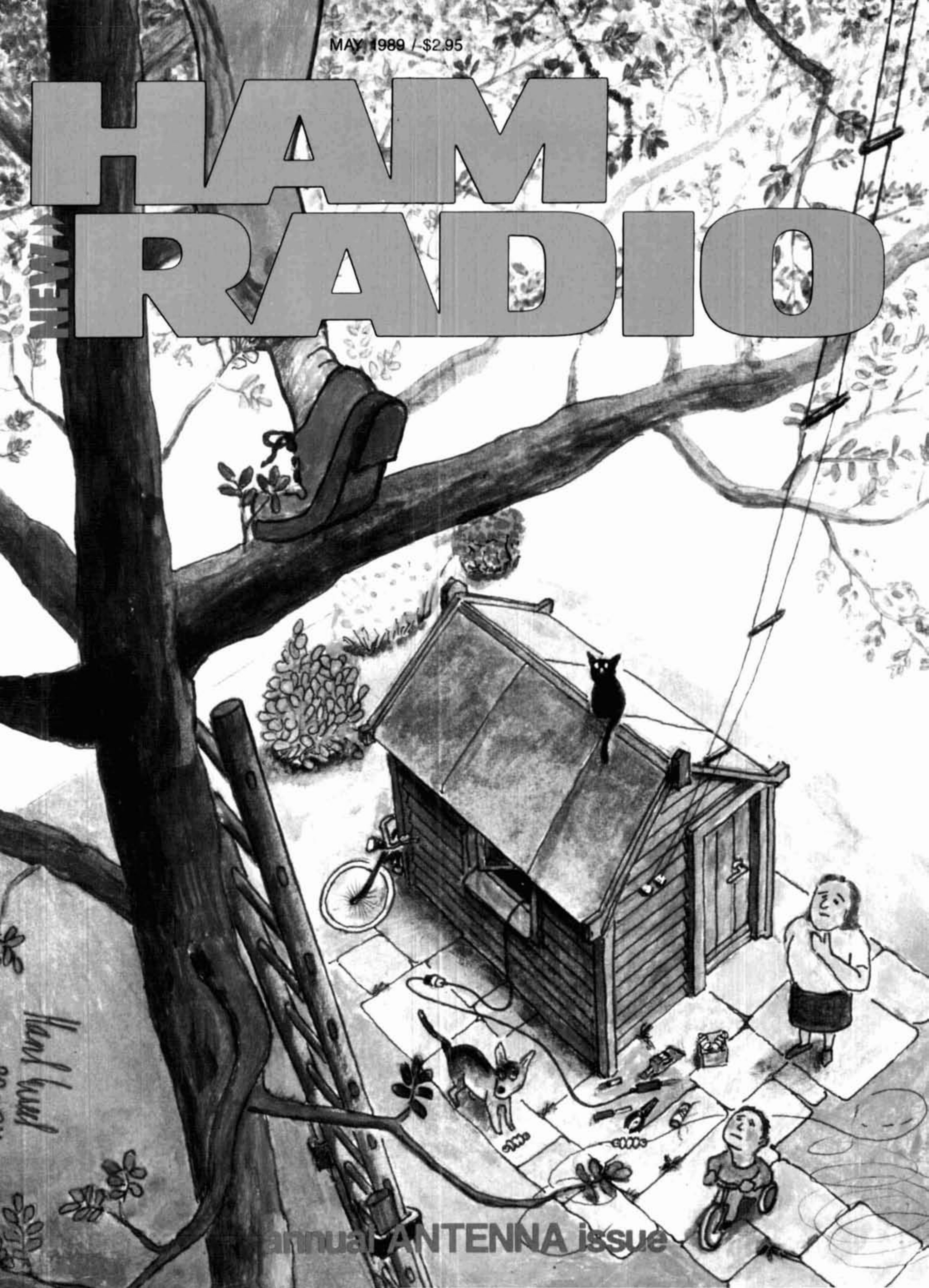
MAY 1989 / $2.95

NEW HAM RADIO



annual ANTENNA issue

HOME IS WHERE YOUR IC-725 IS

Fixed, mobile or portable, ICOM's new IC-725 delivers band-commanding performance. The easy-to-operate IC-725 reflects ICOM's world-renown excellence in circuit designs, versatility and dependability. Your enjoyment is also guaranteed with ICOM's one full year warranty!

SMALL SIZE, BIG PERFORMANCE!

Extraordinary Performance! Includes: 160 through 10 meter operation • 100 watts output • Shortwave reception from 100kHz to 33MHz • SSB, CW and AM modes (FM optional) • Sensitive 105db dynamic range receiver • Low noise DDS switching • Panel-selectable RF preamp and attenuator • Dual VFO's • Selectable AGC • Rugged full duty cycle finals.

GLOBE-SPANNING OPERATION!

Full Featured Operation! 26 tunable memories with Band Stacking Registers which enable you to store a frequency, switch bands, and return to the stored frequency • 10Hz digital frequency display • Three tuning rates • Three scan modes • Highly effective Noise Blanker • RIT • Semi-QSK CW • Optional narrow CW filter • Built-in AH-3 controller • IC-725 measures only 9.0 x 3.7 x 9.4 inches (H, W, D).

Optional AH-3 automatic and remote antenna tuner for mobile and portable operation. Plugs directly into the IC-725. Wide impedance matching range. Mating whip unit (AH2-B) bolts to auto's frame, works 80-10 meters.

ICOM

First in Communications

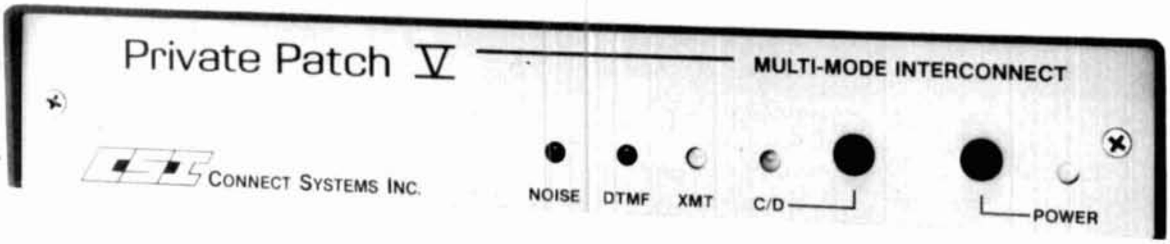
ICOM America, Inc., 2380-116th Ave. N.E., Bellevue, WA 98004
Customer Service Hotline (206) 454-7619
3150 Premier Drive, Suite 126, Irving, TX 75063 / 1777 Phoenix Parkway, Suite 201, Atlanta, GA 30349
ICOM CANADA, A Division of ICOM America, Inc., 3071 - #5 Road, Unit 9, Richmond, B.C. V6X 2T4 Canada

All stated specifications are subject to change without notice or obligation. All ICOM radios significantly exceed FCC regulations limiting spurious emissions. 7251288

✔ 113

FOUR user selectable operating modes and a 90 number autodialer make Private Patch V the ONLY choice!

NEW!



SELECT AN OPERATING MODE USING THE BUILT-IN KEYBOARD . . .

1. SIMPLEX SAMPLING PATCH

Private Patch V achieves a level of sampling patch performance unobtainable in any other product. Crucial to performance is the noise squelch filter. Compare our five pole filter to the competition's two pole filter. Advanced software algorithms perform noise correlation tests which result in greater useable range than the competition. Nine selectable VOX enhancement ratios allow you to vary performance from straight sampling to highly VOX enhanced. (sampling rate decreased while the land party is speaking). The mobile is in full control and can break-in at any time.

2. SIMPLEX VOX PATCH

VOX mode offers superb simplex operation with any radio, including synthesized and relay switched models. VOX mode has other advantages too. **1.** A linear amplifier can be used to extend straight simplex range. **2.** You can operate through any remotely located repeater to greatly extend range. **3.** If desired you can connect Private Patch V to the MIC and speaker jack of your radio. NO INTERNAL CONNECTIONS ARE REQUIRED. Control is maintained automatically with built-in dial tone detection, busy signal detection and fully programmable activity and time out timers. An optional electronic voice delay board eliminates first word clipping with slow switching radios.

3. DUPLEX PATCH

Select duplex mode when connecting Private Patch V to your existing repeater or duplex base station. Many features including semi-duplex privacy mode are user programmable. The mobile is in full control at all times.

4. REPEATER CONTROLLER

Private Patch V will convert any receiver and transmitter into an outstanding performing repeater with duplex autopatch. Features such as repeater on/off code, hangtime, activity timer time, CW ID interval etc. are fully user programmable. Private Patch V is the right choice for your club system.

Private Patch V is a totally new concept in automatic phone patches. A built-in keyboard and menu driven display allow you to customize all modes, features, and functions specifically to *your application.*

Private Patch V can be a sampling patch today. A VOX patch tomorrow. And a repeater controller next year!

You may never need another patch again.

COMPARE THESE FEATURES . . .

- 90 phone number autodialer
- Last number redial
- Regenerated tone/pulse dialing
- Toll restrict: 1st and 2nd digit restrict, prefix lockout and digit counting
- 1-5 digit connect/disconnect code
- 2-5 digit secret toll override code
- User programmable CW ID
- Remote hook flash
- Auto disconnect on dialtone/busy signals
- Telephone remote base
- Remote controlled relay (relay optional)
- Lightning protected

Call or write today for your FREE brochure.

CSI

CONNECT SYSTEMS INC.

2064 Eastman Ave., #113 Ventura, CA 93003
Phone (805) 642-7184 FAX (805) 642-7271

AMATEUR ELECTRONIC SUPPLY: Milwaukee WI, Wickliffe OH, Orlando FL, Clearwater FL, Las Vegas NV • **BARRY ELECTRONICS CORP.**: New York NY • **ERICKSON COMMUNICATIONS**: Chicago IL • **HAM RADIO OUTLET**: Anaheim CA, Burlingame CA, Oakland CA, Phoenix AZ San Diego CA, Van Nuys CA, Atlanta GA • **HENRY RADIO**: Los Angeles CA • **INTERNATIONAL RADIO SYSTEMS**: Miami FL • **JUNS ELECTRONICS**: Culver City CA • **MADISON ELECTRONICS SUPPLY**: Houston TX • **MIAMI RADIO CENTER CORP.**: Miami FL • **MIKES ELECTRONICS**: Ft. Lauderdale, FL • **N&G DISTRIBUTING CORP.**: Miami FL • **OMNI ELECTRONICS**: Laredo TX • **PACE ENGINEERING**: Tucson AZ • **THE HAM STATION**: Evansville IN • **VALLEY RADIO CENTER**: Harlingen TX • **CANADA—COM-WEST RADIO SYSTEMS, LTD.**: Vancouver BC

✓ 114

HAM RADIO

MAY 1989
volume 22, number 5

KZ3K, page 49

W6SAI, page 74

See page 25 for the winners of March's Weekender contest.

FEATURES

DEPARTMENTS

HAM RADIO Magazine (ISSN 0148-5989) is published monthly by Communications Technology, Inc. Greenville, New Hampshire 03048-0498 Telephone: 603-878-1441. **Subscription Rates:** United States: one year, $22.95; two years, $38.95; three years, $49.95; Europe (via KLM air mail), $40.00; Canada, Japan, South Africa and other countries (via surface mail): one year, $31.00; two years, $55.00; three years, $74.00. All subscription orders payable in U.S. funds, via international postal money order or check drawn on U.S. bank. **International Subscription Agents:** page 100.

Microfilm copies are available from Buckmaster Publishing Mineral, Virginia 23117. 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. *Send change of address to HAM RADIO, Greenville, New Hampshire 03048-0498.*

William W. Eitel, W6UF
1908 - 1989

W6UF: Amateur Radio frontiersman

To say "It can't be done" was a challenge to William W. Eitel, W6UF. In 1927 it was thought that the new 10-meter band was workable for line-of-sight transmissions only, as the 5-meter band seemed to be. W6UF was one of the first stations on the band, determined to prove that 10-meters was good for long distance communication. In a few weeks he was running daily skeds with W1CCZ and ZL2AC, establishing beyond a doubt the DX qualities of the new band. His homemade transmitter used a crystal he had ground from a chunk of quartz found in a mountain stream. He saved money for weeks to buy an 852 tube for the 150-watt amplifier stage. He built a two-tube regenerative receiver. His efforts were summarized in *QST* in January 1929. Ten meters was not like the "ultra-high" frequencies! It was a DX band!

This was an auspicious beginning for a 20-year-old lad with a consuming curiosity about radio communications. His biggest problem was the cranky 852 tube; it required enormous plate voltage to work properly at 10 meters. He decided he could build a better tube, which would work at a reasonable plate potential.

His chance came in 1933 when he went to work for a vacuum tube manufacturer in the San Francisco area. Bill, along with Jack McCullough, W6CHE, developed a low-voltage, high-current tube that proved superior to the 852. Unfortunately, the company (a marine communication business) wasn't interested in selling tubes to Amateurs , so tube sales languished. Bill and Jack soon left the company, and in 1934 started a new enterprise — Eitel-McCullough, Inc. Their goal was to build reliable "EIMAC" tubes that would operate at higher frequencies than anything available. They borrowed $5,000 and designed a revolutionary new triode tube, the 150T.

This was the start of something big. EIMAC tubes were quickly adapted for commercial and military use, and the little company prospered. Within a decade it became the United States' leading producer of power electron tubes and related devices. The combination of Jack (the planner and designer) and Bill (the hands-on activist) was fortuitous. The right guys with the right products at the right time!

Bill's interest in Amateur Radio, although curtailed by the effort of building a company and the demands of war production, never flagged. Bill and Jack went out of their way to enlist Radio Amateurs in the company, to encourage them in the new communication industry, and to develop new tubes for Amateur Radio.

Over the years, Bill never lost his inventor's curiosity. His interest in advancing the frontiers of Amateur Radio continued. In 1961 the EIMAC Radio Club, under the leadership of Bill, Jack, and Hank Brown (W6HB), established the first Amateur two-way "moonbounce" contact on 1296 MHz with W1FZJ.

Bill was a member of the Northern California DX Club and Project OSCAR. He donated time, equipment, and money to make the early OSCAR satellites successful. If there was a job to be done, he'd do it. His enthusiasm and support were often all that kept the early OSCAR satellite program from foundering. He was a remarkable, enthusiastic leader in the best sense of the word. He was an excellent operator, CW or phone, and set the pace for Amateurs many years his junior.

Upon retirement, Bill moved to Dayton, Nevada and set up his own experimental laboratory, continuing to work on ideas that interested him. He was a life member of the ARRL, Project OSCAR, and the 5-Star Operator's Club. He was elected to a fellowship in the Radio Club of America.

He passed away in February 1989 at the age of 81. His accomplishments were many. In addition to being an active Radio Amateur, inventor, company founder, and executive, he was a good companion. He left behind a multitude of friends who mourned his passing. He left his mark in electronics and the Amateur world. His discontent with the status quo drove him to succeed when others dropped by the wayside. His inquisitive mind made him an alert problem solver. Along the way he helped others. He was an American original: a self-educated small-town boy who grew up in a turbulent era of rapid and productive scientific growth — and mastered his world.

We will all miss him. 73, Bill, and SK.

Bill Orr, W6SAI

KENWOOD

...pacesetter in Amateur Radio

All New!

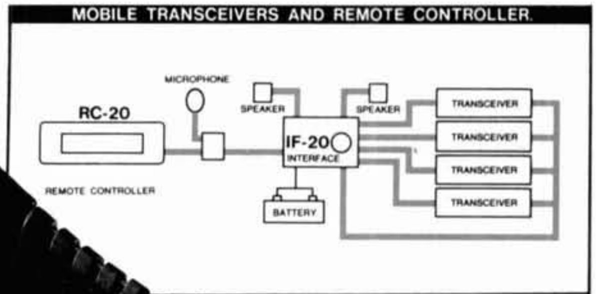
Stacked in Your Favor!

TM-231A/431A/531A

FM Mobile Transceiver

Looking for a compact transceiver for your mobile VHF and UHF operations? KENWOOD has a compact rig for each of the most popular VHF/UHF bands.

