JUNE 1984 / $2.50

ham radio magazine

hr
focus on communications technology

also: the peaked lowpass — a look at the ultraspherical filter • microphone calibration • impedance matching • applied Yagi antenna design • VHF/UHF world • ham radio techniques

KENWOOD

...pacesetter in amateur radio

Scan the World.

R-2000

Kenwood's R-2000 receiver has opened the doors to a new world in the 150-kHz to 30-MHz HF bands, with microprocessor controlled operating features and an UP conversion PLL circuit for maximum flexibility and to enhance the excitement of listening to stations from east to west, and from pole to pole. An optional VC-10 VHF converter, for 118 to 174-MHz, allows access to police, aviation, marine, commercial, and two meter Amateur frequencies. With dual digital VFO's, ten memories that store frequency, band and mode information, memory scan, programmable band scan, fluorescent tube digital display, and dual 24-hour clock with timer, this outstanding radio has the versatility needed to reach out and catch those distant and elusive stations in the most remote areas of the world.

The R-2000 receives in the USB, LSB, CW, AM, and FM modes, and its ten memories allow moving from band to band without concern for mode of operation. The programmable band scan feature permits scanning over operator selected limits, reducing scan cycle time. Memory scan allows the operator to scan all, or only specific memories. Lithium battery memory backup (Estimated 5 year life) is built-in.

With the sensitive R-2000, only the best in selectivity will do. It has three built-in IF filters, with NARROW/WIDE selector switch, and an optional 500-Hz narrow CW filter is available. A noise blanker, and an all-mode squelch circuit further enhance the operators control of his listening environment. An AGC switch, and an RF attenuator switch allow selection of the best signal-to-noise ratio. It has a large, front mounted speaker, a tone control, an "S" meter, high and low impedance antenna terminals, and operates on 100/120/220/240 VAC, or on 13.8 VDC, with an optional DCK-1 DC cable kit. Other features include a record output jack, an audible "beeper," a carrying handle, a headphone jack, and an external speaker jack.

The R-2000 places the world at your finger tips.

R-2000 optional accessories:
VC-10 VHF converter • HS-4, HS-5, and HS-6 headphones • DCK-1 DC cable kit • YG-455C 500-Hz CW filter.

R-1000 High performance receiver • 200 kHz–30 MHz • digital display/clock/timer • 3 IF filters • PLL UP conversion • noise blanker • RF step attenuator • 120-240 VAC (Optional 13.8 VDC).

R-600 General coverage receiver • 150 kHz–30 MHz • digital display • 2 IF filters • PLL UP conversion • noise blanker • RF attenuator • front speaker • 100-240 VAC (Optional 13.8 VDC).

More information on these products is available from authorized dealers of Trio-Kenwood Communications, 1111 West Walnut Street, Compton, California 90220.

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

ham radio

magazine

contents

JUNE 1984

volume 17, number 6

ham radio magazine is published by
Communications Technology, Inc.
Greenville, New Hampshire 03048 0498
Telephone: 603-878-1441

subscription rates

United States:
one year, $19.50; two years, $32.50; three years, $42.50
Canada and other countries (via surface mail):
one year, $21.50; two years, $40.00; three years, $57.00
Europe, Japan, Africa (via Air Forwarding Service): one year, $28.00
All subscription orders payable in U.S. funds, via international postal money order or check drawn on U.S. bank

international subscription agents: page 128

Microfilm copies are available from
University Microfilms, International
Ann Arbor, Michigan 48106
Order publication number 3076

Cassette tapes of selected articles from ham radio
are available to the blind and physically handicapped
from Recorded Periodicals,
919 Walnut Street, Philadelphia, Pennsylvania 19107

Second-class postage paid
at Greenville, New Hampshire 03048-0498
and at additional mailing offices
ISSN 0148 5989

Postmaster send form 3579 to *ham radio*
Greenville, New Hampshire 03048-0498

REFLECTIONS

SCORE: 99 FOR . . . 1 AGAINST

Of the thousands of towers installed in the United States last year, 99 percent remain standing. This is truly a remarkable statistic, considering how many of these structures were installed using less than the best techniques and, to boot, were hardly ever maintained.

Of those that came down, we could say that some unusual weather condition (hurricane, tornado, or ice storm) or some other extraordinary occurrence was to blame — but stop and think how many of these would still be standing today if the proper foundation had been laid, if wire instead of nylon rope had been used for guys, if that 10 feet of additional masting hadn't been used .

Do you recognize any of these situations? Is your present installation ready to become a negative statistic? If so, read on.

O.K., we're all Amateurs, but just for the moment, let's borrow some good advice from the engineering disciplines (or maybe it's just good old common sense). Before putting up that 6-element super deluxe 27 dBn gain (decibels with respect to a conductive noodle) Yagi atop the 102-foot perch, sit down, take pencil in hand and think it through. A safe tower/antenna installation (or any installation for that matter) can and should be engineered in three simple steps: DESIGN it according to the manufacturer's specifications, INSTALL it correctly, and MAINTAIN it. Unfortunately, most of us (and I don't exclude myself) are in such a rush to become operational — taking advantage of the good weather and time off from work, vacation, or chores — that we just can't afford to take the time to do it right. Or can we? Can we afford to come home one day and find an irate neighbor shouting and pointing to our aluminum thing of beauty, still attached to our tower, protruding upside down from *his* roof?

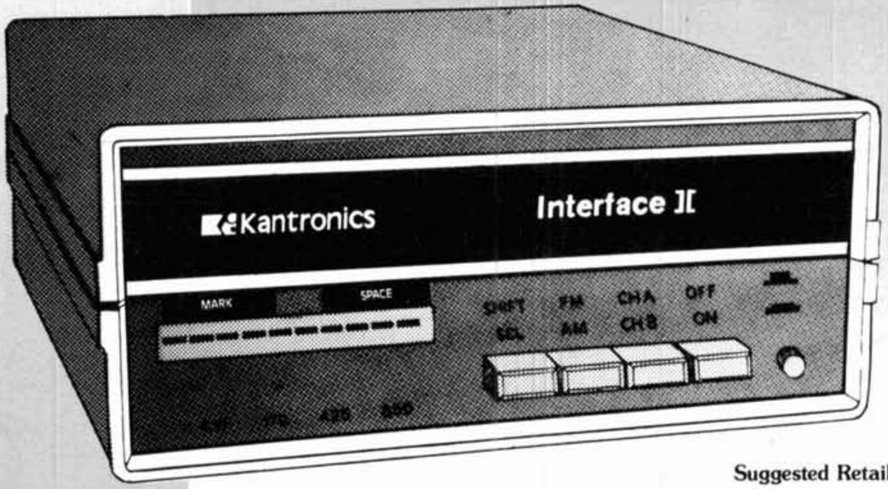
Just because we're Radio "Amateurs," it doesn't mean that our installations have to be "amateur." And it doesn't mean that all commercial installations are necessarily safer. A case in point: a friend of mine was doing a site survey for a cable TV outfit and had to climb one of the existing towers for the preliminary observation phase. Well, it was getting late in the day and, to be quite honest, my friend was a wee bit leery about climbing that tower because of something unnerving — but not readily identifiable — about the foundation and the sandy soil. When he came back the next day to climb the tower, he found the tower on the ground, having fallen by its own accord during the night.

To help prevent this kind of near-disaster, and real disasters as well, the theme of this issue (if you haven't already guessed) is *towers*. In a sequence of articles not dissimilar to a Greek trilogy, Roger Cox (WBØDGF), John Haerle (WB5IIR), and Steve Makulec (KB9IW) discuss the three important steps of tower construction: design, installation, and maintainance — and there's nothing mythological about that.

Rich Rosen, K2RR
Editor-in-Chief

Kantronics Interface II

The Interface For
Apple, Atari, TI-99/4A, TRS-80C, VIC-20, and Commodore 64
Computers



Suggested Retail Price 269.95

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

X-Y scope outputs and dual interface outputs for VHF and HF connections make Interface II compatible with almost any shack. All three standard shifts are selectable, and Interface II is AMTOR compatible. Interface II is designed for use with Kantronics software.

Kantronics Software — The Industry Standard

Hamsoft

Our original program for reception and transmission of CW/RTTY/ASCII. Features include Split Screen Display, Message Ports, Type-ahead buffer, and printer compatibility. Apple Diskette $29.95, VIC-20 cartridge $49.95, Atari board $49.95, TRS-80C board $59.95, TI-99/4A cartridge $99.95.

Hamtext

All the features of Hamsoft with the following additional capabilities: text editing, received message storage, variable buffer sizes, diddle, word wraparound, time transmission, and text transmission from tape or disc. The program is available on cartridge for the VIC-20 or Commodore 64, and diskette for the Apple. Suggested Retail $99.95.

Hamsoft/Amtor

This program has Hamsoft features with the added ability of communicating in the newest coded amateur format-AMTOR. AMTOR offers error free low power communication. Hamsoft/Amtor is available for the Atari, TRS-80C, VIC-20, and Commodore 64 computers. Suggested Retail $79.95.

Amtorsoft

For the serious AMTOR operator using a VIC-20, Commodore 64, or Apple computer. This program is similar to Hamtext in capabilities, but can only be used for AMTOR. The Apple version includes both Hamtext and Amtorsoft on one diskette ($139.95), while the Vic-20 and Commodore 64 cartridge is just Amtorsoft ($89.95).

presstop de W9JUV

PRESSURE IS BUILDING IN THE 900 MHZ SPECTRUM for a variety of possible uses, at least some potentially in conflict with the Amateur 902-928 MHz allocation that came out of the 1979 WARC. Mura, a leading producer of cordless phones and other consumer electronics, has petitioned the FCC to establish a new "Consumer Radio Service" at 935-938 MHz. Mura's proposal would provide 120 channels using automatically identified radios with a five-mile range at a projected cost of under $100 each. Mura also proposes phasing out 27 MHz and GMRS CB, and rejects GE's earlier proposal for a 900 MHz service with repeaters and telephone interconnect as simply a variation of the new cellular communications system.

Cordless Phones Are Yet Another Prospective 900 MHz User, proposed by the Electronic Industries Association in another Petition for Rule Making. The EIA wants two 2-MHz bands in the 900 MHz region, separated by at least 45 MHz, to become available by January 1, 1987. The FCC did recently add 10 new "interim" cordless phone channels at 46/49 MHz.

All This Is In Addition To The Rapid Growth Of Paging, cellular radio and other two-way services in the 800-1000 MHz spectrum. However, on March 28 the ARRL filed its own Petition for Rule Making, asking for early implementation of privileges for Technician and higher class licensees on the 902-928 MHz Amateur band. The FCC reports very little previous Amateur input about this band. At the same time, the ARRL also asked for use of the new 24-MHz band, by General Class and higher. Yet another petition, by five Amateurs who all hold experimental licenses for both the new 18 and 24-MHz Amateur allocations, asks that Amateur operation be permitted on both bands on a non-interference basis.

THE FIRST VOLUNTEER-ADMINISTERED AMATEUR EXAMS WERE GIVEN APRIL 17 IN ALASKA, giving the No. 1 VEC, Anchorage Amateur Radio Club, still another first in the program. 42 Tech and General exams were given in their session. The Dayton ARA wasn't far behind, giving about 400 exams during its April 28-29 Hamvention weekend. Dissatisfaction over ARRL inaction on the VEC program seems widespread, and rumors of some sort of forthcoming shakeups at Newington were circulating at the Hamvention.

Amateur Frustration With Lack Of Upgrade Opportunity is now becoming serious in some areas. The third call area, for one, is now booked solid through the year's end, when FCC-administered exams end and the volunteer program must take over. However, a third call area VEC, the Laurel (Maryland) ARC, is expected to be certified shortly.

A Seventh District VEC, The Boeing Employees Amateur Radio Society, has been accepted by the FCC, and the Dallas ARC has been certified as the VEC for the fifth district. In the second and eighth call areas additional VECs are also coming on board. However, the first, zero, and sixth districts still have no known prospects, though a sixth district group is reported to be preparing to make a proposal.

The FCC's NPRM On Exam Fees Drew Only a Handful Of Comments from several clubs, a few concerned individuals, and of course the ARRL. Most supported the concept of expense reimbursement for examiners as well as the VECs, under the direction of the VECs. It is hoped the Commission will be able to authorize fee collection before the summer recess.

The Revised Novice Exam Program, In Place Since Last Summer, is working well for the most part, though Gettysburg says they still have some problems. Some Amateur examiners still don't realize they're supposed to write, administer, and grade the exams themselves, and are still writing Gettysburg for exams or sending applicants' answer sheets there for grading. The other major problem is with improperly filled out Form 610s: the examiner either neglects to certify that both the CW and written exams were passed, or neglects to include a signed statement certifying that the examination was properly administered.

OPERATING AFTER HIS LICENSE WAS LIFTED BROUGHT A SUSPENDED sentence with a threat of prison to a California ex-Amateur. The former N6BII, who lost his license for jamming WESCARS and other 40-meter operations was sentenced to a 90-day suspended sentence and three years probation in Federal District Court April 19. Under the terms of his probation, however, he can go to jail if he even talks over another Amateur's station during the probation period, unless the FCC chooses to relicense him.

EXPANSION OF ADDITIONAL PHONE BANDS IS STILL in the FCC's hopper, but staff cuts at the Commission and implementation of the Volunteer Exam Program have kept it on the back burner. There's hope that the Commissioners will be able to act on expansion before the summer recess. but what direction expansion (if any) will take is very much up in the air.

DAYTON HAMVENTION'S "HAM OF THE YEAR" IS DAVE BELL, W6AQ, honored "...for dedicated use of his Cinematographic skills to bring the story of Amateur Radio to the world." This year's "Special Achievement Award" went to Ethel Smith, K4LMB, for her efforts on behalf of the YLRL. The "Technical Achievement Award" went to Lyle Johnson, WA7GXD, for development of the Tucson Terminal Node Controller for packet radio. Congratulations to all!

A NUMBER OF SCHOLARSHIPS FOR AMATEURS who are now or will be attending a full-time college are being offered by the Foundation for Amateur Radio. Write them at 6903 Rhode Island Ave., College Park, Maryland 20740, for application information.

EXTENSIVE REVISION OF 2-METER REPEATER FREQUENCIES ALONG THE U.S.-MEXICAN border may be coming in the wake of recent interference problems. Mexican government authorities have met with their Amateurs to discuss on-going across-the-border coordination difficulties, and have proposed joint meetings with the FCC and U.S. Amateurs to resolve them.

Attention Moonbouncers

and Satellite Communications Enthusiasts

Introducing New Ultra High Performance Antennas from KLM Electronics, Inc.

KLM Electronics is fueling the Moonbounce and Oscar 10 revolution with Antenna Equipment that delivers truely Out-of-This-World performance.

For the Moonbouncer, our New 2M-16LBX is designed to be the highest gain 2 meter antenna available on the market today by more than a full db, making the 2M-16LBX an outstanding performer as a single antenna or in Moonbounce (EME) arrays.

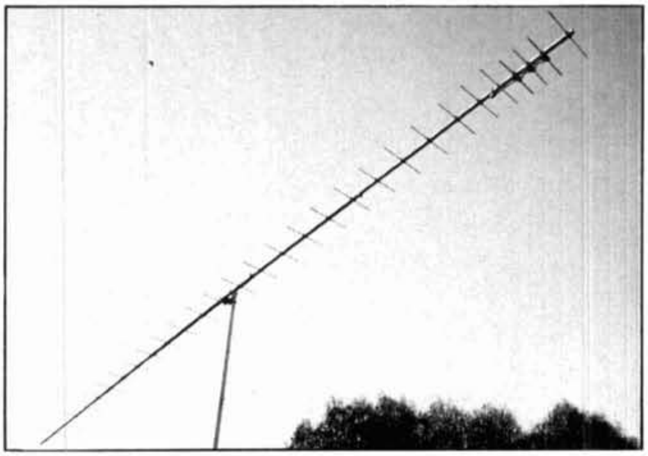
The New 432-30LBX follows the same pattern as the 2M-16LBX, and soon will become the industry's standard of comparison.

Featuring straight forward construction, and an innovative tapered boom that greatly reduces windload and adds strength and durability. Virtually unbreakable, insulated, 3/16″ rod parasitic elements are anchored through the boom to insure years of trouble-free performance.

For the satellite enthusiasts, the 2M-22C high gain 2 meter, circular polarized antenna, features the same rugged construction and total flexibility as our very popular 2M-14C with a 2db increase in gain.

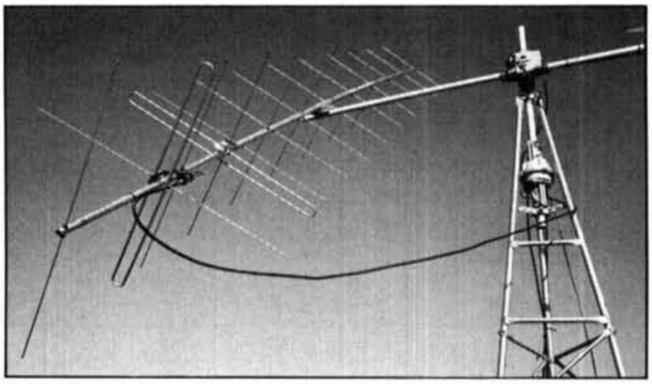
Four or more 2M-22Cs make an excellent array for Moonbounce (EME) by elminating Faraday fading.

Fiberglass/aluminum stacking frames are available as well as 2 and 4 port power dividers and phasing harnesses to optimize the performance of these type arrays. Watch for our new elevation drive system coming soon.



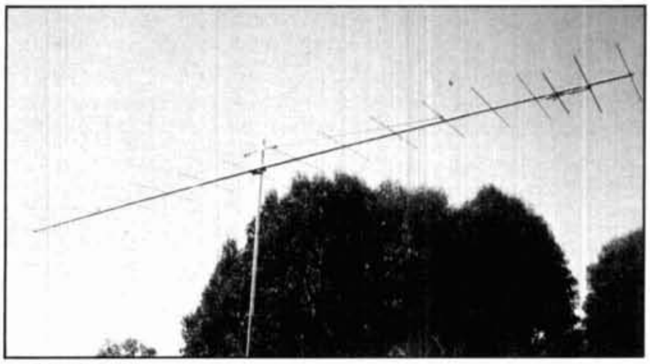
432-30LBX

BANDWIDTH	430–440 MHz
GAIN	17.3 dBd
BEAMWIDTH	20°
FEED IMP	50 ohms unbal.
BALUN	included
BOOM LENGTH	21 ft. 9 in.
F/B	20 dB
F/S	35 dB
VSWR	1.5:1
WINDLOAD	1.43 sq. ft. (typical)
TURNING RADIUS	12 ft. 5 in.
WT. (lbs.)	9 lbs.



2M-22C

BANDWIDTH	144–148 MHz
GAIN	13 dBd
BEAMWIDTH	34°
FEED IMP	50 ohms unbal.
BALUN	(2) 4:1 coax
BOOM LENGTH	19 ft. 1 in. (tapered)
VSWR	1.5:1
WINDLOAD	1.85 sq. ft.
ELLIPTICITY	3 dB max.
CIRCULARITY SWITCHER	CS-3 included
WT. (lbs.)	11 lbs.

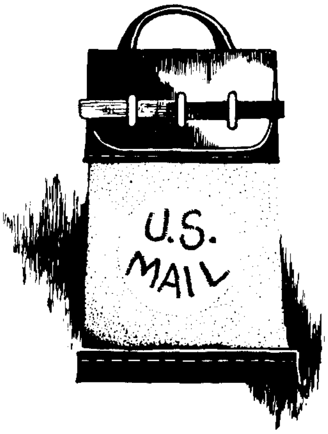


2M-16LBX

BANDWIDTH	143–146 MHZ
GAIN	(144 MHz) 14.8 dBdc
BEAMWIDTH	(V) 28°, (H) 33°
FEED IMP	50 ohms unbal.
BALUN	4:1 RG303, Teflon
BOOM LENGTH	28 ft. 1 in. (tapered)
VSWR	1.4:1
WINDLOAD	(H) 1.75 sq. ft. (V) 2.44 sq. ft.
WT. (lbs.)	10 lbs.
TURNING RADIUS	15 ft. 6 in.

✓ 154

KLM electronics, Inc.
P.O. Box 816
Morgan Hill, CA 95037



comments

can you help?

Dear HR:

I need a schematic for the ES 221K frequency counter advertised by ESE in the October, 1974, issue of *ham radio*, page 90. I have a problem with the counter, but no manual or schematic.

A.J. Massa, W5VSR
New Orleans, Louisiana

Dear HR:

I need a schematic and/or manual for a Model 555/N oscilloscope made by the Data Instruments Division of Pennsauken, New Jersey. Upon writing to them I found that they have moved (or closed) without leaving a forwarding address.

I am willing to pay for a photocopy of this data. Please contact me at the address below.

Tom Adams, K9TA
110 N. Few St. Apt. #2
Madison, Wisconsin 53703

aiming for excellence

Dear HR:

Your excellent editorial ("Reflections," February, 1984, page 6) really tells it like it is. I wish every Amateur would read it and take your advice.

In most endeavors people strive for excellence. The shooter, golfer, bowler, artist, craftsman, and so on, aspire to excellence — why shouldn't Amateur Radio operators seek a similar goal?

I made some friendly suggestions recently to a group of several newly licensed Amateurs on how to improve their operating procedure. You would not believe the reaction to my suggestions. There were such comments as:

"You have no responsibility for the way we choose to operate."

"Ham radio is a hobby for the average citizen and was not intended for engineers — hence the name, *Amateur* Radio."

"You old-timers want to take over and run us newcomers out."

"You give technical talks to the club only to show how smart you are."

These are pretty sick comments, but of course, they come from a very few insecure people. The majority of hams are mighty fine people.

I operated a DX station for three years in China and the Phillipines. When I encountered the operating rudeness to which you refer I had a very effective response. Even though the signal was very loud, I would report it as impossible to copy or even ascertain the call. A call on the QSO frequency was an immediate entry to my blacklist. Let me assure you that some pretty big names in the DX ratrace never got a QSO from me while I was in Canton, Swatow, Amoy, or Foochow.

Keep up the good work.

I.L. McNally, K6WX
Sun City, California

better SSB

Dear HR:

I was pleased to read the article: "Better-Sounding SSB" in the February, 1984, issue of *ham radio*. I for one have always maintained that SSB should sound just as good as the voice at the mike! However, for years "communications quality" has been in vogue. The simple changes mentioned by Mr. Measures are good. Now if some enlightened manufacturer would just lead the way and recognize that many hams would prefer smooth, undistorted audio, I might finally buy a new rig!

Let's have more such articles!

James E. Taylor, W2OZH
Webster, New York

optical receiver cost

Dear HR:

I found Poon and Pieper's "Construct an Optical FM Receiver," (November, 1983, page 53) very interesting. The drawings and equations resemble those found in my engineering log book as of late. This is quite state-of-the-art technology, and experimentation should be encouraged; however, the authors did not mention the cost of their project. To prevent anyone seriously interested in persuing this project from becoming discouraged, I thought I might pass along my costing estimate of the items specified. Depending on the type and power of laser purchased and quality of lenses used, the cost of the project will run between $858.00 and $1228.00. (This, by the way, is relatively cheap for a basic acousto-optic receiver.)

Good luck.

David A. Clingerman, W6OAL
Newbury Park, California

(A call to Edmund Scientific revealed that an Aerotech 1 milliwatt Helium-Neon laser could be purchased for $330 and a complete set of spherical/cylindrical lenses for under $50 . . . **Ed**)

HF operations

Dear HR:

I would like to correspond with anyone involved in HF mobile operation or the design of HF solid-state amplifiers.

Phil Zelter-Jenkins
70, Cross Oak Road, Berkhamsted
Hertfordshire, HP4-3HZ, England

TOWER DESIGN:

match your antenna to your tower

Here's how to calculate wind area, wind load, and bending moment

Have you heard the story *about the ham across town who bought a new $500 long-boom tribander to replace his older, smaller beam? He rented a "cherry-picker" at $50 an hour to have it installed on top of the tower he'd originally bought for his 5/8-wave CB antenna in the days before he'd become a ham. The rotator, a small CDE unit he'd bought for $10 at a flea market, had worked fine with the TH3JR that he'd also purchased soon after getting his ham ticket.*

A few months later, a snowstorm driven by 50 MPH winds demolished his entire antenna system, and worse yet, sent the tribander crashing through the roof of his neighbor's house. He wound up in a hassle with his insurance company over the damages, and the neighbor soon began circulating a petition to ban antennas and towers from that city.

You don't think this could happen? Look at the towns of Burbank, Illinois, and Cerritos, California, and see what Amateurs in those communities are fighting. A ruined antenna and tower may not only rob your wallet, but may also rob you and your friends of your operating privileges because of the negative publicity that inevitably follows such an incident.

the match game

When someone says that an antenna is perfectly "matched," most people assume that he or she means that the VSWR is a perfect 1:1. But there's another kind of "match" that's at least as important as VSWR and essential in preventing the kind of mayhem described above. This is the match that occurs when an antenna is *physically* mated to its mast, rotator, tower, and any other antenna on the tower.

How can you determine whether your antenna is properly "matched"? Well, for starters, check the specifications of the equipment you're now using. Don't wait until something happens; you may have added a small VHF antenna or a 30/40 meter add-on kit without realizing that you've exceeded the wind-loading of your tower or rotator.

Start by referring to your antenna instruction or assembly manual. All legitimate antenna manufacturers include both electrical and mechanical specifications with their products. If you can't find your manual, or if the specifications are not listed, write or call the manufacturer's customer service department for this information.

wind area

Look for the entry titled "Wind Area" or "Effective Surface Area" under "Mechanical Specifications." This number, expressed in square feet or square meters, is a measure of the physical size of the antenna. It represents the maximum surface area against which the wind could theoretically push. The total wind area figure should represent the "worst-case" surface area of the antenna — a combination of both the total boom and total element surface areas.

If two or more antennas are mounted within approximately 2 feet of each other, their wind areas can simply be added together to provide a total Antenna System Wind Area. This wind area should be equivalent to or less than the rated wind area maximums of the rotator and tower.

As an example, consider a tribander with a wind area of 5.7 square feet (0.53 square meter) and a 2-meter vertical with an area of 1.5 square feet (0.14 square meter) mounted 2 feet (0.61 meter) above the tribander. The total Antenna System Wind Area of this system would be 7.2 square feet (0.67 square meter),

By Roger A. Cox, WBØDGF, Telex Communications, Inc./Hy-Gain Division, 8601 Northeast Highway 6, Lincoln, Nebraska 68505

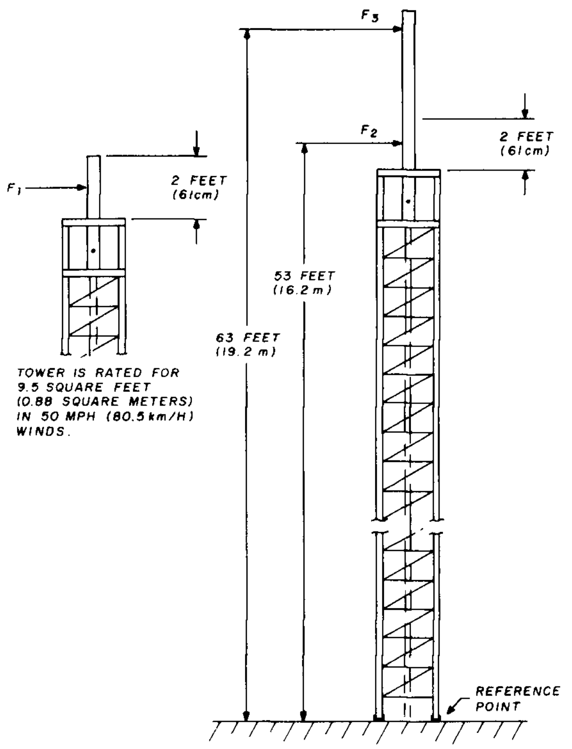


fig. 1. Locations of forces on tower masts.

and would easily match a tower rated at 9 square feet (0.84 square meter) or a rotator rated at 8.5 square feet (0.79 square meter).

Determining wind area becomes more complex when you want to stack two or more HF beams or numerous arrays of VHF Yagis, because under these circumstances the separation required for good electrical performance is almost always greater than 2 feet (0.61 meter).

To analyze complex antenna systems made up of antennas spaced *more* than 2 feet (0.61 meter) apart, you need to know how each antenna contributes to the loading of the entire system.[1] Check your manual under "Mechanical Specifications" once more; you should be able to find the "Wind Load" of the antenna at a specific wind velocity. [Usually a wind velocity of either 80 (129 km/hour) or 100 MPH (161 km/hour) is used.]

wind load

The wind load of an antenna is related to the wind area of the antenna through the equation:

$$F = PA \tag{1}$$

where F is the wind load force in pounds, P is the wind pressure in lb./ft.^{2}, and A is the antenna wind area in ft.^{2}. P is dependent upon the wind velocity, V, and is usually* found from the equation:

$$P = 0.004\ V^2 \tag{2}$$

where V is the wind velocity in MPH. At 80 MPH, $P = 25.6$; at 100 MPH, $P = 40\ lb./ft.^2$.

In **fig. 1** a tower with a wind load limit of 9.5 square feet in 50 MPH winds is shown. From **eq. 2** we can find the pressure, P, which the wind exerts on the antenna in a 50 MPH wind.

$$\begin{aligned} P &= 0.004\ (50)^2 \\ &= 10\ lb./ft.^2 \end{aligned}$$

In order to find the maximum force which may be exerted on the tower, we use **eq. 1**.

$$F = PA = 10(9.5) = 95\ lbs.$$

Therefore the maximum allowable force within the 2-foot limit is 95 pounds.

the bending moment

In order to evaluate the effects of placing more than one antenna on a mast above the tower, we must look at the bending moment, M, with respect to the weakest point in our tower/mast system. The moment, M, is found by

$$M = FD \tag{3}$$

where F is the force and D is the distance to the weakest point. The moments may be added together for the various antennas as long as the same point is used as a reference. In **example 1**, if we suspected that the tower base was our weakest point, and that our force F_1, was applied to the mast 53 feet above the point, the moment, M_1 could be expressed as:

$$M_1 = F_1D = 95(53) = 5035\ ft.\ lbs.$$

If we were to replace F_1 with an antenna that exhibited 50 pounds of force, and added another antenna 10 feet above it that exhibited 40 pounds of force, would we exceed the allowable moment of 5035 ft. lbs.? Your first guess may be no, because the forces add up to only 90 pounds and this is less than the 95 pounds we had before. And if you were to compare wind areas, you would find that the 50 pound antenna at 5 square feet and 40 pound antenna at 4 square feet also add up to less than 9.5 square feet, or rated wind area for this tower.

But if you were to add up the moments,

$$M = \Sigma\ FD \quad (\Sigma = sum\ of\ldots)$$

$$M_2 = 50\ (53) = 2650$$

$$M_3 = 40\ (63) = 2520$$

$$M_2 + M_3 = 5170\ ft.\ lbs.$$

*The equation $P = 0.004\ V^2$ takes wind gusts and turbulence into consideration. For a steady (laminar) flow, the equation $P = 0.00256\ V^2$ should be used. Consult the Uniform Building Code (UBC) for a more thorough explanation.

you would find that they easily exceed the moment limit of 5035 ft. lbs.

The base of the tower may not always be the weakest point of your tower/mast system. Other susceptible points are the point of attachment of the top set of guy wires, a house bracket, a junction in a telescoping tower or mast, or even the point of attachment of the mast to the tower. If you've used short inserts to reinforce the mast, the end of any insert within the mast may be a point of vulnerability as well. Your best bet is to follow the tower and mast manufacturer's recommendations whenever you stack large antennas.

rotator wind area

As in determining the wind area of your antenna, you should begin analysis of your rotator's wind area by reading your instruction manual. If the specifications are not listed, or if you cannot find your manual, write or call the manufacturer's Customer Service Department for this information.

Look in the specifications section for the entry titled "Maximum Wind Area." There will be two different entries — one for mast mounting and one for inside tower installations. For mast mounting, there will also be a maximum distance of the antenna above the rotator provided; this is usually 2 feet (0.61 meter).

Just as in the previous example, if all of your antennas are mounted within this range (2 feet/0.61 meter) you may add the antenna wind areas together and compare that total to the rotator's rating.

loading

If you're using a small tower or mast, with the rotator installed on top, be extra careful to observe the rotator's mechanical limitations on side thrust. Use the procedures shown in the wind load section of this article with the rotator's rated wind area and wind speed to determine the maximum force that can be applied within 2 feet (0.61 meter) of the top of the rotator. If no wind speed is given, use a conservative figure such as 50 MPH.

As an example, consider the Hy-Gain CD4511. When mast-mounted, its rated wind area is 5.0 square feet (0.46 square meter). I will use 50 MPH as the wind speed. Using **eqs. 1** and **2**:

$$F = 0.004\ V^2\ A = 0.004\ (50)^2(5) = 50\ lbs.$$

In this case, using a distance of 2 feet (0.61 meter) above the rotator, the moment is 100 ft. lbs. You can use the same procedures shown in the bending moment section to evaluate the effects of placing more than one antenna on a mast above a rotator.

Although stacking antennas above a rotator installed on top of a mast or tower is not recommended, it can be done if the maximum moment limitations are adhered to. The weakest point in this case is assumed to be the center of the rotator.

Although slightly exceeding the maximum ratings of a rotator may not break or permanently damage it, doing so will more than likely impair its operation in some way, especially during windy conditions. Continued use in this manner is sure to shorten the useful life of your rotator.

If you install a rotator inside a tower, a different set of mechanical limitations applies. The side thrust is now less important, but the stall and braking torque of the rotator is more important. This is why a different wind area rating is listed for rotators installed within a tower.

The rotator's wind area rating within a tower is usually related more to the braking power rather than to the stall torque of the rotator. The braking power is the maximum allowable torque that the antenna load may present to the rotator without causing it to rotate. This torque is usually not a steady torque, but rather a pulsing, almost sinusoidal torque produced by the antenna rocking back and forth in a violent wind storm.

moment of inertia

The amount of torque produced by this rocking action is directly related to the moment of inertia of the antenna. The moment of inertia is similar to the bending moment as discussed earlier, because it is related to force and its distance from a reference axis. However, complex structures such as antennas must be analyzed as the summation of all the moments produced by the various portions of the antenna. Also, since each moment is directly related to the mass of each antenna portion and the square of its distance to the axis, an antenna with a very long boom with heavy elements will have *more* total moment of inertia than an antenna with a short boom with very light elements, even though they may have the same total wind area! This has produced some difficulty in assigning wind area ratings for rotators. Luckily most commercially available Amateur antennas have short enough booms so that their wind areas and moments of inertia are closely related. However, on long-boom homebrew, commerical, or military-type antennas, one has to be extremely cautious when selecting a rotator when given only a wind area rating.

Although the wind area rating of a rotator is not wholly determined by the rotator stall torque, a higher stall torque is required for turning larger antennas. On a calm day, the act of rotating the antenna produces wind against each element and boom. This wind is a force that opposes the direction of rotation. If, at full speed, this force produces the amount of torque required to stall the rotator, the rotator will slow down until the wind force is less than that which produces a stall. Therefore, a rotator with a small stall torque will sometimes turn more slowly than one with a higher

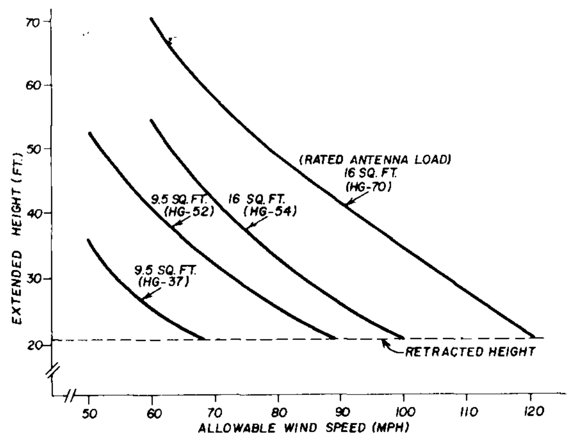


fig. 2. Extended height of self-supported crank-up tower is a function of wind speed and antenna location.

stall torque. On a windy day, the rotator with less stall torque may not be able to overcome the forces produced by the wind.

towers

Every tower ever commercially manufactured has some kind of instruction manual or specification guide, no matter whether it is a crank-up, guyed, or self-supporting tower built of steel or aluminum tubular or right-angle stock.

The manuals accompanying crank-up towers, with which I am most familiar, list a "wind load limit." This is the maximum wind area in square feet (or square meters) that the tower will *safely* hold at its maximum height at a particular wind velocity. The industry standard is to rate these towers at either 50 MPH (80.5 km/hour) or 60 MPH (96.6 km/hour).

Because of the specific nature of crank-up towers, the owner can crank the tower up and down for antenna installation and servicing and also crank the tower down whenever high winds are expected. With the tower completely retracted, the bending moment at the base of the tower caused by the antenna load is significantly reduced.

If you're willing to crank the tower down every time strong winds are expected, it's possible to expect your antenna system to survive near-hurricane conditions even with the maximum allowable antenna wind area. **Fig. 2** shows the wind velocities under which you can expect a Hy-Gain crank-up tower to survive given the maximum rated antenna loads at the extended heights shown in the graph.

For example, if you have a 9.5 square foot (0.8 square meter) antenna load on your Hy-Gain HG-52SS tower, which is cranked down to 21 feet (6.4 meters), you can expect your system to survive a wind velocity of 90 MPH (145 km/hour). (This assumes, of course, that the tower was properly installed, and that all the manufacturer's recommendations were followed.)

You can also expect your fully extended tower to survive higher wind velocities than specified if the antenna wind area is less than the maximum rating for the particular size tower. **Fig. 3** shows how the maximum antenna wind area for a given tower varies with the allowable wind velocity. For example, the HG-70HD, which is rated at 16 square feet (1.5 square meters) in 60 MPH (96.6 km/hour) winds, can safely handle only 10 square feet (0.9 square meter) in 70 MPH (113 km/hour) winds.

As you can also see from **fig. 3**, larger antenna loads may be possible if lower wind velocity figures are used. Unless your tower is sheltered from the wind, it would be dangerous to assume that the wind would always stay under 30 MPH (48 km/hour). These figures should be used only as a demonstration of what may be possible in your installation. Other factors such as the type of soil, ice loading, and wind-driven sand (sandstorms) may affect your particular installation. Again, your best bet is to follow the manufacturer's recommendations on anything questionable.

The manufacturers of guyed towers (such as the Rohn Model 25G and Model 45G) usually recommend specific guying configurations depending on the height of the tower and the specific area of the country in which installation is planned.[3] The maximum wind area is specified as "allowable load" for each type of tower.

The Electronic Industries Association has divided the continental U.S. into 3 wind load zones (see **fig. 4**).[4]

Zone A encompasses most of the United States. Short towers constructed within this zone should be capable of withstanding loading of 30 pounds per square foot (147 kilograms per square meter). This corresponds to approximately 87 MPH (140 km/hour) winds.

Zone B encompasses northwest Washington, north-central California, part of the northern Great Plains and northern Rockies, the area surrounding Madison, Wisconsin, and most of the Gulf Coast and eastern seaboard. Short towers within this zone should be capable of withstanding loading of 40 pounds per square foot (196 kilograms per square meter). This corresponds to approximately 100 MPH (161 km/hour) winds.

Zone C encompasses two areas, the southeast tip of Florida and most of the eastern coast of North Carolina. Short towers within this zone should be capable of withstanding loading of 50 pounds per square foot (245 kilograms per square meter). This corresponds to approximately 112 MPH (180 km/hour) winds.

Fig. 5 shows typical guying configurations for the Rohn Model 25G guyed tower installed in Zone A at various heights. This configuration is for an "allowable load" of 6 square feet (0.56 square meter).

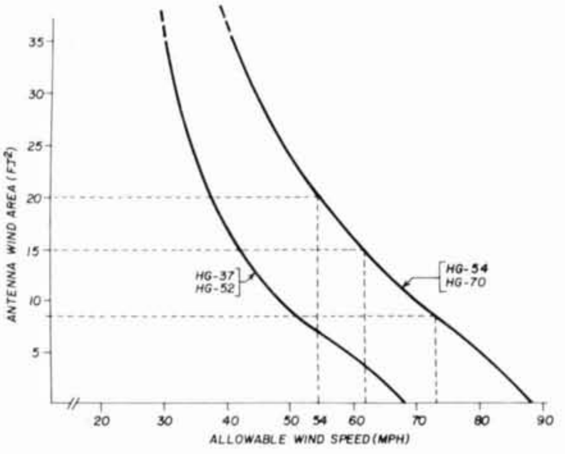


fig. 3. Example of antenna wind area versus wind speed for four commercially-available towers.

Self-supporting towers are similar to crank-up towers in their specifications. They usually specify a maximum wind area or wind load limit at a particular wind velocity. If a particular manufacturer does not list a wind velocity with the load rating, you should ask for this figure from its customer service department. If the wind velocity rating given is less than 50 MPH (80.5 kmph), you may wish to add guys to your tower if you are at or near the rated load. If the wind velocity given is greater than 80 MPH (129 kmph), the rated loading should be safe unless you live in Zones B or C, as previously mentioned. If you do live in one of these zones, be sure to choose a tower with a rated wind velocity figure greater than 100 MPH (161 kmph), or be prepared to add guys.

masts

While the mast doesn't receive as much attention as the tower or rotator in the ratings game, it can be of vital importance in maintaining the integrity of your antenna system.

Only a few manufacturers supply masts for antenna systems. Normally it's easier and cheaper for an individual to purchase a length of steel tubing at the local lumber yard or electrical supply store than it is to purchase it by mail order. For the average antenna installation, this is quite adequate. A length of 2-inch (51 mm) O.D. schedule 40 or schedule 80 pipe is suitable for a tribander and a small VHF antenna. However, if you plan to stack HF antennas in Christmas-tree fashion to assemble an array of VHF antennas for EME, you may wish to analyze your system and consider other possibilities.

Following the previous examples given, find the wind area for each antenna, boom, and mast in your system. Use these wind areas and an appropriate wind velocity to determine the loading from each. Multiply these loads by the distance to the nearest supporting boom, mast, or tower to find the bending moments of these points. To analyze the flexural strength at these points, you'll need to have information about the structural member at each point.

You will also need the initial moment of inertia, I, of the cross section about the neutral axis. This can be obtained from:

$$I = \frac{\pi(d_1^4 - d_2^4)}{64} \; in.^4 \qquad (4)$$

(for a circular cross section)
where d_1 is the members O.D. in inches, and d_2 is the members I.D. in inches.

U.S. WIND LOADING ZONES

Recommended wind loading zones values of wind loading in pounds per square foot for tower designs as recommended by Electronic Industries Association (RS222C).

WIND LOADS FOR VARIOUS AREAS IN U. S.

Tower Height	ZONE A	ZONE B	ZONE C
Under 300 Ft.	30 Lbs/Sq. Ft.	40 Lbs/Sq. Ft.	50 Lbs/Sq. Ft.
301 Ft. to 650 Ft.	35 Lbs/Sq. Ft.	48 Lbs/Sq. Ft.	60 Lbs/Sq. Ft.
Over 650 Ft.	50 Lbs/Sq. Ft.	65 Lbs/Sq. Ft.	85 Lbs/Sq. Ft.
MAP CODE			

fig. 4. Chart details recommended wind loading on towers of various heights, per E.I.A. RS222C.

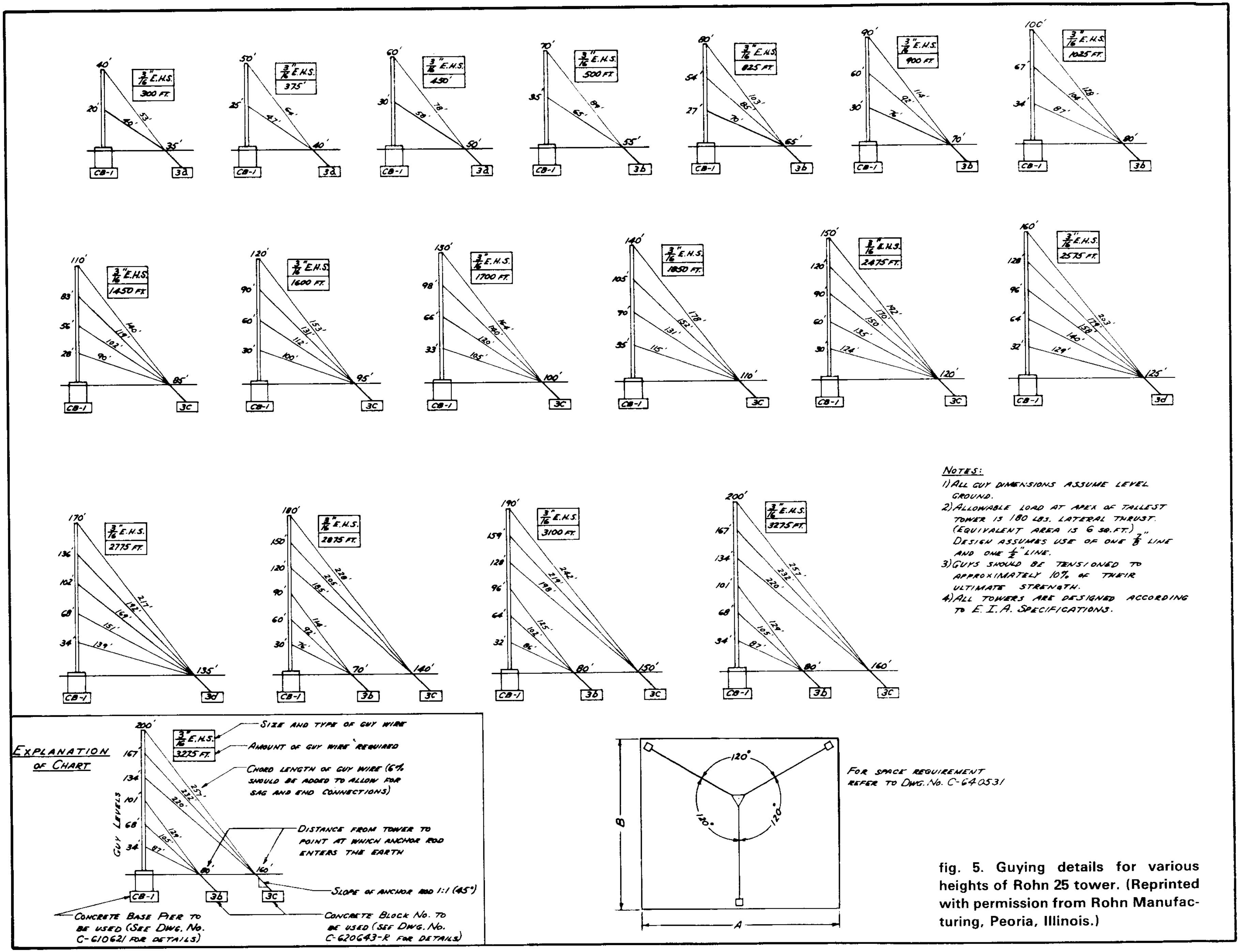


fig. 5. Guying details for various heights of Rohn 25 tower. (Reprinted with permission from Rohn Manufacturing, Peoria, Illinois.)

You will also need the initial distance from the neutral axis to the extreme fiber where failure occurs, c.

$$c = \frac{d_1}{2} \text{ inches} \tag{5}$$

The flexual strength can then be obtained by

$$f = \frac{12\ M\ c}{I} \text{ lbs./in.}^2 \text{ (psi)} \tag{6}$$

The constant 12 is necessary for the feet-to-inch conversion if the moment is expressed in foot pounds.

When the flexural strength exceeds the yield strength given for the particular member, the member will deform or break. The yield strength for tubular steel is typically 50,000 - 100,000 pounds per square inch. You will need to check with your local supplier to obtain this information.

Your masts and supporting booms should be strong enough to support your antenna system and be able to withstand the environmental conditions in your area. For example, if you live near salt water or in a highly industralized area, you should be especially vigilant about preventing and correcting corrosion.

Normally antenna and tower manufacturers are aware of these concerns and take steps to protect their product. Antennas are made from a corrosion-resistant alloy of aluminum, usually 6063-T6 or 6061-T6. Towers are normally hot-dip galvanized steel.

Masts purchased locally may not have any protection at all. If the mast has a very thick wall, this may not be a problem, but thin-walled steel or aluminum may be susceptible to corrosion if not protected.

summary

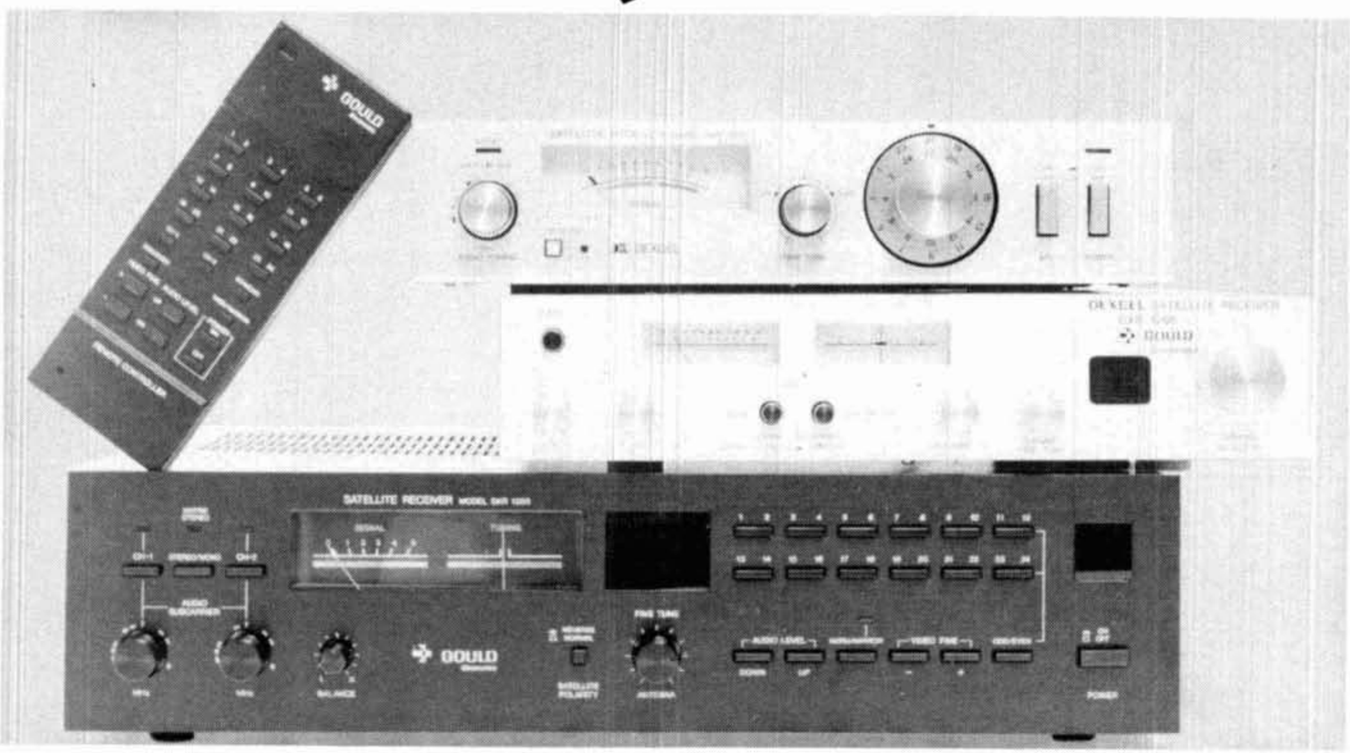
It may be unwise to follow the old saying, "If it doesn't come down, it isn't big enough." It's to your advantage to ensure the integrity of your antenna/tower system by matching the components so that your antenna system stays where it's supposed to stay. Know the limitations of your system's components and how each component interacts with the other and with the environment. It's up to the manufacturer to supply you with sufficient information to enable you to analyze your system, so that you can enjoy your hobby and not have to worry about your installation or your neighbor's roof.

references

1. Eugene Fuller, W2FZJ, "The Application of Stress Analysis to Antenna Systems," *ham radio*, October, 1971, page 23.
2. Telex/Hy-Gain Amateur Radio Catalog, 1983 edition, Telex Communications, Inc., 9600 Aldrich Avenue, South, Minneapolis, Minnesota 55426.
3. Unarco/Rohn Tower Catalog, 1976 edition, Rohn, P.O. Box 2000, Peoria, Illinois 61656.
4. EIA Standard: Structural Standards for Steel Antenna Towers and Antenna Supporting Structures, RS-222-C, Engineering Department, Electronic Industries Association, Washington, D.C., March, 1976.

ham radio

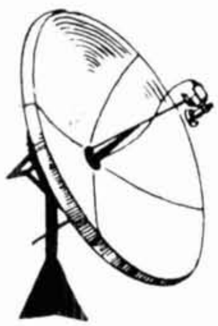
WHO ELSE HAS A ~~ONE~~ TWO YEAR WARRANTY?



DEXCEL

GOULD
Electronics

Master Distributor for DEXCEL in Florida and the Caribbean



Southeast Satellite

PIONEER MEMBER OF SPACE

DISTRIBUTORS, INC.

U.S. 1 North / Tall Pines Industrial Park
P.O.Box 3229 St. Augustine, Florida 32085

186

Call Toll Free (800) 824-3474 - In Florida (800) 824-3300

We Ship Worldwide

For Technical Assistance Call (904) 824-1915

TOWER INSTALLATION:

make it sturdy, make it safe

For beginner to expert — useful information for safe tower installation

It's no joke to wake up some morning after a bad storm, walk outside, and see all or part of your tower lying haphazardly on the ground. Even less amusing is the sight of your antenna lying in the yard next door. People can be hurt — even lose their lives — because a tower wasn't big enough for its job, or wasn't erected properly . . . or both. Careful consideration of several factors can help prevent disaster and enhance your peace of mind. These factors are the tower type and size, versus the load on top; the adequacy of the tower base; a proper guying system; safe guy anchors; and proper tower maintenance.

choosing the right tower

Your first and main concern is wind. It can do unbelievable things to a tower, and it's of prime importance that you have the greatest respect for that fact. A basic rule of thumb is that if there's the slightest doubt, make your tower *stronger* than the situation seems to merit. A little extra money spent on your tower may be the cheapest insurance you'll ever buy.

The force the wind exerts against your tower depends on the number of square feet of surface area presented to the wind by the tower and the antennas, masts, and rotors on top. The tower manufacturer provides a specification indicating the maximum load, in square feet of antennas and related equipment, that the tower can bear. This specification means, of course, that you don't have to add the square footage of the tower to the antenna load. In other words, it means that the tower is strong enough to handle the specified load as well as whatever square footage is presented by the tower itself.

In turn, the antenna manufacturer gives you the square footage presented to the wind by its antenna. What it all adds up to is that if the tower manufacturer says its tower will handle a 16-square foot load and the antenna specification is 12 square feet, you're on safe ground, even after adding the mast and rotator. If, however, antenna, mast, and rotator come to just 16 square feet, that might be a little too close for comfort.

Another important consideration when choosing the correct tower for maximum safety is where you live. The Electronic Industries Association has done quite a bit of research, assembling meteorological data, county by county, throughout the United States, specifying the maximum wind likely to be encountered in any given location.

The United States (as well as most other areas on earth) is divided into three zones: Zone A, with winds up to 87 MPH (140 km/hr); Zone B, with winds up to 100 MPH (161 km/hr); and Zone C, with winds up to 112 MPH (180 km/hr). If the tower has been manufactured to meet standards established by the Electronic Industries Association, the manufacturer will specify, along with the square footage of the antenna's wind load, in which zone that square footage will apply. Of course, this specification assumes that the tower owner has followed the tower manufacturer's rules for installation and has installed an appropriate base and guy system.

