 3A) isn’t advised because of the reduction in radiation resistance. More often, natural coupling tends to be capacitive and needs only to be supplemented. One advantage of the quad is that loops couple more tightly than straight dipoles; this probably accounts for its popularity despite a poor reputation for survival in high winds. On the other hand, bent elements (see figs. 3B and 3C) lend themselves to the design of more compact but equally efficient antennas with overcoupling rather than undercoupling as the more common fault. This is easy to correct either by an alteration of spacing or, if necessary, neutralization, as shown in fig. 3C.

mutual impedance

From the narrowing of the radiation pattern, it is evident that there must be gain relative to a dipole. But how, one might ask, can this be if the elements are tending to cancel each other? The answer lies in the fact that the element currents rise to whatever value may be necessary to account for the observed gain, and they can do so only by virtue of the mutual resistance between the elements which subtracts from the self-resistances when closely spaced elements are excited in antiphase. Without mutual resistance, there can be no power gain; these quantities are inseparable, so that given equal currents, one follows from the other. On the other hand, mutual resistance alone cannot achieve the degree of current equality necessary for obtaining deep nulls. This requires mutual reactance, which exists in most cases but may need to be increased or decreased, with reflector operation requiring negative reactance. Mutual resistance, \( R_m \), and reactance, \( X_m \), data appears to be available only for straight \( \lambda/2 \) elements (fig. 4), but the “size rule” implies that mutual resistance bears a constant relationship to the single-element radiation resistance (R), and so the mutual resistance can, if necessary, be inferred from it. Likewise, if the elements are self-resonant, mutual reactance can in principle be determined from

spacing (0.05\( \lambda \)). Nulls in the directional pattern are filled in and gain is also adversely affected.

Coupling between straight elements can be increased by moving them closer together. But for this to be effective, spacing has to be reduced to about 0.05\( \lambda \), which is normally regarded as unacceptable because of reduction in bandwidth and efficiency. For this spacing, my calculations and those of W2PV are in close agreement. In my case, however, due to the assumption of equal current amplitudes, dependence on physical dimensions has been eliminated.

Inductive coupling (fig. 3A) isn’t advised because of the reduction in radiation resistance. More often, natural coupling tends to be capacitive and needs only to be supplemented. One advantage of the quad is that loops couple more tightly than straight dipoles; this

---

**fig. 1.** (A) Two closely-spaced sources separated by distance “S.” (B) Vector addition results in voltage \( V \) that for small angles is proportional to \( \phi_0 \). (C) Polar plot shows variation of field voltage as a function angle to observer. No additional (electrical) phase shift has been introduced — i.e., \( \phi = 0 \). (D) Field pattern if electrical phase shift, \( \phi \) equals physical phase shift (\( \phi_0 \)).

---

**fig. 2.** Decrease of gain with increase of spacing. Note that gain is a minimum for both two- and three-element beams as spacing diminishes though practical constraint impose a lower limit of about 0.1\( \lambda \).
directions of minimum response by obtaining corresponding values of $\phi / \phi_0$ from fig. 5, since with no detuning the phase shift $\phi$ is determined solely by the phase angle of the mutual impedance — i.e. by $X_m / R_m$ so that by knowing $\phi, \phi_0$, and $R_m$ we can evaluate $X_m$. This method has not been evaluated in practice and its use is restricted by the fact that with large departures of $X_m$ from its optimum value the nulls will not be deep enough for their direction to be determined. In general, however, with two elements there should be no need to know the actual value of $X_m$ since constructions are available which allow it to be adjusted by trial and error. Additionally, by virtue of the “size rule” calculations or measurements for a set of dimensions for which $X_m$ is known can be applied to any other, with due allowances for differences in $R$. Calculations, simplified by assuming equal currents, have led to further results:

- Radiation resistance ($R_B$) for a parasitic array is given by
  \[ R_B = 2 \left( R - R_M \cos \phi \right) \]
- For an array in which each element has its own feed-line, the radiation resistances are:
  \[ R \text{ director} = R - R_M \cos \phi + X_M \sin \phi \]
  \[ R \text{ reflector} = R - R_M \cos \phi - X_M \sin \phi \]

With a resonant reflector and equal currents, the null directions are approximately 130 degrees relative to the beam heading in all cases. The total resistance is the same as before, but that of the reflector (or director if $X_M$ is positive) can be zero or even negative, which bodes ill for the matching process. Until now, driven operation has been the usual method of trying to equalize currents, but the reason for some failures may now be apparent, particularly because the usual phasing lines must be matched for correct operation. Solutions to this problem have been discussed before. Driven operation remains a possible solution to the problem of obtaining equal currents with straight elements, and a number of such antennas have been described. Most of these, intended to be reversible, specify $\lambda/4$ spacing, which is too wide, or $\lambda/8$ spacing, which is convenient and simplifies the mathematics to the extent that $X_M$ disappears. Unfortunately, because of mutual reactances of opposite sign, which each element induces into the other, a very high VSWR exists in each of the individual feeders. This high VSWR may not be noticed because it doesn’t appear in the common feed from the transmitter; if it were corrected, the beam couldn’t be reversed because the correction would then be of the wrong sign and make matters worse. Open wire lines can be used, but result in excessively narrow bandwidth (though I’ve overcome this by using folded dipole elements).

Overcoupling is a problem likely to be experienced in the case of quads with less than 0.15 $\lambda$ spacing. The “Swiss Quad” (with 0.1 $\lambda$ spacing) gets around this by driven operation, but as we’ll discuss later, there are many advantages to be derived from resonant feeders, including the possibility of increasing coupling or neutralizing excess coupling by means of capacitance between the lines. Figure 5 shows the dependence of gain, radiation resistance, and null directions on the phase shift ratio. If any one of these quantities is known, all the others except radiation resistance ($R_B$)

---

**fig. 3.** Inductive and capacitive coupling of two elements. (A) Elements bent inwards at their centers couple inductively. (B, C) Ends bent inwards couple capacitively. (D) Excessive coupling may be neutralized by capacitors as shown in (C). In (D), the two couplings cancel each other if $S = \lambda/8$, leaving only the resistive coupling, $R$. Straight elements minimize coupling.
to know the value for a single element \((R)\); with a few exceptions, this can be obtained from fig. 6. The method of calculation is explained in reference 5. Figure 7 is a further extension of fig. 5 showing the direction and magnitude of the back lobes in the radiation pattern. They demonstrate the crucial importance of the ratio \(\phi/\phi_0\) in determining all aspects of the performance of two-element beams (including bandwidth, since this is linked to radiation resistance, as discussed later).

directivity gain

So far we've assumed that there are no losses. Apart from feeder loss, other losses may occur because of proximity to nearby structures, use of very thin wire, or as the limiting factor when trying to make an antenna as small as possible. Besides radiation pattern distortion, currents induced in booms or supporting structures due to lack of symmetry may introduce additional losses. If equal currents and correct phasing are maintained, losses as such have no effect on directivity which, because of high external noise levels, is usually the sole requirement in the case of reception on the hf bands.

Losses can make it impossible to equalize currents by means of increased coupling, but there is then no longer any problem with driven operation since the mutual resistance, as a result of these losses, is no longer in control of the situation. Because of this, it's customary to distinguish between directivity gain and power gain, the two being equal when there are no losses.

---

fig. 4. Mutual resistance \(R_m\) and mutual reactance \(X_m\) as a function of spacing for two-element beams.

fig. 5. Relationship between phase angle, gain, null directions, and radiation resistance for all close-spaced, two-element beams with equal current drive. Note: losses not included; gain figures valid within 0.3 dB for null depths > 10 dB (approx.). Radiation resistance (in ohms) for half-wave elements spaced \(\lambda/8\) (see text for other beams).
Horizontal monoband hf beam losses rarely exceed a few ohms, and with radiation resistances of a few tens of ohms, can usually be neglected. In doubtful cases they can be roughly estimated from conductor sizes, assuming one has some idea of the current distribution.

Resistance data in graph form can be found in textbooks, but a handy figure to remember is one ohm per half-wavelength for 3-mm diameter copper wire (approximately No.10 AWG) at 14 MHz. The loss is inversely proportional to diameter and to the square root of frequency. However, divide by 2 for long conductors that have a sine wave current distribution, such as antenna wires or resonant feeders. This gives the resistance referred to a point of maximum current, which is standard practice also in the case of the radiation resistance with which it must be compared. For parallel wires, divide by the number of wires; for aluminum alloy, multiply by 1.6, and don’t use iron or steel!

Bandwidth

Bandwidth is roughly proportional to radiation resistance but also varies inversely with the length of the resonant system (which includes the antenna up to the point of matching). We are interested in two kinds of bandwidth:

- **SWR bandwidth** — i.e., the frequency range over which the SWR is less than 2.0. As might be expected by analogy with coupled circuits, bandwidth in this sense is improved by tighter coupling between elements. The better the SWR bandwidth, the less frequently the antenna tuner has to be readjusted, or the better the chance of being able to dispense with it. In general, SWR tends to rise steeply at the low frequency end of the tuning range, since tuning low is equivalent to tuning the reflector higher. This reduces φ, causing a shift to the left on the curves shown in fig. 5, with Rb dropping to a relatively low value.

- **Pattern bandwidth**, or the frequency range in which a specified null depth such as 10 dB is exceeded or the forward gain remains within 1 dB of maximum. Despite their relatively small size the antennas to be described here come close to meeting the above specifications on most bands without retuning the reflector. This is consistent with a reasonable degree of operating convenience, but to take advantage of very deep nulls it’s essential for the reflector to be connected through its own feeder to a tuning device at the operating position. In this case, pattern bandwidth is less important but makes for added convenience. Use of two feeders provides an additional bonus: the ability to reverse beam direction.

Design of elements

Although elements don’t have to be identical, it usually helps — and is essential if one wants to be able to reverse beam direction without having to retune. Figure 6 shows that half-wave elements can be reduced by 30 percent in length for only a trivial reduction (17 percent) in radiation resistance, provided capacitive end-loading (or its equivalent) is used. Figure 8 shows three practical ways of achieving this. In the case of fig. 8C, AB and CD act solely as end
MFJ TUNERS

This may be the world’s most popular 3 KW roller Inductor Tuner because it’s small, compact, reliable, matches virtually everything and gives you SWR/Wattmeter, antenna switch, dummy load and balun—all at a great price!

Meet "Versa Tuner V". It has all the features you asked for, including the new smaller size to match new smaller rigs-only 10½"Wx4½"Hx14½"D.

Matches coax, balanced lines, random wires—1.8 to 30 MHz. 3 KW PEP—the power rating you won’t outgrow (250W-6KV caps).

Roller Inductor with a 3-digit turns counter plus a spinner knob for precise inductance control to get that SWR down to minimum every time.

Built-in 300 watt, 50 ohm dummy load, built-in 4:1 torritte balun.

MCJ989B $349.95

MFJ’s Fastest Selling TUNER

MFJ-941D $99.95


New antenna switch! Front panel mounted. Select 2 coax lines, direct or through tuner, random wire/balanced line or tuner bypass for dummy load.

New airwound inductor! Larger more efficient 12 position airwound inductor gives lower losses and more watts out. Run up to 300 RF power output.

Matches everything from 1.8 to 30 MHz! dipoles, inverted vee, random wire, verticals, mobile, mobile whips, beams, balanced and coax lines.

Built-in 4:1 balun for balanced lines. 1000 V capacitor spacing. Black. 11 x 3 x 7 inches. Works with all solid state or tube rigs. Easy to use anywhere.

MFJ’s 1.5 KW VERSA TUNER III

MFJ-9628 $229.95

Run up to 1.5 kw PEP and match any feedline continuously from 1.8 to 30 MHz: coax, balanced line or random wire.

Lighted Cross-needle Meter reads SWR, forward and reflected power in one glance. Has 300 and 3,000 watt ranges. 6 position antenna switch handles 2 coax lines, wire and balanced lines. 4:1 balun. 250 pf, 6 kw variable capacitors. 12 position composite switch.

New smaller size matches new rigs: 10½ x 4½ x 14½ inches. Flip stand for easy viewing. Requires 12V for light.

ORDER ANY PRODUCT FROM MFJ AND TRY IT—NO OBLIGATION. IF NOT SATISFIED, RETURN WITHIN 30 DAYS FOR PROMPT REFUND (less shipping).

• One year unconditional guarantee • Made in USA • Add $5.00 each shipping/handling • Call or write for free catalog, over 100 products.

TO ORDER OR FOR YOUR NEAREST DEALER, CALL TOLL-FREE 800-647-1800

MFJ ENTERPRISES, INC.
Box 494, Mississippi State, MS 39762

Visa

May 1987

More Details? CHECK—OFF Page 130
loading because radiation from them is cancelled by that from \( AE \) and \( DE \).

Most of the designs to be described are based on the small delta loop (fig. 8C), which can be suspended between the tips of fiberglass fishing rods angled upwards, thus achieving an effective height considerably in excess of the mast height, since there’s little or no radiation from the sides of the loop. In this form it has become known as “The Claw” for reasons obvious from the photograph (fig. 15). In most cases there seems to be little point in exceeding an element span of about 35 percent of the longest wavelength to be used; further size reduction is governed by three main constraints: bandwidth, losses, and difficulty of folding enough loading wire into the space available. For a reasonable approximation to “full size” performance, the above length can be more than halved if some form of remote tuning is provided. Practical difficulties escalate rapidly as the span length drops below 0.25\( \lambda \).

The arrangement shown in fig. 8D can be erected as an inverted V and is important as an alternative option though the sinusoidal current distribution halves the radiation resistance for a given span.

**coupling and null depth**

All four arrangements shown in fig. 8 provide increased coupling. In cases A and D, this is readily adjustable by altering the spacing between ends; 30 inches for a span of 20 to 24 feet at 14 MHz has been found suitable, but some experiments may be advisable. Adjustment of coupling isn’t critical. I’ve found that “design by guesswork” frequently produces null depths in excess of 20 dB. It’s best for errors to be corrected in the antenna itself, but for fine tuning, placing capacitors between convenient points on feeders has been found satisfactory. These can be connected either in phase to increase coupling or out of phase to neutralize excessive coupling. I then find it possible to get null depths usually in excess of 20 dB, and often much greater, for all back directions and in-band (14 MHz) frequencies with single-knob tuning of

---

**fig. 8.** Two-element horizontal beams with reduced length and enhanced coupling. Reflector should preferably be a duplicate of the driven element (see text). Otherwise, if currents equal (i.e. if deep nulls are obtainable), tune reflector to the low edge of desired band. (A) Bent dipole elements (20 x 10 feet suggested, though dimensions are not critical) xy (nylon fishing line) = 30 inches. (B) End-loading by vertical rods. Single elements have been used successfully with the dimensions shown. Coupling may need augmenting. (C) Small delta loops (ABCD) should be just over \( \lambda/2 \). Size can be reduced by small loading stubs. BB’ may be 0.12-0.2\( \lambda \); EF < BB’/2. (D) Erect between posts or as inverted V. Spreader (or boom) may be 9-12 feet for 14 MHz.
HF Superiority!

**TS-930S All band transceiver with general coverage receiver**

Throughout the contest and DX world, the TS-930S is recognized as THE HF rig to own—with the most outstanding performance per dollar ratio!

- Easily modified for HF MARS and CAP operation
- IF notch filter
- Excellent receiver dynamic range
- All solid state, 28 volt final amplifier for lowest inter-modulation distortion
- Power input rated at 250 watts on SSB, CW, FSK, and 80 watts on AM
- Full break-in or semi-break-in CW
- Dual mode noise blanker ("pulse" or "woodpecker") with threshold control
- Eight memory channels
- RF speech processor
- High stability, dual digital VFOs
- AC power supply built in
- Fluorescent tube digital display
- One year limited warranty on parts and labor
- A complete line of accessories is available

**TS-430S Compact all band transceiver with general coverage receiver**

Kenwood engineering brings you "Digital DXterity"—QSY from band to band, mode-to-mode, and frequency-to-frequency with ease!

- Easily modified for MARS operation
- Superb interference reduction
- Programmable scanning
- 8 memories store mode, frequency, band. Each channel may be used as a separate VFO
- Superior solid state design
- VOX, semi-break-in CW with sidetone
- Dual digital VFOs
- A complete line of accessories is available

Complete service manuals are available for all Trio-Kenwood transceivers and most accessories. Specifications and prices are subject to change without notice or obligation.
EIMAC's new DX champion! The 3CX800A7.

Varian EIMAC continues to commit its development of reliable tubes for HAM radio.

The new, rugged 3CX800A7 power triode provides 2 kW PEP input for voice service or 1 kW cw rating up to 30 MHz. Two tubes will meet the new, higher power ratings authorized by the FCC.

Designed for today's low profile, compact linear amplifiers, the 3CX800A7 powerhouse is only 2½ inches (6.35 cm) high. Cooling requirements are modest and a matching socket, air chimney and anode clamp are available.

A data sheet and more information is available from Varian EIMAC. Or the nearest Electron Device Group sales office. Call or write today.

Varian EIMAC
301 Industrial Way
San Carlos, California 94070
Telephone: 415-592-1221
the reflector. "Deepest possible" nulls aren't thought to be worth additional effort, given the unstable nature of the ionosphere and sensitivity to local field disturbances — for example, trees blowing in the wind, the presence of other antennas, even aircraft reflections. Up to 30 dB can be useful, but deeper nulls require precise adjustments of phase and amplitude (two knobs). By the time these adjustments are made, the interference one is trying to remove has probably disappeared anyway! With deep nulls a tendency has been observed for non-reciprocity between transmission and reception, due probably to pickup on wiring in the shack. If a linear is used, this won't be identical for the two cases.

fig. 9. Reflector tuning of "Claw" antenna: (A) Long feedline; (B) short feedline; (C) resonant feedline. This method, especially as illustrated in (B), is convenient, since point B is more likely to be accessible. Total L = 3.5 \mu H. Terminations can be band-switched, but often cover two or three bands.

fig. 10. Application of enhanced coupling to conventional beams. (A) monobander — coupling wires (w) suggested as alternatives to bending the elements. (B) Beam with traps. (C) is similar to A, except in that the reflector is tuned via the feeder.
Expanding Our Horizons

Introducing

Mirage/KLM 1.2–44 LBX

The first 1240 MHz to 1300 MHz
Made in the U.S.A.

- Factory Tested
- Completely Assembled
- Completely Weatherized Balun
- Also Available Soon...
  Power Dividers

SPECIFICATIONS

Electrical
- Band Width .................. 1240–1300 MHz
- Gain .................. 18.2
- VSWR .................. Better than 1.5 to 1
- Feed Imp. .................. 50 Ohms
- Balun .................. 4:1 Rigid Coax

Mechanical
- Beam Length .................. 12' 4"
- Element Length .................. 4.5"
- Mast .................. 2" O.D.
- Windload .................. 1 sq. ft.

Mirage Communications Equipment, Inc.
P.O. Box 1000
Morgan Hill, CA 95037
(408) 779-7363
reflections from other antennas

These reflections can be large enough to seriously degrade forward gain at distances of over 30 meters at 14 MHz. (In one case I observed a loss of 2 S-units due to screening by another antenna at about 25 meters.) Their effect on front/back ratio is much greater. From mutual resistance data, it appears that another antenna 7 wavelengths away might be expected to degrade a 30-dB null by about 6 dB. Such effects depend, of course, on the extent to which the interfering antenna is in the beam path, so the effective radiation pattern varies with beam heading. The interfering antenna may be “removed” by detuning or rotating it to an end-on position, but any front/back ratio it may possess applies only to its own input terminals and does nothing to help. Unless such effects can be eliminated, the possibility for serious errors remains. This further emphasizes the importance of being able to make adjustments at the operating position to suit the needs of the moment. However good its f/b ratio, a large Yagi will still be wide open to reflected signals from other antennas in its beam path.

reflector tuners and t/r switching

Separate optimization of transmitting and receiving characteristics by switching between two different reflector tuners is a further important option. Tuning of the reflector to null out an interfering station can have a large effect on the SWR unless the antenna tuner is readjusted. Using an FS710H automatic inline SWR meter, I haven’t found this to be a problem, but without such a device and with modern solid-state amplifiers it can be an embarrassment. Because transmitting and receiving requirements aren’t identical, it makes sense, in any case, to use separate tuners switched by a relay, not forgetting to use the “trans-
ATV MADE EASY WITH OUR SMALL ALL IN ONE BOX TC70-1 TRANSCEIVER AT A SUPER LOW $299 DELIVERED PRICE!

CALL 1-818-447-4565 AND YOURS WILL BE ON ITS WAY IN 24 HRS (VIA UPS SURFACE IN CONT. USA).

TC70-1 FEATURES:
* Sensitive UHF GaAsfet tuneable downconverter for receiving
* Two frequency 1 watt p.e.p. transmitter. 1 crystal included
* Crystal locked 4.5 mHz broadcast standard sound subcarrier
* 10 pin VHS color camera and RCA phono jack video inputs
* PTL (push to look) T/R switching
* Transmit video monitor outputs to camera and phono jack
* Small attractive shielded cabinet - 7 x 7 x 2.5”
* Requires 13.8vdc @ 500 ma. + color camera current

Just plug in your camera or VCR composite video and audio, 70cm antenna, 12 to 14 vdc, and you are ready to transmit live action color or black and white pictures and sound to other amateurs. Sensitive downconverter tunes whole 420-450 mHz band down to channel 3. Specify 439.25, 434.0, or 426.25 mHz transmit frequency. Extra transmit crystal add $15.

Transmitting equipment sold only to licensed radio amateurs verified in the Callbook for legal purposes. If recently licensed or upgraded, send copy of license. Receiving downconverters available to all starting at $59 (TCV-2G).

WHAT ELSE DOES IT TAKE TO GET ON ATV?
Any Tech class or higher amateur can get on ATV. If you have a camera you used with a VCR or SSTV & a TV set, your cost will just be the TC70 and antenna system. If you are working the AMSAT satellites you can use the same 70 cm antennae on ATV.

DX with TC70-1s and KLM 440-27 antennas line of sight and snow free is about 22 miles, 7 miles with the 440-6 normally used for portable uses like parades, races, search & rescue, damage assessment, etc. Get 50 watts p.e.p. with the Mirage D24N or D1010N-ATV amp for greater DX or punching thru obstacles.

The TC70-1 has full bandwidth for color, sound, like broadcast. You can show the shack, home video tapes, computer programs, repeat SSTV, weather radar, or even Space Shuttle video if you have a home satellite receiver. See the ARRL Handbook chapt. 20 & 7 for more info & Repete Directory for local ATV repeaters.

PURCHASE AN AMP WITH THE TC70-1 & SAVE!
50 WATT WITH D24N-ATV....$499
All prices include UPS surface shipping in cont. USA

COMPLETE ATV STATION

HAMS! Call or write for full line ATV catalog....downconverters start at only $59

P.C. ELECTRONICS 2522 S. PAXSON LN. ARCADIA CA 91006 (818) 447-4565
TOM W6ORG  MARYANN WB6YSS
Compuserve 72405,1207

AMATEUR TELEVISION

ATV Transceiver
Astron RS20M...$129
13.8 vdc 20A Power Supply

Mirage D24N.....$219
(optional) all mode 70cm amp 13.8vdc 9 amps @ 50 watts RF

KLM 440-27 14dbd $107
KLM 440-14 11dbd $77
KLM 440-6 8dbd $52

CQ ATV
TV SET
TV CAMERA

May 1987
mit” (tuner) condition when checking for prior channel occupancy. While any feeder length can be used, it simplifies matters to choose one that allows series tuning as shown in fig. 9, preferably as shown in fig. 9B, which increases the chance that points such as xx, where the rf voltage is suitable for coupling adjustment, will still be available in the shack if required.

With feeder impedances of both 50 and 600 ohms at 14 MHz, I have found a capacitance (C) of 40 to 250 pF and an inductance (L) of 3 to 4 μH to be suitable, but this would depend on feeder length. The trick is to pick a likely-looking capacitor out of the junk box and, with a grid dip oscillator, find an inductance that allows the reflector to be tuned through the band and down to about 2 percent lower.

**beam reversal**

This reduces the average time required for changing beam heading since rotation can be limited to about 140 degrees. Also, in many cases an Armstrong method of rotation can be employed, with two ropes substituted for the usual heavy, expensive, and sometimes unreliable beam rotator. It can be particularly useful in multi-way contacts, and if there’s uncertainty about whether propagation is short or long path. It also provides confirmation that the antenna is working correctly. Figure 10 includes suggestions for the addition of controlled coupling to conventional beams which, though as yet untried, may be useful to experimenters. In (A) and (C), it may be easier to pull the ends in toward each other with nylon fishing line. To permit beam reversal and null-steering, the reflector must be replaced by a replica of the driven element.

**comparison between two and three elements**

Two-element beams can be expected to produce deeper and more controllable nulls, but this may not help if more than one interference source is present. In this respect, three-element beams are superior, assuming fixed tuning of the reflector in both cases. With two elements, a rejection ratio better than 18 dB can be obtained for all back angles if the nulls are placed at 150 degrees to the beam heading; this is for a spot frequency, but can be obtained throughout the band if reflector tuning is synchronized with the main tuning. With three elements, W2PV² found null depths in excess of 20 dB over 2 percent bandwidth in the best case, but this was only for the 180 degree direction. It has also been shown that three elements can provide rejection in excess of 28 dB at all back angles simultaneously on a spot frequency.⁴ From tuning data given in this reference, I estimate a minimum rejection of around 18 to 20 dB over a 2 percent band, which is little better than the two-element result and requires very precise adjustment of the kind difficult to obtain in practice because one is working with too many variables. The two-element beam, moreover, provides the option of deeper nulls in specific directions, though the rejection of QRM from several sources simultaneously may then be adversely affected. In practice, not more than 1 to 1-1/2 dB extra gain can be expected from the third element, and in terms of the low-angle radiation required for chordal-hop propagation (which is probably responsible for most long-haul DX⁵), this is equivalent to an antenna height increase of only 15 to 20 percent. The small size, light weight, and construction of antennas described in the next section should, in many cases, lead to height increases of this order. It is not suggested that these small beams can compete with a six-element monobander on a 100-foot tower, but they can hold their own in more ordinary circumstances, requiring only a modest means of support, indifferent results quoted by earlier authors being attributable entirely to the assumption of straight elements and the resulting current inequalities. Much of this ground has been covered in earlier publications; a complete bibliography can be found in reference 5.

**multiband beams**

Multiband beams have previously consisted mainly of tribanders involving some degree of compromise. Instead of using the whole of a 14-MHz λ/2 element on 28 MHz, it is cut down to size by traps, or 28-MHz loops are stacked inside 14-MHz loops which could be used to provide extra gain on 28 MHz. This sacrifices 2 to 4 dB of gain at 28 MHz¹, as well as incurring losses due to circulating currents in traps or “wrong way” currents induced in unused elements, which can reduce bandwidth and affect coupling.

Trapped beams rate highly in terms of convenience as well as off-the-shelf availability, and their popularity could no doubt be further enhanced by design improvements — for example, along lines suggested by W0JF.¹¹ At the same time, the fact that now we have, within 1-1/2 octaves, six bands instead of three, presents an exciting challenge unlikely to be met by traps or stacking without further compromises. The log periodic antenna, though simple in use, is large, heavy, expensive, and inferior in performance to a Yagi of the same size.

**the “poor man’s log periodic” (PMLP)**

When short of new ideas, it often helps to take a fresh look at old ones, which is what I’ve been doing in the case of resonant feeders. Though these have been blamed for TVI, radiation from balanced lines is very small, and they’ve consequently also been recommended as cures for TVI. It’s true that they can get themselves twisted around the mast or entangled in guy ropes, but there’s no excuse for this if beams are
reversible as previously recommended, since rotation can then be restricted to less than 180 degrees. A more serious objection is the restriction of bandwidth. But with remote tuning, this becomes an inconvenience rather than a basic limitation. Now, through a fortunate accident, a solution to the bandwidth problem has also emerged and with it a family of small, lightweight antennas that provide the performance and other characteristics of the antennas described earlier, yet are tunable over the frequency range from 10 to 30 MHz. This largely achieves the object of the log periodic antenna, though the principle at work is entirely different.

the ideal antenna?

To establish the respectability of resonant feeders and provide a useful perspective, the design of a “best possible” multiband beam will be attempted.

Consider three identical straight tubing elements 44 feet long, spaced 8 feet apart, fed with about 46 feet of open wire line, and tuned to 14 MHz. The radiation resistance of a single element is 150 ohms and the bandwidth of antenna plus feeder for an SWR of 2:1 is about 8 percent, differing only slightly from that of a normal half-wave element. This should provide gain and f/b ratio in line with the previous three-element example. The larger value of radiation resistance, however, makes it much easier to use resonant feeders for remote tuning and beam reversal; even if this is not required, it helps to ensure reasonable bandwidth. The main benefit occurs at other frequencies, since on 28 MHz the elements are “extended double Zepp,” which was the reason for the choice of length. The boom length is nearly optimum, bringing the total gain to about 10.5 dBi. The spacing is too wide for good f/b ratio on 28 MHz, but this could be improved by additional coupling. On 10 MHz, omitting the center element provides for satisfactory spacing and achievable gain is in accordance with numbers indicated in fig. 5. Losses are negligible. The lower end of the feeders is assumed to be accessible near the antenna and can be lengthened or matched into, if necessary, utilizing band switching, depending either on local requirements or bandwidth considerations. With two elements, the boom length would have to be reduced, with 0.1λ the minimum acceptable length at 10 MHz. The gain at 28 MHz is reduced to 7 dB, but remains high for two elements. For comparison, the gain of a log periodic will be in the region of 6 dBi, assuming a boom length of 50 feet, making the PMLP far superior except for the inconvenience of having to tune it. This can be done in the shack if the feeders aren’t too long. Nevertheless even the PMLP in this ideal form is in the “monster” class, and much effort has been devoted to applying the same principles to smaller antennas.

the small delta loop

The antenna shown in fig. 8C, a fixed pair of loops supported by a tree, was selected for this purpose after being used initially as the quickest and easiest way of getting back on the air from a new location. Though it wasn’t possible to make a direct comparison, the performance of a full-size quad — in the same tree at the same height — was later judged to be about the same. The first multiband version of this antenna, shown in fig. 11, was used initially without the switched stubs, with correct coupling established by capacitance between the corner stubs (which also provided a small amount of loading) and by bringing the lower corners in towards the mast. The electrical lengths from top center to a shorting bar at ground level were arranged to be λ on 14 MHz, 1-1/2λ on 21 MHz, and 2λ on 28 MHz, providing for 600-ohm feed-line matching as well. Current nulls in the center of the sides on 14 MHz ensured that all the radiation was from the top of the system, while at higher frequencies the loops radiated as ordinary loops, with effective spacing reduced by bringing the lower corners together. The matched lines (120 feet) were taken respectively to an antenna tuner and a series-tuned circuit for reflector tuning via a beam-reversing switch which interchanged the feeders in the shack. The elements were supported by four 8-foot bamboo garden canes radiating outwards and upwards from an aluminum hub with four 4-foot spokes, for a total radial length of 12 feet. The SWR bandwidth for given settings of the antenna tuner and reflector tuning at 14 MHz was only 100 kHz which generated a tendency to stay in one part of the band. Differences in tuning between wet and dry weather were a nuisance. These were aggravated by short lengths of 300-ohm line initially used for bypassing the rotating joint. Checking the feasibility of operation on 10 MHz was difficult because it required the attachment of matching stubs at half the mast height, but it was achieved on one occasion, which resulted in an S8 report from VK with reasonable f/b ratio.

Despite the narrow bandwidth, such an arrangement may well be acceptable on the grounds that it is simple, cheap, versatile, and efficient, especially if the shack is located at the base of the mast. For me, however, it has one fatal flaw: the difficulty of living with the knowledge that identical performance could be obtained from a smaller antenna! To improve bandwidth on 14 MHz, the stubs were moved a half wavelength closer to the loops, with relays to disconnect them as shown in figs. 11 and 12. This enabled tuning for the 21- and 28-MHz band, where the radiation resistance is much higher, to be carried out at ground level as before.

The small delta loop is mechanically superior to a
Wide Dynamic Range and Low Distortion – The Key to Superior HF Data Communications

- Dynamic Range > 75 dB
- 400 to 4000 Hz
- BW Matched to Baud Rate
- BER < 1 x 10^-5 for S/N = 0 dB
- 10 to 1200 Baud
- Linear Phase Filters

ST-8000 HF Modem

Real HF radio teleprinter signals exhibit heavy fading and distortion, requirements that cannot be measured by standard constant amplitude BER and distortion test procedures. In designing the ST-8000, HAL has gone the extra step beyond traditional test and design. Our noise floor is at -65 dBm, not at -30 dBm as on other units, an extra 35 dB gain margin to handle fading. Filters in the ST-8000 are all of linear-phase design to give minimum pulse distortion, not sharp-skirted filters with high phase distortion. All signal processing is done at the input tone frequency; heterodyning is NOT used. This avoids distortion due to frequency conversion or introduced by abnormally high or low filter Q's. Bandwidths of the input, Mark/Space channels, and post-detection filters are all computed and set for the baud rate you select, from 10 to 1200 baud. Other standard features of the ST-8000 include:

- 8 Programmable Memories
- Set frequencies in 1 Hz steps
- Adjustable Print Squelch
- Phase-continuous TX/Tones
- Split or Transceive TX/RX
- CRT Tuning Indicator
- RS-232C, MIL-188C, or TTL Data
- 8, 600, or 10k Audio Input
- Signal Regeneration
- Variable Threshold Diversity
- RS-232 Remote Control I/O
- 100-130/200-250 VAC, 44-440 Hz
- AM or FM Signal Processing
- 32 steps of M/S filter BW
- Mark or Space-Only Detection
- Digital Multipath Correction
- FDX or HDX with Echo
- Spectra-Tune and X-Y Display
- Transmitter PIT Relay
- 8 or 600 Ohm Audio Output
- Code and Speed Conversion
- Signal Amplitude Squelch
- Receive Clock Recovery
- 3.5" High Rack Mounting

Write or call for complete ST-8000 specifications.

HAL Communications Corp.
Government Products Division
Post Office Box 365
Urbana, Illinois 61801
(217) 367-7373  TWX 910-245-0784

Dayton Booth 231 & 232
THE STANDARDS OF EXCELLENCE

SUPERIOR WEAK SIGNAL PERFORMANCE COMMERCIAL MODEM

COMPARE with ANY unit at ANY Price

Now Available With PACKET RADIO

THE WORLD OF VHF/HF PACKET*, CW, RTTY, ASCII AND NEW DUAL AMTOR** IS AS CLOSE AS YOUR FINGERTIPS WITH THE BRILLIANTLY INNOVATIVE STATE-OF-THE-ART MICRO-COMPUTER CONTROLLED EXL-5000E.

SPECIAL SALE $795

SHOWN WITH OPTIONAL KANTRONICS KPC2400 AND MJF-1270 TNC-2

Everything built in — nothing else to buy!

EXCLUSIVE DISTRIBUTOR DEALER INQUIRIES INVITED FOR YOUR NEAREST DEALER OR TO ORDER AMATEUR-WHOLESALE ELECTRONICS TOLL FREE...800-327-3102 46 Greensboro Highway, Watkinsville, Georgia 30677 Telephone (404) 769-8706 Telex: 4930709 ITT

MANUFACTURER:
TONO CORPORATION
98 Motosoja Machi, Maebashi-Shi, 371, Japan

*PLEASE CALL FOR DETAILS

**Dual Amtor: Commercial quality, the EXL 5000E incorporates two completely separate modems to fully support the amateur Amtor codes and all of the CCIR recommendations 476-2 for commercial requirements.

Specifications Subject to Change.

---

MR. NICAD

REPLACEMENT BATTERIES FOR COMMUNICATIONS

Nickel Cadmium, Alkaline, Lithium, etc.
ICOM - BP-3 Repack - $15.00
BP-2, BP-5, BP-8 Repacks.
NEW HOT ROD PACKS FOR ICOM 2A, 2AT, 20AT, 6 CELL 10v - 500 MAH, 10 CELL 12.5v - 500 MAH......$49.95 ea.

York, Kenwood, Santec, Azden, Tempco, Standard, Cordless Phone etc.

MR. NICAD
E.H. "TOST" & CO.

EVERETT H. "TOST" KBOX1
SAUK CITY, WI 53583
(608) 643-3194

Send for NICAD battery price list.

---

Generate Your Own Electricity

Hundreds of satisfied owners are now using the WINDSTREAM® WIND GENERATOR to provide power for RVs, weekend campers, 24hr workshops, remote locations, emergency - up power and much more.

Portable - weighs only 20 lbs - easily installed with our comprehensive installation manual - minimum maintenance - full warranty.

Thermox Corporation HM 3
One Mill St., Burlington, VT 05401 802-658-1098

---

CREATE
Creative Design Co., Ltd.