- **20 multi-function memory channels.** 20 memory channels allow storage of frequency, repeater offset, CTCSS frequency, frequency step, Tone On/Off status, CTCSS and REV.
- **High performance—high power! 50W (TM-231A), 35W (TM-431A) with a 3 position power switch (high, medium, low).**
- **Optional full-function remote controller (RC-20).** A full-function remote controller using the Kenwood bus line, model RC-20, may be easily connected to the TM-231A/431A/531A and can be mounted in any convenient location. Using the IF-20 interface the RC-20 may be connected to four mobile transceivers. (TM-231A/431A/531A or the TM-701A)
- **Multi-function DTMF mic. supplied.** Controls are provided on the microphone for CALL (Call Channel), VFO, MR (Memory Call or to change the memory channel) and a programmable function key. The programmable key can be used to control one of the following on the radio: MHz, T. ALT. TONE, REV, DRS, LOW or MONITOR.
- **Easy-to-operate illuminated keys.** A functionally designed control panel with backlit keys increases the convenience and ease of operation during night-time use.
- **Auto repeater offset on 144 and 220 MHz.**
- **Built-in digital VFO.**
  - **a) Selection of the frequency step (5, 10, 15, 20, 12.5, 25kHz)**
    *TM-531A: 10, 20, 12.5 25kHz
  - **b) Programmable VFO**
    The user friendly programmable VFO allows the operator to select and program variable tuning ranges in 1 MHz band increments.
- **Programmable call channel function.** The call channel key allows instant recall of your most commonly used frequency data.
- **Selectable CTCSS tone built-in.**
- **Tone alert system—for true "quiet monitoring"!** When activated this function will cause a distinct beeper tone to be emitted from the transceiver for approximately 10 seconds to signal the presence of an incoming signal.
- **Easy-to-operate multi-mode scanning.** Band scan, Program band scan, Memory scan plus programmable memory channel lock-out, with time operated or carrier operated stop.
- **Priority alert.**
- **DRS (Digital recording system).** The optional DRU-1 can store received and transmitted messages for up to 32 seconds, allowing the operator to quickly check or return any call using the tone alert system.
- **Automatic lock tuning function (TM-531A).**
- **Repeater reverse switch.**



Optional Accessories

- **RC-20** Full-function remote controller • **RC-10** Multi-function remote controller • **IF-20** Interface unit handset • **DRU-1** Digital recording unit • **MC-44** Multi-function hand mic. • **MC-44DM** Multi-function hand mic. with auto-patch • **MC-48B** 16-key DTMF hand mic. • **MC-55** 8-pin mobile mic. • **MC-60A/80/85** Desk-top mics. • **MA-700** Dual band (2m/70cm) mobile antenna (mount not supplied) • **SP-41** Compact mobile speaker • **SP-50B** Mobile speaker • **PS-430** Power supply • **PS-50** Heavy-duty power supply • **MB-201** Mobile mount • **PG-2N** Power cable • **PG-3B** DC line noise filter • **PG-4H** Interface connecting cable • **PG-4J** Extension cable kit • **TSU-6** CTCSS unit

Specifications and prices subject to change without notice or obligation.
Complete service manuals are available for all Kenwood transceivers and most accessories.

KENWOOD

KENWOOD U.S.A. CORPORATION
COMMUNICATIONS & TEST EQUIPMENT GROUP
P.O. BOX 22745, 2201 E. Dominguez Street
Long Beach, CA 90801-5745
KENWOOD ELECTRONICS CANADA INC.
P.O. BOX 1075, 959 Gana Court
Mississauga, Ontario, Canada L4T 4C2

PUBLISHER'S LOG

You are now looking at the final step in our redesign program here at *Ham Radio*. It represents well over a year of very hard work on the part of a large number of people including many of you, our readers.

We started with a new editorial staff. Next, we interviewed a sizable sample of both subscribers and non-subscribing Amateurs to find out where you felt our strengths and weaknesses were. What should be done to make the best Amateur Radio magazine even better?

By September of last year you saw phase one, with our new logo and a redirected emphasis on practical construction articles and shorter technical and tutorial pieces. We also instituted the feedback cards to find out just what you liked and didn't like about our many changes.

We listened, we fine tuned, and we listened again. All the while, those responsible for the design of the magazine were hard at work coming up with a product which would be more eye pleasing than ever before. One that would, at the same time, be very efficient in helping the reader to get the most from each page they read.

I'm very happy with this finished product, but I'm even more proud of the many people who have gone the extra distance to bring all of this together. Thanks must go to the whole *Ham Radio* staff; to those at Wallace Press, our typesetter; and to Anne Desmarais, our design consultant.

The formal program is now over, but the striving for improvement will never stop. If you have any good ideas or suggestions, we're always open to them. Let us know what you think.

Skip Tenney, W1NLB

Comments

A good laugh

Dear HR

Your February issue arrived in the mail yesterday and, after a look at the cover, I had one of the best laughs in a long time!

It's hard to tell what the piece of gear is that has your "cover ham" looking so apprehensive, but I immediately thought of the old SB-104 that is sitting on my table; the schematic is just about the same size, so big that I finally pinned it on the wall for convenience.

So congratulations to you and your artist for identifying with us readers who enjoy (?) digging into gear!

Ray Burke, VE1BFG, Bathurst, New Brunswick, Canada

A good recipe—blending old with new

Dear HR

My good friend, Bert Cliff, W2QN, gave me a one year subscription to HR for Christmas. Today, for the first time since a lapse of almost ten years, I received the January issue in top condition.

I could not help but sit down and work through the magazine as soon as I could do so. If I am not mistaken, you are endeavoring to create a blending between the former *Ham Radio Horizons* and *Ham Radio*, which I followed for many years. My first impression is that you have achieved an excellent mixture. I, therefore, would suggest that you continue along this line, and I am eagerly looking forward to the following issues.

I have included my magazine evaluation card. I found the article written by Joe Reisert, W1JR, "VHF/UHF World," of special interest since it may well have put quite a dent into my HF one-sided-ness.

Congratulations to Joe Carr, K4IPV, for his splendid article on "Writing the Technical Article." I was the last editor of the pre-war German DASD Amateur Magazine *CQ* in 1941/43. I do wish I could have read Joe's advise then, or at least in 1947 when I started my sideline career of writing pieces for our first ham mag *QRV* after the war.

Albert Heine, DK7CN, D-8990 Lindau, W. Germany

Food for thought

Dear HR

I have just read a letter by AA6FW in your magazine of February 1989.

I am surprised. Perhaps the radio operators in San Diego are different from those here.

As an Amateur who is a relative newcomer (about 6 years), currently 49 years old, a V.E., and a volunteer operator at a museum demonstration station, I can make the following personal observations:

- I was stimulated to get my license by a man years my junior, not a grandfather.
- The growth of Amateur Radio, in this area, is positive and being aided by classes conducted by radio clubs in Delaware, Pennsylvania, and New Jersey.
- The newcomers are of all ages, and it's often a family affair.
- 5 WPM code can be passed by anyone who makes even a minimal effort. Of course code is an entrance requirement, but, so is a lot of other knowledge — frequencies, rules, regulations, electronics, etc.

Now, if the code requirement is eliminated under the guise of "too hard, scares them away," "not necessary," or some other feeble excuse, what do you suppose might be the next requirement to go — perhaps questions about...oh shucks, why even have an examination! "All an Amateur does is push a bunch of buttons." I can hear it now.

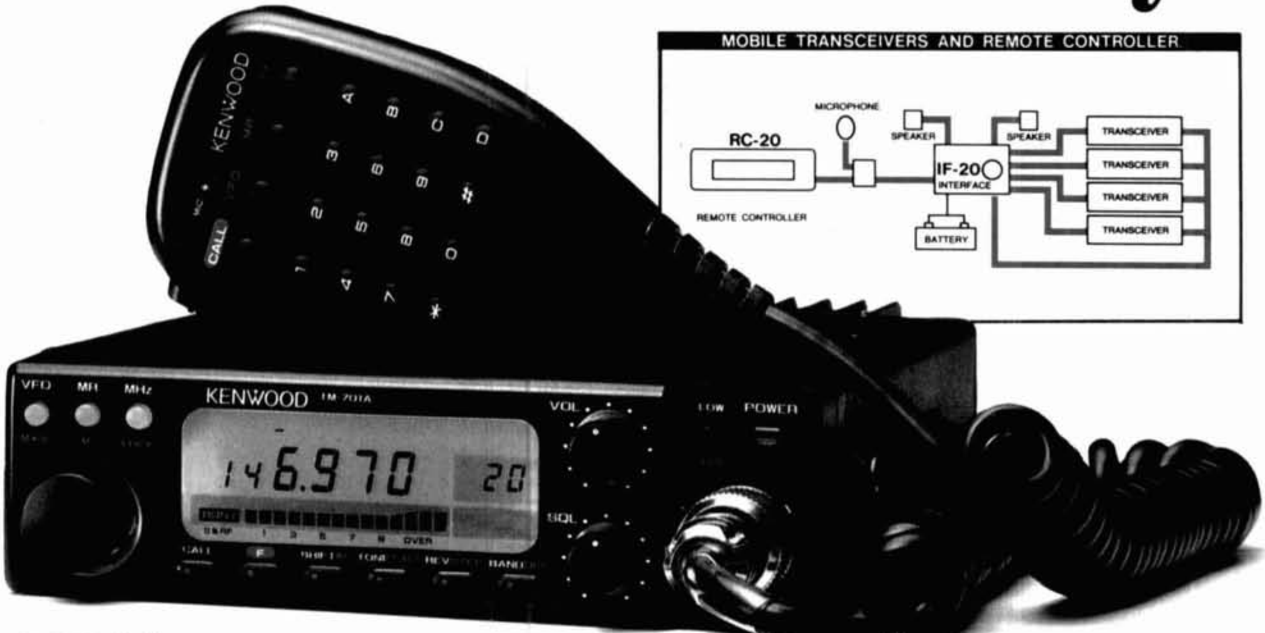
Merrill Jay Mirman, D.O., KT3Z, Springfield, Pennsylvania

KENWOOD

...pacesetter in Amateur Radio

Affordable Breakthrough!

Dual Band Afford-ability!



TM-701A

Dual Bander

The TM-701A combines two radios into one compact package. You get 25 watts on 2 meters and 70cm, 20 memory channels, tone encoder built-in, multiple scanning, auto repeater offset selection on 2 meters, and a host of additional features!

- **20 multi-function memory channels.** 20 memory channels allow storage of frequency, repeater offset, CTCSS frequency, frequency step, and Tone On/Off status, CTCSS and REV, providing quick and easy access during mobile operation.
- **25W on 2m and 70cm.**
- **Selectable full duplex-cross band (Telephone style) operation.**
- **Easy-to-operate front panel layout.**
- **Multi-function DTMF mic. supplied.** Controls are provided on the microphone for CALL (Call Channel), VFO, MR (Memory Call or to change the memory channel) and a programmable function key. The programmable key can be used to control one of the following functions on the radio: MHz, T. ALT, TONE, REV, BAND, or LOW power.
- **Easy-to-operate illuminated keys.** A functionally designed control panel with individually backlit keys increases the convenience and ease of operation during night-time use.
- **Optional full-function remote controller (RC-20).** A full-function remote controller using the Kenwood bus line may be easily connected to the TM-701A and mounted in any convenient location. The new controller is capable of operating all front panel functions.
- **Built-in dual digital VFO's.**
  - **a) Frequency step selection (5, 10, 15, 20, 12.5, 25kHz)**
  - **b) Programmable VFO** The user friendly programmable VFOs allow the operator to select and program variable tuning ranges in 1 MHz band increments.
- **Programmable call channel function.** The call channel key allows instant recall of your most commonly used frequency data.
- **Programmable tone encoder built-in.**
- **Tone alert system—for true quiet monitoring.** When activated this function will cause a distinct beeper tone to be emitted from the transceiver for approximately 10 seconds to signal the presence of an incoming signal.
- **Easy-to-operate multi-mode scanning.**
  - **a) VFO scan** Band scan, Programmable band scan.
  - **b) Memory scan plus programmable memory channel lock-out**
  - **c) Dual scan** Dual call channel scan, Dual memory scan, Dual VFO scan
  - **d) Scan stop modes** Time operated scan (TO), Carrier operated scan (CO)
  - **e) Scan direction**
  - **f) Alert** When the AL switch is depressed memory channel 1 is scanned for activity at approximately 5 second intervals.
- **MHz switch.**
- **Lock function.**
- **Repeater reverse switch.**

Optional Accessories

- **RC-20** Full-function remote controller
- **RC-10** Multi-function remote controller
- **IF-20** Interface unit handset • **MC-44** Multi-function hand mic. • **MC-44DM** Multi-function hand mic. with auto-patch • **MC-48B** 16-key DTMF hand mic. • **MC-55** 8-pin mobile mic.
- **MC-60A/80/85** Desk-top mics. • **MA-700** Dual band (2m/70cm) mobile antenna (mount not supplied) • **SP-41** Compact mobile speaker • **SP-50B** Mobile speaker • **PS-430** Power supply • **PS-50** Heavy-duty power supply • **MB-201** Mobile mount • **PG-2N** Power cable • **PG-3B** DC line noise filter
- **PG-4H** Interface connecting cable • **PG-4J** Extension cable kit • **TSU-6** CTCSS unit

Specifications and prices subject to change without notice or obligation.
Complete service manuals are available for all Kenwood transceivers and most accessories.

KENWOOD

KENWOOD U.S.A. CORPORATION
COMMUNICATIONS & TEST EQUIPMENT GROUP
P.O. BOX 22745, 2201 E. Dominguez Street
Long Beach, CA 90801-5745
KENWOOD ELECTRONICS CANADA INC.
P.O. BOX 1075, 959 Gana Court
Mississauga, Ontario, Canada L4T 4C2

BEST OF MFJ

MFJ, Bencher and Curtis team up to bring you America's most popular keyer in a compact package for smooth easy CW

MFJ-422B

$129⁹⁵

The best of all CW worlds - a deluxe MFJ Keyer using a Curtis 8044ABM chip in a compact package that fits right on the Bencher iambic paddle!

This MFJ Keyer is small in size but big in features. You get iambic keying, adjustable weight and tone and front panel volume and speed controls (8-50 WPM), dot-dash memories, speaker, sidetone and push button selection of automatic or semi-automatic/tune modes. It's also totally RF proof and has ultra-reliable solid state outputs that key both tube and solid state rigs. Use 9 V battery or 110 VAC with MFJ-1305, $9.95.

The keyer mounts on a Bencher paddle to form a small (4 1/8 x 2 5/8 x 5½ inches) attractive combination that is a pleasure to look at and use.

America's favorite paddle, the Bench, has adjustable gold-plated silver contacts, lucite paddles, chrome plated brass, and a heavy steel base with non-skid feet.

You can buy just the keyer assembly, MFJ-422BX, for only $79.95 to mount on **your** Bencher paddle.

Artificial RF Ground

MFJ-931
$79⁹⁵

You can create an artificial RF ground and eliminate RF "bites", feedback, TVI and RFI when you let the MFJ-931 resonate a random length of wire and turn it into a tuned counter-poise. MFJ-931 also lets you electrically **place a far away RF ground directly at your rig** - no matter how far away it is - by tuning out the reactance of your ground connection wire. 7½x3½x7 in.

Antenna Bridge

MFJ-204B
$79⁹⁵

Now you can quickly optimize your antenna for peak performance with this portable, totally self-contained antenna bridge.

No other equipment needed - take it to your antenna site. Determine if your antenna is too long or too short, measure its resonant frequency and antenna resistance to 500 ohms. It's the easiest, most convenient way to determine antenna performance. Built-in resistance bridge, null meter, tunable oscillator-driver (1.8-30 MHz). Use 9 V battery or 110 VAC with AC adapter, $9.95.

Super Active Antenna

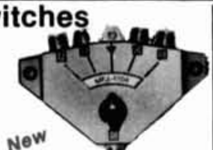
'World Radio TV Handbook' says MFJ-1024 is "a first rate easy-to-operate active antenna ... quiet ... excellent dynamic range ... good gain ... very low noise factor... broad frequency coverage ... excellent choice."

Mount it outdoors away from electrical noise for maximum signal, minimum noise. MFJ-1024 covers 50 KHz to 30 MHz

Receives strong, clear signals from all over the world. 20 dB attenuator, gain control. ON LED Switch two receivers and aux. or active antenna. 6x23x5 in. Remote unit has 54 inch whip, 50 ft. coax and connector. 3x2x4 in. 12 VDC or 110 VAC with MFJ-1312, $9.95.

MFJ-1024 **$129⁹⁵**

MFJ Coax Antenna Switches



$34⁹⁵ MFJ-1701 **$21⁹⁵** MFJ-1702 New **$59⁹⁵** MFJ-1704

Select any of several antennas from your operating desk with these MFJ Coax Switches. They feature mounting holes and automatic grounding of unused terminals. They come with MFJ's one year **unconditional** guarantee.

MFJ-1701, $34.95. Six position antenna switch. SO-239 connectors. 50-75 ohm loads. 2 KW PEP, 1 KW CW. Black aluminum 10x3x1½ inch cabinet.

MFJ-1702, $21.95. 2 positions. Cavity construction. 2.5 KW PEP, 1 KW CW. Insertion loss below .2 dB. 50 dB isolation at 450 MHz. 50 ohm. 3x2x2 in.