It's a good idea to question the supplier and/or manufacturer before making your final selection. If you choose the correct tower and install it according to the manufacturer's recommended procedure, any reputable manufacturer should stand behind its product. If you want to learn about tower selection, installation, and maintenance, contact either a dealer or a tower manufacturer and obtain a copy of a complete catalog. Rohn, for example, provides a catalog (for a modest charge) that contains a wealth of valuable information applicable not only to Rohn towers but to towers in general.*

the tower base

It's important to determine whether the base will be used for a guyed tower or a self-supporting tower — and there's a big difference. In the case of the guyed tower, the force of the wind against the tower is translated by the guys from a lateral force into a

By John M. Haerle, WB5IIR, Route 2, Box 348, Frisco, Texas 75034

downward compression. This places that force plus the dead weight of the tower *on the base*, with the initial tension of the guys also included in the total "weight" to be supported by the base.

The self-supporting tower poses a totally different problem, as far as the base requirement is concerned. Without guys to offer added support, the concrete base on which the tower stands must be much larger, just to keep the wind from uprooting the tower as it might uproot a tree and its entire root structure.

In the absence of guys, the wind force against the tower exerts downward pressure *on the legs* of the tower opposite the side from which the wind is blowing. Equally important is a strong upward lifting force on the legs nearest the source of the wind. *This means that the manner in which the tower is anchored into the base is very important*. A frequent cause of tower failure comes from trying to use a tower designed as a guyed tower as a self-supporting tower. Somehow, the reasoning seems to be that since Rohn 45G sections, for example, are quite strong, it should be OK to put up 40 or 50 feet without guys and mount a triband beam up there. But the base arrangement was simply not designed to bear this kind of load. Oh, I know, somebody out there is saying, "What's he talking about? That's exactly what I'm doing." My answer is, "I hope you're supporting only a 2-meter antenna, that you live in Zone A, and that the fates are kind!" I've seen people get away with — for a while — tower setups that would give a good mechanical engineer nightmares. Always review your tower plan with an experienced tower builder or mechanical engineer. It probably won't cost much — if anything at all, and may save a lot.

Follow the manufacturer's recommendations for your base. Use steel reinforcement bars ("rebar") to strengthen the base. Keeping the steel bars sealed inside the concrete will minimize rust problems. *It is extremely important to keep all ground rods outside and at least 4 inches from the base, bonding these rods directly to the steel tower itself*. If a ground rod goes through the concrete base, lightning can split the base in its search for a path to ground.

guy systems

Most guy systems consist of three guys at each of several levels, equally spaced around the tower and equal in length, with sets of guys spaced up the tower at intervals no greater than 30 feet (even closer if the tower is heavily loaded). For a three-guy system, the guys should ideally be anchored at a distance equal to 80 percent of the tower height. For a light load, such as a small tribander, this distance can be reduced, to say, 65 percent of the tower height. Where you cannot extend the guys this far, or where there is less available space on one side of the tower, you can reduce the distance from the tower to the anchor to as little as 40 percent of the tower height by using four guys at each level. However, as with three guys, their lengths and the spacing between them must be perfectly symmetrical.

Incorrect choice of guy wire is a frequent contributor to tower failure. Somehow the rumor has gotten around that aircraft control cable is suitable for use as guy wire. While it will rust, is harder to work with, and is about 25 percent weaker than real guy wire, you can get by with it . . . but do you really want to? The correct guy wire for most ham towers is 3/16 inch seven-strand EHS (extra high strength) wire. I recommend that you use nothing smaller than this. It will even handle some towers over 100 feet tall, depending on zone, and wind load. Follow the tower manufacturer's recommendation and you will find yourself using either 3/16 inch or for the really big ones, 1/4 inch EHS wire.

It's important, too, that these guys be tensioned properly. A good rule of thumb is to tension the wire to about 10 percent of its breaking strength. It should go without saying that the tension should be equal on all guys at a given level. The reason for using prestretched steel wire at the proper tension is that the tower must be prevented from twisting when the beam is buffeted by high winds. More towers are destroyed by twisting torque forces than in any other way; they just twist in the wind and collapse. For this reason, when you're using long-boom antennas or stacked monobanders, it's advisable to use special "guy assemblies" on the tower, providing stiff steel arms to improve the leverage the guys can exert in preventing the twist.

Be sure to use top-quality galvanized hardware for your guys. This is no place to save money, and the difference between the cheap kind and the rustproof kind is simply not worth the gamble. Use three clamps at each junction, and put the "U" of each clamp over the short, or so-called "dead-end" side of the cable. Use "thimbles" (those horseshoe-shaped pieces) which prevent the cable from kinking when it goes through the eye of a turnbuckle or a hole in a steel plate. Be sure to use the correct turnbuckle for the size of the guy you're using. Don't scrimp on turnbuckles; be sure they're rustproof and that the eyes are forged, not cast. Finally, when you've tightened up the turnbuckles, run a piece of guy wire through the body and both eyes of the turnbuckle in a "figure-eight" configuration to prevent the turnbuckle from working loose. If more than one guy terminates at such a point, use only one figure-eight wire, passing it through all the eyes and turnbuckle bodies.

Connecting the other ends of these guys to the tower is generally accomplished in either of two ways. When using the guy assemblies previously discussed, the guys are looped through the holes in the ends of

*UNR Rohn, Inc., Box 2000, Peoria, Illinois 61656.

the torque arms, using thimbles to prevent kinking; if there are no guy assemblies and the tower members are tubular (such as Rohn), take a single turn around the vertical member, where the cross-members intersect the vertical part. Be sure the loop also goes around the bends in the cross-members, encompassing both bends and the vertical part, compressing them instead of pulling them apart. After making the single turn around the tower in this fashion, fasten with three clamps as usual.

the anchors

Conventional anchoring for most Amateur towers employs the screw-type anchor. This is a 4-foot by 5/8-inch steel rod with a forged eye at one end and a 6-inch diameter auger on the other end. This is simply screwed into the ground at the same angle taken by the guy wire that will be attached to it. This makes a surprisingly strong anchor for some pretty sizable towers. For example, the 68-foot Rohn 45G fold-over tower uses this one. In any case, consult the manufacturer's recommendation. The other anchor normally used when the screw-type is not strong enough is the concrete anchor. This is a 5-foot by 5/8-inch steel rod, with a forged eye on one end and a crook on the other end, encased in concrete. When two or more guys terminate at the same anchor, equalizing plates are often used to divide the tension equally between the guys. Through-the-wall anchors and other types are available for those cases where restricted space does not provide room for conventional ground anchors. Again, the big Rohn catalog describes every conceivable kind of special hardware and includes detailed instructions on how to use such items.

tower maintenance

Most of this is just common sense and we really know pretty much what to do. But time flies and we never seem to get around to maintenance as often as we should. We should check our guys for equal and proper tension. When checking for equal tension, we should use a long carpenter's level, placing it against the vertical part of the tower to be sure that it is truly vertical, or "plumb." A perfectly vertical tower is not affected by the unusual stresses invariably present when a tower is off "plumb." All bolts and nuts should be checked for tightness and replaced if they are rusty. Anything that shows rust but cannot be replaced (such as the tower itself), should be treated. This can be done most effectively with a cold-galvanize spray, which will form a chemical bond with the good galvanizing around the rust spot and prevent further rust formation, making the spot virtually as good as new. There are several brands of this material; the one I have used with good success is made by LPS.*

*LPS® Cold Galvanize, Holt/Lloyd LPS, 4647 Hugh Howell Road, Tucker, Georgia 30084.

conclusion

Be very careful about hinging towers at the base and "walking" them up. This may appear to be the easiest way to erect 40 or 50 feet of tower, but more often than not, it is the most difficult and most dangerous. If you have plenty of people present — at least one of whom understands mechanical stresses — proceed carefully. If not, you may find it easier for just two people to put that tower up, one on the tower with a safety-belt and a "gin-pole," and the other on the ground to handle the pulley rope and pick up the tools the other drops.

In regard to the mast you put in the top of the tower to support your beam, be aware that if the height of the mast above the tower is, say, 10 feet, and the wind is blowing only 60 miles an hour against 8 square feet of antenna, there are some horrendous forces trying to convert that mast to rubble. *You'll be safest with a good steel mast.* A good aluminum-alloy mast may be lighter and just as strong right up to the instant that it crystalizes — something that doesn't happen to a tough steel mast.

High-quality close-woven nylon can do a good job when used for the right job — for instance, for supporting masts or the ends of dipoles. But for towers, it's a different story: twisting destroys towers so, very simply, nylon guys will stretch enough to let them twist; steel guys won't. Incidentally, when guying masts, use only close-woven nylon. The older it gets, the tougher it gets, but the hot sun will eventually disintegrate Dacron and other synthetics.

One more comment on anchors and bases: all that I've said so far has been predicated on the assumption that you'll be constructing your tower over normal soil. When the soil is swampy or sandy, consult an experienced tower builder or a civil engineer.

A couple of notes on climbing: *Spend the money for a good quality, approved safety belt.* It's cheap insurance. (A friend and former colleague lost his life using a home-made safety belt.) When climbing a tower, you come to the moment of truth every time you have to unhook the belt to move up around a set of guys. It may be a little more trouble but it's a good idea to equip your belt with *two* lanyards. You can then leave one fastened around the tower below the guys until you've fastened the other one above the guys . . . after which you can unfasten the lower one and move up with complete safety. If you're squeamish about climbing towers, this system will provide both safety and reassurance.

An excellent source of information on this subject is "Structural Standards for Steel Antenna Towers and Antenna Supporting Structures," *EIA Standard RS-222-C*, March, 1976, available from EIA, 2001 Eye Street, N.W., Washington, D. C. 20006, at $7.40.

ham radio

AEA Brings You The RTTY Breakthrough

NEW MBATEXT™ $109.95 List / $89.95* VIC-20 MBATEXT or C-64 MBATEXT

MBATEXT™ is the most advanced MBA (Morse, Baudot, ASCII) software plug-in cartridge available for the VIC-20 or Commodore 64 computer. Compare our outstanding features and price to the competition.

• KEYBOARD OVERLAY instructions to avoid constant referral to the manual • RTTY and ASCII SPEED ESTIMATE MODE • BREAK-IN CW MODE •QSO BUFFER RECORD TOGGLE •WORD PROCESSOR style insertion, deletion, and correction in TEXT EDIT MODE • CW AUTO SPEED TRACKING plus SPEED LOCK • BREAK-IN BUFFER that is easy to use • Low speed FARNSWORTH CW TRANSMISSION (between 5 and 14 WPM) • RE-TRANSMIT RECEIVED TEXT DIRECTLY without need of disk or cassette • DISK, CASSETTE, OR PRINTER storage of message and QSO buffers • RECEIVE AND TRANSMIT 5-99 WPM MORSE • 10 SOFT-PARTITIONED™ MESSAGE (OR TEST) BUFFERS • WORD WRAP • TIME OF DAY CLOCK • PRECOMPOSE SPLIT SCREEN OPERATION • STATUS INDICATORS on screen • EASY START-UP by simply typing SYS 44444 or SYS 33333 • DEDICATED FUNCTION KEYS for quick operation • Ability to IMBED CONTROL FUNCTIONS in type-ahead buffer • WORD OR CHARACTER mode • SELECTABLE BAUDOT UNSHIFT ON SPACE (USOS) •SEND/RECEIVE 60, 67, 75, 100, 132 WPM BAUDOT PLUS 100, 300 BAUD ASCII • RTTY BLANK-FILL and MORSE BT option for idle transmit periods • AUTOMATIC PTT • *computer control* of TONE REVERSE • MASTER MENU, COMMAND MENU, and OPTIONS MENU makes MBATEXT™ easy to use with no prior experience • INCLUDES CABLE TO INTERFACE WITH AEA model CP-1 COMPUTER PATCH™ • POWERED BY HOST COMPUTER.

NEW MICROPATCH™

MICROPATCH™ IS A NEW LOW-COST, HIGH-PERFORMANCE Morse, Baudot and ASCII SOFTWARE/HARDWARE computer interface package. The MICROPATCH™ model MP-20 or MP-64 incorporates the complete MBATEXT software ROM (described above) for either the VIC-20 or Commodore 64 computers. All circuitry and software is incorporated on a single, plug-in cartridge module featuring the following: • TRUE DUAL CHANNEL MARK AND SPACE MULTI-STAGE 4 POLE, CHEBYSHEV ACTIVE FILTERS • AUTOMATIC THRESHOLD CORRECTION for good copy when one tone is obliterated by QRM or SELECTIVE FADING • EASY, POSITIVE TUNING with TRIPLE LED INDICATOR • NOT a low-cost, low-performance phase-locked loop detector!!! • SWITCH SELECTED 170 Hz or WIDE SHIFT on receive • 800 Hz multi-stage active CW FILTER • AUTOMATIC PTT • RTTY ANTI-SPACE • demodulator circuitry powered by external 12VDC (not supplied) to AVOID OVERLOADING HOST COMPUTER and for maximum EMI ISOLATION • EXAR 2206 SINE GENERATOR for AFSK output • SHIELDED TRANSCEIVER AFSK/PTT INTERFACE CABLE PROVIDED • PLUS or MINUS CW KEYED OUTPUT • FSK keyed output.

The Micropatch is structured for easy upgrading to the AEA Computer Patch™ advanced interface unit without having to buy a different software package! Simply unplug the external computer interface cable (supplied with the Micropatch) from the Micropatch and plug it into the Computer Patch.

$149.95 List $129.95*
MP-20 or MP-64

COMPUTER PATCH™

COMPUTER PATCH™ is the name of our most advanced computer interface equipment for Morse, Baudot, ASCII, or AMTOR operation. The CP-1 will allow you to patch most of the popular personal computers to your transceiver when used with the appropriate AEASOFT™ TU software such as AEA MBATEXT, AMTOR TEXT™, or the MBATEXT RESIDENT ON THE MICROPATCH units. AEA also offers a full feature software package for the Apple II, II plus and IIE; TRS-80 Models I, III and IV; and the IBM-PC. The CP-1 will also work with certain other computers using commonly available software packages.

The CP-1 offers the following advanced and high quality features: • HANDSOME ALL METAL ENCLOSURE FOR MAXIMUM RF IMMUNITY • DUAL CHANNEL, MULTI-STAGE ACTIVE MARK AND SPACE FILTERS • AUTOMATIC THRESHOLD CORRECTION • RECEIVE 170 HZ FIXED OR 100-1000 HZ VARIABLE SHIFT • 800 HZ multi-stage CW FILTER • PRE—LIMITER AND POST-LIMITER FILTERS • SERIAL RS-232 FIELD INSTALLABLE OPTION • 117 VAC WALL ADAPTOR SUPPLIED • PLUS (+) and MINUS (-) CW OUTPUT JACKS • MAGIC EYE STYLE BAR GRAPH TUNING INDICATOR • SCOPE OUTPUT JACKS • NORMAL/REVERSE front panel switch • MANUAL (*override*) PTT switch • VARIABLE THRESHOLD for CW • ANTI-SPACE RTTY • KEY INPUT JACK for narrow shift CW ID on RTTY, CW practice, or keyboard bypass.

The CP-1 is made in the U.S. with high quality components including double-sided glass epoxy through-hole plated boards, complete with solder mask and silk screened parts designators.

$239.95 List $199.95* CP-1

PACKAGE SPECIALS
$239.95*

Combine the VIC-20 or COMM-64 MBATEXT™ software with the CP-1 at time of purchase and you receive a SPECIAL PACKAGE PRICE. NOW the best RTTY COMPUTER INTERFACE SYSTEM is available at prices comparable only to vastly inferior systems.

CP-1/20 (CP-1 with VIC 20 MBATEXT) CP-1/64 (CP-1 with C-64 MBATEXT)

*SUGGESTED AMATEUR DISCOUNT PRICE THROUGH PARTICIPATING DEALERS ONLY

For orders and quotes CALL TOLL FREE 800-336-4799
In Virginia CALL TOLL FREE 800-572-4201
For information: (703) 643-1063

Store hours: MWF: Noon-8 PM; TThS: 10 AM-4 PM
Order hours: M-F 11 AM-7 PM; Sat 10 AM-4 PM

Send 3 stamps for a flyer. **Dealer inquiries invited.**

ege, inc.
13646 Jefferson Davis Hwy.
Woodbridge, Virginia 22191

✓ 133

keep your tower *UP*

Regular maintenance means lasting success

Those of us fortunate enough to have towers with moderate to complex antenna systems sometimes take them for granted. Even though we've invested substantial amounts of time and money in planning and erecting our systems, once they're up we tend to head for the ham shack and forget that they're there. Only the rotator control and the S-meter remind us that there's something out there, after all.

That's why I've designated a specific time of year — well before winter sets in — for a thorough annual inspection of every inch of metal in my system.

Good planning keeps the number of trips up the tower to a minimum, and the work pleasurable.

Choose a comfortable time of year; windy, hot or cold days will only discourage you from staying on the tower any length of time. I usually do my inspection in the fall, when temperatures are moderate and it's a joy to be up there. There's a built-in benefit for your system, too, in choosing fall as the time for your annual inspection. After a summer of heat and ultraviolet stress — and battering by the winds of thunderstorms and perhaps even hurricanes, the stiffening temperatures of winter can bring tape and cables to their natural end. Those who live in areas where seasonal changes are less severe may opt for a different time.

inspect the antenna

Gather the appropriate tools (pliers, wrenches, tape, sealant, etc.) and an approved (not home-made) safety belt. Climb up once, check and correct any deficiencies on the way *down*, and celebrate your good planning.

Most of your time will be spent right at the top, where you'll first make a visual inspection of the antennas. Although most of the hardware will be beyond your reach, a look at the general condition will reveal a great deal. Loose or missing hardware is a sure sign of trouble. Sometimes scratches and the general pattern of weathering will indicate any elements turned from original position. After your visual inspection is complete, *shake* the whole assembly; you'll hear or see anything that's come loose.

The first part of the beams to deteriorate is often the support cable for the boom. Check that thoroughly, because without it the wind tolerance of your beam may be far less than you think. All broken or missing parts should be replaced, even if that calls for a major antenna party. Electrical connections should also be checked thoroughly, since an increase in the resistance at the feedpoint can mean needless loss of power. I routinely spray all connections with clear acrylic sealer. Available in the spray paint section of most hardware stores, this product will prevent corrosion on the connections. A saturating coat sprayed over all connections once every two or three years is easy to apply and seals all cracks, yet allows disassembly when necessary.

don't forget the feedline

While at the top of the tower, remember to check the attachment of the feedline to the antenna and mast. This provides strain relief for the antenna connection. Tight taping is normally used here, but even the stresses of normal turning can loosen these support points. Although most of us use electrical tape for this, fiberglass reinforced strapping tape will serve

By Steve Makulec, KB9IW, 8041 Hilltop Court East, Winnebago, Illinois 61088

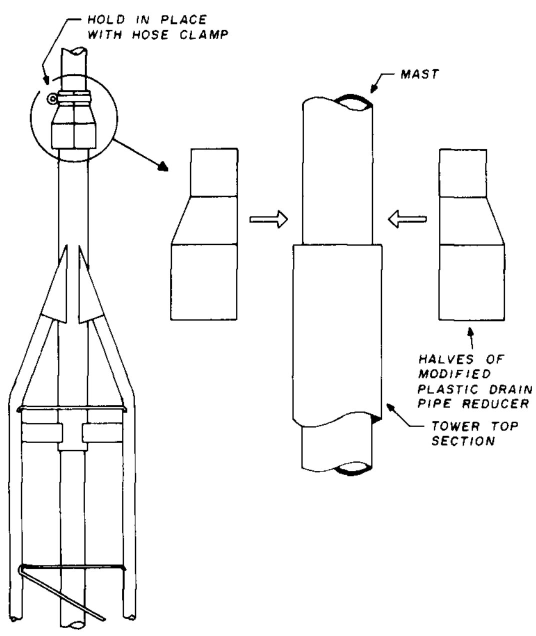


fig. 1. Illustration of split drain pipe reducer as drip-cap for tower top.

well at high-stress points such as this. If loose, retaping is in order; pay particular attention to the loop of feedline necessary to allow rotation of the antenna. Multiple feedlines can be taped together to support each other, but a larger loop should be allowed to accommodate the additional stiffness. (If you put the antenna at the center of its rotation *before* climbing the tower, it will be easier to visualize where this rotation loop must be located, and any necessary repair will thus be easier to spot and simpler to do.)

grease fittings: good idea

A step down the tower's top section will allow inspection of the mast bearing. Check and replenish the lubrication of this bearing if necessary. Most of us use a top section that has no true bearing, utilizing a top pipe section to guide the mast instead; these sections are particularly difficult to lubricate, since the pipe length may be as long as 30 inches. The mast in most installations like this fits loosely, with approximately 0.1 inch (2.5 mm) diametrical clearance. Using a hand grease gun to inject grease through the various holes already in the tower pipe makes this chore easier, and a homemade rubber washer will serve as a seal when pressed over the hole with the grease gun while lubricating.

To simplify lubrication of the entire length of the pipe, I installed automotive grease fittings in a few places along the tower pipe. If you do this, take care to choose fittings that are flat on their bottoms, and install them so they don't protrude into the inside of the tower pipe, because this would cause a wear point on the mast. One alternative is to leave the fittings in only during the lubrication process and then cover the holes with tape. I admit that while installation of the fittings is a cinch on a new tower still on the ground, it could be quite a challenge on an existing tower.

Water and dirt must be kept out of the bearing area. If they're not, your antenna may freeze in place during the winter. You can easily install a drip cap to prevent this, using readily available hardware.

My mast pipe, like most, is a standard pipe size. For the typical installation, 1.5 inch (38.1 mm) pipe which is 1.9 inch (48.3 mm) OD fits through a 2 inch (50.8 mm) ID tower tube, which is in turn about 2.25 inches (57.2 mm) OD. Since the mast pipe is a standard pipe size, a 1.5 inch (38.1 mm) to 2 inch (50.8 mm) reducer for plastic drainpipe makes an excellent drip cap (see **fig. 1**). Just cut it in half with a hacksaw, file out the internal chamfered stop, and fit the two halves snugly over the mast pipe. Use an automotive hose clamp to hold it in place over the top of the tower pipe; water and dirt will be excluded, and the mast will rotate freely for a longer length of time than it might without protection (see **fig. 1**). For other standard mast pipe sizes, different size reducers are required; there should be no problem as long as the water pipe used for the mast and the plastic drain pipe follow the same size conventions.

on the way down

On your way down, check all cables for proper support, replacing tape as necessary. Look for any rust; it's a sure sign that galvanizing in that spot on the tower has been scraped off. Remove the rust with a light sanding and seal with acrylic sealer or aluminum paint.

Check bolts and nuts for tightness, both at the tower section joints and on any other hardware. Guy wire attachment points are particularly important. Treat all bolts to prevent their nuts from rotating off should loosening occur; this can be done by striking a center punch against the bolt thread protruding beyond the nut. By slightly upsetting the thread, you'll prevent the nut from vibrating off, but don't be so aggressive that you destroy both the thread and your chances of disassembly later on.

on the ground

Back on ground level, check the cable entry into the house to make sure it is still properly sealed. Check the connections to the tower ground system, too, both for tightness and for any signs of corrosion that would cause poor contact. If the grounding wires have become kinked for any reason, straighten them as needed for optimum protection against lightning.

Now take a walk around the yard. Are all guy wires and turnbuckles secure, all nuts and bolts tight? Here in particular, upsetting the threads of the bolts as described above is appropriate, since they generally can't be tightened completely and still allow equalizer plate motion. Note the condition and tension of the guy wires: any signs of rust or wear in the wire calls for immediate replacement. In checking tension, remember that it will change from season to season with rising and falling temperatures, which is why I check mine in the fall when temperatures are moderate. This factor is important enough for tower manufacturers to recommend different guy wire tension for different temperatures at the time of installation. Lacking the equipment needed to measure tension, a rule of thumb is to tighten the turnbuckles as much as you can with your bare hands. This will normally leave some sag in the wires, especially if insulators are installed, but don't worry. The last bit of sag requires a great deal of tension to remove and puts undue stress on the wires and the tower. Remember that the wires are pulling not only *out* but also *down*, and all that force has to be supported by the tower.

Finally, if you haven't installed safety loops and checked them, install one now at each guy anchor. A safety loop may be as simple as a short loop of guy wire threaded through the guy wire ends and the anchor rod loop, with the ends held together with normal wire clamps. The loop serves to catch the guy wires and save the tower if a turnbuckle should break. The loop may also be threaded through the turnbuckles in figure-eight fashion to keep the turnbuckles from loosening.

ham radio

Cards and plaque courtesy W6TC

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 94270
Telephone: 415•592-1221

varian

✓ 197

ICOM IC-745

160-10 MTR 100W XCVR / 0.1-30MHz RCVR

The IC-745 represents a major breakthrough in the ham industry...a full featured HF base station transceiver with a combination of standard features found on no other transceiver in its price range.

Compare these exceptional standard features:

- **100KHz - 30MHz Receiver**
- **16 Memories**
- **100% Transmit Duty Cycle Transmitter with exceptionally low distortion**
- **IF Shift AND Passband Tuning**
- **Receiver Preamp**
- **10Hz/50Hz/1KHz Tuning Rates with 1MHz band steps**
- **Adjustable Noise Blanker (width and level)**
- **Continuously Adjustable AGC with an OFF position**
- **Full function Metering with a built-in SWR Bridge**
- **Optional Internal AC Power Supply**

IC-PS30 System Power Supply

IC-SM6 Base Mic

Other Standard Features.
Included as standard are many of the features most asked for by experienced ham radio operators: dual VFO's, RF speech compressor, tunable notch filter, all-mode squelch, program band scan, memory scan (frequency and modes are stored), receiver and transmitter incremental tuning and VOX.

ICOM's proven transceiver designs and technology are used in the IC-745 all ham band transceiver which includes SSB, CW, RTTY, AM receive and an optional FM **plus** a 100KHz to 30MHz general coverage receiver.

ICOM System.
The IC-745 is compatible with ICOM's full line of standard HF accessories.

Accessories available include the IC-PS15 base supply, IC-PS30 system power supply (switching), IC-PS35 internal power supply, the IC-2KL linear amplifier, AT100 automatic antenna tuner, AT500 automatic antenna tuner, HP1 headphones, and HM12 hand or SM6 base microphone.

Options. The EX241 marker and EX242 FM module, plus a wide variety of filters for sharp audio reception are available.

Filter	-6dB Width	Center Freq. MHz
FL45	500 Hz	9.000
FL53A	270 Hz	9.000
FL44A	2.1 KHz	0.455
FL52A	500 Hz	0.455
FL54	250 Hz	0.455

The IC-745 is the only transceiver today that has such features standard...the number of options and accessories available...and such an affordable price.

IC-745 Shown with IC-PS35 Internal Power Supply.

ICOM

The World System

147

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

All stated specifications are approximate and subject to change without notice or obligation. All ICOM radios significantly exceed FCC regulations limiting spurious emissions.

applied Yagi antenna design
part 2:
220 MHz and the Greenblum design data

220 MHz Yagis with different tapers provide best gain and F/B figures

This article addresses antenna design for the 220 MHz VHF band. In comparison to 144 MHz, this band offers similar propagation conditions, with a reduction in antenna size of approximately 35 percent. Hence, for the same physical boom length, more gain and a sharper pattern can be realized. The antennas described for 220 MHz differ from those analyzed for 144 MHz[1] for another reason as well: the Greenblum antenna design data, rather than the Kmosko-Johnson data used in last month's article, is used for the 220 MHz Yagis.

If widespread and long term publishing and republishing are reliable indicators of popularity, then Greenblum's set of charts and curves must be one of the best known design tools in all of Amateur Radio. This formerly Telrex-proprietary data was first published in 1956 as a two-part series.[2,3] One of the first non-Telrex VHF applications was Tilton's six-element 50 MHz Yagi.[4] Applications for other VHF and UHF bands followed.[5] A recent computer-optimized 144 MHz moonbounce antenna developed by Joe Reisert, W1JR, was also based on Greenblum's data.[6]

Yet, as is the case for the 220 MHz band to which this article is addressed, Greenblum's design data remains somewhat of an enigma. Neither Greenblum nor those who republished his charts and tables ever specified a reflector length. Reflector spacing is given, as are director lengths and spacings, but no reflector lengths are provided. As part of the preliminary work in preparing this article, Greenblum antennas using mid-range element spacing values were modeled. With a 100:1 wavelength-to-diameter ratio, maximum gain with six elements occurred with a reflector length of 0.49 wavelengths. The overall pattern was, however, of little use. Reflector lengths dropped as element numbers were reduced, until a reflector of 0.479 wavelengths was reached for the two-element beam. As these antennas would be of little use at 220 MHz, their modeling was not pursued any further.

technical background

As was the case with Lawson,[7] Greenblum's design calculations were derived from Uda and Mushiake.[8] Greenblum's reactance charts and his formula are referenced to the very same pages in Uda and Mushiake's work as those to which Lawson referred. In 1978, Powers[9] reconfirmed the basic Greenblum data by using element spacings from the middle of the specified ranges for all parasitics. Gain and F/B figures similar to those originally stated by Greenblum were said to have been obtained.

Tilton's previously cited work produced a different set of element lengths and spacings. He found that the more or less traditional tapering schemes in use for VHF/UHF antennas resulted in an increase in forward gain. Element spacings used were towards the lower end of the specified range. When the Tilton/Greenblum designs are compared against Viezbicke's findings,[10] very favorable boom-to-gain ratio comparisons are realized. One further measure of the value of Tilton's modifications was the use of his 50 MHz design by a well known commercial antenna manufac-

By Stanley Jaffin, WB3BGU, 800 Stonington Road, Silver Spring, Maryland 20902

table 1. Reference Tilton/Greenblum 220.5 MHz antenna with specified element spacings and parasitic element lengths to be supplied with each computer iteration.

	element	length (inches)	cumulative spacing (inches)	cumulative spacing (λ)
1	Reflector	—	0.0	0.0
2	driven element	25.686378	7.5	0.14011
3	director 1	—	15.0	0.28022
4	director 2	—	24.0	0.44836
5	director 3	—	36.5	0.68188
6	director 4	—	50.5	0.94343
7	director 5	—	65.0	1.21431
8	director 6	—	83.0	1.55058
9	director 7	—	101.0	1.88685
10	director 8	—	119.0	2.22312
11	director 9	—	137.0	2.55939
12	director 10	—	155.0	2.89566
13	director 11	—	173.0	3.23193

turer. In view of Tilton's reputation and the widespread availability of his lifelong work in VHF/UHF antenna applications, a Tilton/Greenblum design will serve as the basis for computer iteration of a 220 MHz Yagi antenna.

the Tilton/Greenblum design

As a result of his previously cited work with the Greenblum data, Tilton published documentation on two 220 MHz antennas. An eleven-element Yagi appeared in the 1968 *Radio Amateur's Handbook*,[11] and a seven-element Yagi appeared in *The Radio Amateur's VHF Manual*.[12] The longer design is a scaling and reoptimization of a 432 MHz antenna of eleven elements. Based on the nature of the Greenblum data, these would appear to be two very different 220 MHz antennas.

For purposes of computer iteration, the eleven-element antenna is extended to thirteen elements by adding two more directors. **Table 1** shows the reference design upon which this article is based. Since it is predicated on the Greenblum design data, the tapering scheme continues through the additional directors, and their spacing is identical to the spacing of the ninth director.

The design frequency is 220.5 MHz, which allows optimizing the design to cover the weak signal area of the 220 MHz band. Yagis at this frequency are more inherently broadbanded than at 144 MHz. With few exceptions, the designs optimized at 220.5 MHz will work equally well over the first few megahertz of the entire band. There are strong indications that Tilton's eleven-element design was optimized close to this design frequency, and that the seven-element Yagi was optimized at 221.5 MHz.

table 2. Optimized gain iteration for a 0.000 taper with a 26.375-inch reflector.

director 1 (inches)	gain (dBi)	F/B(dB)
22.000	14.081	22.951
22.125	14.238	23.961
22.250	14.396	24.725
22.375	14.555	24.863
22.500	14.712	24.122
22.625	14.863	22.680
22.750	15.005	20.929
22.875	15.131	19.149
23.000	15.234	17.465
23.125	15.305	15.923
23.250	15.332	14.537
23.375	15.304	13.317
23.500	15.212	12.281
23.625	15.051	11.460
23.750	14.821	10.909
23.875	14.527	10.729
24.000	14.162	11.100

table 3. Optimized F/B iteration for a 0.000 taper with a 26.875-inch reflector.

director 1 (inches)	gain (dBi)	F/B(dB)
21.750	13.618	29.037
21.875	13.776	29.793
22.000	13.937	29.739
22.125	14.099	28.388
22.250	14.262	26.588
22.375	14.424	24.622
22.500	14.582	22.817
22.625	14.733	21.115
22.750	14.872	19.563
22.875	14.994	18.153
23.000	15.092	16.874
23.125	15.158	15.721
23.250	15.184	14.696
23.375	15.163	13.805
23.500	15.093	13.064
23.625	14.971	12.498
23.750	14.801	12.135
23.875	14.578	12.001
24.000	14.271	12.060

table 4. Frequency response parameters for the zero taper gain optimized antenna.

frequency	gain (dBi)	F/B (dB)
216.5	14.737	16.075
217.5	15.007	16.472
218.5	15.194	16.169
219.5	15.301	15.425
220.5	15.332	14.537
221.5	15.295	13.695
222.5	15.201	13.003
223.5	15.065	12.515
224.5	14.903	12.266

Tilton included matching techniques with the designs for both of his antennas. The iterated thirteen-element antenna can easily use the same matching hardware as the eleven-element antenna because the two additional directors are not going to change the antenna's input impedance by very much. And because Tilton used wooden booms for his antennas, *element length conversion calculations are not* necessary for the reference antenna. The element diameter remains at 0.125 inches. As 0.0625 inches represents the closest tolerance to which most Amateurs can cut antenna elements, tapering schemes will be expressed in multiples of 0.0625 inches. In terms of the parasitic element iteration lengths, multiples of 0.125 inches are used. No real differences were found at 220 MHz by using a finer increment.

table 5. Frequency response parameters for the zero taper F/B optimized antenna.

frequency	gain (dBi)	F/B (dB)
216.5	13.436	19.360
217.5	13.533	21.773
218.5	13.620	24.604
219.5	13.700	27.743
220.5	13.776	29.793
221.5	13.852	28.567
222.5	13.928	25.867
223.5	14.004	23.402
224.5	14.079	21.381

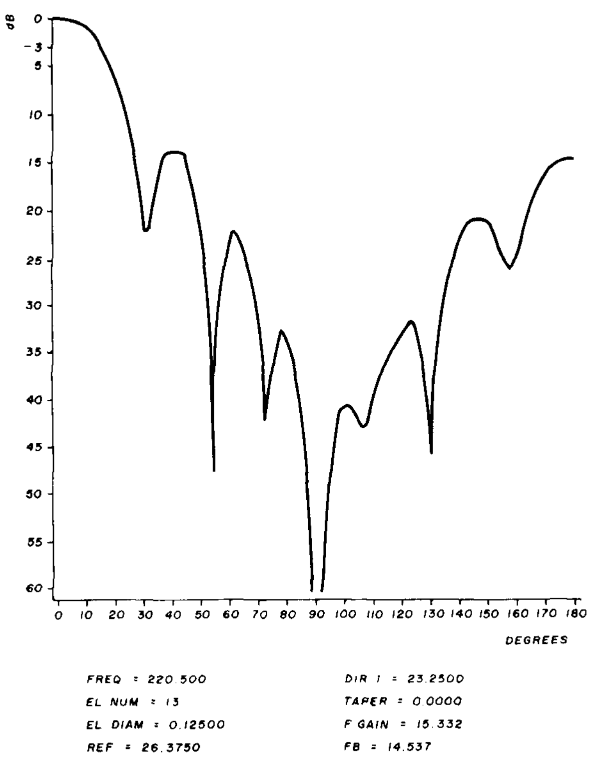


fig. 1. Gain optimized antenna with a zero taper.

computer-designed Tilton/Greenblum antennas

Tilton presented one long Greenblum antenna for 220 MHz. This antenna had a taper of 0.125 inches. For purposes of exploring this design via computer *iteration, five antennas are presented.* In increments of 0.0625 inches, their tapers vary from zero to 0.25 inches. Each antenna is presented with tables showing optimized gain and F/B iterations, calculated performance across an 8-MHz bandwidth (216.5 MHz -

table 6. Optimized gain iteration for a taper of 0.0625 with a 26.375 inch reflector.

director 1 (inches)	gain (dBi)	F/B (dB)
22.000	13.745	20.212
22.125	13.894	20.984
22.250	14.046	21.837
22.375	14.201	22.748
22.500	14.358	23.639
22.625	14.515	24.341
22.750	14.671	24.582
22.875	14.824	24.141
23.000	14.971	23.063
23.125	15.108	21.617
23.250	15.230	20.063
23.375	15.331	18.553
23.500	15.402	17.161
23.625	15.437	15.924
23.750	15.427	14.868
23.875	15.366	14.025
24.000	15.250	13.446

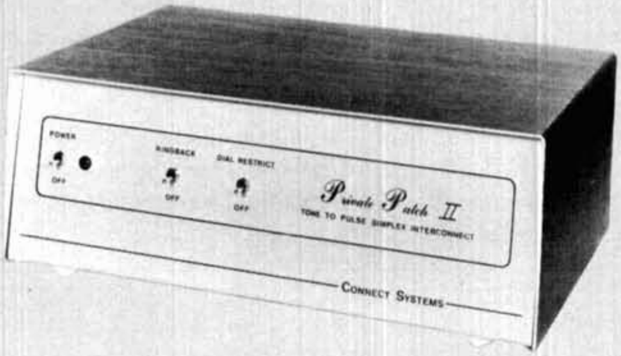
table 7. Optimized F/B iteration for a taper of 0.0625 with a 26.875 inch reflector.

director 1 (inches)	gain (dBi)	F/B (dB)
22.000	13.597	27.636
22.150	13.753	28.716
22.250	13.912	29.485
22.375	14.073	29.543
22.500	14.235	28.702
22.625	14.397	27.227
22.750	14.558	25.514
22.875	14.714	23.809
23.000	14.862	22.211
23.125	15.000	20.753
23.250	15.121	19.437
23.375	15.221	18.266
23.500	15.294	17.241
23.625	15.334	16.372
23.750	15.337	15.679
23.875	15.301	15.194
24.000	15.224	14.969

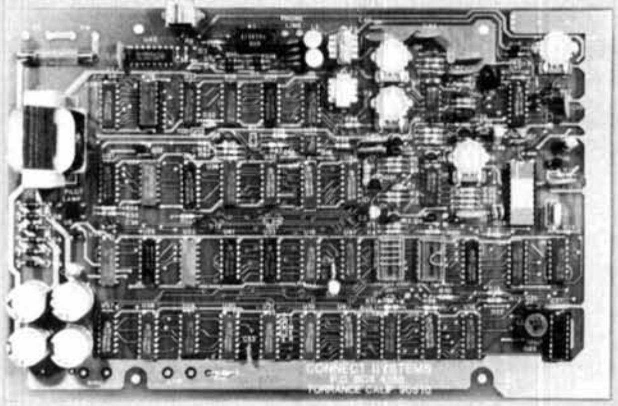
PRIVATE PATCH II

THE ULTIMATE SIMPLEX AUTOPATCH

PRIVATE PATCH II is for the discriminating amateur who demands the finest in simplex autopatch performance, features and quality. Our digitally processed VOX and simplex loop create a level of communications quality which is not even closely rivaled. *Please* . . . do not confuse our technique with sampling!! **PRIVATE PATCH II** has the following major advantages over sampling type autopatches:



- Compatible with every known transceiver—yes, synthesized and relay switched types included.
- No transceiver modifications are ever required!
- Connects only to MIC and external speaker jack—no internal connections to your transceiver required.
- Natural push to talk operation—no need to pause—you may talk the instant the button is pressed.
- No annoying repetitive squelch tails
- No potential for repetitive information loss
- In addition to superb simplex operation, **Private Patch II** will operate through *any* repeater from your base location. Yes, *any* repeater! Tone encoding equipment and repeater modifications are not required.



STANDARD FEATURES

- CW identification—ID ROM chip included.
- Single chip XTAL controlled tone decoder.
- Tone to pulse—compatibility with all telephone systems—eliminates critical tone adjustments in the mobile—no wrong numbers, ever! Can be strapped for straight tone dialing.
- Speed dialer compatible—can consume up to 15 digits per second.
- Sophisticated toll restrict logic—user programmable restrict digits.
- Five digit access code—59,049 user programmable code combinations! (Their three digit code beginning with * has less than 196 combinations.)
- Ringback (reverse patch)—alerts you with CW ID.
- Busy channel ringback inhibit—will not send CW ID alert if channel is in use — defeatable.
- Three/six minute "time-out" timer—resettable from the mobile—four CW ID warnings during final minute.
- Control interrupt timer—assures reliable and positive control.
- Self contained 115VAC supply—230V 50/60 Hz available at slight additional cost.
- Modular phone jack—and seven foot cord.
- 14 day return privilege—when ordered factory direct.
- One year factory warranty.

OPTION: FCC registered coupler.
Inquire about commercial and half duplex models.

VISA MasterCard

OUR QUALITY GLASS BOARD, SUPERB ENGINEERING AND EXCELLENT COMPONENTS BLEND TOGETHER TO PRODUCE THE FINEST AMATEUR AUTOPATCH AVAILABLE.

CONTACT A LOCAL DEALER TODAY

AMATEUR ELECTRONIC SUPPLY
Milwaukee WI, Wickliffe OH, Orlando FL, Clearwater FL, Las Vegas NV,

COLES COMMUNICATIONS
San Antonio TX

ERICKSON COMMUNICATIONS
Chicago IL

HAM RADIO OUTLET
Anaheim CA, Burlingame CA, Oakland CA, San Diego CA, Van Nuys CA

HENRY RADIO
Los Angeles CA, Anaheim CA, Butler MO

JUNS ELECTRONICS
Culver City CA, Reno NV

N&G DISTRIBUTING CORP.
Miami FL

PACE ENGINEERING
Tucson AZ

PIZA ELECTRONICS
Ponce, PR

THE HAM SHACK
Evansville IN

CANADA:
DOLLARD ELECTRONICS
Vancouver, BC

PHILIPPINES:
CORONA INTERNATIONAL
Cubao, Quezon City

CSI **CONNECT SYSTEMS INCORPORATED**

23731 MADISON ST. TORRANCE, CA 90505
PHONE (213) 373-6803

table 8. Frequency response parameters for the 0.0625 taper gain optimized antenna.

frequency	gain (dBi)	F/B (dB)
216.5	14.748	16.050
217.5	15.096	16.967
218.5	15.280	16.992
219.5	15.391	16.552
220.5	15.437	15.924
221.5	15.426	15.328
222.5	15.372	14.904
223.5	15.287	14.750
224.5	15.180	14.954

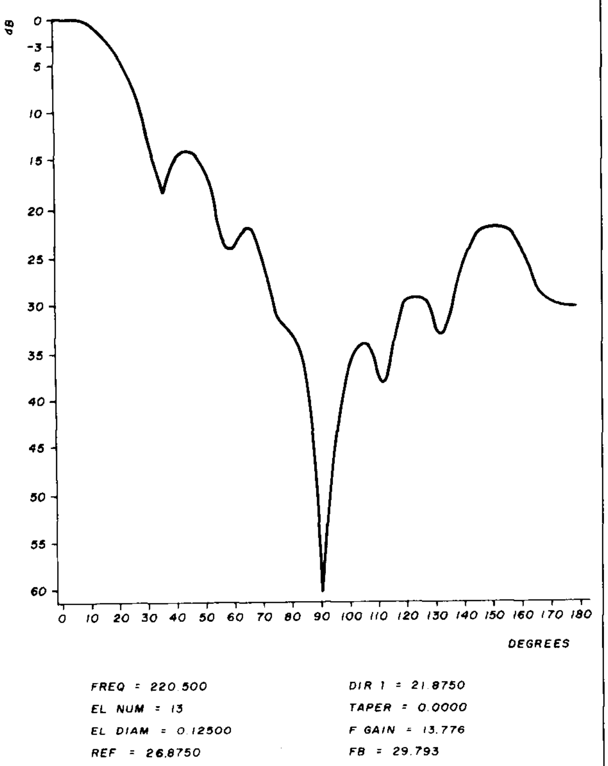


fig. 2. F/B optimized antenna with a zero taper.

224.5 MHz) for each optimized antenna, and cartesian plots of each antenna.

taper = 0.000

Table 2 presents the gain optimizing iteration that resulted in 15.332 dBi of gain, and **table 3** presents the F/B optimizing iteration and its calculated result of 29.793 dB of F/B. Differences of over 1.4 dB in gain and 15 dB in F/B ratio exist between these antennas. **Tables 4** and **5** present these antennas' respective calculated performance over the specified bandwidth. Both antennas show marked peaks at 220.5 MHz in their respectively optimized parameters. **Figs. 1** and **2** present these antennas' respective E-plane plots. The differences in main lobe width and depth are readily apparent, as is the difference in signal attenuation from 160 to 180 degrees. It is interesting to note the obvious differences between optimized antennas with a zero taper when both antennas are based on a design approach that requires a measureable taper.

table 9. Frequency response parameters for the 0.0625 taper F/B optimized antenna.

frequency	gain (dBi)	F/B (dB)
216.5	13.694	20.134
217.5	13.802	22.671
218.5	13.898	25.607
219.5	13.988	28.547
220.5	14.073	29.543
221.5	14.156	27.645
222.5	14.238	25.084
223.5	14.318	22.869
224.5	14.396	21.061

table 10. Optimized gain iteration for a taper of 0.125 with a 26.875 inch reflector.

director 1 (inches)	gain (dBi)	F/B (dB)
22.000	13.286	24.765
22.125	13.434	25.662
22.250	13.586	26.654
22.375	13.740	27.707
22.500	13.898	28.715
22.625	14.057	29.450
22.750	13.325	18.066
22.875	14.380	28.934
23.000	14.540	27.676
23.125	14.698	26.146
23.250	14.850	24.586
23.375	14.994	23.113
23.500	15.127	21.774
23.625	15.243	20.587
23.750	15.339	19.563
23.875	15.410	18.718
24.000	15.543	18.078
24.125	15.556	20.338
24.250	15.439	17.632
24.375	15.371	18.042
24.500	15.243	19.164
24.625	15.014	21.422
24.750	14.608	24.627
24.875	13.952	22.689
25.000	13.093	17.932

taper = 0.0625

Table 6 presents the gain optimizing iteration that resulted in 15.437 dBi of gain, and **table 7** presents the F/B optimizing iteration and its calculated result of 29.543 dB. Nearly 1.4 dB of gain and over 13.6 dB of F/B separate these antennas. **Tables 8** and **9** present these antennas' calculated performance over the specified bandwidth. Both antennas show peaks at

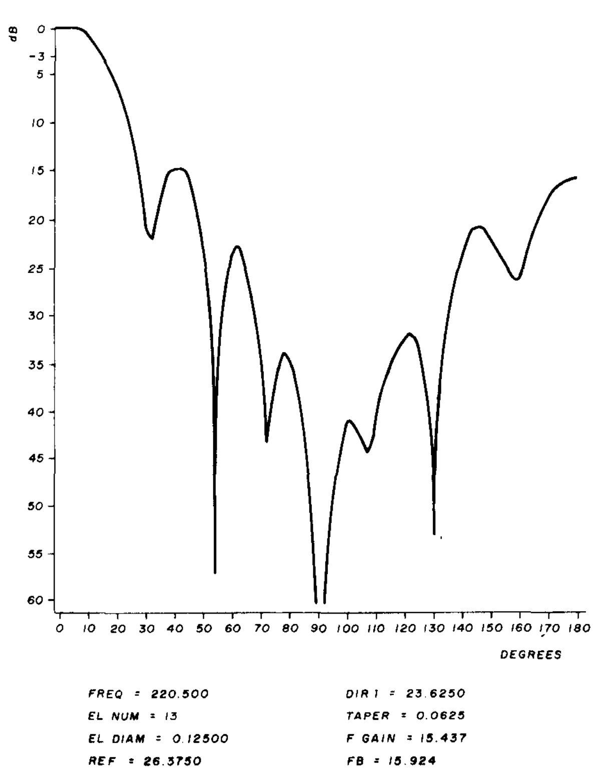


fig. 3. Gain optimized antenna with a 0.0625 taper.

fig. 4. F/B optimized antenna with a 0.0625 taper.

table 11. Optimized F/B iteration for a taper of 0.125 with a 26.375 inch reflector.

director 1 (inches)	gain (dBi)	F/B (dB)
22.000	13.441	18.614
22.125	13.581	19.146
22.250	13.725	19.740
22.375	13.873	20.402
22.500	14.022	21.136
22.625	14.175	21.935
22.750	14.329	22.773
22.875	14.483	23.580
23.000	14.638	24.213
23.125	14.790	24.465
23.250	14.938	24.161
23.375	15.079	23.310
23.500	15.208	22.106
23.625	15.322	20.768
23.750	15.415	19.450
23.875	15.480	18.242
24.000	15.511	17.198
24.125	15.504	16.363
24.250	15.452	15.793
24.375	15.352	15.575
24.500	15.195	15.862
24.625	14.957	16.951
24.750	14.597	19.543
24.875	14.052	26.141
25.000	13.318	32.565
25.125	12.599	21.157

table 12. Frequency response parameters for the 0.125 taper gain optimized antenna.

frequency	gain (dBi)	F/B (dB)
216.5	15.371	20.118
217.5	15.444	19.343
218.5	15.479	18.549
219.5	15.484	17.955
220.5	15.556	20.338
221.5	15.423	17.879
222.5	15.396	18.630
223.5	15.257	20.619
224.5	15.067	24.350

220.5 MHz for their respectively optimized parameters. **Figs. 3** and **4** present these antennas' respective E-plane plots. As was the case for the zero taper antennas, there are obvious differences in main lobe width and depth, and in signal attenuation over the rear-most 20 degrees. The slight taper does not seem to have made much difference in the comparisons between the two 0.0625 antennas and the zero taper antennas. Both gain optimized antennas have the same reflector length, and this is also true of the two F/B optimized antennas. The 0.0625 antennas both have longer director lengths than their zero taper counterparts. Because element spacing has remained constant, this difference is due to director tapering.

NCG CO.

Just Slightly Ahead

10/160M

THE 10/160M GIVES YOU THAT EXTRA BIT OF QUALITY THAT REALLY GETS YOU THROUGH TO THAT SPECIAL DX STATION, OR JUST ENJOYING A FULLY RELAXED QSO WITH ANOTHER AMATEUR THE OTHER SIDE OF THE COUNTRY. YOUR 10/160M GIVES YOU THE EASE OF OPERATION THAT YOU WANT WITH 4 MEMORYS OR THE 3 WAY AUTO SCAN, DUAL VFO, IF SHIFT, CW-W CW-N, HAND MIC AND BUILT IN AC/DC POWER. ALL BANDS ARE FULLY OPERATIONAL INCLUDING THE NEW WARC BANDS. YOUR CHOICE OF EASY OPERATING USB, LSB, CW OR RTTY IS AT YOUR FINGER TIPS. WITH A FULL 200 WATTS PEP OUTPUT YOUR FINALS ARE PROTECTED FROM HIGH SWR.

YOUR 10/160M IS ALL SOLID STATE WITH MODULAR BOARDS THAT ARE EASY ACCESSIBLE. A BRIGHT BLUE FLUORESCENT DIGITAL DISPLAY IS EASY TO READ AT ALL TIMES.

BEST OF ALL THERE ARE NO EXTRA OPTIONS TO BUY TO GET YOU ON THE AIR, ITS ALL THERE. JUST TAKE YOUR 10/160M HOME AND 1. CONNECT A ANTENNA. 2. PLUG INTO 120V AC OUTLET. 3. TURN THE SWITCH ON. 4. SELECT THE BAND AND FREQUENCY AND YOUR ON THE AIR. YOUR RECEIVING AUDIO IS CRISP AND CLEAR, YOUR TRANSMITTED SIGNAL WILL GET YOU A PRAISE FROM EACH CONTACT. THE 10/160M GIVES YOU A SUPERIOR TRANSCEIVER THAT IS UNCOMPARABLE.

MORE INFORMATION IS AVAILABLE FROM YOUR LOCAL DEALER, OR NCG. CO.
1275 N. Grove St., Anaheim, CA 92806

15M

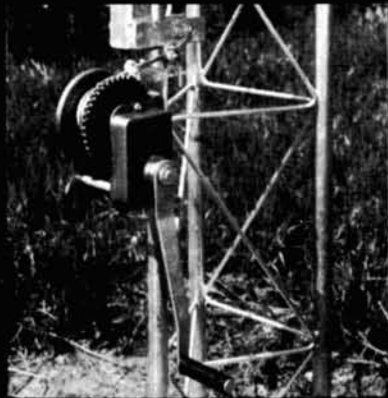
15M-MOBILE IS YOURS TO CONTINUE YOUR QSO WITH THAT SPECIAL FRIEND WHEN YOU GO ON A VACATION OR JUST GOING TO OR FROM WORK. A TRULY QRP RIG WITH THE BIG RIG SIGNAL EITHER CW OR USB. THE DIGITAL FREQUENCY DISPLAY IS EASY TO READ AND YOUR 10 WATTS OR 2 WATTS ON USB OR CW WITH A BUILT IN SIDE TONE, HIGHLY EFFECTIVE NOISE BLANKER, AUDIO ALC GIVES DISTORTION FREE TRANSMISSION. THE VFO BALL WITH GEARS ALLOWS HIGH-PRECISION TUNING. DIGITAL DISPLAY OFFSET WHEN RIT IS IN OPERATION (A MODIFICATION THAT TAKES 5 MINUTES CHANGES THE RIT TO A FINE TUNE CONTROL). A LARGE S/RF METER IN THE CENTER AND A TOP 8 OHM .5W SPEAKER, YOUR RECEIVE AUDIO IS DIRECTED UP.

EXTERNAL SPEAKER AND CW JACKS, MOBILE MOUNTING BRACKET AND A 400 OHM PTT DYNAMIC MICROPHONE. FULL 15 METER BAND OPERATION FROM 21 to 21.450 MHZ, YOUR OFFSET FREQUENCY RANGE OR FINE TUNE IS ±4 KHZ. THE SIGNAL TO NOISE SENSITIVITY IS MORE THAN 10DB DOWN AT -6DB INPUT. POWER SOURCE IS 13.8V DC, 3 AMPS. THE SMALL SIZE WILL ALLOW MOBILE OPERATION FROM EVEN THE SMALL CARS, ITS ONLY 9"H x 2.5W x 9.5D, THE LIGHT WEIGHT OF ONLY 5.7 LBS. MAKES THE 15M A POSSIBLE BACK PACKERS DREAM.

WITH YOUR 15M YOU WILL NOT HAVE A BIG EXPENSIVE PIECE OF EQUIPMENT SETTING IN YOUR VEHICLE, IT CAN BE UNDER THE DASH OUT OF SIGHT.

NOTE: PRICES AND SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE OR OBLIGATION.

TRANSI-TRAP
SURGE PROTECTOR
ALPHA DELTA
R-1



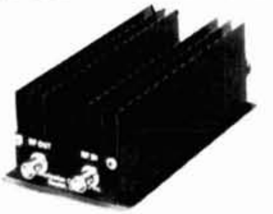


fig. 5. Gain optimized antenna with a 0.125 taper.