ROOF TOWERS! A size to fit your needs
6, 10, or 15 ft.
Competitively Priced Only from your CREATE dealer

Galvanized Steel Bracing and Hardware Dist. by
ORION HI-TECH
P.O. Box 8771, Calabasas, CA, 91302 (213) 663-2541
center-fed bent dipole (fig. 8A), since the center of the element doesn't have to support the weight of the feeder. Other features include higher radiation resistance and reduced effective spacing on 21 and 28 MHz, but on 14 MHz an adverse impedance transformation takes place at the bottom corner of the loops so that an estimated radiation resistance of 45 ohms referred to the top center is stepped down to only 20 ohms in the feeder. Using the relay as shown, this isn't important, since only a short length of line is affected. But with no relay and No. 14 AWG feeders, there's an estimated loss of 1 dB, as well as the narrow bandwidth already noted. With tubing elements as shown in fig. 12, the situation is more favorable, with an estimated impedance reduction of only 30 percent. There's also more flexibility because the impedance discontinuity at the ends of the tubing tends to offset the step-down at the bottom corner and the boom can, if necessary, be used to support a heavier feeder system.

fig. 12. One element of small delta loop array using tubing end-fed with wires. These wires can be thin because current zeros occur at the crosspoints on 14 MHz, and on higher frequency bands RG is relatively large. Element spacing is with the lower corners 4 feet apart. (Reproduced with permission of RSGB.)

fig. 13A. Example of the impedance transforming loop showing principle of operation. (A) Loop acts as pair of \( \lambda/4 \) transformers so that a radiation resistance \( R \) appears (in this case) as \( 4R \) at the feedpoint.

fig. 13B. Alternative forms of inductively loaded dipole. Note: in (1), \( x = 10 \) inches, \( y = 15 \) inches (at 14 MHz). In (2), \( AB = BC = 9 \) feet; each \( L \) is a 40-turn, 1-inch diameter, 20-inch coil.
Figures 11 and 12 represent two extremes of design in which “anything goes.” Typical observed SWR and f/b ratios are included in table 1. No additional coupling or neutralization was needed to obtain the results shown. In the case of the fig. 12 configuration, it must be assumed that although on 14 MHz the radiation was coming from straight elements, the “quad loop effect” was operative with respect to coupling. In the antenna shown in fig. 12, it was found that for two-band operation (14 and 21 MHz), the relay could be omitted because of a chance combination of impedance transformations which caused the second harmonic resonance to occur at only 1.12 times the signal frequency. In general, I’ve not found it difficult to obtain efficient two-band operation of antennas without switching, but three bands are much more difficult.

**the impedance transforming loop (ITL)**

Disadvantages of the systems illustrated in figs. 11 and 12 include the need for switches or relays in positions that are usually inaccessible. Even if this is acceptable, frequency coverage is restricted because as R decreases, switching devices have to meet increasingly stringent requirements with respect to capacitance and rf voltages.

Figures 13, 14, and 15 show a means of dispensing with relays and, to a large extent, the need for matching stubs. This was the outcome of an unsuccessful attempt to develop a small (i.e., 18-foot, 14 MHz) broadband folded dipole by slowing down the wave velocity. The idea was to trick the wave into thinking...

---

**Table 1**

<table>
<thead>
<tr>
<th>Band</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>13</td>
<td>20</td>
</tr>
<tr>
<td>21</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td>14</td>
<td>12</td>
<td>24</td>
</tr>
<tr>
<td>28.5</td>
<td>16 feet, 7 inches</td>
<td>26 inches</td>
</tr>
</tbody>
</table>

Example

<table>
<thead>
<tr>
<th>Dip</th>
<th>HJ</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 feet, 7 inches</td>
<td>26 inches</td>
</tr>
</tbody>
</table>

SWR = 1.9 with no stub
Table 1. Comparison of various antennas described in this article.

<table>
<thead>
<tr>
<th>BAND (MHz)</th>
<th>Antenna</th>
<th>Bandwidth for F/B ratio</th>
<th>Bandwidth for SWR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>&gt;20dB &gt;15dB &gt;10dB &lt;1.25</td>
<td>&lt;1.5 &lt;2.0</td>
</tr>
<tr>
<td>14</td>
<td>S.D.L. (wire)</td>
<td>140 280 110</td>
<td>190 300</td>
</tr>
<tr>
<td></td>
<td>S.D.L. (tube)</td>
<td>150 220 385</td>
<td>225 390</td>
</tr>
<tr>
<td></td>
<td>Claw No. 1</td>
<td>40 120 220</td>
<td>160 330</td>
</tr>
<tr>
<td></td>
<td>Claw No. 2</td>
<td>145 300</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Folded Dipole</td>
<td>230 100 260</td>
<td>260 350</td>
</tr>
<tr>
<td>21</td>
<td>S.D.L. (wire)</td>
<td>320 110 205</td>
<td>370</td>
</tr>
<tr>
<td></td>
<td>S.D.L. (tube)</td>
<td>550 360</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Claw No. 1</td>
<td>85 210 350</td>
<td>420</td>
</tr>
<tr>
<td></td>
<td>Claw No. 2</td>
<td>400 320 380</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Folded Dipole</td>
<td>260 450</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>S.D.L. (wire)</td>
<td>800 190 500</td>
<td></td>
</tr>
<tr>
<td></td>
<td>S.D.L. (tube)</td>
<td>800 550 800</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Claw No. 1</td>
<td>240-300 600</td>
<td>370 680</td>
</tr>
<tr>
<td></td>
<td>Claw No. 2</td>
<td>170 840 1000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Folded Dipole</td>
<td>280 1000</td>
<td></td>
</tr>
</tbody>
</table>

The element was larger, but this was unsuccessful. Being difficult to draw and of limited practical interest, its somewhat fearsome appearance will not be inflicted on the reader, though some performance figures are included in table 1. The surprise came in the form of a chance discovery that long feeders could be connected without degrading the bandwidth; the explanation, though elusive, led eventually to the design of a number of antennas bearing little resemblance to the original dipoles.\(^7,9\)

**principles of operation**

Figure 13A illustrates a small loop element which could be any shape. Two or more half-wave wires are used in parallel for the top part of the loop, resulting in a low value of characteristic impedance \(Z_{OT}\).

The remainder of the loop consists of a second \(\lambda/2\) dipole with a high value of characteristic impedance, \(Z_{OB}\); this can be a helix as shown, or inductively loaded in other ways. Each dipole functions as a \(\lambda/4\) transformer so that the radiation resistance, \(R\), after being stepped up to the value

\[
Z_{OT} / R
\]

at the ends of the top dipole, is then stepped down to

\[
(Z_{OB} / Z_{OT})^2 \cdot R
\]

at the feedpoint. As illustrated, a typical \(R\) value of 50 ohms is stepped up to 200 ohms at the feedpoint, which is high enough to ensure that bandwidth remains an intrinsic property of the antenna and is free from serious degradation due to the feeder. A selection of \(Z\) values is given in table 2. Depending on size and construction, the lower dipole may be a thin wire unloaded V or one of the alternatives shown in fig. 13B. All of these arrangements have been used successfully. The usual objections to inductive loading don’t apply because the radiation is mainly from the top part of the loop. This comes about because the current is stepped down in the ratio of the impedances; because the lower dipole is shorter; and because the current distribution in it is sinusoidal or triangular, in contrast to the almost uniform current in the top dipole. This constitutes a major advantage over the quad loop, in which the mean height is dragged down by radiation from the lower side. On the other hand, there is some radiation from the sides; it can be cancelled

Table 2. Design data for ITL antennas.

<table>
<thead>
<tr>
<th>Number of conductors</th>
<th>Diameter (inches)</th>
<th>Spacing (inches)</th>
<th>(Z_0) (ohms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.04</td>
<td></td>
<td>1000</td>
</tr>
<tr>
<td>2</td>
<td>0.04</td>
<td>4</td>
<td>690</td>
</tr>
<tr>
<td>3</td>
<td>0.04</td>
<td>6</td>
<td>640</td>
</tr>
<tr>
<td>4</td>
<td>0.04</td>
<td>12</td>
<td>550</td>
</tr>
<tr>
<td>5</td>
<td>0.04</td>
<td>4</td>
<td>550</td>
</tr>
<tr>
<td>6</td>
<td>0.04</td>
<td>4</td>
<td>490</td>
</tr>
</tbody>
</table>

Note: \(Z_0\) values are calculated for 14 MHz. However, because of some length dependence, they will be slightly different for other bands. No data is available for helical windings.
AVCOM's Portable Test Receiver has a full range of outputs to provide signals for large TV monitors, video recorders, and audio amplifiers. A special IF sampled output is available for observing 70-MHz IF signals including TI, if any, on the PSA-35A Portable Spectrum Analyzer. A large easy to read signal strength meter is located on the control module and an audible signal strength indicator function is also provided.

AVCOM MSG-1000A  0 to 1000 MHz
MICROWAVE SWEEP GENERATOR $1565
The MSG-1000A generates signals from 100 kHz to 1000 MHz. Its LED frequency readout is accurate to ±1 kHz. The MSG-1000A can be used as a marker generator for the PSA-35B Spectrum Analyzer. Other possible uses include: sweeping IF filters and amplifiers. Built in 1-KHz FM modulation standard. Operates from 110 VAC or its own internal rechargeable batteries.

AVCOM STA-70D
SOPC TEST ANALYZER $1960
The AVCOM STA-70D conveniently connects to the 70 MHz IF output of your C or Ku band downconverter. Signal levels, interference, and all carriers appear on the spectral display. The display span is continuously adjustable from 0 to more than a full transponder, the display sensitivity is switchable from 2 dB to 10 dB per division.

AVCOM MSG-1750A  950 to 1750 MHz
MICROWAVE SWEEP GENERATOR $1275
The MSG-1750A digital frequency readout is accurate to ±0.1 MHz. The MSG-1750A has been developed for international use with the wider block frequency band from 950 to 1750 MHz. Operation from 220 VAC is standard, 110 VAC is available. The MSG-1750A can be used as a marker generator for the PSA-35A Spectrum Analyzer to accurately specify TI filters or to establish performance criteria for satellite communications contracts.

Avicom's Portable Test Receiver is the first spectrum analyzer designed for the satellite communication industry. The AVCOM PSA-35A offers frequency coverages of 10 to 1750 MHz and 3.7 to 4.2 GHz. The PSA-35A is portable and can be operated from 115 VAC (220/240 VAC available) or its own rechargeable internal batteries. The AVCOM-PSA-35A will quickly become the most important test instrument you own for installing or servicing TVRO systems.

AVCOM PSA-35A PORTABLE SPECTRUM ANALYZER $1965

AVCOM PSA-35A ACCESSORIES
TISH-40 - Terrestrial Interference Survey Horn - $127
SSC-70 - Signal Sampler and Calibrator - $175
AVSAC - AVCOM Spectrum Analyzer Carrying Case - $69
WCA-4 - Waveguide to Coax Adapter - $78
QHM-35 - Quick Release Rack Mount - $124

MTG-3600 MICROWAVE TRACKING GENERATOR $1865
Turn your HP 8566 Spectrum analyzer into a powerful network analyzer with scalar frequency response function. AVCOM's model MTG-3600 Tracking Generator outputs -5 dBm (typical) tracked RF signal from less than 100 KHz to over 10 GHz. Flattens ±1.5 dB typical. IF feedthru below -65 dBm typical. LO is a phase locked cavity oscillator referenced to an oven stabilized crystal oscillator.

AVCOM PTR-24 PORTABLE TEST RECEIVER $1375
AVCOM's Portable Test Receiver has a full range of outputs to provide signals for large TV monitors, video recorders, and audio amplifiers. A special IF sampled output is available for observing 70-MHz IF signals including TI, if any, on the PSA-35A Portable Spectrum Analyzer. A large easy to read signal strength meter is located on the control module and an audible signal strength indicator function is also provided.

AVCOM STA-70D
SOPC TEST ANALYZER $1960
The AVCOM STA-70D conveniently connects to the 70 MHz IF output of your C or Ku band downconverter. Signal levels, interference, and all carriers appear on the spectral display. The display span is continuously adjustable from 0 to more than a full transponder, the display sensitivity is switchable from 2 dB to 10 dB per division.

AVCOM MSG-5
MICROWAVE SWEEP GENERATOR $1087
AVCOM'S Model MSG-5 Microwave Sweep Generator provides the capability of generating very accurate signals in the 3.7 - 4.2 GHz satellite communications band. A sweep capability is standard over the entire 3.7-4.2 GHz band to bandwidths less than one MHz at any center frequency between 3.7 and 4.2 GHz. Frequency can be read on an LED display with better than 1 MHz accuracy. A built-in modulation generator can verify TVRO system performance. An external video modulation input is included. The MSG-5 features line or battery operation, portability, and rugged construction.

MTG-3600 MICROWAVE TRACKING GENERATOR $1865
Turn your HP 8566 Spectrum analyzer into a powerful network analyzer with scalar frequency response function. AVCOM's model MTG-3600 Tracking Generator outputs -5 dBm (typical) tracked RF signal from less than 100 KHz to over 10 GHz. Flattens ±1.5 dB typical. IF feedthru below -65 dBm typical. LO is a phase locked cavity oscillator referenced to an oven stabilized crystal oscillator.

AVCOM PSA-35A PORTABLE SPECTRUM ANALYZER $1965

AVCOM PSA-35A ACCESSORIES
TISH-40 - Terrestrial Interference Survey Horn - $127
SSC-70 - Signal Sampler and Calibrator - $175
AVSAC - AVCOM Spectrum Analyzer Carrying Case - $69
WCA-4 - Waveguide to Coax Adapter - $78
QHM-35 - Quick Release Rack Mount - $124
by reverting to a more or less triangular shape as shown in fig. 14. Assuming an ITL to be designed for 14 MHz, operation on the higher frequency bands differs little from that of the small delta loops described earlier; at 21 MHz there tends to be some "wrong-way" impedance transformation, suggesting the desirability of matching stubs at ground level in the case of long feeders. Concentrated loading, as shown

![Diagram](null)

fig. 16. Typical performance of Claw No. 1 on 14 MHz. F/B ratio curves demonstrate null-filling due to any slight error in adjustment. In this case, one test signal was slightly too close. SWR rapidly increases as the signal approaches zero. The reflector was adjusted for nulls at 140-150 degrees, but curves were roughly repeatable over a range of 110-180 inches without readjustment of coupling.

![Diagram](null)

fig. 17. Typical performance of Claw No. 1 on 21 MHz. Note steep rise in SWR at low frequencies — i.e., as θ decreases.
in fig. 13B2, improves matters on 14 MHz by increasing $Z_{OB}$ (see table 2), but reference to a Smith Chart suggests that at 21 MHz this could lead to an increase of SWR in the open-wire line of 2 or more. On the other hand, with long coils of small diameter (20 inches x 1 inch), as shown in fig. 14, much better agreement between theory and practice resulted from regarding them as a harmless continuation of the traveling wave system.

**construction**

Figures 14 and 15 illustrate the latest version of the Claw antenna, which uses two pairs of fiberglass fishing rods 13 feet long, extended at their lower ends by an additional 6 feet of 1-inch diameter fiberglass tubing. These are plugged into alloy sockets which radiate outwards from the top of the mast. They are braced back with further lengths of fiberglass tubing to a short mast extension. The elements are held apart by 6-foot spacing rods of 1/2-inch diameter alloy tubing. Plastic rod end-pieces are used to keep the rods a few inches clear of the elements; even so, these may be responsible for some of the coupling. The tips of the fishing rods are pulled in by nylon fishing line to give an element spacing of 12 feet. Points on the rods are guyed back to crosspieces at the top of the mast. The top wires are held 11 inches apart in the horizontal plane by fiberglass spacers cut from the discarded tips of the fishing rods. Additional spacers on the rods themselves (with fishing-line ties) are used to maintain even tension in the wires to avoid flexing and breakage. Earlier versions used three copper wires spaced 4 inches apart, but the benefit from the extra wire hardly justifies the added complication (see table 2). The latest version uses No. 16 AWG aluminum alloy wire, which reduces weight for a given rf resistance, but increases windage. Since the rf resistance is only half that of a single wire, mechanical considerations are more likely to be the deciding factor. Wires break if not kept under tension, but with two antennas over a period of three years — which has included periods of heavy winds — no fishing rods have broken, and there has been no other damage to the main structures.

The same wire gauge is used throughout. The loading helices are each wound with 40 turns over a total
length of 20 inches, partly near the lower end of the rod extensions and partly on the bracing struts. Because of the low radiation resistance on 10 MHz, it's advisable to provide matching as close as possible to the antenna. In one case, 28-inch stubs were placed 16 feet, 7 inches from the element. Later, for greater convenience I used a pair of series-connected 10-pF capacitors near ground level. The location could be determined by finding points of "zero" current and then moving 3 feet closer to the antenna. Matching on the other bands was used initially, but discarded because it made no difference in signal strengths, though table 1 suggests the loss of some bandwidth. Even on 10 MHz, despite the additional 120 feet of open wire line (No. 19 AWG), the loss without matching was less than one S-unit. Measured performance data for both Claw antennas is included in table 1. The plots of f/b ratio and SWR shown in figs. 16, 17 and 18 are typical of results obtained with Claw No. 1.

alternative designs

The loops can also be suspended from spreaders between two supports. In this case planar loading (an idea suggested to me by Steve Hart, VK5HA), as shown in fig. 13B, is suggested. The assembly can be supported by three lengths of nylon fishing line with small ring insulators cut from fiberglass tubing to keep adjacent edges apart. I find that nearly a 3:1 reduction in length can be achieved this way; because it uses less wire, its efficiency is greater than with helical loading. For this reason, it was used in the first two versions of the Claw, but helical windings in this case are easier and neater, with losses insignificant. Similar loops can be suspended from their centers in inverted V fashion. I've also built a rotary version of such an antenna modelled after the one shown in fig. 3B. This used a lightweight mast extension surmounted by a 1/2-inch diameter aluminum boom. Two fiberglass radial arms were used to hold up the dipole ends. Apart from the neutralization problem mentioned earlier, this worked well on 14 MHz. A three-element version of the Claw was also constructed; since only triband operation was required, I was able to use a coaxial feeder for the center element and a relay to switch in an additional length of helix on 21 MHz. The third element was effective on 28 MHz and was indirectly useful for 10 MHz because, though not in use, it allowed wider spacing between the other two elements without degradation of performance on 28 MHz. On 14 and 21 MHz, there was no improvement compared to using any one of the three possible pairs on its own. SWR on 14 MHz could be varied between 1.0 and at least 5.0 by tuning the parasitic elements! The problem was basically one of "too many variables," and it was concluded that for three elements to be viable, they would need to be spread out along
I/O FOR REAL WORLD CONTROL

$199.95 CALL OR WRITE FOR MORE INFORMATION

NOW ANY PERSONAL
COMPUTER CAN HAVE THE
MOST COST EFFECTIVE
AND VERSATILE I/O BOARD
ON THE MARKET TODAY!

- Serial Link Interface
- RS-232 or TTL
- 8 Relay Outputs, High Current AC/DC Form A & C
- 8 Opto-isolated Inputs
- Plus 8 Bit Counter
- 8 Bit A/D with Span
- Adjust 0 to 5V
- Provisions for up to
- 8 Input Channels

EASILY Programmed & Controlled Using BASIC Statements
Perfect for Lab Work, Machine Control, Security Systems, & Data Acquisition
Unprecedented Usability as Attested by Universities, Government & Industrial Users
Complete Documentation with Software Examples & Total Engineering Support

IBM • HP • RADIO SHACK • COMMODORE

S1AS Engineering, Inc.
831 S. POWERS RD. / SALINA, KS 67401 / (913) 823-9209

INTERNATIONAL MONTHLY MAGAZINE BY AND FOR ACTIVE RADIOSPORTS

Radiosporting

A magazine dedicated to quality and sportmanship in
amateur radio operating. Fresh, timely, practical and down to
earth reading for little pistols and big guns. Written by the
world's best in their fields: ON4UM, SM9AGD, L22CJ,
VE3BMY, KH6BF, DJ3BZ, ZS6BRZ, W7YW, N2AU, K7GCO,
K4ZB, W4GE, VE3JQ, WBA4NZH, WB9TBV, KQZM, 6L6X,
W5GF, KA3B, KIPLR, N7CDO, VE3XN, AB3X, J6ICKA and others.
Includes DX News, QSL Info, 160m, 80m, 10m, 6m columns,
Dxpeditioning, Propagation, Awards, Contest rules and results,
Traffic - Emergency, FCC News, New Products, Antennas,
Technical news and articles, equipment reviews and
modifications, computer programs, Radio Funnies, Club Life,
RTTY, VHF/UHF, Mail Box, Classified Ads and much more in a
magazine format with the speed of a bulletin.

RADIOSPOTING sponsors DX Century Award, Contest
Hall of Fame and World Radio Championship contest.

"Your publication is superb! Keep it up!" Joe Reisert, W1JR
"Your W2PV articles are priceless. Your magazine is superb!"
Rush Drake, W7RM
"Let me congratulate you on a very impressive magazine. Just
what I've been looking for as a DXer and Contestor!"
Dick Men, N7RO
"RADIOSPOTING, once received, cannot be tossed aside until
it is read from cover to cover. Then reviewed again and
again." "Chas Browning, WAPKA

Subscription rates: 1 year USA $18, Canada CDN$26, Overseas
US$23; 2 years $33, $48, $52 respectively. Single issue $2.
USA First Class Mail add $8/year, DX Air Mail add $15/year.

TRY US! SUBSCRIBE OR SEND $1 FOR YOUR SAMPLE COPY.

RADIOSPOTING

Magazine

PO Box 282, Pine Brook, NJ 07058, USA

see us at dayton booth #430

vertical arrays

Vertical beams can also be constructed using controlled
coupling. Figure 19 shows two examples. The first is an "asymmetrical dipole" array that uses inductively-loaded counterpoises to form the lower half of the dipoles. The inductances can take the form of linear loading. The elements are movable and can be plugged into sockets on fence posts. Coupling is varied by rotating the counterpoises towards each other and all adjustments are conveniently accessible. Each half of the dipole should be resonated separately against a $\lambda/4$ wire. The second can be regarded as a "vertical VK2ABO antenna. It's best to use four wires at right angles; adjacent pairs may be connected in parallel, though they can also be used in a three-element configuration. In the two-element case, which is recommended, overcoupling was experienced, requiring neutralization as shown. ("Zepp feed" can also be used, provided the open end of the feeder is closed with a $\lambda/4$ stub as recommended by G6CJ.)

conclusion

My intention has been to provide guidelines, rather than blueprints, for the construction of antennas tailored to suit individual needs. The Claw designs will be useful even if the best mast available is only a garden post, and I hope that some who have decided regretfully that beams are "not for them" will have second thoughts. The null-steering and beam-reversal capabilities are particularly useful. In addition to coverage of six bands — with "monoband" performance on several — Claw elements are particularly suitable for use as top-loaded verticals for the lower frequency bands.

references

11. Private communication.

G6XM's book, HF Antennas for All Locations is available from Ham Radio's Bookstore for $11.95 plus $3.50 S&H.

ham radio
Now! In America

For the first time, the AR2002 is available in the U.S.A.! Acclaimed worldwide for its full spectrum coverage, its superior sensitivity, excellent selectivity and convenient, compact design; it has all the features a sophisticated and discerning public service band radio user desires.

Experts in Europe, and around the world report excellent performance in independent lab tests. For example: sensitivity across all bands will typically exceed 0.3 microvolts in NFM. And now the AR2002 is available to you exclusively through this offer.

Performance Above and Beyond

You'll hear signals from 25 through 550 MHz, plus 800 MHz through 1.3 GHz. In any mode: narrow band FM, wide band FM, or AM. Search through entire bands, or enter selected frequencies into any of 20 memory channels. The sidelighted LCD gives full information on status and programming. Profession quality hinged keys and a digitized front panel control knob make tuning easier than ever before. There's even a real time clock with backup, a signal strength meter and a front panel headphone jack. Plus, programmable search increments, a laboratory quality BNC antenna connector with switchable attenuator, full memory backup, and power cords for AC or DC operation. A professional quality swivel mount telescoping antenna is also supplied.

...And More!

Every AR2002 has a special connector on the rear panel. It interfaces to our custom RC-pack. A little device that makes the AR2002 controllable by ANY computer with an RS-232C port. The possibilities that result from this option are nearly limitless. In effect, virtually your only monitoring constraint will be your imagination.

Yet Convenient to Own

The AR2002 is available exclusively through us — so call us direct, TOLL FREE. We'll be happy to answer any questions you may have. And if you respond like thousands of other monitor users the world over, we'll be shipping you an AR2002 within 48 hours by surface UPS for only $455. Plus we pay all freight and handling charges. Remember to ask about our custom test and triple extended buyer protection warranty plans, and our express shipping option. If you're not satisfied within 25 days, return your AR2002. We'll refund your purchase and return shipping costs. There are no catches, no hidden charges.

The AR 2002
The Professional Monitor Receiver

ACE
COMMUNICATIONS
Monitor Division

10707 East 106th Street, Indianapolis, IN 46256

Call Toll Free 800-445-7717
Visa and MasterCard
COD slightly higher
In IN 317-842-7115 Collect
Warehouse: 22511 Aspin Street, Lake Forest, CA 92630
(7½"D × 5½"W × 3½"H Wt. 2 lbs., 10 oz.)
**ASTRON POWER SUPPLIES**

- **HEAVY DUTY** • **HIGH QUALITY** • **RUGGED** • **RELIABLE**

### PERFORMANCE SPECIFICATIONS

- **INPUT VOLTAGE**: 105 - 125 VAC
- **OUTPUT VOLTAGE**: 13.8 VDC ± 0.05 volts
  (Internally Adjustable: 11-15 VDC)
- **rippLe**: Less than 5mV peak to peak (full load & low line)

### RS and VS SERIES

#### SPECIAL FEATURES

- Solid State Electronically Regulated
- Fold-Back Current Limiting Protects Power Supply from excessive current & continuous shorted output.
- CrowBar Over Voltage Protection on all Models except RS-4A.
- Maintain Regulation & Low Ripple at low line input Voltage.
- Heavy Duty Heat Sink
- Chassis Mount Fuse
- Three Conductor Power Cord
- One Year Warranty • Made in U.S.A.

#### PERFORMANCE SPECIFICATIONS

- **INPUT VOLTAGE**: 105 - 125 VAC
- **OUTPUT VOLTAGE**: 13.8 VDC ± 0.05 volts
  (Internally Adjustable: 11-15 VDC)
- **rippLe**: Less than 5mV peak to peak (full load & low line)

### RS-A SERIES

- **MODEL**: RS-4A
  - **Continuous Duty (Amps)**: 3
  - **ICS* (Amps)**: 4
  - **Size (IN)**: 3⅜ x 6⅛ x 9
  - **Shipping Wt. (lbs)**: 5

- **MODEL**: RS-7A
  - **Continuous Duty (Amps)**: 5
  - **ICS* (Amps)**: 7
  - **Size (IN)**: 3⅜ x 6⅛ x 9
  - **Shipping Wt. (lbs)**: 9

- **MODEL**: RS-7B
  - **Continuous Duty (Amps)**: 5
  - **ICS* (Amps)**: 7
  - **Size (IN)**: 4 x 7½ x 10⅛
  - **Shipping Wt. (lbs)**: 10

- **MODEL**: RS-10A
  - **Continuous Duty (Amps)**: 7.5
  - **ICS* (Amps)**: 10
  - **Size (IN)**: 4½ x 8 x 9
  - **Shipping Wt. (lbs)**: 11

- **MODEL**: RS-12A
  - **Continuous Duty (Amps)**: 9
  - **ICS* (Amps)**: 12
  - **Size (IN)**: 5 x 9 x 10¼
  - **Shipping Wt. (lbs)**: 13

- **MODEL**: RS-20A
  - **Continuous Duty (Amps)**: 16
  - **ICS* (Amps)**: 20
  - **Size (IN)**: 5 x 11 x 11
  - **Shipping Wt. (lbs)**: 27

- **MODEL**: RS-35A
  - **Continuous Duty (Amps)**: 25
  - **ICS* (Amps)**: 35
  - **Size (IN)**: 6 x 13¼ x 11
  - **Shipping Wt. (lbs)**: 46

### RS-M SERIES

- **MODEL**: RS-50M
  - **Continuous Duty (Amps)**: 37
  - **ICS* (Amps)**: 50
  - **Size (IN)**: 5⅝ x 19 x 12½
  - **Shipping Wt. (lbs)**: 50

### VS-M SERIES

- **MODEL**: VS-20M
  - **Continuous Duty (Amps)**: 16
  - **ICS* (Amps)**: 19
  - **Size (IN)**: 5½ x 12½
  - **Shipping Wt. (lbs)**: 20

- **MODEL**: VS-35M
  - **Continuous Duty (Amps)**: 25
  - **ICS* (Amps)**: 35
  - **Size (IN)**: 5 x 11 x 11
  - **Shipping Wt. (lbs)**: 29

- **MODEL**: VS-50M
  - **Continuous Duty (Amps)**: 37
  - **ICS* (Amps)**: 50
  - **Size (IN)**: 6 x 13¼ x 11
  - **Shipping Wt. (lbs)**: 46

### RS-S SERIES

- **MODEL**: RS-7S
  - **Continuous Duty (Amps)**: 5
  - **ICS* (Amps)**: 7
  - **Size (IN)**: 4 x 7½ x 10⅛
  - **Shipping Wt. (lbs)**: 10

- **MODEL**: RS-10S
  - **Continuous Duty (Amps)**: 7.5
  - **ICS* (Amps)**: 10
  - **Size (IN)**: 4 x 7½ x 10⅛
  - **Shipping Wt. (lbs)**: 12

- **MODEL**: RS-10L (For LTR)
  - **Continuous Duty (Amps)**: 7.5
  - **ICS* (Amps)**: 10
  - **Size (IN)**: 4 x 9 · 13
  - **Shipping Wt. (lbs)**: 13

- **MODEL**: RS-12S
  - **Continuous Duty (Amps)**: 9
  - **ICS* (Amps)**: 12
  - **Size (IN)**: 4⅝ x 8 x 9
  - **Shipping Wt. (lbs)**: 13

- **MODEL**: RS-20S
  - **Continuous Duty (Amps)**: 16
  - **ICS* (Amps)**: 20
  - **Size (IN)**: 5 x 9 x 10⅛
  - **Shipping Wt. (lbs)**: 18
homebrew antenna mount

Hand tools and standard hardware are all you need for this project.

A number of years ago I visited a ham friend who proudly showed me his new tribander. Sitting atop a rotatable mast secured to a ground-mounted fixture, the antenna could also be lowered so that one could work on it comfortably.

We lived in an apartment then, and the only antennas I could install were dipoles for 80 and 40 meters and a vertical for 20, 15, and 10. Later, when we finally bought a home, I found that despite a large back yard, power and telephone lines — as well as trees we'd planted — put an end to my plans for an antenna farm.

Though finding antennas for 80 and 40 meters was no great chore, finding room for a tower or mast was. It was then I realized I already had a platform for working on my antenna — namely, the gently sloping garage roof. I decided I might be able to put up something similar to the arrangement my friend had shown me years before.

My plan was to use a push-up mast, supported somehow at the bottom, and drive it, with the antenna on top, from ground level. I did some shopping for parts and spent some time at the work bench; using hand tools only (with the exception of an electric drill), the result was a mast which has been in use now for a dozen years or more, with no problems (Photo 1).

initial considerations

One of the first things to realize is that your antenna isn't going to rotate at 5000 rpm. It turns very slowly (my rotor takes a full minute to turn 360 degrees), and hence puts little strain on the bearing you'll use. Aside from the inevitable accumulation of dirt, which is easily removed with a stiff brush and some paint thinner, I've had no problems with the bearing at all.

The second thing to realize is that when you have everything done, extending the push-up mast with the antenna on top of it isn't easy unless you've made some advance preparations. Suppose you've acquired such a mast; it will probably have three or four sections, depending on the height you've chosen. Mine has four, and the outside diameter of the lowest section is 2-1/4 inches. The lifting problem isn't one of weight, but of having some way of knowing when you're reaching the point at which you should stop lifting and secure the section with the clamp provided, and maybe even drill to pass a 1/4-inch bolt through the two sections if you're a bit timid.

mast inspection

Lay the mast out on the ground, fully extended, and examine the point at which the smallest section emerges from the one below it.

Although the smaller section of my mast won't separate from the larger one, there's an illusion at work: when you're lifting the smallest section, with the antenna mounted on it, you become absolutely convinced that at some point the whole thing will pull out, leaving you on the roof with 10 feet of mast and an antenna in your hands and nothing else to hold them. To avoid this, use paint or some other marker to warn you when you're just a few inches from the clamp-off point. Do this with all of the sections. At this point, let me add a caution: whenever you're extending or collapsing the mast, wear heavy gloves! (I use a pair of leather gardening gloves.) The mast sections have a nasty habit of pinching your flesh between them. Wear those gloves!

mounting the mast

Decide where you'll mount the mast. For aesthetic reasons, an exterior garage wall is a good choice; you may prefer to attach hardware through to the exposed studs rather than to a finished interior or exterior wall of your house.

You'll also have to decide how far off the ground the lower end of the mast will be supported. This will

Howard A. Bowman, W6QIR, 5872 West 77th Place, Los Angeles, California 90045
depend on the length of your rotor, which will hang below the "shelf" you'll build (see photo 2), and should clear the earth by a few inches. At this point, do one other thing as well: measure the inside diameter of the lowest section of your mast.

Before you head out to the plumbing supply shop, try to visualize what your array of mast, rotor, and connecting pieces of pipe will look like overall. A short length of pipe should fit snugly inside the lower end of the mast. (Though it doesn't have to be an exact fit, it should be fairly close.) It should be 5 or 6 inches long and threaded on both ends; you'll find it at your local plumbing supply house, described as a "nipple." You'll also need two lengths of pipe — one to run from the support you'll build to the upper clamp of your rotor, and the other to run from the lower clamp of the rotor to about a foot below the surface of the earth. One end of the upper piece must be threaded. Aside from this, it's probably simpler to get one long piece and cut it in half yourself.

You'll also need a reducing fitting. At its larger end, it should accept the threads on the nipple, and at its smaller end it should accept the threads on the longer piece of pipe. Caution: pipe sizes are guaranteed to confuse everyone in the world except plumbers. Pay no attention to the designated pipe sizes; use a tape or a scale and measure everything for yourself. Try the mating pieces to be sure they do what they're supposed to do. That way you won't encounter unwelcome surprises.

The next step takes place in your own workshop. Screw the nipple tightly into the reducing fitting, securing it by drilling and tapping for a machine screw of some convenient size. (The screw won't bear any load, but will keep the two parts from coming apart.) Then slide the nipple into the lowest section of the mast until the lower edge of the mast section rests on the reducing fitting.

At this point I drilled and tapped for 1/4 inch x 20 machine screws and used hex-head screws about 1/2 inch long. This was overkill, but, to some extent, the number of screws you use will depend on the snugness of the fit between the lowest mast section and the pipe inside it. The idea is to square things up as well as you can. If you need four screws 90 degrees apart, use them.

You'll need a bearing with an inside diameter large enough to accept the smaller end of the reducing fitting. The tapered shoulder of the fitting will ride on the inner race of the bearing. I've used two bearings — one a standard ball bearing and the other a tapered roller bearing. Either does fine. The inside diameter of each is 1-5/8 inches, and the outside diameter is just a bit over 3 inches. It's important that the slanted portion of the reducing fitting fit inside the bearing, so take careful measurements or take the fitting with you when you shop for the bearing at an establishment that stocks new and used machinery. In a pinch, you may find one at an automobile junkyard.

**mast and rotor support**

Having come this far, you've done all but the drudgery of making some kind of a support for the mast and rotor. Mine is made of ordinary 1-1/4 inch angle iron, which you can find at any iron fabricating shop or even at some large hardware stores. If you get it at a hardware store, it will most likely be sold in 6-foot lengths; you'll need three of them. If you get it from a shop, be careful. Be sure of your measurements, since the cutter may distort the metal where the cuts are made, making part of it unusable for your purpose.

In planning your shelf, be sure to consider its height above ground and its depth. The shelf must be high enough so that your rotor can hang below it with a few inches clearance above ground. Its depth depends upon the distance your mast will be positioned from the wall. In my case, eaves extend 7 inches from the wall, meaning that my shelf had to be about 15 inches deep to allow the mast to clear the eaves and still
provide adequate support. If you have no eaves to contend with, you may be able to make the shelf only 8 or 10 inches deep. (Keep in mind that this dimension will have some effect on the amount of angle iron you’ll need.)

**triangular supports**

The next step is to make two right-angled triangles out of angle iron. They should be made so that they’re mirror images of each other; that is, each should have the open sides of the angle iron pieces facing the other. One leg of the triangle will extend outward from the wall, another will fit vertically against the wall, and the third will complete the triangle by extending from some point near the outer edge of the horizontal piece to some point toward the lower end of the vertical piece.

Start by drilling both the vertical and horizontal pieces where they overlap and bolt them together. I used 1/4-inch bolts on mine. Use a square to make certain that the angles form a 90-degree angle. Measure carefully for the third leg, cut it to size, and, once again, drill for bolts. Do the same with the other three pieces of angle iron, making sure that the open sides of the triangles face each other.

Now, try to mount these triangles — at least temporarily — to the wall to which they’ll be bolted. Once you’ve decided how far your shelf is to be above ground, locate a point on a stud adjacent to where you want to mount the antenna. (That point should be 2 or 3 inches below the intended level of the shelf.) Drill a small hole through from the inside, keeping it as close to the center of the stud as you can. Now move to the stud on the other side of the intended location and drill a similar hole. These holes should go all the way through the studs and the outside covering of the wall.