MFJ-1704, $59.95. 4 position Cavity Switch with Lightening/Surge protection device. Center Ground position. 2.5 KW PEP, 1 KW CW. Extremely low SWR. Isolation better than 50 dB 500 MHz. Negligible loss. 50 ohm. 6¼x4¼x1¼ in.

"Dry" Dummy Loads for HF/VHF/UHF

MFJ-260 **$28⁹⁵** **MFJ-262** **$69⁹⁵** New **MFJ-264** **$109⁹⁵**

MFJ has a full line of dummy loads to suit your needs. Use a dummy load for tuning to reduce needless (and illegal) QRM and save your finals.

MFJ-260, $28.95. Air cooled, non-inductive 50 ohm resistor. SO-239 connector. Handles 300 watts. Run full load for 30 seconds, derating curve to 5 minutes. SWR less than 1.3:1 to 30 MHz, 1.5:1 30-60 MHz. 2½x2½x7 in.

MFJ-262,$69.95. Handles 1 KW. SWR less than 1.5:1 to 30 MHz. 3x3x13 in.

MFJ-264, $109.95. Versatile UHF/VHF/HF 1.5 KW Dry Dummy Load. An MFJ first. Gives you low SWR to 650 MHz, usable to 750 MHz. You can run 100 watts for 10 minutes, 1500 watts for 10 seconds. SWR is 1.1:1 to 30 MHz, below 1.3:1 to 650 MHz. 3x3x7 inches. SO-239 connector.

MFJ-1286 Gray Line DX Advantage

New **$29⁹⁵** MFJ-1286

Snag rare DX for only $29.95! The MFJ-1286 is a computerized DXing tool that predicts DX propagation. Even the casual DXer can work rare DX by knowing when conditions are best for DX. The Gray Line is the day/night divider line where the most amazing DX happens every day. Now you'll know **exactly** when to take advantage of it.

Gives detailed world map. Shows Gray Line for any date/time, UTC in 24 user chosen QTHs, time zones and more. IBM compatible. Any graphics.

MFJ's Speaker/Mics

For Kenwood, Icom, Yaesu, Santec

MFJ-284 or MFJ-286 **$24⁹⁵**

MFJ's compact Speaker/Mics let you carry your HT on your belt and never have to remove it to monitor calls or talk.

You get a wide range speaker and first-rate electret mic element for superb audio on **both** transmit and receive.

Earphone jack, handy lapel/pocket clip, PTT, lightweight retractable cord. Gray. One year **unconditional** guarantee.

MFJ-284 fits Icom, Yaesu, Santec. **MFJ-286** fits Kenwood.

12/24 Hour LCD Clocks

$19⁹⁵ MFJ-108B **$9⁹⁵** MFJ-107B

Huge 5/8 inch bold LCD digits let you see the correct time from anywhere in your shack. Choose from the dual clock that has separate UTC/local time display or the single 24 hour ham clock.

Mounted in a brushed aluminum frame. Easy to set. The world's most popular ham clocks for accurate logs. MFJ-108B 4½x1x2; MFJ-107B 2¼x1x2.

Lighted Cross/Needle SWR/Wattmeter

MFJ-815 **$69⁹⁵**

MFJ Cross-Needle SWR/Wattmeter shows you SWR, forward and reflected power in 3 ranges (20/200/2000 watts forward/5/50/500 reflected). Push button range selection. 1.8-30 MHz.

Mechanical zero adjust for movement. SO-239 connectors. Light requires 12 VDC or 110 VAC with MFJ-1312, $9.95.

Deluxe Code Practice New Oscillator

MFJ-557 **$24⁹⁵**

MFJ-557 Deluxe Code Practice Oscillator has a Morse key and oscillator unit mounted together on a heavy steel base so it stays put on your table. Also portable because it runs on a 9 volt battery (not included) or an AC adapter ($9.95) that plugs into the side.

Earphone jack for private practice. Tone and volume controls for a wide range of sound. Speaker. The key has adjustable contacts and can be hooked to your transmitter. Sturdy. 8½x2¼x3¾ in. One year **unconditional** guarantee.

MFJ AC Voltage Monitor

$19⁹⁵ MFJ-850 New

Prevent damage to rig, computer or other gear. Monitor AC line voltage for potentially damaging surge/brown out conditions on 2-color expanded 95-135 volt scale.

Plugs into any AC outlet. 2% accuracy. 2¼x2¼x1½ inches.

• One year **unconditional** guarantee • 30 day **money back** guarantee (less s/h) on orders from MFJ • Add $5.00 each s/h • **Free** catalog

MFJ

MFJ ... making quality affordable

MFJ ENTERPRISES, INC.
P.O. Box 494, Mississippi State, MS 39762
(601) 323-5869; TELEX: 534590 MFJSTKV
Nearest Dealer or Orders only: 800-647-1800

✓ 115

IMPROVED HIGH-PERFORMANCE YAGIS FOR 432 MHZ

Obtaining the most from a design

By Steve Powlishen, K1FO, 816 Summer Hill Road, Madison, Connecticut 06443

In the July 1987 issue of *Ham Radio* Magazine,[1] I described a high-performance 432-MHz Yagi design which I built from a Cushcraft 424B. This design improved the radiation pattern and wet weather performance of the original and offered a substantial increase in forward gain.

I gave two versions of the design. The first used 24 elements on a 17′ boom. K2OS, WA3FFC, and W7HAH now use this Yagi on EME. All of them have reported on-air EME performance improvements. A number of tropo operators have also been pleased with the results of my modification. But tropo performance is much harder to quantify and prove than EME performance. The Yagi works so well that several operators have chosen to build it from scratch. As it stands, the 24-element Mark 3 Yagi is still the final version for this boom length. I examined the possibilities of further optimization and found that I wouldn't achieve more than an additional 0.1 dB in theoretical gain. Unfortunately, I could obtain this gain increase only at the expense of pattern deterioration and increased resistive losses.

The second version of my design used a 24′ extended boom and had 32 elements. (See **Table 1** for element length and spacing dimensions.) This extended version has also been used successfully on EME, both in NC1I's 16-Yagi array and my 4-Yagi portable EME array. NC1I used the 4-Yagi array in his Rhode Island and Vermont EME DXpeditions. WA9FWD has used a similar 4 × 32 element Yagi array on EME. (He's now replaced it with an even longer 36-element model.) In the July 1987 *Ham Radio* article,[1] I mentioned that while the 24-element design was a third-generation effort, the 32-element model I described was a second-generation effort which still had room for improvement. I also gave alternative, but untested, director lengths for a potentially improved 32-element Yagi and an even longer 38-element model (both third-generation designs).

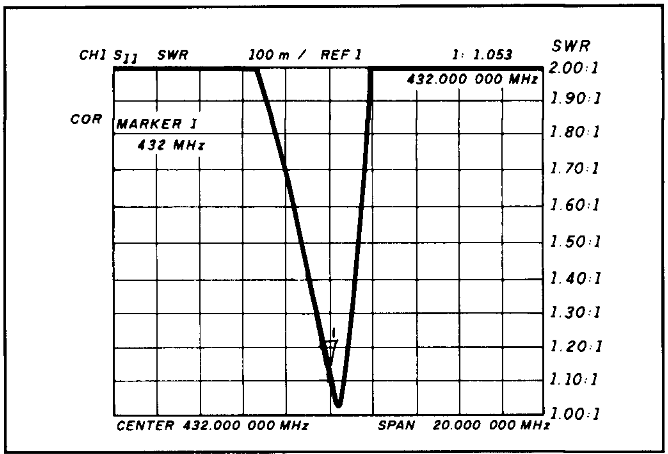
The revised design

Here are the final improved and tested dimensions for the 32-element Yagi. It's called the 32-element Mark 4 Yagi and is the fourth major revision of this design. The improvements to this 32-element Mark 4 Yagi over the earlier published version are:

- Improved radiation pattern, primarily in the rear lobes.
- Greatly improved VSWR bandwidth and wet weather performance.
- Reduced element resistive losses.
- Higher forward gain (~0.2 dB).
- Higher center frequency tuning for improved array performance.

I've also detailed a fully tested 27′6″ long model.

FIGURE 1



Resonant frequency and VSWR bandwidth of the original 32-element Mark 2 Yagi.

Why improve it?

I got the impetus for these changes while helping to assemble NC1I's 16-Yagi EME array. I had determined the driven element T match dimensions by testing a Yagi mounted on a pole in my back yard. When we started checking the driven element matches of the individual Yagis, mounted in place with the other Yagis in the 16-Yagi array, the dimensions for an acceptable VSWR didn't agree with my earlier work. A similar but lesser match problem arose in the 4-Yagi portable EME array. And, although wet weather performance of NC1I's 16-Yagi array was greatly improved over the unmodified Yagis, the wet weather VSWR performance wasn't as good as we'd hoped.

I examined a sample 32-element Yagi on a Hewlett-Packard 8753A network analyzer; it revealed a very narrow match bandwidth. As you can see in **Figure 1** (a printout of the network analyzer measurement), the under 1.2:1 VSWR bandwidth is approximately 1 MHz. The driven element is under 2:1 VSWR over a 5-MHz span. This was substantially narrower than that displayed by the 24-element Mark 3 Yagi. My attempts to improve the match bandwidth on the 32-element Mark 2 Yagi by driven element adjustments alone were unsuccessful. With the help of the network analyzer I found a "natural" match frequency with acceptable bandwidth centered at 423 MHz. Previous work on the 32-element Yagi had shown that shortening all of the elements to raise the center frequency 9 MHz would lower the gain by several tenths of a dB.

I continued my computer analysis. As described in the *Ham Radio* article, the orginal computer analysis for the version 2 Yagi was done using a variation of the WB3BGU program. Because of the limited accuracy of this program, I had to make element adjustments to control the radiation pattern. Investigations done with MININEC showed excessive currents in the first few directors. These directors were also quite long when compared with some other designs. In fact, the director string could be divided into three parts: the first few directors which were tuned too low in frequency; the middle set of directors which were tuned too high in frequency; and the last directors which were tuned close to the correct frequency, but slightly low. Further analysis and work on other long Yagi designs[2] showed that a smooth minor lobe pattern coincided with a good current distribution. I used this information in the 24-element Mark 3 Yagi design.

TABLE 1

Dimensions K1FO 24', 32-element Mark 4 Yagi.

Element Spacing (inches)	Element Length (mm)	Boom	Element
1.000	348		REF
5.250	336		DE
7.875	323		D1
11.563	314		D2
16.813	309	1"	D3
23.563	305		D4
31.875	301		D5
42.125	297		D6
52.375	294		D7
62.625	292		D8
72.875	290		D9
83.125	288		D10
93.375	286	1 1/8"	D11
103.625	285		D12
113.875	284		D13
124.125	283		D14
134.375	283	1 1/4"	D15
144.625	282		D16
154.875	280		D17
165.125	279		D18
175.375	278	1 1/8"	D19
185.625	277		D20
195.875	276		D21
206.125	276		D22
216.375	275		D23
226.625	274		D24
236.875	273		D25
247.125	273	1"	D26
257.375	272		D27
267.625	272		D28
277.875	271		D29
288.125	271		D30

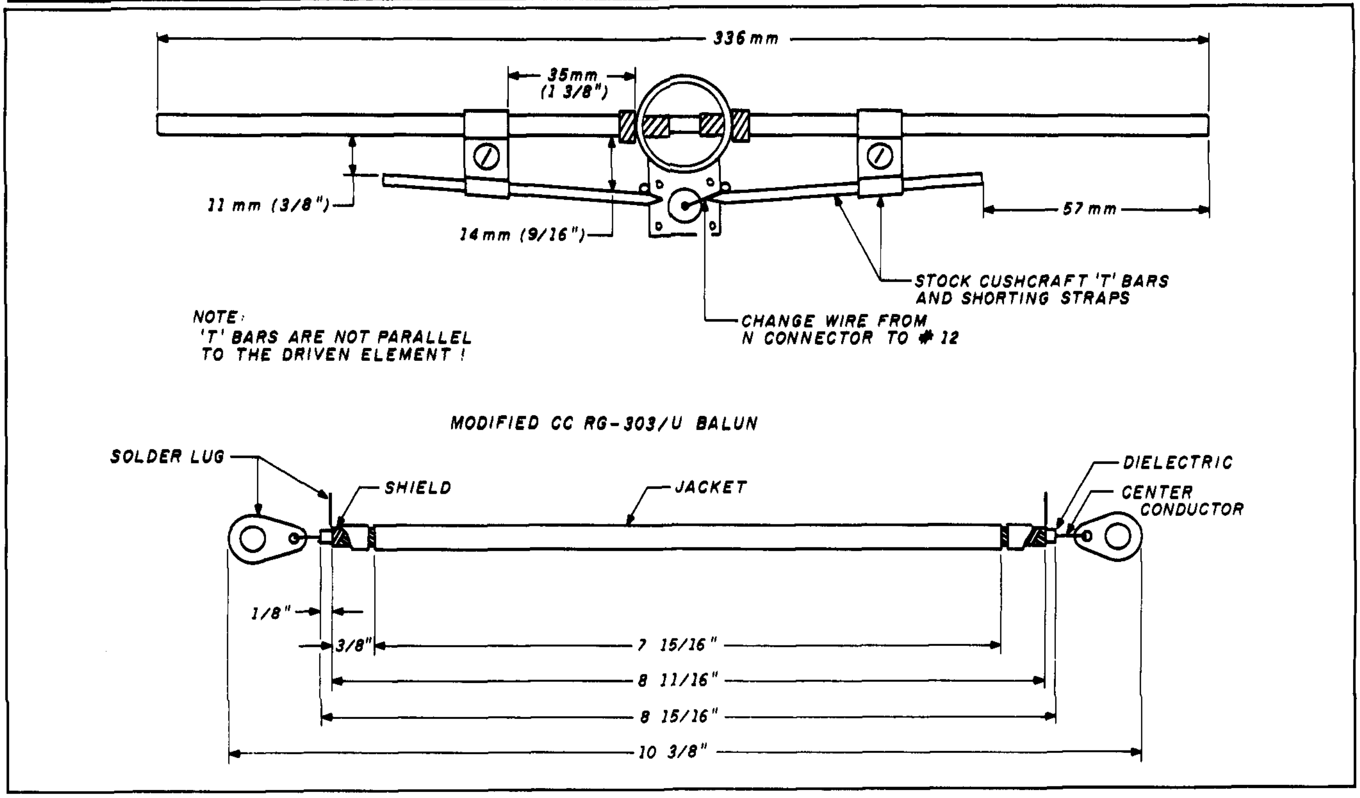
Design details

Up to this point, I'd been doing all my work on the Yagis in English dimensions. I needed an easier measurement method because I was spending considerable time building test Yagis. Metric dimensions for the element lengths were the answer. Not only is the millimeter an easier unit for working with 432-MHz Yagis, but the size of a millimeter (.039") allows for a smoother element taper — without the confusing fractional units.

All element spacings are the same as they were in the earlier versions; they are given in inches. I spent a fair amount of time looking at other spacing arrangements. It was possible to obtain slight performance improvements, but only with extensive spacing changes. These changes would make additional modification and upgrading difficult, defeating my purpose.

To make this improved design, I first converted the English lengths used in the 24-element Mark 3 Yagi to metric dimensions. Next I rounded these millimeter-sized directors to whole millimeters. Then I smoothed out the large changes in director lengths. The computer analysis on MININEC looked promising, but there was a substantial frequency

FIGURE 2



Construction detail of the 32-element Mark 4 driven element using 424B parts.

shift as a result of these manual length changes. I shortened the lengths to center the Yagi at the desired frequency.

Now I had to perform the final length optimization using MININEC. This was a painfully slow process because of the computation time required by the computer available to me at that time. A quick look at the Yagi modeling with four segments required over 2 hours; a more accurate examination using eight segments took almost 8 hours. Consequently, I was able to make only a few element adjustments each day. I'd make an overnight high-accuracy run to ensure that I was still on the right track. Fortunately, the machine I use now solves the problem over six times faster.

When I started this project 4 years ago, I was using a simple program. The original design objective was to increase the Yagi's gain while creating a clean radiation pattern. My current design process adds to the original goals with the following requirements:

- Very high forward gain per boom length.
- Very clean radiation pattern.
- Wide gain bandwidth.
- Acceptable dry and wet weather performance.
- Good driven element match bandwidth.
- Reasonably high natural driven element impedance.
- Good director current distribution.
- Low resistive losses.

Knowledgeable use of the original program can get you 80 percent of the way to a good Yagi design. But the new requirements have rendered my first program obsolete, as it is unable to get all the way to an optimum solution. More complex programs, along with the all-important post-computer optimization steps, now take you 95 percent of the way to the perfect Yagi.