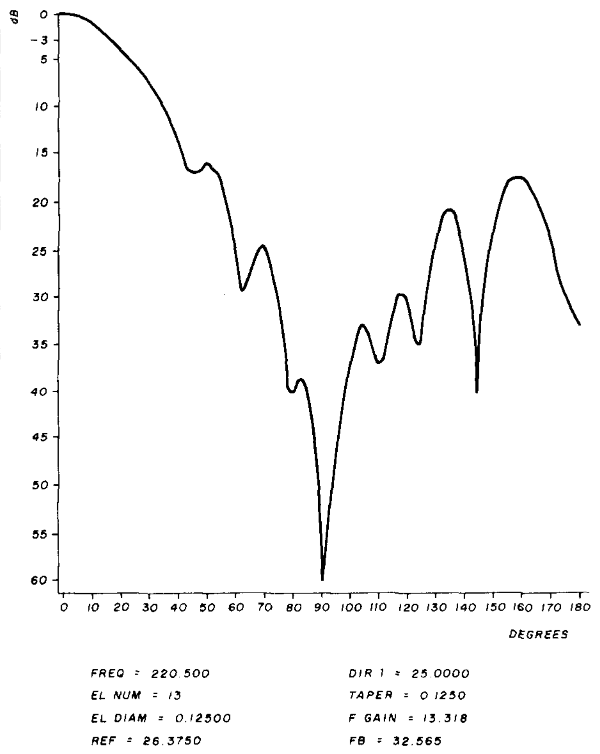


fig. 6. F/B optimized antenna with a 0.125 taper.

table 13. Frequency response parameters for the 0.125 taper F/B optimized antenna.

frequency	gain (dBi)	F/B (dB)
216.5	14.650	12.560
217.5	14.489	14.049
218.5	14.264	16.806
219.5	13.903	22.937
220.5	13.318	32.565
221.5	12.630	20.061
222.5	12.274	17.038
223.5	12.411	14.964
224.5	12.412	13.429

table 14. Optimized gain and F/B iteration for a taper of 0.1875 with a 27.0 inch reflector.

director 1 (inches)	gain (dBi)	F/B (dB)
22.875	14.004	29.444
23.000	14.165	29.547
23.125	14.326	29.052
23.250	14.487	28.061
23.375	14.646	26.802
23.500	14.800	25.472
23.625	14.947	24.189
23.750	15.084	23.012
23.875	15.209	21.973
24.000	15.317	21.096
24.125	15.404	20.405
24.250	15.467	19.941
24.375	15.501	19.768
24.500	15.598	21.030
24.625	15.455	20.831
24.750	15.341	22.712
24.875	15.121	26.857
25.000	14.743	37.306
25.125	14.191	26.858
25.250	13.580	21.249

taper = 0.125

Table 10 presents the gain optimizing iteration that resulted in 15.556 dBi of gain, and **table 11** presents the F/B optimizing iteration that resulted in 32.565 dB of F/B. Over 1.2 dB of gain and over 12 dB of F/B separate these two antennas. **Tables 12** and **13** present these antennas' respective calculated performance over the specified bandwidth. Both antennas show easily determined peaks at 220.5 MHz in their respectively optimized parameters. The high F/B figure is the result of significant single frequency vectorial cancellation. A very good F/B will be recognized over the entire weak signal band segment. **Figs. 5** and **6** present these antennas' respective E-plane plots. The differences in main lobe width and depth are major. In comparison, the F/B optimized antenna almost does without a clearly defined main lobe, and its increased signal attenuation from 170 to 180 degrees comes at a nearly 10 dB (average) reduction in signal attenuation from 120 to 165 degrees. The high degree

table 15. Frequency response parameters for the 0.1875 taper gain optimized antenna.

frequency	gain (dBi)	F/B (dB)
216.5	15.449	21.271
217.5	15.503	20.549
218.5	15.528	19.973
219.5	15.527	19.734
220.5	15.598	21.030
221.5	15.442	21.004
222.5	15.330	23.280
223.5	15.124	28.150
224.5	14.765	30.512

table 16. Frequency response parameters for the 0.1875 taper F/B optimized antenna.

frequency	gain (dBi)	F/B (dB)
216.5	15.520	18.340
217.5	15.547	19.245
218.5	15.337	21.196
219.5	15.118	25.498
220.5	14.743	37.306
221.5	14.184	25.206
222.5	13.543	19.359
223.5	13.117	17.571
224.5	13.179	18.989

of optimization of a single parameter comes at a comparative cost in performance over the rest of this antenna's pattern. Tilton's selection of a gain optimized antenna of this taper is soundly based on his own actual measurements and what this model's calculations have again realized. The F/B level realized by the gain optimized antenna produces a sharp pattern as well as an F/B ratio easily in keeping with the 220 MHz band's level of activity. In comparison with the zero taper antenna and the 0.0625 taper antennas, the 0.125 antenna has a longer first director. As element spacing is fixed, this difference is due to the increased director tapering.

taper = 0.1875

Table 14 presents the gain optimizing iteration that resulted in 15.598 dBi of gain, and it is also the F/B *optimizing iteration that resulted in* 37.306 dB of F/B. Just over 0.85 dB of gain and just under 16.3 dB of F/B separate these two antennas. **Tables 15** and **16** present these antennas' calculated performance over the specified bandwidth. Both antennas show easily located peaks at 220.5 MHz in their respectively optimized parameters. As was the case for the 0.125 taper antenna, this F/B optimized antenna's high F/B figure is the result of single frequency vectorial cancellation.

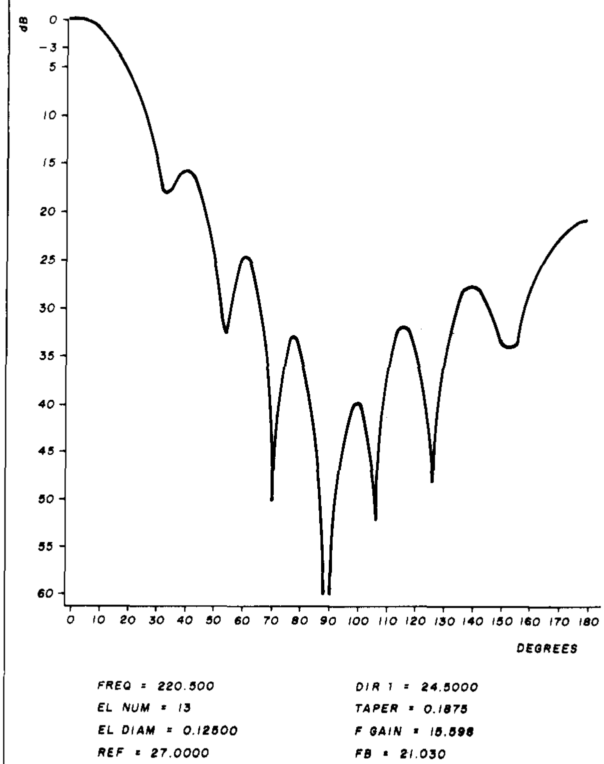


fig. 7. Gain optimized antenna with a 0.1875 taper.

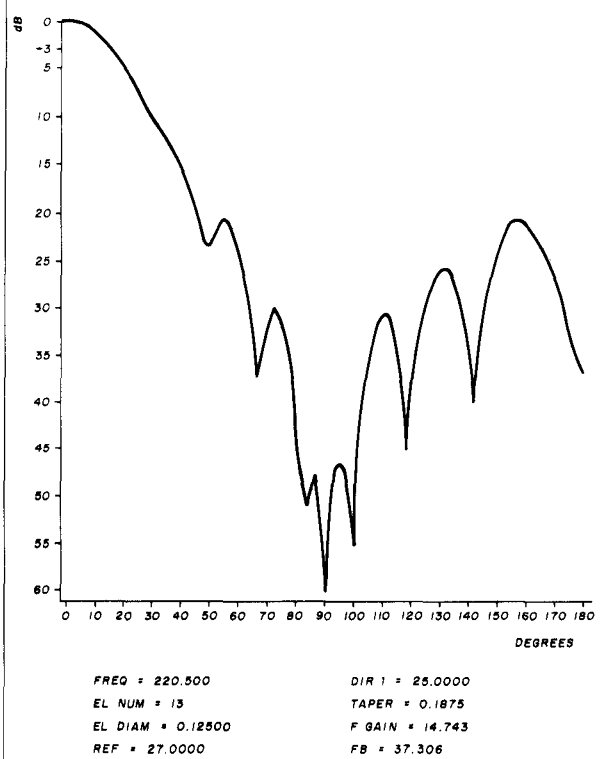


fig. 8. F/B optimized antenna with a 0.1875 taper.

table 17. Optimized gain iteration for a taper of 0.25 with a 26.625 inch reflector.

director 1 (inches)	gain (dBi)	F/B (dB)
23.000	13.976	24.234
23.125	14.128	25.153
23.250	14.282	26.147
23.375	14.435	27.156
23.500	14.589	28.037
23.625	14.740	28.539
23.750	14.887	28.406
23.875	15.028	27.614
24.000	15.160	26.403
24.125	15.279	25.055
24.250	15.382	23.755
24.375	15.464	22.599
24.500	15.519	21.638
24.625	15.543	20.910
24.750	15.529	20.458
24.875	15.467	20.331
25.000	15.342	20.580
25.125	15.133	21.206
25.250	14.823	22.051
25.375	14.441	22.903
25.500	14.114	24.715
25.625	14.030	28.976
25.750	14.062	19.353
25.875	13.857	16.152
26.000	6.991	4.234

table 18. Optimized F/B iteration for a taper of 0.25 with a 26.875 inch reflector.

director 1 (inches)	gain (dBi)	F/B (dB)
23.000	13.901	27.711
23.125	14.057	28.746
23.250	14.214	29.606
23.375	14.372	30.219
23.500	14.530	30.137
23.625	14.685	29.369
23.750	14.835	28.147
23.875	14.980	26.760
24.000	15.115	25.397
24.125	15.237	24.153
24.250	15.344	23.072
24.375	15.429	22.182
24.500	15.490	21.509
24.625	15.519	21.093
24.750	15.510	20.990
24.875	15.450	21.272
25.000	15.320	22.011
25.125	15.095	23.134
25.250	14.759	24.066
25.375	14.351	24.140
25.500	14.030	24.943
25.625	13.994	27.748
25.750	14.026	18.951
25.875	13.842	16.766
26.000	5.770	3.280

Here too, a very fine F/B will be realized over the entire weak signal area. **Figs. 7** and **8** present these antennas' respective E-plane plots. The 0.1875 antennas compare with one another in a manner similar to the 0.125 antennas. The high cost of the high F/B ratio is all too apparent. The gain optimized 0.1875 antenna has a clean pattern and a respectable F/B. Both 0.1875 antennas have the same reflector length but continue the trend toward longer director lengths with an increased taper. However, the 0.125 and 0.1875 F/B optimized antennas have initial directors of the same length. Their difference is the latter's longer reflector.

taper = 0.25

Table 17 presents the gain optimizing iteration that resulted in 15.543 dBi of gain, and **table 18** presents the F/B optimizing iteration that resulted in 30.129 dB of F/B. Slightly more than 1.1 dB of gain and nearly 10 dB of F/B separate these two antennas. **Tables 19** and **20** present these antennas' calculated performance over the specified bandwidth. Both antennas have easily located peaks at 220.5 MHz in their respectively optimized parameters. Unlike the two previous F/B optimized antennas, the 0.25 taper F/B optimized antenna does not have a high single frequency F/B, and maintains a near-optimized F/B across the entire weak signal area. **Figs. 9** and **10** present the 0.25 antennas' E-plane plots. Though the gain optimized antenna has the narrower main lobe, both antennas have clearly defined main lobes. This is in contrast to the pairs of antennas compared at the 0.1875 and 0.125 tapers. Along a similar vein, the great disparities noted in the signal attenuation characteristics between antennas of the two most recently presented tapers, exist only to a limited degree between the 0.25 taper antennas. While the gain optimized 0.25 taper antenna continues the trend to longer director lengths, the F/B optimized antenna significantly *reverses* this tendency.

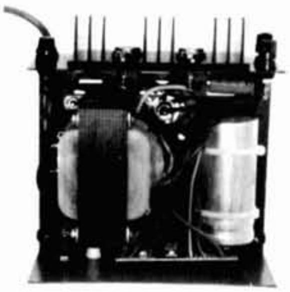
summary

The computer iterations performed on a family of ten 220 MHz Tilton/Greenblum Yagis indicate that the user needs to have a clear understanding of his or her antenna requirements before making a selection. There are great differences between the gain and F/B optimized antennas within each tapering approach. Additionally, for each of the optimized antennas, the best value of the other (non-optimized) parameter generally occured at a frequency far removed from the design frequency of 220.5 MHz. Given the broadbanded nature of Yagis on this band, very little gain is lost during even extensive changes in frequency. For some of the F/B optimized antennas, there are marked penalties in *F/B* for even slight frequency changes.

ASTRON CORPORATION

2852 Walnut Ave., Unit E
Tustin, CA 92680
(714) 832-7770

Canadian Distributor
Eastcom Industries, Ltd.
4511 Chesswood Dr.
Downsview, Ontario, Canada M3J 2V6
(416) 638-7995



INSIDE VIEW – RS-12A

ASTRON POWER SUPPLIES

• HEAVY DUTY • HIGH QUALITY • RUGGED • RELIABLE •

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

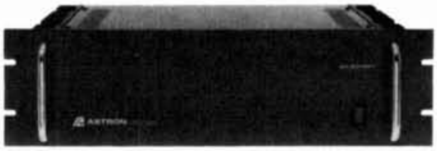
- INPUT VOLTAGE: 105 - 125 VAC
- OUTPUT VOLTAGE: 13.8 VDC ± 0.05 volts (Internally Adjustable: 11-15 VDC)
- RIPPLE: Less than 5mv peak to peak (full load & low line)

MODEL RS-50A

MODEL RS-50M

MODEL VS-50M

RM-A Series



MODEL RM-35A

19" X 5¼ RACK MOUNT POWER SUPPLIES

Model	Continuous Duty (AMPS)	ICS* (AMPS)	Size (IN) HXWXD	Shipping Wt. (lbs.)
RM-35A	25	35	5¼ × 19 × 12½	38
RM-50A	37	50	5¼ × 19 × 12½	50

RS-A SERIES

MODEL RS-7A

MODEL	Continuous Duty (Amps)	ICS* (Amps)	Size (IN) H x W X D	Shipping Wt (lbs)
RS-4A	3	4	3¾ x 6½ x 9	5
RS-7A	5	7	3¾ x 6½ x 9	9
RS-7B	5	7	4 × 7½ × 10¾	10
RS-10A	7.5	10	4 x 7½ x 10¾	11
RS-12A	9	12	4½ x 8 x 9	13
RS-20A	16	20	5 x 9 x 10½	18
RS-35A	25	35	5 x 11 x 11	27
RS-50A	37	50	6 x 13¾ x 11	46

RS-M SERIES

MODEL RS-35M

- Switchable volt and Amp meter

MODEL	Continuous Duty (Amps)	ICS* (Amps)	Size (IN) H x W x D	Shipping Wt (lbs)
RS-12M	9	12	4½ x 8 x 9	13
RS-20M	16	20	5 x 9 x 10½	18
RS-35M	25	35	5 x 11 x 11	27
RS-50M	37	50	6 x 13¾ x 11	46

VS-M SERIES

MODEL VS-20M

- Seperate Volt and Amp Meters
- Output Voltage adjustable from 2-15 volts
- Current limit adjustable from 1.5 amps to Full Load

MODEL	Continuous Duty (Amps) @13.8VDC	@10VDC	@5VDC	ICS* (Amps) @13.8V	Size (IN) H x W x D	Shipping Wt (lbs)
VS-20M	16	9	4	20	5 x 9 x 10½	20
VS-35M	25	15	7	35	5 x 11 x 11	29
VS-50M	37	22	10	50	6 x 13¾ x 11	46

RS-S SERIES

MODEL RS-12S

- Built in speaker

MODEL	Continous Duty (Amps)	ICS* Amps	Size (IN) H x W x D	Shipping Wt (lbs)
RS-7S	5	7	4 x 7½ x 10¾	10
RS-10S	7.5	10	4 x 7½ x 10¾	12
RS-10L(For LTR)	7.5	10	4 × 9 × 13	13
RS-12S	9	12	4½ x 8 x 9	13
RS-20S	16	20	5 x 9 x 10½	18

✓ 114

table 19. Frequency response parameters for the 0.25 taper gain optimized antenna.

frequency	gain (dBi)	F/B (dB)
216.5	15.210	20.451
217.5	15.360	21.259
218.5	15.462	21.417
219.5	15.522	21.186
220.5	15.543	20.910
221.5	15.528	20.845
222.5	15.469	21.154
223.5	15.354	21.922
224.5	15.156	22.978

table 20. Frequency response parameters for the 0.25 taper F/B optimized antenna.

frequency	gain (dBi)	F/B (dB)
216.5	13.948	20.464
217.5	14.067	22.851
218.5	14.175	25.567
219.5	14.276	28.419
220.5	14.372	30.219
221.5	14.466	29.425
222.5	14.557	27.249
223.5	14.646	25.119
224.5	14.732	23.343

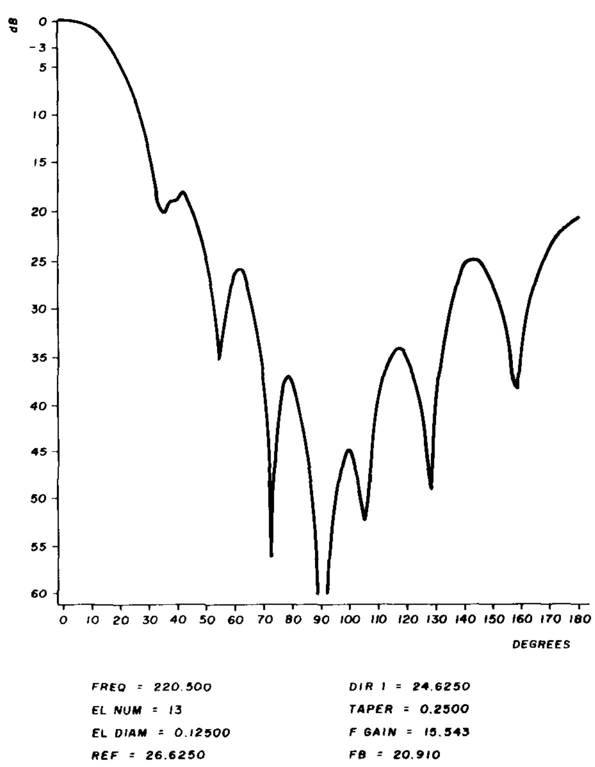


fig. 9. Gain optimized antenna with a 0.25 taper.

With the exception of the zero, 0.0625, and 0.25 taper antennas, F/B optimization is very clearly the result of single frequency vectorial cancellation. A user interested in reasonably high F/Bs that will be recognized across the entire weak signal area (of the band) could easily choose from among the various 0.0625 and 0.25 taper F/B optimized antennas. There is the added bonus of reasonably good gain figures and clearly defined main lobes. The 0.125 and 0.1875 taper F/B optimized antennas have very broad main lobes and are single frequency F/B antennas. Overall, the user in need of a high F/B may find the 0.25 taper F/B optimized antenna to be the best choice.

For the gain-oriented user, the gain optimized antennas with the 0.125 and 0.1875 tapers are a logical choice. Both provide respectable F/B along with a well defined front lobe and an overall clean pattern. While the 0.1875 antenna provides a slight increase in calculated gain, Tilton's 0.125 antenna is every bit as good.

There is a rather intriguing by-product of the Tilton/Greenblum iterations. A boomlength of 3.23 wavelengths is extremely close to the boomlength of 3.2 wavelengths used by Viezbicke. This invites an obvious comparison between the NBS Yagi and the Yagis optimized for this article.

Using the Lawson model to iterate the 3.2 wavelength NBS Yagi results in a computed gain of 15.2

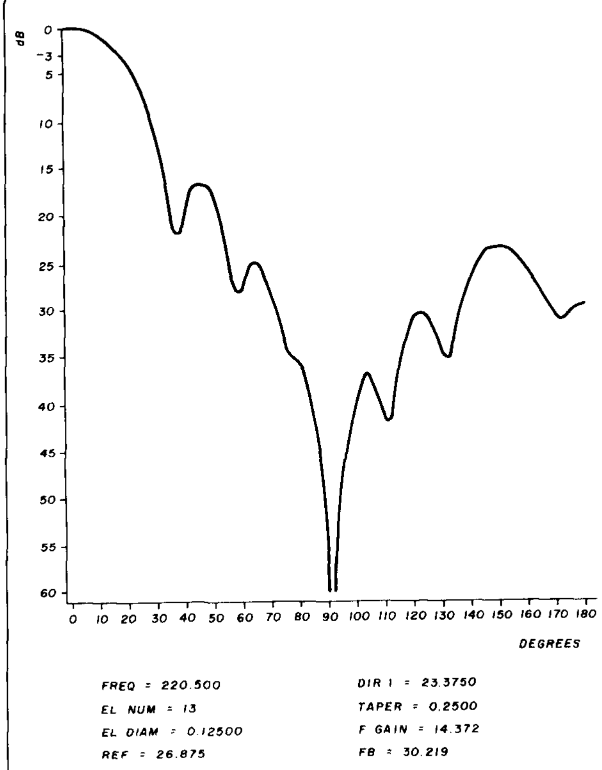


fig. 10. F/B optimized antenna with a 0.25 taper.

dBi.[13] Any of the five Tilton/Greenblum gain optimized Yagis produced gains in excess of this figure. The amount of excess (gain) ranged from 0.132 to 0.398 dB, with a boom only 0.03 wavelengths longer. While longer booms generally result in larger gains, this difference is too small to account for more than the minutest part of the differences in gain. Also, all five gain optimized Yagis have a first minor lobe whose amplitude is from 1 to 4 dB *less* than that of the NBS Yagi. What is even more interesting is the fact that the NBS Yagi uses four more elements than the Tilton/Greenblum Yagi.

The NBS Yagis are element length-optimized with equal director spacing. The Tilton/Greenblum Yagis resulting from computer iteration are also element length-optimized, but director spacing is initially unequal and followed by equally spaced directors. All NBS Yagis use a reflector spacing of 0.2 wavelengths, while the Greenblum design varies reflector spacing as a function of boom length. It would appear that gain optimized Yagis designed as a result of optimizing two variables are more effective than those designed by optimizing a single variable. With fewer elements they are also easier to build. It is only fair to also note that the NBS 3.2 wavelength antenna has an F/B of from 3 to 10 dB above any of the five gain optimized Yagis.

Next month's installment in this series will present computer-iterated alternative Yagis drawn from two well-known 432 MHz design approaches. Iteration-based inferences will be made on a third design, also of long standing. Perhaps as in the case of 220 MHz, 432 MHz may bring a little surprise.

references

1. Stanley Jaffin, WB3BGU, "Applied Yagi Antenna Design, Part 1: A 2-meter Classic Revisited," *ham radio*, May 1984, page 14.
2. Carl Greenblum, "Notes on the Development of Yagi Arrays — Part I," *QST*, August, 1956, pages 11-17, 114, 116.
3. Carl Greenblum, "Notes on the Development of Yagi Arrays — Part II," *QST*, September, 1956, pages 23-26, 122.
4. Edward Tilton, W1HDQ, "Six Elements on Six," *QST*, October, 1957, pages 18-20.
5. Edward Tilton, W1HDQ, "Yagi Arrays for 432 MHz," *QST*, April, 1966, pages 19-22.
6. Personal communication from Joseph Reisert, W1JR, 17 Mansfield Drive, Chelmsford, Massachusetts 01824.
7. James P. Lawson, W2PV, "Yagi Antenna Design: Performance Calculations," *ham radio*, January, 1980, page 25.
8. Shintaro Uda and Yasuto Mushiake, *Yagi-Uda Antenna*, The Research Institute of Electrical Communications, Sendai, Japan, 1954, pages 22-24.
9. G.R. Jessop, Editor, *VHF/UHF Manual*, Fourth Edition, Radio Society of Great Britain, Hertfordshire, Great Britain, 1983, page 8.9. (Note that R.G. Powers, G8CKN, is credited for the entire antenna section.)
10. Peter Viezbicke, WØNXB, "Yagi Antenna Design," *NBS Technical Note 688*, U.S. Department of Commerce, Washington, D.C., 1976, page 7.
11. Doug DeMaw, W1FB, Editor, *The Radio Amateur's Handbook*, 45th edition, ARRL, Newington, Connecticut, 1968, pages 465-6. Ten subsequent editions also contain this same information.
12. Edward Tilton, W1HDQ, *The Radio Amateur's VHF Manual*, 11th edition, ARRL, Newington, Connecticut, 1968, pages 220-2.
13. James P. Lawson, W2PV, "Yagi Antenna Design: Experiments Confirm Computer Analysis," *ham radio*, February, 1980, page 24.

ham radio

SWL HEADQUARTERS

NATIONS LEADING SHORTWAVE EQUIPMENT SUPPLIER

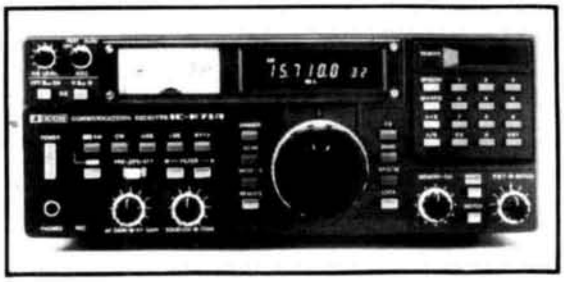
Designed for Serious DXing

ICOM R71

THE ULTIMATE RECEIVER

ICOM DID IT AGAIN

NEW



Sale Price
$699

- 100KHz-30MHz
- Keyboard entry
- 32 memories
- Remote control (optional)
- Scanning
- Pass band & notch tuning
- Memory back-up
- Wide dynamic range
- Voice synthesizer (optional)

→ BUY FROM EEB WITH CONFIDENCE ←

- **We are ICOM's #1 Receiver Dealer**
- **Our factory authorized service center and modification department know ICOM receiver in depth.**
- **You get (at no charge) our double extended warranty covering your receiver parts and labor for 6 months.**

EEB Options Installed —

1. Mechanical filter (Replaces SSB ceramic filter) **$95.00**
2. FL44A 8 pole crystal filter replaces SSB ceramic filter $159. Installed .... **$179.**
3. FM (Detection) 10 meter band $39.50. Installed **$49.50**
4. 12V DC Kit $9.95. Installed **$15.00**

*KENWOOD R-2000

- 100 KHz to 30 MHz
- All mode AM-CW-SSB-FM
- 10 memories (memorizes mode)
- Memory backup
- Memory scan
- Programmable band scan
- 24-hour clock-timer
- VC-10 VHF converter 118-174 MHz $139

R-2000 $599.95 .... **SALE $499**
R-1000 $499.95 .... **SALE $429**
R-600 $399.95 .... **SALE $329**
ADD $6.50 UPS

* PANASONIC RF-B600

Sale
$429
List $595
($6.00 UPS)

- 1.6 to 30 MHz, FM/LW/MW/SW
- Micro computer multi-tuning system
- 9 memory stations, scan
- Slow/Fast rotary tuning
- 10 key direct access tuning
- Universal voltage

RF-9 $99.95 .... **SALE $89.00**
RF-B50 159.95 .... **SALE $129.00**
RF-085 .... **CLOSE OUT $49.95**
RF-B300 $249.95 .... **SALE $209**
RF-3100 $379 .... **SALE $279**
ADD $4.00 UPS

* G.E. WORLD MONITOR

Sale
$169
List $229.95
($4.00 UPS)

Digital readout, wide and narrow selectivity BFO for SSB & CW.

- 3.5 - 31 MHz SW/MW/FM
- 12OV/220V or battery

* YAESU FRG-7700
Sale $399

SPECIAL PACKAGE DEAL
7700-MU7700
FRA-7700
499⁹⁵

- 150 KHz-30MHz
- All mode AM-CW-SSB-FM
- Digital frequency and clock

Options:

- FRA-7700 active antenna **$59**
- MU-7700 12 channel memory **$135**
- FRT-7700 antenna tuner **$59**
- FF-5 VLF low pass filter **$20**
- DC-7700 12 VDC kit **$8**
- FRV-7700 VHF converter **$135**
- ADD $6.50 UPS

* SONY ICF-2002

Introductory Special
$229
List $249.95

Features: Ten memory channels • 12/24 hour quartz clock/PLL tuning for drift-free performance • Dual conversion Super-heterodyne for high sensitivity • SSB/CW

ICR-4800 $99.95 .... **SALE $69.95**
ICF-6500W $199.95 .... **SALE $99.95**
ICF-6800W $699.95 .... **SALE $549**
ICF-7600A $169.95 .... **SALE $139**
AN-1 $79.95 (AC Adapt $9.95)
ADD $4.00 UPS

* 1984 WORLD RADIO TV HANDBOOK

Sale
$17.50

- The shortwave listeners' Bible
- A reference guide for the beginner and serious DXer
- 145 pages devoted entirely to listings of SW, MW, LW, and TV stations around the world
- Listings of English SW broadcasts
- An annual review of shortwave receivers
- $17.50 post paid USA book rate (add $4 Air)

EEB

- We ship worldwide
- Shipping charges not included
- Prices & specifications subject to change without notice
- Canadian Orders: VISA, MC or POSTAL MAIL ORDERS ONLY!

VISA
master charge

10 Miles West of Washington, D.C.
Sorry—No COD's
10-5 Tues., Wed., Fri.
10-9 Thursday
10-4 Saturday
Closed Sunday and Monday

134

Electronic Equipment Bank
516 Mill Street, N.E.
Vienna, Virginia 22180
Order Toll Free 800-368-3270
Virginia 703-938-3350

EEB

impedance matching: a brief review

There's no mystery in finding the right match

In April the author discussed the basics of resonant circuits; this month, he walks us through the fundamentals of impedance matching. Both articles are adapted and reprinted with permission from *RF Circuit Design*, published by Howard W. Sams & Company, Indianapolis, Indiana.*

Impedance matching is often necessary in the design of RF circuitry to provide the maximum possible transfer of power between a source and its load. Probably the most vivid example of the need of such a transfer of power occurs in the front-end of any sensitive receiver. Obviously, any *unnecessary* loss in a circuit which is already handling extremely small signal levels simply cannot be tolerated. Therefore, in most instances, extreme care must be taken during the initial design of such a front-end to make sure that each device in the chain is matched to its load.

background

A well-known theorem states that for DC circuits, maximum power will be transferred from a source to its load if the *load resistance* equals the *source resistance*. A simple proof of this theorem is shown in **fig. 1**. In this figure, for convenience, the source is normalized for a resistance of one ohm and a voltage of one volt.

In dealing with AC or time-varying waveforms, however, that same theorem states that the maximum transfer of power from a source to its load occurs when the *load impedance* (Z_L) is equal to the *complex conjugate* of the *source impedance*. *Complex conjugate* simply refers to a complex impedance having the same *real part* with an opposite reactance. Thus, if the source impedance were $Z_S = R + jX$, then its complex conjugate would be $Z_S^* = R - jX$.

If you followed the mathematics in **fig. 1**, then it should be obvious why maximum transfer of power does occur when the load impedance is the complex conjugate of the source. This is shown schematically in **fig. 2**. The source (Z_S), with a series reactive component of $+jX$ (an inductor), is driving its complex conjugate load impedance consisting of a $-jX$ reactance (capacitor) in series with R_L. The $+jX$ component of the source and the $-jX$ component of the load are in series and thus cancel each other, leaving only R_S and R_L which are equal by definition. Since R_S and R_L are equal, maximum power transfer will occur. So when we speak of a source driving its complex conjugate, we are simply referring to a condition in which any *source* reactance is resonated with an equal and opposite *load* reactance, leaving only equal resistor values for the source and the load terminations.

The primary objective in any impedance *matching* scheme then, is to force a load impedance to "look like" the complex conjugate of the source impedance so that maximum power may be transferred to the load. This is shown in **fig. 3** where a load impedance of 2 − j6 ohms is transformed by the impedance

By **Chris Bowick, WD4C**, 200 Abri Place, Lilburn, Georgia 30247

*Available from Ham Radio's Bookstore, Greenville, NH 03048, $24.45 postpaid.

matching network to a value of 5 + j10 ohms. Therefore, the source "sees" a load impedance of 5 + j10 ohms, which just happens to be its complex conjugate. It should be noted here that because we are dealing with reactances, which are frequency dependent, the perfect impedance match can occur at only one frequency: that is, the frequency at which the +jX component exactly equals the −jX component and thus cancellation or resonance occurs. At all other frequencies removed from the matching frequency, the impedance match becomes progressively worse and eventually non-existent. This can be a problem in broadband circuits where we would ideally like to provide a perfect match everywhere within the broad passband.

There are an infinite number of possible networks which could be used to perform the impedance matching function of **fig. 3**. Something as simple as a 2-element L-C network or as elaborate as a 7-element filter, depending on the application, would work equally well.

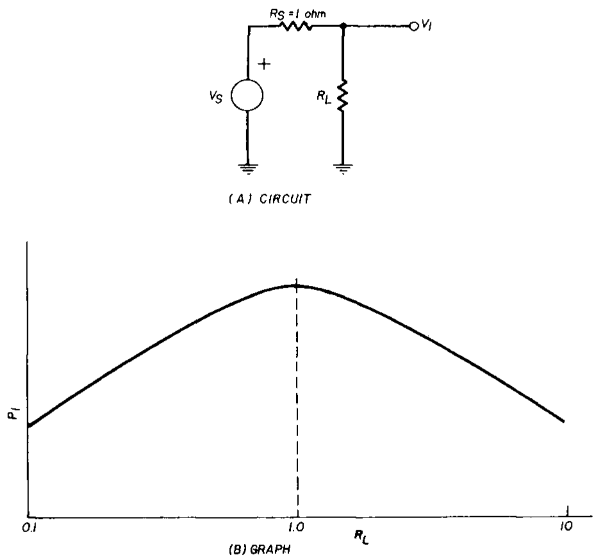


fig. 1. Proof of the power theorem.

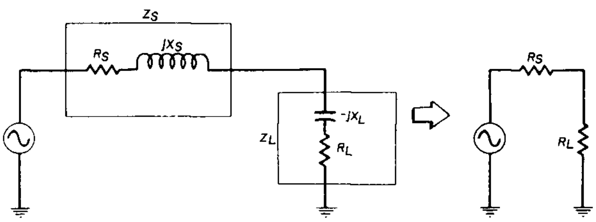


fig. 2. Source impedance driving its complex conjugate and the resulting equivalent circuit.

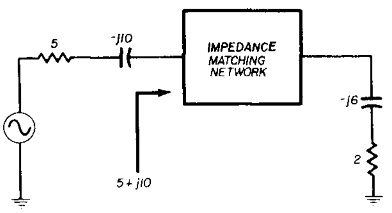


fig. 3. Impedance transformation.

the L-network: why it works

Probably the simplest and most widely used matching circuit is the L-network shown in **fig. 4**. This circuit receives its name from its component orientation, which resembles the shape of an L. As shown in the figure, there are four possible arrangements of the two components. Two of the arrangements, A and B, are in a lowpass filter configuration, while the other two, C and D, are in a highpass filter configuration.

Before we introduce equations that can be used to design the matching networks of **fig. 4**, let's first analyze an existing matching network so that we can understand exactly how the impedance match occurs. Once this analysis is made, impedance matching should seem less mysterious.

Figure 5 shows a simple L-network impedance match between a 100-ohm source and a 1000-ohm load. Without the impedance matching network installed, and with the 100-ohm source driving the 1000-ohm load directly, one-third of the signal *available* from the source is gone before we even get started. The impedance matching network eliminates this loss

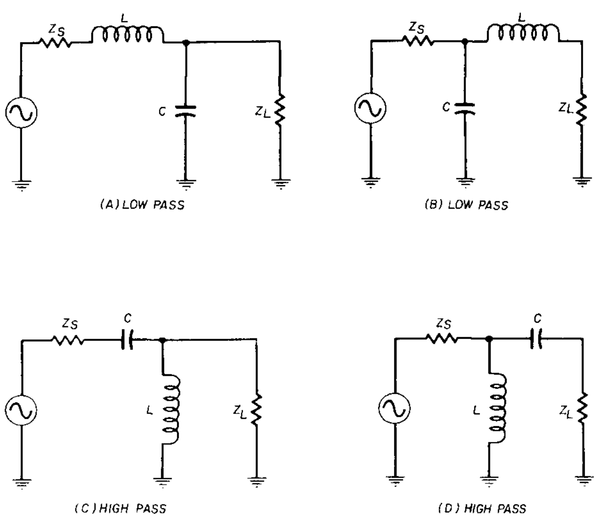


fig. 4. The L-network configured as a low-pass or high-pass circuit.

AEA Brings you the Breakthrough!

MBA-RC Code Converter

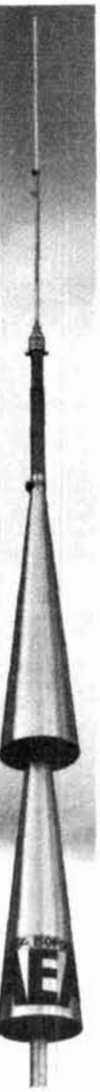
This full function decoder and display unit represents the latest in state-of-the-art decoders. Morse, Baudot, and ASCII. Will perform serial to parallel and parallel to serial code conversions as well as cross mode conversions. Two powerful μPS, 43 ICs, make up one complete package. Compatible with HF, VHF and UHF bands and RTTY modes. Separate receive filters are ahead of and behind a special signal limited circuit.

CALL FOR YOUR PRICE

AEA Computer Patch CP-1

A Personal Computer + Your Transceiver + AEA's CP-1 = FUN! Get a professional quality RTTY/CW terminal on a beer budget price. Easy to hook up and use. The CP-1 demodulator provides greatly improved performance compared to popular single channel RTTY detectors. With appropriate software and your personal computer, you can have hours of fun.

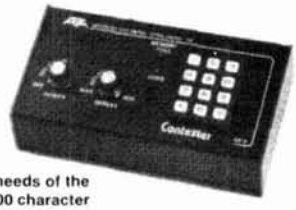
CALL FOR YOUR PRICE



ISOPOLE™

Models available for: 144 MHz, 220 MHz and 440 MHz. Maximum gain, very low angle of radiation. Covers complete band with SWR less than 1.4-1.

CALL FOR YOUR PRICE



AEA Contester™ CK-2

Here's great gift idea for your favorite ham. Designed with the needs of the active contester in mind — at a price that is affordable. Has an 800 character message memory that can be soft partitioned into as many as 10 sections. Mistakes are easily corrected with unique edit mode. Also has automatic serial number generator.

CALL FOR YOUR PRICE

AEA Moscow Muffler WB-1

Blank the woodpecker — once and for all. No modifications necessary to your equipment. Hooks up in your antenna so synchronous blanker works where most effective, in the RF stage. Will not overload from strong adjacent signals. Also has low noise, broadband 6 dB preamp. WB-1 will typically display 40-50 dB of attenuation. Two pulse rates blanking speeds available — 10 and 16 Hz.

CALL FOR YOUR PRICE

AEA Amtor Terminal Unit AMT-1

AMTOR is fast growing in popularity. Don't you want to join the fun? Computer based, self correcting mode of transmission virtually ensures error-free copy — even with strong interference or weak signals, AMTOR can get your message through. AMT-1 contains everything you need to get on AMTOR with the addition of your radio and personal computer. Will also work on standard RTTY and CW for additional flexibility. Great Christmas gift idea. State-of-the-art FUN.

CALL FOR YOUR PRICE

HAMTRONICS is your complete ham dealer. Looking for something and can't find it elsewhere? CALL HAMTRONICS TODAY

MasterCard VISA

HAMTRONICS, INC.

4033 BROWNSVILLE ROAD, TREVOSE, PA. 19047

(215) 357-1400

The Only Factory Authorized **SALES & SERVICE** in **New England**

TEL-COM★ Electronic Communications

Authorized Dealers For

KENWOOD & ICOM

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

ARRL PUBLICATIONS • AEA • ALPHA DELTA • ASTRON • AUSTIN • BENCHER • B&W • DAIWA • MIRAGE • TELEX/HY-GAIN • VIBROPLEX • WELZ • ETC.

TRY US FOR YOUR MAIL ORDER PURCHASES

VISA and MASTER CARDS *Accepted*

✓ 191

OPEN SIX DAYS A WEEK

Telephone 617/486-3400, 3040

675 Great Rd., (Rte. 119) Littleton, MA 01460

1¾ miles from Rte. 495 (Exit 31) toward Groton, Mass.

DESIGN EVOLUTION IN RF P.A.'s

Now with GaAs FET Preamp

- Linear (all mode) RF power amp with automatic T/R switching (adjustable delay)
- Receive preamp option, featuring GaAs FETS (lowest noise figure, better IMD). Device NF typically .5 dB.
- Thermal shutdown protection incorporated
- Remote control available
- Rugged components and construction provide for superior product quality and performance
- Affordably priced offering the best performance per dollar
- Designed to ICAS ratings, meets FCC part 97 regulations
- 1 year transistors warranty
- Add $5 for shipping and handling (Cont. U.S.). Calif. residents add applicable sales tax.
- Specifications/price subject to change

MODEL 1	FREQUENCY 2	OUTPUT POWER	INPUT POWER	SUGG. PRICE LESS TAX
	(MHz)	(W)	(W)	$
1410 1410G	144	160	10	225 265
1412 1412G	144	160	30	199 239
2210 2210G	220	130	10	225 265
2212 2212G	220	130	30	199 239
4410 4410G	440	100	10	225 265
4412 4412G	440	100	30	199 239

1. Models with G suffix have GaAs FET preamps. Non-G suffix units have no preamp.
2. Covers full amateur band. Specify 10 MHz Bandwidth for 420-450 MHz Amplifier.

★*SEND FOR FURTHER INFORMATION*★

TE SYSTEMS

TE SYSTEMS
P.O. Box 25845
Los Angeles, CA 90025
(213) 478-0591

✓ 190

July 28 thru Aug. 10, 1984

Our 25th year

TAKE A VACATION WITH A PURPOSE THIS YEAR

Join students from around the world at OAK HILL's **SILVER ANNIVERSARY** Session

Over 25 years of successful teaching experience means upgrading is as easy as 1-2-3.

Your vacation is spent in the beautiful Blue Ridge Mountains of Virginia with expert instructors in friendly surroundings and with excellent accommodations.

Oak Hill also has a ham lab set up for all to use.

Courses offered are:
Novice to General
General or Tech to Advanced
Advanced to Extra

Learn — don't just memorize the answers to the exam questions.

C. L. PETERS, K4DNJ, Director
Oak Hill Academy Amateur Radio Session
Box 43
Mouth of Wilson, VA 24363

Name ______________ Call ____________

Address ______________________________

City/State/Zip _________________________

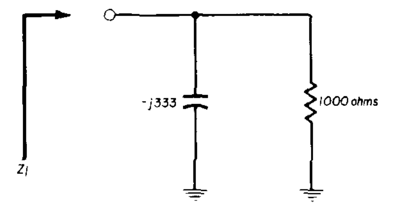


fig. 5. Simple impedance match between a 100-ohm source and a 1000-ohm load.

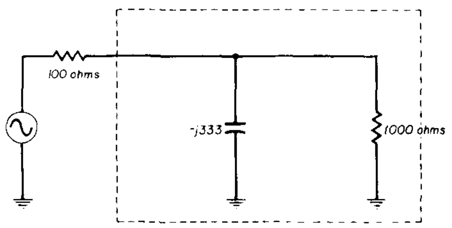


fig. 6. Impedance looking into the parallel combination of R_L and X_c.

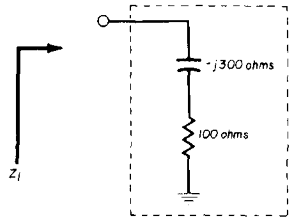


fig. 7. Equivalent circuit of *fig. 6*.

and allows for maximum power transfer to the load. This is done by forcing the 100-ohm source to see 100 ohms when it looks into the impedance matching network. But how?

If you analyze **fig. 5**, the simplicity of how the match occurs will amaze you. Take a look at **fig. 6**. The first step in the analysis is to determine what the load impedance actually looks like when the −j333 ohm capacitor is placed across the 1000-ohm load resistor. This is easily calculated by:

$$Z = \frac{X_c R_L}{X_c + R_L} = \frac{-j333(1000)}{-j333 + 1000}$$

$$= 100 - j300 \text{ ohms}$$

Thus, the parallel combination of the −j333 ohm capacitor and the 1000-ohm resistor *appears* to be an impedance of 100 − j300 ohms. This is a *series* combination of a 100-ohm resistor and a −j300 ohm capacitor as shown in **fig. 7**. Indeed, if you hooked a signal generator up to circuits similar to **figs. 6** and **7** you would not be able to tell the difference between the two as they would exhibit the same characteristics (except at DC, obviously).

Now that we have an *apparent* series 100-j300 ohm impedance for a load, all we have to do to complete the impedance match to the 100-ohm source is to add an equal and opposite (+j300 ohm) reactance in series with the network of **fig. 7**. The addition of the +j300-ohm inductor causes cancellation of the −j300 ohm capacitor, leaving only an *apparent* 100-ohm load resistor. This is shown in **fig. 8**. Keep in mind here that the actual network topology of **fig. 5** has not changed. All we have done is to analyze small portions of the network so that we can understand the function of each component.

To summarize then, the function of the *shunt* component of the impedance matching network is to transform a larger impedance down to a smaller value with a real part equal to the real part of the other terminating impedance (in our case, the 100-ohm source). The series impedance matching element then resonates with or cancels any reactive component present, thus leaving the source driving an apparently equal load for optimum power transfer. So you see, the impedance match isn't mysterious at all; it can be completely explained every step of the way.

Now back to the design of the impedance matching networks of **fig. 4**. These circuits can be very easily designed using the following equations:

$$Q_s = Q_p = \sqrt{\frac{R_p}{R_s} - 1} \qquad \textbf{(1)}$$

$$Q_s = \frac{X_s}{R_s} \qquad \textbf{(2)}$$

$$Q_p = \frac{R_p}{X_p} \qquad \textbf{(3)}$$

where, referring to **fig. 9**:

Q_s = Q of the series leg
Q_p = Q of the shunt leg
R_p = shunt resistance
X_p = shunt reactance
R_s = series resistance
X_s = series reactance

X_p and X_s may be either capacitive or inductive reactance, but each must be of the opposite type. Once X_p is chosen as a capacitor, for example, X_s must be an inductor and vice-versa.

example 1

Design a circuit to match a 100-ohm source to a 1000-ohm load at 100 MHz. Assume that a DC voltage must also be transferred from the source to the load.

Solution: The need for a DC path between the source and load dictates the need for an inductor in the series leg as in **fig. 4A**.

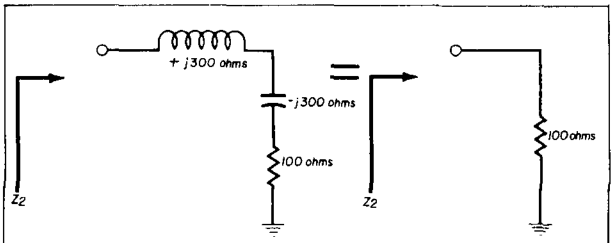


fig. 8. Completing the match.

From **eq. 1** we have:

$$Q_s = Q_p = \sqrt{\frac{1000}{100} - 1} = \sqrt{9} = 3$$

From **eq. 2**:

$$X_s = Q_s R_s = (3)(100) = 300 \text{ ohms (inductive)}$$

From **eq. 3**:

$$X_p = \frac{R_p}{Q_p} = \frac{1000}{3} = 333 \text{ ohms (capacitive)}$$

The component values at 100 MHz are:

$$L = \frac{X_s}{2\pi f} = \frac{300}{2\pi(100 \times 10^6)} = 477 \ nH$$

$$C = \frac{1}{\omega X_p} = \frac{1}{2\pi(100 \times 10^6)(333)} = 4.8 \quad pF$$

This yields the circuit of **fig. 10**. Notice that what you have done is to design the circuit which was previously given in **fig. 5** and analyzed.

dealing with complex loads

The design of **example 1** was for the simple case of matching two *real* impedances (pure resistances). It is very rare when such an occurrence actually exists in the real world. Transistor input and output impedances are almost always *complex*; that is, they contain both resistive and reactive components ($R \pm jX$). Transmission lines, mixers, antennas, and most other sources and loads are no different in that respect. Most will always have some reactive component which must be dealt with. It is, therefore, necessary to know how to handle these stray reactances, and in some instances, to actually put them to work for you.

There are two basic approaches in handling complex impedances as outlined below:

Absorption. It is possible to actually absorb any stray reactances into the impedance matching network itself. This can be done through prudent placement of each matching element such that element capacitors are placed in parallel with stray capacitances, and element inductors are placed in series with any stray inductances. The *stray* component values are then subtracted from the *calculated* element values, leaving new element values, C′,L′, which are smaller than the calculated element values.

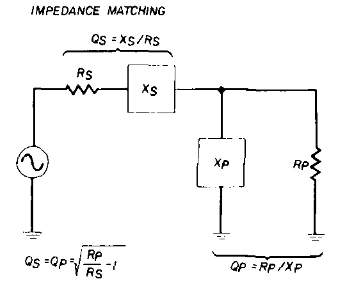


fig. 9. Summary, L-network design.

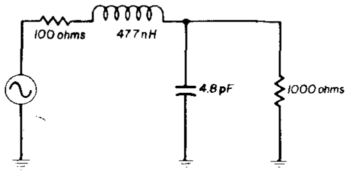


fig. 10. Final circuit of *example 1.*

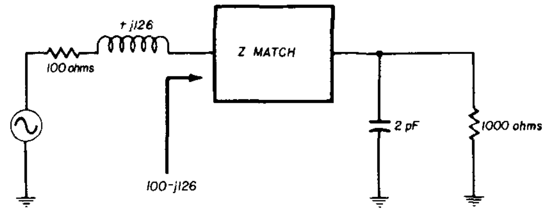


fig. 11. Complex source and load to be matched in *example 2.*

Resonance. Resonate any stray reactance with an equal and opposite reactance at the frequency of interest. Once this is done, the matching network design can proceed as in **example 1** for two pure resistances.

Of course, it is possible to use both of the approaches outlined above at the same time. In fact, the majority of impedance matching designs probably do utilize a little of both. Let's take a look at two simple examples to help clarify matters.

example 2

Use the absorption approach to match the source and load of **fig. 11** at 100 MHz.

Solution: The first step in the design process is to totally ignore the reactances and simply match the 100-ohm real part of the source to the 1000-ohm real part of the load at 100 MHz. Keep in mind that you would like to use a matching network that will place element inductances in series with stray inductance and element capacitances in parallel with stray capacitances. Conveniently, the network of **fig. 4A** is

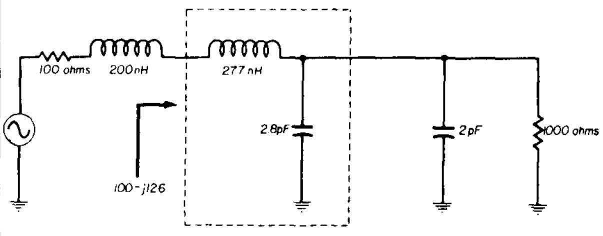


fig. 12. Final design of *example 2*.

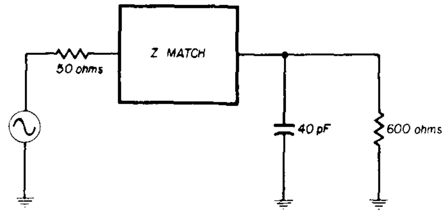


fig. 13. Complex load to be matched in *example 3*.

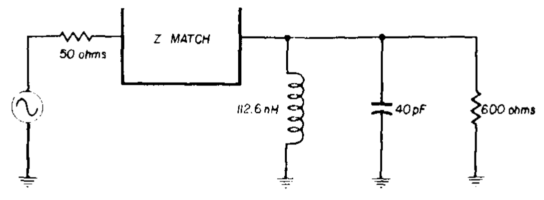


fig. 14. Resonating the stray load capacitance.

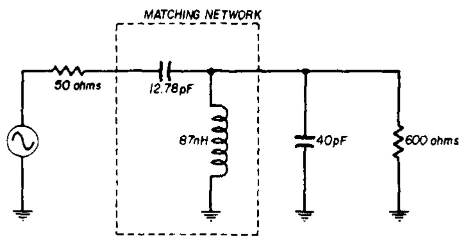


fig. 15. Circuit of *fig. 14* after impedance matching.

again chosen for the design, and again **example 1** provides the details. Thus, the calculated values for the network, if we ignore stray reactances, are shown back in **fig. 10**. But since the stray reactances really do exist, the design is not yet finished as we must now somehow absorb the strays into the matching network. This is done as follows. At the load end we need 4.8 pF for the matching network. We already have a stray 2 pF available at the load, so why not use it? If we use a 2.8 pF *element* capacitor, the *total* shunt capacitance becomes 4.8 pF, the design value. Similarly, at the source, the matching network calls for a series 477 nH inductor. We already have a +j126 ohm, or 200 nH inductor available in the source. If we use an actual element inductance of $477\ nH - 200\ nH = 277\ nH$, then the *total* series inductance will be 477 nH, which is the calculated design value. The final design is shown in **fig. 12**.

Notice that nowhere in the example was a conjugate match even mentioned. However, you can rest assured that if you perform the simple analysis outlined in the previous section of this article, the impedance looking into the matching network, as seen by the source, will be 100 − j126 ohms which is indeed the complex conjugate of 100 + j126 ohms.

Obviously, if the stray element values are larger than the calculated element values, absorption cannot take place. If, for instance, the stray capacitance of **fig. 11** were 20 pF, we could not have added a shunt element capacitor to give us a total needed shunt capacitance of 4.8 pF. In a situation such as this, when absorption is not possible, the concept of resonance coupled with absorption will often do the trick.

example 3

Design an impedance matching network which will block the flow of DC from the source to load of **fig. 13**. The frequency of operation is 75 MHz. Try the resonant approach.

Solution: The need to block the flow of DC from the source to the load dictates the use of the matching network of **fig. 4C**. But first let's get rid of the stray 40 pF capacitor by resonating it with a shunt inductor at 75 MHz.

$$L = \frac{1}{\omega^2 C_{stray}}$$

$$= \frac{1}{[2\pi\ (75 \times 10^6)]^2\ (40 \times 10^{-12})}$$

$$= 112.6\ nH$$

This leaves us with the circuit of **fig. 14**. Now that we have eliminated the stray capacitance, we can proceed with the matching network between the 50-ohm load and the apparent 600-ohm load.

Thus:

$$Q_s = Q_p = \sqrt{\frac{R_p}{R_s} - 1} = \sqrt{\frac{600}{50} - 1} = 3.32$$

$$X_s = Q_s R_s = (3.32)(50) = 166\ ohms$$

$$X_p = \frac{R_p}{Q_p} = \frac{600}{3.32} = 181\ ohms$$

Therefore, the element values are:

$$C = \frac{1}{\omega X_s} = \frac{1}{2\pi(75 \times 10^6)(166)} = 12.78\ pF$$

$$L = \frac{X_p}{\omega} = \frac{181}{2\pi(75 \times 10^6)} = 384\ nH$$

These values then, yield the circuit of **fig. 15**. But notice that this circuit can be further simplified by simply replacing the two shunt inductors by a single inductor.

Therefore:

$$L_{new} = \frac{L_1 L_2}{L_1 + L_2} = \frac{(384)(112.6)}{384 + 112.6} = 87\ nH$$

The final design appears in **fig. 16**.