Locate one of the triangles over the small hole, have someone hold it there, go back inside with your drill, and, using the hole through the stud as a pilot, drill into the metal of the triangle at least far enough to make a mark. Now both holes can be enlarged to accept a 5/16-inch diameter bolt. You can also drill another hole in the triangle vertical leg toward its lower end. Align things carefully so that the leg is vertical, then drill through the wall and the stud for a second bolt.

Studs are sometimes not exactly vertical, so this hole may be a bit off center. Don’t worry. If the triangle is vertical and your bolt has a good bite on the wood of the stud, you’ll be all right. Use a washer under the head of the bolt, and a fender washer (one that is larger in diameter), a lock washer, and a nut on the inside.

Locating the second triangle is a bit tricky because you want its top and the top of the first triangle to be as level as possible. The easiest way to do this is to have someone hold the second triangle against the wall so that one edge of the vertical leg is beside the hole you’ve drilled through the wall, and so that a spirit level across from the first triangle to the second shows that both are at the same height. Carefully mark the angle iron beside the point at which you’ve drilled, then drill the angle iron for the bolt. Locate the position of the second bolt just as you did for the other triangle.

**joining the triangles**

At this point you have two triangles bolted to the outside wall of your garage. The next step is to join them, using two pieces of the same angle iron. One piece should join the outer ends of the triangles, and the other will be several inches closer to the wall, depending on just where the mast will come. It should be midway between these two crosspieces. Having located both pieces, and drilled them and the upper leg of the triangle to accept 1/4-inch bolts, secure them in place.

**shelf assembly**

You’ll note that these two crosspieces and the triangle legs to which they are bolted form a rectangle. Find a piece of wood about 3/4 or 1 inch thick and
cut it to lie inside this rectangle. Then find a piece of aluminum about 1/8 inch thick to go on top of it. (I used marine plywood for the wood, but a solid piece would do just as well.) This assembly — the pieces of aluminum and wood — will form the actual shelf. Drill them for mounting with 1/4-inch bolts, but don’t assemble them yet. With the two pieces clamped or bolted together, mark the center by drawing cross lines from the corners. This is where the bearing will rest. You’ll need to drill a hole through both pieces that’s large enough to clear the inner race of the bearing, and any ham who has had to make a hole for a meter can cope with this. One precaution: make a small pilot hole through both pieces first. You may find that a large socket-hole punch will do for the aluminum, and an expansion bit for the wood.

bearing placement

Once you’ve made this hole, you can mount everything but the bearing. Center the bearing over the hole and mark around the circumference of the bearing with a pencil. You’ll need to devise something to make a “fence” around the bearing to hold it in place. I used some 1/2 x 1/2-inch aluminum angle stock I happened to have. Almost anything will do, so use your imagination. You can use small machine screws to fasten this fence to the shelf; there’s little strain on it. When it’s complete, the bearing should drop neatly into the hole.

When the bearing is in place, lean over and sight down through it to the earth beneath and mark the spot with a chip of wood or some other marker. You may want to drop a plumb bob down to mark this spot; it’s where the lower pipe on your rotor will enter the earth.

Your next job is to dig a square hole about a foot deep with this point at the center. You can also prepare the length of pipe by drilling holes through it at a point which will be well below the surface of the earth. Run some long bolts through it, leaving them so they extend a couple of inches on either side of the pipe. Two or three of these should do nicely.

What will happen, you ask, when you get the mast, the various pieces of pipe, the bearing, the rotor, and everything else set up on the shelf? Answer: it will all fall over. To prevent this, you’ll need an upper support, located directly above the shelf and as high on the wall as you can get it. Perhaps “support” is the wrong word, since it doesn’t bear any load. All it does is hold the mast in a vertical position and allow it to rotate within a loose collar.

wall-to-mast structure

Install a piece of the angle iron horizontally on the wall, bolted between the same pair of studs as the shelf. Then put the mast up temporarily and make sure it’s in a vertical position (use a spirit level). You’ll probably need a helper to make sure the mast stays in this position while you measure the distance from the wall to the nearest edge of the mast.

Now, using the leftover pieces of angle iron, you’ll need to assemble a rectangular structure as deep as the distance from the wall to the mast. It needn’t be as wide as the distance between the studs; mine is only 8 inches wide. It must be wide enough, however, to accept either a band bent to go around the mast, or perhaps a large U-bolt. It should be braced corner-to-corner so that it retains its shape, and further braced by two supports running from the rectangle down to a point on the wall. These last two supports may be pieces of the 1-inch strap iron, suitably bent in your vise, and bolted to the wall. These bolts needn’t go through the studs, but remember to put those large fender washers on the inside.

erecting the mast

Now put the mast up on the fittings you’ve made. Clamp the rotor to the pipe extending below the bearing. Clamp the other piece of pipe to the lower part of the rotor. Mix up some cement and pour it into the hole below the rotor. Go inside, wash your hands, and find yourself a good book that will take you a couple of days to read while the cement cures.

guying

When the curing process is complete, you may want to shovel some dirt back over the top of the cement block. You’ll then be ready to install the antenna on the topmost section of the mast. At this point, you’ll probably recall that your mast was supplied with a set of guy rings — one to fit atop each of the larger sections. In large part, whether you’ll use any at all
will depend on how high your mast is, how much support you can give it at the bottom, and whether experience has told you if you're likely to have a wind problem.

Consider the matter of support at the bottom. My lower installation is on a planter, but yours may be at ground level. Although I had eaves to contend with, you may have none. If your installation allows positioning your lower shelf close to the ground and your upper support near the top of the wall, you may have 7 feet or so between the bearing and upper support. If there are no eaves to force you to extend your structures away from the wall, they'll be more rigid; you may be able to avoid guys entirely.

In my case I thought it best to have a set of guys at the bottom of the topmost section of the mast. Hams traditionally have followed the practice of using three guys spaced 120 degrees apart. However, the guy rings supplied, for reasons known only to the manufacturer, have four holes spaced 90 degrees apart, and a fifth hole midway between two of the others. It appears not to matter. Just use what you can, and don't tighten the guy wires as if they were violin strings. Remember, the mast is going to rotate inside that guy ring, so leave a bit of slack in the wires.

**installing the antenna**

At last you're ready to install the antenna atop the mast. I certainly wouldn't advocate installing a monster with a 30-foot boom, but I used to have a tribander on the mast, and all went well. My present antenna is a 10-meter monobander. Just raise that upper section to about eye level, mount the antenna on it when you get it clamped off, and do whatever final work is necessary while standing in reasonable safety and comfort on your roof.

Once the antenna is mounted, you'll have the task of extending the mast. Let me repeat my warning —
THE DIGITAL NOVICE
by Jim Grubbs, K9EI
Now that novices have digital privileges, there are thousands of new Amateurs anxiously awaiting to get on-the-air. Who's going to answer their questions, however? Jim Grubbs' new book, The Digital Novice, is written with beginner's needs in mind. Each of the popular digital modes is fully covered with a brief history and full description of how it works. Hardware and software are covered in clear, concise terms. The book finishes with a look toward the future. Four appendixes cover: Morse, Baudot, AMTOP and ASCII Codes and has a glossary full of commonly used but misunderstood terms. Great for beginners and experts alike. ©1987 1st edition

□ JG-DN Softbound $9.95

THE PACKET RADIO HANDBOOK
by Jonathan Mayo, KR3T
Packet radio is the fastest growing mode in Amateur operation today. No wonder — it combines the power of today's microcomputer with worldwide digital communications. Newcomers will find this book to be full of helpful tips, tricks and information that will help get them on Packet as quickly as possible. Providing you first with packet basics, this book progresses through the inner workings and operational aspects of packet to a look at future technology still in developmental stages. Also includes: using bulletin boards, traffic handling on packet, modulation methods and networking principles, protocols (both AX.25 and VADCG) and a thorough discussion of the various TNCs and accessories available. ©1987 1st Edition 218 pages.

□ T-2722 Softbound $14.95

Please enclose $3.50 to cover shipping and handling.

ham radio
ANTENNA POLARITY SWITCHER MODEL APS-1

The APS-1 is a self-contained control head designed to allow remote polarity switching of circular antennas such as the Mirage/KLM range of crossed yags.

The APS-1 may be powered by the power adaptor (included) or may alternately be powered from a vehicle or other 13~17 VDC source.

In addition to switchable outputs for two antennas, the APS-1 also contains a 6~13 volt regulated DC power supply. This feature is designed for powering items such as preamplifiers, VHF/UHF converters, etc., but may also be used whenever a low-current stabilized variable voltage source is required.

SPECIFICATIONS:

Power Requirement (AC) .................. 117V ± 10% AC 50/60 Hz 15 Watt
Power Requirement (DC) .................. 11-16 VDC 500 mA

Outputs .................................. Two 12 VDC unregulated, switched (antenna relay supply).
                                   One 6-13 VDC variable regulated auxiliary supply.

Total output current 500 mA with AC transformer that is included, 1 amp with optional high current transformer or external DC supply.
This unit has our popular five (5) year warranty.

P.O. BOX 1000 MORGAN HILL, CALIFORNIA 95037 (408) 779-7363

Come see us in Dayton  Booth 68.
Yagi triangular array

Somewhat unconventional stack performs well mechanically and electrically

Inspired by recent articles on stacking Yagis, I decided to improve my 2-meter antenna system, which consisted of a single 19-element, horizontally polarized Yagi. Before long, I had installed another 19-element antenna above it — and with great anticipation, began making comparative checks with the new system.

Because my primary interest is in terrestrial communications, the 2.5- to 3-dB increase in gain didn’t overly impress me. With a 2 x 2 array in mind, I bought two more antennas and started designing an H-frame structure. Very quickly, however, I realized how large and heavy the completed array would be. I weighed the possibilities: a tilt-over tower, with block and tackle, would allow access to the array, but would probably be unfeasible because of the antennas’ size and weight. After much soul searching, I decided that a stack of four antennas, with the required H-frame, would be out of the question.

alternate stacking methods

I have, from time to time, heard mention of the diamond stacking configuration and claims of improved performance when compared with conventional rectangular stacking. Assuming reports on the diamond’s performance to be correct, and seeing a triangle as half of a diamond, I concluded that a triangle would be likely to offer better performance than an inline stacked array.

Unfortunately, oddball stacking geometry such as the triangle or diamond has received little or no publicity; I’ve yet to find informative literature on anything but the inline stacking methods. (It would almost seem that the numeral 3 simply doesn’t exist in the world of antennas. Instead, the philosophy of “double or nothing” seems to prevail.) Nevertheless, after due consideration of weight distribution on the mast and tower, I concluded that a triangle stack configuration — with two horizontally stacked antennas located at the lower level of the mast and a third Yagi mounted at the top of the mast — would best suit my needs.

Theoretically, three Yagis would provide an additional 1.75-dB gain over a pair. Subtracting the phasing harness loss from the theoretical value, a realistic gain of 4.5 dB over a single antenna should be possible. What was more important to me at this time, however, was what the plotted antenna pattern would be. How would it differ from a rectangular stack of four antennas? The only way to find out would be to build the triangular array and compare the results with published articles on a four-antenna array.

optimum stacking distances

The first problem was to determine the optimum spacing required between antennas. Available stacking data apply only to a pair of antennas stacked in either of two unique locations with respect to each other. Both antennas must be located on the axis of either the E or H plane. Polarization and phasing of both must also be the same.

With triangular stacking, the two lower antennas would satisfy the above conditions. The only way to find out would be to build the triangular array and compare the results with published articles on a four-antenna array.

John C. Cichowski, W2IKP, 167 Emeline Drive, Hawthorne, New Jersey 07506
it became apparent that non-standard H plane stacking dimensions were still useful.

Visualize, as in fig. 1, a pair of vertically stacked Yagis evolving through positions into a horizontal stack. For example, by keeping the lower antenna location and polarization fixed, and swinging the upper one through an arc (which defines a locus), while maintaining the same polarization as the lower one, one ends up with a horizontal stack. Each and every point along the locus will locate the movable antenna at an optimal distance from the fixed antenna. Also, at some point along the locus, the antenna will be equidistant to either of the two lower antenna positions (see fig. 1).

E and H optimum spacing differs

If optimum spacing for E and H plane were identical, the locus would be a 90-degree arc of a circle, with its radius equal to the optimum spacing dimension. However, the E and H plane optimum values are not equal, and studies have shown that optimum spacing, in a particular plane, depends on beamwidth in that plane. The greater the beamwidth, the closer the
fig. 2. Detail drawing of the horizontal H-frame.
spacing. The one feature all Yagis seem to have in common is greater beamwidth in the H plane than in the E plane. Consequently, H plane spacing will be less than the E plane’s. The locus in this case is an arc of an ellipse. (To visualize an ellipse, picture a hoop rotated about its diameter and viewed at an angle.) Put into usable terms, E plane spacing is the value recommended by Joe Reisert, W1JR and Steve Powlishen, K1FO. Their tabulated data includes the most popular antennas in use today. The vertical stacking dimension is 86.6 percent of the optimum H plane dimension or $S = 0.866 S_H$ where $S_H$ is the optimum H plane stacking dimension recommended for inline stacking.$^{1,2}$

**Horizontal H-frame construction**

Horizontal stacking of horizontally polarized antennas requires the use of dielectric material in the immediate vicinity of the Yagi elements. A minimum distance of $1/2$ wavelength of metal-free structure is recommended, or $1/4$ wavelength beyond the active element tips.$^3$ Detail drawings for the structural parts used to assemble the H-frame are shown in fig. 2. The Cushcraft A32-19 antennas used in the Yagi triangle normally require boom supports supplied by the manufacturer; these are not necessary when mounted on this horizontal H-frame. The upper antenna, however, must be mounted in accordance with the manufacturer’s recommendations (see fig. 3). Within reasonable limits, variations in frame design are certainly permissible.

If antennas other than those shown are used, changes in the overall length of items 1 and 2 might be required. Should it be necessary to make such adjustments, remember that the fiberglass support arms of the H-frame must be located midway between
The TNC-220 is a new, low-cost Packet Terminal Node Controller evolved from the Pac-Comm TNC-200 (TAPR TNC-2). It uses more large scale integrated circuits and fewer components to provide greater functionality, reliability and sensitivity with reduced size and cost. The single-chip modem used for both 300 baud HF and 1200 baud VHF operation has two radio ports. Switching between ports is done entirely in software and no cable changing, no switch setting and no retuning is required! The HF port has an active bandpass filter and provides either FSK or AFSK keying. An optional tuning indicator slides inside the cabinet. A standard modem disconnect header will connect accessory high-speed or satellite modems.

- Two radio ports
- 7910 single-chip modem
- 300 and 1200 bauds
- Enhanced command set
- Multi-color status LED's
- Supports RS-232 and TTL computers
- Active HF bandpass filter
- Tuning indicator option
- 12 volt DC operation
- Premium quality case
- 6wx2"hx7"d

The TNC-220 has the familiar TAPR command set and AX.25 Level 2 Version 2 protocol running on a Z80 processor with 32k bytes of EPROM and 16k bytes of battery-backed RAM. A Zilog 8530 SCC performs all packet HDLC in hardware. The terminal port can select either RS-232 or TTL for your C-64/128, VIC-20 or other TTL computer. Five large, color-coded LED's clearly indicate status at a glance. The power switch is now located on the front panel. The TNC-220 is enclosed in a rugged extruded aluminum cabinet with an attractive two-tone blue front panel. All indicators and controls have large, clear labels.

Tech Line (813) 874-2980
Write For Free Packet Catalog

ORDER DIRECT 800-223-3511 FREE UPS BROWN
Pac-Comm Packet Radio Systems, 3652 West Cypress St., Tampa, FL 33607

DX on 160, 80 and 40 meters with your own SECRET WEAPON

Alpha Delta's new DX-A Twin Sloper Antenna combines the tremendous power of the quarter wave sloper with the wide bandwidth of a half wave dipole. Easy to install, simple to tune.

- 160 and 40 m leg approx. 55' long. 80 meter leg 67" long. Installs just like an inverted V. Fed with single 50ft feedline
- Current lobe up high for maximum radiation. Can be installed between 25 and 40 feet
- Broad band performance. Although bandwidth is determined by your installation, tests have shown 85 kHz on 160m, 200 kHz on 80m, and full coverage of 40m. Tuner usually not required.
- No lossy traps. A single "ISO-RES," isolator/resonator coil is used to tune 40 and 80 meters
- Rated at 1.5 KW output
- Quality hardware and UV protected coil. Stainless steel ensures excellent all weather performance.

$49.95 ready to install

Available from your local Alpha Dealer or add $4.00 shipping and handling. (USA only)

ALPHA DELTA COMMUNICATIONS, INC.
P.O. Box 571, Centerville, Ohio 45459
(513) 435-4772 Order line (513) 375-4180 Tech line (antennas only)

131

May 1987
the director elements of the antennas as shown in fig. 3.

**material sources**

I made use of readily available material. A local metal fence supply dealer stocked aluminum pipe and was also equipped with Heliarc welding facilities, which became very useful while constructing the H-frame. The 1-1/2 inch diameter fiberglass tubing, available in 5-foot lengths and used for satellite antenna work, was purchased from my local Amateur Radio dealer.

Because the inside diameter of the 1-1/2 inch aluminum pipe measures slightly more than 1-1/2 inches, it was necessary to shim the fiberglass tubing with glass filament tape to achieve a tight fit. The assembled frame and the three Yagis mounted on top of the tower are shown in fig. 3. All that remained at this point was choosing a feedline and deciding on a power divider method. A 50-ohm impedance, 7/8-inch hardline had already been installed with the previous array. The phasing harness and feedline around the rotator used more flexible RG-8U.

Use good quality cable for the harness. Each leg must be cut to equal electrical lengths, preferably from the same run of cable. Each antenna must be parallel to the others — elements as well as booms — and the most forward director element of all three Yagis must be located within the same vertical plane. Otherwise, the wavefront launched by any one individual antenna will be out of phase with the others, resulting in lower gain, greater sidelobes, and possible multipath propagation. Phasing lines, besides being equal in length, should be kept as short as possible, especially at higher frequencies. Mounting the power divider as shown in fig. 3 allows shorter harness leads.

**three-way power divider**

Obtaining a three-way power divider meant building one from scratch, because I couldn’t locate any commercial units. So I went back to the books and set off on a thorough search of local supply houses for appropriate hardware.

To my knowledge, two methods for power splitting are commonly used. Most popular is the transformation of impedance by the use of a single 1/4 wavelength of coaxial transmission line. A common input port is located at one end and the required number of output ports at the other end. The characteristic surge impedance is determined as the mean value between transmitter output impedance and the parallel combined load impedance presented by the three antennas. Manufacturers of communications equipment have standardized their products for use with 50-ohm coaxial line. This simplifies the mathematics to determine power divider impedance when using more than one Yagi. Reduced to its simplest form, the equation for characteristic surge impedance for the above power divider becomes:

\[
Z = \frac{Z_0}{\sqrt{n}} = \frac{50}{\sqrt{n}}
\] (1)

where \( n = \) number of antennas in array, \( Z_0 = \) impedance of each antenna and equals the transmitter output impedance of 50 ohms.

Using eqn. 1, the characteristic impedance is:

\[
Z = \frac{50}{\sqrt{3}} = 28.9 \text{ ohms}
\]

To determine the proper diameter ratio for coaxial line
WHAT'S REALLY HAPPENING IN HOME SATELLITE TV?

STV THE HOME SATELLITE TELEVISION MAGAZINE

A monthly of 100-plus pages—has everything you need to know about where to find equipment, how to install it, system performance, legal viewpoints, and industry insights! With your subscription to STV you will receive a FREE LCD Calendar/Clock.

* Only $19.95 per year (12 monthly issues)
* $1.00 for sample copy

STV®/OnSat®

WHAT'S REALLY HAPPENING IN HOME SATELLITE TV?

The best in satellite programming! Featuring: ★ All Scheduled Channels ★ Weekly Updated Listings ★ Magazine Format ★ Complete Movie Listing ★ All Sports Specials ★ Prime Time Highlights ★ Specials Listing and ★ Programming Updates!

* Only $45.00 per year (52 weekly issues)
* 2 Years $79.00 (104 weekly issues)
* $1.00 for sample copy

Visa® and MasterCard® accepted (subscription orders only). All prices in US funds. Write for foreign rates.

Send this ad along with your order to:

STV®/OnSat®

P.O. Box 2384—Dept. HR • Shelby, NC 28151-2384
SUBSCRIPTION CALLS ONLY
TOLL FREE 1-800-438-2020

May 1981

with the above impedance, the following relationship is used:

\[ \frac{a}{b} = \text{antilog} \left( \frac{Z}{138} \right) = 1.62 \]

where:
- \( a \) = Inside diameter of outer conductor
- \( b \) = Outside diameter of inner conductor
- \( Z \) = Characteristic surge impedance of coaxial line in the power divider.
The above diameter ratio \((a/b)\) can be closely satisfied by using standard 3/4-inch diameter copper plumbing tubing (which actually measures 7/8 inch diameter) and 1-1/2 inch diameter brass tubing with 0.02-inch wall, normally used for kitchen sink drains. It can be purchased without the usual nickel plating at most plumbing supply stores.

To cap each end of the 1/4-wavelength line, it’s necessary to machine 1-1/4 inch NPT brass cleanout plugs and end caps to the dimensions shown in the detail and assembly drawing for the three-way power divider (fig. 4).

Suitable connectors for this application are the familiar UHF type with 1/2-28 thread mounting capability. Amphenol 83-875 or equivalent can be used. By removing the snap ring, the connector can be dismantled and soldered to the body of the divider. Otherwise, excessive heat will destroy the insulator insert. To simplify assembly, it was necessary to include what at first would seem to be two unnecessary steps: first, the addition of a banana plug and jack at the input end of the line, to allow for adjusting the position of the inner conductor when you’re soldering to output ports; and second, the drilling of three tapped holes (1/2-28) at the output end to hold coax connectors in place while you solder them to the 1-1/2 inch diameter brass tubing.

The power divider shown in figs. 5 and 6 is the 432 MHz version of the above. Also, a scaled-down H-frame for a 432-MHz Yagi triangle is shown in fig. 7. (Although the antennas shown aren’t representative of 144-MHz proportions, the reader may find the photos helpful nevertheless.) For further harness detail, see fig. 8A. The alternate power divider method (fig. 8B) requires 86.7-ohm impedance transformation sections of coaxial line in each leg of harness to the antennas.

\[ Z = Z_0 \sqrt{n} \]  

A 1/4 wavelength of RG-62/U cable whose impedance is 93 ohms should work well. However, transmitter power must be limited to a couple of hundred watts. With higher power, use of RG-63/U is recommended. The velocity factor for both cables is 86 percent, which makes the overall length (including connectors) of the 1/4-wavelength sections 17 inches.

A three-way “T” junction must be used at the feed point. A weathertight metal junction box with closely spaced coaxial connectors will easily satisfy the short junction lead lengths required at the distribution point. A variation of the above division method is shown in fig. 8C. The three 1/4-wavelength sections as well as the three 50-ohm harness cables are replaced with equal lengths of RG-62/U. The three lengths, however, must be odd multiples of 1/4 wavelength each.

Before connecting the harness to the power divider, best results will be obtained if each antenna is separately adjusted for best SWR using that leg (i.e., the same length) of feedline intended for the harness. After adjustments have been made, connect the power divider to the antennas and feedline. Measure the SWR of the assembled array. In some cases, the
The final SWR measurement will appear to be better than that of the individual Yagis. Offhand this would seem to indicate an improvement to the system; however, this may not necessarily be so since the SWR measurements, other than 1:1, simply indicate the presence of a reactive load. The reactance, which can be either inductive or capacitive, depends upon how far the operating frequency is from the center frequency of the antenna and on the adjustment of the matching device at the individual antennas.\footnote{\textsuperscript{1}} The inductive reactance of one antenna can cancel out, in part or completely, the capacitive reactance of another so that the resulting sum can be less than that of the individual antenna. Other than becoming more broadband (i.e., having lower $Q$), this does not imply that gain performance of the stacked array will be enhanced in any way. The SWR, as previously measured at the individual antennas, still exists and should be adjusted for the lowest ratio attainable or the maximum forward gain will be degraded accordingly. Once assured that the individual as well as the overall system SWR measurements are satisfactory, the Yagi triangle is ready for use.

**E plane plot**

The E plane plot shown in fig. 9 indicates a half-power, 15-degree beamwidth. This was determined by the 48.5-percent method described by Gunther Hoch, DL6WU.\footnote{\textsuperscript{2}} A comparison of the E plane plot of four stacked NBS-17 antennas with that of the Yagi triangle shows very little variation.\footnote{\textsuperscript{3}} In fact, the front-to-back response seems to be better with the triangle. This might be attributed to the trigon reflectors on the Cushcraft A32-19 antennas used in the Yagi triangle.
For best gain, to work distant repeaters, FM Simplex, Sideband or Packet, 215WB is the choice of more active hams. For gain and directivity in a limited space, 124WB, with wideband technology, is the newest Boomer.

Both models include time proven computer designed features with T match driven elements for lowest SWR over the entire two meter band. The strong construction is heavy wall tubing, solid aluminum rod elements plus all stainless steel hardware, and precision machine formed components. You will also like the quick easy assembly of these antennas.

Make Boomer your choice today for more 2 meter enjoyment.

**SPECIFICATIONS**

<table>
<thead>
<tr>
<th>124WB</th>
<th>215WB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency MHz</td>
<td>144-148</td>
</tr>
<tr>
<td>Gain</td>
<td>Excellent</td>
</tr>
<tr>
<td>F/B Ratio dB</td>
<td>Excellent</td>
</tr>
<tr>
<td>Boom length ft</td>
<td>4</td>
</tr>
<tr>
<td>Beam width Deg.</td>
<td>2 x 30</td>
</tr>
<tr>
<td>E Plane</td>
<td>2 x 42</td>
</tr>
<tr>
<td>H Plane</td>
<td>2 x 30</td>
</tr>
<tr>
<td>Weight lbs</td>
<td>3</td>
</tr>
</tbody>
</table>

**SHOULD BE ON THE TOWER**

**ANT FACTS**

**ELECTRICAL HAZARDS**

You should consider the location of powerlines when selecting an antenna site. In addition to being very dangerous, powerlines are a source of noise and could interfere with your antenna's performance.

Maintain as much separation possible between your antenna installation and powerlines. During installation, insure that the antenna and its support cannot come in contact with electric cables.

Safety is always important. You should be particularly aware of safety during the planning and installation of antennas.
Word is spreading fast—Nothing matches the KRP-5000 for total performance and value. Not GE, not even Motorola."

RF performance really counts in tough repeater environments, so the KRP-5000 receiver gives you 7 helical resonators, 12-poles of IF filtering, and a precise Schmitt trigger squelch with automatic threshold switching. The transmitter gives you clean TMOS FET power.

**KRP-5000 REPEATER**

SEE US AT DAYTON BOOTH 106, 107 & 108

**THE FIRST CHOICE IN**

Transmitters - Receivers - Repeaters - Power Amplifiers - Voice Mail Systems

No attempt was made to plot the H plane pattern, since no facilities to do so were available. It’s my guess that the pattern would very much resemble that of two vertically stacked A32-19 antennas. Since I expect to duplicate the Yagi triangle at higher frequencies in the near future, a smaller array will be more manageable for the setup required to make H plane measurements.

**antenna rotators and resolution**

As the gain of a beam antenna system is increased, the beamwidth gets smaller until the point at which the resolving capability of the rotating system reaches a practical limit.

Most rotators available for Amateur use are geared to rotate at 1 rpm. The indicator on the control unit is graduated in divisions of 5 degrees. This means that rotation occurs at a rate of 6 degrees per second, or to put it in more dramatic terms, **less than one second per division**. A 15-degree segment (three divisions) will be scanned in 2.5 seconds.

To fix a beam heading, the antenna rotation between first nulls on either side of the main lobe shouldn’t take less than 5 to 6 seconds. A main lobe with 15-degree beamwidth will have approximately 30 degrees between first nulls. Therefore, 1-rpm rotators will perform at the limit of their resolution capability. Antennas with beamwidths less than 15 degrees should be rotated with slower-speed devices. Aircraft prop-pitch motors are often used for this purpose. Manufacturers of one or two commercial rotators available for Amateur use claim dual speed, but the load capability of these units isn’t sufficient for the size...
of the 144-MHz antenna array that would require the lower speed.

Used with 1-rpm rotators, antennas with less than 15-degree beamwidth require rocking the rotation back and forth several times to attain true beam heading. The problem is further compounded because of play (backlash) inherent in all such devices.

Still another resolution gremlin is the inertia that builds up during antenna rotation, causing long-boom Yagis to whip laterally when rotation is suddenly stopped. Many of these antennas have boom braces to keep them from sagging. However, the brace does little or nothing for the side motion. Heavy gusts of wind will also cause lateral flexing with these antennas. Though the two lower antennas of the Yagi triangle aren’t prone to this problem because of the H-frame construction, the upper antenna does occasionally do a little dancing. Polypropylene guys from the upper antenna to the H-frame should remedy this problem.

Rotation at 1 rpm seems like a long enough period of time for a complete 360-degree turn of the antenna, and many of us — myself included — wouldn’t relish the thought of extending the time. Therefore, antenna arrays with beamwidths of 15 degrees, or perhaps by stretching a point or two, even 14 degrees, should satisfy the resolution capability limits of 1-rpm rotators. This Yagi triangle is such an antenna.

performance

The triangle-stacked Cushcraft A32-19 antennas certainly perform better than the original dual stack. The theoretical 1.75-dB increase in signal seems to mock the theoretical 3 dB originally obtained while using the dual stack. ORP signals, unheard before, are now Q5 copy. Reports on my signal are almost always complimentary.

Raising or lowering the tower with the triangle stack is a one-man operation. Repeated inquiries about the triangle stack seem to indicate that others would like to give it a try. Anyone interested in a totally different approach for stacking Yagis will find building the Yagi triangle a worthy and rewarding effort.

references


ham radio
NEW ENGLAND FACTORY-AUTHORIZED SALES & SERVICE
FOR
KENWOOD

Also displaying the popular accessories needed to complete a HAM STATION . . .

ARRL PUBLICATIONS • AEA PRODUCTS • AMPHENOL
• ALPHA DELTA • ASTRON • AUSTIN ANTENNAS • AVANTI
• Belden • Bencher • B & W • DAIWA • ALINCO
• HUSTLER • KLM • LARSEN • MIRAGE • ROHN
• TELEX/HY-GAIN • TOKYO HY-POWER LABS
• TRAC KEYERS • VIBROPLEX • WEILZ • ETC.

OPEN SIX DAYS A WEEK

Telephone 617/486-3400, 3040
675 Great Rd., (Rte. 119) Littleton, MA 01460
1½ miles from Rte. 495 (Exit 31) toward Groton, Mass.

FREE CATALOG!
Features Hard-to-Find Tools and Test Equipment

JENSEN'S new catalog features hard-to-find precision tools, tool kits, tool cases and test equipment used by ham radio operators, hobbyists, scientists, engineers, laboratories and government agencies. Call or write for your free copy today.

JENSEN TOOLS INC.
Dept. HR
7815 S. 46th Street
Phoenix, AZ 85044
(602) 963-6241

ANTENNA STANDARDS

NEW FREE CATALOG NOW AVAILABLE
IXX EQUIPMENT LTD.
P.O. Box 9 Oaklawn, IL 60454
(312) 423-0605

Stone Mountain Engineering Co.
Box 1573 • Stone Mtn., GA 30086

The QSYer - the best thing next to your FT-757GX - or your ICOM IC-735!

The popular FT-757QSYer now has a brother - the 735 QSYer for the ICOM IC-735! Both units are deluxe
frequency- entry keypads
containing their own pre-
programmed micropro-
cessor, audio speaker and
power supply. In operation,
they allow immediate
switching to any frequency
in the transceiver’s range, while the rig retains absolutely all of its
operator’s controls. They install in seconds, connecting to the rig’s
data terminal and power supply output. Their durable metal
enclosures are painted classic metallic gray and black.$99.50 plus $2.50 shipping and handling, and 4½% sales tax for GA
residents. MasterCard and Visa customers please send name, card
number, expiration date, and signature, or call us at 404-879-0241.
10 day money-back guarantee.

In Canada, call Atlantic Ham Radio, Ltd., at 416-831-9636.

SPECIAL
KENWOOD
TM-3530A
25 watt
CALL FOR PRICE

NEW
Novice Band
220 MHz
Equipment & Antennas
In Stock

May 1987
In the northern areas, winter is almost over and signs of spring are in the air. It's a good time to think about antenna systems. A lot of interesting antenna concepts have just been waiting for some good weather to set in! Here are some interesting projects for you to consider . . .

inexpensive base station antenna for 2 meters

I think Fred Dietrich, NM6J, has come up with a winning 144-MHz antenna that has decent gain and a low SWR, and costs very little to construct. Shown in fig. 1, this vertical, omnidirectional array is only about 6 feet tall. The antenna structure is made of a length of 3/4-inch Schedule 40 (thick wall) PVC water pipe. The overall pipe length is long enough so that the antenna can be supported by clamps at the base end. For this particular installation, an 8-foot length of PVC was selected. The top of the pipe is closed with a PVC cap cemented in place using the liquid sealer that applies to such material.

The radiating portion of the antenna is a No. 12 copper wire 51.75 inches long. Enough extra wire is added to this length to allow it to be attached to the cap with PVC cement and to form a solder connection to the coax line at the base of the antenna.

Two phasing sleeves are used. They're made of galvanized hardware cloth folded around the PVC pipe and wrapped with wire to hold them in place. Each sleeve is 17.25 inches long. The retaining wires are soldered to the hardware cloth at several points around the circumference.*

A short jumper wire joins the top of the upper screen to the antenna wire running inside the PVC tubing. It is suggested that this wire be soldered to the antenna wire and then fished out through a small hole drilled in the PVC wall. If this and the following step are done before the top PVC cap is fastened in place, the assembly will proceed smoothly.

A second phasing sleeve is affixed to the structure below the first, as shown in fig. 1. This sleeve is connected to the outer shield of the coax line by means of a short length of wire inserted through a second hole after the antenna wire has been passed within the PVC pipe. After assembly, the holes are filled with cement to make the assembly waterproof.

The antenna is mounted in a vertical position and the coax line is brought down directly below the antenna. A VSWR plot representative of the antenna's performance is shown in fig. 2.

a "rubber duckie" for 160 meters

The ham who lives on a small, treeless lot faces a real problem when contemplating 160-meter operation. One solution to this problem is a vertical antenna. But a quarter-wave vertical antenna on "top band" is over 130 feet high. Joe Moraski, KY3F, has a solution to the problem. He recommends a helix antenna operating in the normal mode— that is, a coil with a small diameter compared to the operating wavelength. Maximum radiation is normal to the axis, hence the name. This is the same mode of operation as that of the 2-meter "rubber duckie" antennas used on handhelds.

*Though more expensive copper-based hardware cloth would maintain its electrical properties longer. — Ed.
a top hat is added to reduce antenna $Q$ and add capacitance at the high voltage point. The resulting reduction in circuit $Q$ causes the feedpoint impedance at the antenna base to vary less rapidly with frequency change than the unloaded antenna. This means that the antenna can be used over a larger portion of the band than would otherwise be possible.

By experiment Joe found that a 20-foot antenna was a good operating compromise. Accordingly, he used two 12-foot sections of 4-inch diameter PVC water pipe cemented together to make a 24-foot mast. He wound No. 18 insulated hookup wire on it at ten turns-per-inch spacing. This helix, in combination with a screen wire capacitance hat on top, resonated in the 160-meter band when operated against a ground rod and quarter-wave counterpoise wire run around the backyard. Four 30-foot radials were added. A sketch of the antenna is shown in fig. 3.

The construction is simple if done in the proper sequence. The first step is to drill holes for the end tie bolts that terminate the winding. The holes are 10 feet apart. Galvanized bolts are used, with washers on each side of the PVC pipe. With a tape measure and felt-tip pen, make small marks at 1-inch intervals between the bolts.

Next, fasten an eye-lug to one end of a 140-foot length of No. 18 insulated wire. Fasten the lug to one bolt and wind the coil on the PVC pipe, using the pen marks as a guide — one turn per mark. Use tape to hold the coil in place as you progress along the form. Wind the wire as tightly as you can and when you reach the second terminating bolt, cut the wire and place an eye-lug on the end that will fit over the bolt.

With the winding properly spaced, run a bead of RTV along the length of
GET ON THE AIR
WITH THE BEST

All Novices Can Now TALK on 220MHz, 10 meters and 1.2GHz.

ICOM extends congratulations to privilege-enhanced Novices, and invites everyone to extend their horizons with ICOM!

ICOM is the only amateur radio manufacturer hosting a full product line especially geared toward privilege-enhanced Novices (and Technicians joining 10-meter activity). Whether your interests include 1.2GHz, 220MHz, HF bands, FM, CW, or SSB, choosing ICOM gear means going First Class!

Explore 1.2GHz DX attractions and local activities with pacesetting ICOM gear. The all mode IC-1271A base station transceiver includes numerous deluxe features and is expandable with your future interests. FM mobiling pleasures begin with ICOM's new 10 watt IC-1200 which is easy to install and operate. Every amateur enjoys handheld portable operations, and ICOM's deluxe IC-12AT handheld is ready to go.

Experience 220MHz activities using high quality ICOM equipment. For your multi-mode interests is the new IC-375A 25-watt base station transceiver: a true masterpiece of modern technology. ICOM's ultra slim IC-37A and compact IC-38A are ideal 25-watt mobile units. For a versatile and rugged handheld, choose the deluxe IC-03AT or the ever-popular IC-3AT.