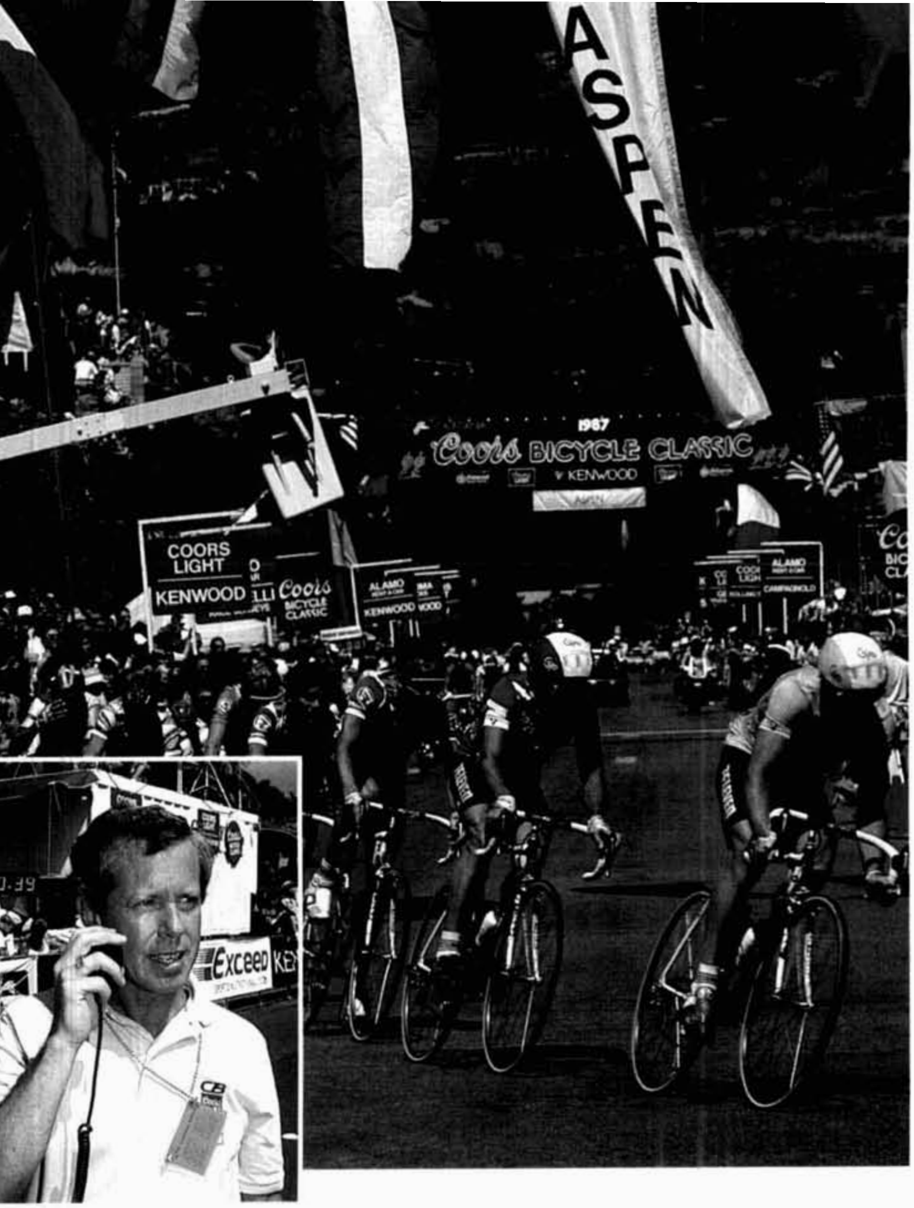
After finalizing the computer-generated dimensions, I began to build and test the project. As I had already built and tested a number of Yagis, I needed to make adjustments only to the driven element and director 1.

Construction

The Yagi's mechanical layout is the same as originally described in the July 1987 *Ham Radio* article. Elements are mounted on plastic bushings which insulate them from the boom sections they extend through. The element ends are chamfered like those of the earlier Yagis. Supports keep the boom from sagging unacceptably. I suggest you review my earlier article before attempting to build these Yagis.

I compared driven element T matches constructed from the original Cushcraft parts used on the 24-element Yagi, with T matches using no. 12 T wires and a UT-141 balun like those of the 32-element Mark 2 Yagi. I obtained similar dry weather matches and match bandwidths with both driven element arrangements. Wet weather performance was slightly better with the no. 12 T wires. A slight adjustment to the balun length made it correspond to an electrical half wavelength. This improved the Yagi's pattern balance.

Figure 2 details the driven element construction using the original Cushcraft parts. Note that the balun must be shortened by 1 inch. As with the 24-element Yagi, I didn't use the original rectangular black spacers and I changed the jumper from the N connector to the T match bar to no. 12 to get a proper match. For the best match don't place the T bars parallel to the driven element.



"You're miles ahead with Larsen."

Rick Woodsome, Communications Consultant
Woodsome and Associates, Boulder, Colorado

When the directors of the Coors International Bicycle Classic needed a sophisticated mobile communications system, they turned to communications consultant Rick Woodsome. As a communications specialist, Woodsome knows what it takes to make a communication system work.

That's why he turned to Larsen Antennas.

"You don't pull off the largest sports event in the Western Hemisphere without good communication. And you don't have good communication without the right equipment.

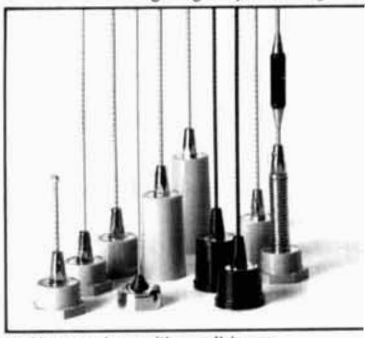
"Larsen antennas were instrumental in making last summer's Coors Classic an overwhelming success. They were key to our entire communication network.

"Without Larsen, it would have been uphill all the way."

Rick Woodsome

THE AMATEUR'S PROFESSIONAL.

Larsen Külrod® and Külduckie® antennas provide amateurs the same advantages enjoyed by commercial two way radio users. Both combine top performance with the long range dependability you want.



See your dealer for the complete line of Larsen antennas and permanent and temporary mounts. You can buy with confidence, because they're all backed by Larsen's No Nonsense Warranty for a full six months.

For a professional approach to amateur radio, tune in to Larsen.

Larsen Antennas

The Amateur's Professional™

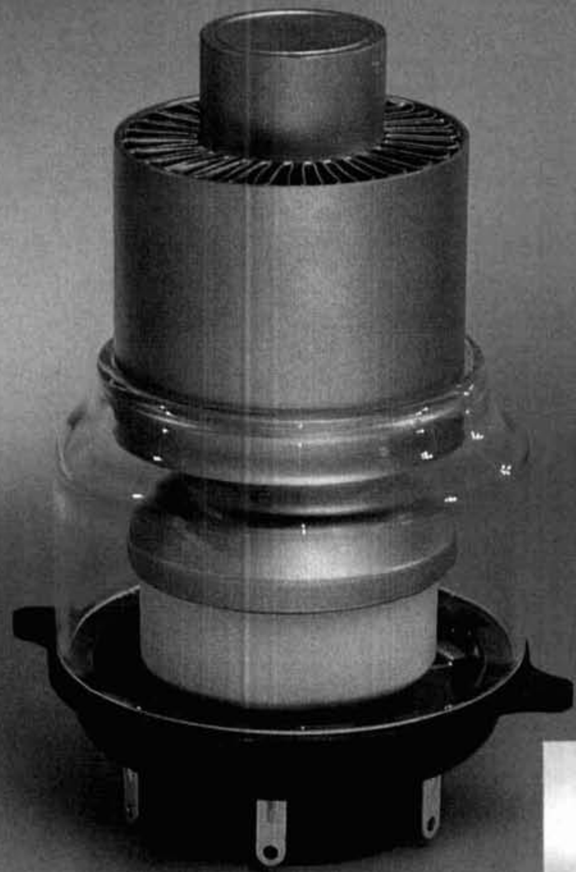
See your favorite amateur dealer or write for a free amateur catalog.

IN USA: Larsen Electronics, Inc., 11611 N.E. 50th Avenue, P.O. Box 1799, Vancouver, Washington 98668 (206) 573-2722.

IN CANADA: Canadian Larsen Electronics, Ltd., 149 West 6th Avenue, Vancouver, B.C. V5Y 1K3 (604) 872-8517.

✓ 117

✓ 118



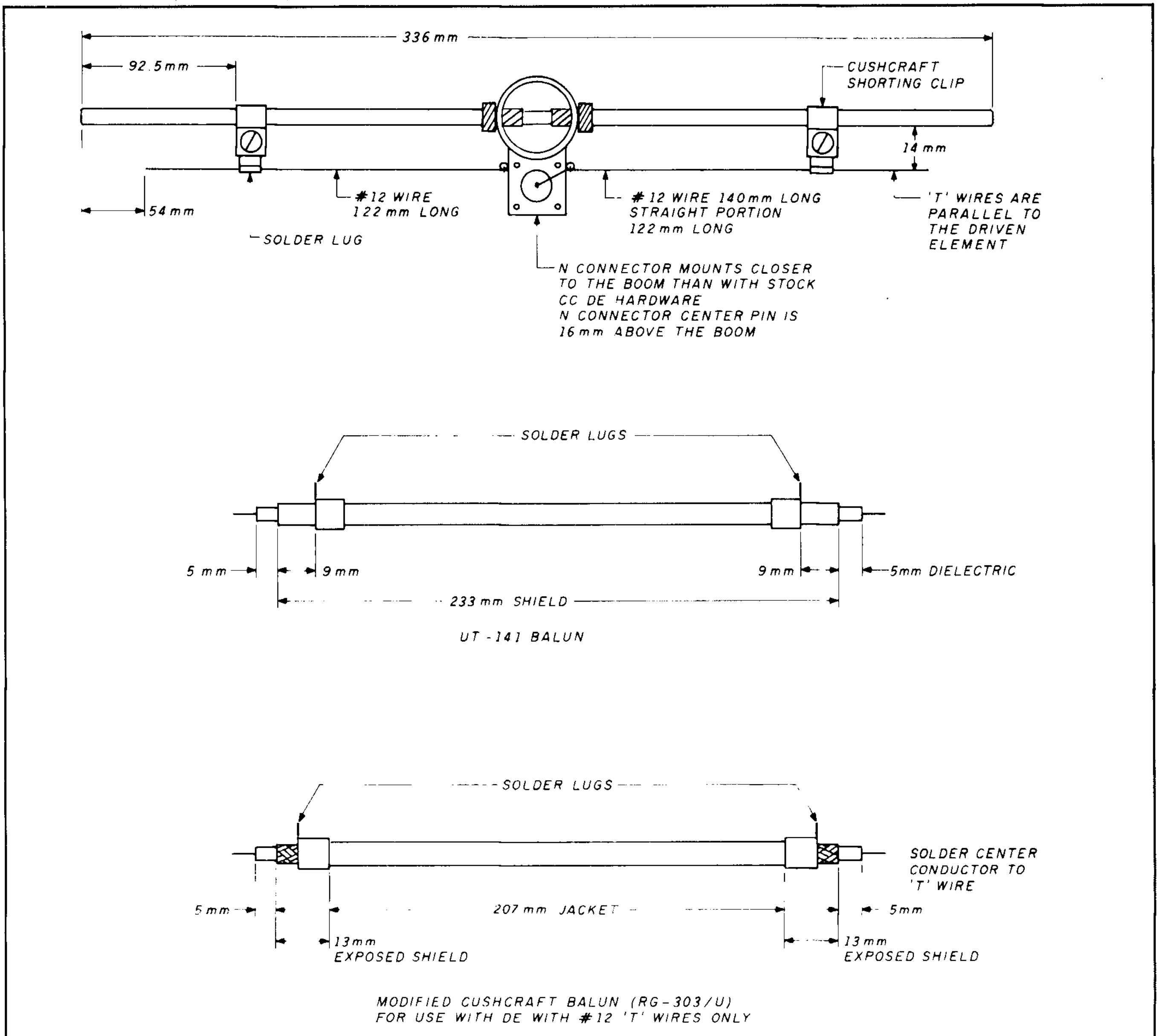
The second version of the driven element is shown in **Figure 3**. It uses no. 12 T wires in place of the original 3/16" diameter T bars. This allows for a greater natural impedance setup. I prefer this arrangement because the shorting straps are farther out on the driven element, away from the high-current point. I tried baluns made from UT-141 solid copper shield coax and RG-303 (like the original 424B) with similar results. If you make the balun from RG-303 you'll need to use a set of dimensions different from those used with the first driven element arrangement. I thought it was desirable to eliminate the original solder lugs and solder the center conductor directly to the T match wires instead.

Performance

The computed E and H plane patterns for the 32-element Mark 4 Yagi in **Figure 4** show a very smooth lobe structure. The first sidelobes are 1 dB stronger than those in the original version. This seemed an acceptable tradeoff for a smoother overall lobe structure and significantly lower rear and mid-H plane lobes, in combination with higher overall gain. Calculated gain on MININEC is 17.9 dBd (20.1 dBi). Because of program inaccuracies and resistive losses, the real gain of the Yagi is closer to 17.8 dBd (19.9 dBi) — still an excellent figure for the boom length. DJ9BV examined the Yagi design using the more sophisticated NEC program. His results gave an excellent pattern correlation. The NEC-calculated gain figure of 17.8 dBd (19.9 dBi) also agrees closely with antenna measurements.

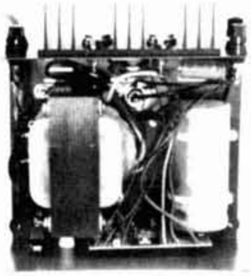
On the antenna range, the new model consistently measures about 0.2 dB higher than the earlier 24' long version. It also measures about 0.4 dB higher than my "high-gain" reference Yagi, the KLM 432-30 LBX. This places the real-

FIGURE 3



Construction detail of the 32-element Mark 4 driven element using no. 12 T wires. Further details for modifying the Cushcraft Balun for use with the no. 12 T wire match.

ASTRON CORPORATION
9 Autry
Irvine, CA 92718
(714) 458-7277


INSIDE VIEW — RS-12A

ASTRON POWER SUPPLIES

• HEAVY DUTY • HIGH QUALITY • RUGGED • RELIABLE •

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-3A, RS-4A, RS-5A.**
- 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

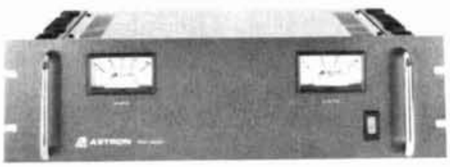
- INPUT VOLTAGE: 105-125 VAC
- OUTPUT VOLTAGE: 13.8 VDC ± 0.05 volts (Internally Adjustable: 11-15 VDC)
- RIPPLE Less than 5mv peak to peak (full load & low line)
- **Also available with 220 VAC input voltage**


MODEL RS-50A


MODEL RS-50M


MODEL VS-50M

RM SERIES


MODEL RM-35M

19" × 5¼ RACK MOUNT POWER SUPPLIES

MODEL	Continuous Duty (Amps)	ICS* (Amps)	Size (IN) H × W × D	Shipping Wt. (lbs.)
RM-12A	9	12	5¼ × 19 × 8¼	16
RM-35A	25	35	5¼ × 19 × 12½	38
RM-50A	37	50	5¼ × 19 × 12½	50
• Separate Volt and Amp Meters				
RM-12M	9	12	5¼ × 19 × 8¼	16
RM-35M	25	35	5¼ × 19 × 12½	38
RM-50M	37	50	5¼ × 19 × 12½	50

RS-A SERIES


MODEL RS-7A

MODEL	Continuous Duty (Amps)	ICS* (Amps)	Size (IN) H × W × D	Shipping Wt. (lbs.)
RS-3A	2.5	3	3 × 4¾ × 5¾	4
RS-4A	3	4	3¾ × 6½ × 9	5
RS-5A	4	5	3½ × 6⅛ × 7¼	7
RS-7A	5	7	3¾ × 6½ × 9	9
RS-7B	5	7	4 × 7½ × 10¾	10
RS-10A	7.5	10	4 × 7½ × 10¾	11
RS-12A	9	12	4½ × 8 × 9	13
RS-12B	9	12	4 × 7½ × 10¾	13
RS-20A	16	20	5 × 9 × 10½	18
RS-35A	25	35	5 × 11 × 11	27
RS-50A	37	50	6 × 13¾ × 11	46

RS-M SERIES


MODEL RS-35M

MODEL	Continuous Duty (Amps)	ICS* (Amps)	Size (IN) H × W × D	Shipping Wt. (lbs.)
• Switchable volt and Amp meter				
RS-12M	9	12	4½ × 8 × 9	13
• Separate volt and Amp meters				
RS-20M	16	20	5 × 9 × 10½	18
RS-35M	25	35	5 × 11 × 11	27
RS-50M	37	50	6 × 13¾ × 11	46