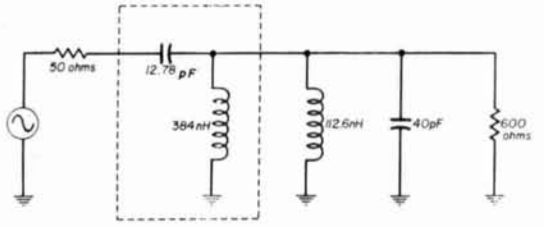


fig. 16. Final design of *example 3.*

conclusion

Examples 2 and **3** detail some very important concepts in the design of impedance matching networks. With a little planning and preparation, the design of simple impedance matching networks between complex loads becomes a simple number-crunching task using elementary algebra. Any stray reactances present in the source and load can usually be absorbed into the matching network, (**example 2**) or can be resonated with an equal and opposite reactance which is then absorbed into the network instead (**example 3**).

Impedance matching isn't really magic at all, is it?

ham radio

AEA Brings You The RTTY Breakthrough

NEW MBATEXT™ $109.95 List / $89.95* VIC-20 MBATEXT or C-64 MBATEXT

MBATEXT™ is the most advanced MBA (Morse, Baudot, ASCII) software plug-in cartridge available for the VIC-20 or Commodore 64 computer. Compare our outstanding features and price to the competition.

• KEYBOARD OVERLAY instructions to avoid constant referral to the manual • RTTY and ASCII SPEED ESTIMATE MODE • BREAK-IN CW MODE •QSO BUFFER RECORD TOGGLE •WORD PROCESSOR style insertion, deletion, and correction in TEXT EDIT MODE • CW AUTO SPEED TRACKING plus SPEED LOCK • BREAK-IN BUFFER that is easy to use • Low speed FARNSWORTH CW TRANSMISSION (between 5 and 14 WPM) • RE-TRANSMIT RECEIVED TEXT DIRECTLY without need of disk or cassette • DISK, CASSETTE, OR PRINTER storage of message and QSO buffers • RECEIVE AND TRANSMIT 5-99 WPM MORSE • 10 SOFT-PARTITIONED™ MESSAGE (OR TEST) BUFFERS • WORD WRAP • TIME OF DAY CLOCK • PRECOMPOSE SPLIT SCREEN OPERATION • STATUS INDICATORS on screen • EASY START-UP by simply typing SYS 44444 or SYS 33333 • DEDICATED FUNCTION KEYS for quick operation • Ability to IMBED CONTROL FUNCTIONS in type-ahead buffer • WORD OR CHARACTER mode • SELECTABLE BAUDOT UNSHIFT ON SPACE (USOS) •SEND/RECEIVE 60, 67, 75, 100, 132 WPM BAUDOT PLUS 100, 300 BAUD ASCII • RTTY BLANK-FILL and MORSE BT option for idle transmit periods • AUTOMATIC PTT • computer control of TONE REVERSE • MASTER MENU, COMMAND MENU, and OPTIONS MENU makes MBATEXT™ easy to use with no prior experience • INCLUDES CABLE TO INTERFACE WITH AEA model CP-1 COMPUTER PATCH™ • POWERED BY HOST COMPUTER.

NEW MICROPATCH™

MICROPATCH™ IS A NEW LOW-COST, HIGH-PERFORMANCE Morse, Baudot and ASCII SOFTWARE/HARDWARE computer interface package. The MICROPATCH™ model MP-20 or MP-64 incorporates the complete MBATEXT software ROM (described above) for either the VIC-20 or Commodore 64 computers. All circuitry and software is incorporated on a single, plug-in cartridge module featuring the following: • TRUE DUAL CHANNEL MARK AND SPACE MULTI-STAGE 4 POLE, CHEBYSHEV ACTIVE FILTERS • AUTOMATIC THRESHOLD CORRECTION for good copy when one tone is obliterated by QRM or SELECTIVE FADING • EASY, POSITIVE TUNING with TRIPLE LED INDICATOR • NOT a low-cost, low-performance phase-locked loop detector!!! • SWITCH SELECTED 170 Hz or WIDE SHIFT on receive • 800 Hz multi-stage active CW FILTER • AUTOMATIC PTT • RTTY ANTI-SPACE • demodulator circuitry powered by external 12VDC (not supplied) to AVOID OVERLOADING HOST COMPUTER and for maximum EMI ISOLATION • EXAR 2206 SINE GENERATOR for AFSK output • SHIELDED TRANSCEIVER AFSK/PTT INTERFACE CABLE PROVIDED • PLUS or MINUS CW KEYED OUTPUT • FSK keyed output.

The Micropatch is structured for easy upgrading to the AEA Computer Patch™ advanced interface unit without having to buy a different software package! Simply unplug the external computer interface cable (supplied with the Micropatch) from the Micropatch and plug it into the Computer Patch.

$149.95 List $129.95*
MP-20 or MP-64

COMPUTER PATCH™

COMPUTER PATCH™ is the name of our most advanced computer interface equipment for Morse, Baudot, ASCII, or AMTOR operation. The CP-1 will allow you to patch most of the popular personal computers to your transceiver when used with the appropriate AEASOFT™ TU software such as AEA MBATEXT, AMTOR TEXT™, or the MBATEXT RESIDENT ON THE MICROPATCH units. AEA also offers a full feature software package for the Apple II, II plus and IIE; TRS-80 Models I, III and IV; and the IBM-PC. The CP-1 will also work with certain other computers using commonly available software packages.

The CP-1 offers the following advanced and high quality features: • HANDSOME ALL METAL ENCLOSURE FOR MAXIMUM RF IMMUNITY • DUAL CHANNEL, MULTI-STAGE ACTIVE MARK AND SPACE FILTERS • AUTOMATIC THRESHOLD CORRECTION • RECEIVE 170 HZ FIXED OR 100-1000 HZ VARIABLE SHIFT • 800 HZ multi-stage CW FILTER • PRE—LIMITER AND POST-LIMITER FILTERS • SERIAL RS-232 FIELD INSTALLABLE OPTION • 117 VAC WALL ADAPTOR SUPPLIED • PLUS (+) and MINUS (-) CW OUTPUT JACKS • MAGIC EYE STYLE BAR GRAPH TUNING INDICATOR • SCOPE OUTPUT JACKS • NORMAL/REVERSE front panel switch • MANUAL (override) PTT switch • VARIABLE THRESHOLD for CW • ANTI-SPACE RTTY • KEY INPUT JACK for narrow shift CW ID on RTTY, CW practice, or keyboard bypass.

The CP-1 is made in the U.S. with high quality components including double-sided glass epoxy through-hole plated boards, complete with *solder mask and silk screened parts designators.*

$239.95 List $199.95* CP-1

PACKAGE SPECIALS
$239.95*

Combine the VIC-20 or COMM-64 MBATEXT™ software with the CP-1 at time of purchase and you receive a SPECIAL PACKAGE PRICE. NOW the best RTTY COMPUTER INTERFACE SYSTEM is available at prices comparable only to vastly inferior systems.

CP-1/20 (CP-1 with VIC 20 MBATEXT) CP-1/64 (CP-1 with C-64 MBATEXT)

*SUGGESTED AMATEUR DISCOUNT PRICE THROUGH PARTICIPATING DEALERS ONLY

MIDWEST AMATEUR RADIO SUPPLY

3454 Fremont Avenue, North
Minneapolis, MN 55412
Store Hours: Mon.-Fri. 9-6, Saturday 9-3
(612) 521-4662

✓ 161

ham radio TECHNIQUES

Bill Orr W6SAI

fifty years ago

1934 was a very good year. True, the United States was in the grip of a worldwide depression and unemployment ran over 30 percent, nationwide. But for Radio Amateurs it was a golden year of opportunity. Interest in the hobby was booming and the number of licensed Amateurs grew rapidly. The advent of the AC-operated broadcast receiver and the loosening of patents on vacuum tubes and the superheterodyne receiver brought forth new circuits, new tubes, and new techniques.

For nearly a decade Amateur Radio had been in the doldrums, overshadowed by the "broadcast craze." But now it was coming into its own. For a newly licensed Radio Amateur (like me) the opportunities were numerous. *QST* blazed with enticing advertisements for such newly-created companies as Hallicrafters, Collins Radio Co., and Eitel-McCullough (EIMAC).

Getting on the air, however, was a formidable problem for a high school lad with a weekly allowance of fifty cents. That, plus money earned on odd jobs around the town, soon grew to a grand sum of about fifteen dollars that could be spent on a ham transmitter, and a few months after my license arrived, I was on the air with a 40 watt phone/CW "breadboard" transmitter.

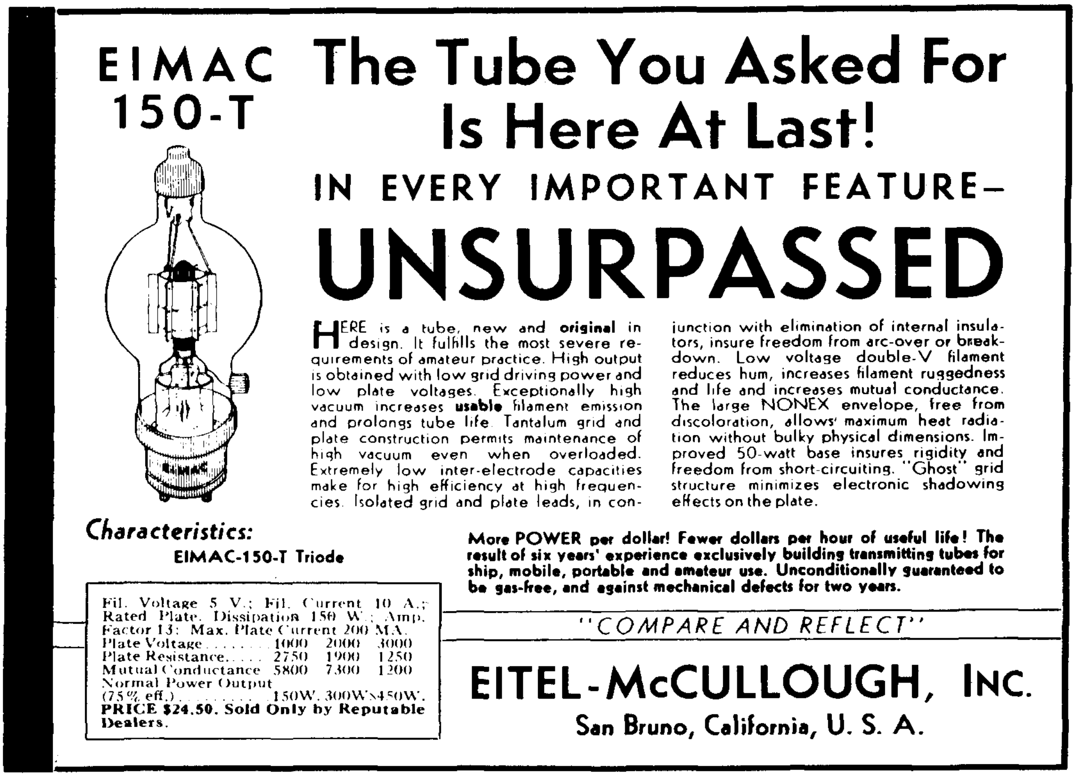


fig. 1. This modest ad started it all in 1934. W6UF and W6CHE couldn't buy the tube they wanted, so they built their own.

It was the beginning of a long journey, still in progress. In 1934, I had little inkling of where the future would lead me.

Across the continent, in San Bruno, California, two young Radio Amateurs were betting their future on a new tube development. Bill Eitel, W6UF, and Jack McCullough, W6CHE, combined their brains, talent, and their thin pocketbooks to start manufacturing a precedent-setting transmitting tube. Little did they realize they would revolutionize the world's tube industry and quickly assume a dominant role in the communications industry. And little did I realize, as I read the first EIMAC ad in November, 1934s *QST* (**fig. 1**), that these two pioneers would become my close friends and colleagues in years to come. Yes, 1934 was a very good year.

more on video disc RFI

In last month's column I commented on the severe RFI problems encountered with the video disc player which has active circuits that function in the 900-925 MHz range. No sooner had I written the column than I received the ARRL Letter which said, in part, that the FCC "had been informed by RCA Corporation that there is a potential interference problem resulting from the new 902-928 MHz secondary status allocation to the Amateur Radio service under Part 2 of the Rules."

RCA went on to state that the FCC should "seek recognition of the need for balancing a possible continuing experimental use of the 902-928 MHz band against the beneficial influence of the video disc player in the lives of millions of U.S. consumers, now, and for years to come."

Amazing! RCA, which has known of the potential incompatibility of its video disc player (as discussed in this column last month), could have chosen to redesign the unit to be immune to RF pickup, but instead chose to lay a "guilt trip" on the Radio Amateur and the FCC. The ARRL promises strong opposition to this move. I'll keep you informed!

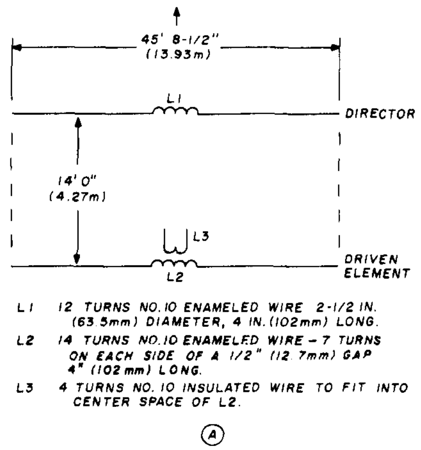


fig. 2A. Top view of 40-meter beam. Dimensions are for 7.2 MHz. Add 10 inches (254 mm) to tips for resonance at 7.025 MHz. Note that both elements are the same length.

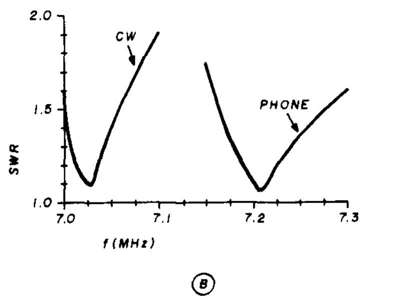


fig. 2B. SWR curves of 40-meter beam for CW and phone operation.

. . . and on RF lamps

Since the late 1970's several companies (General Electric, North American Phillips, International Energy Conservation System, and Soli-Tronics — among others) have been developing and manufacturing limited numbers of RF lighting devices. In general, these are fluorescent tubes that have electronic ballasting instead of an electromagnetic ballast.

One form of RF light is a self-contained lamp that screws into a standard bulb socket; a second type is an external solid-state RF ballast package that will replace the conventional ballast device in existing fluorescent lamps; and a third type of lamp makes use of RF energy delivered to it over the wires.

Most electronic ballasts operate between 20 and 40 kHz, but at least one type operates in the ISM (Industrial-Scientific-Medical) band at 13.56 MHz.

The general theory of operation is that rectified AC is applied to an inverter whose output is RF energy at a frequency above 20 kHz. The RF energy is then applied to a fluorescent tube to strike an arc that excites the fluorescent coating to emit light.

Some of the RF lamps require that the RF oscillator be on continuously while the lamp is lit, while others require a burst of RF energy only when the lamp is turned on.

Compared to an incandescent lamp, the RF lamp is supposed to be more energy-efficient, using only 25 percent as much energy to produce the same lumen output as a conventional bulb.

A powerful argument exists, then, for the marketing of the RF lamp, if only as an energy conserver. The unanswered question is, how much RF interference do these lamps generate? And what will be the effect upon radio communications when hundreds of thousands (or millions) of these lamps are in daily use?

Last fall the FCC granted a limited waiver to various companies to manufacture and market 10,000 electronic ballast units and 100,000 RF light bulbs to be used in field testing and evaluations. The companies will study the cumulative effect of a large number of devices (installed in one plant and all connected to a single wiring system) on the amount of RF interference created, and how this correlates with the RFI level of a single device.

All well and good, but this operation reminds me of a student grading his or her own exam paper! I'm sure these noise generators will soon be on the market; the question is how much control will be exerted by the FCC over the noise radiated by these new RF lamps?

a compact 40-meter beam

As the sunspot cycle continues on its downward trend, activity picks up on the lower frequency bands that are less affected by the rise and fall of the MUF (Maximum Usable Frequency). Forty meters is *really* coming into its own as a DX band! Some very effective beams are being used on this band, making it very hard for the average ham with a dipole or groundplane to enjoy contacts with exotic DX stations. One answer to this vexing problem is the miniature beam antenna. Despised by those who own full-size beams, the "mini-beam" can give a good account of itself provided it is well designed and properly built. Even a 40-meter mini-beam is quite large, and it's difficult to build one that won't fall apart in heavy wind. Shown in **fig. 2A** is a practical and rugged mini-beam design that has stood the test of time. Used by various California DXers for a decade, it can hold its own in a pile-up and also endure buffeting by heavy winds.

Center-loaded elements are used even though loading coils placed near the element tips are theoretically more efficient. The elements are made of 1 1/4-inch (31.75 mm) OD aluminum tubing with telescoping tips. Twelve foot (3.66 meters) long tubes are used.

The parasitic element is a director, and for CW operation at the low end of the band, is resonant at about 6.7 MHz. The driven element is resonant at 7.025 MHz. The elements are adjusted to resonance with the aid of a dip-oscillator before the beam is assembled. The coils are fixed and frequency adjustments are made to the tip sections.

Loading coils are wound on a 2 1/2 inch (6.35 mm) OD phenolic rod and are given a coat of epoxy after completion. RF current in the coils is quite high, so solid connections must be made between the coil and the elements with 1/2-inch (12.7 mm) wide copper strap.

The elements are supported on a 15-foot (4.57 m) long boom of 2 1/2-inch (63.5 mm) diameter, heavy wall aluminum tubing. Mounting plates and U-bolts hold the elements to the boom. Insulating sleeves are used between the U-bolts and the element sections, as illustrated.

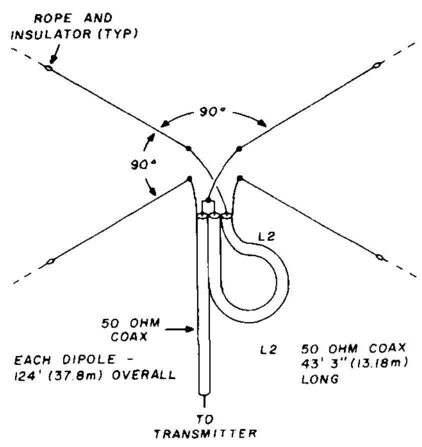


fig. 3. The 80-meter wideband antenna at ZS6ZO. Two dipoles spaced 90 degrees apart in plan view are fed 90 degrees out-of-phase with an electrical quarter-wavelength interconnecting line. Shields of lines are all soldered together at dipole feedpoint and connected to adjacent antenna sections.

SWR curves for the mini-beam are shown in **fig. 2B**, for the CW and SSB band segments. The SWR curve is affected by the director length, primarily, and by the adjustment of the coupling coil at the center of the driven element. Changing the director length by a few inches should drop the SWR curve down to a reasonable value at the design frequency.

Proper operation requires that the beam be well up in the air; a half-wavelength above ground is suggested as a minimum height. That means about 65 feet! Good results have been achieved with the beam as low as 35 feet, but the advantages of low angle radiation are lost when the beam is placed at a low elevation.

the ZS6ZO wideband 80-meter antenna

Dave, ZS6ZO, has had good luck on 80 meters with the Turnstyle-type antenna shown in **fig. 3**. He uses two dipoles cut to the middle of the band and spaced 90 degrees apart. He feeds them 90 degrees out-of-phase with a quarter-wave length of coaxial line between the dipoles. This provides circular polarization to the zenith and omnidirectional horizontal polarization to the horizon.

As one dipole increases in electrical length with respect to the design frequency, the other, via the quarter-wave line, appears shorter. This results in doubling the bandwidth over just two dipoles fed in parallel at the center points.

the forgotten RG-58 cable

Save money on your feedline? That's always an attractive proposition. It's not always necessary to use the expensive RG-8A/U or RG-213/U coax, especially for a lower frequency antenna when moderate power levels are used. This is where the RG-58 family of cable comes into use. As with other cables, there are several forms of RG-58 on the market: RG-58/U, RG-58/U type, RG-58A/U, RG-58A/U type and RG-58C/U type. The first two are older style cables with an impedance of 53.5 ohms. Stay away from these, because modern SWR meters are designed for 50-ohm line (the RG-58/U type may also be an inferior cable). The newer, 50-ohm cables are the RG-58A/U and the RG-58C/U. Of the two, the C/U is the better choice because of a non-contaminating (longlife) outer jacket. (The RG-58A/U and the RG-58A/U type both have the lower cost, PVC outer jacket which has a much shorter life.)

The RG-58C/U, when used below approximately 10 MHz, has only about 1 dB loss per one hundred feet, with the loss dropping as the frequency goes down. While the cable is not rated in terms of power carrying ability, I have used it with no problems at 1 kW PEP and CW input. Indeed for short runs of up to 25 or 30 feet, it can be used with success up to 30 MHz. At 28.6 MHz a 30 foot section runs slightly warm with 1 kW PEP input working into a load SWR of 1.5:1.

In order to use the cable with the popular PL-259 style of plug an adapter is required. The military number of this part is UG-175/U (Amphenol No. 83-185). The adapter fits inside the

PL-259 and allows the user to make a tight connection between plug and cable.

using the cable adapter

It is tempting to use the cable/plug assembly drawings shown in most handbooks, but I've found a simpler process that allows you to use the plug and adapter more than once. In other words, this method is easier to use and to disassemble than the process outlined in the handbook.

Strip the cable jacket back by 3/4 inch. (I use a sharp nail scissors to do this to prevent nicking the braid.) Trim the end of the jacket square; then, using the scissors, cut the braid back so that only 1/4 inch projects out from under the jacket. At this point (or before) the adapter and PL-259 outer coupling ring are slid over the cable, leaving just the short braid projecting from the rim of the adapter.

Spread the braid out evenly over the rim of the adapter and with the scissors, trim it back to the outer edge of the adapter. Only a fraction of an inch of the braid covers the lip of the adapter now. Next, solder the braid to the lip of the adapter all around the rim. (Use only a small soldering iron to avoid overheating the center insulation of the cable.) When the adapter has cooled, file the rough edges of the braid and solder down to a smooth surface. Thread the adapter and cable into the PL-259 plug and twist the plug/adapter combination tight with the aid of two pliers. Solder the inner conductor of the cable to the end of the center pin of the plug.

It actually takes longer to describe the operation than to do it. The connection has never worked loose in my experience, and it is very easy to unsolder the adapter and reuse it.

Remember that the PL-259 series of plugs are not waterproof; they should be protected against moisture regardless of the assembly technique used. I wrap mine with several layers of electrical tape and that seems to do the job.

ham radio

NEW!

Full Featured ~ Miniature H/T Power to Go...

FROM

MIRAGE

B23A
(144–148 MHZ)

Actual Size:
2" x 3½" x 7¼"

C22A
(220–225 MHZ)

- **2 Watts in = 30 Watts out**
- **Built-in Receive Preamp**
- **All mode operation (FM, CW, or SSB)**
- **Automatic Antenna Changeover**

- **2 Watts in = 20 Watts out**
- **Built-in Receive Preamp**
- **All mode operation (FM, CW, or SSB)**
- **Automatic Antenna Changeover**

MIRAGE COMMUNICATIONS **P.O. Box 1000 Morgan Hill, CA 95037**

✓ 162

Free Antenna Accessories Catalog

◂ Coaxial Antenna Relays

Remotely select up to 9 antennas from your transmitter, using only *one* coaxial cable. Environmentalized, high power and low loss.

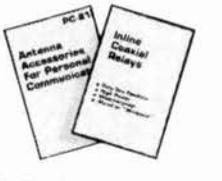
W2AU and W2DU Baluns▸

Our baluns, center insulators and insulators have been preferred for 20 years by Hams, industry, and the armed forces. Protect against TVI and lightning 1.8–200 MHz.

◂W2VS Antenna Traps

Add these traps to your dipole and get low SWR on 2 to 6 bands, depending on how many you add. Antenna wire and custom kits also available.

Send For Yours Today▸



Don't delay. Call or write today, and we will send you free literature which fully describes our Ham antenna accessory product line.
Dealer inquiries also welcome.

UNADILLA/REYCO/INLINE
A Division of Microwave Filter Co., Inc.

6743 Kinne St., East Syracuse, NY 13057
Toll Free 1-800-448-1666 TWX 710-541-0493
NY/HI/AK/Canada (Collect) 315-437-3953

✓ 160

CB-10 FM SPECIAL

- Hy Gain 40-Channel Board
- 40-Channel Switch
- Volume & Squelch Control
- FM Detector Module
- Full Instructions Included

$14.95 *Add $2.00 shipping & handling* *BOARD ONLY $6.95*

QRP TRANSCEIVER SET – $34.95

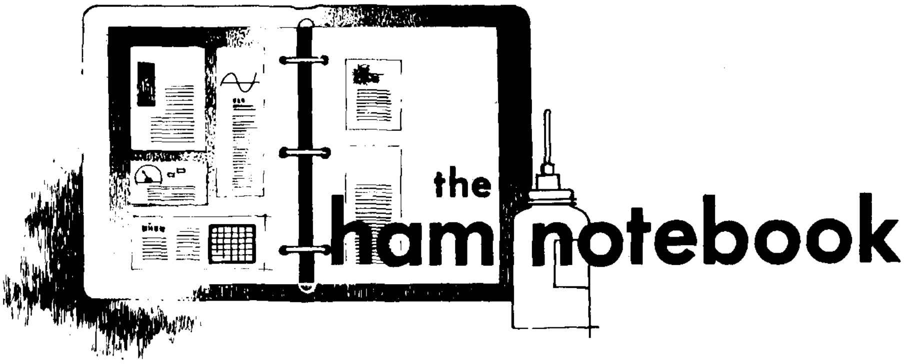
VHF CONVERTER SET — $24.95

Add $2.00 For Shipping & Handling – Send For FREE Brochure

SEND $2.00 FOR FULL MANUAL WITH CIRCUIT DIAGRAMS
MANY OTHER MODULES AVAILABLE

MORNING DISTRIBUTING CO.
P.O. BOX 717, HIALEAH, FLA. 33011

✓ 164



limited space inverted "L"

During the past two years I have been assigned to Great Lakes Naval Training Center and have lived in a townhouse at Grayslake, Illinois. Needless to say, I never thought that I would be able to get on the air from this location at all — let alone on 160, 80, and 40 meters. How did I do it? With a good earth reference and some short inverted "L"s.

The ground reference for the antennas is a "window-well" retaining wall. The dimensions are 4 × 5 feet with 2 feet on each side, leaving a total of 80 square feet of visible ground contact.

The antennas, all "shunt-fed," measure 14 feet in the vertical dimension. I spaced them across the front of the window-well 18 inches from the side of the house. Switching is made possible with a Heathkit antenna switcher. A single line trails into the basement via the air-conditioner pipe hole-through.

Figure 1 illustrates the three-band antenna configuration. Coil taps may vary because your ground situation is unique to your QTH. However, the given coil information should be close. My successes have been "WAS" on 80/40 and 42 on 160 so far. I have worked 66 countries on top band and 74 on 80/40 this year, and also worked four JA stations for WAC on 160 again (last year I worked only one JA). I hope you can install the same kind of system I have had so much success with while "confined" to a townhouse.

Fred C. Race, W8FR

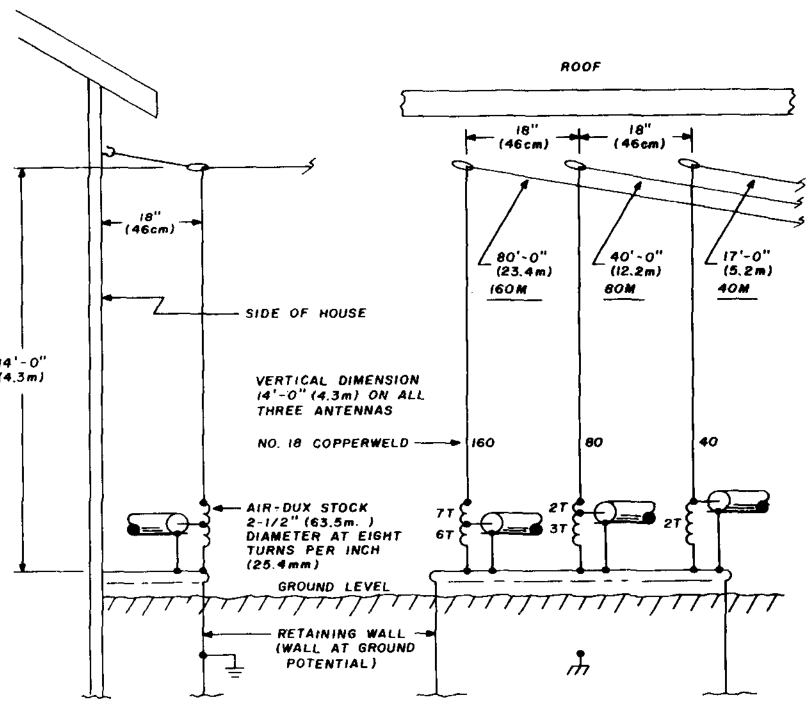


fig. 1. Vertical sections of the shortened inverted L are only 14 feet in length.

neutralizing 572B final at 1500 watts output

The recent FCC ruling setting 1 1/2 kW as the maximum power output prompted me to rework one of my home-made amplifiers, a pair of 572Bs, grounded grid, to grounded cathode for more output.

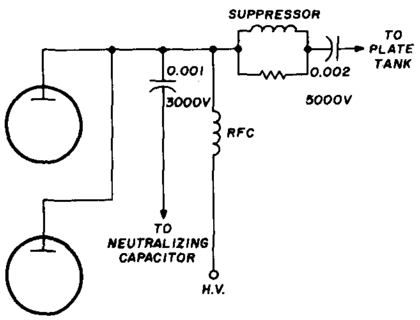


fig. 1. New neutralizing circuit.

The two tubes, fan cooled, would put out 550 watts in grounded grid before showing any color. Grid driven in Class C, they put out a nice 1425 watts. But there was a problem with the frequency-sensitive neutralizing settings. I could adjust the neutralization for stability on any one band, but it would sometimes take off on some other band. In the past I solved this problem by using a form of negative feedback in the filament circuit. However, this requires more drive power on the higher bands, and Class C is hard enough to drive as is.

After much fruitless cut-and-try with

parasitic coils, I decided to take the parasitic coils out of the neutralizing path. I wired the two tubes directly to the hot end of the RF plate choke. From the same point I connected a 0.001 μF 5000 volt mica capacitor to the neutralizing capacitor. Also from the same point I wired in one of the parasitic suppressors to the regular plate coupling capacitor. (See **fig. 1**.) This cured any tendency towards instability. Now with zero bias on the tubes and a full 2750 volts on the plates, no amount of band switching or knob twisting will show the tiniest twitch on the meters.

The parasitic choke is a self-supported coil consisting of seven turns of No. 14 wire, 5/16 inch (8 mm) diameter and 3/4 inch (19 mm) long. The swamping resistor is a Globar with a cold resistance of 400 ohms.

John Labaj, W2YW

high-frequency dummy load

This 52-ohm dummy load consists of twelve 620 ohm, 2-watt resistors housed in a salve can. The load is useful to 175 MHz.

It is capable of dissipating 30 watts on a 50 percent cycle and 50 watts on a shorter duty cycle.

Start construction by filing the outboard shoulder of a UG-176/UHF sleeve to a 3/32 inch (2.5 mm) height. Tin the inner shoulder of the sleeve and outboard end of the PL-259 fitting. The tinned areas are indicated as "solder" in the drawing.

Next, drill and ream a hole in the center of the bottom salve can to accommodate the UG-176/UHF sleeve. Then drill twelve No. 50 drill holes around the periphery of the can. They are on a line half way up the can. Tin area inside and out around each hole, mount the coax connector on the bottom and sweat solder in place.

Solder a 2-3/4 inch (70 mm) length of No. 14 wire center of PL-259 connector extending into the salve can. Fit each 620 ohm 2-watt resistor in place between the center conductor and hole drilled in the rim of the can. Clip outer end about 1/32 inch (1 mm) beyond can and solder. Form resistor wire approximately half way around the No. 14 wire. After 12 resistors are mounted, consolidate their other ends about the No. 14 wire and solder.

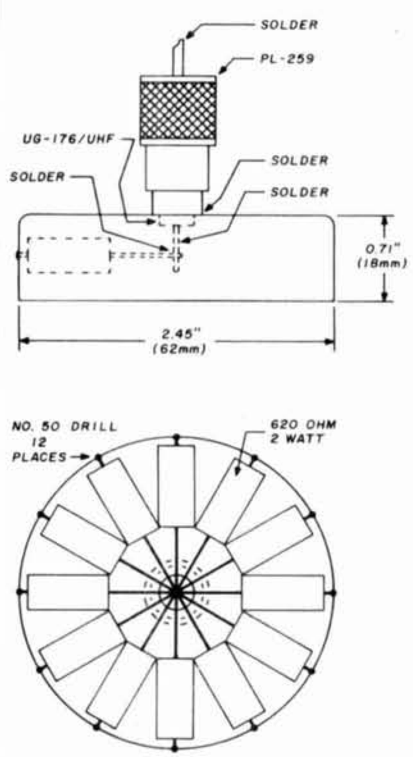


fig. 1. HF dummy load, construction details.

Clip excess from No. 14 wire. Fit on the cover and you have a shielded dummy load.

William J. Goodwin, W1KWE

(Reprinted with permission from *Air Force MARS Communicator*.)

antenna support

I have been using nylon rope to hold up my vertical antennas. Nylon rope, however, tends to stretch and come apart, and it needs constant attention.

A better method is to use nylon fishing line. For small vertical antennas, a 300 to 600 pound-test line is okay. For larger antennas ask for cod line, which is almost 1/16-inch thick and very tough. Look in your fishing book for the right knots.

Ed Marriner, W6XM

JPC/AZDEN®

4000 SERIES FM TRANSCEIVERS

10 METERS & DOWN

New!

PCS-4000
2-m FM Transceiver

COMMERCIAL-GRADE QUALITY AT AMATEUR PRICES

EXCLUSIVE 1 YEAR LIMITED WARRANTY! *COMPARE!*

THE 4000 SERIES

PCS-4300 70-cm FM Transceiver

PCS-4500 6-m FM Transceiver

PCS-4800 10-m FM Transceiver

SALE

PLEASE CALL FOR SPECIAL PRICE

PCS-300
2m Handheld
FM Transceiver
142-149.995 MHz

✓ 109

- **WIDE FREQUENCY COVERAGE:** PCS-4000 covers 142.000-149.995 MHz in selectable steps *of 5 or 10 kHz. PCS-4200 covers 220.000-224.995* MHz in selectable steps of 5 or 20 kHz. PCS-4300 covers 440.000-449.995 MHz in selectable steps of 5 or 25 kHz. PCS-4500 covers 50.000-53.995 MHz in selectable steps of 5 or 10 kHz. PCS-4800 covers 28.000-29.990 MHz in selectable steps of 10 or 20 kHz.
- **CAP/MARS BUILT IN:** PCS-4000 includes coverage of CAP and MARS frequencies.
- **TINY SIZE:** Only 2"H × 5.5"W × 6.8"D. COMPARE!
- **MICROCOMPUTER CONTROL:** At the forefront of technology!
- **UP TO 8 NONSTANDARD SPLITS:** *Ultimate* versatility. COMPARE!
- **16-CHANNEL MEMORY IN TWO 8-CHANNEL BANKS:** Retains frequency and standard simplex or plus/minus offsets. *Standard offsets are 600 kHz* for PCS-4000, 1.6 MHz for PCS-4200, 5 MHz for PCS-4300, 1 MHz for PCS-4500, and 100 KHz for PCS-4800.
- **DUAL MEMORY SCAN:** *Scan memory banks* either separately or together. COMPARE!
- **TWO RANGES OF PROGRAMMABLE BAND SCANNING:** Limits are quickly reset. Scan the two segments *either separately or together*. COMPARE!
- **FREE AND VACANT SCAN MODES:** Free scanning stops 5 seconds on a busy channel; auto-resume can be overridden if desired. Vacant scanning stops *on unoccupied frequencies.*
- **DISCRIMINATOR SCAN CENTERING (AZDEN EXCLUSIVE PATENT):** Always stops on frequency.
- **TWO PRIORITY MEMORIES:** Either may be instantly recalled at any time. COMPARE!
- **NICAD MEMORY BACKUP:** Never lose the programmed channels!
- **FREQUENCY REVERSE:** The touch of a single button inverts the transmit and receive frequencies, no matter what the offset.
- **ILLUMINATED KEYBOARD WITH ACQUISITION TONE:** *Unparalleled ease of operation.*
- **BRIGHT GREEN LED FREQUENCY DISPLAY:** Easily visible, even in direct sunlight.
- **DIGITAL S/RF METER:** Shows incoming signal strength and relative power output.
- **BUSY-CHANNEL AND TRANSMIT INDICATORS:** Bright LEDs show when a channel is busy and when you are transmitting.
- **FULL 16-KEY TOUCHTONE® PAD:** Keyboard functions as autopatch when transmitting (except in PCS-4800).
- **PL TONE:** Optional PL tone unit allows access to private-line repeaters. Deviation and tone frequency are fully adjustable.
- **TRUE FM:** Not phase modulation. Unsurpassed intelligibility and audio fidelity.
- **HIGH/LOW POWER OUTPUT:** 25 or 5 watts selectable in PCS-4000; 10 or 1 watt selectable in PCS-4200, PCS-4300, PCS-4500, and PCS-4800. Transmitter power is fully adjustable.
- **SUPERIOR RECEIVER:** Sensitivity is 0.2 uV or better for 20-dB quieting. Circuits are designed and manufactured to rigorous specifications for exceptional performance, second to none. COMPARE!
- **REMOTE-CONTROL MICROPHONE:** Memory A-1 call, up/down manual scan, and memory address functions may be performed without touching the front panel! COMPARE!
- **OTHER FEATURES:** Dynamic microphone, rugged built-in speaker, mobile mounting bracket, remote speaker jack, and all cords, plugs, fuses, and hardware are included.
- **ACCESSORIES:** CS-7R 7-amp ac power supply, CS-4.5R 4.5-amp ac power supply, CS-AS remote speaker, and Communications Specialists SS-32 PL tone module.
- **ONE YEAR LIMITED WARRANTY!**

EXCLUSIVE DISTRIBUTOR: *DEALER INQUIRIES INVITED*

AMATEUR-WHOLESALE ELECTRONICS **TOLL FREE...800-327-3102**

8817 S.W. 129th Terrace, Miami, Florida 33176 Telephone (305) 233-3631 Telex: 80-3356

VISA MasterCard

MANUFACTURER:

JPC AZDEN **JAPAN PIEZO CO., LTD.**
1-12-17 Kamirenjaku, Mitaka, Tokyo, 181 Japan. Telex: 781-2822452


Communications Specialists TE-64

CALL TOLL FREE FOR QUOTES

TNT RADIO SALES INC.

1-800-328-0250
1-612-535-5050
(IN MINNESOTA- COLLECT)

A Winning Combo SPECIAL for Mobile or Shack!

Kenwood TS 430S
& Hustler Mobile HF Ant.

Special Only $789

Includes TS 430S, Hustler Bumper Mount, & Mast, 5-400W. PEP Resonators, 10-80 Meters

SP-430 TS-430S AT-250

KENWOOD
ICOM
MIRAGE
AEA
KANTRONICS
SANTEC
KDK
AZDEN
NYE VIKING
MFJ
TELEX HY-GAIN
HUSTLER
KLM
CUSHCRAFT
ROHN
LARSEN
BUTTERNUT

VISA/MASTER CARD
FREE SHIPPING
ON MOST RIGS FOR CASH!

MasterCard VISA

S.A.S.E. FOR OUR
"BENCH-TESTED"
USED EQUIPMENT LISTING

MONDAY - SATURDAY
9 AM to 6 PM CENTRAL TIME

4124 West Broadway, Robbinsdale, MN 55422 (Mpls./St. Paul)

192

IF WE WERE YOU

MODEL 6154 TERMALINE®

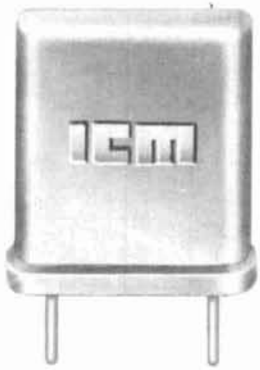
I'D BUY FROM US

YOUR INQUIRY OR ORDER WILL GET OUR PROMPT ATTENTION

AUTHORIZED BIRD DISTRIBUTOR

Webster associates
115 BELLARMINE
ROCHESTER, MI 48063
CALL TOLL FREE
800-521-2333
IN MICHIGAN 313 – 375-0420

202



RELIABILITY & ACCURACY.

Precision Quartz Crystals 70 KHz to 200 MHz. International is a major supplier to the commercial, industrial, and amateur crystal market.

ICM

For complete information contact our sales department.
INTERNATIONAL CRYSTAL MFG. CO., INC.
10 North Lee, P.O. Box 26330, Oklahoma City, Oklahoma 73126 (405) 236-3741

149

KENWOOD

...pacesetter in amateur radio

TS-930S "DX-traordinary"

TS-930S

We call it "DX-traordinary" because the TS-930S has now become the favorite rig of the serious contester! Its superior capability for full break-in split-frequency operation, the speed and convenience with which its eight memory channels can be accessed, its unsurpassed receiver dynamic range and its remarkable ability to select the desired signal during periods of heavy QRM, utilizing VBT, Slope tuning, IF Notch filtering, and tuneable audio filtering, have all combined to make this the rig that gives you the EXTRA EDGE!

The TS-930S is loaded with all the special features that you always wanted in an HF transceiver. Full coverage of the 160 through 10 meter bands, including the new WARC frequencies, (easily modified for HF MARS), plus a general coverage receiver that can tune any frequency from 150 kHz to 30 MHz. Operation in the SSB, CW, FSK, and AM modes, with selectable full or semi CW break-in. All solid-state, with 250 watts PEP input on SSB, CW, FSK, and 80 watts input on AM. SWR/power meter. Triple final protection circuits plus two cooling fans built-in. 10-Hz step synthesized frequency control. Available with optional automatic antenna tuner built-in, another industry first! Dual digital VFO's. Eight memory channels that store both frequency and band information, with internal battery back-up, (batteries not supplied). Dual mode adjustable noise blankers, especially effective in eliminating "woodpecker" type interference. SSB IF slope tuning, for maximum rejection of interference. CW variable bandwidth, with pitch and sidetone control. IF notch filter. Tuneable audio peaking filter. Unique six digit white fluorescent tube digital display is easy-on-the-eyes during those long contests. RF speech processor, for higher average "talk-power." SSB monitor circuit. 4-step RF attenuator. VOX. 100-kHz marker. AC power supply built-in, 120, 220, or 240 VAC.

TS-930S Optional Accessories: AT-930 automatic antenna tuner, SP-930 external speaker, with selectable audio filters, YG-455C-1 (500 Hz), YG-455CN-1 (250 Hz), YK-88C-1 (500 Hz) CW filter, YK-88A-1 (6 kHz) AM filter, all plug-in type. SO-1 commercial stability TCXO, MC-60A deluxe desk microphone, MC-80 and MC-85 communications microphones, MC-42S mobile hand microphone, TL-922A linear amplifier (not for CW QSK), SM-220 station monitor, PC-1A phone patch, SW-2000 SWR/power meter, 160 ~ 6 meter, SW100A SWR/power/volt meter 160-2m HS-4, HS-5, HS-6, and HS-7 headphones.

Isn't it about time you stepped into the winner's circle?

More information on the TS-930S is available from authorized dealers of Trio-Kenwood Communications, 1111 West Walnut Street, Compton, California 90220.

Specifications and prices are subject to change without notice or obligation

KENWOOD

...pacesetter in amateur radio

TM-201A/TM-401A

TM-201A/TM-401A "comp-ACT"... tough act to follow.

The word "compact" best describes the TM-201A VHF (a big 25 watts!) or the TM-401A 70-cm (12 watts) mobiles. Measures 5.6Wx1.6Hx7.2D inches (the TM-201A and TM-401A are the most compact rigs available). Ideal in size, their performances are superlative. Each features a HI/LO power switch, dual digital VFO's built-in, 5 memories plus a "COM" channel with lithium battery back-up, memory scan, programmable band scan, priority alert scan, and GaAs FET RF (front end) amplifiers. They have a highly visible yellow LED digital display, a repeater offset switch, a reverse switch, and a "beeper" to confirm operation of various switches. For superior sound quality, the separate, external speaker can be easily mounted to project the sound in the desired direction. A 16-key autopatch UP/DOWN mic. allows easy remote operation of major front panel functions. Thanks to KENWOOD, compact radios are now available for the popular VHF and UHF bands providing high performance and superior sound quality.

Other TM-201A/TM-401A Optional Accessories:
TU-3 Programmable two-frequency CTCSS encoder, KPS-7A fixed station power supply, MA-4000 dual-bander mobile antenna with duplexer, SW-100A/B SWR/power meter, MC-55 mobile microphone with time-out timer.

Optional FC-10 Frequency Controller
Connects to the TM-201A or TM-401A. Convenient control keys for frequency UP/DOWN MHz shift, VFO A/B, and MR (memory recall or change memory channel). A green LCD display indicates transmit/ receive frequencies, memory channel number, ALERT, and SCAN (with blinking MHz decimal).

TW-4000A

TW-4000A
FM "Dual-Bander"

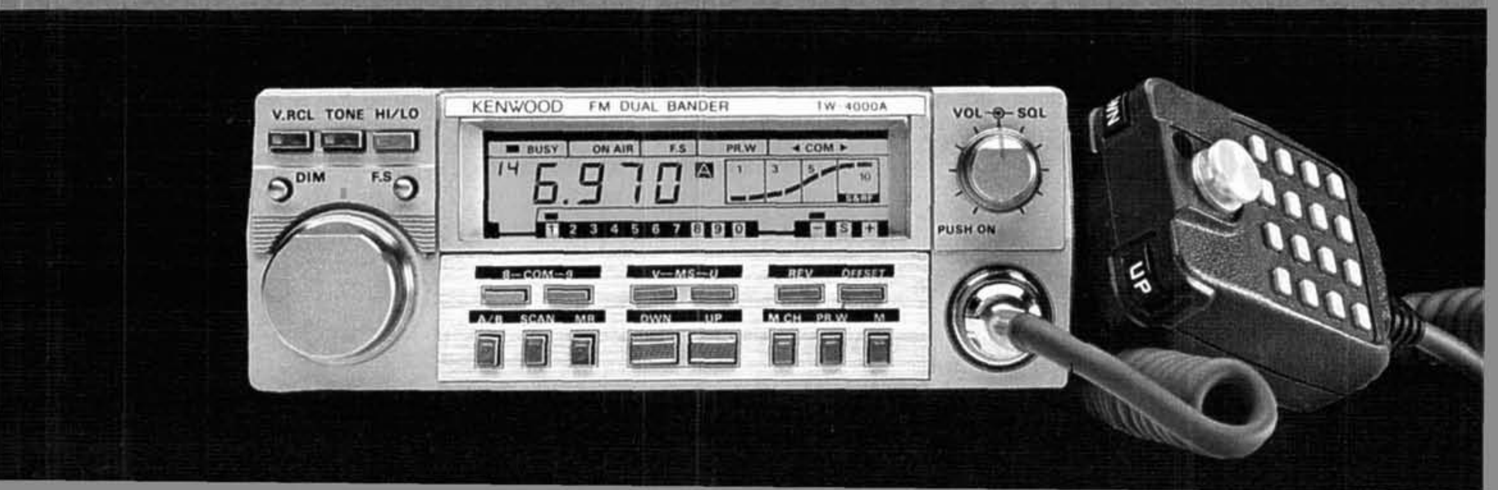
KENWOOD'S TW-4000A FM "Dual-Bander" provides new versatility in VHF and UHF operations, uniquely combining 2-m and 70-cm FM functions in one compact package. It covers the 2-m band (142.000-148.995 MHz), including certain MARS and CAP frequencies, and the 70-cm band (440.000-449.995 MHz), all in a package only 6-3/8 W x 2-3/8 H x 8-9/16 D inches. RF output power measures 25 watts on either band. The TW-4000A features a large, easy-to-read LCD display, front panel illumination for night operations, 10 memories with OFFSET recall and lithium battery backup, programmable memory scan, band scan in selected 1-MHz segments, priority watch function, common channel scan, dual digital VFO's, repeater reverse switch, GaAs FET front ends, rugged die-cast chassis, "beeper" through speaker, a mobile mount, and a 16-key autopatch UP/DOWN mic.

The new optional VS-1 voice synthesizer has everyone talking! A voice announces the frequency, band, VFO A or B, repeater offset, and memory channel number when these functions are selected.

Other TW-4000A optional accessories:
VS-1 voice synthesizer, TU-4C programmable two-frequency CTCSS encoder, KPS-7A fixed station power supply, SP-40 compact mobile speaker, SP-50 compact mobile speaker, MA-4000 dual-band mobile antenna with duplexor, MC-55 mobile microphone with time-out timer, and a SW-100B SWR/power meter.

More information on the TM-201A/TM-401A and TW-4000A is available from authorized dealers of Trio-Kenwood Communications 1111 West Walnut Street Compton, California 90220.

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



microphone calibration

Don't guess — here's how to determine your microphone's frequency response with or without a computer

A look around the serious ham's shack will often reveal many pieces of test equipment used to monitor the performance of commercial gear and run tests during the construction of homebrew gear. This equipment is also invaluable for "checking" items obtained during those innumerable scrounging trips that legend says soon become part of every Amateur's life.

Yet, the same serious Amateur who wouldn't dream of trying out a new antenna without first pulling out a trusty VSWR meter may think nothing of sticking a loudspeaker in a box without testing to see whether there are any nasty resonances, and will mount a microphone element in a holder other than the one for which it was designed without doing any tests at all. This lack of quantitative measurement in the performance of acoustic equipment is apparent in the poor audio quality of many stations you hear on the air. In light of the fact that many hams also consider themselves audio buffs, it's surprising that more testing isn't done and that discussions often include such inaccurate descriptions of sound quality as "wide-range," "boomy," "vibrant."

One reason more testing isn't done is that a calibrated microphone is necessary for truly accurate results. Calibrated microphones are expensive and their purchase difficult to justify, considering the few times that they are needed. This article describes a method of calibrating *any* microphone for use as a standard. You don't need an expensive microphone; in fact, instead of a microphone, a small loudspeaker will be sufficient. Any irregularities in the frequency response are not important. The calibration curve will reveal their location and magnitude, thereby enabling the proper allowances to be made.

Those of us who like to use only the latest technology may be disappointed to learn that the method used, the Reciprocity Principle, was described in a book entitled *Theory of Sound* written by Lord Rayleigh in 1877. It apparently wasn't new even at that time.

In applying the principle to microphone calibration, two loudspeakers, (one of which must be reversible), and the microphone under test are employed. When we say that one of the loudspeakers must be reversible, we mean simply that it must be capable of functioning as both a loudspeaker and a microphone. Common cone-type speakers with voice coils meet this requirement.

The first step consists of setting up the equipment shown in **fig. 1**. Loudspeaker SP1, and amplifier A serve simply as a sound source and do not need any special features. The loudspeaker of your stereo system, already connected to an amplifier, can be used as a convenient SP1.

Loudspeaker SP2, which must be reversible, and microphone M, whose calibration we seek, are placed side by side at distance *d* in front of SP1. (Distance *d* should be the same as the distance you intend to use for future tests because the low-frequency response of many microphones varies slightly with distance from the sound source.) The distance selected will depend upon the nature of the information desired; a microphone-to-speaker spacing of less than two feet greatly excludes the acoustic effects of

By Daniel Peters, NY6U, Falcon Communications, P.O. Box 620625, Woodside, California 94062

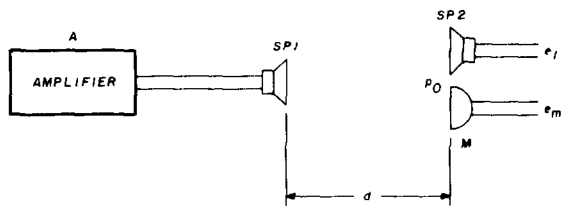


fig. 1. First step toward microphone calibration requires reversible loudspeaker.

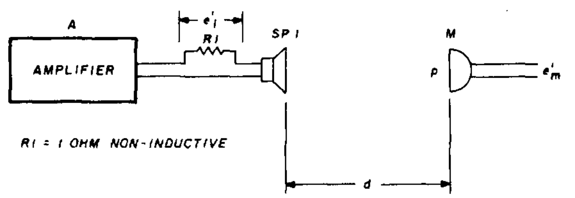


fig. 2. Insertion of one ohm resistor in amplifier output provides convenient measurement terminals.

the room, while larger spacings provide a measure of the effect of room acoustics. If you are calibrating your usual station microphone, it would be well to set distance *d* the same as your normal mouth-to-microphone distance.

Because the high frequency response of most microphones changes for different angles of incidence, position M and SP2 so that they point directly at SP1. For the same reason, place M and SP2 close to each other and aim SP1 squarely at them.

Feeding an audio tone into SP1 results in a sound pressure P_o at M and SP2, which generates an open circuit voltage e_m and e_l, respectively. Measure and record these voltages at each frequency of interest, using either a millivoltmeter or an audio amplifier followed by an AC voltmeter. As long as you use the same meter to make all measurements, the frequency response of the measuring instrument will not affect the results. Likewise, it is not necessary that SP1, or the audio signal driving it, have a flat, or even known amplitude. If you do not have a variable frequency audio generator to drive the amplifier connected to SP1, a tape with recorded audio tones will serve. Again, frequency response is not important; all you need is a source of known frequency.

Use a signal into SP1 sufficient to mask any background noise. However, keep the amplitude low enough to prevent overloading; otherwise the harmonics generated will give erroneous results.

Next, connect the equipment as shown in **fig. 2.** Note that we have replaced SP1 with SP2 and have added a 1-ohm resistor in series with the amplifier output. Distance *d* should remain unchanged. Supply audio power and measure voltages e'_m and e'_l at the same frequencies and with the same meter as used in the preceeding steps. Actually the current in SP2 is the quantity of interest; the 1-ohm resistor, R1, provides a 1-volt drop for every ampere of current, thereby allowing the use of the same voltmeter used in our other measurements.

After measuring e'_m and e'_l at the same frequencies at which e_m and e_l were measured, you should end up with a set of data such as shown in table 1.

table 1. Sample microphone calibration data.

f(MHz)	e_1*	e_m	e'_1	e'_m
20	0.50	0.40	190	3.6
30	0.50	0.70	250	6.0
40	0.60	1.50	320	4.8
60	0.40	2.30	320	1.6
80	0.62	2.60	320	5.2
100	2.40	1.40	320	1.8
150	0.65	0.50	320	5.2
200	0.36	1.40	320	5.1
300	0.36	2.70	320	8.8
500	0.74	5.40	320	25.5
700	1.90	7.80	320	170.0
1000	1.50	36.00	320	30.0
1500	2.20	12.00	320	37.0
2000	2.90	14.00	320	84.0
3000	0.70	0.16	320	34.0
4000	0.28	8.20	320	110.0
5000	0.14	6.80	320	54.0
7000	0.08	1.60	320	52.0

*All voltages in millivolts.

The formula for calculating the microphone sensitivity, S_m, is:

$$S_m = K\sqrt{\frac{e_m e'_m}{e_l e_l{}' f}} \quad \textbf{(1)}$$

The derivation of the above formula, including the value of *k*, is provided in the appendix. However, since a relative response curve is all that is generally required, the value of *k* is not important and can be left out of the formula, resulting in:

$$S_{mr} = \sqrt{\frac{e_m e'_m}{e_l e_l{}' f}} \quad \textbf{(2)}$$

In the above formula, S_{mr} is the relative microphone sensitivity, and *f* is the frequency in Hz; voltages are expressed in volts. If you took your readings in mV, you can use mV, if you use mV for all four entries.