Enjoy HF QSOs worldwide and depend on ICOM transceivers for top communications performance. The exciting new IC-761 offers you superb "everything in one cabinet" operation. Or there's the ICOM deluxe midsize transceivers, the IC-751A and IC-745. The IC-735 is today's most popular fixed/mobile rig. Also, friends, all ICOM HF transceivers include a full one-year warranty.

ICOM Accessories are interchangeable. Use them with ICOM's 2-meter and 440MHz gear when you upgrade!

Get on the Air with ICOM and explore 1.2GHz, experience 220MHz, and enjoy HF QSOs.
The standard of the electronics industry is selling a new standard for amateur radio use as well.

The Fluke 77 multimeter is ideal for testing and repairing any amateur radio gear. It's inexpensive, easy to use, and filled with professional features. Plus a full line of accessories let you measure high frequency, high voltage and current, and temperature. Made in the U.S.A. and backed by a 3-year warranty, the new Fluke 77 is the world's first handheld meter to combine analog and digital displays.

For a free brochure or the distributor nearest you, call toll-free 1-800-227-3800, ext. 229, or write John Fluke Mfg. Co., Inc., P.O. Box C9090, Everett, WA 98206. Distributor programs available.

FROM THE WORLD LEADER IN DIGITAL MULTIMETERS.

FLUKE 73
$150
- Analog/digital display
- Volt, ohm, 10A, diode test
- Auto-ranging
- 0.7% basic dc accuracy
- 2000 + hour battery life
- 3-year warranty

FLUKE 75
$165
- Analog/digital display
- Volt, ohm, 10A, diode test
- Auto-ranging
- 0.7% basic dc accuracy
- 2000 + hour battery life
- 3-year warranty

FLUKE 77
$200
- Analog/digital display
- Volt, ohm, 10A, diode test
- Auto-ranging
- 0.7% basic dc accuracy
- 2000 + hour battery life
- 5-year warranty
- Multipurpose holder

The two pipe sections are now joined with a plastic pipe splice section and PVC cement. Align them quickly and let the joint dry (fig. 4). Some PVC pipes have a built-in coupling joint — nice if you can locate one. For added strength, run four No. 10 self-tapping sheet metal screws through the joints where the PVC pipes and splice section overlap. Finally, connect a wire jumper between the two coils to form one 20-foot coil.

The next step is to make the "top hat." A section of 1/2-inch mesh chicken wire or drywall screen can be used. Wrap it into a cylinder about 1 foot in diameter and 4 feet long. Solder the overlapping wires. Drill the cap piece of the antenna for a No. 10 bolt, which is bolted through the overlap portion of the top hat. Use large washers on each side of the screen to enhance stability. Then run four No. 18 sheet metal screws through the screen and cap to keep the screen from turning or buffeting in the wind (see fig. 5).

The final step is to attach the top hat to the top of the helix with a jumper wire. Glue the top hat in place and pass four sheet metal screws through the hat to hold it securely to the PVC pipe.
We just struck gold with a miniature, high quality and very reliable DTMF decoder at a rock bottom price of $59.95. Our DTD-1 will decode 5040, 4 digit codes with the security of wrong digit reset. It contains a crystal controlled, single chip DTMF decoder that works great in bad signal to noise environments and provides latched and momentary outputs. Why carry that heavy gear when its size is only 1.25 x 2.0 x .4 inches and it comes with our etched in stone, legendary, one year warranty.

Instead of sifting through the field...searching, use our super quick one day delivery and cash in on a rare find.

$59.95 each
THE STANDARD OF EXCELLENCE
Definitely Superior!
AZDEN PCS-5000
COMMERCIAL — GRADE

UNPRECEDENTED WIDE FREQUENCY RANGE: Covers 140.000-153.000 MHz in steps that can be set to any multiple of 5 Khz up to 50 KHz.
CAP/MARS/NAVY MARS, BUILT IN: The wide frequency range facilitates use of CAP and ALL MARS FREQUENCIES including NAVY MARS. COMPARE!
TINY SIZE: Only 2 inches high, 5 1/2 inches wide and 7 1/4 inches deep!
MICROCOMPUTER CONTROL: Gives you the most advanced operating features available.
UP TO 11 NONSTANDARD SPLITS: COMPARE this with other units!
20 CHANNELS OF MEMORY IN TWO SEPARATE BANKS: Retains frequency, offset information, PT tone frequency.
DUAL MEMORY SCAN: Scan memory banks separately or together. ALL memory channels are tunable independently. COMPARE!
MEMORY SCAN LOCKOUT: Allows you to skip over channels you don't want to scan.
TWO RANGES OF PROGRAMMABLE BAND SCANNING: Limits are quickly reset. Scan ranges separately or together with independently selective steps in each range. COMPARE!
BUSY SCAN AND DELAY SCAN: Busy scan stops on an occupied channel. Delay scan provides automatic auto-resume.
DISCRIMINATOR CENTERING (AZDEN EXCLUSIVE PATENT): Always stops on frequency desired when scanning.
PRIORITY MEMORY AND ALERT: Unit constantly monitors one memory channel for signals, alerting you when channel is occupied.
LITHIUM BATTERY BACKUP: Memory information can be stored for up to 5 years even if power is removed.
FREQUENCY REVERSE: Allows you to listen to repeater input frequency.
ILLUMINATED KEYBOARD WITH ACQUISITION TONE: Keys are easily seen in the dark, and actuation is positively verified audibly.
CRISP, BACKLIT DISPLAY: Easily read no matter what the lighting conditions!
DIGITAL S/RF METER: Shows incoming signal strength and relative transmitter power.
MULTIFUNCTION INDICATOR: Shows a variety of operating parameters on the display.
FULL 16-KEY TOUCH TONE PAD: Keyboard functions as autopatch when transmitting.
MICROPHONE CONTROLS: Up/down frequency control and priority channel recall.
PT TONE GENERATOR BUILT IN: Instantly program any of the standard PL frequencies into the microcomputer. COMPARE!
TRUE FM, NOT PHASE MODULATION: Unsurpassed intelligibility and audio fidelity. COMPARE!
HIGH/LOW POWER: Select 25 watts or 5 watts output — fully adjustable.
SLOPE GENERATOR: Sensitivity is better than 0.15 microvolt for 20-dB quieting. Commercial-grade design assures optimum dynamic range and noise suppression. COMPARE!
DIRECT FREQUENCY ENTRY: Streamlines channel selection and programming.
OTHER FEATURES: Rugged dynamic microphone, built-in speaker, mobile mounting bracket, remote speaker jack, and all cords, plugs, fuses and hardware are included.

EXCLUSIVE DISTRIBUTOR: DEALER INQUIRIES INVITED FOR YOUR NEAREST DEALER OR TO ORDER:
AMATEUR-WHOLESALE ELECTRONICS  TOLL FREE...800-327-3102
46 Greensboro Highway, Watkinsville, Georgia 30677  Telephone (404) 769-8706  Telex: 4930709 111

MANUFACTURER:
JAPAN PIEZO CO., LTD.
1-12-17 Kamirenjaku, Mitaka, Tokyo. 181 Japan
Telex: 781-2822452
To make the pivot joint, insert a section of 2x4 lumber within the PVC tubing. Fasten this extension to the 4x4 ground post with one lag bolt, used as a pivot. (See fig. 6 for details.) Bolt the 2x4 and 4x4 together, with the 2x4 in a vertical position. Then raise the antenna to a vertical position and drop it down over the 2x4 section. When the antenna is in the final position, it will sit atop the 4x4 post with the 2x4 section acting as a positioning guide. Various views of the installation are shown in the accompanying photographs.

When completed, the radials and outer shield of the coax line are connected together and the inner conductor is connected to the helix by a short length of wire. The open end of the coax is taped and covered with RTV to keep water out.

As shown, the antenna is resonant at the top end of the 160-meter band. Four close-spaced turns were added at the bottom of the antenna to bring the resonant frequency down to 1.94 MHz. By picking the part of the band you wish to use most and adjusting the extra turns at the antenna base, you can resonate the antenna at any spot in the band you wish. SWR plots of Joe’s antenna are shown in fig. 7.

Joe says the helix seems stable without any guy ropes, but recommends that ropes be added if the antenna is in an exposed, windy location. Light nylon guys would do the job.

**BATTERY MEMORY ADAPTER for KWM-380 TRANSCEIVER**

- Easy installation
- WARC frequencies
- No board modifications
- Plugs into ROM socket
- Battery sealed in memory IC
- Ten year battery life
- All memories and A/B VFO saved
- Top quality construction
- $149 (shipping cont. USA included)
- SASE for flyer & Special Price

Kiron Corporation, 1516 Essex Road Columbus, Ohio 43221

---

**MISSION COMMUNICATIONS**

11903 Alief Clodine Rd #500
Houston, Texas 77082
713-879-7764
telex 166872 MCON UT (MC/VISA/COD)

---

**COMMODORE 64 LADDER NETWORK ANALYSIS PROGRAM “ALADYN-64”**

This program is a menu-driven design tool with a built-in circuit file editor, fast calculations and graphic output to either the screen or printer. Useable for circuits which operate from VLF through Microwave. Circuit elements include Rs, Ls, Cs, transmission lines, transistors and FETs. Output format rectangular or Smith chart.

$59.95 PPD. Check or M.O.

INTERCEPTOR ELECTRONICS INC.
ROUTE 1, BOX 439, ROUND HILL, VA 22141-9307 PHONE (703) 338-4905

---

**Invitation to Authors**

*ham radio* welcomes manuscripts from readers. If you have an idea for an article you’d like to have considered for publication, send for a free copy of the *ham radio* Author’s Guide. Address your request to *ham radio*, Greenville, New Hampshire 03048 (SASE appreciated).

---

**NEW... 2 meter squared SSB mobile $45.**

* Bug Catchers... still the best HF mobile antenna 250 watt & 1kw sizes 80-10-meters (we pay shipping on above items)

**Call for other antennas available—both commercial and amateur**

---

**Photo 3. Joe, KY3F, standing beside his 160-meter "Rubber Duckie."**

**fig. 7. "Rubber Duckie" for 160 meters has 2:1 bandwidth SWR over 110 kHz. Antenna was adjusted for 1940 Hz.**
For art supplies, kits and economical equipment to produce at home professional quality printed circuit boards... ask for the pro's - Kepro Circuit Systems, Inc. Kepro has been producing prototype and short run equipment, as well as providing PCB supplies to industrial companies for years. Their specialized expertise and knowledge provides the home hobbyist an economical and convenient source of equipment and supplies for a professional, one-of-a-kind, printed circuit board.

Shears, etchers, sensitized and unasemblised copperclad laminates, art supplies, kits and Keproclad... all you need to make a professional quality printed circuit board at home and at a cost you can afford.

Kepro, your one stop source for at home PCB's.

Write or call Kepro for their catalog and price list:
1-800-325-3878 or 1-314-343-1830 (MO)
630 Grumbine Drive, Fenton, MO 63026-2992.

---

Introducing the Jo Gunn
10 Meter Antennas
Jo Gunn Enterprises
Route 1, Box 383
Ethelsville, AL 35461
(205) 658-2595 or 658-2229

OTHER DIRECTIONAL MODELS
ALSO AVAILABLE

JOGLAR - PISTOL
JOGLAR - HILLBILLY

Specifications
Gain: 4.75 DB
Multiplication Factor: 12 Times
Power Rating: 2000 CW, 4000 PEP
Height: 11 Feet
Weight: 8.0 Lbs.
Material: Anodized 6063T6 Aircraft
Aluminum Tubing
Requires 1 Coaxial Cable for Hook-up

Call or Send $2.00 for Complete Catalog and Pricing of Antennas.
($2.00 Refundable on 1 st Order.)

DEALER INQUIRES, PLEASE CALL

---

Iron Powder and Ferrite
TOROIDAL CORES
Shielding Beads, Shielded Coil Forms
Ferrite Rods, Pot Cores, Baluns, Etc.

Small Orders Welcome
Free 'Tech-Data' Flyer

AMIDON
Since 1963

12033 Otsego Street, North Hollywood, Calif. 91607

In Germany, Elektronik-Ven. Wilhelm — Mellies Str 88, 4930 Detmold 18, W. Germany
In Japan, Toyotani Electronics Company, Ltd. T 79 2 Chome Sota Kanda, Chiyoda Ku, Tokyo, Japan

---

CADDELL
COIL CORP.

35 Main Street
Poulton, VT 05764
802-287-4055

BALUNS
Get POWER to your antenna! Our Baluns are already wound and ready for installation in your transmatch or you may enclose them in a weatherproof box and connect them directly at the antenna. They are designed for 3-30 Mhz operation. (See ARRL Handbook pages 19-9 or 6-20 for construction details.)

100 Watt (4 5 6 9 1 1-1 Impedance—select one) $10.50
Universal Transmatch 1 KW (4 1 Impedance) 14.50
Universal Transmatch 2 KW (4 1 Impedance) 17.00
Universal Transmatch 1 KW (6 9 1 9 1-1—select one) 16.00
Universal Transmatch 2 KW (6 9 1 9 1-1—select one) 18.50

Please send large SASE for info.

---

Subscribe Today
Call Toll Free
(orders only)
1 (800) 341-1522
Have your credit card ready
Ham Radio Magazine
a 2-meter halo antenna

After obtaining a 2-meter multimode radio and operating it mobile for a short time, I came to a conclusion: 2-1/2 watts output and a 5/8-wave vertical wasn’t good enough.

I decided to improve the antenna first; I could install my small 80-watt amplifier later for long trips. I decided to build a 2-meter halo since I’d worked several mobile stations who were using them, and they seemed to do a good job.

construction

The halo is a half-wave dipole bent into a circle (fig. 1). To make the insulator mounting block (fig 2), cut a piece of 1/2-inch thick plastic into a 2-1/2 by 3-inch rectangle. Cut a slot and drill the holes as shown in fig. 2.

The driven element or dipole is made from a 38-inch long, 3/8-inch diameter piece of copper tubing. Mark the center of the piece of tubing and bend it into a hoop measuring 12 inches in diameter. Drill a 9/64-inch hole at the top of the center mark on the dipole element. Secure the dipole element to the mounting block by inserting a screw through the dipole element and mounting block. Fasten with a lock-washer and nut. Insert a small piece of 5/16-inch diameter wood dowel into the ends of the halo element, leaving a 1-1/2 inch gap between the tubing ends. This completes the main element of the halo (see fig. 1).

To assemble the rest of the halo, refer to fig. 3. Mount the small plastic box under the insulator mounting block.

Following the details shown in fig. 3, drill the holes in the box and install the coax connector and gamma match capacitor. A variable capacitor of about 35 pF will work fine.

A 6-inch length of 3/8-inch diameter copper tubing is used for the gamma rod. Bend it around the halo’s element to form it into a slight circle. Make a shorting bar now so you can secure the gamma rod to the halo antenna. (Any kind of easily bendable metal will work.) Be careful to keep the spacing between the gamma rod and dipole element to about 1-3/4 inch.

Insert one end of the gamma rod into the gamma match box and install the shorting bar on the other end. Lay the halo on its side, with the open end of the gamma box facing up. Apply some 5-minute epoxy around the gamma rod and let it dry. Your halo is now finished and needs only to be tuned.
**The "Flying Horse" sets the standards**

Continuing a 66 year tradition, there are three new Callbooks for 1987.

The North American Callbook lists the calls, names, and address information for licensed amateurs in all countries from Canada to Panama including Greenland, Bermuda, and the Caribbean islands plus Hawaii and the U.S. possessions.

The International Callbook lists the amateurs in countries outside North America. Coverage includes South America, Europe, Africa, Asia, and the Pacific area.

The 1987 Callbook Supplement is a new idea in Callbook updates; it lists the activity in both the North American and International Callbooks. Published June 1, 1987, this Supplement will include all the new licenses, address changes, and call sign changes for the preceding 6 months.

Publication date for the 1987 Callbooks is December 1, 1986. See your dealer or order now directly from the publisher.

- North American Callbook
  - incl. shipping within USA: $28.00
  - incl. shipping to foreign countries: 30.00
- International Callbook
  - incl. shipping within USA: $28.00
  - incl. shipping to foreign countries: 30.00
- Callbook Supplement, published June 1st
  - incl. shipping within USA: $13.00
  - incl. shipping to foreign countries: 14.00

**SPECIAL OFFER**
- Both N.A. & International Callbooks incl. shipping within USA: $53.00
- incl. shipping to foreign countries: 58.00

**fig. 3. Matchbox details.**

**tuning**

Mount the halo 5 to 6 feet above the ground or temporarily attach it to your car. Adjust the spacing on the driven element for minimum reflected-power indication. (Mine was lowest at an 11/16-inch spacing.) Do the same for the shorting bar, sliding it back and forth along the gamma rod. (My lowest SWR was 1 inch from the end of the gamma rod.) The final adjustment is made by tuning the gamma-match capacitor for minimum reflected power. My final SWR is 1.2:1 on the halo.

Remove the halo and seal the gamma match box. Plug the end of the gamma rod with RTV or epoxy. Coat the wood dowel spacer on the driven element with epoxy; this will waterproof it and keep it from slipping. The last step is to spray paint the assembly with a nonlead-based paint.

The 2-meter halo has increased my range significantly. While on vacation in Oklahoma, I worked West Virginia, New Jersey, and Maryland during an E opening. (My normal range is 50 to 100 miles with only 2-1/2 watts.)

One final word of caution: if you build and mount the halo, be prepared for lots of strange stares and questions. You’ll get plenty of them.

Jerry Felts, NR5A

**short circuit**

**MMIC multiplier chains**

In fig. 5 of N6JH’s article, “MMIC Multiplier Chains for the 902-MHz Band” (February, 1987, page 72), all values indicated as “pF” should be corrected to read “μF.” Note too that coil L1, which can be seen just to the left of the crystal and directly above the partially meshed plates of the variable capacitor (fig. 7), is not the same as the coils in the multiplier. L1, which is five turns of No. 24 (AWG), is air-wound with an interior diameter of about 0.2 inches — this dimension is not critical because only broad resonance is needed to select the correct crystal overtone.
The BEST is still “made in U.S.A.”

American made RF Amplifiers and Watt/SWR Meters of exceptional value and performance.

- 5 year warranty
- prompt U.S. service and assistance

**RF AMPLIFIERS**

**2 METERS-ALL MODE**

<table>
<thead>
<tr>
<th>Model</th>
<th>Power (in)</th>
<th>Power (out)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>B23</td>
<td>2W</td>
<td>30W</td>
<td>useable in: 100 mW-5W</td>
</tr>
<tr>
<td>B108</td>
<td>10W</td>
<td>80W</td>
<td>(1W=15W, 2W=30W) RX preamp</td>
</tr>
<tr>
<td>B1016</td>
<td>10W</td>
<td>160W</td>
<td>(1W=35W, 2W=90W) RX preamp</td>
</tr>
<tr>
<td>B3016</td>
<td>30W</td>
<td>160W</td>
<td>(useable in: 15-45W) RX preamp</td>
</tr>
<tr>
<td></td>
<td>10W-100W</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**220 MHz ALL MODE**

<table>
<thead>
<tr>
<th>Model</th>
<th>Power (in)</th>
<th>Power (out)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>C106</td>
<td>10W</td>
<td>60W</td>
<td>(1W=15W, 2W=30W) RX preamp</td>
</tr>
<tr>
<td>C1012</td>
<td>10W</td>
<td>120W</td>
<td>(2W=45W, 5W=90W) RX preamp</td>
</tr>
<tr>
<td>C22</td>
<td>2W</td>
<td>20W</td>
<td>(useable in: 200mW-5W)</td>
</tr>
</tbody>
</table>

**RC-1 AMPLIFIER**

**REMOTE CONTROL**

Duplicates all switches, 18' cable

**WATT/SWR METERS**

- peak or average reading
- direct SWR reading

**MP-1 (HF)** 1.8-30 MHz

**MP-2 (VHF)** 50-200 MHz

**430-450 MHz ALL MODE**

<table>
<thead>
<tr>
<th>Model</th>
<th>Power (in)</th>
<th>Power (out)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>D24</td>
<td>2W</td>
<td>40W</td>
<td>(1W=25W)</td>
</tr>
<tr>
<td>D1010</td>
<td>10W</td>
<td>100W</td>
<td>(1W=25W, 2W=50W)</td>
</tr>
</tbody>
</table>

Available at local dealers throughout the world.

16890 Church St., Morgan Hill, CA 95037. (408) 779-7363
ICOM IC-R71A
Superior Grade General Coverage Receiver
SALE! CALL FOR PRICE

ICOM IC-275A/275H
138 - 174 MHz IC-275A (25w) IC-275H (100w)
GREAT PRICE!

ICOM IC-1271A
1.2 GHz Transceiver:
The First Full-featured 1240-1300 MHz Transceiver
ARE YOU READY FOR 1.2 GHz OPERATION?

ICOM IC-2A
NOW! RAPID DELIVERIES
FROM STORE NEAREST YOU

ICOM IC-735
2-METER MOBILES
IC-28A (25w) IC-28H (45w)
LOW PRICE!

ICOM IC-R7000
The Latest in ICOM's Long Line of HF Transceivers
CALL FOR LOW, LOW PRICE

ICOM IC-02AT
IC-03AT
IC-04AT
IC-2AT
IC-3AT
IC-4AT

HAND-HELD VHF/UHF

ICOM IC-µ2A/µ2AT
Mini Hand-Held AT Model w/ TT Pad
GREAT PRICE!

CALL TOLL FREE (800) 854-6046
Toll free including Hawaii. Phone Hrs. 7:00 am to 5:30 p.m. Pacific Time. California, Arizona and Georgia customers call or visit nearest store. California, Arizona and Georgia residents please add sales tax. Prices, specifications, descriptions subject to change without notice.

Tell 'em you saw it in HAM RADIO!

Worldwide Distribution

Largest Ham Outlet in the World

7 Store Buying Power

Sale! Call for Price

Now! Rapid Deliveries
From Store Nearest You

All Major Brands in Stock Now!
Ham Radio Outlet
LARGEST HAM OUTLET IN THE WORLD

7 STORE BUYING POWER

KENWOOD TS-940S
TOP-OF-THE-LINE HF TRANSCEIVER
GREAT PRICE, CALL

KENWOOD
TM-3530A
The First Comprehensive 220 MHz FM Transceiver
ARE YOU READY FOR 220 MHz OPERATION?

US TOWER CORPORATION
MA-40
40' TUBULAR TOWER
$745 SALE! $549

MA-550
55' TUBULAR TOWER
$1245 SALE! $899
- Handles 10 sq. ft. at 50 mph
- Plessey neighbors with tubular streamlined look

TX-455
55' FREESTANDING CRANK-UP
- Handles 18 sq. ft. at 50 mph
- No guying required
- Extra-strength Construction
- Can add raising and motor drive accessories

IN STOCK FOR QUICK DELIVERY
OTHER MODELS AT GREAT PRICES

HY-GAIN CRANKUP SALE!
Single Strength
(handles 9 sq. ft.)
HG37SS - 37' Tower
HG52SS - 52' Tower
Heavy Duty
(handles 16 sq. ft.)
HG54HD - 54' Tower
HG70HD - 70' Tower
- All steel
- Includes base & rotor plate
- No guying required
- Hot dip galvanized
- Accessories available
CALL FOR PRICE!

HAM RADIO HOME STUDY
NOVICE VOICE COURSE
- Updated novice voice questions
- 6 stereo code & theory cassette tapes
- 2 text books, code oscillator key & battery
- Color Ham Bands wall chart & frequency list
- Sealed novice exam for a Ham friend to give you the code & theory test in your home
- FCC license application forms & instructions to your examiner. Ideal for spouse & the kids!
$49.95

All Major Brands in Stock Now!

CALL TOLL FREE (800) 854-6046

More Details? CHECK—OFF Page 130

May 1987
New PK-232 Breakthrough

Six Digital Modes - Including Weather FAX

Your home computer (or even a simple terminal) can be used for radio data communication in six different modes. Any RS-232 compatible computer or terminal can be connected directly to the PK-232, which interfaces with your transceiver. The only program needed is a simple terminal program, like those used with telephone modems, allowing the computer to be used as a data terminal. All signal processing, protocol, and decoding software is in ROM in the PK-232.

The PK-232 also includes a no compromise VHF/HF/CW modem with an eight pole bandpass filter, four pole discriminator, and 5 pole post detection low pass filter. Experienced HF Packeteers are reporting the PK-232 to have the best Packet modem available.

Operation of the PK-232 is a breeze, with twenty-one front panel indicators for constant status and mode indication. The 240 page manual includes a “quick start” section for easy connection and complete documentation including schematics. Two identical back panel radio ports mean either your VHF or HF radio can be selected with a front panel switch. Other back panel connections include external modem disconnect, FSK and Scope Outputs, CW keying jacks, and RS-232 terminal interface.

The RS-232 connector is also used for attaching any Epson graphics compatible parallel printer for printing Weather Fax. Weather maps and satellite photos, like the one in this ad, can be printed in your shack.

Contact your local AEA dealer today for more information about the one unit that gives you six modes for one low price, the PK-232.

$319.95
AMATEUR NET
$379.95 AEA RETAIL

A new software enhancement makes the AEA PK-232 the only amateur data controller to offer six transmit/receive modes in a single unit.

* Morse Code
* Baudot (RTTY)
* ASCII
* AMTOR
* Packet
* Weather FAX

Brings you the Breakthrough
a no-compromise, multiband, low-VSWR dipole

Back-to-basics design uses capacitor divider/balun for high-efficiency operation

In searching for an effective, balanced feed system for a dipole, I developed an antenna that's efficient, exhibits low VSWR across several bands at the same time, and meets my original objectives. Patented under the title, "Dipole of Delight," its design is based on the use of a capacitive balun at the center of the dipole. The use of capacitors at the midpoint of the dipole allows the resonance currents in the dipole to reach larger amplitudes than are possible when the 50-ohm cable impedance is present as a series resistance. Apart from the copper loss, the principal limitation of resonant currents is the radiation loss. For this reason the capacitor dipole is highly efficient and has a very wide bandwidth.

Before studying the details, one should review the problems associated with the traditional half-wave dipole (see fig. 1), which are chiefly:

• an unbalance that causes an undesirable current on the outside of the shield results in higher levels of electrical noise from local sources on receive, and on transmit provokes annoying rf voltages at the transceiver (i.e., microphone feedback or finger burns); and
• matching problems between free-space impedance (377 ohms), a typical traveling wave on a wire dipole (800 ohms), and the feedpoint impedance of a half-wave dipole, said to be 73 + j 42 ohms.

The first problem experienced with the conventional dipole has traditionally been solved by using a balanced feedline or a transformer balun. Unfortunately, use of a transformer brings its own problems: increased weight; the possibility of saturation and harmonic generation; or introduction of even more inductive reactance, from its leakage reactance, which necessitates shortening the antenna more than the customary 5 percent to achieve resonance.

The next step involves replacing the dipole with its equivalent (resonant) circuit as seen at its center where the voltage is least and the current is maximum. See figs. 1, 2, and 3.

The magnitude of the various components are:

\[ Z_0 = \sqrt{\frac{L}{C}} \]

where \( Z_0 \) = traveling wave impedance
where \( L \) = inductance per meter
and \( C \) = capacitance per meter
traveling wave velocity

\[ v = \frac{1}{\sqrt{LC}} \]

Rearranging terms, the impedance exhibited by a wire can be expressed in terms of velocity and capacitance as:

\[ Z_0 = \frac{1}{vC} \]

Because the velocity of a traveling wave on a wire in air is almost equal to its free-space velocity (3 \( \times 10^8 \) m/s) and the capacitance per meter of a 2-mm (0.08 inch) diameter wire is approximately 4.17 pF, then this same 2-mm diameter wire impedance is:

\[ Z_0 = \frac{1}{3 \times 10^8 \times 4.17 \times 10^{-12}} = 800 \text{ ohms} \]

The circuit can be considered to consist of two equal and opposite sign reactances (800 ohms) that correspond to two oppositely traveling waves, and a shunt

Maurice C. Hately, GM3HAT, 1 Kenfield Place, Aberdeen AB1 7UW, Scotland, UK.
A traditional coax-fed half-wave dipole is shown in Figure 1. The half-power bandwidth of a half-wave dipole is 9.3 percent of the nominal resonance frequency. $Q$ is the reciprocal of the percentage bandwidth or equal to $1/0.093 = 10.7$ (for a length-to-diameter (L/D) ratio of 10,000 and a height above ground of $\lambda/4$). The shunt loss resistance value (i.e., radiated power) in parallel resonance is reactance times $Q$ or $800 \times 10.7 = 8.56$ k. On the other hand, the series equivalent “loss” resistance (series resonance) is $800/10.7$, or approximately 73 ohms. Figure 4 shows the complete parallel equivalent circuit. Figure 5 shows the next progression, developed by splitting all three terms, which enables one to place at this location a virtual ground or balance point. Next, Figure 6 shows the actual induction field couplings which exist from end to end. $M$ shows the magnetic field and $E$ shows the anti-phase electric field coupling. (The electric field has two 180-degree out-of-phase components that are at the same time out of phase with the current maxima and magnetic field. In other words, the energy stored in the resonant system of the antenna has either most of its energy in the electric field, or a quarter of a cycle later in time, in the magnetic field.) These are not small effects — in fact, they are considerable and must therefore always be taken into account.

If Kraus had drawn the half-wave dipole in this way, he would have shown it as it appears in Figure 7. The extra -j42 ohms required for resonance, and the necessity for some balun in order to properly feed the coaxial cable, led me to decide to put in series two equal-value capacitors of -j21 ohms reactance and to feed the power across one of them as shown in Figure 8. The coaxial shield is now connected to the electric field center of the antenna. When first tried, this arrangement immediately showed promise in the removal of most of the local hash from machines, TV sets, and computers. But the VSWR on the feeder could not be reduced below 2:1 no matter what value capacitors were tried, or at which length or frequency the antenna was operated. Some of the problems must have been attributable to the unwarranted connection resistance that represents total losses (mainly attributable, one would hope, to radiation into space).
of a capacitor of only 21 ohms across a 50-ohm feeder. It turns out that there are two solutions to this problem: you can install a series inductor before the capacitor (see fig. 9) or use a second resonant circuit, thereby making the antenna a dual-band radiator (see fig. 10). This approach extended its operating on two, three, four, or even five bands with low SWR, while still providing a balanced structure — hence the name, "Dipole of Delight," under which these capacitor dipoles are sold.

The additional reactance needed in the capacitive balun of the monoband dipole helped match the transmission line (50 ohms) to 800-ohm characteristic impedance of the antenna wires. It turns out that the optimum capacitive reactance is \(-j50\) ohms (see fig. 11). If this is redrawn as a single-ended equivalent, all the components must be scaled down by a factor of \(1/\sqrt{2}\). This is due to the sharing of the load in the two halves and the doubling of the impedance on return to a dual, or balanced form (fig. 12). After slight rearrangement (fig. 13), the two capacitors are seen...
as a capacitive autotransformer that works efficiently because of the considerable circulating current I. The equivalent inductive autotransformer is shown in fig. 14. The input resistance seen by the source is

\[ 3026 \times \left( \frac{36.3}{283} \right)^2 = 49.7 \text{ ohms} \]

Figure 15 shows a series inductive reactance of almost j50 ohms. This is needed to cancel out the equal

\[ \frac{-j50}{j50} \]

and opposite capacitive reactance of 50 ohms, leaving a pure resistive termination of approximately 50 ohms. The \( Q \) of this resonant circuit is 1, and consequently does not affect the overall bandwidth of the system. The antenna bandwidth is determined by the \( Q \) of the dipole (10.7). As table 1 shows, the input impedance is a genuine 50 ohms over a considerable bandwidth.

**Table 1.** Input impedance is a genuine 50 ohms for a considerable bandwidth.

<table>
<thead>
<tr>
<th>Frequency (MHz)</th>
<th>VSWR</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.7</td>
<td>1.45</td>
</tr>
<tr>
<td>13.8</td>
<td>1.25</td>
</tr>
<tr>
<td>13.9</td>
<td>1.14</td>
</tr>
<tr>
<td>14.0</td>
<td>1.08</td>
</tr>
<tr>
<td>14.1</td>
<td>1.03</td>
</tr>
<tr>
<td>14.2</td>
<td>1.02</td>
</tr>
<tr>
<td>14.3</td>
<td>1.07</td>
</tr>
<tr>
<td>14.4</td>
<td>1.13</td>
</tr>
<tr>
<td>14.5</td>
<td>1.22</td>
</tr>
<tr>
<td>14.6</td>
<td>1.30</td>
</tr>
<tr>
<td>14.7</td>
<td>1.40</td>
</tr>
<tr>
<td>14.8</td>
<td>1.50</td>
</tr>
</tbody>
</table>
NEW
POCKET SIZE
SIZE: 4” H x 3.5” W x 1” D
MADE IN USA

$99.95 - $150.00

Small enough to fit into a shirt pocket, our new 1.2 GHz and 1.3 GHz, 8 digit frequency counters are not toys. They can actually outperform units many times their size and price! Included are rechargeable Ni-Cad batteries installed inside the unit for hours of portable, cordless operation. The batteries are easily recharged using the AC adapter/charger supplied with the unit.

The excellent sensitivity of the 1200H makes it ideal for use with the telescoping RF pick-up antenna; accurately and easily measure transmit frequencies from handheld, fixed, or mobile radios such as: Police, firefighters, Ham, taxi, car telephone, aircraft, marine, etc. May be used for counter surveillance, locating hidden “bug” transmitters. Use with grid dip oscillator when designing and tuning antennas. May be used with a probe for measuring clock frequencies in computers, various digital circuitry or oscillators. Can be built into transmitters, signal generators and other devices to accurately monitor frequency.

The size, price and performance of these new instruments make them indispensable for technicians, engineers, schools, Hams, CBers, electronic hobbyists, short wave listeners, law enforcement personnel and many others.

STOCK NO:

#1200HKC Model 1200H in kit form, 1-1200 MHz counter complete including all parts, cabinet, Ni-Cad batteries, AC adapter/battery charger and instructions .......................................................... $99.95

#1200HC Model 1200H factory assembled 1-1200 MHz counter, tested and calibrated, complete including Ni-Cad batteries and AC adapter/battery charger .......................................................... $137.50

#1300HC Model 1300H factory assembled 1-1300 MHz counter, tested and calibrated, complete including Ni-Cad batteries and AC adapter/battery charger .......................................................... $150.00

ACCESSORIES:

#TA-100S Telescoping RF pick-up antenna with BNC connector .......................................................... $12.00

#P-100 Probe, direct connection 50 ohm, BNC connector .......................................................... $18.00

#CC-70 Carrying case, black vinyl with zipper opening. Will hold a counter and accessories .......................................................... $10.00

ORDER FACTORY DIRECT

1-800-327-5912

OPTOelectronics inc
5821 N.E. 14th Avenue
Ft. Lauderdale, Florida 33334

SEE US AT DAYTON BOOTH #49
This second solution — i.e., the addition of a second, third, or fourth resonant system with voltage dividing capacitors, as shown in figs. 10 and 16 — works by inducing current in the resistive components by inductive coupling from left-hand-traveling current in wire 1 to right-hand-traveling current in wire 2 into capacitor 2, and so on. Table 2 gives the measured SWR values for a four-band antenna for the older HF Amateur bands. The system is not harmonic-dependent however, as can be seen in table 3, which lists data for a production version for the WARC Amateur bands.

Figure 19 shows the Smith chart display of the input impedance of a four-band Dipole of Delight when fed through approximately 50 feet of transmission line. The dot at the exact center of the chart represents exactly 50 ohms. Notice how closely the curve approaches this point for the 40, 20, 15, and 10-meter Amateur bands. Figure 20 illustrates the effect with the feeder length canceled out. The equipment used for these experiments was a Hewlett-Packard Network Analyzer Model 8407A sweeping from 1 to 33 MHz.

![Figure 18: Route of chimney-supported inverted V.](image)

![Figure 19: Input impedance of a four-band antenna at height of 8 meters (approx. 27 feet), fed by coax 15 meters (approx. 49 feet) long.](image)
NOVICES!

Call TODAY (215) 357-1400

for all your new gear needs. Transceivers, handhelds, digital gear — *everything* you need to take advantage of your new, expanded voice and digital privileges!

If you stop in, we would like to shake your hand, congratulate you and give you a free gift for your shack...No, you don't have to buy anything.

ACCESSORIES PLUS MUCH MORE

Technicians, Generals, Advanced and Extra Class Operators Too!

HAMTRONICS HAS IT ALL

Call today for Your SPECIAL PRICES
Join AMSAT...Today

Amateur Radio Satellite OSCAR 10 provides:

- A New Worldwide DX Ham Band
  open 10 hours a day.

- Rag Chew With Rare DX Stations
  in an uncrowded, gentlemanly fashion.

- Popular Modes In Use:
  SSB, CW, RTTY, SSTV, Packet

- Full Operating Privileges
  open to Technician Class
  licensee or higher.

Other AMSAT Membership Benefits:

Newsletter Subscription:
Dependable technical articles, satellite news,
orbital elements, product reviews, DX news,
and more.

Satellite Tracking Software
Available for most popular PCs.

QSL Bureau, AMSAT Nets, Area Coordinator
Support, Forum Talks

Construction of Future Satellites For Your
Enjoyment!