VS-M AND VRM-M SERIES


MODEL VS-35M

- Separate 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 × W × D	Shipping Wt. (lbs.)
VS-12M	9	5	2	12	4½ × 8 × 9	13
VS-20M	16	9	4	20	5 × 9 × 10½	20
VS-35M	25	15	7	35	5 × 11 × 11	29
VS-50M	37	22	10	50	6 × 13¾ × 11	46
• Variable rack mount power supplies						
VRM-35M	25	15	7	35	5¼ × 19 × 12½	38
VRM-50M	37	22	10	50	5¼ × 19 × 12½	50

RS-S SERIES


MODEL RS-12S

- Built in speaker

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

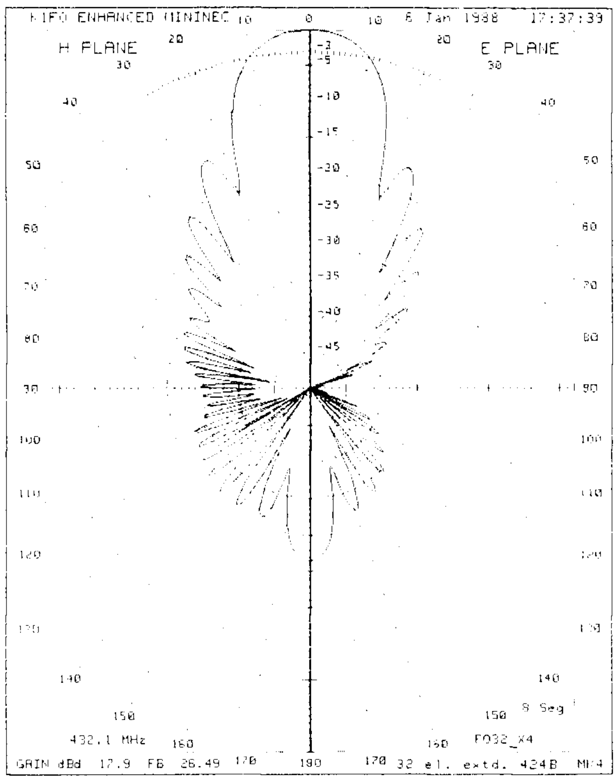
*ICS—Intermittent Communication Service (50% Duty Cycle 5min. on 5 min. off) world gain of the new 32-element Mark 4 Yagi at about 17.8 dBd (19.9 dBi). Earlier measurements with the Mark 2 Yagi were slightly optimistic; the real-world gain for this version was about 17.5 dBd. (This has also been confirmed by NEC analysis.)

Array temperature is an important parameter on EME and for high-performance tropo stations. Array noise is the combination of noise received by the array (manmade or natural) and the noise generated from resistive losses in the material used to make it. DJ9BV calculated that an array of four of the 32-element Mark 4 Yagis pointed at cold sky has a noise temperature of 25K. This figure is 5K lower than the original Yagi design — a significant number on EME. Array noise measurements, using earth to cold sky and stellar sources to cold sky, place the array temperature somewhat higher than the calculations. Measured array temperatures for four Yagis arranged 2 × 2 are about 30K for the new Mark 4 Yagi, and about 37K for the old version.

To calculate the overall system temperature, you have to add the phasing line, relay, and balun losses, and the receive system noise temperature to the array noise. For a high-performance EME system with very low loss phasing lines (like the Andrew Heliax™ and a 25K preamplifier), this reduced array temperature would provide an additional 0.5-dB signal-to-noise improvement on receive over the original 32-element Yagis. Including the additional gain of the improved design, you can expect to hear your own moon echoes almost 1 dB stronger — a significant improvement for no array size increase.

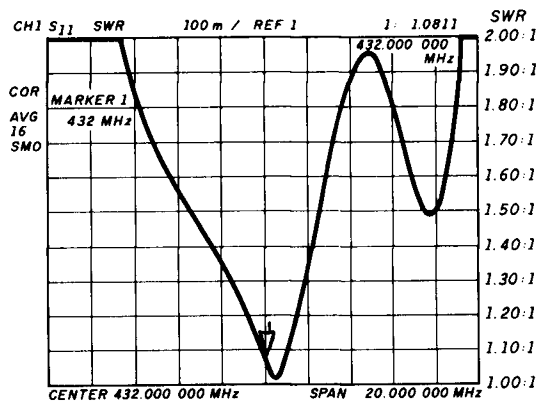
Figure 5 is a network analyzer plot of the driven element match. When you compare this with **Figure 1** (the same plot for the original 32-element Yagi) you can see that the

FIGURE 4



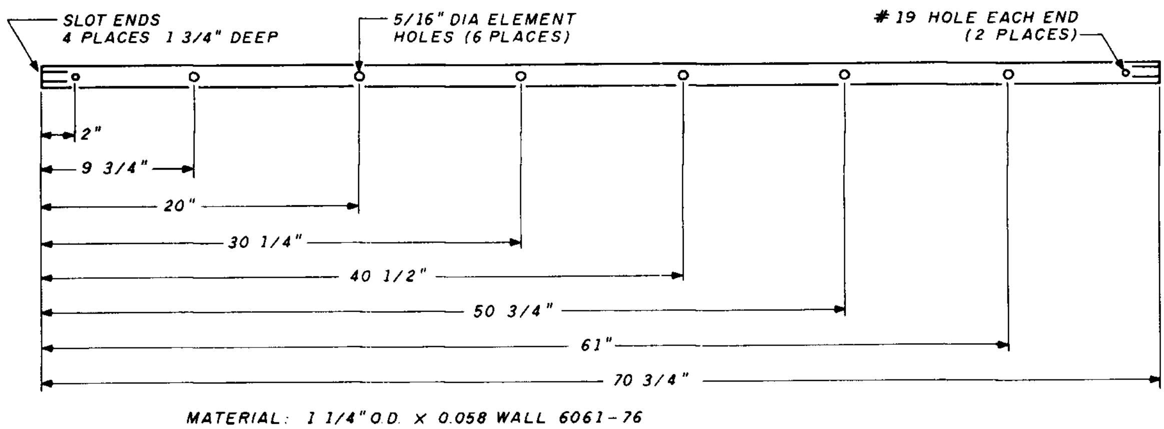
Calculated E and H plane patterns for the K1FO 32-element Mark 4 Yagi.

FIGURE 5



Resonant frequency and VSWR bandwidth of the improved 32-element Mark 4 Yagi.

FIGURE 6



Element mounting dimensions for the center section of the boom for the 36-element extended modified 424B Mark 4 Yagi.

match bandwidth is much broader. On the 32-element Mark 4 Yagi, the SWR is now less than 1.2:1 for almost 2.5 MHz. This is 2-1/2 times wider than the original. The SWR is less than 2:1 over 16 MHz, or more than 3 times greater than the earlier version.

With the revised dimensions, the 32-element Yagi behaves well when wet. The VSWR curve shifts down in frequency approximately 2 MHz under simulated heavy rain conditions. This raises the SWR to a still acceptable 1.35:1 when the antenna is very wet. This is a significant improvement over the 32-element Mark 2 Yagi, which would show about a 2.2:1 VSWR in heavy rain.

Proper stacking distances for the 32-element Mark 4 Yagi are 82 inches in the E plane and 78 inches in the H. At these distances, the stacking gain (before phasing line losses and mechanical errors are factored in) is over 2.9 dB in each plane. A 4-Yagi EME array using low-loss phasing lines would have 23.3 dBd (25.5 dBi) array gain. This is more than adequate to work a number of different 432-MHz EME stations. An 8-bay 32-element Yagi array has enough gain to give you a standout EME signal.

A longer 36-element version

NC1I did his portable EME operations in the summer, usually the worst time of year for EME. Although the original 4 × 32 element Yagi array performed well, I wanted a little extra performance without having to add more Yagis. I chose the 27-1/2′ length because it was the minimum size increase which would make a significant performance improvement. (See **Table 2** for element length and spacing details.)

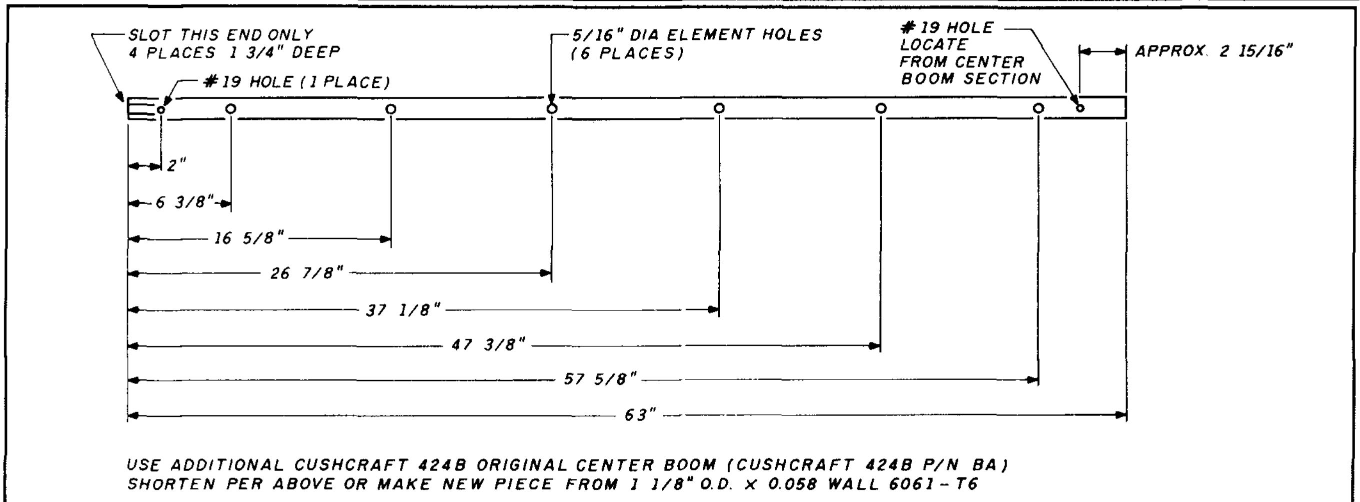
Electrically, the design is virtually identical to the 32-element Mark 4 Yagi. Mechanically, the changes are a little more detailed. I built a 6′ long 1-1/4″ diameter center boom section from scratch for the long Yagi. I reinforced this new center section with a 1-3/8″ outer diameter, 0.058″ wall thickness, 24″ long piece of 6061-T6 aluminum tubing. The 1-3/8″ diameter tube is centered at the mast mounting point. This arrangement gives you a very rugged (though slightly heavy) boom section.

TABLE 2

Dimensions K1FO 36-element Yagi 27′4-1/8″ boom.

Element Spacing (inches)	Element Length (mm)	Boom Diameter	Element
1.000	347		REF
5.250	327		DE
7.875	322		D1
11.563	313		D2
16.813	308		D3
23.563	304	1″	D4
31.875	300		D5
42.125	296		D6
52.375	293		D7
62.625	291		D8
72.875	289		D9
83.125	287		D10
93.375	285		D11
103.625	284	1 1/8″	D12
113.875	283		D13
124.125	282		D14
134.375	282	1 1/4″	D15
144.625	282	1 3/8″	D16
154.875	281		D17
165.125	279		D18
175.375	278	1 1/4″	D19
185.625	277		D20
195.875	275		D21
206.125	275		D22
216.375	274		D23
226.625	274	1 1/8″	D24
236.875	273		D25
247.125	273		D26
257.375	272		D27
267.625	271		D28
277.875	270		D29
288.125	270		D30
298.375	269	1″	D31
308.625	269		D32
318.875	268		D33
329.125	268		D34

FIGURE 7



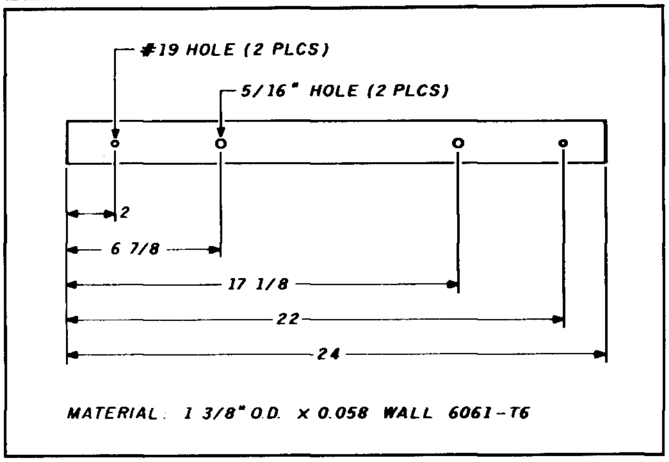
Detail for the new no. 2 rear boom section for the 36-element extended Mark 4 Yagi.

Though the doubled-up center piece may seem like overkill, it's very easy to bow a 0.058″ wall tube when you tighten the mast bracket U bolts. A few degrees of bend in the boom may not be noticeable on a short Yagi, but when you translate this bend to a 27-1/2′ long boom it becomes a significant curvature.

The new center boom section is detailed in **Figure 6**. **Figure 7** describes boom section no. 2 (between the rear and the middle section). You can make this second boom section from a spare 424B original center section, or from scratch. Just follow the drawing and use 1-1/8″ diameter × 0.058″ wall aluminum tube. The center boom reinforcing piece is shown in **Figure 8**.

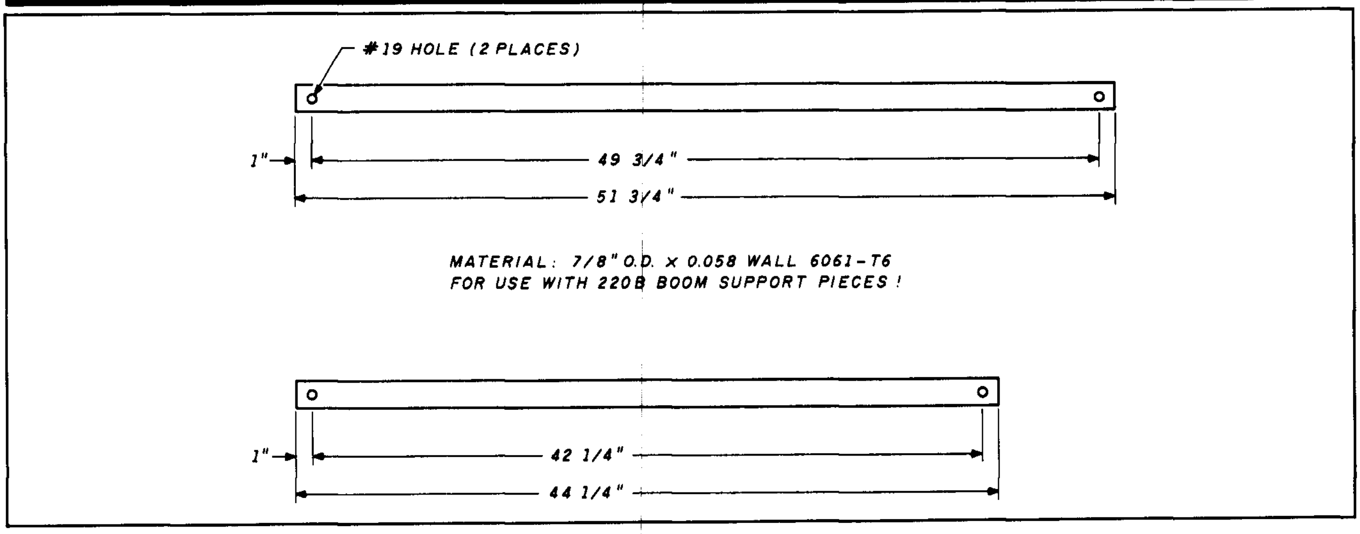
I made new pieces for the boom supports so I could extend them. I positioned the mast mounting point for the boom supports 30″ from the boom. This creates a large enough angle and prevents overstressing the supports. Like the earlier Yagis, I used old-style Cushcraft 220B bent support pieces with longer homemade center sections. **Figure 9** shows these new boom support splice pieces. Cushcraft has since changed the design of their boom supports. If you don't want to make your own supports from scratch, Cushcraft 4218-XL boom supports will do the job.

FIGURE 8



Detail for reinforcing the center boom section of the 36-element extended Mark 4 Yagi.

FIGURE 9



Detail for the boom support pieces on the 36-element extended Mark 4 Yagi.

Electrical changes

You'll notice that the element lengths start out 1 mm shorter than on the 32-element Mark 4 Yagi. I changed the length to keep the gain center frequency in the right place. Remember that the Yagi's center frequency oscillates up and down as you add directors. Tapered designs like this one minimize the effect, but the trait still exists.