Substitute the values recorded for each frequency in the formula and calculate the relative sensitivities. After finding the relative sensitivity for frequencies of interest, select a value considered an average and calculate all other points in reference to the selected one, table 2. Sample relative microphone sensitivity calibration chart.

f(MHz)	e_1*	e_m	e_1'	e_m'	S_{mr}	%S_{mr}**
20	0.50	0.40	190	3.6	0.0275	99.21
30	0.50	0.70	250	6.0	0.0334	120.60
40	0.60	1.50	320	4.8	0.0306	110.30
60	0.40	2.30	320	1.6	0.0218	78.89
80	0.62	2.60	320	5.2	0.0291	105.10
100	2.40	1.40	320	1.8	0.0057	20.64
150	0.65	0.50	320	5.2	0.0091	32.89
200	0.36	1.40	320	5.1	0.0176	63.44
300	0.36	2.70	320	8.8	0.0262	94.49
500	0.74	5.40	320	25.5	0.0341	122.90
700	1.90	7.80	320	170.0	0.0558	201.10
1000	1.50	36.00	320	30.0	0.0474	170.90
1500	2.20	12.00	320	37.0	0.0205	73.89
2000	2.90	14.00	320	84.0	0.0251	90.71
3000	0.70	0.16	320	34.0	0.0028	10.25
4000	0.28	8.20	320	110.0	0.0501	180.80
5000	0.14	6.80	320	54.0	0.0404	145.90
7000	0.08	1.60	320	52.0	0.0215	77.65
					average sum 0.0277	

*All voltages in millivolts.

$$**\%\ S_{mr} = \frac{S_{mr}}{S_{mr}(average)} \times 100\%$$

where S_{mr} average = sum of all S_{mr} readings divided by 18 (number of lines of data)

either as a percentage or in dB, using the selected value as 0 dB. (See **table 2.**) (Results may be plotted in the form of a graph.)

You are now ready to use your newly calibrated microphone. One word of caution: when you use the calibrated microphone to test a favorite loudspeaker or microphone that you thought to be "flat," don't be surprised if the response curve resembles a Rocky Mountain skyline.

Individually tuning the ports seen on many microphone cases and loudspeaker enclosures by partially covering or otherwise impeding the air flow with various fabrics can often do much to improve their response. However, even when you've adjusted the system for optimum performance the curve is still going to look pretty rough, and it's better not to mention it to your uninitated friends because they'll inevitably insist that their similar component is "flat." It isn't — and you know it — but why lose friends?

appendix

derivation of formula

Referring to **fig. 1**:

$$e_l = S_l P_o \tag{1}$$

$$e_m = S_m P_o \tag{2}$$

where: S_l = sensitivity of SP2 (in abvolts per dyne per square centimeter)

S_m = sensitivity of M

If we assume SP2 is a conventional loudspeaker, we know that e_l is produced by a conductor moving in a magnetic field, or:

$$e_l = blv \tag{3}$$

where: b = flux density in speaker gap, in Gauss

l = length of wire in the voice coil, in cm

v = velocity of the coil, in cm per second

From the "Ohms law" of mechanical circuits:

$$V = \frac{P_o A}{Z_m} \tag{4}$$

where: A = diaphragm area in square centimeters

Z_m = mechanical impedance of the vibrating system in mechanical ohms

Combining **eqs. 1**, **3**, and **4**:

$$S_l = \frac{e_l}{P_o} = \frac{blA}{Z_m} \tag{5}$$

Referring now to **fig. 2**, the pressure p at M, caused by SP2 located d centimeters away, is given by:

$$P = \frac{r_a V}{2\lambda d} \tag{6}$$

where: r_a = acoustic impedance of the atmosphere in mechanical ohms (41.5 for standard air at sea level)

λ = wavelength of sound, in cm

The velocity v for a current of i abamperes in SP2 is given by:

$$v = \frac{bli}{Z_m} \tag{7}$$

Combining **eqs. 6** and **7**:

$$P = \frac{rblAi}{2\lambda d Z_m} \tag{8}$$

From **eqs. 8** and **5**:

$$P = \frac{riSl}{2d\lambda} \tag{9}$$

The pressure p on M produces a voltage e_m' given by:

$$e_m' = S_m P \tag{10}$$

Combining this with **eq. 9**:

$$Sm = \frac{2d\lambda e_m'}{S_l ri} \tag{11}$$

Combining **eqs. 1** and **2** to eliminate P_o and then substituting for S_1:

$$S_m = \sqrt{\frac{2d\lambda e_m e_m'}{e_l ri}} \tag{12}$$

However, since $i = e_l'$, by virtue of the 1-ohm resistor:

$$S_m = \sqrt{\frac{2d\lambda}{r} \bullet \frac{e_m e_m'}{e_l e_l'}} \tag{13}$$

Finally, remembering that $\lambda = v/f$, where v = velocity of sound in cm/sec:

$$S_m = \sqrt{\frac{2dv}{r}} \bullet \sqrt{\frac{e_m e_m'}{e_l e_l' f}}$$
$$= k\sqrt{\frac{e_m e_m'}{e_l e_l' f}} \tag{14}$$

Thus, using only equipment likely to be found in any well equipped shack, an absolute calibration curve for the sensitivity of a microphone can be obtained without the use of a previously calibrated standard.

microphone calibration program

By Nick Corcodilos, 765 San Antonio Road #51, Palo Alto, California 94303

The program listing provided here has been designed to automate the number-crunching necessary in calibrating your microphone. Although developed for the Radio Shack TRS-80 Model 1® computer, the program should run on other TRS-80s, and, with a little modification, on most computers that have a BASIC interpreter. Even though BASIC is widely used, there is no standard version usable on all machines. So if you're using a Commodore or a Timex/Sinclair, for example, some of the code will have to be modified.

The version of BASIC used here is what Radio Shack calls Level II BASIC. It requires no disk drives. An Epson MX-80 dot matrix printer was used to test the program; other printers should work equally well.

Once you've typed the program into your computer, you'll want to save it for later use. You can do this using disks or a cassette storage device. Look up the "SAVE" command in your computer manual for instructions. The "LOAD" and "RUN" commands will also be useful.

The TRS-80 Model 1 CRT Monitor, (16 lines × 60 characters) can display fourteen calibration samples before it scrolls. The program takes these limits into account. If you have a TRS-80 with a 24 line by 80 character screen, you'll have to modify the program to take full advantage of your monitor.

To start, begin typing in the program. Type in the lines of code exactly as they are listed. The spaces between words are as critical as characters; count the spaces carefully and put them in the right places. There are important differences between commas (,), semicolons (;), and colons (:). Type patiently and check and recheck your typing.

Because the program was written to be understandable, plenty of "Remark" statements are included. These remarks are preceded by a single quote (') either after a line number or at the end of a line of code, and are not executed during a program run. They are included to break up the code and help you see which sections of code do what. When you type these, be sure to include the leading (').

When you run the program, it will prompt you to enter five data values for each sample: the frequency (Hz) of the sample, loudspeaker voltages E(L) and E(L)1 where 1 signifies "prime," and microphone voltages E(M) and E(M)1. (These correspond to e_l,e_l', e_m, and e' in the tables.) Since all values for one sample are to be entered together, you'll have to record your original data on paper while you're taking measurements with L2 in its two different positions. (Note L1 = SP1, L2 = SP2.)

The program will produce three tables at the end of its run. Together, these tables will be roughly equivalent to **table 2** in the article. When each table appears on the screen, you'll be asked if you want to print that table. When responding to the "<P> to print to printer?" prompt, be sure to use a capital "P." Lower case won't work.

The main values you'll be interested in are the Relative Microphone Sensitivities (Smr's) for each sample frequency. Also provided is the Average Smr, which you may or may not be interested in. Keep in mind that the Average Smr is just an intermediate value; it is provided in case you should want to do something with it.

In the interest of simplicity, the program has limited error-recovery capability. BASIC does not allow dividing a number by zero. Because some of the calculations the program performs are divisions (in lines 510 and 598), you may experience this problem. If you enter a zero data value, you'll get a "divide by 0" or "/0" error on the screen and your results will be invalidated; the program will "crash." If you enter a character instead of a number (the program accepts numerical data only), you'll get a "?redo from start" error message. Just retype your data value, using a number this time.

If you enter a value incorrectly (for example, 125 instead of 12.5), you will have an opportunity to correct *your error after all values for that one sample have been entered (you cannot correct a zero entry).* In other words, you can cancel a sample and re-enter it if you do so before going on to the next sample. You cannot change a sample after all samples have been entered. When responding to the prompt "<X> to correct this sample" be sure to use *a capital, not lower case,* "X."

Be sure your printer is on before you request the printing of a table. Programs run on the Model 1 computer have been known to "crash" if a printer wasn't ready and waiting when needed.

To cancel the program at any point, press <BREAK>. Type "run" *followed by a carriage return to* start the program again. When the last table has been displayed on the screen, the program will recycle to its beginning, with all data wiped out. You'll know you're there when you see "MICROPHONE CALIBRATION — NEW DATA" at the top of the screen. New data must then be typed in.

Those who need more than fourteen samples in your calibration efforts can either run the program more than once with the additional samples, or tweak the program a bit; with tweaking, your tables will scroll off the screen because they'll be too big, but if you have a printer, the full tables can be printed there with no losses. To tweak the program, change every "14" in lines 220, 350, and 355 to the number of samples you wish to use. That's it. (If your program crashes after these modifications, it's probably because your computer doesn't have enough memory to handle the new number of samples.)

Note: This program is also available in a version designed for use on the IBM PC. For a copy of that program, send a business-sized SASE to N.A. Corcodilos, 765 San Antonio Road #51, Palo Alto, California 94303. — **Editor**

```
50 '                 PROGRAM BY N A CORCODILOS 2/25/84
55 '                 DEVELOPED AROUND AN IDEA BY D PETERS
60 '
100 '                MICROPHONE CALIBRATION PROGRAM - TRS80 MODEL 1
110 '                                                 LEVEL II BASIC
150 '
200 '-------------------------DEFINITION OF VARIABLES
210 '
220 DIM M(14), M1(14), L(14), L1(14), F(14), SMR(14)
250 '
300 '-------------------------DATA ENTRY
310 '
320 CLS
330 PRINT "MICROPHONE CALIBRATION DATA - NEW DATA"
340 PRINT
350 INPUT "HOW MANY SAMPLES WILL YOU ENTER (14 MAX)     ";S
355 IF S<1 OR S>14 THEN 300  'CHECKS FOR TOO MANY OR FEW SAMPLES
400 CLS
430 '
440 FOR J=1 TO S
445   PRINT "MICROPHONE CALIBRATION DATA     ";S;" SAMPLES"
446   PRINT
450   PRINT "SAMPLE # ";J
460   INPUT "F(HZ)          ";F(J)
470   INPUT "E(L)           ";L(J)
480   INPUT "E(M)           ";M(J)
490   INPUT "E(L)1          ";L1(J)
500   INPUT "E(M)1          ";M1(J)
510   I=((M(J)*M1(J))/(L(J)*L1(J)*F(J)))  'INTERMEDIATE VALUE
520   SMR(J)=SQR(I)      'SQR IS A BASIC FUNCTION WHICH TAKES SQ ROOT
530   PRINT
540   PRINT "SMR FOR ";F(J);"HZ = ";:PRINT USING "##.####";SMR(J)
550   PRINT
560   INPUT "<X> TO CORRECT THIS SAMPLE, <ENTER> TO CONTINUE ";Q$
570   IF Q$="X" THEN CLS:PRINT "MICROPHONE CALIBRATION DATA      ";S;" SAMPLES"
575   IF Q$="X" THEN PRINT:Q$="":GOTO 450
580   IF Q$<>"" THEN Q$="":GOTO 560
585   Q$="":CLS
590   NEXT J
591 '
592 '----------------------------SUM & AVERAGE SMR'S
593 '
594 FOR J=1 TO S
595   H=H+SMR(J)         'H IS A HOLDING VARIABLE
596   NEXT J
597 '
```

```
598 AVGSMR=(H/S)
600 '
610 '----------------------------PRINT CALIB TABLE 1 TO SCREEN
620 '
630 PRINT "F(HZ)","E(L)","E(M)","    TABLE 1"
640 FOR J=1 TO S
650   PRINT F(J),L(J),M(J)
660   NEXT J
675 INPUT "<P> TO PRINT TABLE TO PRINTER, <ENTER> TO CONTINUE INSTEAD ";Q$
676 IF Q$="P" THEN GOSUB 2000 ELSE IF Q$<>"" THEN 675
678 '
680 '----------------------------PRINT CALIB TABLE 2 TO SCREEN
681 '
682 CLS:PRINT "F(HZ)","E(L)1","E(M)1"
684 FOR J=1 TO S
685   PRINT F(J),L1(J),M1(J)
686   NEXT J
688 INPUT "<P> TO PRINT TABLE TO PRINTER, <ENTER> TO CONTINUE INSTEAD ";Q$
689 IF Q$="P" THEN GOSUB 3000 ELSE IF Q$<>"" THEN 688
690 '
900 '----------------------------PRINT CALIB TABLE 3 TO SCREEN
910 '
920 CLS
970 PRINT "F(HZ)","SMR","AVERAGE SMR = ";:PRINT USING "##.####";AVGSMR
990 FOR J=1 TO S
1000   PRINT F(J),
1010   PRINT USING "##.####";SMR(J)
1050   NEXT J
1110 INPUT "<P> TO PRINT TO PRINTER, <ENTER> TO RESTART PROGRAM ";Q$
1115 IF Q$="P" THEN GOSUB 4000 ELSE IF Q$<>"" THEN 1110
1200 RUN         'RESTART PROGRAM AFTER FINISH PROCESSING
1900 '
2000 '---------------------------LPRINT ROUTINE TABLE 1
2020 '
2100 CLS:INPUT "TURN PRINTER ON & ALIGN PAPER - PRESS <ENTER> ";Q$
2110 LPRINT:LPRINT "MICROPHONE CALIBRATION TABLE 1"
2120 LPRINT:LPRINT
2130 LPRINT "F(HZ)","E(L)","E(M)"
2140 LPRINT
2150 FOR J=1 TO S
2160   LPRINT F(J),L(J),M(J)
2170   NEXT J
2175 LPRINT:LPRINT:LPRINT:LPRINT
2178 Q$=""
2180 RETURN
2190 '
3000 '---------------------------LPRINT ROUTINE TABLE 2
3020 '
3100 CLS:INPUT "TURN PRINTER ON & ALIGN PAPER - PRESS <ENTER> ";Q$
3110 LPRINT:LPRINT "MICROPHONE CALIBRATION TABLE 2"
3120 LPRINT:LPRINT
3130 LPRINT "F(HZ)","E(L)1","E(M)1"
3140 LPRINT
3150 FOR J=1 TO S
3160   LPRINT F(J),L1(J),M1(J)
3170   NEXT J
3175 LPRINT:LPRINT:LPRINT:LPRINT
3178 Q$=""
3180 RETURN
3190 '
4000 '---------------------------LPRINT ROUTINE TABLE 3
4010 '
4100 CLS:INPUT "TURN PRINTER ON & ALIGN PAPER - PRESS <ENTER> ";Q$
4110 LPRINT:LPRINT "MICROPHONE CALIBRATION TABLE 3"
4120 LPRINT:LPRINT
4130 LPRINT "F(HZ)","SMR","AVERAGE SMR = ";:LPRINT USING "##.####";AVGSMR
4140 LPRINT
4150 FOR J=1 TO S
4160   LPRINT F(J),:LPRINT USING "##.####";SMR(J)
4170   NEXT J
4175 LPRINT:LPRINT:LPRINT:LPRINT
4178 Q$=""
4180 RETURN
```

ham radio

✓ 177

RAMSEY ELECTRONIC'S Inc.

PARTS WAREHOUSE

We now have available a bunch of goodies too good to bypass. Items are limited so order today

2575 Baird Rd.
Penfield, NY 14526
716-586-3950

Call your Phone Order in Today. TERMS: Satisfaction guaranteed or money refunded. C.O.D. add $2.50. Minimum order $6.00. Orders under $10.00 add $1.50. Add 6% for postage insurance handling. Overseas add 15%. N.Y. residents add 7% tax

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

FM MINI MIKE

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

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

Color Organ

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

Complete kit, ML-1
$8.95

Video Modulator Kit

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

Led Blinky Kit

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

Super Sleuth

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

CPO-1

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

FM Wireless Mike Kit

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

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

Whisper Light Kit

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

Tone Decoder

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

Universal Timer Kit

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

UT-5 Kit **$5.95**

Mad Blaster Kit

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

MB-1 Kit **$4.95**

Siren Kit

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

60 Hz Time Base

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

CLOCK KITS

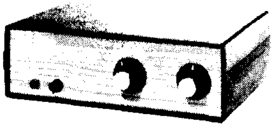
Your old favorites are here again. Over 7,000 Sold to Date. Be one of the gang and order yours today!

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

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

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

SATELLITE TV KIT



THE POPULAR SAT-TEC RECEIVER IN KIT-FORM!

NEW, LOWER PRICES!

Featured in a Radio Electronics magazine cover story (May 82), the reliable R2B Sat-tec TV receiver is now operating in thousands of locations. The R2B is easy to build; pre-etched plated boards with screened component layout assures accurate component placement and the critical IF section and local oscillator are pre-assembled and aligned! All parts are included for the R2B; attractive case, power supply, descriptive operating manual as well as complete assembly instructions. Features of the receiver include; dual conversion design for best image rejection, fully tunable audio to recover 'hidden' subcarriers, divide by two PLL demodulator for excellent threshold performance, tight tracking AFC to assure drift free reception, and of course, full 24 channel tunable coverage.

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

SOLD OUT

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

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

Prices include domestic UPS shipping and insurance.

PARTS PARADE

IC SPECIALS

LINEAR

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

TTL

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

SPECIAL

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

CMOS

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

FERRITE BEADS

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

READOUTS

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

Sockets

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

TRANSISTORS

2N3904 NPN C+F	15/$1.00
2N3906 PNP C+F	15/$1.00
2N4403 PNP C+F	15/$1.00
2N4410 NPN C+F	15/$1.00
2N4916 FET C+F	4/$1.00
2N5401 PNP C+F	5/$1.00
2N6028 C+F	4/$1.00
2N3771 NPN Silicon	$1.50
2N5179 UHF NPN	3/$2.00
Power Tab NPN 40W	3/$1.00
Power Tab PNP 40W	3/1.00
MPF 102/2N5484	$.50
NPN 3904 Type T+R	50/$2.50
PNP 3906 Type T+R	50/$2.50
2N3055	$.60
2N2646 UJT	3/$2.00

Diodes

5.1 V Zener	20/$1.00
1N914 Type	50/$1.00
1KV 2Amp	8/$1.00
100V 1Amp	15/$1.00

25 AMP 100V Bridge **$1.75 each**

Mini-Bridge 50V 1 AMP 2 for $1.00

Resistor Ass't

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

Crystals

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

Switches

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

Earphones

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

AC Adapters

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

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

Mini 8 ohm Speaker

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

Solid State Buzzers

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

Slug Tuned Coils

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

AC Outlet

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

CAPACITORS

TANTALUM Dipped Epoxy
1.5 uF 25V 3/$1.00
1.8 uF 25V 3/$1.00
.22 uF 25V 3/$1.00

ALUMINUM Electrolytic
1000 uF 16V Radial **$.50**
500 uF 20V Axial **$.50**
150 uF 16V Axial **5/$1.00**
10 uF 15V Radial **10/$1.00**

DISK CERAMIC
.01 16V disk **20/$1.00**
.1 16V **15/$1.00**
.001 16V **20/$1.00**
100 pF **20/$1.00**
.047 16V **20/$1.00**

DC-DC Converter

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

Ceramic IF Filters
Mini ... SOLD OUT ...7 kHz
B.W ...kHz $1.50 ea.

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

Trimmer Caps

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

Crystal Microphone

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

Mini RG-174 Coax
10 ft. for $1.00

Coax Connector

Chassis mount
BNC type **$1.00**

9 Volt Battery Clips

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

Parts Bag

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

Connectors

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

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

Varactors

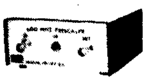
Motorola MV 2209 30 PF Nominal cap 20-80 PF - Tunable range - **.50 each or 3/$1.00**

Audio Prescaler

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

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

600 MHz PRESCALER



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

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

30 Watt 2 mtr PWR AMP

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

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

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

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

Power Supply Kit

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

OP-AMP Special

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

Regulators

SOLD OUT

723	$.50
309K	$1.15
7805	$1.00
7812	$1.00
7815	$1.00
7905	$1.25
7912	$1.25
7915	$1.25

Shrink Tubing Nubs

Nice precut pces of shrink size 1" x ¼" shrink to ⅛". Great for splices **50/$1.00**

Mini TO-92 Heat Sinks

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

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

Molex Pins

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

CDS Photocells

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

More Details? CHECK—OFF Page 132

✓ 178

VHF/UHF WORLD

Joe Reisert W1JR

improving meteor scatter communications

It has been estimated that each day 50 to 100 million particles orbiting in space enter the Earth's gravitational field and are literally swept into the ionosphere. These particles, or meteors, as they are often called, are usually quite small — even as small as a grain of sand — and may leave a bright trail as they burn up by frictional heating when entering the atmosphere.

As meteors burn they produce ionization in the "E" layer (typically 50 to 150 km above the Earth). For many years VHF/UHFers have been using this ionization as one of the primary modes of propagation for working DX on 6 and 2 meters. A form of forward scatter, this is usually referred to as "meteor scatter."

During the late 1950s the race for the first 2-meter WAS began, and meteor scatter became one of the prime propagation modes. It soon became obvious that it was very difficult to work new states, especially when they were over 1200 miles (1930 km) distant. Predicting the best time and day were mainly based on luck or past experience.

When the competition for the first 220 MHz and 70 cm (432 MHz) meteor scatter QSOs began, the difficulty increased even further.[1] In fact, as of today, only about a half-dozen 70 cm QSOs have been claimed since the original one on August 12, 1972.[2]

Over the past ten years I have been gathering information on meteor scatter communications and developing techniques, some already known, and some that are perhaps new to Amateurs. This information may assist you in pinpointing meteor scatter maximums, choosing the optimum dates and the best time to schedule, optimizing your equipment, and learning how to listen for meteors. Understanding this material should increase your success rate and possibly add to the data base that will be presented here. Since the prime meteor scatter season is just around the corner, I thought this would be a good time to present this material.

background information

There are two basic types of meteors: sporadic and shower. The sporadic meteors have random orbits in space and are drawn in by the gravitational force of the Earth as it passes them in its orbit around the sun. However, they are for the most part concentrated toward the ecliptic plane (the plane of the Earth's orbit) and move around the sun in the same direction as the Earth. Because of the geometry involved, these sporadic meteors tend to peak for east-west paths every day around 0600 and are at a minimum at 1800 local time with approximately 4:1 ratio.[3] North-south paths tend to peak around 0200 and 1000 local time with a similar minimum. Sporadic meteors are not uniformly distributed and tend to be random in speed (more on this later) as well as difficult to predict. There is a further seasonal variation because of the tilting of the Earth's axis relative to the ecliptic plane. Sporadic meteors tend to peak with a broad maximum occurrence in July and a broad minimum in February.

Shower meteors, on the other hand, are more spectacular, but account for only a small fraction (less than 5 percent) of the total incidence of meteors. They are believed to be the remnants of old or extinct comets which have specific orbits and velocities around the sun. When the Earth intersects one of these orbits, there is a dramatic increase in the quantity and size of the meteors entering the ionosphere. Hence the name "meteor shower" has been coined to describe this phenomenon. The most observed meteor showers have been given astronomical names corresponding to the constellations in the sky from which they appear to originate. Because of their distinct orbit (in comparison to the sporadic types), they can peak at any time of the day or night. The duration of the shower may last anywhere from a few hours to as long as a week or two. Since they are so concentrated (compared to the sporadic types), they considerably enhance the possibility of a completed QSO.

table 1. Data for major meteor showers.

shower name	E.L.*	best dates	duration	accuracy	hourly rate**	velocity (km/sec)	local*** rise/set
Quadrantids	282.83	Jan 1 - 4	10 hours	± 15 min	50	43	2300-1800
April Lyrids	31.40	April 20 - 23	2 days	± 12 hrs	12	51	2100-1100
Eta Aquarids	44.00	May 2 - 6	5 days	± 12 hrs	15	64	0300-1200
Arietids	75.00	June 1 - 15	8 days	± 12 hrs	66	39	0330-1530
June Lyrids	84.00	June 10 - 21	2 days	± 12 hrs	10	51	2100-1100
Delta Aquarids	125.00	July 26 - 30	2 days	± 12 hrs	20	43	2200-0600
Perseids	139.30	Aug 10 - 14	4 days	± 75 min	49	60	(note 1)
Orionids	207.00	Oct 18 - 23	2 days	± 12 hrs	18	67	2230-0930
Taurids	220.00	Oct 30 - Nov 10	20 days	± 12 hrs	10	31	1900-0630
Leonids	234.70	Nov 14 - 19	3 hours	± 12 hrs	10	72	0000-1230
Geminids	261.20	Dec 10 - 15	3 days	± 12 hrs	60	37	1900-0900
Ursids	270.00	Dec 21 - 24	12 hours	± 12 hrs	15	35	(note 2)

* Ecliptic longitude in 1950 coordinates.
** Estimated meteors per hour at maximum. Can vary greatly from year to year depending on shower.
***For northern mid-latitudes.
Note 1. Never sets. Minimum at 1730.
Note 2. Never sets. Minimum at 2030.

Sporadic meteors will continue to be used by VHFers on 6 and 2 meters. The best times for use will be in the morning hours and during the summer months as stated earlier. However, long haul 2-meter DX and especially operation on 220 MHz and above would best be served by concentrating on specific meteor showers.

pinpointing meteor shower peaks

Although many articles have been written on meteor showers, there has been very little information on pinpointing exactly when these meteor showers peak. Most of the available information lists only the approximate dates of the expected peak.[4,5,6] Some of these showers are of extremely short duration (one to four hours). Considering operation on only one particular day, or even during any six to ten hours off peak on a short duration shower will probably prove to be a waste of time.

Often you hear someone say, "Oh, that shower always peaks at 8 AM on August 12," only to hear conflicting stories about the same shower from someone else. The reasons for contradiction are many. Often overlooked is the basic fact that *the Earth takes 365¼ days to complete one orbit around the sun.* (This is the reason we need one leap year every four years in order to get the calendar back in synchronization.) Therefore the shower we encounter today will typically peak six hours later next year, allowing, of course, for leap year when it occurs. Astronomers have a way to predict the time that the meteor showers are expected to peak.[7] This method uses celestial information to predict the time the Earth intersects the orbit of the meteor stream based on data that has been generated by long-term visual observation of the more well known showers. Some information has also been generated from radar observations. I gave a talk on this prediction method at the Central States VHF Conference in Sioux Falls, South Dakota in July, 1981 and have been continuously updating the handout information that accompanied that presentation. (Each month I use this method to forecast the various meteor shower peaks and list them in the "Important VHF/UHF Events" at the end of the column.)

Let's see how to use this method. First you have to know the ecliptic (sometimes called solar) longitude of the various showers. This is listed each year in various publications[8] and I believe *Sky and Telescope Magazine* uses the same information for its monthly meteor shower predictions. However, *beware of meteor shower peak predictions in astronomy magazines;* their interest is primarily visual. If, for instance, the peak of the shower is during the day or on an evening near full moon, astronomy magazines may not provide sufficient information to determine the real peak. Most astronomers couldn't care less about the use of meteor showers for radio communications!

I have generated **table 1** to show the ecliptic longitude in 1950 (astronomical) coordinates for the peak of the meteor showers, the range of dates and times, the duration of the shower, the approximate accuracy of the predictions, and the hourly rate and velocity. To predict the time of the actual meteor shower peak, you need to acquire a table showing "Ecliptic Longitude at 0000 UTC" for the year of interest[9] or calculate this data yourself (more on this later). Because four years of data are required, this would be an extensive table. Therefore, using reference 9, I have calculated and listed in **table 2** the ecliptic longitude for just the principal dates surrounding the major meteor showers. Days on either side of those listed could be estimated if desired. Because the Earth returns to approximately the same place in its orbit every four years (as described earlier) all you have to do is repeat the proper year. For example, the 1984 table is also good for 1976, 1980, 1988, and so on.

The equation for calculating the ecliptic longitude daily is found in reference 9. W4WD has taken this equation and some of the data shown in **table 1** and written a computer program for the TRS-80 computer.[10] Jim Reisert, AD1C, has revised the program and data. A copy of his program is shown in **fig. 1**.

using the tables

A few examples of how to use **tables 1** and **2** should clarify the method.

Find the date and peak time for the Perseids meteor shower in 1984. Table 1 shows the peak at ecliptic longitude 139.3. Scan through the ecliptic longitudes listed on **table 2** for 1984 and find the day before and the day after the 139.3 peak, noting the date and ecliptic longitude shown for 0000 UTC. The day before is August 11 at ecliptic longitude 138.51, and the day after is August 12 at 139.47. Therefore, the shower will peak on August 11. To find the peak shower time, insert this ecliptic longitude data into the following equation:

$$T = 24 \cdot \frac{(E.L. - E.L.1)}{(E.L.2 - E.L.1)}$$

$$= 24 \cdot \frac{(139.30 - 138.51)}{(139.47 - 138.51)}$$

$$= 24 \cdot (0.823) = 19.75$$

or 1945 hours

where T is time in UTC, $E.L.$ is ecliptic longitude from **table 1** for the shower of interest, $E.L.1$ is from **table 2** for the day before and $E.L.2$ is from **table 2** for the day after peak for the proper year. Therefore, the next peak of the Perseids meteor shower should be August 11, 1984, at approximately 1945 UTC.

Find the peak for the great Leonids shower of 1966. Table 1 shows the peak at ecliptic longitude 234.7. Looking through **table 2** for 1982 (same as 1966 table, as explained earlier) we find the data for the day before and after as November 17 at 234.28 and November 18 at 235.39. Inserting these eclip-

fig. 1. Meteor shower peak prediction time program. Though written for TRS-80™, BASIC program can be adapted to any personal computer.

```
100 REM:  PROGRAM BY JAMES REISERT, AD1C - 12 FEBRUARY 1984
105 REM:  BASED ON PROGRAM BY RUSS WICKER, W4WD
110 K=57.2957795130B
115 PRINT
120 PRINT TAB(5);"METEOR SHOWER PEAK TIME PREDICTION"
125 PRINT TAB(5);"----------------------------------"
130 PRINT
135 PRINT "WHAT IS THE YEAR (YYYY) ";
140 INPUT Y
145 PRINT
150 PRINT TAB(15);"METEOR SHOWER"
155 PRINT TAB(15);"-------------"
160 PRINT
165 PRINT " 1)  QUADRANTIDS";TAB(33);"1-4 JAN."
170 PRINT " 2)  APRIL LYRIDS";TAB(33);"20-23 APR."
175 PRINT " 3)  ETA AQUARIDS";TAB(33);"2-6 MAY"
180 PRINT " 4)  ARIETIDS";TAB(33);"1-15 JUNE"
185 PRINT " 5)  JUNE LYRIDS";TAB(33);"10-14 JUNE"
190 PRINT " 6)  DELTA AQUARIDS";TAB(33);"26-30 JULY"
195 PRINT " 7)  PERSEIDS";TAB(33);"10-14 AUG."
200 PRINT " 8)  ORIONIDS";TAB(33);"18-23 OCT."
205 PRINT " 9)  TAURIDS";TAB(33);"30 OCT.-10 NOV."
210 PRINT "10)  LEONIDS";TAB(33);"14-19 NOV."
215 PRINT "11)  GEMINIDS";TAB(33);"10-15 DEC."
220 PRINT "12)  URSIDS";TAB(33);"21-24 DEC."
225 PRINT
230 PRINT "TYPE IN THE NUMBER OF THE DESIRED SHOWER (1-12) ";
235 INPUT N
240 IF N<1 OR N>12 THEN 230
245 RESTORE
250 FOR I=1 TO N
255   READ S$,E,D$,A$,M,D
260 NEXT I
265 REM:  CALCULATE THE JULIAN DATE
270 J=365*(Y-1981)+INT((Y-1)/4)-INT((Y-1)/100)+INT((Y-1)/400)
275 J=J+INT(30.55*(M-1)-1.4)+2*INT((12-M)/10)+D
280 IF M<2 OR (Y/4)<>INT(Y/4) THEN 290
285 J=J+1
290 GOSUB 435
295 IF E1>E THEN 320
300   J=J+1
305   D=D+1
310   GOSUB 435
315   GOTO 295
320 IF E1<=E THEN 350
325   E2=E1
330   J=J-1
335   D=D-1
340   GOSUB 435
345 REM:  CALCULATE SHOWER PEAK TIME IN GMT
350 T=24*((E-E1)/(E2-E1))
355 H0=INT(T)
360 M1=INT(60*(T-H0)+.5)
365 G=100*H0+M1
370 IF D<=31 THEN 385
375 D=D-31
380 M=M+1
385 PRINT
390 PRINT "THE ";S$;" METEOR SHOWER WILL PEAK ON";M;"/";D;"/";Y-1900
395 PRINT "AT ";G;" GMT.  THIS SHOWER LASTS ";D$;" AND"
400 PRINT "THIS PREDICTION HAS AN ACCURACY OF ";A$
405 PRINT
410 PRINT"DO YOU WANT ANOTHER RUN (Y/N) ";
415 INPUT A$
420 IF A$="Y" THEN 115
425 GOTO 555
430 REM:  SUBROUTINE TO CALCULATE ECLIPTIC LONGITUDES
435 T1=(J-276)/36525
440 C0=0.016717-0.00004*T1
445 M2=(0.985609*(J-117.821)-0.3227*T1)/K
450 C2=M2+C0*SIN(M2)
455 M0=C2-C0*SIN(C2)
460 D0=(M2-M0)/(1-C0*COS(C2))
465 C2=C2+D0
470 IF ABS(D0)>0.0001 THEN 455
475 T=K*2*ATN(SQR((1+C0)/(1-C0))*SIN(C2/2)/COS(C2/2))
480 E1=T+1.7192*T1-77.396
485 IF E1<0 THEN E1=E1+360
490 RETURN
495 DATA QUADRANTIDS,282.83,10 HOURS,+/-15 MINS.,1,4
500 DATA APRIL LYRIDS,31.4,2 DAYS,+/- 12 HOURS,4,21
505 DATA ETA AQUARIDS,44.0,5 DAYS,+/- 12 HOURS,5,4
```

```
510 DATA ARIETIDS,75.0,8 DAYS,+/- 12 HOURS,6,5
515 DATA JUNE LYRIDS,84.0,2 DAYS,+/- 12 HOURS,6,14
520 DATA DELTA AQURIDS,125.0,2 DAYS,+/- 12 HOURS,7,26
525 DATA PERSEIDS,139.3,4 DAYS,+/- 75 MINS.,8,11
530 DATA ORIONIDS,207.0,2 DAYS,+/- 12 HOURS,10,20
535 DATA TAURIDS,220.0,20 DAYS,+/- 12 HOURS,10,31
540 DATA LEONIDS,234.7,3 HOURS,+/- 12 HOURS,11,16
545 DATA GEMINIDS,261.2,3 DAYS,+/- 12 HOURS,12,13
550 DATA URSIDS,270.0,12 HOURS,+/- 12 HOURS,12,21
555 END


       READY

       RUN


             METEOR SHOWER PEAK TIME PREDICTION
             ----------------------------------

       WHAT IS THE YEAR (YYYY) ? 1984

                        METEOR SHOWER
                        -------------

        1)   QUADRANTIDS                   1-4 JAN.
        2)   APRIL LYRIDS                  20-23 APR.
        3)   ETA AQUARIDS                  2-6 MAY
        4)   ARIETIDS                      1-15 JUNE
        5)   JUNE LYRIDS                   10-14 JUNE
        6)   DELTA AQUARIDS                26-30 JULY
        7)   PERSEIDS                      10-14 AUG.
        8)   ORIONIDS                      18-23 OCT.
        9)   TAURIDS                       30 OCT.-10 NOV.
       10)   LEONIDS                       14-19 NOV.
       11)   GEMINIDS                      10-15 DEC.
       12)   URSIDS                        21-24 DEC.

       TYPE IN THE NUMBER OF THE DESIRED SHOWER (1-12) ? 7

       THE PERSEIDS METEOR SHOWER WILL PEAK ON 8 / 11 / 84
       AT  1939  GMT.  THIS SHOWER LASTS 4 DAYS AND
       THIS PREDICTION HAS AN ACCURACY OF +/- 75 MINS.

       DO YOU WANT ANOTHER RUN (Y/N) ? N


       READY
```

tic longitudes into the equation from above, we obtain:

$$T = 24 \cdot \frac{(E.L. - E.L.1)}{(E.L.2 - E.L.1)}$$

$$= 24 \cdot \frac{(234.70 - 234.28)}{(235.29 - 234.28)}$$

$$= 24 \cdot (0.416) = 9.98$$
$$= 0959 \text{ hours}$$

Checking back in history, we see that the peak indeed occurred on November 17, 1966, between 0900 and 1300 UTC.[11] Not bad for an estimate! Wait until the next Leonids peak in 1999; it will occur on November 17 at 1541 UTC. Check out the math yourself — and if I'm not around, remember that I told you so!

A few notes of caution are in order. As pointed out earlier, meteor shower peaks are based primarily on visual sightings. Radio peaks may vary slightly because the ionization for radio reflection may not necessarily cause a bright visual display. However, the radio and visual peaks are probably not much different. Another factor is the orbits of the showers themselves. Sometimes an orbit may be deflected, especially if it passes near one of the major planets such as Jupiter. If this happens, the shower may peak at a different date and/or time or even completely disappear! Also, some showers such as the Leonids are believed to be much younger, astronomically speaking, and hence are more concentrated. Therefore, they may be good only during certain peak years. The astronomy magazines are good sources of information to determine when these peak years will occur. In the interest of brevity, I have not mentioned minor showers or those that have been dormant in recent years perhaps because of a shift in orbit. They are still worth investigating if you have the time and inclination! New showers may be discovered but will take time to pinpoint exactly.

getting the best reflection

Another reason why different persons may quote different shower peaks is that they may have overlooked the geometry factor that must be observed.[4,6] In some cases there may be no optimum time for communications between two stations because a specific shower may not pass over the proper reflection point between the stations involved. However, when there is a usable meteor shower, there is an optimum time when the meteors will be in the proper location for the maximum signal reflection for the desired direction. W4LTU listed optimum times in his tables for scheduling between stations during meteor showers based on the direction of the path[6] This data is very important if you want to enhance your chance of a completed contact and not spend endless hours when the meteors are in the wrong position.

Some European VHF/UHFers have recently written computer programs to aid in selecting the best times to operate in any desired direction. They use the geometry specified by W4LTU in reference 4 with right ascension data for the meteor shower. Their program also adds data pertaining to effectiveness, thereby giving all times of the day with a quality factor of 0 to 100 percent for any desired path. Hopefully this program will soon be available here in the United States.

choosing the optimum shower

Another often overlooked fact is that each shower has its own specific characteristics. Time and space do not permit a long discussion here, but I will try to summarize some data I have collected to assist you in determining the best meteor shower to use for a specific frequency and path.

It is generally agreed that the optitable 2. Ecliptic longitude at 0000 UTC for selected days (from The American Ephemeris and Nautical Almanac for year of interest).*

date		1984*	1985*	1986*	1987*
Jan	3	281.79	282.54	282.26	282.04
Jan	4	282.81	283.55	283.27	283.06
Jan	5	283.83	284.57	284.29	284.08
Apr	21	31.08	30.81	30.54	30.34
Apr	22	32.06	31.78	31.52	31.32
Apr	23	33.03	32.76	32.49	32.29
May	4	43.72	43.45	43.18	42.99
May	5	44.69	44.42	44.15	43.95
May	6	45.66	45.39	45.12	44.92
June	5	74.53	74.26	73.99	73.80
June	6	75.48	75.21	74.95	74.75
June	7	76.44	76.17	75.91	75.71
June	14	83.13	82.86	82.60	82.41
June	15	84.08	83.82	83.56	83.36
June	16	85.04	84.77	84.51	84.32
July	27	124.15	123.88	123.63	123.43
July	28	125.11	124.84	124.58	124.38
July	29	126.06	125.80	125.54	125.34
Aug	11	138.51	138.25	137.99	137.79
Aug	12	139.47	139.21	138.95	138.75
Aug	13	140.43	140.17	139.91	139.71
Oct	20	206.78	206.52	206.52	206.04
Oct	21	207.78	207.51	207.24	207.03
Nov	2	219.76	219.49	219.22	219.00
Nov	3	220.76	220.49	220.22	220.00
Nov	4	221.76	221.49	221.22	221.00
Nov	16	233.82	233.55	233.28	233.06
Nov	17	234.83	234.56	234.28	234.07
Nov	18	235.84	235.57	235.29	235.08
Dec	12	260.15	259.88	259.61	259.39
Dec	13	261.17	260.90	260.62	260.41
Dec	14	262.19	261.92	261.64	261.42
Dec	21	269.31	269.04	268.76	268.55
Dec	22	270.33	270.06	269.78	269.56
Dec	23	271.35	271.08	270.80	270.58

*Each table repeats itself every 4 years. Hence the table for 1984 will be usable in 1988, 1992, and so on. See text for further information.

mum path length for meteor scatter communications is between 700-1000 miles (1126-1609 km), but this is based mainly on an average meteor's ionizing at 100 km altitude. The slower velocity showers (11-40 km/sec., see velocity column on **table 1**) such as the Geminids can ionize as low as 60-80 km and hence are good for shorter distances, while the faster showers (40-72 km/sec.) such as the Perseids may ionize at as high an altitude as 150 km. Therefore, the faster showers will generally yield the best DX.

Likewise, the fast showers seem to be the best ones for 220 MHz and above. The duration and signal strength of the burst drops off rapidly with decreasing wavelength and therefore is considerably shorter and weaker on 220 MHz than on 2 meters. Even on a fast shower, very few long bursts will be detected on 70 cm. The ideal shower for the most difficult paths and higher frequencies should have a good rate of meteors per hour because several bursts may be required to complete the exchange of information required for a QSO. Therefore, fast showers with few meteors, such as the Leonids of late, are not good prospects except during peak years in their cycle. The Orionids and Eta Aquarids meteor showers are believed to be associated with Halley's comet which is due to rendezvous with the sun in 1986. This could mean a big increase in the rate of these showers over the next few years. Stay tuned in!

In short, I feel the Perseids is the ideal all-purpose shower, especially for 220 MHz and above. It has a long duration, high speed, lots of large particles, and is evenly distributed from year to year. Is it any wonder why all reported 70 cm meteor scatter completed contacts have taken place during this shower? The Geminids, even though slow in speed, are reliable year after year for paths up to 1000 miles (1609 km), with lots of meteors and good performance even on 220 MHz. The Quadrantids are great if you are lucky enough to catch the narrow peak. The Delta Aquarids can also be good, but it has been pointed out in recent years in astronomy magazines that this shower may be comprised of up to six or seven other showers, hence explaining its erratic nature from year to year.

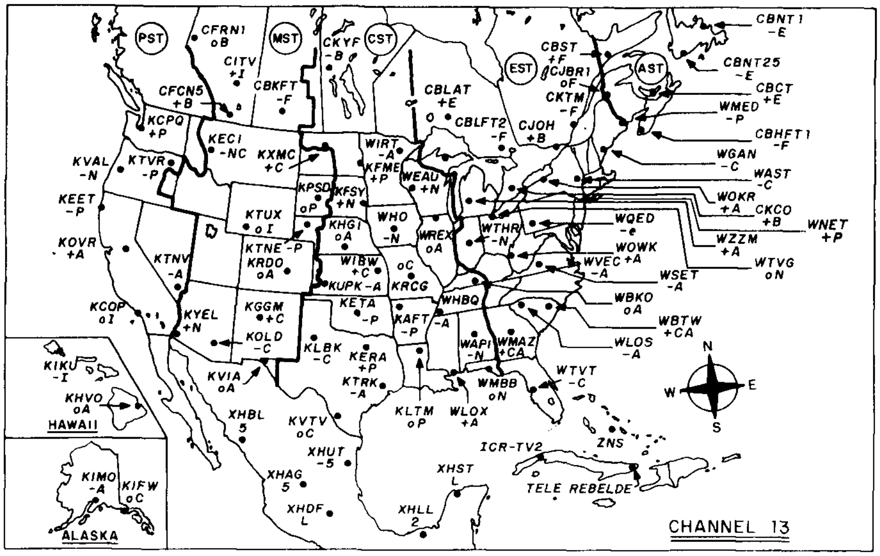


fig. 2. Map showing TV channel 13 locations and offset can be used to determine meteor scatter openings. (Reprinted with permission from the Worldwide TV FM DX Association, Buffalo, New York.)

optimizing your equipment

It is possible to make 6- and 2-meter meteor scatter contacts during meteor showers with power as low as 10 watts and a 10-12 dBd gain antenna. However, these contacts would not be the long-haul DX (over 1200 miles or 1931 km) and would take some luck. For reliable meteor scatter work on 6 and 2 meters, it usually requires greater than 100 watts and an antenna gain of 12-15 dBd. A good noise figure would be desirable to take advantage of the weaker and shorter bursts, but even a 5-10 dB noise figure will work because bursts on these frequencies are usually well above the noise.

QSOs on 220 MHz and 70 cm via meteor scatter are another story. Signal levels are definitely weaker, especially on the longer haul. The bursts are also much shorter. A "blue whizzer" on 2 meters may be 30 to 90 seconds long, but the same kind of burst on 220 MHz may last only 15 to 30 seconds. On 70 cm, pings are typical, and if you're lucky enough to get a burst, it will probably only be a few seconds long since 5 to 10 second bursts are extremely rare. Hence, it helps to have a good receiver noise figure (2 dB or better) and more power, at least 100 but 500 watts or more if possible. Likewise, higher antenna gain is desired.

A factor often overlooked on meteor scatter communications is the geometry involved. It has been pointed out by W4LTU that for ideal conditions, the reflection point from the meteor trail will be optimum approximately 5 to 9 degrees on either side of the direct path depending on path length.[4] Fortunately, as the path lengthens, the angle narrows. Indeed, it has been further suggested that you can optimize the path by aiming your antenna to the proper offset from the direct path as pointed out in **table 1** of reference 6. Antenna height is also important, because nulls will appear in the pattern based on height in wavelengths. Herein lies the rub. More antenna gain will only aggravate the situation because higher gain implies narrower beamwidth.[12]

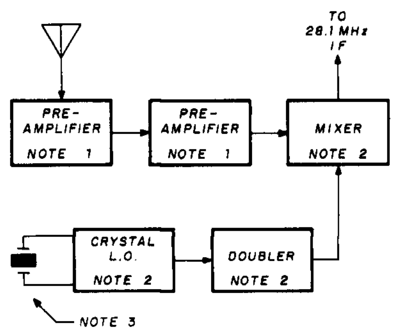
On 220 MHz the typical high gain Yagis in present-day use have a beamwidth of 26 to 30 degrees. If these antennas are stacked two high and/or two wide, the beamwidth will typically be 13-15 degrees, meaning that signals at the reflection point on either side of the path will be at about 3 dB down. On 70 cm the problems are usually worse; typical high performance stations use four Yagis, each with 20 to 24 degree beamwidth. An array of four Yagis arranged in a square would be 10 to 12 degrees wide, at least 3 dB down on the band where we are already fighting feedline loss and very weak, short duration bursts.

There is a partial solution to this dilemma. If possible, stack your antennas vertically so that the horizontal beamwidth will be the same as a single antenna. The beamwidth may drop to 4 to 6 degrees in the vertical plane, but it doesn't really matter at distances greater than 750 miles (1207 km).[4]

monitoring a meteor shower

There is an easy and effective way to monitor meteor showers. I have been listening to VHF TV station channels 12 or 13 video carriers for many years with a simple homebrew converter and Yagi antenna.[13] The normally specified TV video carrier frequency is 1.25 MHz above the bottom end of the allocated band. What isn't always known is that on the VHF channels (2 through 13), there are three different video carrier frequencies for each TV channel: one on the listed frequency, called the zero offset; one 10 kHz below, named the minus offset; and one 10 kHz above, labeled the plus offset. The accuracy of these carriers is ±1 kHz and they are assigned by the FCC so as not to cause video beating between similar channels in any wide geographical area. I have listed the standard carrier frequencies in **table 3**. (The actual assigned frequency for each TV station is listed in *Part 73, Subpart E-Television Broadcast Stations of the FCC Rules and Regulations.*) Knowing the assigned frequency for a specific station will aid in positive identification. These frequencies, along with offsets, effective radiated power, and such are also listed in the *WTFDA TV Station Guide,*[14] with individual maps for each TV channel to aid the user to locate the stations on each channel (see **fig. 2**).

Several things should be considered when selecting a TV channel to monitor. A TV channel 2 monitor (55.25 MHz) may be very active and useful for 6 meters, but gives little insight into what's really happening up on 2 meters or 220 MHz. It is best to use one of the



NOTES:
1. SEE FIG. 4
2. SEE TEXT AND REF. 15
3. SEE TEXT

fig. 3. Block diagram of a typical receive type down-converter for monitoring TV video carriers.

table 3. Selected TV video carrier frequencies for U.S.A., Canada, and most North American TV stations.

TV channel No.	frequency (MHz)*
2	55.250
3	61.250
4	67.250
5	77.250
6	83.250
7	175.250
8	181.250
9	187.250
10	193.250
11	199.250
12	205.250
13	211.250

*This is the zero-offset frequency. Channels may be on this frequency, ± 10 kHz of the same based on FCC frequency assignments (see text).

higher VHF channels since they are widespread; this gives plenty of opportunity to hear meteor bursts in different areas. The higher frequency channels also give a better indication when the meteors are really hot for DX, and when 220 MHz is possible. Channels 12 and 13 are ideal in this regard. Select a channel that isn't used locally (within 100 miles or 161 km), because strong channels could overload your receiver and may produce extraneous 15,750 kHz video birdies.

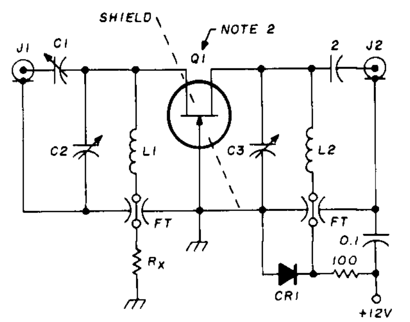
My converter is typical of those used on 2 meters or 220 MHz for weak signal work and is patterned according to the circuitry shown in my March, 1984 *ham radio* article.[15] A block diagram of this converter is shown in **fig. 3**. I chose channel 13 (video carrier on 211.250 MHz from **table 3**) and use a local oscillator frequency of 183.150 MHz derived with the actual crystal oscillator operating at 91.575 MHz. My IF is 28.1 MHz for reasons specified in reference 15. For a preamplifier I used two U310 JFET stages as shown in **fig. 4** which will work from 200-225 MHz and over a wider frequency range if the inductors are scaled accordingly. This configuration is more than adequate to hear the weak TV video carriers out to 300 miles even on poor days with no propagation enhancements. Remember, these stations are radiating high power and usually at high elevations.

The choice of receiving antenna is very important. For best operation you should have a sharp and clean antenna pattern with low side lobes so that you can null out a loud station as well as be able to distinguish which direction the signals are coming from. I prefer the NBS 2.2 wavelength Yagi and have shown a suitable design in reference 16. I have recently changed to a T-match and would recommend same if you are making your own antenna.

A few final comments about monitoring TV video carriers: short meteor bursts on channel 12 or 13 will probably indicate that 2-meter scatter is good; 5 to 10 second bursts probably mean good DX as well as opportunities on 220 MHz and above. I have noticed that the burst starts first on the higher frequency. Hence, if you hear a good burst start in the desired direction, the lower frequency path will open shortly afterward. Conversely, a burst on 200 MHz may occur too late for you to catch a 70 cm path. Pings or rapid Doppler means that there are underdense bursts which aren't going to be of much help, but they do indicate that there are meteors present. Use of this type of monitor is not only helpful to see when, where, and if a meteor shower is in progress, *but can also be used to catch other VHF/UHF openings such as sporadic E, auroral or tropo*.

operating procedures

In the United States, meteor scat-



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

item	description
C1,C2,C3	1-10 pF air variable capacitors
CR1	1N4001 or equivalent "idiot" diode
FT	0.001 μF feedthrough capacitor
J1,J2	BNC connector
L1,L2	3 turns No. 18 1/4" ID, 1/2" long
Q1	U310 JFET (do not substitute J310) (see Note 2)
R_X	set for I_D 8-12 mA, 150 ohms typical

Note 1. Preamplifier can be built on P.C. board mounted to cover of a Pomona 2417, Bud CU123 or equivalent cast box per construction techniques in reference 15.
Note 2. Mount U310 upside down in a 0.191" (4.85 mm) diameter hole (made with a No. 11 drill). Quickly solder the transistor can to the P.C. board.

fig. 4. Low noise JFET preamplifier (200-225 MHz) for video carrier monitor has a 11-12 dB gain, a noise figure of 2.5 dB and a 8-9 MHz bandwidth.

ter schedules are usually run for one hour with the station farthest south and/or west transmitting the first and third 15 seconds of each minute. CW used to be the prime mode, but now SSB is used almost exclusively. CW is best on weak signals (especially for long DX and 70 cm) and is easy to tune in, but has a low data rate. SSB is definitely faster — especially if the burst is long enough to complete the exchange — but is more difficult to tune in especially when signals are weak. Call signs must be exchanged by both stations although not necessarily in a single burst. Reports and "rogers" received by both parties complete the QSO. If a burst is long or falls at the end of a transmission, break-in procedures may be used to complete the contact on a single burst.

Until recently, Europeans had only two bands to use for meteor scatter, 2 meters, and 70 cm. In Europe, high speed (75-125 WPM!) CW is still in wide use. In contrast to the United States, where the contact takes place in real time, the Europeans usually run long (1 to 5 minutes) transmitting sequences and then record on tape. This method is less critical on timing (using 15 second sequencing can cause a 33 percent loss of information if one station is off 5 seconds in timing!). At the end of a receiving sequence, the tape is quickly replayed at reduced speed to pick off any information received. This procedure does favor short bursts because entire call sets and reports can be sent in seconds or less and replayed until the information is deciphered. SSB is now gaining popularity in Europe.

In some sense, the high-speed CW used in Europe is similar to the procedures being proposed by those interested in packet or computer-oriented communications.[17] It's no secret that many of us still feel that communications must still be heard and deciphered by the operator rather than just appear as a letter or message on a video screen. However, such is progress! Reviewing the material in reference 17 should be very interesting to those with computer experience.

summary

I can't believe this article grew so long! Hopefully the material presented will be interesting and helpful. Let me point out that I am not advocating the use of only certain meteor showers. I presented this material to help you increase your success record — especially on the longer DX, 220 MHz and above. If the shower isn't materializing, why waste the kilowatts? However, using the material presented here, you may be able to discover other shower opportunities or input data to refine the peaks of existing showers.

Various methods have been presented to predict more accurately when the better meteor showers will peak. Remember, you can't use a short duration shower if it peaks when the radiant is not above your horizon! In addition to the information in **table 1**, refer back to W4LTU's table[6] for best times for the path direction desired. Optimize your equipment especially if it is not up to the standards recommended; build up a monitor as described and you'll be amazed how helpful it will be, not only for meteor scatter but for other propagation modes as well.