AMSAT Membership is $24 a year, $26 out-
side North America. VISA and MC accepted.

AMSAT
P.O. Box 27
Washington, DC 20044
301 589-6062

Table 2. Measured SWR values for a four-band antenna
for the older hf Amateur bands.

<table>
<thead>
<tr>
<th>Frequency (MHz)</th>
<th>VSWR</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.00</td>
<td>1.3</td>
</tr>
<tr>
<td>7.05</td>
<td>1.2</td>
</tr>
<tr>
<td>7.10</td>
<td>1.3</td>
</tr>
<tr>
<td>7.15</td>
<td>1.4</td>
</tr>
<tr>
<td>7.20</td>
<td>1.6</td>
</tr>
<tr>
<td>14.0</td>
<td>1.32</td>
</tr>
<tr>
<td>14.1</td>
<td>1.15</td>
</tr>
<tr>
<td>14.2</td>
<td>1.20</td>
</tr>
<tr>
<td>14.3</td>
<td>1.30</td>
</tr>
<tr>
<td>14.35</td>
<td>1.45</td>
</tr>
<tr>
<td>21.0</td>
<td>1.3</td>
</tr>
<tr>
<td>21.1</td>
<td>1.15</td>
</tr>
<tr>
<td>21.2</td>
<td>1.15</td>
</tr>
<tr>
<td>21.3</td>
<td>1.25</td>
</tr>
<tr>
<td>21.4</td>
<td>1.37</td>
</tr>
<tr>
<td>28.0</td>
<td>1.62</td>
</tr>
<tr>
<td>28.2</td>
<td>1.45</td>
</tr>
<tr>
<td>28.4</td>
<td>1.22</td>
</tr>
<tr>
<td>28.6</td>
<td>1.05</td>
</tr>
<tr>
<td>28.8</td>
<td>1.36</td>
</tr>
<tr>
<td>29.0</td>
<td>1.56</td>
</tr>
</tbody>
</table>

Table 3. Measured SWR values for a production version
for the WARC Amateur bands.

<table>
<thead>
<tr>
<th>Frequency (MHz)</th>
<th>VSWR</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.9</td>
<td>1.45</td>
</tr>
<tr>
<td>10.0</td>
<td>1.3</td>
</tr>
<tr>
<td>10.1</td>
<td>1.18</td>
</tr>
<tr>
<td>10.2</td>
<td>1.25</td>
</tr>
<tr>
<td>18.0</td>
<td>1.25</td>
</tr>
<tr>
<td>18.1</td>
<td>1.15</td>
</tr>
<tr>
<td>18.2</td>
<td>1.20</td>
</tr>
<tr>
<td>18.3</td>
<td>1.32</td>
</tr>
<tr>
<td>24.8</td>
<td>1.38</td>
</tr>
<tr>
<td>24.9</td>
<td>1.12</td>
</tr>
<tr>
<td>25.0</td>
<td>1.08</td>
</tr>
<tr>
<td>25.1</td>
<td>1.22</td>
</tr>
</tbody>
</table>

capacitor construction

The capacitors consist of etched double-sided
epoxy-glass-fiber circuit board. One side is not etched
at all and is connected to the coaxial cable shield. The
other side is etched, leaving copper patches (in pairs)
of sufficient size to provide the needed capacitance
for each wire. The glass fiber acts as the dielectric of
the capacitor. In this way a lightweight capacitor balun
without too much wind-catching area and usable at
a kilowatt PEP level can be made from single-layer pc
board. The only reported failures have been thought
to be due to lightning flashover across the unconnect-
ed right-side wires to the shield. A solution to this problem is presently being investigated. For medium powers – up to 100 watts of rf power output – lumped silver mica capacitors are used. These are easily concealed in a small center connector assembly which presents a negligible wind load. Photo A shows the center card and UHF connector and cable hanging from the water-shedding cowl.

**ATU not needed**

Since the VSWR is so close to 1:1 on 40 through 10, there’s no need for an ATU between the transmitter and the antenna. This feature provides the freedom to QSY rapidly in a competitive situation without wasting time retuning. For blind or handicapped operators, it offers considerably simplified operation. For

---

*Photo A. Capacitor card of a three-band Dipole of Delight for 14, 21, and 26 MHz.*

---

fig. 20. Antenna feedpoint input impedance as shown in fig. 19, but with effect of feeder cable counterbalanced out.
use with a no-tune semiconductor PA or linear, no antenna system could be more appropriate. The VFO is the only control that has to be moved!

Electrically, it's advantageous to have the shield of the coaxial cable at the rf zero potential right down to the shack. It should be emphasized that in order to preserve the balance, the cable should come away from the dipole at right angles until the feeder gets to an object such as the ground beneath the antenna, a tree, or a garage roof, for example, where it may then be turned to run to the shack along the same earth boundary (see figs. 17 and 18). This helps reduce VSWR. Observe SWR as shown in fig. 17, then pull the feedline to the side and watch the SWR rise from 1.02:1 and go up to 1.3:1. With the thorough balance of the Dipole of Delight it's never necessary to ground the case of the transceiver. There's a complete absence of rf feedback to the microphone and electronic keyer, and never any sign of "hand capacitance."

Because the feedline is at rf zero voltage right to the center balun unit, the Dipole of Delight works well as an inverted V. The support can be metal or any other material and there will be no effect on VSWR or radiation pattern.

helps TVI

Since no current flows down the outside of the feedline, no vertical polarization rf currents are induced into the downleads of nearby TV antennas. One disabled GM operator for whom ham radio is his main daytime activity (he tells me he is on 40 and 80 meters for 8 to 10 hours every day and likes to use his linear all the time) has found that a dual-band Dipole of Delight has not only cured TVI and BCI next door, but has also cured interference to an electronic organ at a church across the street. Now he can operate on Sunday mornings as well! We don't promise purchasers that TVI will be less than they've had with other antennas; in fact, the ground plane versions of these antennas, are definitely not recommended where TVI is a problem, though they are nevertheless useful for low-angle radiation, of course.

references

GaAs FET PREAMPS

at a fraction of the cost of comparable units!

**LNG -(*)**
GaAs FET PREAMP

ONLY $49!

Wired/TESTED

FEATURES:
- Very Low Noise: 0.7dB VHF, 0.8dB UHF
- High Gain: 13-20dB, depending on freq
- Wide Dynamic Range: to resist overload
- Stable: new-type dual-gate GaAs FET
  * Specify tuning range desired: 26.30, 46.56, 137-150, 150-172, 210-230, 450-470, or 800-950 MHz.

**LNW -(*)**
MINIATURE
GaAs FET PREAMP

Unbelievably Low Price --------
ONLY $19/kit,

$34 Wired/TESTED

GaAs FET Preamp similar to LNG, except designed for low cost & small size. Only 5/8"W x 1-5/8"H x 3/4"D. Easily mounts in many radios.

**HRA -(*)**
HELIAC RESONATOR PREAMP

ONLY $49 VHF or $64 UHF

Low-noise preamps with helical resonators reduce intermod & cross-band interference in critical applications.

**ACCESSORIES**

- **TD-2 BTMF DECODER/CONTROLLER** kit only $78. Full 16 digits, 5 functions, toll call restrictor, programmable. Much more. Great for selective calling too!
- **AP-1 AUTOPATCH** kit only $78. Reverse patch & phone line remote control std.
- **AP-2 Simplex Autopatch**. Use with above.
- **CWID kit**, new low price $48. Field programmable, timers, the works!
- **COR-2 kit**, $48, with courtesy beep.
- **MD-202 FSK DATA MODULATOR** kit $38. Run up to 1200 baud digital or packet radio signals through any FM transmitter.
- **DE-202 FSK DATA DEMODULATOR** kit $38.

**HAMTRONICS, INC.**
65-E Moul Rd.; Hilton NY 14468-9535

□ High quality equipment at reasonable prices surely appeals to me; but I want more details before I buy! Rush my copy of the 40-page Hamtronics catalog by return first class mail. I enclose $1 ($2 for overseas air mail).

Name ____________________________________________
Address __________________________________________
City __________________________________ State/ZIP ________

□ Order by phone or mail • Add $3 S&H per order (Electronic answering service evenings & weekends)
- Use VISA, MASTERCARD, Check, or UPS COD.

______May 1987
______Page 79

More Details? CHECK — OFF Page 130

If you want to own the newest receiver around, then you'd better take a good look at the **Kenwood R-5000**. GILFER SHORTWAVE has them in stock - walk in and try it out in our new showroom - 210 sq. ft. of shortwave heaven. All the receivers and antennas operational.

You'll also see the best portable around, the **Sony 2010**. Why buy the copy when the original is at its lowest price ever!

New Book Offers.

Giler has a fascinating new book for utility buffs. Entitled **Utility Address Handbook**, authored by Reinhard Klein-Arendt, this compilation of UTE station addresses has the majority of world addresses and they're 99% up-to-date! Countries are listed in alpha order with stations listed by type. Address divisions are Post, telephone & telegraph, maritime, aeradio, airlines, meteorological, military, relief groups (Red Cross etc.) diplomatic, police, press, scientific, U.S. MARS, etc. This is the easiest way to get UTE addresses and the least costly, 140 pp just $12.95 (+ $2).

For DXers interested in the subrosa broadcasts of the world, Giler publishes **Confidential Frequency List**, a 304 pp compendium of fixed, FAX, military, aeronautic, embassy, INTERPOL, VOM, press, coastal and hundreds of RTTY stations plus mystery stations etc. Covers 4 - 26 MHz by frequency and gives broadcast modes and hours. Chapters include an Introduction by Tommy Kneitel, a Primer on RTTY, About Cyrillic, etc. Now in its 6th edition. $15.95 (+ $2).

**Save with this Combo Offer.** Order both the Utility Address Handbook and the Confidential Frequency List and save $6.95. Both for just $24.95 postpaid!

The Best in Listening Aids.

This **Datong FL-3** Automatic Audio Filter, exclusive with Giler, gives you six different ways to dig out the weak SSB DX, hear CW you didn't know was there, pull RTTY out of noise, remove whistles and heterodynes. Has two notch filters, one manual, one automatic; variable high and low pass filtering. Easy between receiver-and-speaker connection. $229.95 (+ $4).

**The Best in Active Antennas.**

Giler exclusive - **Dressler** Active Receiving Antennas. They're perfect for limited antenna space - perform like they were outdoor full size jobs, but they fit anywhere. Two models: **ara 30** is ideal for SWL, covering 200 kHz to 30 MHz optimum, up to 100 MHz reduced performance. 10 dB gain. $159.95 (+ $4); model **ara 500** is perfect for VHF-UHF scanner receivers, covering 50 MHz - 650 MHz optimum, up to 900 MHz reduced performance. Up to 16 dB gain. $169.95 (+ $4).

Order service ph. 1-800-GILFER-1
For Flyer, send SASE
**GILFER SHORTWAVE**
52 Park Ave, Park Ridge, NJ 07656
1-800-445-3371 • In NJ 201/391-7887
grounding, shielding, and isolating: part 2

Last month we discussed the problems of keeping outside interference from adversely affecting our equipment and preventing cross-interference between equipment in the same system.

Grounding problems affect not only single circuits, but collections of equipment as well. In fig. 1A, we see a prescription for disaster: the equipment grounds are daisy-chained together and grounded to earth at a point close to only one piece of equipment, identified as D. Typically, the ground lines are small-diameter sections of wire not particularly appropriate for the purpose.

One way to correct this problem — the star ground — is illustrated in fig. 1B. Ground conductors from all four pieces of equipment are brought together at a common point, which is then grounded. Although it’s difficult to achieve the exact configuration shown in fig. 1B in an actual Amateur station, we can approximate it using the arrangement shown in fig. 2. Keep in mind that our goal is to radiate as much of the available power as possible, while keeping spurious radiations (mostly harmonics) at home. Given the nature of most radio communications situations, if we have to sacrifice a little power at the fundamental operating frequency in order to lower the level of harmonics, then it’s to our advantage to do so.

The signal flow logic for an hf station is shown in the inset in fig. 2. The output circuit, a low-pass filter and an antenna matching network, surprises few Amateurs. The low-pass filter for hf usually has a cutoff frequency above the 10-meter band, but below 6 meters (36 and 42 MHz are often quoted in the advertisements). Above that frequency, attenuation is quite high.

The antenna matcher is seen in many Amateur stations today because solid-state final amplifiers aren’t tolerant of high VSWR loads. Such rigs include shut-down circuitry that reduces output power sharply when a VSWR greater than 1:1 is encountered. Previously, many Amateurs didn’t use matching networks because tube-type finals used pi networks that could match a wide variety of antenna impedances. Many years ago, former ARRL President Vic Clark (W4KFC) told me that he recommended antenna matching networks even on well-matched antennas because they add another stage of relatively high-Q tuned circuitry between the transmitter and the antenna... and thus reduce TVI-producing harmonics.

What may come as a surprise to many readers is the low-pass filter at the input of the linear amplifier. Because the exciter/transmitter output signal isn’t perfectly clean, and will contain harmonic energy, we should attenuate those signals prior to amplifying them in a 1500-watt amplifier! Use of a low-pass filter helps that situation tremendously.

There is one problem with using a low-pass filter on some solid-state equipment. Many linear amplifiers, especially grounded-grid designs, either don’t have a 50-ohm input impedance or have a widely varying input impedance that is frequency dependent. The characteristics of LC low-pass filters are guaranteed only when the correct load impedance is presented to the filter (in our case normally 50 ohms, resistive). If the linear amplifier input impedance varies, then filter performance is adversely affected. In addition, the impedance reflected to the filter input will also vary. This
Announcing New 6- & 8-Pole Crystal Filters For ICOM, Kenwood & Yaesu Radios

- ICOM 730/735/740/745/751/R70/R71A SSB 2 kHz, 8-Pole — Exact replacement for FL-44A
- Model IR455H10S — $90
- ICOM IC-271/471/1271/CW
- 8-Pole — Great for DXing or EMJ

Model IR07H100C — $115

- Kenwood TS-590/940/830/4000 CW Super Selective 250Hz 8-Pole 455 kHz Filter
  - Comes mounted on high-quality glass PC board for the TS-930 and TS-940, drops into the TS-830.

- Model IR455H125C — $125

- TS-940/930/830 Super Selective CW Switch Kit
  - This new kit allows you to add another CW bandwidth. For example, on the 930/940/830, if you already have 400Hz or 500Hz filters installed, you can now select a set of IR250Hz filters. Our 250Hz matched set allows for a lower noise floor for super quiet DXing.

- 9 MHz 8-Pole Crystal Filters for Experimenters
  - All 6-Pole Filters — $60
  - All 8-Pole Filters — $80
  - For FM
    - A. 2.4kHz @ 6dB
    - B. 2.1kHz @ 6dB
    - C. 1.8kHz @ 6dB
    - D. 2.2kHz @ 6dB (6-8 pole)
    - E. 2.2kHz @ 6dB (6-8 pole)
    - F. 6kHz @ 6dB
    - For AM
      - A. 6kHz @ 6dB
      - B. 6kHz @ 6dB
      - $5.00 shipping and handling on all orders.

For more information, call
International Radio, Inc.
747 So. Maceo Blvd.
Port St. Lucie, FL 33452
(305) 879-6868

---

**TUBES and IC’s FAST DELIVERY**

**LOWEST PRICES**

call Toll Free (800) 221-5802

**In-depth inventory — Industrial & Receiving Tubes**

3-500Z — $95.00 813 — $45.00
572-B — 75.00 6L6 — $9.00
811-A — 15.00 6JS6C — $8.20
6146-B — 9.00 6CA7 — $7.60
8950 — 12.75 6MJ6 — $9.39
4CX250-B — 85.00 8417 — $9.23
SG613 — 11.50 20LF6 — $9.09

**CHEMICALS**

- Tuner Wash 24 oz. TR-61 — $2.50
- Tuner Cleaner 16 oz. TR-201 — $2.20
- Video Head Cleaner 24 oz. TR-441 — $4.95
- Freeze Spray 15 oz. TR-129 — $2.20

Major Manufacturers Factory Baked and Full Line of Sylvania ECG Replacement Semiconductors

**Minimum order $25.00 — Allow 3 UPS charges**

**FOR DEPENDABLE SOURCES**

**NEW!**

**STEEL PTFE Lined**

**TUBES**

- 600kHz at 6dB
- $5.00 shipping and handling on all orders.

**FOR WHOLESALE ENQUIRIES CALL**

**SUB PROBLEM?**

**Contact Sue. She’ll fix it for you!**

(603) 878-1441

**Ham Radio**

Greenville, N. H. 03048

---

**ACCUacy**

**DigiMax**

**Performance**

10 MHz Oven Oscillator
10 Hz to 1.2 GHz . 1 PPM ACCURACY

ALL MODELS HAVE 1 YEAR WARRANTY

Optional factory installed rechargeable battery pack available

**DigiMax Instruments Corp.**

---

**ALL BAND TRAP**

**"SLOPER" ANTENNAS**

**FULL COVERAGE ALL BANDS AUTOMOTIC SELECTION with PROVEN Weatherproof System.**

**GROUND MOUNT SLOPERS — No Radios Required**

- Connect Top To Roof, Buildings, Parks, etc or ANY angle from 8 degrees to 65 degrees for excellent "SLOPER" DX Antenna Gain or send it anywhere you need it! 2000 Watt PEP input, max. Permanent or portable use installs in 10 minutes only for SMALL-NEAT-ALMOST INVISIBLE — No one will know you have a 100-Watt DX Antenna. Use FOR CONDOS APARTMENTS RESTRICTED AREAS — Pre-wired for 2 or less SWR over ALL bands (except 5G-160-3000K) No adjustments needed — COMPLETELY ASSEMBLED, with 6000Watts output and PL-259 Connector. Rapid installation — ready to hook-up!!

**FULL INSTRUCTIONS**

- No. 10105 — 40-20-15-10-5 — 40 ft. — $95.95
- No. 10105C — 40-20-10-5-3 — 1 trap 20 ft. — $95.95
- No. 10125 — 20-15-10-6-5 — 1 trap 20 ft. — $95.95
- No. 10115 — 10-15-10-5-3 — 1 trap 20 ft. — $95.95

**SEND FULL PRICE FOR PROB IN USA (Canada is $5.00 extra for postage etc) or order using VISA, MASTERCARD.**

**SHIPPING & HANDLING**

- $5.00 for postage etc. for orders under $25.00
- $10.00 for postage etc. for orders $25.00 and over

**Satisfaction Guaranteed**

- 10 days money back return

**WESTERN ELECTRONICS**

1930 Farnsworth Dr.
Kearney, NE 68847
difficulty will cause a high VSWR to be seen at the transmitter output, causing it to fold back.

I experienced this problem using a Drake low-pass filter between a Kenwood TS-120 transmitter and a Heath SB-220 linear amplifier. There are two possible solutions. First, we can place a 50-ohm attenuator pad between the filter output and the linear amplifier input. The pad swamps out the impedance variations, although at the loss of some power. The attenuator pad method is recommended only where suitable resistors are available, and there's plenty of power to drive the linear and accommodate a 1- to 3-dB power loss. Second, we can either replace the low-pass filter with a variable matching network or add an antenna matcher to the circuit between the filter and amplifier. When I owned the TS-120, my solution was to use a Drake MN-4 matcher in place of LPF A (see fig. 2).

Note the configuration of the operating position in fig. 2. The equipment was mounted on a door converted into a table. The grounding system consisted of a piece of 7-inch wide copper roofing flashing along the back of the table. Though you probably won't find copper flashing at your local hardware store, it should be available from metal distributors and professional roofing supply outlets. I found mine at a metal distributor after asking a neighbor, a contractor, where he bought his copper roofing supplies.

Although the cost per foot (or per pound, as some sell it) for the amount that you need will probably be relatively low, the distributor may want a $50 to $100 minimum purchase. Joining with other Amateurs in a group order, therefore, might be wise. Copper flash-
job. Choose your solder carefully, however. Some of the solder used for this purpose, and sold in local hardware stores, is acid-core. Also, some solders don’t have the right metals mix. You want either resin core or coreless solder with resin flux, lead/tin solder of 50/50 or 60/40 mix.

Finally, make sure that the ground wire isn’t resonant on either the fundamental frequency or one of the low order harmonics (e.g., second and third). Try to avoid even 1/8 or 1/4 wavelengths, even though this requirement may be difficult to achieve in practice on 80- to 10-meter antennas.

**ground rods**

The goal in a station ground system is to reduce the resistance between the radio and the earth. In most cases, this requirement translates to surface area in contact with the ground — and our goal is to maximize that area. Several different options are available to us regarding ground rods.

First, we could do what a friend of mine did 20 years ago: he found an old copper bathtub in his grandfather’s garage and buried it in an 8-foot deep hole. Considering the amount of work involved in burying a bathtub 8 feet underground, I’d prefer to sell the bathtub either for its metal content or its antique value. . . . and use the proceeds to buy a truckload of proper ground rods!

Second, we could build a ground matrix grid on our property. When I was in high school, a local Amateur built a new home nearby. He arranged for several “custom extras” to the house. First, a concrete pedestal for the 60-foot tower was installed. Around the base of the tower was a series of eight or ten 8-foot copper clad steel ground rods. He then constructed a grid of No. 12 solid copper wire (bare) over the entire 150 x 150-foot lot. At each crossover point on the grid the conductors were soldered together. He also added several more ground rods at nodes around the lot. The grid was clamped and soldered to the tower grounding system, then attached to a rather massive 3-inch copper pipe coming through the wall of the house from the intended operating position. After this extensive ground system was installed, sod was brought in by the builder, who was clearly bewildered by the seemingly odd behavior of his eccentric client.

Third, we can use copper clad steel ground rod, available in several lengths from electrical supply outlets. Although this type is preferred for Amateur applications, surprisingly few Amateur outlets sell these rods in the proper lengths. The non-copper clad type, though less useful for Amateur applications, is also available.

Copper clad steel rods are normally sold in 4-, 6-, and 8-foot lengths. Ten-foot lengths, used by some power companies, are also occasionally available. Of these, the 8-foot length is probably the best, and may be the only legal in your area. (Your local electrical inspector may have an enforceable opinion regarding your choice of ground rod. In many jurisdictions, electrical codes specify the 6- or 8-foot minimum length for towers and sometimes even Amateur stations.)

The 4-foot types, typically used by TV antenna installers, are the most common. But because they’re less effective for both radio grounding and lightning protection, they should be avoided — except, perhaps, where multiple rods are used.

Another alternative is shown in fig. 4. This ground system, which uses a copper plumbing pipe, is especially useful for areas with hard clay-rich soil. The top end of the pipe is fitted with a “Tee” connector and short pipe sections to be used as a handle. One end of the handle is closed off with an end cap, while the other is fitted with a spigot nipple of the sort used to connect a garden hose. The bottom end of the 1-inch x 8-foot pipe is beveled to a point with a hacksaw. Drive the pointed end into the ground and apply water pressure. Although a bit messy, this method will allow you to work the pipe down into the soil with relative ease.

When you finish driving the copper pipe into the ground you will discover
With conventional ground rods you wire (which is sometimes difficult), or with a heavy pair of pliers, hammer "vil"), or other means. You can then drill use a clamp (which easily comes loose). The pipe end can be flattened to simplify installation in hard soil.

fig. 4. Pipe ground uses water pressure

fig. 5. Adding connections to pipe ground.

one or more 1/4-inch holes in the flattened end to accept a nut and bolt to hold the ground wire (see fig. 5).

A word of caution is needed for those who are going to drive ground lines into the earth. Find out where the gas, water, sewer, and power lines are on your property. Although you can usually make intelligent guesses, some configurations are hard to determine. For example, at my old QTH, the gas line ran in a dog-leg path from the shut-off valve on the street to the meter on the back of the house. Unless you knew that the gas company was trying to serve two dwellings with the least amount of pipe, you wouldn't easily guess its path. Information on utility service run locations is often recorded on your survey plate, or in the local building inspector or engineer's office, or can be obtained from the utility involved. An 8-foot ground rod can disrupt these utilities — and that's always expensive and sometimes dangerous.

a warning on some defibrillator capacitors

In an earlier column I mentioned using medical defibrillator capacitors in high-power, high-voltage dc power supply filters. While that advice is still valid, a reader pointed out one possible pitfall. Some manufacturers of these machines depend upon the fact that defibrillator capacitors are charged for only a few minutes to de-rate some capacitors. As a result, in 7000-volt circuits they use capacitors with as little as 2000-WVDC dielectric strength. The small size of these capacitors enhances the portability of the product.

The capacitors to which I referred are high-quality units manufactured by well-respected companies such as CDE and Sangamo; marked for 7500-WVDC or 10,000-WVDC, they're oil-filled and quite large. My reference capacitors came from American Optical and Hewlett-Packard (Model 7802) machines. No one has miniaturized those high-voltage capacitors significantly, so if a surplus defibrillator capacitor seems too small to be a 7 kV unit, then it probably isn't what it seems to be.

ham radio

one of the advantages of this system. With conventional ground rods you must either sweat-solder the ground wire (which is sometimes difficult), or use a clamp (which easily comes loose). The pipe end can be flattened with a heavy pair of pliers, hammer (with a 2 x 4 backstop used as an "anvil"), or other means. You can then drill
I CALL LONG DISTANCE ON YOUR HANDHELD The Model 115A will deliver 35 watts of power using the most advanced state-of-the-art circuitry. The amplifier will operate SSB or FM and is compatible with most handheld transceivers, including the TR2400, TR2500, IC-2AT, Yaesu, Xantec, and Ten-Tec. Only 5 watts input will deliver 5 watts output. Maximum input drive level is 5 watts.

Our products are backed by prompt factory service and technical assistance. WE SPECIALIZE IN: Complete parts list for the 140 watt, 300 watt RF amplifiers per Motorola Bulletins EB911, EB912, EB913, AN768, and AN769. We also carry a full line of ATV equipment. Call or write us for our free catalog.

MODEL 335A Kit $79.95 Watt $96.95

CALL LONG DISTANCE ON YOUR HANDHELD

<table>
<thead>
<tr>
<th>Price Cuts</th>
<th>Lower Prices</th>
</tr>
</thead>
<tbody>
<tr>
<td>KIT COMPLETE WITH</td>
<td>*SPIDER</td>
</tr>
<tr>
<td>KIT COMPLETE WITH</td>
<td>SPIDER</td>
</tr>
<tr>
<td>BOOM WHERE NEEDED</td>
<td>BOOM WHERE NEEDED</td>
</tr>
</tbody>
</table>

WINNER OF MANITOBA DESIGN INSTITUTE AWARD OF EXCELLENCE

Buy two elements now — a third and fourth may be added later with little effort. Enjoy up to 8 db forward gain on DX, with a 25 db back to front ratio and excellent side discrimination.

Ask for our new 2m Quad Kit when you order your Gem Quad. It's FREE for the asking! Get maximum structural strength with low weight, using our "Trade" arms. Please inquire directly to:

GEM QUAD PRODUCTS LTD.
PO BOX 291
BOISSEVAIN, MANITOBA R0K 0E0
CANADA

TELEPHONE (204) 534-6184

STTV SOFTWARE
Introducing A New Dimension in STTV

Gest VideoTools
- MS/DOS based advanced software package for 1200 c Robot users.
- Create/transmit your own high resolution graphic images.

Full Paint Package Features:
- 65K on screen colors out of a range of 256K
- ICOM-based menus, mouse-driven, easy to learn, easy to use
- Over 70 functions
- Enlarge, reduce, save, load video image and image fragments
- Combine video images, graphics and text
- Full image processing including noise reduction features
- Save images, live off air
- Animation
- Zoom function and back/forward through software
- Auto I.D.

Now available to amateur market
Send check or money order, $599 per system to:

TORONTEL TECHNOLOGY SYSTEMS LTD.
174 Bellamy Rd. North
Scarborough, Ontario
Canada M1J 2L5
416-292-9952

GEM-QUAD FIBRE-GLASS
ANTENNA FOR 10, 15, AND 20 METERS

Two Elements $235.00
Extra Elements $164.00
Price is F.O.B. Transcona INCLUDES U.S. Customs Duty

86 May 1987

CALL LONG DISTANCE ON YOUR HANDHELD

The Model 335A will deliver 35 watts of power using the most advanced state-of-the-art circuitry. The amplifier will operate SSB or FM and is compatible with most handheld transceivers, including the TR2400, TR2500, IC-2AT, Yaesu, Xantec, and Ten-Tec. Only 5 watts input will deliver 5 watts output. Maximum input drive level is 5 watts.

Our products are backed by prompt factory service and technical assistance. WE SPECIALIZE IN: Complete parts list for the 140 watt, 300 watt RF amplifiers per Motorola Bulletins EB911, EB912, EB913, AN768, and AN769. We also carry a full line of ATV equipment. Call or write us for our free catalog.
Simplify antenna matching with WB0IKN's handy program

WB0IKN's article, "Basic Gamma Matching" provided a useful program for the Apple II+ computer. Because I needed gamma matching data for a homebrew project but have a C-64, I decided to convert the program. (If you own a Commodore 128, simply set the computer to 64 mode and you're ready to calculate.)

Figure 1 lists the revised program. The most significant modifications appear in the calculation lines. These changes were made to avoid exceeding the C-64's maximum input of 80 characters per statement.

I renumbered and compacted the program, adding an Option Menu from which you may choose to print hard copy, start new calculations, or end the program.

The final results were also truncated to two decimals; for practical purposes, this number of significant digits should be sufficient. The last three inputs of line 10 change the screen/border/letter colors. If you prefer the standard blue, omit all POKE statements and colons in line 10.

Design examples and program notes

To demonstrate the conversion program, and to allow you to check operation as well as the correctness of your data entry, I've used WB0IKN's design examples. I suggest you read his article; for convenience — or in case you don't have a copy of the January, 1985, issue — I've summarized details below.

The hardest part will be determining the driven element impedance. Fortunately, the feedpoint characteristics of most common antennas are sufficiently documented to provide good data. Use your impedance meter or noise bridge, if no published data are available. You must know the diameter of your driven element and gamma rod. Then select an arbitrary gamma rod spacing. Use common sense, as in any homebrew project.

Load and run the program. Input the requested data when prompted. The computer will then calculate and display the results in the format shown in figs. 3 and 4.

If the values aren't acceptable, select Menu Option 2 ("all new calculations"). By trying a different gamma rod spacing or diameter, or varying the feedpoint impedance by slightly changing the length of the driven element, you can find the best combination with reasonable mechanical and electrical parameters. If the antenna isn't suitable for gamma rod matching, you'll learn this quickly, without tedious experimentation.

Figure 2 shows the screen display on a run for a computer-generated six-element, 20-meter Yagi design by Lawson. The calculated feedpoint impedance of the antenna is 20 + 7.5 ohms. In this example, the assumptions are a 1.5-inch diameter element, a gamma rod diameter of 0.25 inch, and a gamma rod spacing of 3 inches.

Additional designs

The results of two additional gamma match designs for the Yagi antenna are shown in fig. 3. In fig. 3(A) the gamma rod spacing has been increased to 6 inches; in fig. 3(B) the gamma rod diameter has been increased to 0.5 inch.

Figure 4 shows the results for a monopole approximately 1/4 wavelength high. In this case the

Fred A. Sontag, N0CAO, Lake Farm, Route 1, Box 86, Tebbetts, Missouri 65080
Gammas Match Design

By Richard A. Nelson - WB1KN

For Apple II+ Computer

Printed & customized for C64 with options for print/new calcs & end

by Fred A. Sontag, P.E. - NC0AO

Rem version 1.3

Print "gamma length <degrees> = "; US: FT = (948/F)/(LDG/360) * N: FT = GOSUB550

Print "gamma length <feet> = "; US: IN = FT * 12: N = IN: GOSUB550

Print "gamma length <in> = "; US: CM = IN * 2.54: N = CH: GOSUB550

Print "gamma length <cm> = " ; US: N = CM: GOSUB550

Print "gamma cap in pf = "; US

Print "1. hardcopy"

Print "2. all new calculations"

Print "3. End"

Print "press option no. - then press return "; ;: INPUT#1, X: PRINT

Print "open file 1. then close 1, 0: GOSUB 50"

IF X = THENCLOSE 1, 0: GOSUB 50

IF X = THENCLOSE 1, 0: GOSUB 10

IF X = THENCLOSE 1, 0: PRINTCHR$(147) : END

GET#3, AS: PRINT#4, AS: NEXT: CLOSE 3: CLOSE 4: PRINTCHR$(147) : GOSUB 70

US = STR$(N): L = LENCUS: PD = 0: FOR I = 1 TO L: IF MID$(US, I, 1) = "": THEN PD = I

NEXT I: IF L <= (PD = 2) THENRETURN


AUS = SVAL$(US): .01: US = STR$(US * SGN(N)): RETURN

Ready.

Fig. 1. Gamma matching program listing for the C-64/128.
gamma rod is a length of No. 10 wire (approximate diameter = 0.1 inch). Figure 4(A) is for a 60-foot tower used as a vertical radiator on 3.8 MHz. (WBØIKN's computer analysis shows its impedance to be approximately 33 + j1.3 ohms. Figure 4(B) is for a 55-foot tower operated on the same frequency. The results show how a smaller gamma capacitor may be used if the radiator is made capacitively reactive by reducing its overall height.
DIPOLE ANTENNA
FREQUENCY <MHZ> = 14.2
DRIVEN ELEMENT DIAM = 1.5
GAMMA ROD DIAM = .25
GAMMA ROD SPACING = 6
DRIVEN ELEMENT RESISTANCE = 20
DRIVEN ELEMENT REACTANCE = 7.5
FEEDLINE RESISTANCE = 50
GAMMA LENGTH <DEGREES> = 25.32
GAMMA LENGTH <FEET> = 4.7
GAMMA LENGTH <IN> = 56.34
GAMMA LENGTH <CM> = 143.12
GAMMA CAP IN PF = 241.89

DIPOLE ANTENNA
FREQUENCY <MHZ> = 14.2
DRIVEN ELEMENT DIAM = 1.5
GAMMA ROD DIAM = .5
GAMMA ROD SPACING = 3
DRIVEN ELEMENT RESISTANCE = 20
DRIVEN ELEMENT REACTANCE = 7.5
FEEDLINE RESISTANCE = 50
GAMMA LENGTH <DEGREES> = 38.34
GAMMA LENGTH <FEET> = 7.11
GAMMA LENGTH <IN> = 85.32
GAMMA LENGTH <CM> = 216.72
GAMMA CAP IN PF = 262.10

DIPOLE ANTENNA
FREQUENCY <MHZ> = 3.8
DRIVEN ELEMENT DIAM = 12
GAMMA ROD DIAM = .1
GAMMA ROD SPACING = 12
DRIVEN ELEMENT RESISTANCE = 33
DRIVEN ELEMENT REACTANCE = 1.3
FEEDLINE RESISTANCE = 50
GAMMA LENGTH <DEGREES> = 44.82
GAMMA LENGTH <FEET> = 31.06
GAMMA LENGTH <IN> = 372.69
GAMMA LENGTH <CM> = 945.64
GAMMA CAP IN PF = 122.62

MONOPOLE ANTENNA
FREQUENCY <MHZ> = 3.8
DRIVEN ELEMENT DIAM = 12
GAMMA ROD DIAM = .1
GAMMA ROD SPACING = 12
DRIVEN ELEMENT RESISTANCE = 25
DRIVEN ELEMENT REACTANCE = 30
FEEDLINE RESISTANCE = 50
GAMMA LENGTH <DEGREES> = 53.73
GAMMA LENGTH <FEET> = 37.24
GAMMA LENGTH <IN> = 1134.92
GAMMA CAP IN PF = 76.99

As stated previously, I strongly recommend that you read WB0IKN’s article and also the publications dealing with gamma matching design and construction referenced therein.

Fig. 3A. Calculated results for additional run on the antenna described in fig. 2, showing gamma rod spacing increased to 6 inches.

Fig. 3B. Calculated results for additional run on the antenna described in fig. 2, showing gamma rod diameter increased to 0.5 inch.

Fig. 4A. Results of run for a 75-meter vertical monopole antenna on 3.8 MHz, (60-foot tower).

Fig. 4B. Results of run for 75-meter vertical on 3.8 MHz, (60-foot tower).

references

ham radio
TEN-TEC Pocket-Sized
P.O. Box 4405
220 N. Fulton Ave.
Evansville, IN 47710

Store Hours
MON-FRI: 9AM - 6PM
SAT: 9AM - 3PM
CENTRAL TIME

SEND SASE FOR NEW & USED SHEETS
WARRANTY SERVICE CENTER FOR:
ICOM, YAESU, TEN-TEC

TERMS:
Prices Do Not Include Shipping.
Price and Availability Subject to Change Without Notice
Most Orders Shipped The Same Day

DISCOUNTS ON RIGS AND ACCESSORIES FROM:
AEA, ARL, ALINCO, ALLIANCE, ALPHA-Delta,
AMECO, AMERITRON, AMP SUPPLY, ANTENNA SPECIALISTS, ASTRON, BENCHER, BUTTERNUT, B & W, C5I,
CALLBOOK, CUSHCRAFT, DAIWA, DIAMOND, ENCOMM, HAL, HEIL, HUSTLER, ICOM, KDK, KANTRONICS, KENPRO,
LARSEN, MJP, MICROLOG, MIRAGE/klM, NYE, PALOMAR, RF CONCEPTS, ROHN, SANTEC, SHURE, TE SYSTEMS,
TELEX/HYGAFF, TEN-TEC, TOKYO HY-POWER, VIBROPLEX, W2AU BALUNS, WELZ, YAESU

For Orders and Price Checks Call 800-523-7731
Indiana and Information
Call 1-812-422-0231

BLACK DACRON® POLYESTER
ANTENNA ROPE
• UV-PROTECTED
• HIGH ABRASION RESISTANCE
• REQUIRES NO EXPENSIVE POTTING HEADS
• EASY TO TIE & UNEE KNOTS
• EASY TO CUT WITH OUR HOT KNIFE
• SIZES: 3/32" 3/16" 5/16"
• SATISFIED CUSTOMERS DECLARE EXCELLENCE THROUGHOUT U.S.A.