The driven element was easy to set up for both a good SWR at 432 MHz and a minimum centered above 432 MHz. This is the best way to ensure good wet weather performance. The match bandwidth on the 36-element model is actually better than on the 32. The driven element match on the 36-element Yagi also was relatively insensitive to the balun length — another good sign. The driven element for the 36-element Yagi is outlined in **Figure 10**.

Stacking the 36-element Yagi

At a 12-wavelength boom length a good Yagi will have a nearly symmetrical pattern. You can see from the calculated pattern in **Figure 11** how the H plane is starting to show nulls at 90 degrees in the pattern, similar to the E plane. The −3 dB beamwidth is still slightly wider in the H plane, even at this long boom length. This indicates that optimum spacings will be close but not quite equal in both planes.

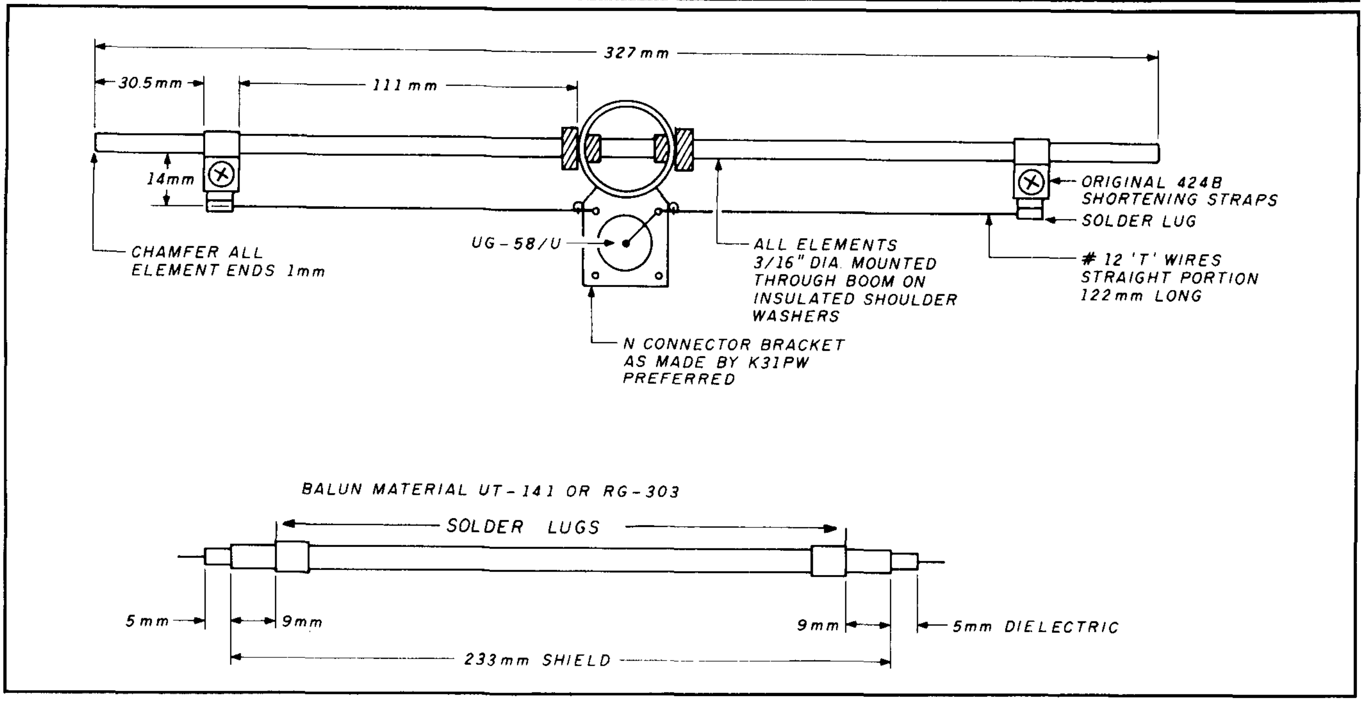
The optimum spacings for the 36-element Yagi are 87″ in the E plane and 85″ in the H plane. At these spacings the theoretical stacking gain in each plane is 2.9 dB.

Performance of the 36-element Yagi

The calculated pattern for the 36-element Yagi (**Figure 11**) is quite similar to the 32-element Mark 4 Yagi. The sidelobe structure is almost identical. The main lobe E and H plane beamwidths are about 1 degree narrower than the 32-element Yagi at 18 × 18.5 degrees.

Measured gain of the 36-element Yagi is approximately

FIGURE 10



Detail of the driven element of the 36-element Yagi using the no. 12 T wire match. Total boom length is 27′ 4-1/8″.

0.6 dB higher than the 32-element Mark 4 Yagi at 18.3 dBd or 20.5 dBi. Array temperature is even better than the shorter Yagis at a calculated 24K. Measurements indicate an array temperature under 30K.

Of course, on-the-air performance is what counts. WA9FWD reported a significant improvement when he upgraded from four of the 32-element Mark 2 Yagis to four of the 36-element model.

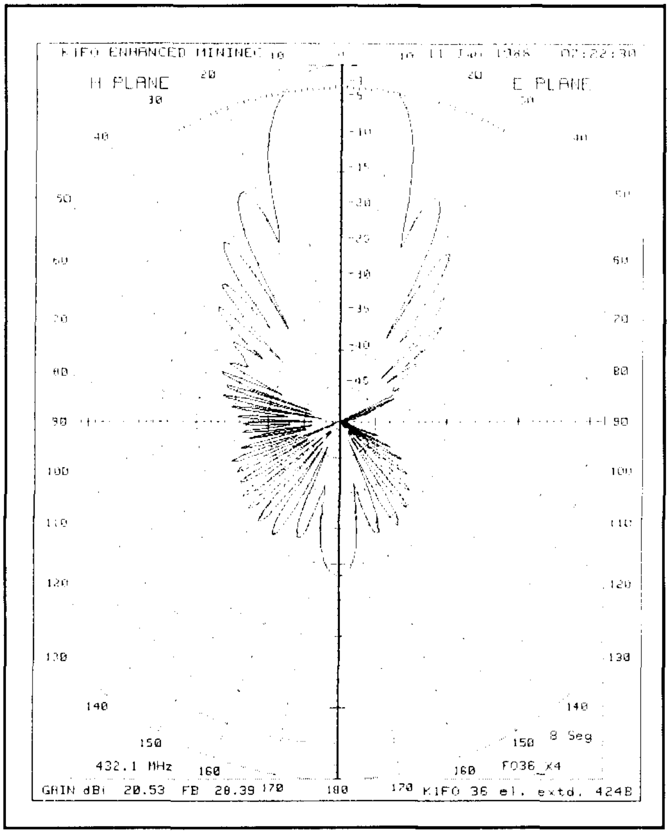
NC1I and I recently rebuilt our portable EME array to use four of the new 36-element models. The old array was 4 × 32 element Mark 2 Yagi. The new array seems to follow the predicted improvements. Measured sun noise is up 1.5 dB from the best we measured with the old array. The new array uses the same phasing lines, power divider, and preamp as the old one. The sun noise improvement is in the expected range. Gain of the 36-element Yagi is 0.8 dB higher than the 32-element Mark 2. Signal-to-noise improvement due to noise pickup and resistive losses is calculated to be over 0.5 dB. The sum, 1.3 dB, is close to the measured 1.5-dB improvement.

We first tested the new array at W1NY during the January VHF contest. We made a total of 15 EME QSOs in only 5 hours of EME operation, all with a bad antenna relay! After the contest we fixed the relay and activated the array the following weekend. We had 16 hours of EME operation spaced over the two weekends. We made 34 EME QSOs with 26 different stations, all on random. Echoes were noticeably better with the new array.

Conclusion

A top performing 432-MHz Yagi must have a proper balance of several desirable characteristics:

FIGURE 11



Calculated E and H plane patterns for the K1FO 36-element Mark 4 Yagi.

Ultracompact and includes everything you need for underdash installation

- High forward gain for the boom length.
- Excellent sidelobe structure.
- Good gain bandwidth.
- Good driven element SWR bandwidth.
- Low resistive losses.

Once you've defined these electrical traits, you must contruct your Yagi so that it will not only work in the real world, but stay up and retain that performance for many years. The K1FO 32 and 36-element Yagis have an excellent balance of these design goals, especially when you consider that they can be made easily from an existing commercial Yagi and its spare parts.

The 4-element (41″ long) Yagi extension appears to be worth the effort. During initial operation with the 36-element Yagi arrays, it seemed we finally had an array that was better than a 4-Yagi array was supposed to be. As any given Yagi design is extended, its driven element impedance and rear lobe structure oscillate up and down. At a length of 27-1/2′, the pattern and driven element are in optimal combination. If you plan to build a long 432-MHz Yagi from scratch, I suggest that you take a serious look at the 36-element model.

The results of the computer analysis suggest that the design could be extended still further with good results. But keep in mind that the boom would have to be extended by more than the same percent of boom change when going from 32 to 36 elements for another 0.5-dB gain. You'd need to add at least five more elements, possibly six, to see an equivalent improvement. This would make the boom almost 32 feet long. Since the 36-element Yagi weighs over 12 pounds and has a wind area of over 3 square feet, an even longer Yagi may quickly become unmanageable. A very long object also develops quite a momentum when it's moved. This added inertia requires a large increase in the mechanical strength of the array's stacking frame.

Acknowledgment

I'd like to thank Rainer Bertelsmeier, DJ9BV, for his NEC analysis and array temperature calculations of my Yagi designs. hr

REFERENCES

1. Steve Powlishen, K1FO, "High-Performance Yagis for 432 MHz," *Ham Radio*, July 1987, page 8.
2. Steve Powlishen, K1FO, "An Optimum Design for 432-MHz Yagis, Part 1," *QST*, December 1987, page 20.

MARCH WINNERS

Congratulations to George Gorsline, VE3FIU, our March sweeps winner and Rick Littlefield, K1BQT, author of March's most popular WEEKENDER — "Solo-16 Acoustic CW Speaker." Both will receive a copy of *The Radio Handbook* by Bill Orr, W6SAI.

Our WEEKENDER sweepstakes ends with the April issue. You still have a chance to send your April evaluation cards and win. The winners of the April sweeps will be announced in the June issue of *Ham Radio*.

Thanks to all of you who sent in your cards. Your comments have been invaluable to us!

Terry Northup, KA1STC

CONVERTER TUNES 4 TO 18 MHz
WITH NO BANDSWITCH

By Jack Najork, W5FG, 723 Flamingo, Duncanville, Texas 75116

If you buy a new SSB rig today, chances are it includes a "general coverage" receiver that tunes from 100 kHz to 30 MHz. This range includes all the international short-wave bands and many other radio services — lots of interesting listening!

Those of us with older rigs don't have this feature. If we want to eavesdrop on these frequencies we can trade in our rigs, invest several hundred dollars (or more) in a general coverage receiver, or dig into the junkbox and create some form of compromise. My junkbox is much larger than my bank account (thanks to Dallas' famous monthly electronic sidewalk sale), so I chose the compromise approach and built a converter.

My converter covers 4 to 18 MHz in two bands: 4 to 11 MHz and 11 to 18 MHz. This span includes most of the popular short-wave bands as shown in **Table 1**. To use this converter your SSB receiver needs only to tune to 3.5 MHz, and be able to receive in the AM mode (since most broadcasters still use this form of modulation).

How it works

If you look at **Figure 1**, you'll see that the unit consists of RF amplifier Q1, local oscillator Q2, and mixer Q3. The two bands are covered without a bandswitch by using an IF of 3.5 MHz. By selecting the appropriate oscillator frequency range, you can tune this range above or below the desired incoming signal. A bit of math is all you need to understand this approach.

The oscillator range is 7.5 to 14.5 MHz. Incoming signals from 4 to 11 MHz are mixed with the oscillator to produce the 3.5 MHz IF. Signals from 11 to 18 MHz mixed with the oscillator will also produce an IF of 3.5 MHz. All that remains is to make sure you can separate the two incoming signals. Because at any one oscillator frequency the two incoming signals are 7 MHz apart, this isn't a great problem.

How does this converter compare with a new general coverage receiver? First of all, it doesn't have the same extensive frequency coverage. Secondly, the tuning rate is coarser (comparatively speaking). Each band covers 7 MHz, so the kilohertz zip by at an astounding rate as you tune. Tune very slowly and use your SSB receiver for fine tuning. On the plus side, the converter's sensitivity is excellent — 10 feet of antenna will tune in the world! And...you've saved lots of money. Despite its limitations, the converter fits the bill for casual short-wave listening.

Circuit details

RF amplifier input C1-L1 comprises a high-Q, lightly loaded, tuned circuit. This is essential for good band separation. A tapped toroid coil, along with light coupling to Q1 and loose antenna coupling, help keep the Q high. (If you don't have a suitable toroid, I've included specs for a solenoid-type substitute.) Space it at least 1 inch from metal surfaces on all sides to maintain high Q. C1 is a junkbox broadcast variable, with sections in parallel for a capacity range of 15 to 500 pF. This tunes the 4 to 18 MHz span without bandswitching.

Most SSB receivers have excellent sensitivity at 3.5 MHz, so the converter doesn't need high gain. Including an RF stage lets you use a small, indoor antenna (unless you live in a shielded building). This, in turn, aids front end selectivity and avoids possible overload. RFC1 in the drain of Q1 peaks up gain at the higher frequencies.

TABLE 1

International short-wave broadcast bands.

5.95 — 6.2	MHz	— 49 meters
7.10 — 7.5	MHz	— 41 meters
9.50 — 9.98	MHz	— 31 meters
11.70 — 12.08	MHz	— 25 meters
15.10 — 15.45	MHz	— 19 meters
17.70 — 17.90	MHz	— 16 meters
21.45 — 21.95	MHz	— 21 meters

Please enter my subscription

BUSINESS REPLY CARD

First Class   Permit No. 1   Greenville, NH

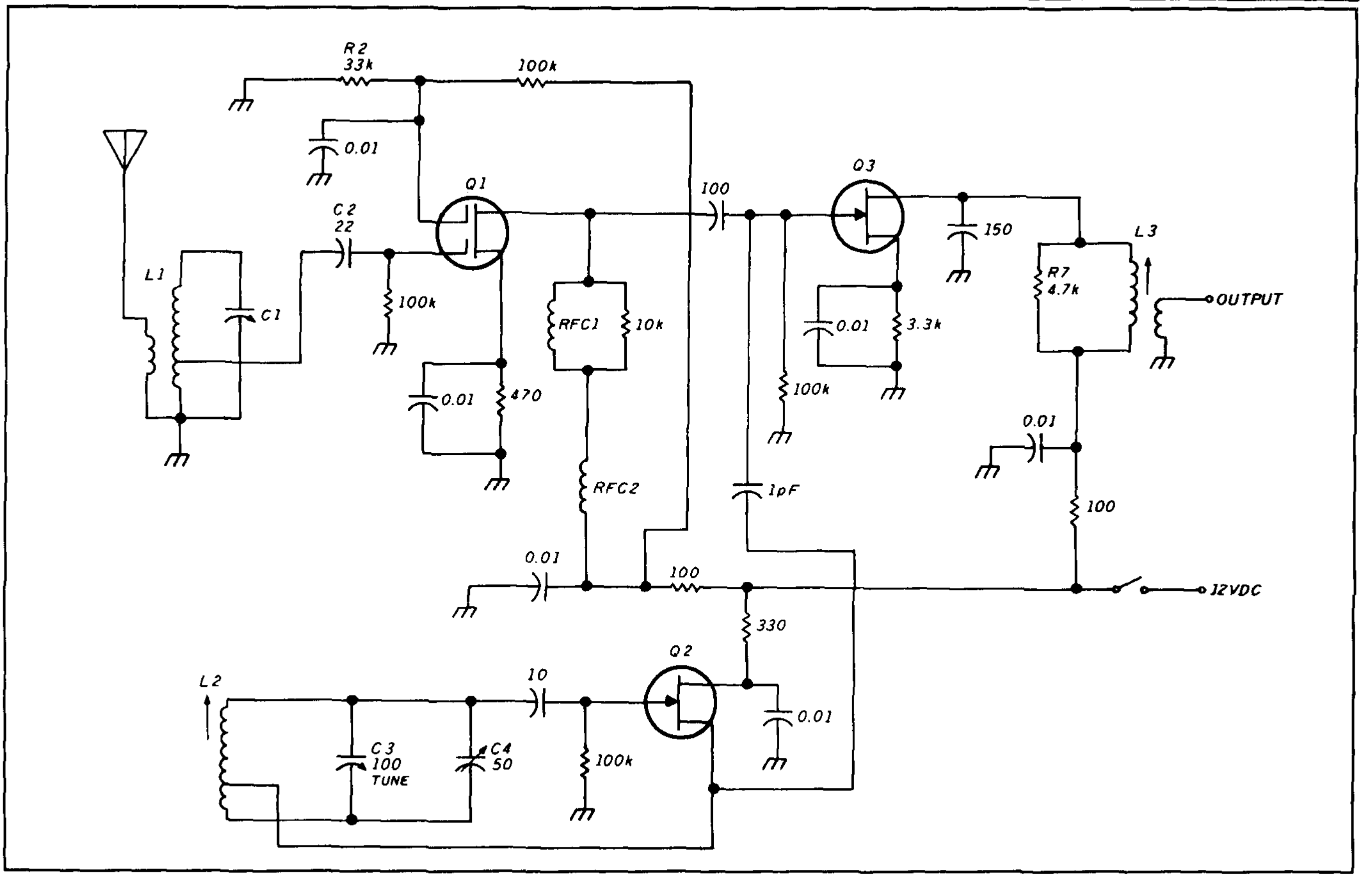
Postage Will Be Paid By Addressee

HAM RADIO

Greenville, NH 03048

NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

FIGURE 1



Schematic diagram.