Finally, let me thank W4WD and AD1C for their help in determining the shower peaks by computer. Also, many thanks to Chip Brown, KR1P, for the material he helped me obtain on this subject as well as his helpful suggestions; to WTFDA for use of their map; and the people at *Sky and Telescope Magazine* for their help. Good luck on your next meteor scatter schedule and let me know if you can improve the data base in this article.

references

1. Bill Smith, WB4HIP, "The World Above 50 MC," *QST*, October, 1968, page 94.
2. Bill Smith, KØCER, "The World Above 50 MC," *QST*, October, 1972, page 115.
3. George Sugar, "Radio Propagation by Reflection from Meteor Trails," *Proceedings of the IEEE*, February, 1964, pages 116-136.
4. Walter Bain, W4LTU, "VHF Meteor Scatter Propagation," *QST*, April, 1957, pages 20-24.
5. Walter Bain, W4LTU, "Revised Meteor Shower Data for VHF Use," *QST*, May, 1967, page 78.
6. Walter Bain, W4LTU, "VHF Propagation by Meteor-Trail Ionization," *QST*, May, 1974, pages 41-47.
7. Alistair Simpson, GM8NCM, "Calculation of Meteor Shower Visual Maximum" *DUBUS*, January, 1979, pages 22-23.
8. *The Handbook of the British Astronomical Association*.
9. *American Ephemeris and Nautical Almanac* (for the year of interest).
10. Russ Wicker, W4WD, "Meteor Shower Peak Predictor," *Lunar Letter*, May, 1983, page 3.
11. Sam Harris, W1FZJ, "The World Above 50 MC: November Leonids — Shower of a Lifetime," *QST*, January, 1967, page 83.
12. Joe Reisert, W1JR, "Determining VHF/UHF Antenna Performance," *ham radio*, May, 1984, page 110.
13. Bill Smith, KØCER, "The World Above 50 MC: Using TV Video Carriers as Propagation Indicators," *QST*, February, 1972, pages 76-77.
14. *WTFDA TV Station Guide*, available from Worldwide TV-FM DX Association, P.O. Box 514, Buffalo, New York 14205 at $8.00.
15. Joe Reisert, W1JR, "VHF/UHF Receivers," *ham radio*, March, 1984, pages 42-46.
16. Joseph H. Reisert, W1JR, "How to Design Yagi Antennas," *ham radio*, August, 1977, pages 22-31.
17. Jeffrey W. Moore, KQ1E, "Packet Meteor Scatter Communications," *QEX*, December, 1983, page 3.

VHF/UHF coming events

June 5:	*1200 UTC, peak of Arietids daytime meteor shower*
June 9-10:	*ARRL VHF QSO Party*
June 14:	*2200 UTC, peak of June Lyrids meteor shower*
June 15-17:	*SMIRK (6 meters) Contest*
June 21:	*Mean date of 2-month annual peak of sporadic-E propagation*

ham radio

NEW LOW-NOISE PREAMPS

Hamtronics Breaks the Price Barrier!

*

No Need to Pay $80 to $125 for a GaAs FET Preamp.

FEATURES:

- Very Low Noise: 0.7 dB VHF, 0.8 dB UHF
- High Gain: 18 to 28 dB, Depending on Freq.
- Wide Dynamic Range for Overload Resistance
- Latest Dual-gate GaAs FET, Stable Over Wide Range of Conditions
- Rugged, Diode-protected Transistors
- Easy to Tune
- Operates on Standard 12 to 14 Vdc Supply
- Can be Tower Mounted

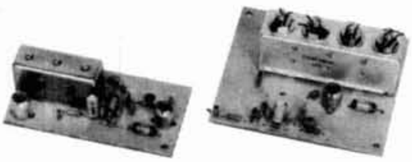
MODEL	TUNES RANGE	PRICE
LNG-28	26-30 MHz	$49
LNG-50	46-56 MHz	$49
LNG-144	137-150 MHz	$49
LNG-220	210-230 MHz	$49
LNG-432	400-470 MHz	$49
LNG-40	30-46 MHz	$64
LNG-160	150-172 MHz	$64

ECONOMY PREAMPS

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

- P30K, VHF Kit less case $18
- P30W, VHF Wired/Tested $33
- P432K, UHF Kit less case $21
- P432W, UHF Wired/Tested $36

HELICAL RESONATOR PREAMPS



Our lab has developed a new line of low-noise receiver preamps with helical resonator filters built in. The combination of a low noise amplifier and the sharp selectivity of a 3 or 4 section helical resonator provides increased sensitivity while reducing intermod and cross-band interference in critical applications. See selectivity curves at right. Gain = approx. 12 dB.

Model	Tuning Range	Price
HRA-144	143-150 MHz	$49
HRA-220	213-233 MHz	$49
HRA-432	420-450 MHz	$59
HRA-( )	150-174MHz	$69
HRA-( )	450-470 MHz	$79

RECEIVING CONVERTERS

Models to cover every practical rf & if range to listen to SSB, FM, ATV, etc. NF = 2 dB or less.

	Antenna Input Range	Receiver Output
VHF MODELS	28-32	144-148
Kit with Case $49	50-52	28-30
Less Case $39	50-54	144-148
Wired $69	144-146	28-30
	145-147	28-30
	144-144.4	27-27.4
	146-148	28-30
	144-148	50-54
	220-222	28-30
	220-224	144-148
	222-226	144-148
	220-224	50-54
	222-224	28-30
UHF MODELS	432-434	28-30
Kit with Case $59	435-437	28-30
Less Case $49	432-436	144-148
Wired $75	432-436	50-54
	439.25	61.25

SCANNER CONVERTERS Copy 72-76, 135-144, 240-270, 400-420, or 806-894 MHz bands on any scanner. Wired/tested Only $88.

SAVE A BUNDLE ON VHF FM TRANSCEIVERS!

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

Cabinet Kit, complete with speaker, knobs, connectors, hardware. Only $60.

REPEAT OF A SELLOUT!

While supply lasts, get $60 cabinet kit free when you buy an FM-5 Transceiver kit. Where else can you get a complete transceiver for only $178.

TRANSMIT CONVERTERS

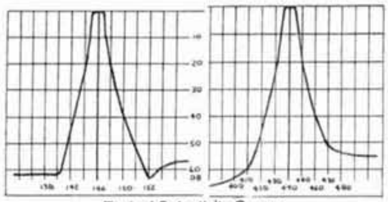
For SSB, CW, ATV, FM, etc. Why pay big bucks for a multi mode rig for each band? Can be linked with receive converters for transceive. 2 Watts output vhf, 1 Watt uhf.

	Exciter Input Range	Antenna Output
For VHF,	28-30	144-146
Model XV2	28-29	145-146
Kit $79	28-30	50-52
Wired $149	27-27.4	144-144.4
(Specify band)	28-30	220-222*
	50-54	220-224
	144-146	50-52
	50-54	144-148
	144-146	28-30
For UHF,	28-30	432-434
Model XV4	28-30	435-437
Kit $99	50-54	432-436
Wired $169	61.25	439.25
	144-148	432-436*

*Add $20 for 2M input

VHF & UHF LINEAR AMPLIFIERS. Use with above. Power levels from 10 to 45 Watts. Several models, kits from $78.

LOOK AT THESE ATTRACTIVE CURVES!



Typical Selectivity Curves of Receivers and Helical Resonators.

IMPORTANT REASONS WHY YOU SHOULD BUY FROM THE VALUE LEADER:

1. *Largest selection of vhf and uhf kits in the world.*
2. *Exceptional quality and low prices due to large volume.*
3. *Fast delivery; most kits shipped same day.*
4. *Complete, professional instruction manuals.*
5. *Prompt factory service available and free phone consultation.*
6. *In business 21 years.*
7. *Sell more repeater modules than all other mfrs. and have for years. Can give quality features for much lower cost.*

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

hamtronics, inc.

65-E MOUL RD. ● HILTON NY 14468
Phone: 716-392-9430

Hamtronics® is a registered trademark

the peaked lowpass:
a look at the ultraspherical filter

Use a pocket calculator
for filter design,
analysis, experimentation

Much of the fundamental work done in filter design and analysis over the past twenty years has been the result of detailed computer studies done by researchers in industry and education. Now, with personal computers, even home hobbyists can perform the complex calculations necessary for thorough examination of existing filter types and understanding of new types, exceeding the current standards, as they become available.

The most obvious opportunity for Amateur exploration in this field is in design, using published equations for the generation of tables. For example, using modern network theory,[1] a computer program can easily generate the table for Chebyshev filters of any arbitrary ripple value.[2] This allows one to design using available standard components.[3]

An equally useful computer application is filter analysis. An analysis program allows the user to enter component values and examine the response of that filter. Both gain (transducer gain) and phase response are easily generated with a simple ladder analysis program. More refined programs provide details regarding the filter response to a nonsinusoidal input such as an impulse or step; each of these is of interest to the circuit theorist.[4]

A well-designed filter analysis program does more than confirm the traditional — and therefore expected — results. It allows practical details, such as the effects of loss in the elements (finite Q inductors and capacitors) and parasitic reactances, to be enumerated and evaluated. One can also use a filter analysis program to study what happens when certain component values are changed.

It isn't even necessary to use a personal computer; for this study, a modest but powerful handheld calculator (an HP-41CV) was employed, using a previously published ladder analysis program.[5,6] The program was applied to the ultraspherical filter, a polynomial filter whose utility in certain special applications outweighs its apparent lack of popularity. (The fundamental work on this type of filter was done by Johnson and Johnson;[7] their work will be extended — and some practical details added — in this article.)

lowpass filters

To begin, let's examine a traditional lowpass filter. The filter chosen, a 5-pole Chebyshev with a 2-dB passband ripple, has been designed for a ripple cutoff frequency of 5.258 MHz. Its circuit appears in **fig. 1** with its frequency response shown in **fig. 2**. The usual Chebyshev characteristics are evident. There are five half-cycles of ripple in the passband. The response is down by 2 dB, the ripple value, at the 5.258 MHz ripple cutoff frequency.

This filter also exhibits an interesting but rarely appreciated property of the Chebyshev: with a 5.258-MHz ripple cutoff, the filter has its final peak at 5 MHz. Further examination reveals that the relationship between the positions of the response peaks are related to the cutoff by constants that are *not* dependent on the ripple. That is, all doubly terminated 5-pole Chebyshev filters will have their final peak at a frequency that is below the ripple cutoff by a factor 0.9509 (= 5.00/5.258) for all ripple values. Further analysis provides the relationships for other filter orders and for the other peaks.

Having examined a classic filter, let's now consider the effect of changing, or perturbing, some of the

By Wes Hayward, W7ZOI, 7700 SW Danielle Avenue, Beaverton, Oregon 97005

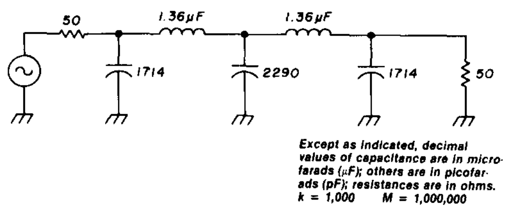


fig. 1. Schematic of a 2 dB ripple Chebyshev lowpass filter with ripple cutoff at 5.258 MHz.

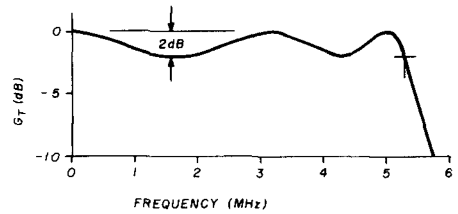


fig. 2. Frequency response of a Chebyshev lowpass filter with 2 dB passband ripple.

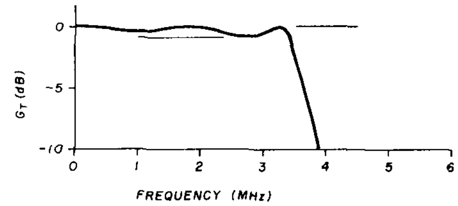


fig. 3. Response of an ultraspherical filter. Note that the ripples are not equal.

component values. First, we'll increase the inductor values from those shown in **fig. 1**. We'll keep the filter symmetrical with equal inductors, but increase the value from 1.36 to 3 microhenries. With the larger inductors, we would expect the cutoff frequency to decrease; this is confirmed in the frequency response (**fig. 3**). Of greater interest, however, is a change in filter shape. The filter still has ripples in the passband, but they are no longer of equal value. The first (close to zero frequency) dip in the response is not as deep as the second one, closer to the cutoff. A further increase in inductor values will further emphasize this effect.

Next we examine the modified filter with the goal of moving the response peak back to 5 MHz. This can be realized in at least two ways. All component values can be reduced equally to produce a filter with an identical shape with the peak at 5 MHz. We could, alternatively, reduce only the center capacitor until the final peak is at 5 MHz. This occurs with the center capacitor reduced from 2290 to 812 pF, yielding the response shown in **fig. 4**. This result is especially interesting — the shape is an even more extreme departure from the original Chebyshev, with a drastic difference in the dips in the curve — the ripples. Indeed, the smaller ripple, shown in **fig. 4**, is labeled in order that it not be missed!

This filter is so extreme that we might well ask whether it's worth considering for any practical application. The ripple has become large enough that the filter has taken on a bandpass-like filter characteristic. This wouldn't be very useful for an application in which a true lowpass shape was needed. However, this is *not* the way lowpass filters are used in most applications; in Amateur Radio, the most common application is in harmonic filtering, in which we wish to pass one frequency or narrow band while attenuating the harmonics of that frequency as much as possible. The filter with the response shown in **fig. 4** will do just that. The harmonic attenuation is greater at 10 MHz than the original Chebyshev prototype. We'll term this circuit a "peaked lowpass filter," or PLPF.

Returning to the original Chebyshev prototype of **fig. 1**, we can now consider an opposite pertubation, a reduction of inductor values. Allow the inductors to decrease from 1.36 to 1 microhenry; this will increase the peak frequency above the original 5 MHz. This increase is compensated for by increasing the center capacitor from 2290 to 4000 pF. The resulting response and circuit are shown in **fig. 5**. Again, the response has five half-cycles of ripple oscillation. The ripples are unequal, but the large dip in the passband is now the one close to zero frequency. This filter might be termed a "double peaked lowpass." This particular circuit, if properly scaled, would produce a lowpass response with good harmonic attenuation, and with a flat characteristic with only 0.15 dB ripple over the 3.1 to 4 MHz range.

insertion loss

The frequency response curves presented so far have assumed lossless components. (This is the common approach in analyzing lowpass filters.) While this can be a mistake, it is easily remedied with the computer or calculator. A more detailed examination will show that the main loss occurs in the inductors. Typically, the inductors have Q_u (unloaded Q) values of 250 or less (toroids at HF). In contrast, mica capacitors often show a Q_u value in excess of 700 at HF.

If we assume a Q_u that is constant with frequency, we find that the greatest loss occurs at or near the lowpass filter cutoff. (Effects are minimal at lower frequencies.) This loss can be significant in a high-ripple Chebyshev. The effects are also significant in PLPF, especially as the peak becomes sharper. Design then becomes a tradeoff between acceptable insertion loss and the desired selectivity characteristics. This tradeoff between loss and selectivity is a central theme in all filter design, and is especially significant with bandpass filters with a narrow fractional bandwidth.

the double pi-network: a design method for the PLPF

The circuit we have discussed is a familiar one if we consider only superficial details. It could be a lowpass designed from tables for one sort of polynomial or another. It is, however, a double pi-network, the cascade of two familiar impedance matching networks. The matching circuit is designed for a single specific frequency; our analysis of the PLPF has also focused on a single peak frequency. This similarity suggests a method for design.

First, we'll analyze the impedance characteristics of a pi-network. Our analysis will then form the basis for derivation of some special design equations for the PLPF. This method may be used for higher order versions of the PLPF, either with numerical methods on our computer or in closed mathematical form.

Analysis of the pi-network begins with the circuit of **fig. 6A**, an end resistance, R_o, paralleled with an end capacitor, C_e. The admittance of this combination is written directly, $Y_a = G + j\omega C_e$ where $G = 1/R_o$. This is converted to an impedance by taking the reciprocal of Y.

The impedance looking into plane *"a"* may now be combined with a series inductor, shown in **fig. 6B**. The resulting impedance is $Z_b = Z_a + j\omega L$. Keep in mind that both Z values are complex, with both real and imaginary parts. The admittance looking into plane *"b"* is obtained again by complex inversion, $Y_b = 1/Z_b$. This admittance consists of two parts, a real conductance, G_b, and an imaginary susceptance, jB_b. The imaginary term will be negative, indicating that the admittance is inductive. This may be cancelled, or tuned with a shunt capacitance, C_t, producing the traditional pi-network of **fig. 6C**. The capacitance required for tuning is:

$$C_t = \frac{-1}{\omega} Im(Y_b) \qquad \textbf{(1)}$$

where $\omega = 2\pi f$ and f is in Hz. L and C values are in Henrys and Farads.

Thus we have formed a traditional pi-network. The input impedance looking in will be real (resistance only), with a value of $R_{in} = 1/G_b$. This circuit would most likely be mismatched if driven by a source resistance R_o. However, we can eliminate the mismatch, and the loss that would result from it, by transforming an R_o source to "look like" a source resistance of R_{in}. This is easily realized with another pi-network identical to the one we have just "de-

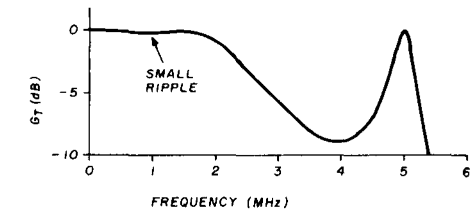


fig. 4. Response of extreme version of a PLPF.

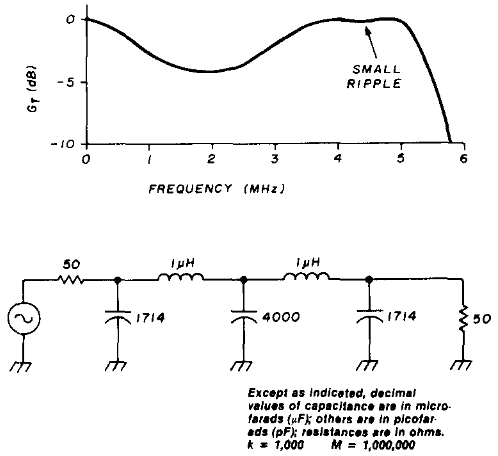


fig. 5. Double peaked lowpass, ultraspherical filter. Note the small ripple between 4 and 5 MHz.

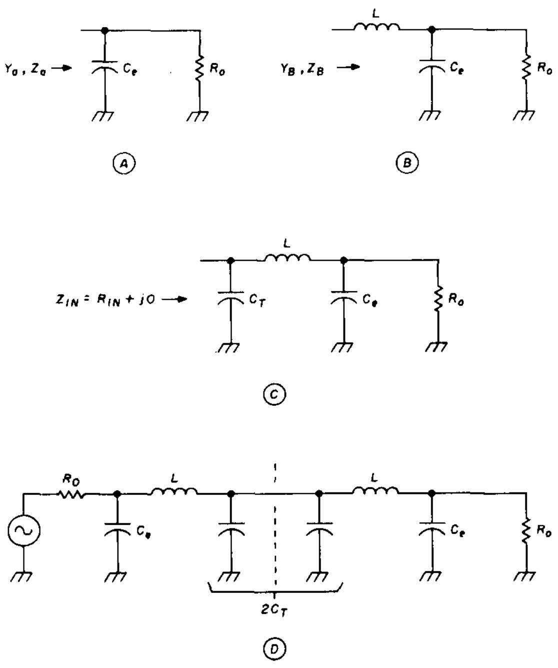


fig. 6. Circuits showing the analysis of a pi-network and its evolution into a double pi-network.

table 1. Normalized component values for 5th order ultraspherical lowpass filters. $Q_u = 200$ for inductors, capacitors are lossless. Also shown is the peak ripple in the passband, the insertion loss and the responses at the 2nd and 3rd harmonics.

g_1	g_2	g_3	ripple dB	IL, dB	$-G_t(2f_p)$ dB	$-G_t(3f_p)$ dB
1	1.0	2.0000	0.37	0.09	25.1	45.7
1	1.2	1.8919	0.16	0.10	29.0	48.8
1	1.4	1.6981	0.21	0.12	31.4	50.9
1	1.6	1.5068	0.47	0.14	33.2	52.3
1	1.8	1.3402	0.84	0.16	34.5	53.5
1	2.0	1.2000	1.29	0.17	35.6	54.5
1	2.5	0.9412	2.56	0.22	37.7	56.4
1	3.0	0.7692	3.83	0.26	39.4	57.9
1	3.5	0.6486	5.03	0.30	40.7	59.2
1	4.0	0.5600	6.13	0.34	41.9	60.3
1	5.0	0.4390	8.04	0.42	43.8	62.1
2	1.0	3.0000	1.15	0.22	42.2	61.8
2	1.2	2.3529	1.78	0.26	43.6	63.0
2	1.4	1.9231	2.82	0.30	44.7	64.0
2	1.6	1.6216	3.84	0.34	45.7	64.9
2	1.8	1.4000	4.81	0.38	46.5	65.8
2	2.0	1.2308	5.71	0.42	47.3	66.5
2	2.5	0.9438	7.70	0.53	49.1	68.1
2	3.0	0.7647	9.35	0.63	50.5	69.5
2	3.5	0.6425	10.76	0.73	51.7	70.7
2	4.0	0.5538	11.99	0.83	52.8	71.8
2	5.0	0.4340	14.02	1.02	54.6	73.5
3	1.6	1.5294	8.99	0.67	52.3	71.5
3	1.8	1.3274	10.11	0.75	53.1	72.3
3	2.0	1.1724	11.10	0.83	53.9	73.1
3	2.5	0.9072	13.20	1.02	55.7	74.8
3	3.0	0.7397	14.89	1.21	57.1	76.2
3	3.5	0.6244	16.31	1.40	58.4	77.4
3	4.0	0.5401	17.54	1.58	59.4	78.5
3	5.0	0.4253	19.57	1.94	61.3	80.3
4	1.6	1.4628	13.51	1.11	56.9	76.1
4	1.8	1.2764	14.63	1.24	57.8	77.0
4	2.0	1.1321	15.62	1.36	58.6	77.8
4	3.0	0.7231	19.39	1.97	61.9	81.0
4	4.0	0.5311	22.01	2.54	64.2	83.3
4	5.0	0.4197	24.02	3.08	66.1	85.2
5	1.6	1.4197	17.24	1.64	60.6	79.8
5	2.0	1.1059	19.33	2.01	62.3	81.5
5	3.0	0.7122	23.05	2.86	65.6	84.7
5	4.0	0.5252	25.65	3.64	68.0	87.1
5	5.0	0.4160	27.65	4.35	69.9	89.0

signed," but reversed. The final circuit is shown in **fig. 6D**.

We have done all our design and analysis at one frequency, one where we desire a response with no loss (assuming ideal components). This is not especially illuminating as far as filter properties are concerned. Still, it has provided a simple method for choosing the center capacitor in a filter so as to ensure minimum attenuation at one particular frequency.

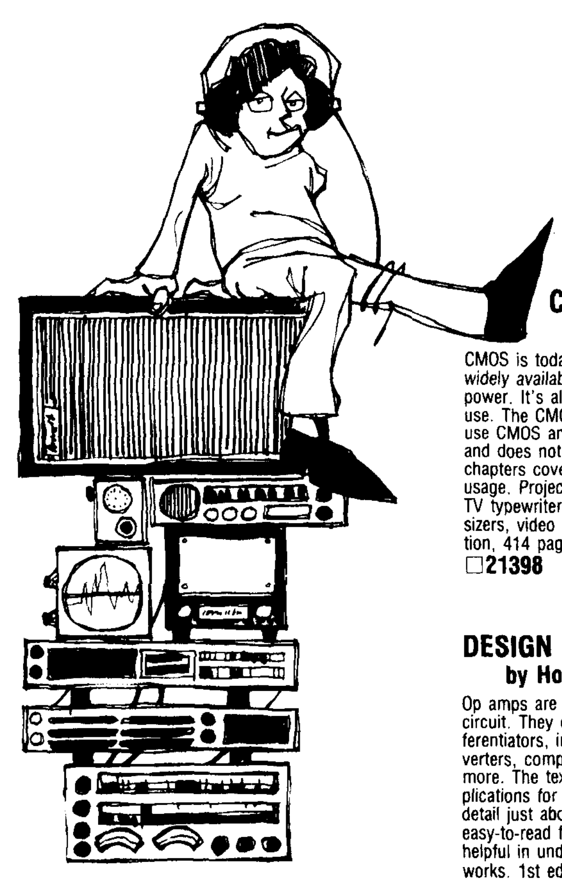
A direct extension of the previous analysis will lead to design equations for the 5th order PLPF. If the end capacitor chosen has reactance X_e at the peak frequency and the inductor has reactance X_L, with the end resistance R_o, the total center capacitance is:

$$C_t = \frac{1}{\pi f}\left[\frac{X_L - \frac{R_o^2}{X_e}(1 - X_L/X_e)}{R_o^2(1 - X_L/X_e)^2 + X_L^2}\right] \qquad (2)$$

where f is the peak frequency in Hz

We have already mentioned the importance of considering insertion loss. Further manipulation of the equations (with the assumptions that capacitors are lossless, but that the inductors have a known unloaded Q), shows that the insertion loss is:

$$IL\ (dB) = 20 \log\left[1 + X_L \frac{X_e^2 + R_o^2}{X_e^2 R_o Q}\right] \qquad (3)$$



Ham Radio's BOOK STORE BUILDERS' SPECIAL

MODERN DICTIONARY OF ELECTRONICS — 6th Edition
by Rudolf Graf

This book should be in every ham's library. It has over 20,000 terms unique to electronics and other closely related fields. 3000 additions to the 5th edition and twice the size of the 1st edition! From A or angstrom to zoom lens, you'll find it in this updated dictionary. 6th edition, ©1984, 1152 pages.

☐**22041** **Hardbound $39.95**

TTL COOKBOOK
by Don Lancaster

Despite the advent of CMOS, there is still plenty of design work being done with TTL circuitry. This book gives you a broad overview of exactly what TTL is, how it works and is full of design ideas and practical circuits. Some areas that receive attention are, flip-flops, clocked logic, counters and counting techniques, noise generators and much more. You also get a complete discussion of practical TTL applications including digital counter, events counter, stopwatch and voltmeter to name just a few. ©1974, 1st edition, 333 pages.

☐**21035** **Softbound $12.95**

ACTIVE FILTER COOKBOOK
by Don Lancaster

Active filters are unique combinations of integrated circuits, resistors and capacitors. They give excellent performance from sub-audible to ultrasonic frequencies. And they are relatively low in cost, simple to design and construct. This book is written for the user and will help you tailor filters to specific needs or applications. Ten chapters are full of helpful information and are illustrated with plenty of drawings and circuits. ©1975, 1st edition, 240 pages.

☐**21168** **Softbound $14.95**

CMOS COOKBOOK
by Don Lancaster

CMOS is today's state-of-the-art! It's low cost, widely available and uses an absolute minimum of power. It's also fun to work with and very easy to use. The CMOS Cookbook is written to help you use CMOS and is chock-full of practical circuits and does not dwell on math or heavy theory. Eight chapters cover just about every aspect of CMOS usage. Projects include high-performance op-amps, TV typewriter, digital instruments, music synthesizers, video games and more. ©1977, 1st edition, 414 pages.

☐**21398** **Softbound $13.95**

DESIGN OF OP AMP CIRCUITS
by Howard Berlin, W3HB

Op amps are a versatile and inexpensive integrated circuit. They can be used for linear amplifiers, differentiators, integrators, voltage and current converters, comparators, rectifiers, oscillators and more. The text includes 37 different uses and applications for op-amps. Ten complete chapters detail just about every facet of the op-amp in an easy-to-read format. Beginners will find this book helpful in understanding exactly how an op-amp works. 1st edition, ©1977, 221 pages.

☐**21537** **Softbound $11.95**

DESIGN OF ACTIVE FILTERS WITH EXPERIMENTS
by Howard Berlin, W3HB

Here's an excellent introduction to the theory, implementation and design of active filters using the 741 op-amp. This book starts the reader with an introduction to the 741 op-amp and then progresses to filter design basics. Also covered are first order low and high pass filters, second order voltage controlled voltage source filters, second order multiple feedback filters and more. Throughout the book, experiments are given to enable you to gain first hand experience on just how each filter operates. Great for all levels of electronic interest. 1st edition, ©1977, 239 pages.

☐**21539** **Softbound $10.95**

DESIGN OF PHASE LOCKED LOOP CIRCUITS WITH EXPERIMENTS
by Howard Berlin, W3HB

Due to prohibitive costs, the phase loop circuit did not become widely used until the development of the monolithic IC and the incorporation of complete PLL circuitry inside these solid state devices. This book serves as an introduction to the theory, design and implementation of PLL using a variety of TTL and CMOS devices. Opening with an introduction of PLL, this book covers in a basic building block approach, the phase detector, voltage controlled oscillator and the loop filter. Appendices include manufacturers design information and description of breadboarding techniques. Experiments are included to ensure the reader fully understands PLL design nuances. 1st edition, ©1978, 255 pages.

☐**21545** **Softbound $10.95**

IC OP AMP COOKBOOK
by Walter Jung

This second edition is broadly updated in terms of device coverage. It includes the latest in state-of-the-art developments such as J Fet and MosFet in both single and multiple formats. This cookbook is edited into three basic parts. Part I introduces the IC op amp and discusses general considerations. Part II covers practical circuit applications. Part III is an appendix consisting of manufacturers and data sheets and other pertinent information. With the same clear, easy-to-read format of the first edition, you'll find the wealth of information, as well as over 200 practical circuit applications, to be invaluable. ©1980, 2nd edition, 480 pages.

☐**21695** **Softbound $15.95**

SOLID STATE CIRCUIT FILES
by Ed Noll, W3FQJ

These two volumes are full of interesting circuits. Volume 1 covers in three major sections; bipolar transistors, field effect transistors and linear integrated circuits. Volume 2 has two major sections; transistor logic digital circuits and CMOS circuit design. Over 60 basic and more advanced circuits allow for experimentation and study. Wherever possible, low cost devices are used to facilitate breadboarding. Ideal for schools or home study. Both editions ©1980, 1st edition.

Vol. 1 Bipolar Transistor FET and Linear IC ☐**21753** **$8.95**

Vol. 2 TTL and CMOS Circuits ☐**21754** **$8.95**

MICROPROCESSOR CIRCUITS
by Ed Noll, W3FQJ

Volume 1 presents basic concepts and fundamental circuits of microprocessor systems. Volume 2 presents microprocessor I/O circuits and programmable controllers. Each volume is written and edited in an uncomplicated manner. By using the experience gained from these books, the reader can progress to higher levels of computer complexity with a minimum of problems. Every attempt is made to keep costs down so that experimentation is facilitated. Both books, 1st edition, ©1983.

Vol. 1 Fundamentals & Microcontrollers ☐**21877** **$9.95**

Vol. 2 I/O Interfacing and Programmable Controllers ☐**21977** **$9.95**

ELECTRONIC PROTOTYPE CONSTRUCTION
by Stephen D. Kasten

Here's a great book for either the beginner looking to try electronic prototyping for the first time or the expert looking for a handy reference guide. Areas covered include wire wrap and related techiques such as solder pad and perf. board asembly. When rough schematics are converted to PC boards, this book will help you through all the pitfalls of PC board design. It will also give you handy tips on how to make PC boards simply, with a minimum of fuss. Finally, when the project is nearing completion, you must consider packaging or how to put it all together in an attractive but functional package. Great reference book! 1st edition, ©1983, 399 pages.

☐**21895** **Softbound $17.95**

PLEASE ADD $2.50 FOR SHIPPING AND HANDLING
FOREIGN ORDERS FOB GREENVILLE

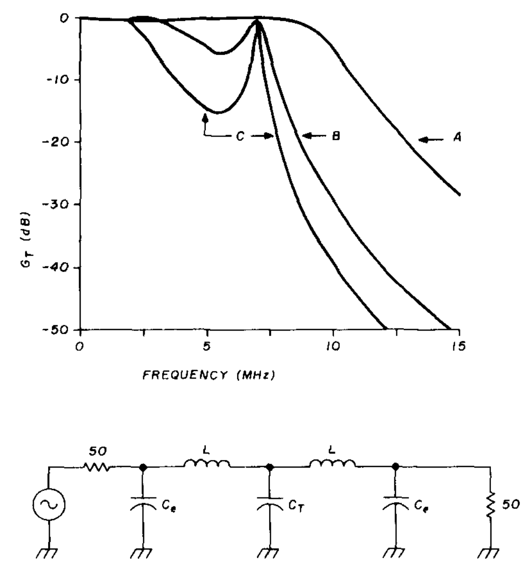
✓ 141

ham radio magazine BOOKSTORE

GREENVILLE, NH 03048 (603) 878-1441

These equations may be used for the design of a practical PLPF if some restrictions are noted. The end capacitor should have a reactance $X_e \leq R_o$, while the inductors should have a reactance $X_L \geq R_o$. Both are evaluated at the peak frequency.

Filter design usually begins with standard-value end capacitors and inductors already on hand. The value of the tuning capacitor and level of insertion loss are calculated; if the loss is acceptable, construction can proceed. If an appropriate program is used, analysis will provide the expected levels of harmonic attenuation.



CASE	C_e	L	C_T
A	455	1.14µH	903
B	1000	2µH	647
C	1500	3µH	385

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

fig. 7. Three variations of the PLPF produce dissimilar responses.

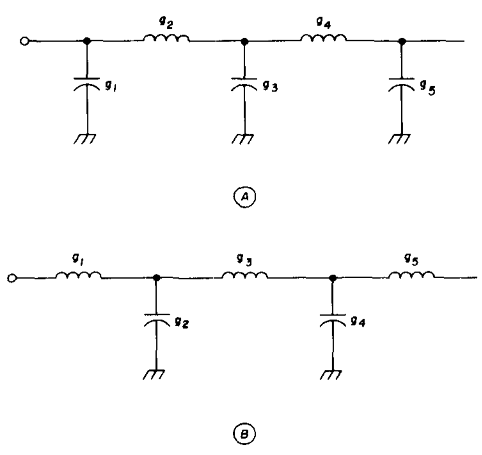


fig. 8. Normalized peaked lowpass filters (PLPF) to be used with *table 1*.

The nature of the PLPFs possible is illustrated in **fig. 7**. Three filters have been designed for a peak at 7 MHz. One, shown as curve A, is the popular half-wave filter.[9] While its peak is not very sharp, this is an easy filter to build. The insertion loss for inductors with $Q_u = 250$ is low, but the harmonic attenuation is poor at best. This filter may be designed with methods outlined, with $X_e = X_L = R_o$. Curves B and C of **fig. 7** are much more dramatic, showing significantly improved harmonic attenuation. The insertion loss is higher for these filters, however, but this is the price of increased selectivity.

normalized tables for the PLPF

Most of the more familiar lowpass filters are designed from tables. Extensive data is available for the Chebyshev and Butterworth polynomial filters, as well as many more.[10] Manipulation of the equations above allows us to formulate tables for the PLPF, presented in **table 1** for only the 5-element filter. The g_k values shown are the values of capacitors or inductors for a filter with a peak frequency of 0.1592 Hz (one radian) and 1 ohm terminations at both ends. The possible circuits are shown in **fig. 8**. The form with capacitors at the ends is preferred. The first and second elements, g_1 and g_2, were chosen arbitrarily. Then the required tuning element, g_3, was calculated. **Eq. 2** was placed in normalized form for this evaluation,

$$g_3 = \frac{2(g_1^2 g_2 + g_2 - g_1)}{(1 - g_1 g_2)^2 + g_2^2} \qquad (4)$$

Table 1 contains the normalized component values for several PLPF circuits. Also shown are the values of the largest ripple in the "passband," the insertion loss is based on an inductor Q of 200, and the attenuation values at the 2nd and 3rd harmonics. It's easy to use the table for designing a PLPF; simply study the insertion loss and harmonic attenuation columns to find a circuit that will meet the requirements for the application at hand. Then design the circuit using,

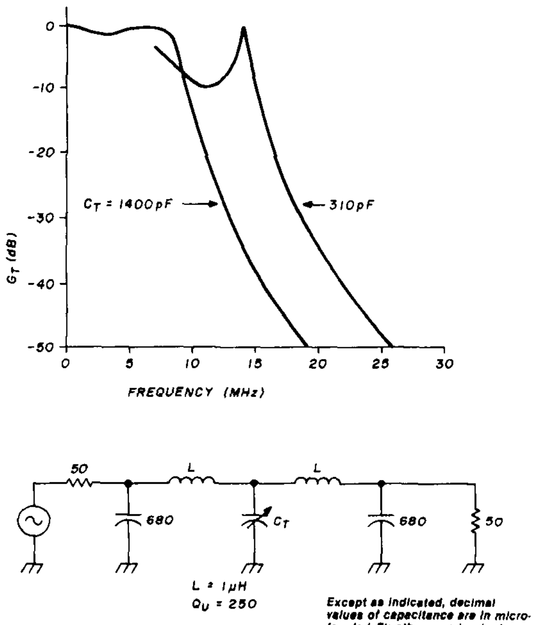
$$L = \frac{g_2 R_o}{\omega_p} \qquad (5)$$

and

$$C_k = \frac{g_k}{R_o \omega_p} \qquad (6)$$

where $\omega_p = 2\pi f_p$ with f_p being peak frequency in Hz. **Equation 6** provides both the end capacitors from g_1 and the tuning capacitor with g_3.

Any filter designed directly from the table would probably not be the most practical one. A more realistic design method would use the table merely as a guide: a preliminary filter would be designed according to the table; end capacitors and inductors — with



f_{PEAK}	C_T	IL	G_T (AT $2f_{PEAK}$)
7MHz	1400	0.1dB	-34.1dB
10MHz	698	0.24dB	-46.0dB
14MHz	310	0.59dB	-52.9dB
21MHz	125	1.75dB	-62.8dB
28MHz	68	3.62dB	-70.0dB

fig. 9. A PLPF that may be tuned over a 4:1 frequency range with the change of but one element, the center capacitor. (See text for discussion.)

values close to those calculated — would then be selected from the junk box. **Equation 2** would be used to determine the final tuning capacitor value.

There is one practical complication associated with the PLPF, especially in the more extreme examples, in which g_1 and g_2 are large in comparison to unity. The peak frequency will change significantly with the tuning capacitor. Hence, a trimmer is usually required. This is a small price to pay for the improved harmonic attenuation that can result.

variations on the PLPF

Many things can be done with the PLPF. One problem mentioned in the previous section was the tuning sensitivity of the center capacitor. An adage used by engineers applies to this situation: "If you can't fix it, feature it." We find that a peaked lowpass filter may be tuned over a wide frequency range merely by changing the center capacitor. This is illustrated with the filter and response curves shown in **fig. 9**. A single filter is tuned over the range of 7 to 28 MHz with one variable element. The ripple depth and the insertion loss both grow as the filter is tuned to higher frequencies, limiting its practical application.

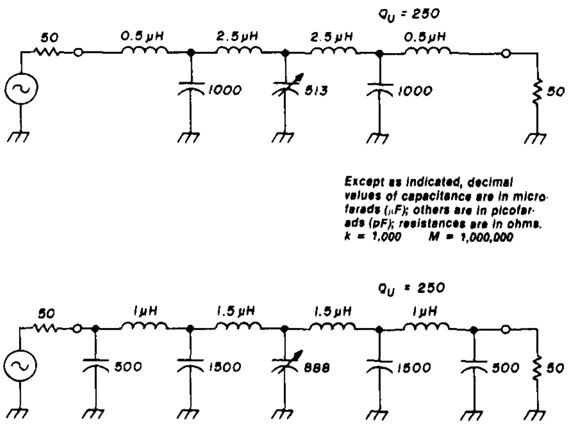


fig. 10. Ultraspherical filters of 7th and 9th order.

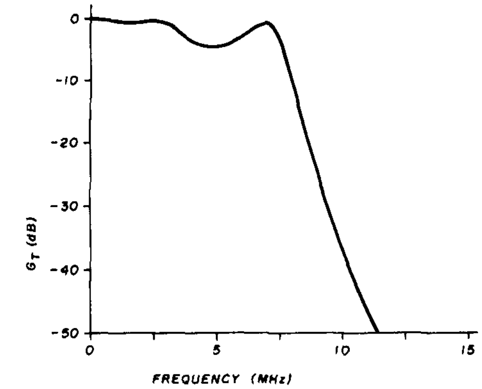


***fig. 11.* Frequency response of the 9th order lowpass filter shown in *fig. 10*. Note the combination of unequal passband ripple and good harmonic attenuation.**

The ultraspherical filter is not limited to circuits with only five elements. **Fig. 10** shows two circuits peaked at 7 MHz using 7 and 9 elements. Methods such as those used in analysis of the pi-network were applied to determine the value of the tuning capacitors in these circuits. The 7-element filter has an insertion loss of 0.38 dB and 2nd harmonic attenuation of 52.5 dB. The 9th order filter has an even lower IL of 0.30 dB and 2nd harmonic attenuation of 71.4 dB. The reduction in IL results from the improved impedance matching aided by the additional end elements. The matching is effective at the peak frequency, but continues to contribute to the filtering at harmonics. **Fig. 11** shows the response of the 9-element filter of **fig. 10**.

An interesting traditional filter is the elliptic or Cauer-Chebyshev.[11] A lowpass of this type may have its inductors replaced by parallel resonant traps. We can perform the same modification on the PLPF. An ex-

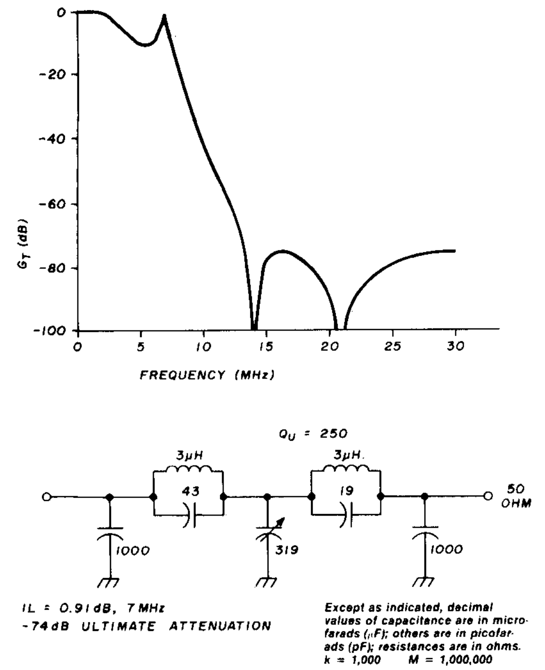


fig. 12. Application of elliptic filter methods to a 5th order PLPF.

ample is presented in **fig. 12**, peaked at 7 MHz. The traps are tuned to 14 and 21 MHz. The result is a filter similar to the ultraspherical in the passband with unequal ripples, but with deep notches at the harmonics. The main deficiency of this circuit is a limited ultimate attenuation at VHF of −74 dB. This limitation is typical of traditional elliptic circuits.

bandpass filters based upon the PLPF

A characteristic found with the peaked lowpass circuit was a bandpass-like response for the extreme cases. This characteristic can be used to advantage, especially when a filter must also have extremely good attenuation in the high frequency stopband.

Fig. 13 shows a filter that was designed as a preselector to precede an 80-meter receiver.[12] The receiver used a 9 MHz IF and a 5 MHz LO, so the image was at 14 MHz. High image rejection was required, and some "close-in" selectivity was required in the 3.5 to 4 MHz region. A 5th order PLPF was used for the basic filter. This was cascaded with a 7th order highpass circuit to eliminate the low frequency response. **Fig. 13** gives the overall response as well as those of the lowpass and highpass sections alone. Note the bump in the bandpass response at the 3 MHz cutoff of the highpass. This was not a problem in practice. The overall filter yielded nearly 100 dB image rejection and was tunable over the 80-meter band with a single section variable capacitor.

The more interesting bandpass filters are those with a multiplicity of resonators, or tuned circuits. Hence, two of the previous PLPF circuits were cascaded (on the computer), producing the response and circuit shown in **fig. 14**. The response shows a double peaked response like that of an overcoupled double tuned circuit.[13] The 0.01 μF coupling capacitor between PLPF sections was increased to 0.015 μF, yielding a single peak with little change in bandwidth or insertion loss. This circuit will tune over a reasonable range with a dual section variable capacitor.

The filters of **figs. 13** and **14** are still basically lowpass designs, even though they emphasize the bandpass characteristics. The shunt end capacitors, when viewed in light of the bandpass filtering, serve merely to transform the end load resistance to a different value. Similarly, the shunt coupling capacitor between PLPF sections (**fig. 14**) controls the energy in one resonator shared by the other. Similar results would occur if these elements were shunt inductors with reactances equal to the capacitors previously used. These changes were made, resulting in the circuits of **fig. 15**. These are true bandpass filters, showing infinite attenuation at zero frequency.

The circuits of **fig. 15** have two very interesting properties. First, the response shapes are very symmetrical. This symmetry is maintained even if the two-resonator filter is redone for a wider bandwidth. The second feature is the wide tuning range available. Note

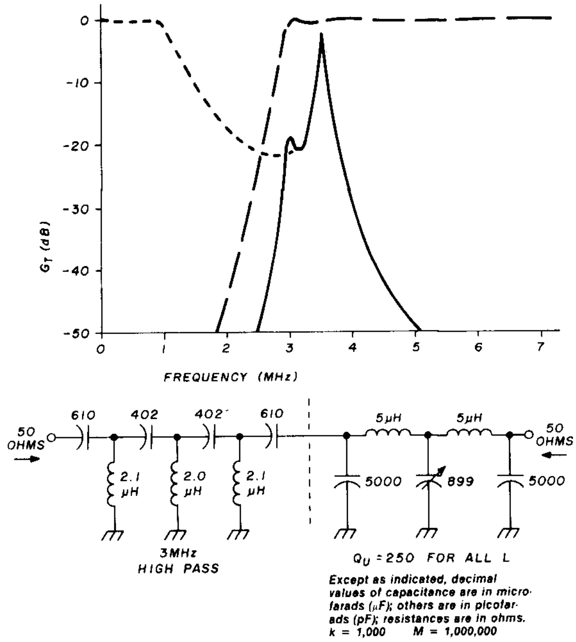


fig. 13. Use of an extreme version of the 5th order PLPF as a bandpass filter. Attenuation at 14 MHz is nearly 100 dB. Dotted and dashed curves show the response of the individual PLPF and the 7th order highpass filter, respectively.

that the only capacitors in the network are those used for tuning. All other elements are inductors. When the same concepts are applied to a more conventional double tuned circuit, the tuning range is expanded. The computer analysis showed that decreasing the two capacitors of **fig. 15B** from 766 to 95 pF produced a peak at 10 MHz, well above the original 3.5 MHz peak.

The double tuned circuit of **fig. 15B** was scaled to a slightly higher frequency and a model was built. Four 3-microhenry inductors were used with a dual section 400 pF variable capacitor. The main inductors were wound on T50-6 toroids, while smaller cores were used for the shunt elements. The circuit was tested with a spectrum analyzer and tracking generator (Tektronix 7L14 and TR-502) to confirm the calculations. This filter was especially easy to align and tuned 6 to 18 MHz. The circuit operates with an approximately constant loaded filter Q — that is, the bandwidth increases as the filter is tuned to higher frequency. Insertion loss varies little with tuning. Agreement with the computer modeling was excellent.

The work presented is restricted to doubly terminated designs. All circuits described have been built, confirming the computer results.

The first step in any filter design should be a careful evaluation of the requirements of the filter. The PLPF is well suited to some applications where a true low pass response is not really needed. The Chebyshev is not the only viable design for a low pass filter.

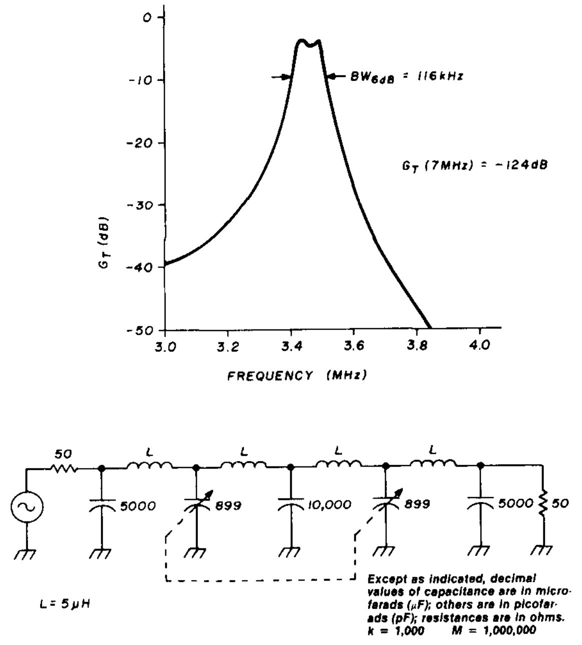


fig. 14. Result of cascading two PLPFs to form a double tuned circuit. See text for discussion on eliminating the double peak, a result of overcoupling.

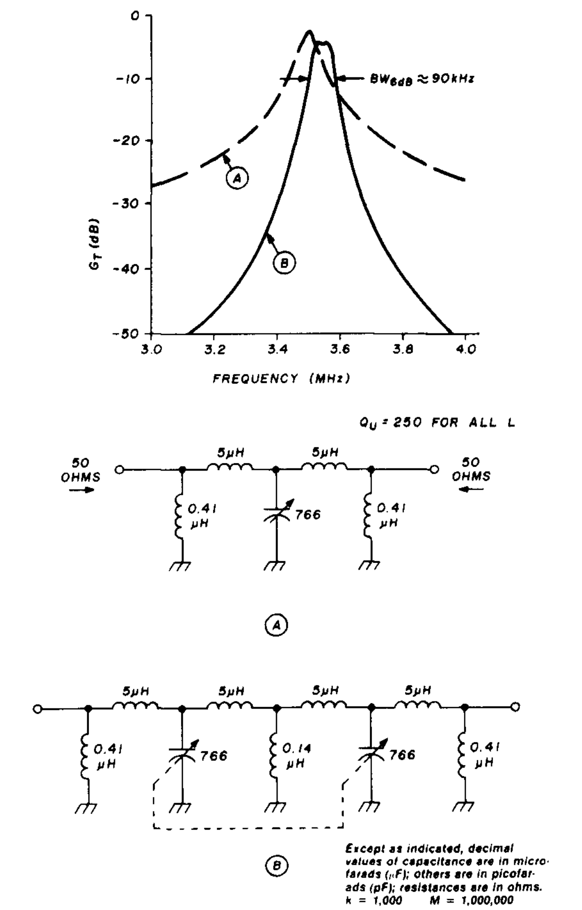


fig. 15. Wide tuning range bandpass filters that evolved from the PLPF.

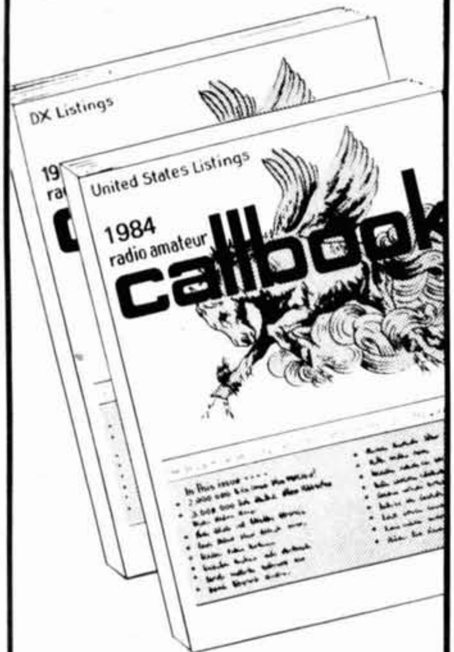
Computer methods are very powerful, but are no substitute for formal analysis and synthesis. The best computer applications in electronics seem to be those that extend our intuition about circuit design.

references

1. *Reference Data for Radio Engineers*, Fourth Edition, 1956, International Telephone and Telegraph Corp., Chapter 7.
2. Wes Hayward, W7ZOI, *Introduction to Radio Frequency Design*, Prentice-Hall, Englewood Cliffs, New Jersey, 1982, (See sections 2.7 and 2.8)
3. Ed Wetherhold, W3NQN, "Lowpass Filters for Amateur Radio Transmitters," *QST*, December, 1979, page 45. (See also many other papers by Wetherhold.)
4. T. Cuthbert, Jr., *Circuit Design Using Personal Computers*, John Wiley and Sons, New York, 1983, page 172.
5. Reference 2, page 51.
6. Wes Hayward, W7ZOI, "General Purpose Ladder Analysis with the Programmable Calculator," *rf design*, September/October, 1983.
7. D. Johnson and J. Johnson, "Lowpass Filters Using Ultraspherical Polynomials," *IEEE Transactions on Circuit Theory*, Volume CT-13, No. 4, December, 1966, pages 364-369.
8. Wes Hayward, W7ZOI, and Doug DeMaw, W1FB, *Solid-State Design for the Radio Amateur*, ARRL, Newington, Connecticut, 1977, page 54.
9, 10. A Zverev, *Handbook of Filter Synthesis*, John Wiley and Sons, New York, 1967.
11. Wes Hayward, W7ZOI, and John Lawson, K5IRK, "A Progressive Communications Receiver," *QST*, November, 1981, page 11.
12. Reference 2, Chapter 3.

ham radio

1984 CALLBOOKS



Order today!
1984
RADIO AMATEUR CALLBOOKS

Known throughout the world for accuracy, the 1984 Callbooks are a better value than ever before. The U.S. Callbook contains over 433,000 listings; the Foreign Callbook has over 413,000. More than 100,000 changes have been made in each edition since last year. Special features include call changes, Silent Keys, census of amateur licenses, world-wide QSL bureaus, international postal rates, prefixes of the world, and much more. You can't beat this value! Order your 1984 Callbooks now.

	Each	Shipping	Total
☐ U.S. Callbook	$19.95	$3.05	$23.00
☐ Foreign Callbook	18.95	3.05	22.00

Order both books at the same time for $41.95 including shipping within the USA.

Order from your dealer or directly from the publisher. Foreign residents add $4.55 for shipping. Illinois residents add 5% sales tax.

Keep your 1984 Callbooks up to date. The U.S. and Foreign Supplements contain all activity for the previous three months including new licenses. Available from the publisher in sets of three (March 1, June 1, and September 1) for only $12.00 per set including shipping. Specify U.S. or Foreign Supplements when ordering. Illinois residents add 5% sales tax. Offer void after November 1, 1984.

✓ 176

RADIO AMATEUR callbook INC.
Dept. F
925 Sherwood Dr., Box 247
Lake Bluff, IL 60044, USA

Tel: (312) 234-6600

Features never before available in one handheld.

Made in the U.S.A. And it's priced right.

The Ten-Tec 2591 offers everything you've ever wanted in a 2-meter handheld.

★ Memory Lockout permits the scanner to temporarily bypass channels for quick lockout of busy frequencies, yet retain them in memory for normal operation on demand ★ 10 Memories with stored offset. Channel 0 accepts any non-standard offset ★ Modifiable Band Scan without complete reprogramming. Scan any section of the band within user defined upper and lower limits in steps of 5, 10, 15, 25, or 30 kHz.. Change step size, upper and lower limits independently. Manual Scan also up or down, in 5 kHz steps ★ Selectable Skip or Hold ★ 2.5 Watts or .4 Watts ★ Covers 143.5–148.995 MHz ★ LCD Readout with Back Light ★ Quick-Release 450 mAH NI-CAD Battery Back ★ 16-Key Dual Tone Encoder, built-in ★ LED shows battery status and transmit mode ★ Designed and Manufactured in Tennessee. And it carries the famous TEN-TEC one year warranty. Put it to work for excellent 2 meter performance.

See your Ten-Tec dealer or write for details.