LET US INTRODUCE OUR DACRON® ROPE TO YOU • SEND YOUR NAME AND ADDRESS AND WE'LL SEND YOU FREE SAMPLES OF EACH SIZE AND COMPLETE ORDERING INFORMATION

KENNEDY ASSOCIATES
Amateur Radio Division
5707A Mobud
San Antonio, TX 78238
Telephone: 512-680-6110

KUNWOOD

Amateur Radio Division
5707A Mobud
San Antonio, TX 78238
Telephone: 512-680-6110

COMING SOON 1986-87 ARRL Repeater Directory
$5.00 postpaid from ham radio Bookstore
Greenville, NH 03048 (603) 878-1441
optimized 2- and 6-meter yagis

Several years ago I decided to take a different approach to 2-meter EME. The idea was to build an array of eight small Yagis mounted on a short tower. The stacking frame would be attached to a single boom not exceeding 30 feet. Such a system could be mounted conveniently in my back yard with minimum interference to existing structures and would be easily transportable for EME DXpeditions.

It seemed reasonable that a physically small Yagi with a clean radiation pattern and high gain-per-unit boomlength could be designed. Small Yagis require only short, low-loss phasing lines. If this approach was successful on 2 meters, I concluded, the design could later be scaled to 70 cm (432 MHz), where the individual Yagis could be rear-mounted and possibly rotated in polarity for EME operation.

I decided that a 12-foot boom, 144-MHz Yagi might be the ideal answer for the individual antenna; 12-foot boom material is readily available, and short Yagis can be mounted on towers that are only 12 to 15 feet high.

Several designs emerged for both 2 and 6 meters. While some of the results of this study were unexpected, they do answer several frequently asked questions.

where to begin

I started by designing a 2-meter Yagi on a 12-foot boom. Obviously, the boomlength could not exceed 142 inches — which, at 144 MHz, is approximately 1.75 wavelengths. I wanted the sidelobes to be as low as possible, at least 16 to 18 dB in the E plane, and a minimum of 13 dB in the H plane. If improved performance was possible, so much the better.

I studied but quickly discarded the NBS Yagis because the only designs near my requirements, 1.2 or 2.2 wavelengths, were either too short or too long. Then I considered the Greenblum designs. Unfortunately, design information was incomplete; furthermore, previous Yagi designs using the Greenblum tables didn't produce very clean radiation patterns, especially in the H or vertical plane.

Several articles in the IEEE Proceedings discussed a method of optimizing Yagi performance through the use of nonequally spaced and nonuniform length elements. They started with an initial six-element design using equal spacing and director lengths. The elements were 0.0067 wavelengths in diameter on a 1.49 wavelength boom. The reflector was 0.51 wavelengths long and spaced 0.25 wavelength behind the driven. All directors were equally spaced at 0.31 wavelength and were 0.43 wavelengths long.

They ran a program similar to that used by Morris — the forerunner of the one used by W2PV on a large IBM computer. It calculated the gain of this antenna at 11.2 dBi, with relatively high first sidelobes.

Maintaining the same reflector length and spacing, believed to be near optimum, the director spacings were mathematically iterated (adjusted in small steps) for maximum gain. This step increased the Yagi gain by 1.65 dB to 12.85 dBi. However, the boomlength had increased to 1.70 wavelengths, and all director spacings were now unequal. The pattern was definitely cleaner, but not terrific. The next step involved adjusting the reflector length and spacing, but very little improvement resulted.

A further improvement in the computer program through the use of larger matrices allowed for the simultaneous iteration of element spacing and length. The results were quite gratifying. After several optimizations, a new Yagi design with approximately the same boomlength (1.69 wavelengths with a gain of over 13.4 dBi) emerged, showing an improvement of 2.2 dB over the original constant length and spacing design and a cleaner radiation pattern.

Some preliminary conclusions can be drawn as a result of this study. With a fixed number of elements, there is a particular boomlength for optimum gain. Furthermore, gain and pattern aren't optimum when constant director length and spacing are used. For best Yagi performance, the boomlength and all element spacings and lengths must be individually optimized.

implementing the design

Limited practical information was, however, available for the "optimized" Yagi design. No element diameter scaling information was available to me at that time (in the mid-1970s) and the diameters recommended were rather impractical — over 0.5 inch at 2 meters! Therefore I decided to scale my own design by overlaying the element lengths on an NBS-type of scaling graph. I designed a 144-MHz Yagi using 3/16-inch diameter rod (0.0023 wavelength diameter at 144 MHz).

I built this antenna and tested it on a commercial antenna range. The gain was as predicted. However, the bandwidth for maximum gain was very nar-
row, only about 1.0 MHz at the −1 dB points, and gain peaked near 146 MHz. Back to the drawing board!

Based on the data taken on the antenna range, I was able to correct my scaling graph. I then scaled the design to 50.1 MHz. It worked like a champ. The lengths and spacings chosen are shown in the first and second columns of table 1. A typical antenna radiation pattern is shown in fig. 1.

Upon close inspection of the radiation pattern, however, the f/b ratio wasn’t worth writing home about. Dave Oleen, K1WH5, figured that he could trade gain, if necessary, for a better f/b ratio. He left the element spacings constant, but shortened the last director by almost 10 inches; by lengthening the reflector a few inches, he was able to obtain a nearly infinite f/b ratio, though over only a very narrow bandwidth. The cost was about 1 dB in forward gain. The pattern of the modified Yagi is superimposed on the original design in fig. 1. The final element lengths chosen are shown in column 3 of table 1.

A close inspection of the patterns illustrated in fig. 1 shows that the side-lobes aren’t as good as my original design goals. Also, the improved f/b design had lower gain than desired. With the help of John Kenny, W1RR, a computer optimization was conducted on a similar six-element Yagi design scaled to 2 meters.* The results were similar to those reported in references 5 and 6. Either maximum gain or reasonable f/b ratio could be achieved, but not simultaneously!

I decided to make another search and again reviewed the Greenblum designs.* Using his designs, I found that eight elements were required for a 1.75-wavelength boom. I quickly calculated a 144-MHz design and W1RR computed the radiation pattern with his program. The gain was right on the money, but as previously speculated, the radiation pattern had very high sidelobes.

Next John ran an optimization routine on my new eight-element design. The input design parameters were maximum gain with all side and rear lobes at least 18 to 20 dB down in the E plane, with the overall boomp

*Fig. 1. E plane radiation pattern of the original (solid lines) and modified (dotted lines) Yagi. Modifications involved lengthening the reflector and significantly shortening the last director.

fixed at 1.734 wavelengths (142 inches at 144 MHz).

After many computer iterations, a new design emerged. The pattern looked too good to be true. The gain penalty for a clean radiation pattern was only a few tenths of a dB, not a big compromise for over 13 dBi gain! The bandwidth of the design was also very good — several MHz at the −1 dB points.

I hurriedly ran out and built the optimized design using leftover materials from Cushcraft 2-meter beams. Cushcraft uses above-the-boom element mounting, which requires a 0.312-inch element extension when mounted on a 1.0-inch diameter boom. A T match with a 4:1 half-wave balun completed the design. Construction details on the final design are shown in fig. 2.

Soon afterwards, the improved design was measured on a commercial antenna test range and was found to be satisfactory. A typical radiation pattern is shown in fig. 3. All side and rear lobes were about 20 dB down, and the gain was only 0.75 dB less than the NBS 2.2-wavelength design that used a trigonal reflector. Not bad for a design with a lot less hardware, six fewer elements and a 36-inch shorter boom!

Seven more copies were built along with the necessary phasing lines. They were assembled into a “quick and dirty” 2-meter EME array consisting of a 30-foot irrigation tube for the main boom, four 12-foot vertical masts, and a 12-foot portable tower. The spacing was 8½ feet horizontally and 8 feet vertically. The VSWR of the entire array was fine. A photo of the completed array is shown in fig. 4.

The rest is history. On October 17, 1981 — even before making a single QSO — we broke it up and immediately set off for Rhode Island, where we fired it up for the first time on EME. In two nights of activity, we worked 25 stations in 16 states off the moon. Several stations completed a 2-meter WAS; only two stations scheduled were missed, but they turned out to be no-shows. Not bad performance for a small transportable array with only 64 elements!
TELEWAVE ANTENNAS
FIBERGLASS COLLINEAR

COOL BLUE

Telewave's POWER MASTER ANTENNA line features heavy duty fiberglass, end fed antennas which are especially designed for the most adverse conditions. The cool blue color blends with the skyline yet absorbs the rays from the sun which assist in de-icing the antenna. All internal components are brass or copper, designed in a manner to allow for years of flexing without fracturing of any joints. The heavy duty tapered design with its strong interwoven fiberglass housing is fabricated to withstand wind loading of up to 125 MPH with 1/2 inch if radial ice or 150 MPH wind loading without ice. The strong flexible action helps to de-ice the antenna with only a minimum of movement. The brass cap at the tip of the antenna is designed to exhibit DC ground potential while assisting on lightning protection. The unique design of each antenna provides two internal ground planes, eliminating the need for troublesome external ground planes. The broadband design of these antennas with their excellent VSWR and rugged construction makes these the most desirable antennas for any duplexing or multicoupling application. One set of heavy duty mounting clamps and one 12 inch jumper cable will be shipped standard with each antenna.

With the MILLENNIUM SEAL™ of Quality

TELEWAVE, INC.
1155 TERRA BELLA, MOUNTAIN VIEW, CALIFORNIA 94043
(415) 968-4800 • TWX 910-3758555 • FAX (415) 968-1741
ORDER TOLL FREE — (800) 331-3390

NEW
SNAP-ON CHOKE
ELIMINATES RADIO FREQUENCY INTERFERENCE

$15.00 ea. + $2 for shipping

Manufactured and available in Canada from:

JEJEU MANUFACTURING
4087 HARVESTER RD UNIT # 10 BURLINGTON, ONT. L7L 5M3

A Publication for the Radio Amateur
Especially Covering VHF, UHF and Microwaves

English Language Magazine Published in Germany 4 Times Yearly. Available Again in the U.S.

1 Year Subscription $20.00
SAMPLE ISSUE (U.S. only) $4.00

Single Copies $5.00 each at Better Amateur Dealers or Send for FREE Brochure with Partial Article Index.

KITS are Available for Published Project Articles

Write Today
U V COMMS
Dept. H, P.O. Box 432
Lanham, MD 20706 (301) 459-4924
K3RIS

VHF-UHF POWER DIVIDERS

RF power dividers provide the best way to feed in phase 2 and 3 antenna arrays to maximize system gain and at the same time reduce losses to a minimum. Covering 144 thru 1296 Mhz, this series of VHF-UHF power dividers are premier RF devices designed for a long service life with low VSWR and broad operating bandwidth.

Extruded aluminum body with a rugged mount is an added plus in addition to silicon sealing at connector flanges results in a ruggedized unit for all array installations. Available with N-type connectors only, these units are unconditionally guaranteed for 2 years.

MODEL
144-4P (2 ports)
144-6P (2 ports)
144-8P (4 ports)
220-4P (2 ports)
220-6P (2 ports)
220-8P (4 ports)
430-4P (2 ports)
430-6P (2 ports)
430-8P (4 ports)
902-4P (2 ports)
902-6P (2 ports)
902-8P (4 ports)
1295-4P (2 ports)
1295-6P (2 ports)
1295-8P (4 ports)

PRICE
$55.00
$65.00
$85.00
$58.00
$85.00
$125.00
$65.00
$85.00
$125.00
$65.00
$85.00
$125.00
$35.00
$45.00
$57.00

ORDER TOLL FREE — (800) 331-3390

STRIDSBerg ENGINEERING, CO.
P.O. Box 7973 • Shreveport, LA 71107 • USA
Phone: (318) 663-0522

1986-87 CALL DIRECTORY

A publication of W6EPE Publishing, Inc.

See us at Dayton BOOTH #430

178

MULTI-BAND SLOPERS

Also Dipole & Limited Space Antennas

Outstanding performance of W6KAB antennas is well known—now available in Multi-Band Slopers. Each can be ordered with 4 band, 3 band, 2 band or 1 band versions. For the price of the single band model, you can order the multi-band version with 2 to 4 bands. Each is rated for use with 50 ohm line. Details of all units available. See us at Dayton BOOTH #430.$50.00 each

PO BOX 39349, MI. PROSPECT, I11. 60056

Buckmaster Publishing
Mineral, Virginia 23117
703-894-5777

94 May 1987
insulated element mounting

Since the original Yagi was constructed, insulated through-the-boom element mounting has become quite popular. Fortunately, the same dimensions as those shown in fig. 2 can be used, since the correction factor for through-the-boom with insulated elements is about the same as the one used in the original design. Just maintain a 1.0-inch diameter boom and 3/16-inch element diameters with insulators and keepers as described in reference 9. However, the driven element length and/or the lengths and spacings of the T match will probably have to be optimized if low (1.2:1 maximum) VSWR is to be maintained.

I've used the eight-Yagi, 2-meter array on EME for several years. WAC was accomplished with less than 600 watts of output in the shack. Several European stations are using this Yagi on tropo and meteor scatter. Several local Amateurs and I have also used it to put rare grids on the air, since it's so compact and uncluttered.

This Yagi design is highly recommended where a small, simple, high-gain antenna with excellent sidelobe suppression is preferred. It's easily duplicated and can be used singly or as part of an array. Despite its size, four of these Yagis stacked 8-1/2 feet horizontally and 8 feet vertically make a good beginner's 2-meter EME array. Eight are better for the more serious EMEer, yet still affordable.

A secondary benefit of this 2-meter array hasn't previously been discussed, but may be worth mentioning. Because of space limitations, I can't fit both a 2-meter and a 135-cm (220 MHz) EME array in my back yard at the same time. But fortunately, if you use the 4.2-wavelength NBS Yagi designs on 135 cm, the mechanical spacings used on 2 meters just happen to be the same as the optimum mechanical spacing for 135 cm. In my case, when I change bands I just swap out the Yagis, reconnect the same phasing lines, change the power dividers, and presto! For just an hour or so of changeover effort, I'm on 135-cm EME. (A photo of this array on a 1984 expedition to New Hampshire, using the same tower and stacking frame, is shown in reference 10).

6-meter Yagi

Shortly after this 2-meter Yagi design was completed, several Amateurs who needed a high-performance, high-gain array decided to build it. The results were promising and encouraged me to try it on 6 meters. Several years later, the design, analysis, and construction guidelines have been published in several clubs' publications and QST.

I've used various Yagi, 6-meter arrays on EME for several years. They are also very effective on tropo and meteor scatter. Several local Amateurs have also used these Yagis for putting rare grids on the air, since they're compact and uncluttered.

This Yagi design is highly recommended where a small, simple, high-gain antenna with excellent sidelobe suppression is preferred. It's easily duplicated and can be used singly or as part of an array. Despite its size, four of these Yagis stacked 8-1/2 feet horizontally and 8 feet vertically make a good 6-meter EME array. Eight are better for the more serious 6-meter EMEer, yet still affordable.

A secondary benefit of this 6-meter array hasn't previously been discussed, but may be worth mentioning. Because of space limitations, I can't fit both a 6-meter and a 2-meter EME array in my back yard at the same time. But fortunately, if you use the 4.2-wavelength NBS Yagi designs on 135 cm, the mechanical spacings used on 2 meters just happen to be the same as the optimum mechanical spacing for 135 cm. In my case, when I change bands I just swap out the Yagis, reconnect the same phasing lines, change the power dividers, and presto! For just an hour or so of changeover effort, I'm on 2-meter tropo, 135-cm EME, and 135-cm tropo. (A photo of this array on a 1984 expedition to New Hampshire, using the same tower and stacking frame, is shown in reference 10).

Table 1. Length and spacing for six-element, 6-meter Yagi.

<table>
<thead>
<tr>
<th>Element</th>
<th>Spacing (inches)</th>
<th>Element length (inches)*</th>
<th>Element length (inches)**</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>59.0</td>
<td>113.75</td>
<td>117.0</td>
</tr>
<tr>
<td>DR</td>
<td>68.0</td>
<td>113.0</td>
<td>113.0</td>
</tr>
<tr>
<td>D1</td>
<td>95.5</td>
<td>104.75</td>
<td>104.75</td>
</tr>
<tr>
<td>D2</td>
<td>75.5</td>
<td>103.88</td>
<td>103.88</td>
</tr>
<tr>
<td>D3</td>
<td>100.0</td>
<td>104.25</td>
<td>104.25</td>
</tr>
<tr>
<td>D4</td>
<td>103.88</td>
<td>93.88</td>
<td></td>
</tr>
</tbody>
</table>

*Maximum gain model.

**Optimized for best f/b ratio. A 2-inch diameter, 33-1/2 foot boom is used. The elements are 3/16-inch diameter, and are attached to the boom with U-bolt mounting as shown in fig. 5C. A 0.625-inch element lengthening correction is included for this method of boom mounting.
gain 6-meter Yagi with clean radiation patterns — one that would also be usable on EME — approached me. Their requirements seemed to call for a frequency-scaled copy of the 2-meter design. At 6 meters, this would require a boomenlength of about 35 feet.

Several mechanical configurations were evaluated. It appeared that a boom diameter of at least 2 inches was in order. "Through-the-boom" element mounting (fig. 5A), either directly in contact with or insulated from the boom, was immediately discarded since it would severely degrade the mechanical strength of the boom. Insulated elements mounted above the boom are advisable, but require special materials (see fig. 5B).

Several commercial element mounting methods were also evaluated. Cushcraft uses large diameter (3/4 inch) elements on its 6-meter "Boomer™" and places a U-bolt directly through the element with a stiffening half-diameter element above and below the element (fig. 5C). Wilson antennas (now out of production) use a different mounting method that doesn't pierce the element (fig. 5D). Finally, with the help of Don Cook, K1DPP, a homebrew nonpiercing above-the-boom mounting was also fabricated (fig. 5E.)

The final element mounting scheme chosen was that shown in fig. 5D, since many of the older Wilson eight-element antennas are still available and easily modified for the new design. However, any of the above-the-boom mounting schemes shown will work satisfactorily. If you don't have an old Wilson beam to modify, I recommend the element mounting scheme shown in fig. 5E. More on this shortly.

Based on the use of an obsolete Wilson eight-element Yagi, the 2-meter design was scaled to 50.1 MHz. This design uses a 4-foot section of 5/8-inch diameter tubing for the inner portion of the elements and 1/2-inch diameter tubing for the outer portion of the elements. Construction details are shown in fig. 6.

Several 6-meter Amateurs have used this design. Each has used a slightly different set of tubing for the driven element matching, so the sizes shown for the driven element matching assembly may need some final adjustment. Either the length of the driven element and/or the length and spacing of the matching section may have to be changed slightly to suit your individual design.

If you build your own from scratch, the element mounting schemes shown in figs. 5C, D or E are recommended. The elements used may be either 1/2-, 5/8-, or 3/4-inch diameter tubing, or you can use graduated tubing as shown in fig. 6, since the difference in tuning is negligible (less than 100 kHz). If you use insulated mounted elements as shown in fig. 5B, each of the elements should be shortened approximately by 5/8 inch.

If you're building from scratch,
recommend the use of a 30-foot length of irrigation pipe measuring 2 inches in diameter. This is available in farming supply stores. To obtain the required 35-1/12 foot length, a 1-7/8 inch outside diameter tube can be telescoped into the end of the tubing near the last director. Suitable tubing can be obtained from WD4BUM.**

Any boom this length and size should be supported from above. Two suggested methods are shown in fig. 7. This beam is large and has a high wind load, so any short cuts can turn into an expensive disaster.

If you decide to build your own, use the element mounting method shown in fig. 5E. A 2-inch wide aluminum channel measuring 1/2 inch thick and 5 to 6 inches long is recommended. It’s easy to file out a semicircular groove in the channel to match the boom curvature. Don’t file too deeply; the strength of the channel will be diminished if you go all the way down to the base plate.

The elements are held to the channel with short pieces of aluminum straps approximately 1/2 inch wide, 1/16 inch thick, and 2-1/12 inches long. These straps are held in place with stainless steel screws, nuts, and washers. For best element alignment, each channel should be attached to the boom using two U-bolts. Suitable stainless steel U-bolts can be purchased from suppliers such as WB9IPG*** or homebrewed.

At the suggestion of K1DPP, I made my own U-bolts using 3/16-inch diameter stainless steel welding rods available from a local welding supply house. All that was required was a 10-32 die, a die handle, and some patience. If you’d like to try this, first de-burr the edges of the rod and then cut the required length of threads on both ends. Next, place a 2-inch diameter tube upright in a bench vise. Place about a 6-inch piece of suitable diameter tubing over each threaded end of the rod. Then carefully bend the rod around the 2-inch diameter tube until the desired U-shape is obtained.

6-meter results

The performance of the 6-meter Yagi design has been gratifying to all who built one. Some Amateurs used it in contests to set high scores. Compared with most other designs, the pattern is very clean, and the gain definitely matches or exceeds that of any other 6-meter Yagi designs, even those with more elements or longer boomlengths.

Ray, WA4NJP, who’s been active on 6 meters for many years and has used several different Yagi designs, recently built a large array for 6-meter EME. After finding his results only marginal, he asked for my recommendation.

I gave him the details shown in fig. 6, and he built four of the 6-meter Yagis, stacking them 28-1/2 feet in the E plane and 24 feet in the H plane. He started hearing EME echoes on 50 MHz immediately. Recent tests have yielded EME echoes regardless of where the moon is in the sky; previously, he could use the moon only when it was at low elevations to obtain horizon gain. Echoes more than 10 dB above the noise are now quite common off the moon — even on SSB!

**George Shira, WD4BUM, Route 7, Box 258, Anderson, South Carolina 29624.
***H. C. Van Valzah Company [WB9IPG], 1140 Hickory Trail, Downers Grove, Illinois 60515.
RAMSEY OSCILLOSCOPES

All Ramsey oscilloscopes feature unsurpassed quality at an unbeatable price. Of heavy duty construction, they are suitable for hobby, service and production applications.

R消息O SCILLOSCOPES

Includes 2 hook-on probes.

$399.95*

20 MHz Dual Trace

Features component testing easily fits in your pocket, you can take it anywhere. It features full overload protection - no dice or CD readout - recessed input jacks - safety probes - diode check function - 2000 hours battery life.

INTEGRAL COUNTER

CT-70 Digital 525 MHz

$199.95

MODEL 100

$139.95

WIDE INCLUDES AC ADAPTOR

$169.95

WIDE INCLUDES AC ADAPTOR

$499.95*

35 MHz Dual Trace

$499.95*

15 MHz Dual Trace Portable

Field bench applications - built-in charger and battery pack - up to 2 hours operation per charge - SX horizontal magnification - high brightness CRT - front panel trace rotator.

MINI-100 COUNTER

CT-90 Digital 600 MHz

$189.95

WIDE INCLUDES AC ADAPTOR

$189.95

CT-125 9 DIGIT 1.2 GHz

$189.95

WIDE INCLUDES AC ADAPTOR

$189.95

R消息M FREQUENCY COUNTERS

Ramsey Electronics has been manufacturing electronic test gear for over 10 years and is recognized for lab quality products at breakthrough prices. Our frequency counters have features and capabilities of counters costing twice as much. BF-4 Nicad battery pack for CT-70, CT-90 and CT-125 Frequency Counters. $9.95. 

PS-2 MULTIPLIER

The PS-2 is handy for high resolution audio or radio frequency measurements. Multiples up to 10 in 0.1 MHz resolution. Multiply up to 10 in 0.1 MHz resolution. 

PS-10B 1 GHz PRESCALER

Extend the range of your present counter to 1 GHz. Preselected range for 0.1 MHz resolution. 

MINI KITS - EASY TO ASSEMBLE - FUN TO USE - FOR BEGINNERS, STUDENTS AND PROS

TIME RECORDER

A complete time divider on a single PC board. Feature: 400-1000 MHz adjustable range via 70 MHz voltage regulation. QTC. Useful for time division, delay, 8-bit, etc. Can also be used as a receive tone encoder. Runs on 3.6 Vdc.

$9.50

COLOR DIAGRAM

Converts color for transmission and reception. Each individual color is adjusted and driven up to 1000 MHz. Runs in TQCC. ML 1/2.

$8.95

LED BLINKY KIT

Adaptable to almost any LED driven or powered with 3V to 12V. Designed for 3V to 12V. Runs up to 12V LED.

$2.50

SUPER SLEUTH

A super sensitive amplifier which will pick up to 100 MHz signal on 100 MHz. A complete kit. Runs in 100 MHz.

$7.95

MINI TIME BASE

Runs in 15 MHz. Low current. Commonly used for time measurements.

$5.95

PHONE ORDERS CALL

716-586-3950

TELEX 466735 RAMSEY CI

FAX 716-586-4754

ACCESSORIES FOR RAMSEY COUNTERS

Telescopic whip antenna - BNC plug...

High impedance probe, light housing...

Low pass, high pass, audio probe...

Diode probe, general purpose...

Tilt ball for CT-70, 90, 125...

$8.95

$16.95

$13.95

$13.95

$3.95

$14.95

$19.95
summary

Since these Yagis were originally designed, additional data has indicated that optimum boom lengths exist for Yagi antennas, especially those shorter than 4 wavelengths. The optimum boom length for short Yagi designs seems to be an odd multiple of quarter-wavelengths (i.e., 0.25, 0.75, 1.25, and 1.75 wavelengths). If these boom lengths are used with the proper number of elements, optimum gain and pattern can often occur simultaneously. According to my analysis, the optimum number of elements for any specific boom length seems to follow those recommended by Greenblum. Furthermore, the use of a T match with a built-in 4:1 half-wave type balun, as shown in figs. 2 and 6, is strongly suggested.

This month’s column was primarily aimed at the design of shorter boom-length Yagis. Emphasis was on performance, with high gain-per-unit boom lengths and clean radiation patterns. Several designs for 2 and 6 meters that meet the criteria specified above were discussed. These designs should be just the ticket for those who want high performance with an antenna they can modify or build for themselves.

acknowledgements

Any project this size requires plenty of help. I’d especially like to thank John Kenny, W1RR, for his work on optimizing the designs. Thanks also to Dave Olean, K1WHS, for his assistance with measurements and the optimization of the f/b ratio on the six-element 6-meter design. Stan Jaffin, WB3BGU, has been particularly helpful in analyzing my results and comparing notes on this and other designs. Thanks also go to Don Cook, K1DPP, for his help with the 6-meter antenna mounting brackets and hardware. Finally, thanks to Ray Rector, WA4NJP, for trusting my designs enough to build his large 6-meter EME array that works so well. I hope I didn’t forget anyone!

new records

In last month’s column I predicted...
that before the April issue was printed, the 33-cm (903 MHz) record would again be broken. On Christmas Eve, 1986, another unexpected Midwest tropo opening occurred; this time, Sam, W2PGC (FN02OR), completed a two-way QSO with Gary, K3SIW/9 (EN52WA), for a record-shattering distance of 478 miles (769 km). Both stations were using modest setups, 10 and 70 watts, respectively, and single-loop Yagi antennas. Signals were S9 each way, and the contact was completed on two-way SSB. Congratulations to Sam and Gary.

East Coast VHF Society

One of the first of its kind, the East Coast VHF Society is now being reactivated by president Russ Pillsbury, K2TXB, vice-president Roger Amidon, K2SMN, secretary Allen Katz, K2UYH, and treasurer Tom Kirk, K2VAD. There are plans for a newsletter and an annual flea market, as well as antenna and noise figure measuring contests in July. Equipment loan and activity to various rare grids are also planned. Contact K2UYH for further information.
MININEC 3 is available

From time to time I've mentioned computer-aided antenna modeling programs. Till now, these computer programs were either difficult to obtain, not generally available, or suitable only for mainframe or other large computers.

All that has changed. MININEC 3 is now available for general distribution for use on IBM and IBM-compatible personal computer systems. This program is faster than its predecessor and has more available options. To obtain your copy, send an MS DOS-formatted, double-sided, double-density disk with sufficient return postage and a note requesting a copy of MININEC 3 to Jim Logan, Code 822, Naval Ocean Systems Center, 271 Catalina Boulevard, San Diego, California 95152-5000.

important VHF/UHF events

May 2-3 West Coast VHF Conference (contact WB6FGJ)
May 5 Predicted peak of the Eta Aquarids meteor shower at 1300 UTC
May 8 ARRL 902-MHz Spring Sprint Contest (Friday evening)
May 8 2304 EME special by WA2WEB (contact K2UYH for skeds)
May 14 ARRL 1296-MHz Spring Sprint Contest (Thursday evening)
May 15 EME perigee
May 16-17 13th Annual Eastern VHF/UHF Conference, Nashua, New Hampshire (contact W1EJ)
May 23-24 ARRL 50-MHz Spring Sprint Contest (Saturday evening)
June 7 Predicted peak of the daytime Arietids meteor shower at 1900 UTC
June 10 Predicted peak of the Zeta Perseids meteor shower at 0400 UTC
June 13 EME perigee
June 13-15 ARRL June VHF QSO Party
June 20-21 SMIRK 6-Meter QSO Party Contest (contact KA0NNO)
June 21 ± 1 month. Peak of Sporadic E propagation

references


ham radio

KAGIL "Over the Top" DUSTCOVERS... here's what a few Radio Amateurs have said...

"Second to none..." - Joe NM2O
"I think this is my 5th order..." - Dr. Morales NS9KCT
"I am showing them to my friends!" - YC4GNM
"Please send more order blanks... recommended by (a friend)..." - W1JOT
"Received new covers yesterday...they fit perfectly!" - N5GKV
"You did an outstanding job from my drawings..." - WAGGER

- Waterproof PAK Nylon
- FIVE Colors
- Economical
- For ALL Amateur Radio Gear

Send (SASE) Today for brochure, samples & order form

KAGIL Dustcovers Box 06780
Portland, OR 97206

The DJ2UT-Multiband-Systems offer:
- Maximum gain plus F/B ratio with low VSWR across each band
- 2 KW CW output power
- 10/15/20/30 40-meter bands with up to 7 band coverage incl. WARC bands with self-supporting "TWIN-BOOM" and boom-legs from 8 to 20 ft
- Air-core teflon dielectric coax-balan and stainless-steel hardware at no extra cost
- traditional Blackforest craftsmanship

The DJ2UT-MULTIBANDERS provide the superior full-size monoband-beam performance required during the present sunspot minimum.

For further information contact:

H.J. Theiler Corp.
P.O. Box 5369
Spartanburg, SC 29304
(803) 576-5566
or our distributor in Canada:
Doland's Radio West
P.O. Box 58236
762 S.W. Marine Drive
Vancouver, B.C. V6P 6E3
Selected dealerships available.

May 1987 / 101
QUALITY PARTS  DISCOUNT PRICES  FAST SHIPPING!

1987 CATALOG...  48 PAGES!

ALL ELECTRONICS CORP.

INTERFERENCE?

★ Interference Location
★ Stuck Microwaves
★ Cable TV Leaks
★ Security Monitoring

New Technology (patent pending) converts any VHF or UHF FM receiver into an advanced Doppler shift radio direction finder. Simply plug into receiver's antenna and external speaker jacks. Uses four omnidirectional antennas. Low noise, high sensitivity for weak signal detection. Call or write for full details and prices.

DOPPLER SYSTEMS, INC. P.O. Box 31819
Phoenix, AZ 85046
(602) 488-9755

SPECIALISTS IN FAST TURN P.C. BOARDS

PROTO TYPE P.C. BOARDS
AS LOW AS $25.00
- SINGLE & DOUBLE SIDED
- PLATE THROUGH HOLES
- TEFLOM AVAILABLE
- P.C. DESIGN SERVICES

FOR MORE INFORMATION
Midland Technologies
34374 EAST FRONTAGE ROAD
BOZEMAN, MT 59715 (406) 586-1190

MAKE YOUR OWN CANOPIES

WE HAVE:
★ SNAP JOINTS & PARTS FOR ½" & 1" TUBING.
★ SILVER, WHITE OR BLUE TARP.
★ BUNGEE'S & ACCESSORIES.
★ COMPLETE PACKAGES AVAILABLE.
★ FREE BROCHURE ON REQUEST.

ELAINE MARTIN, INC.
PO Box 261, Dept. H
Highwood, IL 60040
Phone: 312-433-0106

DOWN EAST MICROWAVE

MICROWAVE ANTENNAS AND EQUIPMENT
- Log Poles + Power Connectors + Linear Amplifiers + Complete Arrays + Microwaves Transverters + 400 MHz + New! MICROWAVE TRANSVERTERS BY LMW ELECTRONICS
- TROPO + 100 W + WEAK SIGNAL + OSCAR + 2400 + 1296
- 2400 + 3400 + 5400 MHz
- 2400 LY 45dB link Yagi 1296 MHz + 995
- 2300 LY 45dB loop Yagi 1296 MHz + 995
- 3333 LY 33dB loop Yagi 2304 MHz + 995
- NEW! MICROWAVE TRANSVERTERS BY LMW ELECTRONICS

Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
Add 80 UPS SH, $11 West of the Mississippi.
<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>IC-735</td>
<td>Hf transceiver/ SW cw/ vhf</td>
<td>199.00 999</td>
</tr>
<tr>
<td>PS-55</td>
<td>External power supply</td>
<td>199.00 999</td>
</tr>
<tr>
<td>AT-150</td>
<td>Automatic antenna tuner</td>
<td>445.00 3499</td>
</tr>
<tr>
<td>FL-32</td>
<td>500 Hz filter</td>
<td>66.50</td>
</tr>
<tr>
<td>EX-243</td>
<td>Electronic keyer unit</td>
<td>56.00</td>
</tr>
<tr>
<td>UT-30</td>
<td>Tone encoder</td>
<td>17.50</td>
</tr>
<tr>
<td>IC-745</td>
<td>9-band v/cr w/ 1-30 MHz crv 1049.00 8999</td>
<td></td>
</tr>
<tr>
<td>PS-35</td>
<td>Internal power supply</td>
<td>119.00 1799</td>
</tr>
<tr>
<td>EX-241</td>
<td>Marker unit</td>
<td>22.50</td>
</tr>
<tr>
<td>EX-243</td>
<td>Electronic keyer</td>
<td>56.00</td>
</tr>
<tr>
<td>FL-45</td>
<td>500 Hz filter (1st if)</td>
<td>65.00</td>
</tr>
<tr>
<td>FL-54</td>
<td>270 Hz filter (1st if)</td>
<td>53.00</td>
</tr>
<tr>
<td>FL-52A</td>
<td>500 Hz filter (2nd if)</td>
<td>108.00 999</td>
</tr>
<tr>
<td>FL-33</td>
<td>AM filter</td>
<td>35.25</td>
</tr>
<tr>
<td>FL-70</td>
<td>2.8 kHz wide SSB filter</td>
<td>52.00</td>
</tr>
<tr>
<td>IC-751A</td>
<td>9-band v/cr. 1-30 MHz crv 1049.00 1399</td>
<td></td>
</tr>
<tr>
<td>PS-35</td>
<td>Internal power supply</td>
<td>199.00 1799</td>
</tr>
<tr>
<td>FL-32</td>
<td>500 Hz filter (1st if)</td>
<td>66.50</td>
</tr>
<tr>
<td>FL-33</td>
<td>250 Hz filter (1st if)</td>
<td>54.50</td>
</tr>
<tr>
<td>FL-32A</td>
<td>500 Hz filter (2nd if)</td>
<td>108.00 999</td>
</tr>
<tr>
<td>FL-33</td>
<td>AM filter</td>
<td>35.25</td>
</tr>
<tr>
<td>FL-70</td>
<td>2.8 kHz wide SSB filter</td>
<td>52.00</td>
</tr>
<tr>
<td>OPC</td>
<td>Opt. cord, specialty 2, 4, 6 pin plug</td>
<td>20.00</td>
</tr>
<tr>
<td>MB</td>
<td>Mobile mount, 735/755/757/75A</td>
<td>24.50</td>
</tr>
<tr>
<td>SP-3</td>
<td>External speaker</td>
<td>61.00</td>
</tr>
<tr>
<td>SP-7</td>
<td>Small external speaker</td>
<td>49.00</td>
</tr>
<tr>
<td>CR-64</td>
<td>High stab. ref. exal (75/757)</td>
<td>63.00</td>
</tr>
<tr>
<td>PF-1</td>
<td>Speaker/patch</td>
<td>109.25 1499</td>
</tr>
<tr>
<td>SM-6</td>
<td>Desk microphone</td>
<td>44.95</td>
</tr>
<tr>
<td>SM-10</td>
<td>Desk microphone - 10 pin plug</td>
<td>175.00 2699</td>
</tr>
<tr>
<td>SM-10C</td>
<td>Compress/peak EQ, 8 pin mc</td>
<td>136.25 1249</td>
</tr>
<tr>
<td>AT-100</td>
<td>100-bw SP/4400 MHz</td>
<td>445.00 3899</td>
</tr>
<tr>
<td>AT-500</td>
<td>500-900 MHz, 4400 MHz</td>
<td>559.00 4899</td>
</tr>
<tr>
<td>AH-2</td>
<td>B-band tuner</td>
<td>625.00 5499</td>
</tr>
<tr>
<td>AH-2A</td>
<td>antenna tuner system,</td>
<td>495.00 4299</td>
</tr>
</tbody>
</table>

**HOURS** Mon. thru Fri. 9:30-5:30 Sat. 9-3
Milwaukee WATS line: 1-800-558-0411 answered evenings until 8:00 pm Monday thru Thursday.
WATS lines are for Quotes & special orders only. Use regular line for other Info & Service Dept.