Q2 is a conventional FET oscillator. C3 is another junkbox item, salvaged from an AM/FM radio. Combining the BC oscillator section (85 pF) with one FM section (20 pF) gave me the capacity spread I wanted. You can use higher capacities (like 125 or 150 pF) here, but you'll have to juggle the values of C4 and L2 to achieve the desired tuning range of 7.5 to 14.5 MHz.

Mixer Q3 is also conventional. R7, the 4.7-k resistor across the IF output coil, lowers the drain impedance to decrease possible overload. It also lowers the output circuit Q, so you can use your SSB receiver to fine tune signals 50 kHz or more on either side of 3.5 MHz.

Tune-up

Start by getting the oscillator to tune from 7.5 to 14.5 MHz. It helps to use a grid-dip meter. Next, check the C1-L1 combination for coverage with a grid dipper *before* wiring it into the circuit. If your C1 minimum capacity is too large, you won't get complete 4 to 18-MHz coverage. Some math helps here. First, determine the ratio of frequency coverage: $18 \div 4 = 4.5{:}1$. The capacity ratio needed to cover this range is equal to the frequency ratio squared. Consequently, your capacity ratio should be 4.5^2 or 20.25:1. To determine the required minimum capacity, divide the 500-pF capacitor by 20.25; you'll get 24.7 pF. Because a little overlap is good, try to reduce this minimum further — say to 15 pF. This is about the best you can do with such a large capacitor. Many BC tuning capacitors have built-in mica trimmers. Remove these, or you may never reach the minimum. Your connecting leads to C1-L1 should be short and dressed away from the chassis to prevent additional stray capacitance. (Connecting Q1 adds a few pF.) Attach C2 as close as you can to the tap on L1.

PARTS LIST

PARTS LIST

C1	***15—500 pF variable.***
C2	***22 pF.***
C3	***100 pF variable.***
C4	***50 pF variable.***
L1	***26 turns no. 24 enameled on T50-2 toroid or 10 turns no. 20 enameled spaced 3/4" on 1-1/4" form. (35-mm film container.) L = approximately 3.2 μH. Link: 2 turns. L1 center tapped.***
L2	***22 turns no. 24 enameled on 3/8" slug-tuned form, tap 6 turns from ground. L = 3μH.***
L3	***40 turns no. 32 enameled on 1/4" slug-tuned form. L = 15 μH. Link: 5 turns.***
Q1	***Dual-gate FET, 40673 or similar.***
Q2,Q3	***JFET, MPF 102 or similar.***
RFC1	***50 turns scramble wound on 1/4-watt, 10-k resistor. No. 32 enameled.***
RFC2	***1 mH RFC.***

With everything wired and the smoke test passed, you should hear a definite noise peak on your 3.5-MHz receiver when you tune the IF output coil of the converter with the power on. With a short antenna on the converter, tuning C1 *slowly* should produce two noise peaks. If you get whistles and birdies when tuning C1, the RF stage is oscillating. Make sure the C1-L1 combination and wiring are well isolated from the drain circuit of Q1. If Q1 is unusually "hot," reducing the value of R2 to 22 k or 15 k will generally tame the oscillations.

Because of the large frequency spread of each band, you'll find a good-quality slow-tuning vernier dial is essential for oscillator tuning. It's best to do your dial calibration with a signal generator. You need to calibrate only one band; the second is automatically 7 MHz different from the first.

You should also do a rough calibration of C1 so you'll know which band you're tuning. To check the quality (selectivity) of your C1-L1 combination, tune to the 7 to 14-MHz calibration mark. Tuning C1 slowly from minimum capacity should first bring in 20-meter CW; as C1 is increased, 20 should drop out and 40-meter CW should appear. The C1 tuning peak should be very sharp and you can judge it best by watching your receiver's S-meter.

As I mentioned earlier, you should use a short antenna to minimize the possibility of overloading and decreased front end selectivity. **hr**

All parts can be obtained from Radiokit, Box 973, Pelham, NH 03076. Ed.

THE FOLD WIRE FED

TOP-LOADED GROUNDED VERTICAL

By Walter J. Schulz, Jr., K3OQF, 15225 Wayside Road, Philadelphia, Pennsylvania 19116

It's common practice to use the folded wire tapped to a grounded tower to feed the tower as a vertical radiator with top-loaded Yagi or quad antennas. You can use these installations as top-loaded verticals on 40, 75, and 160 meters. John True, W4OQ, did an empirical study of this type of system and wrote about the results in *Ham Radio* Magazine.[1,2] After reading his study, I decided that I needed to be able to design the system on paper — independent of sets of interpolative electrical measurements. I had to answer a number of questions to achieve my design goals; there were two that concerned me most. What's the actual grounded tower electrical height with Yagi or quad antennas, and what's the impedance to be expected at a tap point on the tower? To resolve these questions, I looked at the physical aspects in a different way. I assumed that the whole antenna system was a transmission line UHF tank circuit (**Figure 1**).

It's well known that the quarter-wave transmission line will act as an impedance transformer and match two different impedances. This phenomenon is an advantage at ultra-high frequencies where lump-constant components of capacitance and inductance are too large to be used in a tank circuit. A quarter-wave transmission line can be used as a tank circuit;[3] it will display a very high quality factor (Q). Keep the transmission line length at a quarter wave and place a tap along the length for matching impedances if you wish. This tap will transform impedances between the tap point and an active device like a tube or transistor.

Sometimes it's desirable to have a shorter length of transmission line. You can reduce the length of the line by using a loading capacitance at its open end. The transmission line is shorted at one end and capacitively loaded at the other. The tap point along the transmission line will always be a pure resistance with no reactive component, as long as the line is equivalent to a quarter wave which is parallel resonant.

The transmission line tank circuit can be compared with a tower capacitively loaded by a Yagi or quad antenna. The impedance is transformed by placement of a tap along the tower. It's difficult to figure out where to place the tap on the tower or transmission line, as every Amateur location is unique. You can make a fairly accurate first approximation; this will place the tap near the optimum position on the tower for an impedance match. Once you've made your calculation, a little experimentation will show exactly where the tap should go.

Here's an example. A Rohn Model 25 tower has 90-degree electrical height on 3.8 MHz. This serves as a reference parameter for further calculations. Use the algorithim that follows to determine the tap point on the tower that gives you a 52-ohm match.

Establish the feedpoint impedance for the height and diameter of the tower using Schelkunoff's equation.[4] In this instance his equations derive shape factor as Z_0 = 316, and a complex feedpoint impedance as R_r = 37.7 ohms + j21.8 ohms. Next, find the quality factor:

$$Q = \frac{X_L}{R_r} = \frac{+j21.8\Omega}{37.7\Omega} = 0.5782 \quad \textbf{(1)}$$

Treating the tower as a transmision line, find the loop resistance:

$$R = \frac{6.28(Z_o)}{Q(\lambda)} = \frac{6.28(316)}{(0.5782)(78.96)} = 43.4635 \quad \textbf{(2)}$$

λ = 78.95 meters

$$\lambda = \frac{3\times10^8}{f} = \frac{3\times10^8}{3.8\times10^6} = 78.9475 \textit{ meters} \quad \textbf{(3)}$$

Find R1 (loop resistance) value on the tower:

$$R1 = \frac{8(Z_o)^2}{R(\lambda)} = \frac{8(316^2)}{(43.4635)(78.96)} = 232.773 \quad \textbf{(4)}$$

Find the ratio of R_t to R1:

$$\alpha = \frac{R_t}{R1} = \frac{52}{232.773} = 0.2234 \quad \textbf{(5)}$$

FIGURE 1

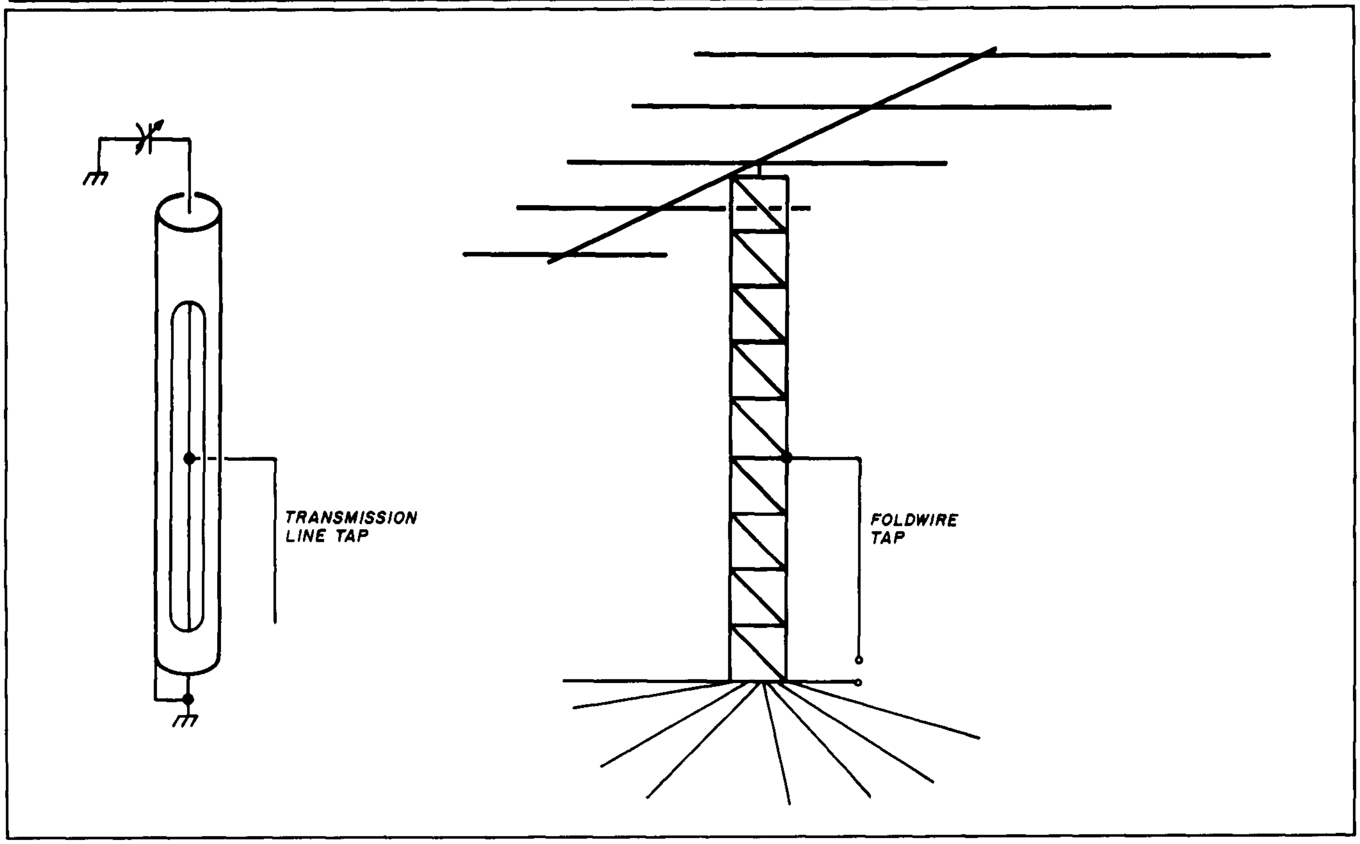


Illustration of a shunt fed tower and its electrical equivalent.

Note: R_t is the tap point impedance. In this case it's 52 ohms.

θ tap point on tower

$\theta\ tap\ point = arc\ sin\ (\alpha\ sin^2\theta_{Gt})^{1/2}$

$\theta\ tap\ point = arc\ sin\ [0.2234 sin^2(90)]^{1/2}$

$\theta\ tap\ point = arc\ sin\ 0.4727$

$\theta\ tap\ point = 28.2°$ **(6)**

Convert tap point height from degrees to feet above ground:

$$\frac{28°}{360°}(259) = 20\ feet \quad \textbf{(7)}$$

If you want to find other tap points above the tower's base and along its length, you need to know the total electrical height of the whole antenna system. Determine the tap point position on the tower length by using proportions to get the first approximation. The first approximation gives you a starting point from which to calculate tap placement on the tower. You may find you have to move the tap up or down. This adjustment, which increases or decreases resistance transformation at the tap point, is necessary for a match to the transmission line.

Electrical antenna height or line length

I'm sure you've seen how electrical antenna height differs from actual physical antenna height. Literature on the subject shows how this phenomenon has been put to use changing antenna current distribution and raising the radiation resistance. You might find it helpful to ask the following questions about an antenna structure already supporting a Yagi or quad antenna, especially if you want to fold wire feed a grounded tower as a vertical radiator.

- What is the total antenna electrical height?
- What is the equivalent electrical height represented by top loading?
- What is the proper tower tap point for shunt feeding?

Consider a Rohn Model 25 tower 55 feet high. This tower supports a TH6DXX triband Yagi which, for our purposes, can be compared to a flat-top antenna with parallel wires. Assume the elements are parallel wires forming a flat top, but each is of a different length. You must average all element lengths (six in the example) to get a uniform length for use in a capacity equation by Grover.[5] You must also average each element's different spacing along the boom. After averaging these boom lengths and spacings, you're ready to use these values to find the flat-top capacitance loading.

The average element spacing is 57″; the average element length is 276″.

Find the capacitance:

$$C\ in\ pF = 7.36\frac{\ell}{F} \quad \textbf{(8)}$$

$$Q = log\frac{2h}{D} - K = log\frac{1320}{57} - 0.874 = 0.4907 \quad \textbf{(9)}$$

$$P = log\frac{4h}{dia} - K = log\frac{2640}{l} - 0.874 = 2.5476 \quad \textbf{(10)}$$

$$F = \frac{P + (n - 1)Q}{n} - K_n = \qquad (11)$$

$$\frac{2.5476 + ((6 - 1)(0.4907))}{6} - 0.252 = 0.5815$$

$$C = \frac{7.36\ (23\ ft)}{0.5815} = 291\ pF \qquad (12)$$

The capacitive value represented by the Yagi is 291 pF.

Find the capacitive reactance from the previous value:

$$X_c = \frac{1}{6.28\ (3.8 \times 10^6)\ (291 \times 10^{-12})} = 144\Omega \qquad (13)$$

Find the shape factor for the antenna tower:

$$Z_o = 60 \ln \frac{(2h)}{(a)} - 1 = 60 \ln (2)\ \frac{(660'')}{(2.95'')} - 1 = 306 \qquad (14)$$

Find the equivalent electrical height of the whole structure:

$$\theta H_b = \text{arccotan}\ \frac{X_c}{Z_o} = \text{arccotan}\ \frac{144}{306} = 65^\circ \qquad (15)$$

$\theta H_a = 76^\circ$
$\theta H_b = 65^\circ$
$\theta Gt = 141^\circ$ *total height ϵ electrical degrees*

Finding the tap point on the tower

You know that the tap point on the reference tower structure is 28 electrical degrees above the tower's base for a tower of 90 electrical degrees in length. This means you'll use proportions to find the tap point for antenna heights other than 90 degrees. Say you want to find the tap point for an antenna height of 141 electrical degrees. Let X be the unknown value for the tap point on the tower. Once you determine the tap point in electrical degrees, convert this value to feet.

$$\frac{90}{28} = \frac{141}{X} \qquad (16)$$

$$3.2143 = \frac{141}{X} \qquad (17)$$

$$X = \frac{141}{3.2143} = 44^\circ \qquad (18)$$

Converting to feet:

$$\left(\frac{44}{360}\right)(258.9474) = 32\ feet \qquad (19)$$

(See **Figure 2**.)

Preparing the tower for shunt feeding

One of the first things you must do when shunt feeding a grounded tower is insulate the upper portions of the tower from ground. Do this by placing egg insulators where the guy wires connect to the tower. It's usually advisable to break up the guy wires with insulators every 1/10 of a wavelength to prevent reradiation by the wires and radiation pattern distortion.