TEN-TEC, INC.
SEVIERVILLE, TENNESSEE 37862

BIRD Wattmeters

Authorized BIRD Distributor

Complete inventory of all Bird wattmeters, dummy loads, switches, carrying cases and accessories.

Order by phone
1-800-431-7777
In Ohio call 216-828-2071
Free shipping with certified check orders.

Model 4381
$675.00

Model 43
$162.00

All BIRD Elements In Stock

5A through 1000E elements (5W - 1000W; 25 - 1000 MHz) $48

50H through 1000H elements (50W - 1000W; 2 MHz - 30 MHz $59

2500H and 5000H elements (2500W and 5000W; 2 MHz - 30 MHz $75

✓ 172

PARAMOUNT

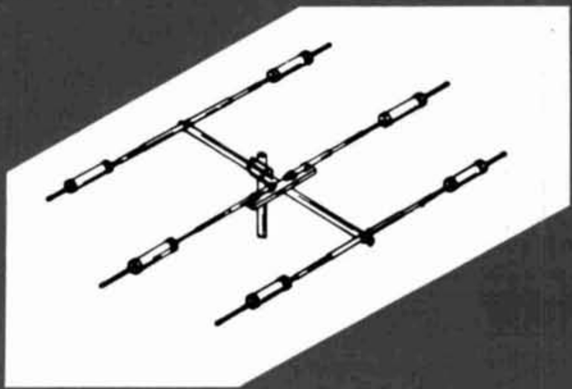
COMMUNICATIONS ELECTRONICS
PO Box 506, Burnett Ave., Dalton, OH 44618

Mosley............

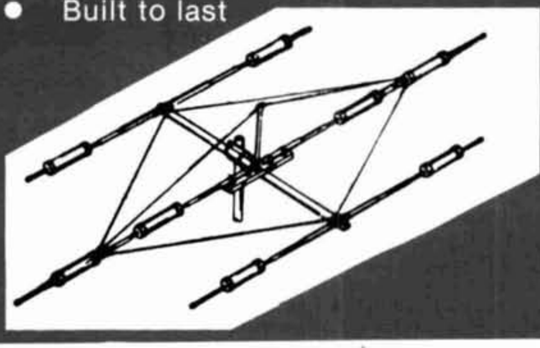
A BETTER ANTENNA ....

WHY SETTLE FOR LESS?

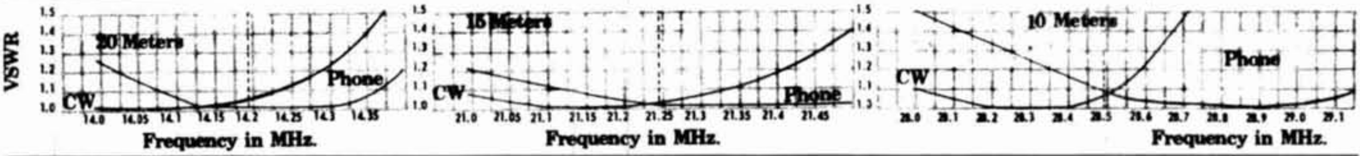
LOOK WHAT THE MOSLEY TA-33 OFFERS



- 3 Element full power
- All stainless steel hardware
- Ease of assembly
- No balun required
- Now a 2 year limited warranty
- Now a standard 2" mast adapter
- Built to last



- Expandable to 30 or 40 meters
- Superb front to back ratio
- Excellent gain
- Outstanding SWR



SPECIFICATIONS:

Forward gain		
Front-to-Back Ratio		
Power rating	CW	1KW
	SSB	2KW P.E.P.
Feedpoint Impedance		52 ohm
VSWR HT Resonance		1.5 to 1 or better
Matching System		Mosley
Number of Elements		3
Longest Element		28'
Boom Length		14'
Mast Size		1½" or 2"
Turning Radius		15'6"
Wind surface area (in. sq. ft.)		5.7
Wind load (EIA standard 80 mph)		114 lbs.
Assembled Wt.		39 lbs
Shipping Wt.		44 lbs.

- Used around the world
- Work CW or phone without tuning or adjusting antenna
- A great antenna for the new solid state rigs

ALL MOSLEY ANTENNAS AND CATALOGS AVAILABLE AT QUALITY DEALERS OR CALL TOLL FREE

1-800-325-4016

ASK ABOUT OUR FALL SPECIAL

Prices and specifications subject to change without notice or obligation.

REMEMBER WHETHER YOU USE TRAPS OR LINEAR LOADING, 8db GAIN IS 8db GAIN

YOUR RECEIVER CAN'T TELL THE DIFFERENCE . . . MOSLEY . . TRAP MASTERS QUALITY STILL SETTING THE PACE . . .

Mosley Electronics,

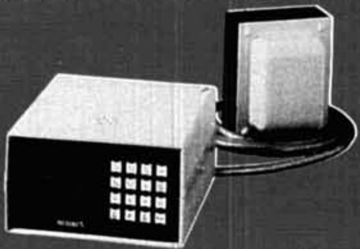
A DIVISION OF WURDACK & ASSOCIATES INC. 1344 BAUR BOULEVARD ST. LOUIS, MO. 63132 1-314-994-7872

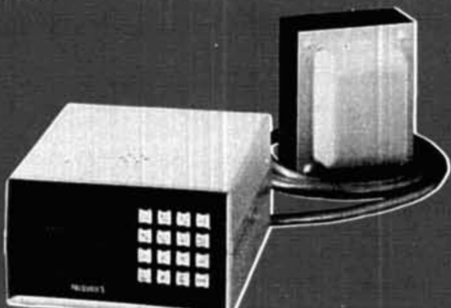
✓ 165

MORE FROM PRO-SEARCH™ ELECTRONICS

PRO-SEARCH™ Reaching The World

NOW THREE MODELS OF OUR
DIGITAL ANTENNA CONTROL
Your Choice Of Center, North Or South





GOOD
PSE-1A, 3A

The "CONTESTER" provides the least expensive DIGITAL CONTROL UNIT WITH COMPLETE COMPUTERIZED CONTROL, BUT WITH LESS FEATURES, than the "DX'ER" and "DELUX".
This unit gives you the current position of your antenna digitally in 5° steps. It has 2 memories and the command mode, plus single button operation. The PSE-1A, "CONTESTER" comes with a 7.0 amp continuous duty motor supply. PSE-3A has a 12 amp power pack.
It is not capable of being modified to talk or accept the computer interface or remote interface.
It is completely shielded and made of the same quality components as the other models.
The warranty on our unit is one year on materials and labor, and ninety days on parts.
This unit is a very inexpensive way to have the best of both worlds. A real time saver during contests. Hands off operation will save many hours of hanging on the rotor. Just a few dollars more than the manual control box, but worlds apart in state-of-the-art and operation. Price $229.95*

BETTER
PSE-1, PSE-3

The "DX'ER" is the top of the line of the non-voice synthesized units, and is for the ham who is in need of more features on their controller. It has "2" digital readouts, one to show the antenna's current position, plus a storage readout which holds a heading or digitally displays your last position. This is valuable for switching between long path or short path, or checking front to back, or working between two different stations...a real time saver and a nice convenience.
The "DX'ER" also has "5" scan functions: 0-90, 90-180, 180-270, 270-360, and 0-360. This is a real aid in looking for that dogleg opening or peaking a weak signal. The "DX'ER" has 2 memories for storing headings, it can be expanded to talk, and does have the hardware necessary to use with the computer interface.
It can be remotely keyed, where verbal confirmation isn't required. Price $362.95*

BEST
PSE-2, PSE-4

This is the ultimate in rotor controls. Nothing tops this one.
It has all the features of the other models, plus it talks...Yes, it talks.
The "DELUX" has a voice synthesizer which confirms your entries, plus tells you your heading as you enter it and when your antenna arrives.
All commands are spoken, plus as your antenna turns you hear a 400HZ tone going in one direction and a 80HZ tone in the other. This gives you positive verification of movement.
This unit, as the others, will combine with the HAM IV, T2X, and HDR-300, giving you the best antenna rotor combination you could ever want at any price. Price $469.00*

INTRODUCING THE ULTIMATE PACKAGE...FROM PRO-SEARCH™ NINE COMBINATIONS OF OUR CONTROL UNIT AND THE TELEX/HYGAIN* ROTOR MOTORS...
FOR JUST A FEW DOLLARS MORE YOU CAN HAVE THE CONTROLLER OF THE FUTURE TODAY!

Package #1 PSE-1A

#1 The "Contester" Package...try one of these TELEX/HY-GAIN rotors with our PSE-1A/3A. A system which is low in cost, high in performance.


HAM IV*


T2X*


HDR-300*

PSE-1A will save you lots of time in your favorite contests. No more hanging on the rotor control...Gives you positive control with DIGITAL readout plus 2 memories, command positioning, and single button manual movement.

Package Special

PSE-1A + HAM IV	$369.95
PSE-1A + T2X	415.95
PSE-3A + HDR-300	544.95

*Printed with permission of TELEX/HYGAIN Telex Communications, Inc.

Package #2 PSE-1/PSE-3

The "DX'ER" Package...Couple this unit with a rotor and you have the best non talking control we make. Expandable, plus has 5 scan functions, 2 DIGITAL displays and REC/LAST to check long path or short path. Has all internal hardware to plug into our computer interface. Can be remotely controlled from accessory jack.
Try this with any of the TELEX/HY-GAIN* Rotors! This will give you the broadest of functions with a mid-range price.

Package Special

PSE-1 + HAM IV	$502.95
PSE-1 + T2X	548.95
PSE-3 + HDR-300	677.95

Package #3 PSE-2/PSE-4

The "Delux" is the most sophisticated antenna control unit ever made. With the "Delux" you have all the functions of our other units, plus it talks...Yes it talks. Not only do you have your headings digitally displayed, but is also said as your antenna stops...All commands are spoken, plus as your antenna turns you hear a 400Hz tone in one direction and an 80Hz in the other, giving you positive varification of movement. This unit, when combined with the HAM IV, T2X or HDR-300 gives you the best buy anywhere at any price...

Package Special

PSE-2 + HAM IV	$608.95
PSE-2 + T2X	655.00
PSE-4 + HDR-300	784.00

PRO-SEARCH™ Reaching The World

Controllers also available for other rotors.

Prices and specifications subject to change without notice or obligation.

U.S. and Foreign Patents

*For PSE, 3A, 3, 4 add $24.50 for 12 amp power pack

Write or Call for our Catalog • Pro Search Electronics Co. 1344 Bauer Boulevard St. Louis, Missouri 63132 • 1-314-994-7872 (Missouri) 1-800-325-4016

DX FORECASTER

Garth Stonehocker, KØRYW

sporadic E (E_s) DX

Last month the fundamentals of E_s and E_s propagation were reviewed. Now, before the E_s season gets further along, let's look at how E_s propagation can be used for DX. Because E_s propagation is short skip — i.e., 900 miles (1450 km) in hop length — the take-off angle needs to be low (5 to 10 degrees off the ground) in order to obtain the maximum length per hop. This keeps the number of hops (signal loss) to a minimum. For the higher frequency bands where horizontal beam (Yagi) antennas are used, this means tall towers with heights exceeding 60 feet — or even better, 100 feet or more. On the lower frequenices (below 10 MHz) vertical antennas in clear, treeless settings, situated over moist earth and equipped with sufficient ground systems are needed to obtain 5 to 10 degree take-off angles. (To obtain substantial energy at these angles, even at 7 MHz, ground systems should be measured in terms of wavelengths. — **Editor**).

To obtain the highest probability of "reflecting" from an E_s "cloud," a fairly wide beamwidth should be used. Because the beamwidth of Yagis (50 to 60 degrees) is better than the beamwidth of rhombics (20 to 30 degrees), Yagis are preferred for "hitting the clouds." E_s clouds usually measure about 10 by 100 km in length and about 0.6 km in depth. Their thin, dense configuration results in mirror-like reflections rather than the refractions that are characteristic of the F region. Reflection enhances signal strength by an average of 25 dB over refraction.

Another rule of thumb for E_s DX is to use the lowest frequency that isn't absorbed too much. In other words, during daytime, don't use the 10-meter band when 20 is available. The probability of E_s occurrence is higher when the frequency is lower. You can expect an increase of at least 6 to 7 dB in E_s signal strength by using the lowest band that is open.

last-minute forecast

DX conditions are expected to be best for the higher frequency bands, 10 to 30 meters (daytime bands), from the 12th through 21st of the month, providing long and short skip openings. The lower frequency bands, 30 to 40 meters, are expected to be the best the first few days of the month and the last week of the month (the 25th and later), including some daytime openings when the solar flux is 80 units or below. The 80 to 160 meter bands will be poor because of noise, except for some sporadic E short-skip openings toward the end of the month.

The Aquarid meteor shower starts about the 18th, peaks about the 28th, and lasts until about August 7th. The maximum radio-echo rate will be 34 per hour. The full moon is on June 13th, lunar perigee the 7th, and solstice on the 21st at 0502 UT.

band-by-band summary

Six meters will provide occasional openings to South Africa and South America around local noontime by short-skip E_s.

Ten meters will be open to the south and southeast for a short period before local noon; to the south at noon and to the southwest in the afternoon. Openings will last longer when the solar flux is at a maximum and improve (transequatorial one-long-hop) during periods of geomagnetic field-disturbances. Listen to WWV at 18 minutes after the hour for pertinent announcements.

Fifteen and twenty meters, almost always open to some part of the world, will be the main daytime DX bands. *Twenty meters* should stay open on long southern paths into the night, though 15 will drop out in the late afternoon. Operate on 15 first, then move down to 20 meters later. DX is 5,000 to 7,000 miles (8,000 to 11,300 km) on these bands. There may be some one-long-hop transequatorial propagation.

Thirty and forty meters are both daytime and nighttime bands. Intermediate distance operation, 1000-1500 miles (1600-2400 km), in any direction is considered daytime DX. Nighttime DX on these two bands may be expected to occur over greater distances than on 80 meters and, like 80, will follow the darkness path across the sky. Signal strength and distances covered are reduced on days of high solar flux values. In addition, no 30-meter openings will take place during the predawn hours on the morning after these high radio flux values.

Eighty and one-sixty meters will exhibit short skip conditions during daylight hours and lengthen for DX near dark. Eighty meters will open to the east just before your sunset, swing more to the south as midnight approaches, and end up in the Pacific areas during the hour or so before dawn. (160 opens later and ends earlier.)

ham radio

JUNE

WESTERN USA

GMT	2300	2200	2100	2000	1900	1800	1700	1600	1500	1400	1300	1200	1100	1000	0900	0800	0700	0600	0500	0400	0300	0200	0100	0000	
PDT	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	7:00	6:00	5:00	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	7:00	6:00	5:00	
ASIA FAR EAST	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	15	15	15	15	20*	20	20	20	20	N
EUROPE	15	15	15	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	15	15	15	NE
S. AFRICA	15	15	10	10	10	10	10	10	15	15	15	15	15	20	20	20	20	20	20	20	20	20	15	15	E
S. AMERICA	10	15	15	15	15	20	20	20	20	20	20	20	20	20	20	15	15	15	10	10	10	10	10	10	SE
ANTARCTICA	20	20	20	20	20	20	20	20	30	30	30	30	30	30	30	30	30	30	30	30	30	20	20	20	S
NEW ZEALAND	10	10	15	15	15	15	15	15	20	20	20	20	20	20	15	15	10	10	10	10	10	10	10	10	SW
OCEANIA AUSTRALIA	10	15	15	15	15	15	20	20	20	20	20	20	20	20	20	15	15	15	10	10	10	10	10	10	W
JAPAN	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	15	15	15	15	15	15	15	15	NW

MID USA

GMT	2300	2200	2100	2000	1900	1800	1700	1600	1500	1400	1300	1200	1100	1000	0900	0800	0700	0600	0500	0400	0300	0200	0100	0000	
MDT	5:00	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	7:00	6:00	5:00	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	7:00	6:00	
ASIA FAR EAST	20	20	15	15	15	15	15	15	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	N
EUROPE	15	15	15	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	15	15	15	NE
S. AFRICA	15	15	10	10	10	10	10	10	15	15	15	15	15	20	20	20	20	20	20	20	20	20	20*	15	E
S. AMERICA	15	15	10	10	10	10	10	10	10	15	15	15	15	20	20	20	20	20	20	20	20	20	20	15	SE
ANTARCTICA	20	20	20	20	20	20	20	20	30	30	30	30	30	30	30	30	30	30	30	30	30	20	20	20	S
NEW ZEALAND	10	10	15	15	15	15	15	20	20	20	20	20	20	20	15	15	15	10	10	10	10	10	10	10	SW
OCEANIA AUSTRALIA	10	15	15	15	15	15	20	20	20	20	20	20	20	20	15	15	15	15	10	10	10	10	10	10	W
JAPAN	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	15	15	15	15	15	20	20	NW
CDT	6:00	5:00	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	7:00	6:00	5:00	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	7:00	

EASTERN USA

EDT	7:00	6:00	5:00	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	7:00	6:00	5:00	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	
ASIA FAR EAST	20	20	15	15	15	15	15	15	20*	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	N
EUROPE	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	NE
S. AFRICA	15	15	10	10	10	10	10	10	10	15	15	15	15	20	20	20	20	20	20	20	20	20	15	15	E
CARIBBEAN S. AMERICA	15	15	10	10	10	10	10	10	10	15	15	15	15	20	20	20	20	20	20	20	20	20	20*	15	SE
ANTARCTICA	20	20	20	20	20	20	20	20	30	30	30	30	30	30	30	30	30	30	30	30	30	20	20	20	S
NEW ZEALAND	10	10	15	15	15	15	15	20	20	20	20	20	20	20	15	15	15	10	10	10	10	10	10	10	SW
OCEANIA AUSTRALIA	10	15	15	15	15	15	20	20	20	20	20	20	20	20	20	15	15	15	15	10	10	10	10	10	W
JAPAN	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	15	15	15	15	20	20	20	NW

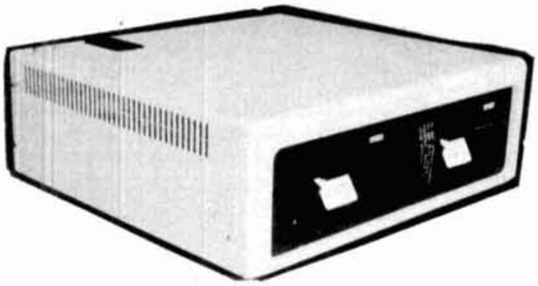
The italicized numbers signify the bands to try during the transition and early morning hours, while the standard type provides the MUF during 'normal' hours.

*Look at next **higher** band for possible openings.

John J. Meshna Jr., Inc.

19 Allerton Street • Lynn, MA 01904 • Tel: (617) 595-2275

DUAL FLOPPY DISC DRIVES

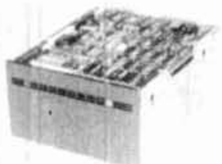


BRAND NEW, dual floppy disc drives made for Digital Equipment Corp. (DEC model no. RX 180 AB). This beautiful piece of computer hardware consists of 2 Shugart compatible TEAC 40 track, double density, 5¼" mini-floppy disc drives brand new in the case with their own regulated, switching power supply, cooling fan & on/off switch. Each unit also comes with a line cord & documentation. These were made for DEC, but are also compatible with other personal computers such as IBM, TRS 80 models I, II, III, & the Color Computer, and other Shugart compatible interfaces. Naturally you supply the cables and disc controller card to suit your particular system. The RX 180 AB runs off of 115 /230 VAC 50/60 Hz. w/out any modifications to the drives. Each system comes in the original factory box and are guaranteed functional. A blockbuster of a buy !! Shpg. wt. 20 lb. Stock no. RX 180 AB $250.00

HIGH SPEED KSR PRINTER TERMINAL

World famous, high speed G. E. Terminet 1200 RS 232 KSR printer terminals are now in stock ready for shipment to you. This has to be one of the finest letter quality printers ever offered at a bargain price. These terminals can be used as an RS 232 asynchronous communications terminal or used in the local mode as a typewriter. The terminals were removed from service for upgrading. Highlights of these machines are: Standard RS 232, full duplex, asynchronous data comm., fully formed upper and lower case letters, 128 character ASCII set, selectable baud rates of 110, 300, or 1200 BPS, 80 columns on pin feed paper, and less weight & size than an ASR 35 teletype with far less racket. They are virtually electronically foolproof as every pc board is Pico fuse protected. Should your machine not work, just check the on board fuses & 9 out of 10 times that is where the problem lies. Schematics are provided w/ each machine sold. Current price of this machine new is over $2000.00 ! Our meager price for this fantastic printer is only 10% of this: $200.00 each!!! Visually inspected prior to shipment to insure completeness. Shpd. truck freight collect. $200.00

5 MEGABYTE SEAGATE ST 506 5¼" MICROWINCHESTER HARD DISC DRIVES



The Seagate Technology ST 506 MicroWinchester hard disc drives are identical in size and mounting configuration to the industry standard 5¼" mini-floppy disc drives. These drives utilize 2 5¼" fixed platters as storage media. Each surface employs 1 read/write head to service 153 tracks. The storage capacity is 5 megabytes formatted ! The voltage requirements are only 5vdc 700ma & 12vdc 1.6 amps. hardly more than a regular mini-floppy drive. The drives we have are in beautiful condition and look to be unused. Each one comes with factory literature which includes the pinouts. The ST 506's will run with computer systems from Kaypro, IBM, Xerox, and other Shugart compatible interfaces when used with the proper controller card (not provided). Only 10 pieces in stock, so order early.
Seagate ST 506 Shpg. wt. 9 lb. $300.00 2/$575.00

IBM model no. 745

NEW IBM SELECTRIC BASED TYPEWRITER PRINTERS

Send for free data sheet.

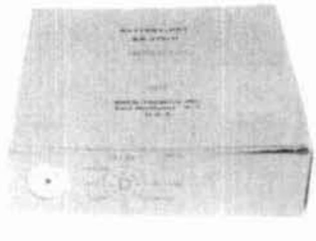
These rugged, handsome printers were made for one of the giants of the computer industry. They can be used as a standard typewriter or as a printer in a word processing system for true letter quality printing. Solenoids were added to the selectric mechanism which disabled the manual repeat function but still allows electronic repeat functions. It uses standard IBM typing balls. The voltage requirements are standard 115 vac, 5 vdc @ 100 ma, & 24 vdc @ 4 amps. All are new in factory boxes, but may require adjustments. We provide literature and schematics with 1 ribbon & cleaning tools. With the addition of our Centronics to Selectric I/O adapter, you could easily interface this printer to almost any micro computer system.
Typewriter Printer stock no. RE 1000A $375.00 shpg wt. approx. 80 lb. shpd. by truck collect.
Centronics to Selectric adapter. Fully tested & operational $245.00 Shpd. UPS 15 lb.

SHUGART 901 8" FDD

We just got in a small lot of nice clean world reknown Shugart 8" disc drives. Single side, single density units. Each drive will come with data on using the 901's in 801 compatible systems which should make them very versatile. Schematics are also provided. Used, good condition. Shpg. wt. 15 lb. $75.00

BA 279 BATTERIES

Unused surplus from Uncle Sam. Output is 135v, 67½ v, 6v, & 1½v. Socket is made to fit plug from PRC 8,9,& 10. May fit other rigs as well. Current list price is $42.25. Our price is only $15.00 Shpg. wt. 9 lb.



Phone Orders accepted on MC, VISA, or AMEX
No COD's. Tel. 1-617-595-2275

Surplus Electronic Material

Send for our free 72 page catalogue jam packed with goodies.

B. G. MICRO

P. O. Box 280298 Dallas, Texas 75228
(214) 271-5546

74LS

LS00	.24	LS164	.60
LS01	.24	LS165	.90
LS02	.24	LS166	.99
LS03	.24	LS169	1.25
LS04	.24	LS174	.60
LS05	.24	LS175	.50
LS08	.24	LS181	1.99
LS10	.24	LS191	.90
LS11	.24	LS192	.80
LS12	.30	LS193	.80
LS13	.50	LS195	.65
LS14	.50	LS197	.85
LS20	.24	LS221	.80
LS21	.25	LS240	.95
LS27	.24	LS241	.80
LS30	.28	LS242	.90
LS32	.36	LS243	.90
LS42	.49	LS244	1.25
LS51	.24	LS245	1.50
LS74	.40	LS251	.50
LS85	.60	LS257	.55
LS86	.39	LS258	.55
LS90	.50	LS266	.50
LS93	.55	LS273	1.25
LS109	.39	LS279	.45
LS112	.39	LS283	.60
LS123	.75	LS290	.85
LS124	2.75	LS293	.85
LS125	.45	LS298	.89
LS132	.50	LS299	1.60
LS133	.49	LS366	.45
LS138	.60	LS367	.50
LS139	.60	LS368	.40
LS151	.50	LS373	1.25
LS153	.50	LS374	1.35
LS154	1.75	LS375	1.19
LS155	.50	LS377	1.49
LS156	.55	LS378	.85
LS157	.60	LS390	1.19
LS161	.60	LS393	1.19
LS162	.65	LS399	1.25
LS163	.50		

TTL

7400	.19	74125	.49
7402	.19	74151	.50
7404	.19	74154	1.19
7408	.24	74157	.50
7410	.19	74164	.75
7440	.19	74174	.85
7474	.35	74175	.79
7486	.29	74367	.59
74109	.45		

6500

6502	4.50	6545	10.00
6522	6.95	6551	10.00

6800

6800	2.50	6840	10.00
6802	5.00	6845P	10.00
6803	14.95	6850	2.60
6810	2.00	68A21	4.95
6820	3.25	68B45	17.50
6821	2.95		

EPROM

2708 1KX8 450 n.s. 2.20
27A08 1KX8 350 n.s. 3.95
2758 1KX8 +5V 450 n.s .. 2.50
2716 2KX8
450 n.s. 3.20
2716-1 2KX8 350 n.s. 5.50
2732 4KX8 450 n.s. 4.75
2532 4KX8 450 n.s. 5.50
2764-25 250 n.s. 7.50

EPROM SPECIAL

We bought a large quantity of 2708s from a computer manufacturer who redesigned their boards. We removed them from sockets, erased and verified them, and now we offer the savings to you. Complete satisfaction guaranteed.
2708
$1.49 or 10/$12.00

STATIC RAM

TMM2016-2KX8
200 n.s. 8/39.95
2101-1 - 256X4
500 n.s. .... .75
21L02-1 350 n.s. .... .65
2102AL-4 L.P. 450 n.s. .... .49
2114L-3 1KX4 300 n.s.
L. P. 2.75 8/16.00
TMS4044 (MCM6641 C-25)
4KX1 250 n.s. 8/6.00
TMS4046 450 n.s. .... .65
5101E-8 - 256X4 -
CMOS $1.00
HM6116P-4-2KX8
200 n.s. CMOS 8/39.95
6501-5 256X4 - CMOS - Data Retention 2 Volts - 22 Pin - 200 n.s. Typ. - 5V - Very Low Power 1.00
8108-5 1KX8 NMOS 500 NS
22 Pin 2.00

4K STATIC RAMS

LESS THAN 50¢ EACH
MK4104J-4 - 250 N.S. 18 Pin Ceramic Computer Mfg. Surplus. PRIME. Fully Static. Easy to Use. Has Same Pin Out as TMS4044, but slightly different timing. With Specs. (Mostek)
8 for 5.00   32 for 15.95
VERY LOW POWER!

DMA CONTROLLER

SPECIAL
9517A-4 (8237-4)........ 10.50

DYNAMIC RAM

5280N-5 (2107B-4 • TMS4060)
4KX1 .... 8/3.95
4027-4KX1-250 n.s. 1.00
4116-16KX1-250 n.s. ... 8/9.00
4116-16KX1-200 n.s. .. 8/11.50
4164- +5v 64K 200 n.s. 8/48.00

8000

Z8002	29.95	8085A	5.95
8035	4.50	8086-2	30.00
8039	5.00	8087-3	175.00
8080A	2.00	8088	20.00

8200

8202A	15.95	8253	4.95
8212	1.25	8253-5	5.95
8214	2.00	8255-5	5.50
8216	1.50	8257	6.00
8224	1.50	8259A	4.95
8228	3.00	8275	19.95
8237-4	10.50	8279-5	7.95
8250B	9.95	8287	5.75
8251	3.95	8288	24.95

DIP SWITCH

DT08 BY ALCO
8 POSITION DIP SWITCH
Super low profile -
Made for automatic insertion -
SPECIAL — .90   10/7.50
DT-10 .... 1.00 10/8.50

Z80

Z80 2.5 MHZ CPU 3.50
Z80CTC 3.75
Z80DMA-DMA 9.95
Z80PIO 3.95
Z80SIO/O 16.95
Z80A-4MHZ CPU 4.95
Z80A DART 9.95
Z80A-PIO 5.95
Z80A SIO/O 19.95
Z80B 6 MHZ CPU 14.95

UART

1602 (COM 2017) 2.95
1863 .... 3.95
IM6402-+5v High speed
UART-AY5-1013 pin out 2.95
INS 8250B 9.95

2114 SPECIAL!

COMPUTER MANUFACTURERS EXCESS INVENTORY SALE!
PRIME! 2114-300 n.s.
INCREDIBLE PRICE!
YOU SAVE!
8/$9.00
GUARANTEED

SOCKETS

Low Profile SOLDER TAIL

6 Pin	14/1.00
8 Pin	13/1.00
14 Pin	10/1.00
16 Pin	8/1.00
18 Pin	8/1.00
20 Pin	7/1.00
24 Pin	6/1.00
28 Pin	6/1.00
40 Pin	5/1.00

BUY $10
GET $1.00
FREE CHOICE

F.D. CONTROLLERS

1771 Single Density 15.00
1791 Double Density ... 20.00
1793 .... 22.00
1797 .... 24.95
2793 .... 35.95

CONTROLLER SET

THREE CHIP SET
1797, 2143-03, 1691 by W.D.
Compare at up to 86.85.
B.G. SPECIAL
All 3 for only $29.95

CRYSTALS

32.768 Khz SPECIAL ...... .65
262.144 .... .75
300.000 .... 1.00
307.200 .... 1.25
1.5432 Mhz .... .75
1.8432 .... 2.49
2.000000 .... 2.49
3.000 .... 1.15
3.120 .... 1.20
3.579545 - HC18 .... 1.00
4.000 .... 2.49
4.194304 .... 1.50
4.433618 .... .75
4444.000 .... 1.25
4.9152 .... 2.49
4.916 Bd. Rate 1.25
5.000000 .... 1.50
5.0688 .... 3.75
5.616 .... 1.59
8.000 .... 1.99
9.90000 .... 1.25
10.69425 .... 3.75
10.8864 .... 1.49
11.088 .... 1.59
13.440 .... 1.00
12.000 .... 2.75
15.2 .... 1.10
14.31818 .... 2.49
16.00000 .... 1.50
17.430 .... 2.49
18.2259 .... 1.00
20.000 .... 3.75
21.87108 .... 1.00
22.092 .... 1.00
32.000 .... 2.49
40.000 .... 2.00
87.3333 .... 1.00
91.000 .... 1.00
104.8 .... 1.00

TERMS: (Unless specified elsewhere) Add $1.50 postage, we pay balance. Orders over $50.00 add 85¢ for insurance. No C.O.D. Texas Res. add 6% Tax. 90 Day Money Back Guarantee on all items. All items subject to prior sale. Prices subject to change without notice. Foreign order - US funds only. We cannot ship to Mexico. Countries other than Canada, add $3.50 shipping and handling.

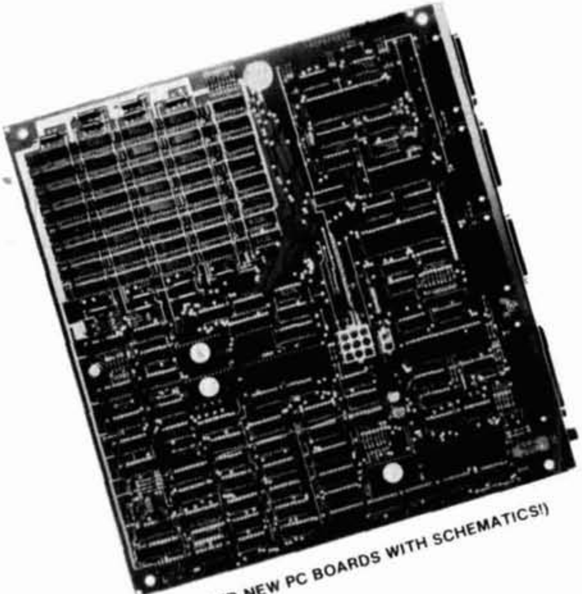
B. G. MICRO

P. O. Box 280298 Dallas, Texas 75228
(214) 271-5546

Z80* SINGLE BOARD COMPUTER!

64K RAM — 80 x 24 VIDEO DISPLAY — FLOPPY DISK CONTROLLER

RUNS CP/M* 2.2!



(BRAND NEW PC BOARDS WITH SCHEMATICS!)

$29.95
(BLANK BOARD WITH DATA AND ROM'S.)

NEW PRICE

GROUP SPECIAL: BUY 6 FOR $165!

USES EASY TO GET PARTS!

BOARD MEASURES 11½" x 12½"

ALL ORDERS WILL BE PROCESSED ON A *STRICT*, FIRST COME, FIRST SERVED BASIS! ORDER EARLY!

GIANT COMPUTER MANUFACTURER'S SURPLUS!
UNBELIEVABLE LOW PRICE!!!

Recently Xerox Corp. changed designs on their popular 820* computer. These prime, new, 820-1 PC boards were declared as surplus and sold. Their loss is your gain! These boards are 4 layers for lower noise, are solder masked, and have a silk screened component legend. They are absolutely some of the best quality PC boards we have seen, and all have passed final vendor QC. Please note, however, these surplus boards were sold by Xerox to us on an *AS IS* basis and they will not warranty nor support this part.

We provide complete schematics, ROM'S, and parts lists. If you are an *EXPERIENCED* computer hacker, this board is for you! Remember, these are prime, unused PC boards! But since we have no control over the quality of parts used to populate the blank board, we must sell these boards as is, without warranty. You will have to do any debugging, if necessary, yourself!.

ADD $2 PER PC BOARD FOR SHIPPING. (USA and Canada)

WE'VE GOT EM!

5-1/4"
HALF SIZE DRIVES

- 40 Track per side
- Double-sided, double density
- Same as SA455
- Latest head & drive technology
- Fast access time

Two of These Half Size Drives will Fit in the Same Space as 1 Full Size Drive!

$179.00 per drive

Compare at up to $349 ea.

ADD $3.00 UPS PER DRIVE

*CP/M TM OF DIGITAL RESEARCH INC. (CALIF.) 820 TM OF XEROX CORP. Z80 TM OF ZILOG

TERMS: Orders over $50 add 85¢ insurance. No COD. Tex. Res. Add 6% Sales Tax. Subject to prior sale. Foreign orders: US funds only. We cannot ship to Mexico. Foreign countries other than Canada add $6 per board shipping.

The small dish that captures all the entertainment.

WILSON MICROWAVE SYSTEMS, INC.

Only Wilson Microwave Systems can give you the versatility of hand-held control of the total satellite television spectrum at such a remarkably low price.

Total System Design.

From the solid steel antenna to the state-of-the-art electronic receiver and hand-held control unit, Wilson gives you the most complete, integrated system you can own.

At Wilson Microwave Systems, we put the world of entertainment in the palm of your hand.

BUILT BY YAESU
1 year warranty on receivers
4 year limited warranty on dish

NOW ONLY

$1695.00 F.O.B. Nampa, ID

Includes: 110° LNA - Polarizer I - 100' Cable
Wilson MD9 Dish - YM1000 Receiver

Dealerships Available

Antenna is shown with optional LNA cover.

Distributed by

NAMPA SATELLITE SYSTEMS

312 12th Avenue South • Nampa, Idaho 83651
(208) 466-6727
In State Wats 1-800-654-1319 • Out of State Wats 1-800-654-0795

✓ 167

product REVIEW

ProSearch PSE-2N computerized antenna control

With all the advances in computer technology and applications, it was only a matter of time before someone designed a computer-controlled antenna rotator. The ProSearch PSE-2N is the first microprocessor controlled unit and features enunciated beam headings (with a computer generated voice). It will scan, is programmable for up to ten different beam headings, and has a computer actuated braking circuit. Like other ProSearch controllers, the PSE-2N is compatible with all commonly available rotators.

When I asked Gary Wurdack, President of ProSearch, for some background on the ProSearch Controller, he explained that the design came from his operating experience at KØVUW, where he is actively involved in many contests, and that the ProSearch controller design evolved from his efforts to simplify and streamline the station. He explained his "wish list" of capabilities to a team of design engineers, and asked them to produce a computer controlled antenna rotator. The result is the ProSearch line of controllers.

Of particular interest to *ham radio* readers who have computer-integrated their stations, the PSE-2N can be hooked up to a master computer so that it can be controlled from a single source. This offers a number of exciting possibilities for complete computerization of ham shacks, and it will be interesting to see what results.

design

The heart of the ProSearch PSE 2 controller is a microprocessor that will process, store, and retrieve information and antenna headings and will control, in a manual mode, the operation of the rotator. Command entries are made through a 16-button keyboard on the front of the unit. Output commands from the microprocessor are fed to three driver amps that will activate the left and right movement of the rotator and the brake function. The microprocessor also controls the "talker" voice signals. When numbers are entered through the keyboard, they are read back for confirmation. The computer also controls the 80-Hz tone for CCW rotation and the 400-Hz tone for CW rotation.

As the rotator turns, a positive feedback potentiometer sends analog voltage signals back to the controller, indicating which direction the antenna is pointed. This signal is filtered and then converted into a digital signal to be compatible with the PSE microprocessor.

One admirable feature of the PSE-2N is its ten storable memory locations. Five of these memories have special buttons, keys 1-5, on the keypad for easy access. These areas are marked "Japan," "Europe," "Africa," "South America," and "New Zealand," respectively. Keys 6-0 can also be used to store beam headings for other areas of the world.

operation

Once you've connected all the rotator wires to the Cinch-Jones plugs and connected power to the unit, you are ready to go.

To turn the unit on, simply push the "SCAN & 7" button. All control instructions are entered from the keyboard and each key stroke is verbally confirmed.

The first order of business after installation is to calibrate the unit. This process is quite simple to accomplish using the step-by-step instructions provided and will take only a few minutes to accomplish. After the unit has been calibrated, it is ready to use in normal operations.

In order to demonstrate how the unit determines a specific heading, let's arbitrarily choose 45 degrees for Europe. Punch in a three-figured azimuth, (045 in this case), and push the "GO" button twice. Before the brake unlocks, the unit will say "0-4-5-GO-GO." The unit will unlock and begin to turn. Because of inaccuracies in rotor potentiometers, the computer will need to sample the analog input several times before stopping the unit in a desired direction, but when it stops, your antenna will be within ±4 degrees of the desired direction.

ProSearch has built a protective circuit into the PSE-2N that will prevent accidental rotor damage from running the unit at full power into the stops: on north-centered units, inputs are within 15 degrees of the stops above 164 degrees or below 195 degrees; on south-centered units, the stops are between above 344 degrees and below 015 degrees. Should there be a heading you want in one of these areas, you can manually direct the antenna into these areas.

programming

To program the antenna for one of the ten memories, you first enter the beam heading. (Let's choose 045 degrees for Europe again.) Push the "STORE" button, then push the 2/EU (Europe). Memory position 2/EU is now programmed at 045 degrees and can be recalled by simply pushing the "GO" button once and then the 2/EU button. The antenna will automatically turn toward Europe at 045 degrees. Button 1/JA, 3/AFRICA, 4/SOUTH AMERICA and 5/NEW ZEALAND can now all be programmed with the appropriate information for your location. Memories 6-0 also can be programmed with any additional headings that you might desire or require.

Another useful feature is Scan. The PSE-2N has five "scan" functions. Scan-1 will have the rotator scan from 0-90 degrees; Scan-2, 90-180 degrees; Scan-3, 180-270 degrees; Scan-4, 270-360 degrees; and Scan-5, a full 360 degrees.

When in the Scan mode the antenna will swing back and forth between the desired section while you look for the station and the optimal signal. Once you hear the station and you get the maximum signal strength, hit any key. The rotator will stop, locked onto the signal.

3 ALL NEW HT AMPLIFIERS

. . . . by VoCom

HT POWER!
25-35 Watt

You again have a choice at this power level. Our popular 200mW input model is back! (2C025-200) You'll get a whopping 25-35w signal from the LOW POWER (battery saving) position of your handheld and the input is UNCONDITIONALLY protected against accidental overdrive. Both this and our popular 2w drive model (2C025-2) come with our unique battery charger feature.

2C025-200 .... \$ 99.95 Suggested List
2C025-2 .... \$ 84.95 Suggested List

MORE HT POWER!
50-70 Watt

Our popular 50 watt model is now even better. A nominal 1½w - 2w input gets you a clean 50w output. The massive NEW heatsink/case has over 250 square inches of surface area. This along with our high efficiency design allows us to rate this amplifier for CONTINUOUS duty.

2C050-2 .... \$124.95 Suggested List

EVEN MORE HT POWER!
100-120 Watt

No one will believe you're on a handheld radio with this beauty. Over 300 square inches of heat sink area. Ultra-stable Wilkinson combining techniques in the final RF stage. Two models available. 1-5 watt drive (2C100-2) or 25 watt drive (2C100-25).
CONTINUOUS duty operation.

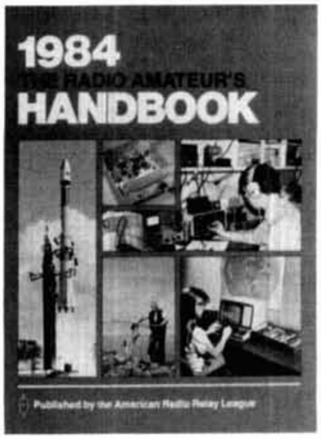
2C100-25 .... \$179.95 Suggested List
2C100-2 .... \$199.95 Suggested List

To order or for your nearest dealer
CALL US AT
1-800-USA-MADE

VoCom
PRODUCTS CORPORATION
65 E. Palatine Rd., Prospect Heights, IL 60070
(312) 459-3680

All VoCom products are designed, built and 100% tested at our Prospect Heights, Illinois facility.

✔ 201

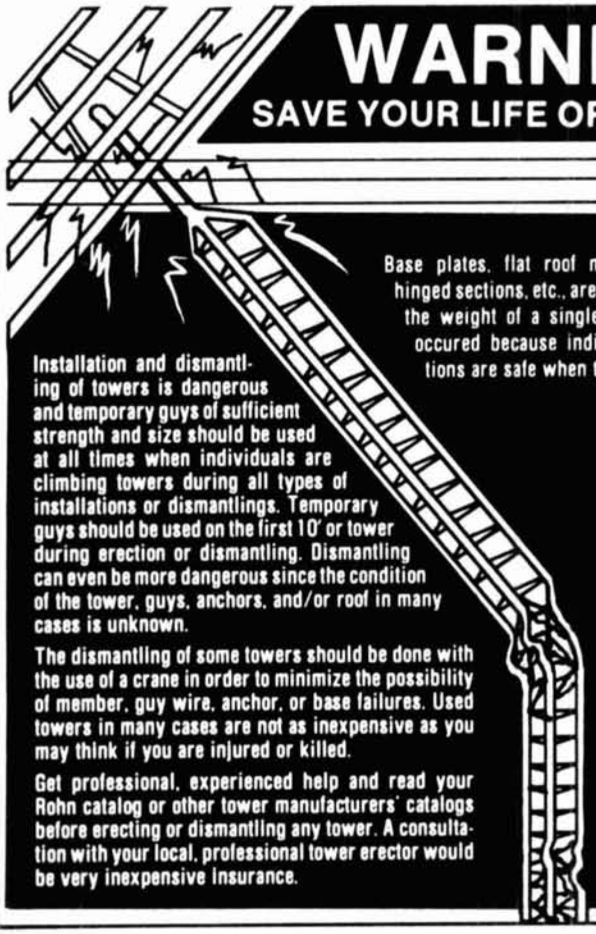


STATE OF THE ART

The 1984 Edition of *The Radio Amateur's Handbook* carries on the tradition of the previous editions by presenting 640 pages of comprehensive information for the radio amateur, engineer, technician and student. Paper edition: **\$12** in the U.S., **\$13** in Canada, **\$14.50** elsewhere. Cloth: **\$17.75** in the U.S., **\$20** elsewhere. In U.S. funds.

THE AMERICAN RADIO RELAY LEAGUE
225 MAIN ST.
NEWINGTON, CT 06111

✔ 110



WARNING

SAVE YOUR LIFE OR AN INJURY

Base plates, flat roof mounts, hinged bases, hinged sections, etc., are not intended to support the weight of a single man. Accidents have occured because individuals assume situations are safe when they are not.

Installation and dismantling of towers is dangerous and temporary guys of sufficient strength and size should be used at all times when individuals are climbing towers during all types of installations or dismantlings. Temporary guys should be used on the first 10' or tower during erection or dismantling. Dismantling can even be more dangerous since the condition of the tower, guys, anchors, and/or roof in many cases is unknown.

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

Get professional, experienced help and read your Rohn catalog or other tower manufacturers' catalogs before erecting or dismantling any tower. A consultation with your local, professional tower erector would be very inexpensive insurance.

Paid for By the Following:

ROHN®
P.O. Box 2000
Peoria, IL 61656

This Publication is available in Microform.

University Microfilms International

Please send additional information
for ________________
Name________________
Institution________________
Street________________
City________________
State________ Zip________

300 North Zeeb Road
Dept. P.R.
Ann Arbor, Mi. 48106

product REVIEW

While scanning is a pleasurable activity, ProSearch does not recommend protracted amounts of scanning. They suggest that you don't scan for more than ten minutes without giving your rotator at least a few minutes' rest. This is required so that the brake solenoid will have sufficient time to cool.

The ProSearch PSE-2N isn't just a fully automatic unit. As you might expect, you can also turn the antenna manually with a clockwise or counter-clockwise rotation. This is helpful in fine tuning the direction of the beam to maximize signals.

computerization

Here's an area where you can really be at the forefront of current technology. When engineers designed the PSE-2N, they were able to provide an interface port that will facilitate connecting the controller to your home computer. The possibilities that this opens up are truly exciting. One thought is that you could design your station to be run completely by remote control. Why, you could even program a computer to work DX stations while you're at work or at home, sound asleep! You could store all the pertinent information about a particular station and your station could automatically turn on, aim the beam in the right direction, select the appropriate antenna and . . . well it *is* possible and may, in fact, already have been done. It is a fascinating thought; anyone who's actually done it is invited to drop us a note and tell us all about it.

summary

When I write a product review, I generally take the unit home to put it through its paces. In this case, because of the unique nature of the unit, I installed it into our club station WB1AHV so that all the hams here could try it out. It was interesting to hear the first impressions of the staff and station visitors to the PSE-2N; all were pleasantly surprised by the talk-back feature, and commented that it's a valuable asset. In casual operating, all who used the PSE-2N found it to be well engineered and easy to use, even with a minimum of instruction. One of the real benefits I found was its simplified operation. Instead of pushing and holding down both the brake and rotator control, insertion of desired heading plus the execute command left my hands free to do other things. In a contest this could free up valuable time for copying, logging, or checking QSO rate and multiplying counts. The ProSearch PSE-2N was a real "fun" piece of equipment to review.

The ProSearch line of rotator controllers uses high quality components throughout, and all double-sided glass board to ensure long, trouble-free service. The PSE-2N is priced at $469. The PSE-1A "Contester," which sells for $229.95, provides many of the same features, such as memory and digital input, but without "talk back" and computer interface capability. ProSearch is making a name for itself with these controllers — any one of which would be a valuable addition to any ham shack.

If you'd like more information, contact ProSearch at 1344 Baur Boulevard, St. Louis, Missouri 63132.

Circle #303 on Reader Service Card.

N1ACH

NEW products

GaAs FET receiver preamp

Hamtronics, Inc. has just announced a new low-noise preamp that uses a new dual-gate GaAs FET recently designed especially for service in the VHF/UHF bands. Up until now, to get the low-noise figure of a GaAs FET, a designer had to adapt a transistor originally intended for microwave service; while such transistors work well, they are often costly and tend to oscillate because they have so much gain at the lower VHF and UHF frequencies. As single gate devices, they tend to have the characteristically high feedback capacitance associated with triodes, which makes them hard to tame under a wide variation in load impedances.

The new LNG-( ) series of preamps provides good gain and moderately low noise figure (0.7 to 0.8 dB, depending on band), at a cost of $49, compared to anywhere from $80 to $125 for the earlier type of GaAs FET preamps.

The units operate on standard 12 to 14 VDC, are easy to tune, and may be mounted anywhere, including the tops of towers. LNG preamps are available for all Amateur bands, from 10 meters through 450 MHz.

For more information, including a free catalog on other Hamtronics® products, contact Hamtronics, Inc., 65 Moul Road, Hilton, New York 14468-9535.

Circle #302 on Reader Service Card.

tool and instrument catalog

Contact East is offering a free copy of its 1984 Electronic Tool and Test Instrument catalog, featuring over 5,000 technical products for assembling, testing, and repairing electronic equipment. Products listed include precision hand tools, test instruments, tool kits, soldering supplies, plus a full selection of static control products. All products are fully illustrated with photographs accompanied by detailed descriptions, and prices.

For a copy, write to Contact East, 7 Cypress Drive, P.O. Box 160, Burlington, Massachusetts 01803.

Circle #301 on Reader Service Card.

GaAs, TUNNEL DIODES, ETC.

* R F TRANSISTORS *

TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE
THOMSON CSF							
SD345	$ 5.00	SD1119	$ 5.00	SD1278-5	$18.00	SD1453-1	$48.00
SD445	5.00	SD1124	50.00	SD1281-2	8.00	SD1454-1	48.00
SD1004	15.00	SD1127	3.50	SD1283	10.00	SD1477	48.00
SD1009	15.00	SD1133	14.00	SD1289-1	15.00	SD1478	21.00
SD1009-2	15.00	SD1133-1	14.00	SD1290-4	15.00	SD1480	60.00
SD1012	9.90	SD1134-1	3.00	SD1290-7	15.00	SD1484	1.50
SD1012-3	9.90	SD1135	8.00	SD1300	3.00	SD1484-5	1.50
SD1012-5	9.90	SD1136	15.00	SD1301-7	3.00	SD1484-6	1.50
SD1013-3	13.50	SD1136-2	15.00	SD1305	3.00	SD1484-7	1.50
SD1013-7	13.50	SD1143-1	12.00	SD1307	3.00	SD1488	39.00
SD1014	11.00	SD1143-3	17.00	SD1308	3.00	SD1488-1	28.00
SD1014-6	11.00	SD1144-1	3.00	SD1311	1.00	SD1488-7	27.00
SD1016	15.00	SD1146	15.00	SD1317	10.00	SD1488-8	28.00
SD1016-5	15.00	SD1147	15.00	SD1335	3.00	SD1499-1	39.00
SD1018-4	15.00	SD1188	10.00	SD1345-6	5.00	SD1520-2	18.00
SD1018-6	15.00	SD1189	24.00	SD1365-1	2.50	SD1522-4	33.00
SD1018-7	15.00	SD1200	1.50	SD1365-5	2.50	SD1528-1	24.00
SD1018-15	15.00	SD1201-2	10.00	SD1375	7.50	SD1528-3	34.00
SD1020-5	10.00	SD1202	10.00	SD1375-6	7.50	SD1530-2	38.00
SD1028	15.00	SD1212-11	4.00	SD1379	15.00	SD1536-1	41.00
SD1030-2	12.00	SD1212-12	4.00	SD1380-1	1.00	SD1545	34.00
SD1043	12.00	SD1212-16	4.00	SD1380-3	1.00	SD1561	79.00
SD1043-1	10.00	SD1214-7	5.00	SD1380-7	1.00	SF4557 Mot.	25.00
SD1045	3.75	SD1214-11	5.00	SD1405	40.00	SK3048 RCA	5.00
SD1049-1	2.00	SD1216	12.00	SD1409	18.00	SK3177 RCA	15.00
SD1053	4.00	SD1219-4	15.00	SD1410	22.00	SMS7714 Mot.	2.50
SD1065	4.75	SD1219-5	15.00	SD1410-3	21.00	SRF750 Mot.	36.00
SD1068	15.00	SD1219-8	15.00	SD1413-1	18.00	SRF1018 Mot.	5.00
SD1074-2	18.00	SD1220	8.00	SD1416	50.00	SRF2147 Mot.	22.00
SD1074-4	28.00	SD1220-9	8.00	SD1422-2	24.00	SRF2356 Mot.	38.00
SD1074-5	28.00	SD1222-8	16.00	SD1428	33.00	SRF2378 Mot.	16.00
SD1076	20.00	SD1222-11	7.50	SD1429-2	15.00	SRF2584 Mot.	40.00
SD1077-4	4.00	SD1224-10	18.00	SD1429-3	15.00	SRF2821 Mot.	25.00
SD1077-6	4.00	SD1225	18.00	SD1429-5	15.00	SRF2857 Mot.	20.00
SD1078-6	24.00	SD1228-8	POR	SD1430	12.00	TA8894 RCA	15.00
SD1080-8	6.00	SD1229-7	13.00	SD1430-2	18.00	TIS189/MRF966	3.55
SD1080-9	3.00	SD1229-16	13.00	SD1434-5	30.00	TP312	2.50
SD1084	8.00	SD1232	4.00	SD1434-9	30.00	TP1014 TRW	5.00
SD1087	15.00	SD1240-8	15.00	SD1438	26.00	TP1028 TRW	15.00
SD1089-5	15.00	SD1244-1	14.00	SD1441	91.00	01-80703T04/ 458-949 Mot.Comm.	65.00
SD1095	15.00	SD1262	12.00	SD1442	15.00	TXVF2201 H.P.	450.00
SD1100	5.00	SD1263	15.00	SD1444	6.00	62803 RCA	100.00
SD1109	18.00	SD1263-1	15.00	SD1444-8	6.00	TA7205/2N5921	80.00
SD1115-2	8.00	SD1272	13.00	SD1450-1	28.00	TA7487/2N5920	75.00
SD1115-3	8.00	SD1272-2	15.00	SD1451	18.00	TA7995/2N6267	150.00
SD1115-7	2.50	SD1272-4	15.00	SD1451-2	18.00	SRF2092 Mot.	18.00
SD1116	5.00	SD1278	20.00	SD1452	20.00	MRF479	8.05
SD1118	22.00	SD1278-1	18.00	SD1452-2	20.00		

We Can Cross Reference Most RF Transistors, Diodes, Hybrid Modules And Any Other Type Of Semiconductor.