All Prices in this list are subject to change without notice.
BIRD
43
THRUNLINE WATTMETER
0.45-2300 MHz
0.1-10,000 watts

Ask for model 43 Bulletin

BIRD Electronic Corporation
30303 Aurora Rd., Cleveland (Solon), Ohio 44139
216-248-1200 TLX: 98-5298 Cable: BIRDELECG
1986 propagation review

Now that most of the geophysical and propagation data for 1986 is in and has been analyzed, let's review the significant events so you can compare them with your DX operating log.

There were only four major geomagnetic-ionspheric disturbances (i.e., those with a geomagnetic A index greater than 40) during the year and eight large ones (i.e., those with an A index greater than 30). Surprisingly, April was the quietest month. The four major disturbances occurred in February, May, September, and November; with the exception of the September disturbance, these occurred as the 27-day solar flux cycle was decreasing. The February event (from February 5 to February 10) was so extraordinary that it warranted special coverage in the July, 1986, column.

The next major solar event, which occurred from May 1 through May 4, included a geomagnetic-ionspheric disturbance (to K7) at 1200 UT on May 2. On May 3, an old-cycle solar flare at 2017 UT (with signal attenuation in the United States and in the Pacific area) produced protons at the polar regions at 1255 UT on the following day, with the next geomagnetic-ionspheric disturbance (to K6) about 2100 UT on May 5. A decrease of as much as 22 percent in mid-latitude maximum usable frequencies (MUF) occurred on east-west paths, which included QSB.

On September 11 at 1837 UTC, the next major event occurred during a period of relatively constant solar flux. Possibly attributable to a small new-cycle flare, it produced a sudden-commencement geomagnetic-ionspheric disturbance. As a result of a favorable sun-earth equatorial alignment, an A of 49 and a K of 7 were registered, with an aurora visible as far south as Albuquerque, New Mexico, and Columbia, Missouri. MUFs decreased 25 percent on September 12, with considerable fading and weak signals occurring on east-west paths. There must have been good transequatorial openings to southern areas on this one, but I didn't hear of them.

The last of the four events took place in early November, as the solar flux decreased from its October 23 peak. The driving forces for this event were probably several small old-cycle flares and numerous solar flux bursts, the largest of which occurred on October 31 at 2249 UT. A sudden-commencement geomagnetic-ionspheric disturbance (to K6) started on the November 3 at 2354 UT and ended at 1500 UT on the 5th. A decrease of 20 percent in the MUF during the early part of the 4th was experienced on east-west paths to Europe from this short disturbance. This MUF decrease is related to equatorward extension of the lower F layer electron density of the auroral Atlantic trough situated between 60 to 70 degrees north latitude. Signal levels on the normal great circle paths are lower and QSB is experienced. However, perhaps other less common paths were useful and resulted in some interesting DX in your log.

new forecasting tool — via computer BBS

In October 1978 the Institute for Telecommunication Science of the Department of Commerce in Boulder, Colorado, stopped providing radio propagation quality information to the public via mailed weekly bulletins and WWV broadcasts of "N7's" at 14 minutes after the hour. They've been replaced with solar flux and geomagnetic A and K data included with the geophysical alert announcements at 18 minutes after the hour. With the help of articles by Ted Cohen, N3AT, George Jacobs, W3ASK, and others of us, hams became their own forecasters.

Now the Space Environment Services Center (SESC) in Boulder has resumed radio quality reporting with an expanded, worldwide version of the "N7" report/forecast system. They've divided the northern hemisphere into a grid of four longitude quadrants, 0 to 90 and 180 degrees east and west, and five latitude zones, 0-10-30-55-70-90 degrees north. A two-digit code (such as N7) appears in each grid space. The letter (W, U, or N) represents conditions for the current 6-hour period; the number (1 through 9) indicates the forecast for the next 6-hour period. The primary forecast is at 0600 UTC daily with 6-hour updates.

You can use your computer terminal to obtain these forecasts from SES's "bulletin board" service. Call (303) 497-5000 with the usual 300/1200-baud, 8-bit (1 stop bit, no priority) conventional protocol of bulletin board systems. An simple menu will allow copying data for up to 5 minutes. Registration (entering your name and intended use) will give you a user number and extend available data-copying time to 15 minutes. User acceptance of the experimental service will assure permanence and menu expansion.

last-minute forecast

The higher frequency bands, 10 through 30 meters, are expected to be favorable for DX openings the first and last weeks of the month, when the possibility of higher solar flux is greatest. Short-skip sporadic-E openings are also possible during the last week or so. On the lower bands, the middle weeks should be best, with higher daytime and nighttime signal strengths. Atmospheric noise (thunderstorms) may be building up generally now, but not significantly — so enjoy these bands while you can.

Of interest to moonbounce DXers, the lunar perigee occurs on the 15th with a full moon occurring on the 13th. The Aquarid meteor shower, of interest to meteor-burst DXers, peaks be-
MADISON SPRING FLING

New rigs and old favorites, plus the best essential accessories for the amateur.
The italicized numbers signify the bands to try during the transition and early morning hours, while the standard type provides MUF during "normal" hours.

*Look at next higher band for possible openings.*
**TOWERS by ALUMA**

**HIGHEST QUALITY ALUMINUM**

- Telescoping (Crank-up)
- Guyed (Stack-up)
- Tilt-Over Models

Easy to install. Low Prices. Crank-ups to 100 ft.

**EXCELLENT FOR Amateurs Communications**

- Over 36 types of aluminum and steel towers—specials designed and made—write for details.

**SPECIAL**

Four Section 50 ft. Van Mounted Crank-Up, Aluma Tower

**ALUMA TOWER CO.**

*BOX 28004P*

*VERO BEACH, FLA 32960-2806*

*(305) 567-3423* 

*TELEX 80-3405*

---

**ALL ABOUT VERTICAL ANTENNAS**

by Bill Orr, W6SAI and Stu Cowan, W2LX

Smart DX'ers know that the vertical antenna can be the secret to low band DX success. Theory, design, construction, operation—all the secrets of making the vertical work—are fully covered by Ham Radio's well known columnists and book authors Bill Orr in a clear concise easy-to-read text. Or is it a master at making the complex simple and this book is no exception. Here's just a sample of what this exciting new book covers: Horizontal vs vertical—which is best? Top loaded and helical antennas, 5 high efficiency Marconi antennas for 80 and 160, verticals and TVI—Is there a problem? The effects of ground on vertical antennas and a how to make an effective ground system. The Bobtail beam, construction data for 25 different antennas, matching circuits of all descriptions—which is best, plus P.L.E-N-T-Y more! For years Ham's having been asking for this book. You won't regret it! 1986

**Softbound $10.95**

Please enclose $3.50 shipping and handling

**ham radio's bookstore**

Greenville, NH 03048

---

**SYNTHESIZED SIGNAL GENERATOR**

**MADE IN USA**

**MODEL SG-100F**

$429.95 delivered

- Covers 100 MHz to 199.999 MHz in 1 kHz steps with thumbwheel dial
- Accuracy +/− 1 part per 10 million at all frequencies
- Internal FM adjustable from 0 to 100 kHz at a 1 kHz rate
- External FM input accepts tones or voice
- Spurs and noise at least 60 dB below carrier
- Output adjustable from 5-500 mV at 50 Ohms
- Operates on 12 Vdc @ 1/2 Amp
- Available for immediate delivery
- $429.95 delivered
- Add-on accessories available to extend freq range, add infinite
- resolution, AM, and a precision 120 dB attenuator
- Call or write for details

**VANGUARD LABS**

196-23 Jamaica Ave., Hollis, NY 11423

Phone: (718) 468-2720 Mon. thru Thu.

---

**MICROCOMPUTER REPEATER CONTROL**

**$129**

*199*

Introducing the MICRO REPEATER CONTROLLER RPT-2A, a new concept in LOW COST, EASY TO INTERFACE, microcomputer repeater control. Replace old logic boards with a state of the art microcomputer that adds NEW FEATURES, HIGH RELIABILITY, LOW POWER, SMALL SIZE, and FULL DOCUMENTATION to your system. Direct interface (plug n' play) with most repeaters. Detailed interface information included. Original MICRO REPEATER CONTROL article featured in QST Dec. 1983

- Two CW ID Messages
- Time Out Timer
- Pre-Timed Warning Tone
- Post-Timed CW MS2
- Post-Timed CW MS3
- Auxiliary Inputs
- Reprogrammable COR Input
- High Current PTT Interface
- Low Power 9 VDC @ 200 mA
- Size 3 1/2 " x 3 1/2 "
- All Connectors Included

**RPT-2A Kit Only $129**

**plus $3.00 shipping**

**PROCESSOR CONCEPTS**

P.O. BOX 26073

ST. PAUL, MN 55126

(612) 848-9176 7pm-10pm evenings

CALL OR WRITE FOR FREE CATALOG AND SPECIFICATIONS

---

**Want to Advertise in HAM RADIO?**

Call Rally Dennis (603) 878-1441

today for more information

---

between May 4 and 6, with rates of 10 to 25 per hour for the northern and southern hemispheres, respectively.

**band-by-band summary**

Ten, twelve, fifteen, and twenty meters will support DX propagation from most areas of the world during daylight and into the evening, with long-skip out to 2000 miles (3500 km) per hop. Signals on the upper three bands arrive mainly from the southern countries and occur near noontime. Sporadic-E short-skip will be available on some days toward the end of the month near local noon. The direction of propagation will follow the sun across the sky: morning to the east, south at midday, and west in the evening.

Thirty, forty, eighty, and one-sixty meters are the nighttime DXers' bands. Because of low solar flux in midmonth, daytime DX — particularly in the early mornings — may be worthwhile. The direction of propagation follows the darkness path across the sky: evening to the east, south and north around midnight, and toward the west in the predawn hours. Distances will decrease to 1000 miles (1600 km) generally, for skip on these bands. Sporadic-E openings will be observed most frequently around sunrise and sunset toward the end of the month.
Light Weight/High Strength Aluminum Tubing for Masts and Telescoping Elements

How many antennas have you seen ruined by the failure of the mast? If you are stacking antennas, or have a beam antenna, our Light Weight/High Strength Aluminum masts will increase the survivability of your antenna system. These masts are 67% lighter and 50% stronger than galvanized steel tubing. Example of weight difference:

- 3/4" wall x 2" OD x 24' long: AL. 39 lbs., Steel. 112 lbs.
- Sizes available: 1.112" OD x 0.058" wall x 24' long (drawn for telescoping)

- Club and volume discounts are offered M/C and VISA accepted
- Metal & Cable Corp., Inc. (formerly Exmel, Inc.)
  P.O. Box 1172170 E. Aurora Rd.
  Twinsburg, Ohio 44087
  (216) 425-8455

Troubleshooting Microprocessor-Based Equipment and Digital Devices

Attend this 4-day seminar and master the essentials of microprocessor maintenance! Gain a firm understanding of microprocessor fundamentals and learn specialized troubleshooting techniques.

Call or write for brochure with full details and current schedule. Fee is $795.00

- Multiple commands can be executed at once
- Up to 16 digits per command string
- Sub-address tone & speed dial compatible
- Alarm clock & auto-locate includes the following:
  - 300 Touchtone loadable Autodial numbers
  - Auto-Audit (quick access)
  - 300 Reverse patch call sets up, e.g., 100 to 1200 lbs. in weight
  - Full or half duplex
  - Input 22 vocabulary words & letters in 10 MCI
  - Patching capability
  - Storage of MCI/Sprint access codes
  - Call setting allows switching to second phone line
  - Touchtone or dial pulse modes
  - Reverse patch active in all modes

Super ComShack 64

- Dual Remote Base Specifications
- 2M repeater control w/aux.
- 40 lanes on 757/767/980
- Kenwood TS-440/940, Icom IC-735
- 2M repeater control w/aux.
- Kenwood 711/811 or the 7950 or
- 10M H.F.
- Memory channels enter or recall
- Automatic USB/LSB/FM/AM mode select
- Scan up/down, fast, or 100M steps
- Control CS-8 relay latch/master reset/status
- H.F./V.H.F.
- Monitor only or TX enable modes
- All controls in voice
- Frequency, mode, scan status, time, outputs on/off
- Wild remote input, TX enable can be active

Audio Blaster Module IC-02AT/IC-04AT/IC-02AT

- Module installs inside the radio in 15 min. Boost audio to 1 watt! Low standby drain/Connects low audio/1000 of happy users! Works in other H.F.'s too! Used by Police, fire, Emergency, when it needs to be loud!
- Interface: 25A-19.95

Touchdown 4 Digit Decoder & off/On latch

- Touchdown 4 Digit Decoder & off/On latch
- 50,000 combinations

Super Remote Keyed Rows & Columns Controller Plus Two 4 digit decoders (on/off) Will control frequency of any key entry radio such as the Kenwood 795D/2550/1024-DX. Easy to install in parallel or with existing keypad/Use with ComShack 64 as a freq. controller or with Pro Search rotor control box/ versatile base for all remote control applications. The latches may be used for on/off or momentary "REMOTE-A-PAD"

- Model RAP-1 $149.95

Torch Touchtone Decoder: Kit for 5 to 12V lamp

- Torch Touchtone Decoder: Kit for 5 to 12V lamp
- 15mA (SSI-201 compatible) 3.58 MHz crystal/22 pin header/ 600 ohm/Dual diodes/two circuits/20-pin header/16 touchtone, 800/500

H. L. HEASTER, INC. 201 Buckaminn Pike, Clarksburg, W. Va. 26301 Clarksburg Phone (304) 621-5405 or W. Va. Toll Free 1-800-352-3177

Engineering Consulting 583 Candlewood St.
Brea, Ca. 92621
Tel: 714-671-2009

ARORA SYSTEMS INC.
GARNETT, KANSAS 66032
(800) 247-5230

H. L. HEASTER, INC. 201 Buckaminn Pike, Clarksburg, W. Va. 26301 Clarksburg Phone (304) 621-5405 or W. Va. Toll Free 1-800-352-3177

Call us for a quotation. WE WILL SAVE YOU MONEY!
**Ham Radio's guide to help you find your local**

<table>
<thead>
<tr>
<th>State</th>
<th>Address</th>
<th>Phone Numbers</th>
<th>Stocking Lines</th>
</tr>
</thead>
<tbody>
<tr>
<td>California</td>
<td>JUN'S ELECTRONICS</td>
<td>3919 SEPULVEDA BLVD., CULVER CITY, CA 90230</td>
<td>213-390-8033, 800-882-1343 Trades Habla Espanol</td>
</tr>
<tr>
<td>Colorado</td>
<td>COLORADO COMM CENTER</td>
<td>525 EAST 70th AVE., SUITE ONE WEST, DENVER, CO 80229</td>
<td>(303) 288-7373, (800) 227-7373</td>
</tr>
<tr>
<td>Connecticut</td>
<td>HATRY ELECTRONICS</td>
<td>500 LEDYARD ST. (SOUTH), HARTFORD, CT 06114</td>
<td>203-527-1881</td>
</tr>
<tr>
<td>Delaware</td>
<td>AMATEUR &amp; ADVANCED COMMUNICATIONS</td>
<td>3208 CONCORD PIKE, WILMINGTON, DE 19803</td>
<td>(302) 478-2757</td>
</tr>
<tr>
<td>Florida</td>
<td>AMATEUR ELECTRONIC SUPPLY</td>
<td>1898 DREW STREET, CLEARWATER, FL 33575</td>
<td>813-461-4267 Clearwater Branch West Coast's only full service Amateur Radio Store. Hours M-F 9-5:30, Sat. 9-3</td>
</tr>
<tr>
<td>Georgia</td>
<td>DOC'S COMMUNICATIONS</td>
<td>702 CHICKAMAUGA AVENUE, ROSSVILLE, GA 30741</td>
<td>(404) 866-2302 / 851-5610 ICOM, Yaesu, Kenwood, Bird... 9AM-5:30PM We service what we sell.</td>
</tr>
<tr>
<td>Hawaii</td>
<td>HONOLULU ELECTRONICS</td>
<td>819 KEEAUMOKU STREET, HONOLULU, HI 96814</td>
<td>(808) 949-5564 Kenwood, ICOM, Yaesu, Hy-Gain, Cushcraft, AEA, KLM, Tri-Ex Towers, Fluke, Beiden, Astron, etc.</td>
</tr>
<tr>
<td>Idaho</td>
<td>ROSS DISTRIBUTING COMPANY</td>
<td>78 SOUTH STATE STREET, PRESTON, ID 83263</td>
<td>(208) 852-0830 M 9-2; T-F 9-6; S 9-2 Stock All Major Brands Over 7000 Ham Related Items on Hand</td>
</tr>
<tr>
<td>Illinois</td>
<td>ERICKSON COMMUNICATIONS, INC.</td>
<td>5456 N. MILWAUKEE AVE., CHICAGO, IL 60630</td>
<td>312-631-5181 Hours: 9:30-5:30 Mon, Tu, Wed &amp; Fri; 9:30-8:00 Thurs; 9:00-3:00 Sat.</td>
</tr>
<tr>
<td>Indiana</td>
<td>THE HAM STATION</td>
<td>220 N. FULTON AVE., EVANSVILLE, IN 47710</td>
<td>812-422-0231 Discount prices on Ten-Tec, Cubic, Hy-Gain, MFJ, Azden, Kantronics, Santec and others SASE for New &amp; Used Equipment List.</td>
</tr>
<tr>
<td>Maryland</td>
<td>MARYLAND RADIO CENTER</td>
<td>8576 LAURELDALE DRIVE, LAUREL, MD 20707</td>
<td>301-725-1212 Kenwood, Ten-Tec, Alinco, Azden. Full service dealer. T-F 10-7</td>
</tr>
<tr>
<td>Minnesota</td>
<td>TNT RADIO SALES</td>
<td>4124 WEST BROADWAY, ROBBINSDALE, MN 55422 (MPLS/ST. PAUL)</td>
<td>TOLL FREE: (800) 328-0250 In Minn: (612) 535-5050 M-F 9 AM-6 PM Sat 9 AM-5 PM Ameritron, Bencher, Butternut, ICOM, Kenwood</td>
</tr>
<tr>
<td>Missouri</td>
<td>MISSOURI RADIO CENTER</td>
<td>102 NW BUSINESS PARK LANE, KANSAS CITY, MO 64150</td>
<td>(800) 821-7323 Missour: (816) 741-8118 ICOM, Kenwood, Yaesu Same day service, low prices.</td>
</tr>
<tr>
<td>Nevada</td>
<td>AMATEUR ELECTRONIC SUPPLY</td>
<td>1072 N. RANCHO DRIVE, LAS VEGAS, NV 89106</td>
<td>702-647-3114 Dale Porray &quot;Squeak,&quot; AD7K Outside Nev: 1 (800) 834-6227 Hours M-F 9:30-5:30, Sat. 9-3</td>
</tr>
</tbody>
</table>

**Dealers:** **YOU SHOULD BE HERE TOO!**

Contact Ham Radio now for complete details.
Amateur Radio Dealer

New Hampshire

RIVENDELL ELECTRONICS
8 LONDONO DERRY ROAD
DERRY, N. H. 03038
603-434-5371
Hours M-S 10-5; THURS 10-9
Closed Sun/Holidays

New Jersey

ABARIS SYSTEMS
276 ORIENTAL PLACE
LYNDHURST, NJ 07071
201-693-0015
Don W2BGP
Azden, Larsen, KLM, Mirage, Newmar,
Vocom, W1JC, many others.
M-F 10 am-9 pm
SAT 9 am-7 pm
VISAMC

KJI ELECTRONICS
66 SKYTOIP ROAD
CEDAR GROVE, NJ 07009
(301) 239-4389
Gene K2KJI
Maryann K2RVI
Distributor of: KLM, Mirage, ICOM, Lar-
QEP's
110-4 ROUTE 10
EAST HANOVER, N. J. 07936
201-887-6424
In N.J. 1-800-USA-9913
Bill KA2QEP
Jim N2GKW
Belden Coaxial Cable
Amphenol Connectors
Hours: 9:30 am-7:00 pm

New York

BARRY ELECTRONICS
512 BROADWAY
NEW YORK, NY 10012
212-925-7000
New York City's Largest Full Service
Ham and Commercial Radio Store.

VHF COMMUNICATIONS
915 NORTH MAIN STREET
JAMESTOWN, NY 14701
716-664-6345
Call after 7 PM and save! Supplying all
of your Amateur needs. Featuring ICOM
"The World System." Western New
York's finest Amateur dealer.

North Carolina

F & M ELECTRONICS
3520 Rockingham Road
Greensboro, NC 27407
1-919-299-3437
9AM to 7PM Closed Monday
ICOM our specialty — Sales & Service

Ohio

AMATEUR ELECTRONIC SUPPLY
28940 EUCLID AVE.
WICKLIFFE, OH 44092
216-585-7388
Ohio Wats: 1 (800) 362-0290
Outside Ohio: 1 (800) 321-3594
Hours M-F 9-5:30, Sat. 9-3

DEBCO ELECTRONICS, INC.
3931 EDWARDS RD.
CINCINNATI, OH 45209
(513) 531-4499
Mon-Sat 10AM-9PM
Sun 12-6PM
We buy and sell all types of electronic
parts.

MISSOURI AMATEUR RADIO, INC.
1280 AIDA DRIVE
REYNOLDSBURG (COLUMBUS), OH
43066
614-866-4267
Featuring Kenwood, Yaesu, Icom,
and other fine gear. Factory author-
ized sales and service. Shortwave
specialists. Near I-270 and airport.

Pennsylvania

HAMTRONICS
DIV. OF TREVOSE ELECTRONICS
4033 BROWNSVILLE ROAD
TREVOSE, PA 19047
215-357-1400
Same Location for over 30 Years

LaRUE ELECTRONICS
1112 GRANDVIEW STREET
SCRANTON, PENNSYLVANIA 18509
717-343-2124
ICOM, Bird, Cushcraft, Beckman,
Larsen, Amphenol, Astron, Belden,
Antenna Specialists, W2AI/W2VS,
Tokyo Hy-Power Labs, WELZ, Daiva,
Sony, Saxton, Vibroplex, Weller.

Tennessee

MEMPHIS AMATEUR ELECTRONICS
1465 WELLS STATION ROAD
MEMPHIS, TN 38108
Call Toll Free: 1-800-238-6168
M-F 9-5; Sat 9-12
Kenwood, ICOM, Ten-Tec, Cushcraft,
Hy-Gain, Hustler, Larsen, AEA,
Mirage, Ameritron, etc.

Texas

MADISON ELECTRONICS SUPPLY
3621 FANNIN
HOUSTON, TX 77004
713-520-7300
Christmas?? Now??

KENNEDY ASSOCIATES
AMATEUR RADIO DIVISION
5707A MOBUD
SAN ANTONIO, TX 78288
Stocking all major lines. San Antonio's
Ham Store. Great Prices — Great
Service. Factory authorized sales and
service.
Hours: M-F 10-6; SAT 9-3

MISSION COMMUNICATIONS
11903 ALEIF CLODINE
SUITE 500 (CORNER HARWIN &
KIRKWOOD)
HOUSTON, TEXAS 77002
(713) 879-7764
Now in Southwest Houston—full line
of equipment. All the essentials and
extras for the "ham."

Wisconsin

AMATEUR ELECTRONIC SUPPLY
4828 W. FOND DU LAC AVE.
MILWAUKEE, WI 53216
414-442-4200
Wisc. Wats: 1 (800) 242-5195
Outside Wisc: 1 (800) 558-0411
M-F 9:50- SAT 9-3

Foreign Subscription Agents
for Ham Radio Magazine

Ham Radio Austria
Karl Leder
Postfach 3454
D-7850 Loerrach
West Germany

Ham Radio Belgium
Steinhousen
Buisschotenweg 418
Zeebrugge, Gent
Belgium

Ham Radio Holland
Postbus 417
Alkmaar
Holland

Ham Radio Belgium
Steinhousen
Buisschotenweg 418
Zeebrugge, Gent
Belgium

Ham Radio Europe
Box 989
35750 Vught (Venlo)
Netherlands

Ham Radio France
St. Elec-
20 B, Ave des Clarines
F-69000 Aubervi\n
Ham Radio Germany
Kern Ober
Postfach 3454
D-7850 Loerrach
West Germany

Ham Radio Holland
Postbus 417
Alkmaar
Holland

Ham Radio Switzerland
Karin Ober
Postfach 3454
D-7850 Loerrach
West Germany

Ham Radio England
c/o R.G.B.
Alma House
Claremont Road
Princess Risborough
Widnes, Cheshire, WA7 5JW
England

May 1987
ARMED FORCES DAY 1987

Write "BLAST" PO Box 175, St. Joseph, MI 49085.

COLORADO:

MARYLAND:
May 24. Maryland FM Association’s annual Hamfest.

COLORADO:
May 24. Maryland FM Association’s annual Hamfest.

MICHIGAN:
June 7. The Chelsea Swap and Shop, Chelsea Fairgrounds.

Maryland FM Association’s annual Hamfest.

MISSOURI:
May 1. LIMARC will sponsor the ARRL Long Island.

NEW HAMPSHIRE:
May 2. LIMARC will sponsor the ARRL Long Island.

NEW HAMPSHIRE:
May 2. The Northwet Arkansas ARC will hold its 7th annual Hamfest.

NEW JERSEY:
May 9. New England’s favorite The Hoss Club’s annual Hamfest.

NEW YORK:
May 30. First Skaneateles Ham and Computer Festival.

ILLINOIS:

NEW JERSEY:
May 2. The Northwet Arkansas ARC will hold its 7th annual Hamfest.

NEW YORK:
May 30. First Skaneateles Ham and Computer Festival.

ARMED FORCES DAY 1987

ARMED FORCES DAY 1987

ARMED FORCES DAY 1987

NEW JERSEY:
May 9. New Jersey’s Repeater Association’s annual Hamfest.

NEW JERSEY:
May 17. The Kittatinny Repeater Association’s annual Hamfest.

NEW JERSEY:
May 2. The Louisville A.R.T.S. will operate "Run For the

NEW JERSEY:
May 17. The Kittatinny Repeater Association’s annual Hamfest.

NEW JERSEY:
May 9. The Cherryville Repeater Association’s annual Hamfest.

NEW JERSEY:
May 2. The Kittatinny Repeater Association’s annual Hamfest.

NEW JERSEY:
May 9. The Cherryville Repeater Association’s annual Hamfest.

NEW YORK:
May 30. First Skaneateles Ham and Computer Festival.

NEW JERSEY:
May 17. The Kittatinny Repeater Association’s annual Hamfest.

NEW YORK:
May 30. First Skaneateles Ham and Computer Festival.

NEW YORK:
May 30. First Skaneateles Ham and Computer Festival.

NEW YORK:
May 30. First Skaneateles Ham and Computer Festival.

NEW YORK:
May 30. First Skaneateles Ham and Computer Festival.

NEW YORK:
May 30. First Skaneateles Ham and Computer Festival.

NEW YORK:
May 30. First Skaneateles Ham and Computer Festival.

NEW YORK:
May 30. First Skaneateles Ham and Computer Festival.

NEW YORK:
May 30. First Skaneateles Ham and Computer Festival.

NEW YORK:
May 30. First Skaneateles Ham and Computer Festival.

NEW YORK:
May 30. First Skaneateles Ham and Computer Festival.
The Digital Novice helps you answer questions like: "What exactly is AMTOR?", "How is packet different from earlier digital techniques like RTTY and ASCII?", and "What interface should I buy?" without having your face turn red or getting your tongue all tied up in embarrassing knots — and without confusing the questioner. No doubt you can answer all sorts of questions about digital techniques, even roused from a deep sleep after driving home from Dayton for two days straight. But wouldn't it be convenient to just point to The Digital Novice, roll over, and go back to sleep?

This isn't another book about packet radio, by the way, or a book about computers, though there's enough about computers to form a solid basis for understanding the material. It isn't a computer book. It's a book you can give without reservation to any interested beginner, regardless of age. Though it's written for adults, I wouldn't hesitate to give it to a bright, highly motivated eighth-grader. There's no question about it: Jim is a born communicator, a writer who knows his audience and speaks to them in language they understand, simplifying complex subjects without ever "talking down." What might cause us to be rendered essentially inarticulate (as a function of knowing either too much or too little), he explains with refreshing simplicity. As Jim points out, technically knowledgable people aren't necessarily the best "missionaries for the new technologies." Not convinced? Quick: explain spread spectrum in language a Novice can understand.

Describing equipment available, Jim names names and comments, with candor, on every piece of hardware about which Novices need to know, citing advantages and disadvantages of each. Though addresses are not included, they're all here: AEA, GLB, MFJ, Kantronics, Packeterm — and, of course, TAPR and Vancouver as well.

The text is supplemented with an ample glossary plus appendices listing the various digital codes (Morse, Baudot, AMTOR, ASCII). There's a clever little bonus at the end, too: to give readers an opportunity to check how well they've retained what they've read, Jim has included a 33-question test covering topics discussed in the book. Answers are included, plus references to page numbers where subjects covered by questions can be found. Score 80 or better (on your honor), send Jim an SASE, and — just for fun — he'll send you a certificate attesting to your status as an official "Digital Novice."

Ted Barney's cartoons go a long way toward lightening up The Digital Novice. I was pleased, too, by Jim's conscious (but never self-consciously or heavy-handed) effort to ensure gender fairness throughout the text; his deft use of pronouns may help women entering Amateur Radio through the digital modes feel more welcome.

The Digital Novice will be published at this year's Dayton Hamvention®, you can meet the author at his booth (OSKY Publishing, No. 358) if you're there. You can also catch his presentation on Sunday morning at 9:30 AM. Whether or not you make it to Dayton this year, you can order your copy of The Digital Novice from Ham Radio's Bookstore Store for $9.95 plus $3.50 shipping and handling.

— KAILBO
solid-state linear amplifier

The latest addition to the Yaesu product line — the new FL-7000 Solid State Linear Amplifier for the 160 through 15 meter bands — features an automatic antenna tuner with automatic band-switching when used with the Yaesu FT-757GX, FT-767GX, or FT-980 transceivers. Antenna switching is also automatic when using the FAS-1-4R remote antenna selector. Power output is 1200 watts, for approximately 70 watts input. A protection circuit prohibits operation with high SWR until the antenna tuner completes matching process. Thermostatically controlled dual fans run even when the amplifier is turned off, if needed for dissipation of heat.

For details, contact Yaesu U.S.A. Amateur Products Division, 17210 Edwards Road, Cerri- tos, California 90701.

Circle 212 on Reader Service Card.

new dual-port tnc, personal mailbox upgrade

The new KPC-4 Dual Port Communicator from Kantronics features two fully-functional VHF packet ports, digipeating on each port, VHF gateway between ports, and an RS-232 computer port. Digipeating and gateway operations occur simultaneously while you’re connected on one or both ports. You can bridge two frequencies on one band and operate crossbands.

The KPC-4’s RS-232/TTL terminal interfacing provides universal compatibility to all computers, including Commodores and PC compatibles. Stream switching provides for access to both radio ports, each of which supports AX.25.

Priced at $329.00, the KPC-4 contains the popular Personal Packet Mailbox™ feature (optional on all other Kantronics Packet Communicators), a 226K EPROM that allows you (and others) to leave and collect messages on
ARE YOUR REPEATER OR OTHER AUDIO LEVELS UP AND down?

TRY THE AGC-4!

- **DYNAMIC RANGE OF**
  - 45dB
- **OUTPUT CONSTANT**
  - ±2dB
- **SINGLE VOLTAGE**
  - ≥9VDC

KIT - $28.00 PPD IN US/CANADA
BARRETT ELEC. - 525N 2150W
WEST POINT, UTAH 84015

---

**NEW products**

**...MEASURES BOTH YOUR COIL’S INDUCTANCE AND LOSS FACTOR**

<table>
<thead>
<tr>
<th>Measurement range</th>
<th>Measurement range</th>
</tr>
</thead>
<tbody>
<tr>
<td>L: 0.1μH - 1.999H</td>
<td>C: 0.1 pF - 199 μF</td>
</tr>
<tr>
<td>R: 0.1Ω - 19Ω</td>
<td>D: 0.01 - 19.99</td>
</tr>
</tbody>
</table>

$199.95
Freight pd.
CA RES. + tax

**AMERICAN RELIANCE, INC.**
9241 E. VALLEY BLVD.
ROSEMAD, CA 91770
CA (818) 287-8400

---

your system. All other functions of your packet unit continue to be available at the same time. Established and operated from your keyboard, the mailbox uses familiar commands such as SEND, LIST, READ, KILL, and BYE. The number of messages is limited only by the amount of RAM available in your packet unit.

The Personal Packet Mailbox option is currently available for the KAM (Kantronics All Mode), the PKC-1, the KPC-2, and the KPC-2400. To add the Personal Packet Mailbox option to your Kantronics packet unit, contact Kantronics.

For further information, contact Kantronics, Inc., 1202 E. 23 Street, Lawrence, Kansas 66046.

---

**new Radio Handbook**

The 23rd Edition of Bill Orr, W6SAI’s, Radio Handbook has just been released by Howard W. Sams & Company.

Completely revised and updated, this edition contains new material reflecting the latest developments in technology, covering everything from HF-VHF amplifier design to interference reduction for VCRs and video disc players.

Readers will find schematics, photos, construction diagrams, tables, and charts right at their fingertips, for expert guidance and instant reference. Specific topics addressed include an introduction to Amateur Radio communications; fundamental of communications receivers; FM and repeaters; mobile, portable, and marine equipment; radio and television interference; equipment design, components, and controls; VHF and UHF antennas; and transmission lines and matching systems.

Licensed as a radio amateur in 1934, Bill has authored or co-authored many books. Editor of the Radio Handbook since 1966, he’s written hundreds of technical articles, including a monthly column in ham radio.


---

**new 900-MHz antennas**

Two new 900 MHz antennas available from NCG are specifically designed for operation in the 902-928 MHz band.

The anodized black Model CMW-202N mobile antenna, a 5-dB gain antenna capable of a maximum of 30 watts of drive power, uses a magnetic mount with a double coil whip. The 900-MHz base/repeater antenna, model CFS7-71, is a collinear fiberglass antenna with a gain of 7.14 dB and maximum power capability of 50 watts. Mast mounting brackets and hardware is included.

For information, contact NCG Company, 1275 N. Grove Street, Anaheim, California 92806.

---

**new hf amplifier**

Tokyo Hy-Power Labs’ HL-2K/A is a compact hf amplifier utilizing the popular 3-500Z transmitting tubes. Similar to their HL-1K/A, it features a built-in power supply with a heavy-duty transformer that permits continuous key-down operation. The amplifier is equipped with two large panel meters: one monitors plate current, and the other can be switched to read plate voltage, grid current, or power output. A delayed cooling fan system protects the tubes for a timed period after the power has been turned off.
THE MOST POPULAR HAM RADIO ACCESSORIES are available from WELZ. WELZ brand easy-to-read power and VSWR meters and other high quality station accessories are used world-wide. WELZ, good enough to be the best.

THL THE INDUSTRY LEADER IN DESIGN AND PERFORMANCE add-on accessory VHF/UHF amplifiers, antenna couplers and now HF LINEARS too. When power out is your problem, stop in for the THL brand solution.

COMPACT MOBILES MAKE FULL DUPLEX POSSIBLE KDK mobile radios are so small, TWO of them will fit in the space normally accommodating one full size mobile radio. This allows for full duplex cross band operation with 32 memory capacity, plus many other advantages. Check out the FM-240 (VHF) and the FM-740 (UHF) today.

SANTEC PORTABLES

LOOK CLOSELY AND YOU WILL CHOOSE SANTEC. Santec hand-helds are truly the BEST value + quality + performance combination available today. A Full 5 Watts output, Multi-mode Scan, 10 Memories and AUTO-DIALER make the SANTEC a fantastic hand-held radio. Try one yourself at your next trip to your favorite Ham Radio Shop.

KENPRO ROTORS • ACCESSORIES

WHEN YOU TURN YOUR ANTENNA, DO IT WITH KENPRO antenna aiming devices and accessories. From light to heavy-duty there's a KENPRO for you. NEW Satellite tracking AZ-EL units with external computer controller interface.
Measure Up With Coaxial Dynamics Model 81000A RF Directional Wattmeter

Model 81000A is a thoroughly engineered, portable, insertion type wattmeter designed to measure both FWD/RFL C.W. power in Coaxial transmission lines. 81000A is comprised of a built-in line section, direct reading 3-scale meter protected by a shock-proof housing. Quick-match connectors, plus a complete selection of plug-in elements, gives the FRONT RUNNER, reliability, flexibility, and adaptability with a two year warranty. Contact us for your nearest authorized Coaxial Dynamics representative or distributor in our world-wide sales network.

COAXIAL DYNAMICS, INC.

15210 Industrial Parkway
Cleveland, Ohio 44135
216-267-2233
1-800-COAXIAL
Telex: 98-0630

Service and Dependability... A Part of Every Product

---

NEMAL ELECTRONICS

---

Service and Dependability... A Part of Every Product

---

NEW PRODUCTS

---

The price of the HL-2K/A is $1695. For details, contact ENCOMM, Inc., 1506 Capital, Plano, Texas 75074.

Circle 398 on Reader Service Card.

Lunar returns to market

Lunar Industries, Inc., of San Diego has reentered the Amateur Radio market with its well-known line of VHF and UHF preamps and VHF power amps, and has introduced a new line of products scheduled for production early this year. Glenn Rattmann, K6NA, heads the marketing effort.

Lunar recently moved into larger facilities in order to accommodate expanded production of Amateur and commercial communications and television equipment. A network of select dealers is being established and inquiries are encouraged. For details, contact K6NA at Lunar Industries, Inc., 7930 Arjons Drive, San Diego, California 92126.

Circle 398 on Reader Service Card.

cordless tool for soldering, welding, heat shrinking

The Ultratorch, available now from Jensen Tools, is a compact, cordless combination soldering iron, flameless heat tool, and torch. The Ultratorch burns ordinary butane lighter fuel to generate infra-red and ultra infra-red heat by means of a catalytic combustion system. Temperature can be adjusted from 394 degrees to 2372 degrees. Normal settings range from 394 degrees to 932 degrees F for soldering; to 1292 degrees for heat shrinking; and to 2372 degrees for blaging, welding, and other high-heat applications. Soldering/heat ejector, torch ejector, tapered needle soldering tip, heat tip, solder
The RC-850 controller offers your group the most advanced repeater control technology available anywhere. Through ongoing hardware and software enhancements, even our first customers enjoy new features that keep it ahead of the pack.

With the '850, your repeater becomes fully remotely programmable. From command codes to the repeater's operating schedule, virtually everything can be easily changed. Touch-Tone programming from your radio or the phone with synthesized voice readback, or programming from your home computer via modem or packet.

The autopatch supports local and radio-linked remote phone lines, extending your patch coverage to match your RF coverage. You don't even need a phone line at your site! The 250 autodial slots meet everyone's needs, with up to 35 digit storage for personal MCI/Sprint codes.

The easy-to-use mailbox lets you include phone numbers, times, or frequencies in messages. The controller is so smart, it'll leave you a message if you miss a reverse patch or an alarm.

Selective call capabilities range from CTCSS and two-tone to display paging, so you can always be available without having to listen. Voice response telemetry lets you remotely meter your site. Its continuous measurements with storage of updated min and max readings let you find out how cold it gets, how high the reflected power reads... and when.

Individual user access codes, with callsign ID, offer secure access to selected functions to completely prevent horseplay.

The RC-850 Repeater Controller
still the leader of the pack!

35 digit storage for personal MCI/Sprint codes.

The RC-850 controller offers your group the most advanced repeater control technology available anywhere. Through ongoing hardware and software enhancements, even our first customers enjoy new features that keep it ahead of the pack.

With the '850, your repeater becomes fully remotely programmable. From command codes to the repeater's operating schedule, virtually everything can be easily changed. Touch-Tone programming from your radio or the phone with synthesized voice readback, or programming from your home computer via modem or packet.

The autopatch supports local and radio-linked remote phone lines, extending your patch coverage to match your RF coverage. You don't even need a phone line at your site! The 250 autodial slots meet everyone's needs, with up to 35 digit storage for personal MCI/Sprint codes.

The easy-to-use mailbox lets you include phone numbers, times, or frequencies in messages. The controller is so smart, it'll leave you a message if you miss a reverse patch or an alarm.

Selective call capabilities range from CTCSS and two-tone to display paging, so you can always be available without having to listen. Voice response telemetry lets you remotely meter your site. Its continuous measurements with storage of updated min and max readings let you find out how cold it gets, how high the reflected power reads... and when.

Individual user access codes, with callsign ID, offer secure access to selected functions to completely prevent horseplay.

The RC-850 Repeater Controller
still the leader of the pack!
Gunnplexers & accessories 10 & 24 GHz

A. Microwave Associates 10 GHz Gunnplexer. Two of these transceivers can form the heart of a 10 GHz communication system for voice, mic, video or data transmission, not to mention mountaintop DXing! MA87141-1 (pair of 10 mW transceivers) $251.85. Higher power units (up to 200 mW) available. B. Microwave Associates 24 GHz Gunnplexer. Similar characteristics to 10 GHz unit. MA8720-4 (pair of 20 mW transceivers) $798.25. C. This support module is designed for use with the MA87141 and MA8720 and provides all of the circuitry for a full duplex audio transceiver system. The board contains a low-noise, 30-MHz fm receiver, modulators for voice and mcw operation, Gunn diode regulator and varactor supply. Meter outputs are provided for monitoring received signal levels, discriminator output and varactor tuning voltage. RXR3000 assembled and tested $119.95. D. Complete, ready to use communication system for voice or mcw operation. Ideal for repeater linking. A power supply capable of delivering 15 volts dc at 250 mA (for a 10 mW version), microphone, and headphone and/or loudspeaker are the only additional items needed for operation. The Gunnplexer can be removed for remote mounting to a tower or 2 or 4 foot parabolic antenna. TR2/1GA (10 GHz, 10 mW) $399.95. Higher power units available. TR2/4GA (24 GHz, 20 mW) $699.85. Also available: horn, 2 and 4 foot parabolic antennas, Gunn, varactor and detector diodes, search and lock systems, oscillator modules, waveguide, flanges, etc. Call or write for additional information. Let ARR take you higher with quality 10 and 24 GHz equipment!

Advanced Receiver Research Box 1242 • Burlington CT 06013 • 203-582-9409

DEALER INQUIRES INVITED

ANTENNAS TONNA

The X Shack

52 Stonewyck Drive
Belle Mead, New Jersey 08502
IVARS - KC2PX
MARA - SALES

MICROWAVE MODULES LTD.

MON-SAT (201) 874-6013
10AM - 3PM ORDERS
7PM - 10PM ORDERS/TECHNICAL

CALL FOR CATALOG VISA/MASTERCARD

new mic

Shure Brothers Inc. has introduced the Shure Prologue 2L, an economical dynamic microphone for gooseneck applications. Priced at $40, the Prologue 2L provides a wide-range frequency response with a low-end rolloff and high-end presence boost for intelligibility and clarity. Other features include a long-life, easy-
access momentary push-to-talk switch, a tight cardioid polar pattern for effective rejection of feedback and background noise and chrome-plated metal casing.

For information, contact Shure Brothers Inc., Customer Services Department, 222 Hartrey Avenue, Evanston, Illinois 60202-3696.

Circle #506 on Reader Service Card.

two new Kulglass™ antennas

Larsen Electronics has added two new models to its line of patented Kulglass antennas: the KG-440 and the KG-900. The two new antennas offer the same features as the earlier KG-450 and KG-825, but extend Kulglass™ convenience and performance to the 440-450 and 902-928 MHz bands.

The Kulglass tuning assembly is placed on the outside surface of the glass — a car windshield, for example. This allows a low-impedance power transfer through the glass.

The KG-440 is based on a single half-wave design that offers unity gain performance without a ground plane and up to 2.4-dB gain in a typical vehicle installation.
SAVE YOUR EARS
WITH THIS HANDY SIGNAL ENHANCER
See Article in HR's December, 1986 issue 220

Hildreth Engineering
936 Azaela Drive Sunnyvale, CA 94086

Electronic Repair Center
Servicing
Amateur Commercial Radio
The most complete repair facility on the East Coast.
Large parts inventory and factory authorized warranty service for Kenwood, Icom and Yaesu.
SEND US YOUR PROBLEMS
Servicing "Hams" for 30 years, no rig too old or new for us.

HAMTRONICS, INC.
4033 Brownsville Road
Trevose, Pa. 19047
215-357-1400

1 TO 1000 MHZ
Sweep Generator
RMSWG - 4
$175.00
- SWEEP VARIABLE 1-250 MHz WITH LESS THAN 1 DB AMPLITUDE VARIATION
- AFTER WARM UP STABLE 100 KHz FOR 5 MINUTES
- 115 VAC INPUT

ROENSCHE MICROWAVE
R.R. 1, Box 156B, PH: 816-963-2550
BROOKFIELD, MISSOURI 64428

HF/VHF packet radio controller with tuning indicator
MFJ Enterprises' latest TAPR TNC-2 clone, the MFJ-1274, ($169.95) works not only for VHF but also for HF, OSCAR, and other FM packet. MFJ has made the 1274 modem-selectable for both VHF and HF operation, added their precision 20-segment LED tuning indicator, a TTL serial port, an easily replaceable lithium battery for memory backup, and a new cabinet.
All you need to enjoy packet radio is an MFJ-1274, your rig, and any home computer with an RS-232 or TTL serial port and terminal program.
If you have a Commodore 64, 128 or VIC-20 you can use MFJ's optional Starter Pack to get on the air immediately. The Starter Pack includes interfacing cable, terminal software on disk or tape and complete instructions . . . everything you need to get on packet radio. The MFJ-1282 (disk) and the MFJ-1283 (tape) are $19.95 each.
With the MFJ-1274, you'll never have to worry about your TNC's becoming obsolete because you change computers or because packet radio standards change. You can use any computer with an RS-232 serial port with an appropriate terminal program. If packet radio standards change, software updates will be made available as TAPR releases them.
With the addition of a suitable external modem, speeds in excess of 56 kilobaud are possible.
The MFJ-1274 features AX.25 Level 2 Version 2 software, hardware HDLC for full duplex, true Data Carrier Detect for HF, multiple connects, 256K EPROM, 16K RAM expandable to 32K with optional EPROM, simple operation, and socketed ICs.
You get an easy-to-read manual, a cable to connect your transceiver (you have to add a connector for your particular radio), a connector for the multipath signals and low power used in this band.
Both antennas feature a removable whip (which can come in handy in zero clearance situations, such as at the car wash) and Larsen's exclusive Kulrod™ plating. The antenna kits include 14 feet of premium RG-58 A/U dual-shield, low-loss coax and choice of connectors.
For further information, contact Larsen Electronics, P.O. Box 1799, Vancouver, Washington 98668.

Circle #305 on Reader Service Card.

“INSTANT” MORSE CODE
Beginners: Deliciously Easy
Experts: Automatically Fast
CURLYCODE™ MANUAL
ONLY $6.50
Guaranteed

Minds eye Publications, Dept. H25
Suite 115-199
1750 Beverley Rd.
McLean, VA 22101

IF YOU BUY, SELL OR COLLECT OLD RADIOS, YOU NEED...
Antique Radio’s Largest-Circulation Monthly Magazine

ANTIQUE RADIO CLASSIFIED
Articles - Classifieds - Ads for Parts & Services.
Also: Early TV, Ham Equip., Books, Telephones, 40's & 50's Radios & more...
Free 20-word ad each month. Don’t miss out!
Sample - Free. 6-Month Trial - $10.
1-Year: $18 ($24 by 1st Class). Foreign - Write.
A.R.C., P.O. Box 2-2, Carlisle, MA 01741

SSB ELECTRONIC TRANSVERTERS & PREAMPLIFIERS
LT 25 144/276 XVRTR 20W GaAsfet 0DBM $179
LT 35S 900/144 XVRTR 20W GaAsfet DIP $149
LT 35S 1296/144 XVRTR 15W GaAsfet $149
MICRO X 2304/144 XVRTR 0.5W GaAsfet $99
MICRO X 1086/144 XVRTR 0.5W GaAsfet $99
DK series low noise GaAsfet Preamplifier $139
MV series mast mounted GaAsfet Preamplifier $199
K series ex-continental GaAsfet DBM from $199

TRANSVERTERS UNLIMITED
BOX 6286 STATION A
TORONTO, ONTARIO
M5W 1A4

HANS PETERS (VE3CRU)
(416) 759-5563

1-Year: $10.
6-Month: $6.
3-Month: $5.
Foreign: $5 extra for postage.

M A Y 1 9 8 7
ALL NEW!
DUAL BAND ANTENNAS FOR
ULTIMATE PERFORMANCE!!

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Sug. List</th>
</tr>
</thead>
<tbody>
<tr>
<td>2X4Z</td>
<td>Base/Repeater 200 Watt</td>
<td>$168.95</td>
</tr>
<tr>
<td></td>
<td>Gain 146 MHz 8.2dB, 446 MHz 11.5dB</td>
<td></td>
</tr>
<tr>
<td>2X4SR</td>
<td>Mobile with Mag. Mt. 150 Watt</td>
<td>$71.90</td>
</tr>
<tr>
<td></td>
<td>Gain 146 MHz 3.8dB, 446 MHz 6.2dB</td>
<td></td>
</tr>
<tr>
<td>2X4SDY</td>
<td>Mobile with Mag. Mt. 100 Watt</td>
<td>$65.95</td>
</tr>
<tr>
<td></td>
<td>Gain 146 MHz 2.15 dB, 446 MHz 3.8dB</td>
<td></td>
</tr>
<tr>
<td>HT 702</td>
<td>146/446 MHz Hand Held BNC 50 Watt</td>
<td>$29.95</td>
</tr>
<tr>
<td>C7-71</td>
<td>Base/Repeater 920 MHz 50 Watt</td>
<td>$115.95</td>
</tr>
<tr>
<td></td>
<td>7.14 dB Gain</td>
<td></td>
</tr>
<tr>
<td>C202N</td>
<td>Mobile 920 MHz with Mag. Mt.</td>
<td>$72.95</td>
</tr>
<tr>
<td></td>
<td>5 dB Gain 50 Watt</td>
<td></td>
</tr>
<tr>
<td>1234E</td>
<td>Base/Repeater 200 Watt</td>
<td>$178.95</td>
</tr>
<tr>
<td></td>
<td>Gain 446 MHz 8.5dB, 1.2 GHz 10.1dB</td>
<td></td>
</tr>
<tr>
<td>124X</td>
<td>Mobile with Mag. Mt. 100 Watt</td>
<td>$104.95</td>
</tr>
<tr>
<td></td>
<td>Gain 446 MHz 2.5dB, 1.2 GHz 3.5dB</td>
<td></td>
</tr>
<tr>
<td>1221S</td>
<td>1.2 GHz Base/Repeater 100 Watt</td>
<td>$158.95</td>
</tr>
<tr>
<td></td>
<td>Gain 15.5dB, 21 Step colinear</td>
<td></td>
</tr>
<tr>
<td>1210M</td>
<td>1.2 GHz Mobile with Mag. Mt. 50 Watt</td>
<td>$76.95</td>
</tr>
<tr>
<td></td>
<td>Gain 8.8dB</td>
<td></td>
</tr>
<tr>
<td>415M</td>
<td>High power duplexer 146 MHz 400 Watt</td>
<td>$59.95</td>
</tr>
<tr>
<td></td>
<td>446 MHz 250 Watt</td>
<td></td>
</tr>
<tr>
<td>412N</td>
<td>UHF/GHz Duplexer 446/1400MHz</td>
<td>$68.95</td>
</tr>
<tr>
<td></td>
<td>Max. 70 Watt</td>
<td></td>
</tr>
</tbody>
</table>

1275 NORTH GROVE ST.
ANAHEIM, CALIF. 92806
(714) 630-4541
CABLE: NATCOLGIZ
FAX (714) 630-7024

Dealer prices may be different than list.
Prices and specifications subject to change without notice or obligation.

1500 WATT TRANSMATCH KIT $154.95

BASIC KIT—
1-rotary inductor 28uh.......................... $53.60
2-61 ball drives ................................ $0.00 ea.
1-0-100 turns counter ........................... $59.50
2-variable capacitors 25-245 pf 4500 v. ....... $28.00 ea.

OPTIONS—
enclosure (pictured in Sept. 86 CQ) ....... $60.00
4:1 balun kit .................................. $18.75

tails, terminals, chassis, ceramic standoffs, hardware, toroids, amp components. B&W coil stock, etc.

G3RUH, JAS1-1/FO-12 TSK Packet Modem .................................................. $99.00
PC Board for above only, delivered .............. $24.99
Ten-Tec Designer Cabinet for above ............ $12.00
K9CW Memory Contest Keyer .................... $109.00
Oscar 10 Demodulator ........................... $139.95
100 kHz to 60 MHz Converter for .......... $94.95
Yaesu FRG-9600 ................................ $32.95
Light Pen for Tandy 1000, delivered ............ $199.00
50W 75M SSB XCR ................................ $319.00
FACTORY WIRED—

NG200A Amp ........................................ $249.99

Add $4.00 UPS Shipping ......................... $199.00

1987 catalog $1.00
Dayton Booths 351-352
RADIO KIT • P.O. Box 973-H
Pelham, NH 03076 • (603) 635-2235

SAVE TIME
and MONEY
with THE
HAZER

Bring things down for safety and convenience.

Never climb your tower again with this elevator system. Antennas and rotator mount on HAZER, complete system trims tower in verticle upright position. Safety lock system operates while raising or lowering. Never can fail. Complete kit includes winch, 100 ft. of cable, hardware and instructions. For Rotm 20 and 25 G Towers

HAZER 2 - Heavy duty alum. 12 sq. ft. load $297.00 ppd.
HAZER 3 - Standard alum. 8 sq. ft. load $213.00 ppd.
HAZER 4 - Heavy gus steel 16 sq. ft. load $279.00 ppd.
Ball Thrust bearing TB-25 for any of above $42.50 ppd.

KENPRO Antenna Rotors

KR-600 19 sq. ft. Azimuth Rotor $299.95 ppd.
KR-001 C-64 Computer Interface $159.95 ppd.

Send for free details of aluminum towers specifically engineered for use with the Hazer.

Master Charge or mail check or money order.

GLEN MARTIN ENGINEERING INC.
P.O. Box 253
Booneville, Mo. 65233
816-882-2734

POCKET SIZED!

1-500 MHZ
FREQUENCY COUNTER
BUILT, TESTED, AND READY-TO-GO!
ONLY $49.95 Prepaid

HAND HELD!

1-1300 MHZ
FREQUENCY COUNTER
INC INPUT CONNECTOR
ONLY $79.95 Prepaid

DIGITREX ELECTRONICS
division of NCI
10073 North Maryann
Northville, MI 48167
W285-497-2397

Personal checks, money orders, MasterCard or Visa are welcome. Or call in a C.O.D. PHONE (313) 345-7313 NOW!

May 1987
The TTL serial port and a power supply for 110 VAC operation (you can use 12 VDC for portable, remote or mobile operation).

The MFJ-1274 comes with a double guarantee. If ordered directly from MFJ, it may be returned within 30 days for a prompt refund, less shipping. The MFJ-1274 is also covered by MFJ's one-year unconditional guarantee.

For more information, contact MFJ Enterprises, Inc., P.O. Box 494, Mississippi State, Mississippi 39762.

The CR 202, a sophisticated new receiver distributed by Ace Communications, allows monitoring of any frequency from 25 to 550 MHz, plus 800 to 1300 MHz.

With both narrow and wide band reception modes in FM and also AM, the receiver, priced at $445, is excellent for general monitoring and surveillance reception of a wide variety of services.

Uses for the unit include general off-air monitoring, spot frequency monitoring and strength measurement, selective multi-frequency analysis, spectrum surveillance, and detection of unwanted transmissions.

An optional digital control accessory permits the user to interface the receiver to any computer equipped with a standard RS-232C port. The resulting computer control permits virtually unlimited channel monitoring and activity analysis with normal communications, text editing, and data base software. A dedicated menu driver software package and a full line of accessories are available.

For information, contact Ace Communications, Monitor Division, 10707 East 106th Street, Indianapolis, Indiana 46256.

Two new battery packs for King Radio Corporation products are available from Centurion International Inc. No. K60105 is a 9.6-volt, 800 MAH nickel-cadmium rechargeable battery pack; No. AL0514 is a 13.5-volt, 2100 MAH throwaway alkaline pack. For prices and details, contact Centurion International, Inc., P.O. Box 82946, Lincoln, Nebraska 68501.

For more information, contact MFJ Enterprises, Inc., P.O. Box 494, Mississippi State, Mississippi 39762.

Circle 831 on Reader Service Card.

computer control of rf monitoring

The CR 202, a sophisticated new receiver distributed by Ace Communications, allows monitoring of any frequency from 25 to 550 MHz, plus 800 to 1300 MHz.

With both narrow and wide band reception modes in FM and also AM, the receiver, priced at $445, is excellent for general monitoring and surveillance reception of a wide variety of services.

Uses for the unit include general off-air monitoring, spot frequency monitoring and strength measurement, selective multi-frequency analysis, spectrum surveillance, and detection of unwanted transmissions.

An optional digital control accessory permits the user to interface the receiver to any computer equipped with a standard RS-232C port. The resulting computer control permits virtually unlimited channel monitoring and activity analysis with normal communications, text editing, and data base software. A dedicated menu driver software package and a full line of accessories are available.

For information, contact Ace Communications, Monitor Division, 10707 East 106th Street, Indianapolis, Indiana 46256.

Circle 834 on Reader Service Card.

new battery packs

Two new battery packs for King Radio Corporation products are available from Centurion International Inc. No. K60105 is a 9.6-volt, 800 MAH nickel-cadmium rechargeable battery pack; No. AL0514 is a 13.5-volt, 2100 MAH throwaway alkaline pack. For prices and details, contact Centurion International, Inc., P.O. Box 82946, Lincoln, Nebraska 68501.

Circle 8303 on Reader Service Card.
introducing a new dimension...

FROM PRO-SEARCH®

NEW DIGITAL CONVERSION

- For All 8 Wire CDE Rotors
- North & South Center
- Continuous 1° Readout For Full 360°
- Bright ½ x 1½” Display

ONLY $59.95
PLUS SHIPPING

- Made In USA
- Easy To Install
- Quality Material
- Designed For Years Of Service

FOR JUST A FEW DOLLARS MORE YOU CAN HAVE THE CONTROLLER OF THE FUTURE TODAY!

introducing a new LOW COST MODEL THE PSE-1K PRICED AT $189.95 plus shipping

For Contesters, DX’ers, Handicapped Operators and General Purpose Ham Operators:

The Most Advanced Antenna Control Available ....
- The Only Computerized Unit
- The Only Talking Unit
- The Only Scanning Unit
- The Only Programmable Unit
- The Only Automatic Braking Unit

Now Three Models of Our Computerized-Digital Antenna Control Priced From $189.95 to $489.95

- PSE-1K Series
- PSE-1A Series
- PSE-1 Series

Pro-Search Is Adaptable To Many Systems, Simple To Install.
No modifications are necessary.
Disconnect your present antenna control system and connect ours.
Pro-Search is used with HAM-M, HAM-II, III, IV, and TX. Other models are available to work with the HDR-300, etc.

To Order:
1-800-325-4016
1-314-994-7872
(Missouri)

Or write:
Pro-Search Electronics
1350 Baur Blvd.
St. Louis, MO 63132

PRO-SEARCH®
Reaching The World
Novices will find the 220 and 1270 MHz listings a must. For those interested in packet radio and other modes there are almost 1,000 digipeaters and specialized repeaters listed. You'll find much other useful information including a CTCSS (PL) Tone Frequency Chart, addresses of members of both the ARRL VHF-UHF and Repeater Advisory committees, band plans, information on how to operate through repeaters, compilations of frequency coordinators and ARRL Special Service Clubs. Available in the handy pocket-size (3½ x 5¼ in.) that was introduced last year. 16th Edition, copyright 1987, $4.00. Shipping and handling $2.50 ($3.50 for UPS). Off the press in late April. Purchase at your dealer or directly from:

The American Radio Relay League, Inc.
225 Main Street, Newington, CT 06111
Super ComShack 64™

On January 1, 1987, Engineering Consulting shipped the first Super Com Shacks 64’s to previous purchasers of the Com Shack 64 Duplex/Simplex ham shack and repeater controllers. The first units shipped were designed to upgrade existing systems to allow the features found in the new “Super” version.

New features of the “Super” version include a unique code practice mode, speed dial data entry of command strings consisting of multiple commands, and nine complete sets of access codes which can be changed at any time remotely from an HT or telephone, allowing instant repeater access code changes, which can reduce unauthorized use of repeater functions. The system autopatch supports up to 310 stored telephone numbers; ten emergency numbers may be accessed instantly with two digit commands. The balance of the 300 numbers may be stored via touchtone and recalled at any time.

Three hundred call signs can be programmed into the new Super ComShack. In the “directed page mode,” an unlicensed person can call the repeater telephone line and receive a voice message identifying the repeater and requesting input of a three-digit code. A valid code will voice-page the selected call sign over the repeater. If the page message is answered by the Amateur with the proper answer code, the calling party is then put “on the repeater” and a normal conversation can take place. If a control operator needs to gain access to the repeater, it can be done via telephone or touchstone from an HT.

The Super ComShack system offers dual remote base capability, which allows both UHF and HF radios to be input or linked to the main repeater. Total control of the link radio is provided through the use of serial data. Software is included to control the Yaesu FT-757, FT767, FT980, and FT-777; the Kenwood TS440 and TS940; the TM711/811; and Icom’s IC735 transceivers. New radios are being added as manufacturers provide samples for serial data programs to be tested.

A new system — dubbed the “Ultra” — is currently under development. Compatible with the “Super,” the “Ultra” will link several systems together, allow for Packet input, and incorporate other advanced features.

The Super ComShack is available from Engineering Consulting, 583 Candlewood Street, Brea, California 92621.

solder 14 different metals
— with a match

Quick Silver is a new silver-bearing bonding paste that flows at 430 degrees F using a match, butane lighter, or soldering gun — not 1200 to 1300 degrees F, as in conventional silver soldering. Quick Silver has a tensile strength of 18,000 to 22,000 psi compared to only lead solder’s 3,000 psi.

Quick Silver is furnished in a syringe-type applicator that enables the user to apply the paste first and then hold and apply heat. Suitable for electrical work where high conductivity and strength are required, it conforms to pure food laws (i.e. contains no lead, zinc, cadmium or antimony) and provides a good color match to stainless steel. It won’t darken or tarnish.

Quick Silver can be used on brass, bronze, chrome-plated steel, chrome-plated copper, copper, gold-filled and gold-plated materials, molybdenum, nickel silver, silver, stainless steel, steel, sterling silver, 800 silver, tin, and zinc. Priced at $9.95 plus $2.00 postage and handling, it’s available from E.L. Jones Company, P.O. Box 849, Sanford, North Carolina 27330.

Circle F302 on Reader Service Card.

DX nets, beam headings

DX Net List Around the World provides full information about all active DX nets and updates the DX Net List for 1987. Previous editions of the list — with information about DX Nets that might be reactivated as conditions allow — are still available.

DX Beam Headings Around the World shows bearing, distance in miles and kilometers, and reverse bearing for your OSO partner, for both shortpath and longpath, for more than 450 locations throughout the world. Special care has been taken for the Antarctic, USA, USSR, the Peoples Republic of China, and the Pacific Ocean.

For information, contact Ing. Christian Hohenwallner, OE2CHN, Gneisfeldstrasse 5, A-5020 Salzburg, Austria or Dieter Konrad, OE2DYL, Bessarabienstrasse 39, A-5020 Salzburg, Austria.

NEW 24 Page Buyer’s Guide

With Guaranteed Lowest Prices

• Explains all about FREE 100 channel Satellite TV and how to shop for an earth station!
• Lists GUARANTEED LOWEST PRICES...we will not be undersold, save 30-50% over local dealer prices!
• Tells how to easily and quickly Install-Your-Own earth station and save $400 or more!
• Shows how to demonstrate and sell earth stations from your home and earn extra money!

uniden
Panasonic
Sanyo
Charter

SATMAN

1-800-4-SATMAN

1-309-692-9582 Illinois
KENWOOD
TS940S "DX-cellence"
- Programmable Scanning
- High Stability, Dual Digital VFOs
- 40 Channel Memory
- General Coverage Receiver

KENWOOD
TS440S "DX-CITING"
- 100% Duty Cycle
- 100 memories
- Direct Keyboard Entry
- Optional Built-in AT
- On Sale Now, Call For Price!

KENWOOD
TM-3530A
220 MHz MOBILE FM TRANSCEIVER
- 220-225 MHz with 25 Watts
- 7-Digit Telephone No. Memory
- Direct Frequency Entry
- 23-Channel Memory

KENWOOD
TH-215A
"FULL FEATURED 2m HT"
- 141-146 MHz Receive
- 144-148 MHz Transmit
- 5W Output (5w Optional)
- 10 Memories
- Built-in CTCSS Encoder
- Nine Types of Scanning

YAESU
FT-757GX "CAT SYSTEM"
- All Mode Transceiver
- Dual VFO's
- Full Break-in CW
- 100% Duty Cycle
- CALL FOR BEST PRICE!

YAESU
FT-767GX HF/VHF/UHF BASE STATION
- Add Optional 6m, 2m & 70cm Modules
- Dual VFO's
- Full CW Break-in
- Lots More Features

YAESU
FT23/73R
- Zinc-Aluminum Alloy Case
- 10 Memories
- 140-146 MHz, 400-450 MHz
- 600 MAh Standard Opl. 5w
- New "Super Handle"

YAESU
FT-109RH
220 MHz H.T.
- 5 Watts Output
- Battery Saver
- 10 Memories
- Multiple Scanning Routines
- Power Meter

ICOM
IC-735 "NEW"
Can you put a price tag on reliability? Now ICOM offers a ONE YEAR WARRANTY on its HF Transceivers & Receivers purchased after August 1, 1986.

ICOM
IC-751A "NEW"
- 100kHz - 30 MHz
- FM Standard
- 32 Memories
- QSK (Nominal Speed 40 WPM)

ICOM
IC-38A
- Full 25W, 5W low
- 21 memories
- Subtones built in
- RX 215-230 MHz
- CALL FOR BEST PRICE

ICOM
IC-22A2AT
- 140-143 MHz
- 10 Memories
- 1W, 1.5W optional
- 32 tones built in

ICOM
IC-30AT
- 220 to 225 MHz
- 25W, 5W optional
- Built-in subtone
- 10 Memories

KAM
Kantronics All Mode
- CW, RTTY, ASCII, AMTOR, HF & VHF Packet
- RS-232/TTL, Universal Compatibility
- Transmit and Receive CW 6-99 wpm, RTTY,ASCII 45-300
- Baud, ARQ, FEC, SELFEC, Listen ARQ, VHF and HF Packet

MFJ-1274
TNC 2 PACKET RADIO
- VHF and HF Packet
- Precision Tuning Indicator
- AX.25 Level 2 Version 2.0 Software
- TTL Serial Port
- More!

PK 232
- Make any RS-232 compatible computer or terminal a complete digital operating position.
- Morse, Baudot, ASCII, AMTOR, Packet
- Loaded with features.

NOVICES
ARE YOU CONFUSED ABOUT YOUR NEW PRIVILEGES? CALL US FOR THE UP-TO-THE-MINUTE INFORMATION AND ASSISTANCE WITH YOUR GEAR.

ASTRON CORPORATION
Power Supply
- RS2A $48
- RS2A $68
- RS30M $125
- JS3A $123
- JS3M $149
- JS3M $165
- RS50A $199
- RS50M $215
- JS50A $279
- JS50M $299

J.R.L. KANTRONICS KDK
• MOST ORDERS SHIPPED SAME DAY •
Solid Brass
MORSE KEY KIT

- Precision-engineered and fabricated by R. A. Kent (Engineers), England
- Ball race bearings for smooth, trouble-free performance
- Solid silver contacts
- Machined hardwood weighted base with non-slip feet
- Easy assembly

Exclusive U.S. Distributor:
Total Electronic Concepts (TEC)
Post Office Box H 400, Lincoln, MA 01773
(617) 259-0125

Introductory Price
KIT $49.95
ASSEMBLED $59.95
plus $5.00 postage and handling. Massachusetts residents add 5% Tax.

Please send SASE for further information.

SERVICE CENTER
for
ICOM, KENWOOD
and YAESU
Fully equipped repair shop Amateur, Marine and Land Mobile repairs.
FCC NABER Lic
Mon-Fri 10:00-4:00 pm
(206) 776-8993

PACIFIC RIM COMMUNICATIONS
Bob KG7D
23303 56th Ave. West
Mountlake Terrace, Wa 98043

Free Catalog
Includes all Current, Obsolete, Antique, Hard-To-Find Receiving, Broadcast, Industrial, Radio/TV types. LOWEST PRICES, Major Brands, In Stock.
UNITY Electronics Dept. H
P.O. Box 213
Elizabeth, NJ 07206

7 MILLION TUBES
FREE CATALOG

SUBSCRIBE AND RENEW
TOLL-FREE

ham radio magazine

1 YR - $22.95 2YRS - $38.95
3 YRS - $49.95
Prices U.S. only

□ MASTERCARD □ VISA □ BILL ME
Please have your charge card ready.

DATATEL 800™
800-341-1522

OUR 800 NUMBER IS FOR SUBSCRIPTION ORDERS ONLY!
For Errors or Change of Address CALL ham radio
direct at (603) 878-1441 8-5 EST
YOU ALREADY OWN 75% OF A COLOR VIDEO STATION

It's true. With your transceiver, antenna, television set and audio tape recorder, you already have 75% of what's required to receive and send color video world-wide!

Add a ROBOT™ Video Transceiver and your station is complete.

Thousands of amateur video operators around the world are exchanging beautiful color images every day. Whether your favorite mode is SSB or FM or AM—direct, via repeater or satellite—you can join in the high-tech fun without modifying your present equipment. Just add a Robot to your station!

See us in Dayton Booth #472 & 473.
HF performance you can have a real field day with.


Because the FT-757GX/II packs all its HF performance into one highly compact, action-ready case. A case so small, it even fits under airplane seats.

Of course, you’ve probably noticed a similarity to its predecessor, the FT-757GX. That’s purely intentional. And now its performance is even better. With new features like memory storage of operating mode, slow/fast tuning selection, automatic step-change according to mode, IF notch filter, 10 memories, and VFO to VFO scan.

Plus you get an iambic electronic keyer, Woodpecker noise blanker, 600-Hz CW filter, AM and FM modes, AF speech processor, and 25-kHz marker generator. All at no extra charge.

Three microprocessors. Dual VFOs. Single-button VFO/mode swap. Receive coverage from 500 kHz to 30 MHz. Transmit coverage from 10 to 160 meters, including WARC bands. All-mode coverage (LSB, USB, CW, AM and FM). 100-watt RF output.

QSK operation. Massive heatsink and duct-flow cooling system for continuous RTTY operation for up to 30 minutes.

Computer Aided Transceiver (CAT) System for computer control via optional interface (software is available from your Yaesu dealer).

Of course, the FT-757GX/II offers the kinds of options you’d expect from Yaesu, too. Including standard and heavy-duty power supplies, automatic antenna tuner, and more.

So no matter where you work the DX, take along Yaesu’s FT-757GX/II. The full-featured HF rig you’ll have a real field day with.
Kenwood was the first to develop a 2 m/70 cm mobile radio in a single, compact package. Since then, other companies have imitated the concept, but still have not done it the "Kenwood way." The all-new TW-4100A is more compact, more powerful, and packed with more features than ever before! With many new features and accessories, and backed by Kenwood's experience, the all-new Kenwood Dual Bander is light years ahead of the rest!

- Selectable full duplex cross band ("telephone style") operation. Remote base or cross band repeater function possible (a control operator is needed for remote or repeater operation).
- 45 watts on 2 m. 35 watts on 70 cm. 5 watts (adjustable) low.
- Frequency coverage: 142-149 MHz (allows operation on certain MARS and CAP frequencies) and 440-449.995 MHz.
- New compact size! Only 5.9" W x 1.97" H x 7.87" D and weighs less than 4 pounds!
- Proven high performance Kenwood GaAs FET front end receiver.
- Easy to operate! Only 3 knobs and 8 keys on the front panel.
- Separate antenna ports for VHF and UHF. Minimizes loss and increases reliability and performance!
- 10 memory channels. Lithium battery backs up memory. Store frequency, offset, subtone. Two channels store the transmit and receive frequencies independently for odd split or cross band operation.
- MS-4000, MA-4000, and independently for odd split or cross band operation.
- Front panel-selectable CTCSS tone (when optional TU-7 is installed.)
- Non-volatile operating system. Even after memory back up cell dies, all operating features remain intact! No re-programming or "board-swapping" necessary!
- Programmable band scan and memory scan with memory channel lock-out.
- Large, illuminated LCD display and main knob. For excellent visibility in direct sunlight or darkness.
- Selectable frequency step for quick and easy QSY.
- Voice synthesizer VS-2 option.

Optional accessories:
- PS-50/PS-430 DC power supplies
- MU-1 DCL modem unit = TU-7 CTCSS encoder = VS-2 Voice synthesizer = SW-100B SWR/PWR meter 140-450 MHz for mobile use = SW-200B SWR/PWR meter for base station use 140-450 MHz, 0-200 W in 2 ranges = SWT-1 SWT-2 2 m and 70 cm antenna tuner = SP-40 Compact speaker
- Dual band mobile antenna with duplexer (mount not included) = MB-11 Extra mobile mount.

*Please check FCC regulations on repeater operation
*Motor modification necessary for repeater operation
*Specifications and prices subject to change without notice or obligation
*Complete service manuals are available for all Trio-Kenwood transceivers and most accessories.