****

* DIODES (HOT CARRIER,MICROWAVE,PIN,SCHOTTKY,TUNNEL,VARACTOR,GUNN) *

1N21	$ 3.40	1N21B	$ 3.40	1N21BR	$ 3.40	1N21C	$ 3.40
1N21D	4.00	1N21DR	4.00	1N21ER	6.00	1N21RF	5.00
1N21WE	5.80	1N21WG	5.80	1N22	5.00	1N23A	10.00
1N23B	3.40	1N23C	3.40	1N23CR	3.40	1N23D	4.95
1N23DR	4.00	1N23WE	5.00	1N25	7.50	1N25AR	18.00
1N28WE	10.00	1N29	10.00	1N32	20.00	1N53A	55.50
1N76	26.00	1N76R	28.00	1N78	26.00	1N78A	20.00
1N78B	26.00	1N78D	28.00	1N78DR	28.00	1N78R	28.00
1N149	6.00	1N150MR	18.00	1N415	4.00	1N415C	4.00
1N415G	15.00	1N416D	5.00	1N416E	6.00	1N446	10.00
1N831	10.00	1N833	10.00	1N950	4.00	1N1084	2.00
1N2930	15.00	1N2932	15.00	1N3540	15.00	1N3712	11.00
1N3713	18.00	1N3714	11.00	1N3715	16.00	1N3716	10.00
1N3717	14.00	1N3718	10.00	1N3721	14.00	1N3733	10.00
1N3747	21.00	1N4386	20.00	1N4396	15.00	1N4785	11.00
1N4812B	9.00	1N5139A/B	4.25	1N5140A/B	4.25	1N5141A/B	4.25
1N5142A/B	4.25	1N5143A/B	4.25	1N5144A/B	4.25	1N5145A/B	4.25
1N5146A/B	4.25	1N5147A/B	4.25	1N5148A/B	4.25	1N5167	5.50
1N5453	3.75	1N5465	7.65	1N5711	1.00	1N5711 JAN	2.00
1N5713	5.00	1N5767	2.00	1N6263	1.00	1S2199	15.00
1S2200	15.00	1S2208/9	1.00	8B1087/48R869558	65.00	8D3020	65.00
A2X116M Aertech	50.00	BB105B	1.00	BB105G	1.00	BD4/4JFBD4 G.E.	15.00
BL161 Bomac	5.00	CMD514AB C.M.	POR	D4060 Alpha	POR	D4159 Alpha	POR
D4233B Alpha	POR	D4900 Alpha	POR	D4959 Alpha	POR	D4987M Alpha	POR
D5047C Alpha	POR	D5147D Alpa	POR	D5503 Alpha	POR	D5506 Alpha	POR
DGB6158-98 Alpha	POR	DMD6022 Alpha	POR	DMD6460A Alpha	POR	DP20054 Crown	POR
GC1691-89 GHZ	31.35	GC1602-89 GHZ	31.35	GC1607-10 GHZ	31.35	GC2531-88 GHZ	37.40
GC2542-46 GHZ	37.40	GC3208-40 GHZ	37.40	GC17044 GHZ	50.00	HP33644A-H01	125.00
HP5082-0112	14.20	HP5082-0241	75.60	HP5082-0253	105.00	HP5082-0320	58.00
HP5082-0375	POR	HP5082-0386	POR	HP5082-0401	POR	HP5082-0438	POR
HP5082-1028	POR	HP5082-1332	POR	HP5082-2254	POR	HP5082-2302	10.70
HP5082-2303	5.20	HP5082-2696	POR	HP5082-2711	23.15	HP5082-2727	POR
HP5082-2800	1.00	HP5082-2805	4.45	HP5082-2835	1.00	HP5082-2884	POR
HP5082-3039	6.70	HP5082-3040	36.00	HP5082-3080	2.00	HP5082-3188	1.00
HP5082-3379	1.50	HP5082-6459	POR	HP5082-6462	POR	HP5082-6888	POR
HP5082-8016	POR	HP5082-8323	POR	K3A Kemtron	7.00	MA450A	POR
MA475	POR	MA40008	POR	MA41487	POR	MA41765	POR
MA41766	POR	MA43004	48.00	MA43589	POR	MA43622	POR
MA43636	POR	MA45104	27.00	MA47044	POR	MA47051	25.50
MA47100	3.05	MA47202	30.80	MA47771	POR	MA47838*	POR
MA47852	POR	MA49106	37.95	MA49558	POR	MA86731	125.00

* OUR STOCK CHANGES DAILY SO CALL IF IF THE PART YOU NEED IS NOT LISTED **

For information call: (602) 242-3037

Toll Free Number
800-528-0180
(For orders only)

"All parts may be new or surplus, and parts may be substituted with comparable parts if we are out of stock of an item."

MHz electronics

PRICES SUBJECT TO CHANGE WITHOUT NOTICE

TUBES

TYPE	PRICE	TYPE	PRICE	TYPE	PRICE
2C39/7289	$ 34.00	1182/4600A	$500.00	ML7815AL	$ 60.00
2E26	7.95	4600A	500.00	7843	107.00
2K28	200.00	4624	310.00	7854	130.00
3-500Z	102.00	4657	84.00	ML7855KAL	125.00
3-1000Z/8164	400.00	4662	100.00	7984	14.95
3B28/866A	9.50	4665	500.00	8072	84.00
3CX400U7/8961	255.00	4687	P.O.R.	8106	5.00
3CX1000A7/8283	526.00	5675	42.00	8117A	225.00
3CX3000F1/8239	567.00	5721	250.00	8121	110.00
3CW30000H7	1700.00	5768	125.00	8122	110.00
3X2500A3	473.00	5819	119.00	8134	470.00
3X3000F1	567.00	5836	232.50	8156	12.00
4-65A/8165	69.00	5837	232.50	8233	60.00
4-125A/4D21	79.00	5861	140.00	8236	35.00
4-250A/5D22	98.00	5867A	185.00	8295/PL172	500.00
4-400A/8438	98.00	5868/AX9902	270.00	8458	35.00
4-400B/7527	110.00	5876/A	42.00	8462	130.00
4-400C/6775	110.00	5881/6L6	8.00	8505A	95.00
4-1000A/8166	444.00	5893	60.00	8533W	136.00
4CX250B/7203	54.00	5894/A	54.00	8560/A	75.00
4CX250FG/8621	75.00	5894B/8737	54.00	8560AS	100.00
4CX250K/8245	125.00	5946	395.00	8608	38.00
4CX250R/7580W	90.00	6083/AZ9909	95.00	8624	100.00
4CX300A/8167	170.00	6146/6146A	8.50	8637	70.00
4CX350A/8321	110.00	6146B/8298	10.50	8643	83.00
4CX350F/8322	115.00	6146W/7212	17.95	8647	168.00
4CX350FJ/8904	140.00	6156	110.00	8683	95.00
4CX600J/8809	835.00	6159	13.85	8877	465.00
4CX1000A/8168	242.50*	6159B	23.50	8908	13.00
4CX1000A/8168	485.00	6161	325.00	8950	13.00
4CX1500B/8660	555.00	6280	42.50	8930	137.00
4CX5000A/8170	1100.00	6291	180.00	6L6 Metal	25.00
4CX10000D/8171	1255.00	6293	24.00	6L6GC	5.03
4CX15000A/8281	1500.00	6326	P.O.R.	6CA7/EL34	5.38
4CW800F	710.00	6360/A	5.75	6CL6	3.50
4D32	240.00	6399	540.00	6DJ8	2.50
4E27A/5-125B	240.00	6550A	10.00	6DQ5	6.58
4PR60A	200.00	6883B/8032A/8552	10.00	6GF5	5.85
4PR60B	345.00	6897	160.00	6GJ5A	6.20
4PR65A/8187	175.00	6907	79.00	6GK6	6.00
4PR1000A/8189	590.00	6922/6DJ8	5.00	6HB5	6.00
4X150A/7034	60.00	6939	22.00	6HF5	8.73
4X150D/7609	95.00	7094	250.00	6JG6A	6.28
4X250B	45.00	7117	38.50	6JM6	6.00
4X250F	45.00	7203	P.O.R.	6JN6	6.00
4X500A	412.00	7211	100.00	6JS6C	7.25
5CX1500A	660.00	7213	300.00*	6KN6	5.05
KT88	27.50	7214	300.00*	6KD6	8.25
416B	45.00	7271	135.00	6LF6	7.00
416C	62.50	7289/2C39	34.00	6LQ6 G.E.	7.00
572B/T160L	49.95	7325	P.O.R.	6LQ6/6MJ6 Sylvania	9.00
592/3-200A3	211.00	7360	13.50	6ME6	8.90
807	8.50	7377	85.00	12AT7	3.50
811A	15.00	7408	2.50	12AX7	3.00
812A	29.00	7609	95.00	12BY7	5.00
813	50.00	7735	36.00	12JB6A	6.50

NOTE * = USED TUBE

NOTE P.O.R. = PRICE ON REQUEST

"ALL PARTS MAY BE NEW, USED, OR SURPLUS. PARTS MAY BE SUBSTITUTED WITH COMPARABLE PARTS IF WE ARE OUT OF STOCK OF AN ITEM.

NOTICE: ALL PRICES ARE SUBJECT TO CHANGE WITHOUT NOTICE.

For information call: (602) 242-3037

Toll Free Number
800-528-0180
(For orders only)

"All parts may be new or surplus, and parts may be substituted with comparable parts if we are out of stock of an item."

MHz electronics

PRICES SUBJECT TO CHANGE WITHOUT NOTICE

HEWLETT PACKARD SIGNAL GENERATORS

606A	50KHz to 65MHz in 6 bands +-1%,Output level adjustable 0.1uV to 3V into 50 ohms.Built-in crystal calibrator.400 -1000Hz modulation.	$ 650.00
606B	Same as above but has frequency control feature to allow operation with HP 8708A Synchronizer.	$1100.00
608C	10MHz to 480MHz,0-1uV-1V into 50 ohms,AM,CW,or pulse modulation, calibrated attenuator.	$ 500.00
608D/ TS510	10MHz to 420MHz, 0.1uV-0.5V into 50 ohms,+-0.5% accuracy, built-in crystal calibrator, AM-CW or pulse output.	$ 375.00
608E	Improved version of popular 608C.Up to 1V output.Improved stability,low residual FM.	$1450.00
608F	10MHz to 455MHz in 5 bands +-1% frequency accuracy with built-in crystal calibrator.Can be used with HP 8708A Synchronizer. Output continuously adjustable from .1uV to .5V into 50 ohms.	$1100.00
612A	450-1230MHz ,o.1uV-0.5V into 50 ohms,calibrated output.	$ 750.00
614A	900-2100MHz with many features including calibrated output and all modulation characteristics.	$ 500.00
616A/ TS403	Direct reading and direct control from 1.8 to 4.2GHz. The H.P.616A features +-1.5dB calibrated output accuracy from -3127dBm to -dBm.The output is directly calibrated in micro-volts and dBm with continuous monitoring. Simple operation frequency diad accuracy is +-1% and stability exceeds 0.005%-/ C change in ambient temperature. Calibrated attenuator is within +-1.5dB over entire output band. 50 ohm impedance unit has internal pulse modulation with rep rate variable from 40 Hz to 4KHz,variable pulsewidth(1 to 10usec)and variable pulse delay(3 to 300usec).External modulating inputs increas versatility.	$ 375.00
616B	Same as above but later model.	$ 600.00
618B	3.8 to 7.6GHz range,with calibrated output and selection of pulse-FM or square wave modulation.	$ 600.00
618C	Same as above but later model.	$2200.00
620A	7 to 11GHz range,with calibrated output and selection of pulse-FM or square wave modulation.	$ 750.00
620B	Same as above but later model.	$2200.00
626A	10 to 15GHz,10mw output power with calibrated output and pulse-square wave or FM modulation.	$4200.00
8708A	Synchronizer used with 606B,608F.The synchronizer is a phase-lock frequency stabilizer which provides crystal-oscillator frequency stability to 430MHz in the 608F signal generator.Phase locking eliminates microphonics and drift resulting in excellent frequency stability.The 8708A includes a vernier which can tune the reference oscillator over a range of +-0.25% permitting frequency settability to 2 parts in 10 to the seventh.Provides a very stable signal that satisfies many critical applications. (With HP 606B or 608F) (Without)	$ 350.00 $ 450.00
EMC-10	ELECTROMETRICS EMC-10 RFI/EMI RECEIVER Low frequency analyzer covering 20Hz to 50KHz frequency range.Extendable to 500 KHz in wideband mode.	$2500.00
NF-105F	Empire Devices Field Intensity Meter. Has NF-105/TA,NF-105/TX,NF-105/T1,NF-105/T2,NF-105/T3. Covers 14KHz to 1000MHz.	$2100.00

ALL EQUIPMENT CARRY A 30 DAY GUARANTEE.

EQUIPMENT IS NOT CALIBRATED.

UNEX LABORATORIES THS-2 FLEXICOM HEADSET.

these headsets come with data to hook up to a ICOM radios and many other equipment.

Perfect for Airplanes , Helicopters , Mobile Radios , or Just the Telephone.

These Are Factory New In Sealed Boxes. Limited Supply Only $69.95

TERMS: DOMESTIC: Prepaid, C.O.D. or Credit Card
FOREIGN: Prepaid only, U.S. Funds, Money Order, or Cashier's Check Only.

C.O.D.' Acceptable by telephone or mail. Payment from customer will be by Cash, Money Order, or Cashier's Check. We are sorry but we cannot accept personal checks for C.O.D.'s. C.O.D.'s are shipped by air only and thru United Parcel Service.

CONFIRMING ORDERS: We would prefer that confirming orders not be sent after a telephone order has been placed. If company policy necessitates a confirming order, please mark "CONFIRMING" boldly on the order. If problems or duplicate shipments occur due to an order which is not properly marked, the customer will be held responsible for any charges incurred, plus a 15% restock charge on the returned parts.

CREDIT CARDS: We are now accepting MASTERCARD, VISA, AND AMERICAN EXPRESS

DATA SHEETS: When we have data sheets in stock on devices we will supply them with the order.

DEFECTIVE MATERIALS: All claims for defective materials must be made within 30 DAYS after receipt of the parcel. All claims must include the defective material (for testing purposes), a copy of our invoice, and a return authorization number which must be obtained prior to shipping the merchandise back to us. This can be obtained by calling (602) 242-8916 or sending us a postcard. Due to Manufacturer warranties we are unable to replace or issue credit on items which have been soldered to or have been altered in any way. All return items must be packed properly or it will void all warranties. We do not assume responsibility for shipping and handling charges incurred.

DELIVERY: Orders are usually shipped the same day they are placed or the next business day, unless we are out of stock on an item. The customer will be notified by post card if we are going to backorder the item. Our normal shipping method is UPS or U.S. Mail depending on size or the weight of the package. Test Equipment is shipped only by air and is freight collect, unless prior arrangements have been made and approved.

FOREIGN ORDERS: All foreign orders must be prepaid with a Cashier's Check, or Money Order made out in U.S. FUNDS ONLY. We are sorry but C.O.D. is not available to foreign countries and letters of credit are unacceptable as a form of payment. Further information is available on request.

HOURS: Monday thru Friday 8:30 a.m. to 5:00 p.m. Saturdays 8:30 a.m. to 4:00 p.m.

INSURANCE: Please include 25¢ for each additional $100.00 over $100.00. UPS ONLY. All insured packages are shipped thru UPS only. If you wish to have it shipped through the post office there is a $5.00 fee which is additional to the shipping, handling and insurance.

OPEN ACCOUNTS: We regret that we do not issue open accounts.

ORDER FORMS: New order forms are included with each order for your convenience. Additional order forms are available on request.

PARTS: We reserve the right to substitute or replace any item with a part of equal or comparable specification.

POSTAGE: Minimum shipping and handling in the U.S., Canada, and Mexico is $3.00 for ground shipments, all other countries is $5.50. Air rates are available at the time of your order. All foreign orders please include 25% of the ordered amount for shipping and handling. C.O.D.'s are shipped AIR ONLY.

PREPAID ORDERS: Orders must be accompanied by a check.

PRICES: Prices are subject to change without notice.

PURCHASE ORDERS: We accept purchase orders only when they are accompanied by a check.

RESTOCK CHARGES: If parts are returned to MHZ ELECTRONICS, INC. due to customer error, the customer will be held responsible for all fees incurred and will be charged a 15% RESTOCK CHARGE with the remainder in CREDIT ONLY. The following must accompany any return; A copy of our invoice, return authorization number which must be obtained prior to shipping the merchandise back. Returns must be done within 10 DAYS of receipt of parcel. Return authorization numbers can be obtained by calling (602) 242-8916 or notifying us by post card. Return authorizations will not be given out on our 800 number.

SALES TAX: ARIZONA residents must add 6% sales tax, unless a signed ARIZONA resale tax card is currently on file with us. All orders placed by persons outside of ARIZONA, but delivered to persons in ARIZONA are subject to the 6% sales tax.

SHORTAGE OR DAMAGE: All claims for shortages or damages must be made within 5 DAYS of receipt of parcel. Claims must include a copy of our invoice, along with a return authorization number which can be obtained by contacting us at (602) 242-8916 or sending a post card. Authorizations cannot be on our 800 number. All items must be properly packed. If items are not properly packed make sure to contact the carrier so that they can come out and inspect the package before it is returned to us. Customers which do not notify us within this time period will be held responsible for the entire order as we will consider the order complete.

OUR 800 NUMBER IS STRICTLY FOR ORDERS ONLY (800) 528-0180. INFORMATION CALLS ARE TAKEN ON (602) 242-8916 or (602) 242-3037.

MHz electronics

2111 W. CAMELBACK ROAD
PHOENIX, ARIZONA 85015

"All parts may be new or surplus, and parts may be substituted with comparable parts if we are out of stock of an item."

Toll Free Number
800-528-0180
(For orders only)

For information call: (602) 242-3037

PRICES SUBJECT TO CHANGE WITHOUT NOTICE.

More Details? CHECK—OFF Page 132

HAM MART

Ham Radio's guide to help you find your lo(

California

C & A ROBERTS, INC.
18511 HAWTHORN BLVD.
TORRANCE, CA 90504
213-370-7451
24 Hour: 800-421-2258
Not The Biggest, But The Best — Since 1962.

FONTANA ELECTRONICS
8628 SIERRA AVENUE
FONTANA, CA 92335
714-822-7710
714-822-7725
The Largest Electronics Dealer in San Bernardino County.

JUN'S ELECTRONICS
3919 SEPULVEDA BLVD.
CULVER CITY, CA 90230
213-390-8003
619-463-1886 San Diego
800-882-1343 Trades
Habla Espanol

Connecticut

HATRY ELECTRONICS
500 LEDYARD ST. (SOUTH)
HARTFORD, CT 06114
203-527-1881
Call today. Friendly one-stop shopping at prices you can afford.

Delaware

DELAWARE AMATEUR SUPPLY
71 MEADOW ROAD
NEW CASTLE, DE 19720
302-328-7728
800-441-7008
Icom, Ten-Tec, Microlog, Yaesu, Kenwood, Santec, KDK, and more.
One mile off I-95, no sales tax.

Florida

AMATEUR ELECTRONIC SUPPLY
1898 DREW STREET
CLEARWATER, FL 33575
813-461-4267
Clearwater Branch
West Coast's only full service Amateur Radio Store.
Hours M-F 9-5:30, Sat. 9-3

AMATEUR ELECTRONIC SUPPLY
621 COMMONWEALTH AVE.
ORLANDO, FL 32803
305-894-3238
Fla. Wats: 1 (800) 432-9424
Outside Fla: 1 (800) 327-1917
Hours M-F 9-5:30, Sat. 9-3

AMATEUR RADIO CENTER, INC.
2805 N. E. 2ND AVENUE
MIAMI, FL 33137
305-573-8383
The place for great dependable names in Ham Radio.

Hawaii

HONOLULU ELECTRONICS
819 KEEAUMOKU STREET
HONOLULU, HI 96814
(808) 949-5564
Serving Hawaii & Pacific area for 51 years. Complete lines of Amateur equipment, accessories and parts.

Illinois

ERICKSON COMMUNICATIONS, INC.
5456 N. MILWAUKEE AVE.
CHICAGO, IL 60630
312-631-5181
Hours: 9:30-5:30 Mon, Tu, Wed & Fri; 9:30-8:00 Thurs; 9:00-3:00 Sat.

Indiana

THE HAM SHACK
808 NORTH MAIN STREET
EVANSVILLE, IN 47710
812-422-0231
Discount prices on Ten-Tec, Cubic, Hy-Gain, MFJ, Azden, Kantronics, Santec and others.

Kansas

ASSOCIATED RADIO
8012 CONSER, P.O. BOX 4327
OVERLAND PARK, KS 66204
913-381-5900
America's No. 1 Real Amateur Radio Store. Trade — Sell — Buy.

Kentucky

L & S RADIO
307 McLEAN AVENUE
HOPKINSVILLE, KY 42240
502-885-8071
Ten-Tec, Azden, Ameritron Sales and Service.

Massachusetts

TEL-COM, INC.
675 GREAT ROAD, RTE. 119
LITTLETON, MA 01460
617-486-3040
617-486-3400 (this is new)
The Ham Store of New England You Can Rely On.

Michigan

ENCON PHOTOVOLTAICS
Complete Photovoltaic Systems
27600 Schoolcraft Rd.
Livonia, Michigan 48150
313-523-1850
Amateur Radio, Repeaters, Satellite, Computer applications.
Call Paul WD8AHO

Nevada

AMATEUR ELECTRONIC SUPPLY
1072 N. RANCHO DRIVE
LAS VEGAS, NV 89106
702-647-3114
Dale Porray "Squeak," AD7K
Outside Nev: 1 (800) 634-6227
Hours M-F 9-5:30, Sat. 9-3

JUN'S ELECTRONICS
460 E. PLUMB LANE — 107
RENO, NV 89502
702-827-5732
Outside Nev: 1 (800) 648-3962
Icom — Yaesu Dealer

New Hampshire

POLCARI'S ELECTRONICS CENTER
61 LOWELL ROAD
HUDSON, NH 03051
603-883-5005
Southern New Hampshire's only Ham Store. Call today for quotes.

Dealers: *YOU SHOULD BE HERE TOO!*
Contact Ham Radio now for complete details.

...nateur Radio Dealer

New Jersey

RADIOS UNLIMITED
P.O. BOX 347
1760 EASTON AVENUE
SOMERSET, NJ 08873
201-469-4599
800-526-0903
New Jersey's only factory authorized Yaesu and Icom distributor. New and used equipment. Full service shop.

ROUTE ELECTRONICS 17
777 ROUTE 17 SOUTH
PARAMUS, NJ 07625
201-444-8717
Drake, Cubic, DenTron, Hy-Gain, Cushcraft, Hustler, Larsen, MFJ, Butternut, Fluke & Beckman Instruments, etc.

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.

Ohio

AMATEUR ELECTRONIC SUPPLY
28940 EUCLID AVE.
WICKLIFFE, OH (CLEVELAND AREA)
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

UNIVERSAL AMATEUR RADIO, INC.
1280 AIDA DRIVE
REYNOLDSBURG (COLUMBUS), OH
43068
614-866-4267
Featuring Kenwood, Yaesu, Icom, and other fine gear. Factory authorized 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 30 Years.

LaRUE ELECTRONICS
1112 GRANDVIEW STREET
SCRANTON, PENNSYLVANIA 18509
717-343-2124
Icom, Bird, Cushcraft, Beckman, Larsen, Hustler, Astron, Belden, Antenna Specialists, W2AU/W2VS, AEA, B&W, Amphenol, Saxton, J.W. Miller/Daiwa, Vibroplex.

THE VHF SHOP
BOX 349 RD 4
MOUNTAINTOP, PA 18707
717-868-6565
Lunar, Microwave Modules, ARCOS, Astron, KLM, Tama, Tonna-F9FT, UHF Units/Parabolic, Santec, Tokyo Hy-Power, Dentron, Mirage, Amphenol, Belden

Texas

MADISON ELECTRONICS SUPPLY
1508 McKINNEY
HOUSTON, TX 77010
713-658-0268
Christmas?? Now??

Virginia

ELECTRONIC EQUIPMENT BANK
516 MILL STREET, N.E.
VIENNA, VA 22180
703-938-3350
Metropolitan D.C.'s One Stop Amateur Store. Largest Warehousing of Surplus Electronics.

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 9-5:30
Sat 9-3

flea market

RATES Noncommercial ads 10¢ per word; commercial ads 60¢ per word **both payable in advance**. No cash discounts or agency commissions allowed.

HAMFESTS Sponsored by non-profit organizations receive one free Flea Market ad (subject to our editing) on a space available basis only. Repeat insertions of hamfest ads pay the non-commercial rate.

COPY No special layout or arrangements available. Material should be typewritten or clearly printed (**not** all capitals) and must include full name and address. We reserve the right to reject unsuitable copy. **Ham Radio** cannot check each advertiser and thus cannot be held responsible for claims made. Liability for correctness of material limited to corrected ad in next available issue.

DEADLINE 15th of second preceding month.

SEND MATERIAL TO: Flea Market, Ham Radio, Greenville, N. H. 03048.

QSLs & RUBBER STAMPS — Top Quality! Card Samples and Stamp info — 50¢ — Ebbert Graphics 5R, Box 70, Westerville, Ohio 43081.

WANTED: CW transceiver low band coverage, good working condition and fair price. (518) 883-5007.

WANTED: Old RCA, Western Electric, tubes, speakers, amps. (713) 728-4343, Corb, 11122 Atwell, Houston, Texas 77096.

WANTED: Schematic for Stoner model Pro-10. E.H. Newman, 4873 Nelson St., Fremont, CA (415) 657-1322.

TRAVEL-PAK QSL KIT — Converts post cards, photos to QSLs. Stamp brings circular. Samco, Box 203-c, Wynantskill, New York 12198.

RADIO ITEMS before 1930 wanted. Buying battery operated radios, horn and cone speakers, radio tubes and parts, radio literature — books, catalogs, magazines, radio advertising signs, posters. Gary Schneider, 6848 Commonwealth Blvd., Parma Heights, Ohio 44130.

ELECTRONIC CMOS Keyer kit pcb + parts only $9.95 plus $1.50 shipping. WI res. add 5% tax. Send for free information. BEL-TEK, PO Box 125H, Beloit, WI 53511.

WANTED: ASAP FC-102 antenna tuner with or without FAS-1-4R antenna selector unit. Will consider trade. KA1PSQ (212) 729-0714 collect.

Foreign Subscription Agents for Ham Radio Magazine

Ham Radio Austria
Karin Ueber
Postfach 2454
D-7850 Loerrach
West Germany

Ham Radio Belgium
Stereohouse
Brusselsesteenweg 416
B-9218 Gent
Belgium

Ham Radio Canada
Box 400, Goderich
Ontario, Canada N7A 4C7

Ham Radio Europe
Box 2084
S-194 02 Upplands Vasby
Sweden

Ham Radio France
SM Electronic
20 bis, Ave des Clarions
F-89000 Auxerre
France

Ham Radio Germany
Karin Ueber
Postfach 2454
D-7850 Loerrach
West Germany

Ham Radio Holland
Postbus 413
NL-7800 Ar Emmen
Holland

Ham Radio Italy
Via Pordenone 17
I-20132 Milano
Italy

Ham Radio Switzerland
Karin Ueber
Postfach 2454
D-7850 Loerrach
West Germany

Ham Radio UK
P.O. Box 63, Harrow
Middlesex HA3 6HS
England

Holland Radio
143 Greenway
Greenside, Johannesburg
Republic of South Africa

BURGLARY — Nation's number one crime problem. Security alarm industry booming. Get in now. E-Z learn. Employment-business terrific. Information pack $2.00 (redeemable). Security Electronics International, POB 1456-KW, Grand Rapids, MI 49501.

NOTICE: Buy, sell, trade Amateur Radio, computers, video equipment on our Computer Bulletin Board seen worldwide. Free access to all. Large SASE for details. Back in service May 1984. Narwid Electronics, 61 Bellot Road, Ringwood, NJ 07456.

RUBBER STAMPS: 3 lines $4.50 PPD. Send check or MO to G.L. Pierce, 5521 Birkdale Way, San Diego, CA 92117. SASE brings information.

"THE SWAP LIST" has bargains galore. Subscribe now! 6 months for $4.00; 1 year only $6.50. The Swap List, Box 988-H, Evergreen, CO 80439.

ATTENTION C-64 users: Don't buy a logging program until you've read our fact sheet. For free information, write to Crumtronics, PO Box 6187, Ft. Wayne, IN 46896.

REPAIR, ALIGNMENT, calibration. Collins written estimates $25; non Collins $50. K1MAN. (207) 495-2215.

FOR SALE Regency HR 312 2m transceiver with mag mount GAM antenna and mike $90.00. Perfect condition. Dentron monitor tuner 2 kw perfect $100.00. W1CPI (401) 789-1817.

CHASSIS and cabinet kits. SASE K3IWK.

WANTED: Cash paid for used speed radar equipment. Write or call: Brian R. Esterman, PO Box 8141, Northfield, Illinois 60093. (312) 251-8901.

FOUR U.S. plate blocks only one dollar when you request approvals. Please include phone number for reference. Littleflower Stamp Company, RR1 - Box 118(U), Osceola, WI 54020.

STERLING SILVER callsign jewelry pin or tack; $11.95, alligator tie clip; $19.95, all ppd. Info-SASE. Tom's Silver, PO Box 3758, Manchester, NH 03105.

TEKTRONIX scope, single trace, .5 MHz, model 503, $85. Model 516 dual trace, 15 MHz, $200. Plugins, CA $75, 3T77A $75. Tek miniscope model 221 5 MHz single trace, just calibrated, great for field service use, has internal Nicads, carrying case, service manual $700. All postpaid. Dave Roscoe, W1DWZ, 49 Cedar, East Bridgewater, MA 02333. (617) 378-3619.

RECONDITIONED TEST EQUIPMENT $1.00 for catalog. Walter, 2697 Nickel, San Pablo, CA 94806.

FOX-TANGO Newsletters — Since 1972, the prime source of modifications, improvements, and repair of Yaesu gear, free to Club members. Calendar year dues still only $8 U.S., $9 Canada, $12 elsewhere. Includes five year cumulative index by model numbers, or send $1 for index and sample Newsletter. Fox Tango Club, Box 15944, W. Palm Beach, FL 33416.

RTTY-EXCLUSIVELY for the Amateur Teleprinter. One year $7.00. Beginners RTTY Handbook $8.00 includes journal index. P.O. Box RY, Cardiff, CA 92007.

IMRA International Mission Radio Assn. helps missioners — equipment loaned; weekday net, 14.280 MHz, 2-3 PM Eastern. Br. Frey, 1 Pryer Manor Rd., Larchmont, NY 10538.

"HAMS FOR CHRIST." Reach other Hams with a gospel tract sure to please. Clyde Stanfield, WA6HEG, 1570 N. Albright, Upland, CA 91786.

TENNATEST — Antenna noise bridge — out-performs others, accurate, costs less, satisfaction guaranteed. Send stamp for details, W8URR, 1025 Wildwood Road, Quincy, MI 49082.

WANTED: Early Hallicrafter "Skyriders" and "Super Skyriders" with silver panels, also "Skyrider Commercial", early transmitters such as HT-1, HT-2, HT-8, and other Hallicrafter gear, parts, accessories, manuals. Chuck Dachis, WD5EOG, The Hallicrafter Collector, 4500 Russell Drive, Austin, Texas 78745.

HAVE A-M CAPABILITY? Join S.P.A.M. (Society for Promotion A-M). Membership is free. Write S.P.A.M. c/o F. Dunlap, 14113 Stoneshire, Houston, TX 77060.

VERY in-ter-est-ing! Next 4 issues $2. Ham Trader "Yellow Sheets", POB356, Wheaton, IL 60189.

QUALITY COMPONENTS Transco #11300 UHF relays dual 28VDC coils milspec new $80.00. FXR UHF relay 26VDC coil hermetic milspec new $45.00. Collins filter F455FA15 $65.00. High voltage diode stacks 15kV one ampere milspec new $9.25. Power solenoids 3PST 120A new $45.00; 50A new $35.00 28VDC coils. Carborundum #887 100 ohm 50 watt noninductive resistors new $9.75. Prices prepaid insured. W6FR (714) 871-3607.

NEW 1.2 GHz antennas from NCG. Base or repeater use: (includes mounting hardware) #1260 - 17 step, 1/2 wave collinear, 10.2 dBi gain, VSWR less than 1.5-1, 100 watts, 50 ohm coax. $145.00. #1217 - 17 step, 1/2 wave collinear, 10.8 dBi gain VSWR less than 1.5-1, 30 watts, 50 ohm coax. $85.00. Mobile antenna: #1270M - 10 step, 1/2 wave collinear, 8.5 dBi gain, VSWR less than 1.7-1, 20 watts, type "N" connector $54.50. For more information contact: NCG, 1275 North Grove St., Anaheim, CA 92806.

DIGITAL automatic displays for FT-101's, TS-520s, and most others. Six 1/2" digits. Write for information. Grand Systems, PO Box 2171, Blaine, Washington 98230. (604) 530-4551.

WANTED: Schematic for Gonset GR-211 receiver. W.J. Tompkins, 8825 N. Pelham Parkway, Bayside, WI 53217.

RTTY Complete RTTY send/receive station. Printer/keyboard and terminal unit. Nothing else to buy. $200. I ship. H. Parks, 24 Caryl Ave., 6-C, Yonkers, NY 10705. (914) 963-0689.

FOR SALE: Tempo One ac power supply with D-104 mike. Digital two frq. counter extra power supply $400. Write W. Gabali, Rt. 8, Box 624, Lexington, SC 29072.

ATTENTION KENWOOD and Icom owners. Informative separate newsletters. 5th year of publication. Back issues available. Add more selectivity to your 430, 830, and 930. Magicom RF clipper processor for TS-120, 130, 430, 520 and 820. Call for prices. IC-730 FM kit $79.95. TS-830S FM kit $94.95. Send SASE (37¢) for free brochure to International Radio, Inc., 364 Kilpatrick Ave., Port St. Lucie, FL 33452 (305) 335-5545. Master/Visa accepted.

LIKE TO BUY, sell or trade? For the best deals, subscribe to the Ham Boneyard. A complete stockyard of radio and/or related electronic equipment. Second year, published twice monthly, 24 issues annually. Send SASE for free issue. 364 Kilpatrick Ave., Port St. Lucie, FL 33452.

FOR SALE: B&K model E-200D RF signal generator $280.00; electronic navigation model 310L 250kH-110 MHz RF linear amplifier $500.00; Leader model LSG-231 FM stereo signal generator $300.00; Eico model 150 solid state signal tracer $100.00; Lafayette Pip-Speak stereo speakers $50.00; Leader VLM model LP-70B 20k ohm per volt $40.00; Minolta SRT-200 35mm camera with UV filter, 50mm lens and case $125.00; RF Power Labs model V350 2 meter 350W linear amp. with fan cool $800.00; Monroe simplex autopatch, commercial quality, with various remote functions with Yaesu CPU-2500 2 meter memorizer radio $1250.00. Mitchell Rakoff, 114-41 Queens Blvd., Suite 148, Forest Hills, NY 11375 (212) 591-0002.

Coming Events
ACTIVITIES
"Places to go..."

CALIFORNIA: The Satellite ARC's 1984 Santa Maria Swapfest and Barbecue on Father's Day, June 17 at the Union Oil Company Picnic Grounds south of Santa Maria. General Admission 9 AM. Barbecue served at 1 PM. For information, tickets or swap table reservations: Satellite ARC Swapfest, PO Box 5117, Vandenberg Air Force Base, CA 93437.

GEORGIA: The Atlanta Hamfestival 1984, sponsored by the Atlanta Radio Club, June 16 and 17, at the Atlanta Civic Center. 70,000 square feet of air-conditioned exhibitor space and over 800 outdoor flea market spaces will be available. Flea Market $12.50 per space in advance; $15.00 at the gate for both days. Hamfest registration $5.00 in advance, $6.00 at the door. To be pre-registered for the Flea Market or Hamfest, we must receive your application and check by June 8. Pre-registration applications received after June 8 will be returned. Hours 8 AM to 5 PM on Saturday. 8 AM to 2:30 PM on Sunday. Talk in on 3.97 MHz, 146.22/82 and 146.94 simplex. For pre-registration or other information write Atlanta Radio Club, PO Box 77171, Atlanta, GA 30357.

ILLINOIS: "RADIOFEST '84" a display and sale of antique and classic Amateur equipment as well as vintage radio memorabilia, June 21-23, Holiday Inn, I-90 and Illinois 31, Elgin. This event is sponsored by the Antique Radio Club of America and hosted by the Antique Radio Club of Illinois. Amateur radio participation is welcomed. Talk in on 146.52. For details write Joe Willis, Box 14732, Chicago, IL 60614.

INDIANA: State ARRL Convention and Indianapolis Hamfest, Saturday and Sunday, July 7 and 8, Marion County Fairgrounds, I-74 and 465. Flea Market setup 8 AM July 7. Free camping with hookups available on grounds. Nearby motels. Commercial building open to public 8 AM Sunday. Tech forums all day. Food service. Tickets $4.00 includes free parking and all activities. For further information: Indianapolis Hamfest, Box 11086, Indianapolis, IN 46201.

INDIANA: The Lake County Amateur Radio Club will hold its 12th annual "Dad's Day" Hamfest, June 17, Industrial Arts Building, Lake County Fairgrounds, Crown Point. 8 AM to 2 PM. Tickets $2.50. Plenty of parking and food. Talk in on

147.84/24 or 52. For further information: Bill De Geer, W9TY, Chairman, 3601 Tyler Street, Gary, IN 46408.

MARYLAND: *The Frederick Amateur Radio Club's 7th annual* Hamfest, June 17, Frederick Fairgrounds. 8 AM to 4 PM. Admission $3.00. YL's and children free. Tailgaters $2.00 additional. Exhibitors tables $10.00 each; $5.00 each additional table. Gates open for exhibitors 8 PM June 16. Overnight security. For additional information: Jim Devilbiss, WA3FUJ, 915 Pine Avenue Frederick, MD 21701. (301) 662-5784.

MICHIGAN: The Straits Area ARC's annual Swap-Shop and Computer demonstration at Emmet County Fairgrounds 4-H Building, Petoskey, July 21. 9 AM to 2 PM. Admission $2.50. Tables $3.00 with setup at 8 AM. RV camping nearby. Talk in on 146.67 and 52. For information: Irene Stein, KA8NKS, 4487 Robinson Rd., Pellston, MI 49769. (616) 539-8986.

MICHIGAN: The Independent Repeater Association of Grand Rapids will hold its annual Hamfestival, Saturday, June 30, 8 AM to 4 PM, Wyoming National Guard Armory, 44th Street, west of US-131. Free table space to all sellers. Admission $3.50. Satellite operation, packet radio, W5LFL space shuttle movie, Amtor forum, CW RX contest, Antenna forum and shack picture contest. Large swap area. Talk in on 147.165/147.765. For information: Linda Hurley, WD8OHW (616) 457-1253 or write I.R.A., 562 - 92nd Street SE, Byron Center, MI 49315.

NEVADA: The YL International SSB System's annual convention, June 21-24, Sahara Hotel, Las Vegas. Deluxe accommodations and RV parking at reasonable rates. Activities include a tour of Hoover Dam, Lake Mead cruise, gala stage show, cocktail party, banquet and breakfast buffet. DX forum and business meetings. YLRL ladies are invited to meet Thursday evening at 8 PM. A convention station will operate on 14,332 kHz. For complete details and registration packet send business SASE with 37¢ in stamps to: Jan Weaver, N7YL, 2195 East Camero Avenue, Las Vegas, NV 89123.

NEW JERSEY: The Raritan Valley Radio Club's 13th annual Hamfest, Saturday, June 16, Columbia Park, Dunellen. Gates open 8:30 AM. Lookers $2.00. Sellers spots $5.00 each, own tables. Refreshments available. Talk in on Club repeater, W2QW/R 146.025/.625 and 146.52 simplex. Advance tickets may be purchased from any club member. For further information call Jack, W2IWK (201) 756-2546 or Ted, WB2TKU (201) 725-3481 between 10 AM and 10 PM.

NEW JERSEY: *The Jersey Shore Chaverim is sponsoring the* third annual Ham & Computerfest, June 10, 9 AM to 4 PM, Jewish Community Center, 100 Grant Avenue, Deal. 7300 sq. ft. of indoor space. Admission $3 per person (children under 12 and XYL's free). Refreshments available. Indoor table $8 and tailgating $3.50 per space. For reserved space SASE with advance payment to Jersey Shore Hamfest, PO Box 192, West Long Branch, NJ 07764 by June 1. Talk in on 147.045 + .6, 145.110 + .6 and 146.52 simplex. Deal, NJ is less than 50 miles from NYC and 70 miles from Philadelphia. For information call Arnold, W2GDS (201) 222-3009.

NEW YORK: The Putnam Emergency Amateur Repeater League (PEARL) will have its 3rd annual Hamfest, Saturday, July 7, 9 AM to 4 PM, St. John's School, Monsignor O'Brien Blvd., Mahopac. General admission $1.00. Indoor tables $5.00 each. Outdoor tailgating $4.00. For advance registration and information: Frank Konecnik, WB2PTP, RD1, 244 C, Carmel, New York 10512. Talk in on 144.535/145.135 and 146.52.

NORTH DAKOTA/MANITOBA: The 21st annual international Hamfest, July 14 and 15, at the International Peace Garden between Dunseith, ND and Boissevain, Manitoba. Tranmitter hunts, mobile judging, CW contest. Excellent camping. For more information: WD0EMY or WD0DAJ, Box H, Dickinson, ND 58601.

OHIO: The Tusco Amateur Radio Club, W8ZX, and the Canton Amateur Radio Club, W8AL, will hold the 10th annual Hall of Fame Hamfest, July 15, Nimishillen Grange, 6461 Easton Street, Louisville. Admission $2.50 advance and $3.00 at gate. Flea Market additional $2.00 per vehicle. Reserved tables available. Mobile checkin on 146.52/52 and 147.72/12. Call W8ZX or W8AL. For reservations/information: WA8SHP, Butch Lebold, 10877 Hazelview Avenue, Alliance, Ohio 44601. (216) 821-8794.

OHIO: The 20th annual Wood County Ham-A-Rama, Sunday, July 8, Wood County Fairgrounds, Bowling Green. Gates open 8 AM. Free admission and parking. Trunk sales. Food available. Advance table rentals $5.00 (dealers only). Saturday setup until 8 PM. K8TIH talk in on .52. For information or dealer rentals SASE to: Wood Co. ARC, c/o Craig Henderson, Box 366, Luckey, OH 43443.

OREGON: The 9th annual Lane County Ham Fair, July 21 and 22, Oregon National Guard Armory, 2515 Centennial, Eugene. Doors open 8 AM both days. Computer demos, tech seminars, swap tables, kiddie korner, snack bar, free parking for RV's — no hookups. Saturday potluck supper. Tickets and swap tables $5.00 each. FCC exams. Talk in 146.28/88, 147.86/26 and 52. For tickets/tables: Tom Temby, Treas., 3227 Crocker Rd., Eugene, OR 97404. Make checks payable to Lane County Ham Fair.

PENNSYLVANIA: The 13th annual Hamfest sponsored by the Milton ARC, Sunday, June 10, rain or shine, Winfield Fire Co. grounds, Rt. 15, south of Lewisburg. 8 AM to 5 PM. Covered spaces available. Registration $3.00. Spouse and kids free. Flea market, auction and contests. Talk in on 146.37/.97 and 146.025/.625. For further details: Jerry Williamson, WA3SXQ, 10 Old Farm Lane, Milton, PA 17847. (717) 742-3027.

PENNSYLVANIA: The annual "Firecracker" Hamfest, Wednesday, July 4, sponsored by the Harrisburg Radio Amateur Club, Bressler F.C. picnic grounds, exit 1 off I-283. Admission $3.00. XYL and children free. Free tailgating. Nearby motels and restaurants. Plenty of parking. Shaded tables. For details/table reservations: Dave, KC3MG, 131 Livingston Street, Swatara, PA 17113 (717) 039-4957.

WEST VIRGINIA: Wheeling Hamfest, Sunday, July 22, Wheeling Park. Flea market, auction, dealers welcome. Under roof tables available. Admission $3.00. For information/reservations: TSRAC, Box 240, RD 1, Adena, OH 43901. (614) 546-3930.

WISCONSIN: The South Milwaukee ARC's annual Swapfest, Saturday, July 7, American Legion Post #434, 9327 South Shepard Avenue, Oak Creek. 7 AM to 5 PM. Picnic area, refreshments available on grounds, free overnight camping. Admission $3.00 per person includes "Happy Hour" with free beverages. Talk in on 146.94 MHz FM. For details the club at PO Box 102, South Milwaukee, WI 53172.

ONTARIO: The tenth annual Ontario Hamfest, July 14, 7 AM to 4 PM, Milton, Ontario, fairgrounds. Weekend camping, free parking, free flea market tables. Tickets $2.50 advance, $4.00 at gate. Commercial displays, refreshments. Talk in on Club repeater 21/81. For details and pre-registration: Burlington ARC, PO Box 836, Burlington, Ontario L7R 3Y7.

BRITISH COLUMBIA: The Maple Ridge ARC is hosting Hamfest '84, June 30 and July 1, Maple Ridge Fairgrounds 30 miles east of Vancouver. Registration: Hams $5.00, non-Hams over 12 $2.00. Swap and shop, commercial displays, bunny hunts, ladies' and children's programs and more. Camper space available with elec. Talk-in on 146.20/80 and 146.34/94. For information an registration (20% off gate entrance) contact: Maple Ridge ARC, Box 292, Maple Ridge, BC V2X 7G2

OPERATING EVENTS

"Things to do..."

JUNE 16: The Missouri Valley ARC's fifth annual Pony Express Day. 0900 to 1700 CST. and June 17, 1000 to 1300 CST to commemorate the original running of the Pony Express from St. Joseph, MO to Sacramento, CA. Listen for club station W0NH 10 kc's from bottom of General phone bands on 15, 20, 40 and 75 meters. 10 meters 28.575. CW 28.150 on 10; 21.150 on 15; and 7.125 on 40. Send one 1st class stamp and QSL to Missouri Valley ARC, 401 N. 12th Street, St. Joseph, MO 64501.

JULY 7-8 SSB and JULY 28-29 CW. Venezuelan Independence Worldwide Contest. 0000 GMT Saturday — 2400 GMT Sunday. All bands exchange RS(T) plus a three figure QSO number starting with 001. Logs must show date, hour (GMT only), station worked, reports exchanged and respective numerical order, multipliers and points. Each participant will accompany log with US $2.00 or IRC equivalent postmarked no later than August 15, 1984 for SSB participant and September 15, 1984 for CW. Send logs to RCV, PO Box 2285, Caracas 1010-A, Venezuela.

NEW AMATEUR OPERATING CERTIFICATE now being offered by the Bartlesville (Oklahoma) ARC to focus attention on the "Green Country" region of northeast Oklahoma. This award is available to anyone making two-way Amateur radio contact with three hams in the Nowata, Osage and/or Washington Counties of Oklahoma. All bands/modes permitted. Applicants for the award should submit calls and pertinent details of three qualifying QSO's plus $1.00 s&h to W5NS Awards Manager, 1800 Moonlight Drive, Bartlesville, OK 74006.

THE LINCOLN (NEBRASKA) COMMUNICATIONS SOCIETY has constructed a beacon transmitter to provide a signal for propagation studies and frequency reference. The beacon operates CW on 144.055 MHz and is located in the northeast corner of grid square EN-10. I.D. callsign is WB0QIY/B. Reception reports should be sent to Lincoln Communications Society, Att: K0NG, 1801 So. 48th Street, Lincoln, NE 68506.

MAY-SEPTEMBER: N.O.A.R.S. and the U.S.S. COD will be on the air again during the summer of 1984. NOARS members will operate from the COD starting Memorial Day weekend daily through Labor Day weekend. Look for operations in the lower portion of the General bands 10 through 80 meters. Special Novice operations on June 16, July 15 and August 18. Extra operations during Cleveland Hamfest, September 23. For a special 8 x 11 certificate picturing the U.S.S. COD send QSL confirming two-way contact and $1.00 s&h to WD8RZG.

JUNE 11-17: The Henry County ARC will operate club station K8TII to commemorate the Napoleon, Ohio, Sesquicentennial. Frequencies: 3740, 3965, 7065, 14265, 21150 and 21365. Contact with club station or any club members' stations qualifies for certificate. SASE to Roger C. Jaqua, W8SMW, 17136 Mercer Rd., Bowling Green, Ohio 43402.

JUNE 8-10: The Macomb Emergency Communications Association will have its second special event. Operation commences at 2200Z Friday to 2200Z Sunday. Lower end of General class portion of each Amateur band. SSB and CW/RTTY of HF. FM phone on 146.07/67. QSL to MECA, Box 488, Utica, MI 48087 with 9 x 12 SASE. DX stations need send only QSL.

JUNE 29-JULY 1: The Muscle Shoals ARC will operate W4JNB from 1600-2100Z from Spring Park, Tuscumbia, Alabama to celebrate Helen Keller Festival Days. Phone frequencies: 7270-7290 and 14,280-14,295. For certificate send 4 x 10 SASE to Box 2745, Muscle Shoals, AL 35662.

JUNE 30-JULY 1: The Hannibal ARC will issue a fourth annual special certificate from the National Tom Sawyer Days celebration in Mark Twain's boyhood home town, Hannibal, MO. 1500-21000 UTC both days. Frequencies: Phone — 7.245, 14.290, 21.400, 28.770 and CW — 7.125 and 21.125. To receive the certificate send a large SASE and your QSL card confirming contact to Hannibal ARC, W0KEM, 2108 Orchard Avenue, Hannibal, MO 63401.

Advertisers check-off

...for literature, in a hurry — we'll rush your name to the companies whose names you "**check-off**"

Place your check mark in the space between name and number. **Ex: Ham Radio ✓ 234**

Accessory Spec. ____ 101
Ace Comm. ____ 102
ARR ____ 103
Alden Elec. ____ 104
All Elec. ____ 105
Alpha Delta ____ 106
Aluma ____ 107
Amateur-Wholesale ____ 108, 109
ARRL ____ 110
Analog Tech. ____ 111
Antenna Bank ____ 112
Ant. Co. America ____ 113
Astron Corp. ____ 114
Atlantic Surplus ____ 115
ATV Mag. ____ 116
B & W *
Barry *
Bauman ____ 117
B.G. Micro ____ 118
BHCo ____ 119
Birch Hill ____ 120
Buckmaster ____ 121
Butternut *
C & A Roberts ____ 122
California Ampl. ____ 123
Ceco ____ 124
Coaxial Dynamics ____ 125
Comm. Concepts ____ 126
Comm. Elec. Spec. ____ 127
Comm. Spec. ____ 128
Connect Systems ____ 129
Comp. Trader ____ 130
Contact East ____ 301

Doppler ____ 132
EGE ____ 133
EEB ____ 134
Encomm ____ 135
Eng. Cons. ____ 136
Falcon Comm. ____ 137
Fox Tango ____ 138
GLB Elec. ____ 139
Ham MasterTapes ____ 140
HRB ____ 141
Hamtronics, N.Y. ____ 142, 302
Hamtronics, PA. ____ 143
Handi-Tek ____ 144
Harrison Radio ____ 145
Harvey Radio ____ 146
Icom ____ 147
Info. Un. ____ 148
ICM ____ 149
Inter. Media * ____ 150
Kantronics ____ 151, 152
Kenpro ____ 153
Kenwood *
KLM ____ 154

MFJ ____ 155
MHz Elec. ____ 156
Madison ____ 157
Memphis Amateur Elec. ____ 158
Meshna ____ 159
Micro-Mart *
Microwave Filter ____ 160
Midwest Ama. ____ 161
Mirage ____ 162
Missouri Radio ____ 163
Morning Dist. ____ 164
Mosley ____ 165
NCG ____ 166
Nampa ____ 167
Nemal ____ 168
N & V ____ 169
Oak Hill Academy *
Outprint ____ 170
P.C. Elec. ____ 171
Paramount ____ 172
Pipo ____ 173
Pro-Search ____ 174, 303
RF Products ____ 175
Callbook ____ 176
Ramsey ____ 177, 178
Roensch ____ 179
Sartori ____ 180
Satellite Rec. Sys. ____ 181
Scandex ____ 182
Skylane Prod. ____ 183
Slep ____ 184
Smith Software ____ 185
S.E. Satellite ____ 186
Spectrum Int. ____ 187
Spectrum West ____ 188
Spi-Ro Dist. ____ 189
TE Systems ____ 190
Tel-Com ____ 191
Ten-Tec *
TNT Radio ____ 192
Transleteronic ____ 193
Tri-Ex ____ 194
Universal Elec. ____ 195
UNR-Rohn *
Univer. Microfilms *
Vanguard ____ 196
Varian ____ 197
Vector Radio ____ 198
VHF Shop ____ 199

VoCom Prod. ____ 201
Webster Comm. ____ 202
Westcom ____ 203
Western Elec. ____ 204
Westlink ____ 205
Williams Radio ____ 206
Yaesu ____ 207

*Please contact this advertiser directly.

Limit 15 inquiries per request.

June 1984

Please use before July 31, 1984

Tear off and mail to
HAM RADIO MAGAZINE — "check off"
Greenville, N. H. 03048-0498

NAME ....

CALL ....

STREET ....

CITY ....

STATE .... ZIP ....

Advertisers index

ham radio Reader Service

For literature or more information, locate the Reader Service number at the bottom of the ad, circle the appropriate number on this card, affix postage and send to us. We'll hustle your name and address to the companies you're interested in.

101	113	125	137	149	161	173	185	197	209	221	233	245	257	269	281	293	305	317	329	341
102	114	126	138	150	162	174	186	198	210	222	234	246	258	270	282	294	306	318	330	342
103	115	127	139	151	163	175	187	199	211	223	235	247	259	271	283	295	307	319	331	343
104	116	128	140	152	164	176	188	200	212	224	236	248	260	272	284	296	308	320	332	344
105	117	129	141	153	165	177	189	201	213	225	237	249	261	273	285	297	309	321	333	345
106	118	130	142	154	166	178	190	202	214	226	238	250	262	274	286	298	310	322	334	346
107	119	131	143	155	167	179	191	203	215	227	239	251	263	275	287	299	311	323	335	347
108	120	132	144	156	168	180	192	204	216	228	240	252	264	276	288	300	312	324	336	348
109	121	133	145	157	169	181	193	205	217	229	241	253	265	277	289	301	313	325	337	349
110	122	134	146	158	170	182	194	206	218	230	242	254	266	278	290	302	314	326	338	350
111	123	135	147	159	171	183	195	207	219	231	243	255	267	279	291	303	315	327	339	
112	124	136	148	160	172	184	196	208	220	232	244	256	268	280	292	304	316	328	340	

Limit 15 inquiries per request.

NAME ______________________________ CALL ______________

ADDRESS ____

CITY ____________________ STATE ____________ ZIP ____________

Please use before July 31, 1984

June 1984

AFFIX POSTAGE
OR
POST OFFICE
WILL NOT
DELIVER

ham radio magazine

READER SERVICE CENTER
P.O. BOX 358
ARLINGTON, MA 02174

ATTN: Reader Service Dept.

✓ 125

✓ 148

Actual slow motion frames from Ham MasterTapes

1. Larry, N2NY, Lee, KA2RNV

2. Lee discharges cap

3. In slow motion it's dazzling

4. Wow. Can we see it again?

You've never seen this, like this, before this!

And you can see it—in color—again and again when you own the N2NY Ham MasterTapes.

Ever see a cap discharge in slow motion? You will on Ham MasterTapes. Ham MasterTapes can perform the dozens of complicated demonstrations necessary for a beginner's understanding of Ham Radio Theory.

Finally, a step-by-step course in Ham Radio Theory is available on color videotape. The Larry Horne N2NY Ham MasterTapes video course is a unique, effective teaching technique expertly produced by New York's leading professionals in studio and field videotape.

☐ Video Graphics highlight important details.

☐ Carefully worked-out demonstrations on video avoid the problem of getting complex gadgets to work on command in front of a class.

☐ Working examples of every ham radio component, device, or system covered in the FCC guide can be clearly understood.

The N2NY Ham MasterTapes give you a basic grasp of concepts that build theory background—not only for passing the FCC tests, but for understanding electronics.

The hobby has long needed better, clearer, high-tech teaching aids to help newcomers into our wonderful world of Ham Radio.

These six-hour tapes cover completely all the material needed to understand Novice and Tech/General Theory and operations, and include the new 200-question FCC syllabus used beginning September 1983.

Only $199.95. Order direct and specify Beta or VHS format. Call or write: Larry Horne, N2NY

Ham MasterTapes™
THE N2NY HAM RADIO COURSE ON VIDEOTAPE

Ham MasterTapes
136 East 31st Street
New York, N.Y. 10016 212-673-0680.

✓ 140