Once you've located the tap point, you can feed it in one of two ways. The first is to extend a folded wire straight out from the tap point and drop it down parallel to the tower's base. RF excitation will occur at the earth's surface. Another method (which gives slightly better bandwidth and results) is to build a cage about the same diameter as the tower, instead of using a single wire. You can hang the cage on an outrigger extending out from the tap point and running parallel to the tower down towards the ground. The cage works better than an aluminum pipe, and offers less wind resistance. It also decreases the amount of weight that's hanging off the tower.

Once the fold wire or cage is in place, there are a number of things to do before exciting the tower with RF power. To start, hang the outrigger arm at the first approximation tap point. (The arm can extend 1 to 3 feet out from the tower's side. The outrigger arm material is usually a light metal, like alumninum pipe, with a 1-inch outside diameter, that's clamped to the tower legs with U bolts.) Suspend the fold wire or cage from the first outrigger to a second one at the tower's base. Make sure the bottom outrigger has an insulator, so that the cage is insulated above the ground.

The impedance noise bridge is a valuable tool for determining the feedpoint impedance at the fold wire or cage feedpoint on the bottom outrigger. You can move the wire in towards the tower or away from it to determine which spacing gives the best impedance match, then try raising or lowering the tap point for a better match. Observe the reactance value on the bridge once you've found the tap point with the best match.

It may be a good idea to cancel out the inductive reactance before moving the tap point position, or the fold wire in and out from the tower. I've given approximate values for maximum capacitance to cancel out the inductive reactance for the following bands: 1000 pF for 160 meters, 500

FIGURE 2

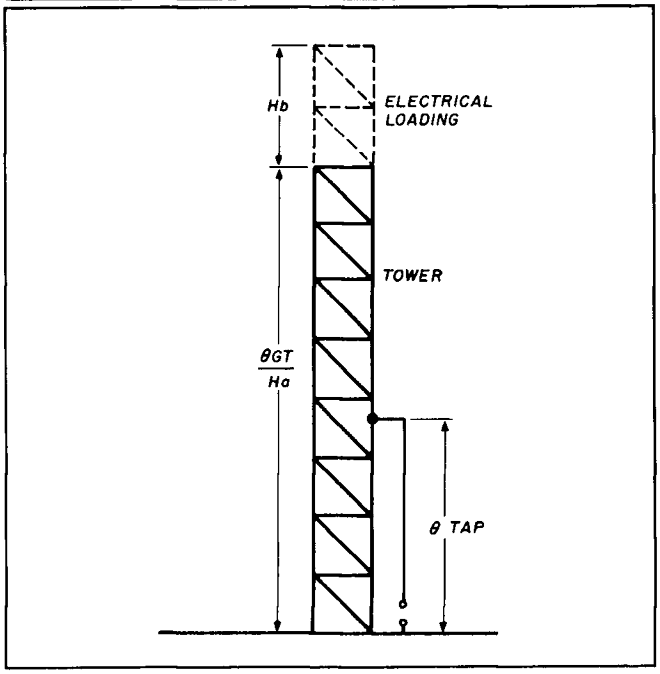


Illustration of the electrical height of the tower in degrees and the approximate placement of the tap in degrees.

John J. Meshna Jr., Inc.

SURPLUS ELECTRONICS

PEEPING TOM SPECIAL

Origianally these giant prisms (8 x 8 x 2½") were used for driving a tank so that the operator didn't get shot to pieces. Now you can use one for whatever clandestine or Tom foolery you can think of. You can look over fences around fences or maybe even find a real use for them. One of our visiting experts suggests these may have been used in M-17 tanks. The exposed surfaces, except for the glass of course, are painted offical olive drab. A unique and unusual find. Used, good condition.

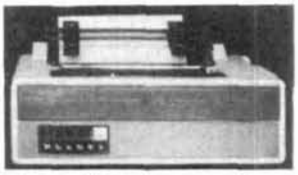
Shpg. Wt. 8 lbs. SPL-16A-52 $12.95

IBM® Compatible Flat Screen Monitor

We just bought a bunch of classy looking IBM® compatible TTL monitors. They were made by Samsung (Sm12SFA7). The monitors utilize a flat, 12" amber high contrast, non-glare CRT. Some of the nice features of this item are: high resolution 80 x 25 character display, they are fully enclosed and come with a tilt & swivel base. The TTL level signals are input thru a sub-D type connector. The monitors run on standard US house current. 95% *of them are in their original factory cartons. They are tagged as having minor defects.* We have looked over a few of them and have found them to be completely intact. We guarantee the CRT's are unbroken and will not have burn marks on them. The original selling price of this very handsome unit was over $125.00 each including the tilt/swivel base. We offer it with the CRT guaranteed OK, as mentioned above. We will also provide a schematic.

"AS IS" Complete with Schematic. Shpg. Wt. 20 Lbs. MOT-17 $37.50

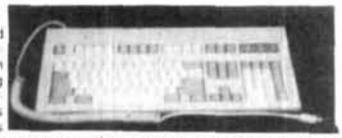
INDUSTRIAL GRADE PRINTER



Heavy duty, industrial grade No. 781 Centronics printers. These print 80 columns wide at 132 CPS. As they stand, they print upper case only, but recognize lower case and print in 5x7 dot matrix. They will print lower case by changing one of the socketed proms and we are trying to obtain copies of the upper/lower case prom. They utilize the standard 36 pin Centronics parallel interface. Each one has an adjustable width tractor feed. If the printers donot receive data for one minute they will automatically go into a stand-by mode. They run on 115VAC, 60 Hz. All are whole and intact. We will throw in for free the paper rack accessories (while they last). These were working when removed from service but due to the nature of such products and shipping, we can not guarantee they are functional.

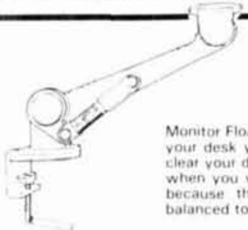
Shpg. Wt. 50 Lbs. SPL-337B-51 $55.00

Enhanced 101 Key IBM Compatible Keyboards



A "Key" U.S. manufacturer recently released his excess inventory of IBM PC, XT & AT compatible "key" boards. They can also be used in the enhanced XT and AT modes by resetting the DIP switches accordingly. We are prohibited from advertising the manufacturers highly respected name; and the name tags have been removed from the cases, but it does appear on the encoder board. These boards feature 101 keys, seperate cursor control & numeric keypads. In addition, 12 function keys are added to take advantage of state of the art software packages and a LED control panel is provided along with snap-open self locking legs. Most of them are in new condition. Some are slightly used. All of them are in excellent working and excellent physical condition. Most are in their original factory cartons. We supply a schematic and operators guide with each one. Shpg. Wt. 5 Lbs. Kybd 11 $39.00 2/$75.00

MONITOR FLOAT ARM



Monitor Float Arm is the easiest way to keep your monitor off your desk yet within reach. Just push your monitor aside to clear your desk. Swing it over to the proper working position when you want to use it. It can all be down with one hand because the Float Arm is phenumatically controlled and balanced to effortlessly float your monitor where you want it.

Use it with any monitor. The arm adjusts vertically, and will accommodate monitors weighing up to 35 lbs. It rotates 90 degrees to the left or right along a 14" radius and arm floats. The unit has a universal 4" diameter mounting plate with a 3" dia bolt circle of 4 holes. We recommand you make a mounting plate of 1/2" thick plywood of a size to fit the base of your monitor, and bolt it to the Monitor Float Arm, them place your monitor on top. It was designed to hold a 14" color monitor for a big name computer manufacturer, and you can buy it at a small fraction of cost.

Shpg. Wt. 10 Lbs. SPL-322-51 $29.95

5 AMP GEL CELLS

The full pacs came in a sturdy plastic enclosure.

We sent "Eagle Eye Al" out hunting in a far away salvage yard a few days ago and he came up with a real winner. While crawling around a big heap of stuff he saw a familiar outline at the bottom. After a few minutes, Lo and behold, some beautiful shiny new Gates gel pacs emerged. The pacs contain 15 2V, 5 amp gel cells for a total of 30 VDC, amp hours. You can buy these unused pacs as follows all guaranteed OK. Here's a tip: Use duct tape to hold the cells together.

15 Cells, 30 VDC in a Sturdy plastic enclosure
Shpg. Wt. 8 Lbs. SPL-274B-52 $40.00
12 Cells, 24 VDC
Shpg. Wt. 4 Lbs. SPL-336B-52 $35.00
6 Cells, 12 VDC
Shpg. Wt. 2 Lbs. SPL-207B-52 $18.00
3 Cells, 6 VDC
Shpg. Wt. 1 Lb. SPL-11B-52 $9.00

OAK SECURITY SWITCHES

We just got in a bunch of beautiful new Oak keyswitches. They are perfect for powering up sensitive pieces of electronic equipment due to their unique 3 key positions. The first position is off. In the second position DPST contacts, rated at 25 amps at 125V, are switched on. In the third position two remote DC contacts make contact and triggers whatever device is attached to them. Each switch comes with hardware and two barrel keys. The keys are removeable in the first and third position. Similiar switches are used on many large computers for security and to insure the proper power up sequence. An unusual item to find surplus and normally very expensive.

Shpg. Wt. 1 Lb. SPL-17B-52 $8.95

BARRIER STRIPS

Mfg. by Kulka Smith. Dual 18 point closed back. 20 amp. List $3.52 each. New.

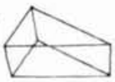
Shpg. Wt. 1 Lb. SP-128A $1.25

10 AMP SOLID STATE RELAY

The relays we have are made by Electronic Relay Inc. their part No. is S505 mm 41053. The control voltage is 5 VDC. The contacts are rated for 240 VAC, 10 amps. *Usually* these are very expensive but not when you are dealing with us. They are removed from unused equipment. Connections are made via spade lugs.

Shpg. Wt. ½ Lb. SP-83A-52 $6.00 2/$11.00

RIGHT ANGLE PRISMS

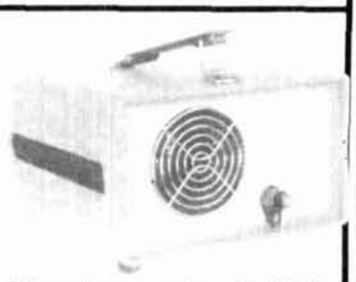


We have had these before and they're always a sell-out. 30-60-90 prisms are great for performing simple optical experiments or just watching the pretty color spectrum that is created when light is bent and reflected throught the prism. They measure 1.5" x 7/8" x 7/8". Some may have slight edge chips but are otherwise OK.

Shpg. Wt. 3 oz. SP-101A-52 $2.00

PARTS GALORE ASSEMBLY

Pictured below is a high reliability power supply. It contains many very useful and expensive parts. We must offer these parts to you individually because, due to the agreement with the manufacturer we can not sell the unit intact.



POWER SUPPLY REGULATOR BOARD Consists of LM 123 IC regulator or equivalent, TIP 32 transistor, 6 amp bridge, 10,000 uf, 50V capacitor, LM 340T12 regulator, a star 6V buzzer, 2 sockets to hold the smaller 2 bands which consist of LM 39N IC, reg, TIP 32 X-ister, 4-10K 10 turn Pots, tantalums, and loads of other parts.
Shpg. Wt. 2.5 Lbs. SP-274B-51 $3.50

TRANSFORMER made by Signal or Aerospace Systems. Input: 110/220VAC. Output: 24v, 3a; 10v, 3a.
Shpg. Wt. 3 Lbs. T-661-51 $5.00

DUAL POWER TRANSISTORS ASSEMBLY 2N6249 or equivalent high power switching X-isters rated at 300VCBO 30 amps. 175 watts silicon NPN which list for over $8.00 each, mounted in an aluminum housing in sockets.
Shpg. Wt. 0.5 Lbs. SP-276B-51 $1.75

FAN similiar in size and speed to IMC Slim Mini Boxer. 115VAC, 50/60Hz. 30 CFM.
Shpg. Wt. 1 Lb. SP-231A-51 $3.75

Finger Guard for above. Zink Plated.
Shpg. Wt. 0.5 Lbs. SP-369D $0.50

CORD for above fan.
Shpg. Wt. 0.2 Lbs. SP-275EG $0.35

CASE aluminum chassis rubber feet and carrying handle. 9⅓x5½x9¼"
Shpg. Wt. 2 Lbs. SPL-107-51 $7.50

John J. Meshna Jr., Inc. SURPLUS ELECTRONICS

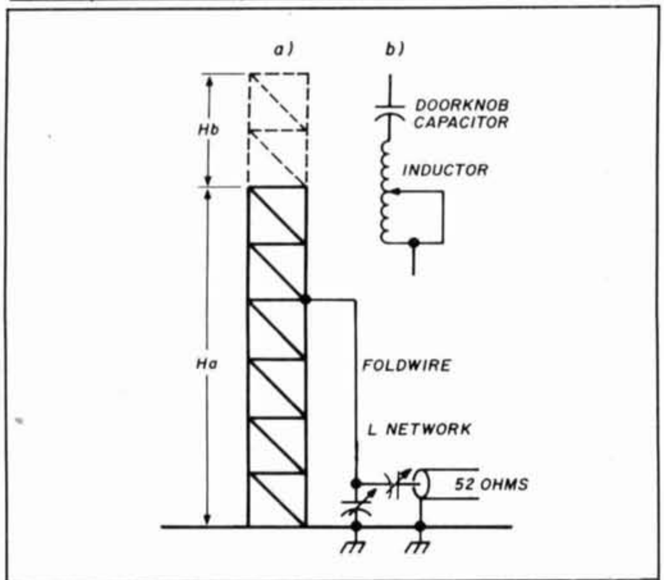
19 Allerton St. P.O. Box 8062
E. Lynn, Massachusettes 01940

MasterCard | VISA | American Express | Diners Club International

Tel. (617)595-2275 * No C.O.D's
FAX. (617)595-4680 * $20.00 Minimum Order

✓ 126

FIGURE 3



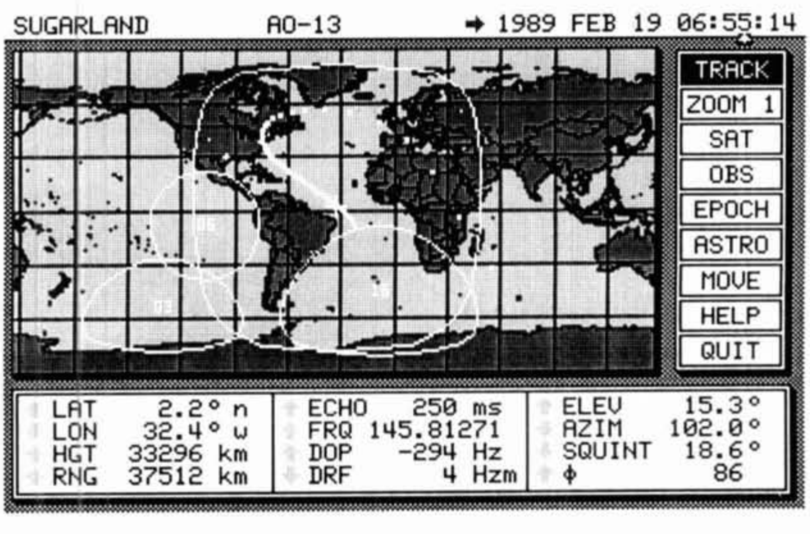
Two methods of tuning out the inductive reactance at the feedpoint on a shunt-fed tower. (A) Variable capacitors are used to tune out inductive reactance. (B) Fixed capacitors are used with a series variable inductor to tune out any additional capacitance in the circuit.

pF for 80 meters, and 300 pF for 40 meters (**Figure 3A**). You can obtain these capacitance values by using a variable capacitor or a fixed capacitance (doorknob capacitor), along with a series inductance to negate the fixed capacitance not needed to cancel out the antenna inductive reactance (**Figure 3B**). When you've canceled out the reactance component, match the resistance value in the usual way. Use an L or T-network, or toroid transformer, if the feedpoint isn't an exact 52-ohm match. Remember the fold wire will always present inductive reactance and this reactance must be canceled out with capacitive reactance. By using the fold wire you eliminate the need for a loading coil, increasing radiation efficiency.

It's also important to remember that you should have a good ground system with many radials when shunt feeding top-loaded towers. This doesn't mean just a few long radials, but a minimum of 60 radials 1/8 wavelength long. If your ground system is inadequate, it will be hard to find the tap point placement and total system adjustment will be very difficult. The calculations are made assuming the ground system will have little loss resistance. **hr**

REFERENCES

1. John R. True, W4OQ, "How to Design Shunt-Feed Systems for Grounded Vertical Radiators," *Ham Radio*, May 1975, pages 34-39.
2. John R. True, W4OQ, "Measurement Techniques for Antennas and Transmission Lines," *Ham Radio*, May 1974, pages 36-42.
3. Capitol Radio Engineering Institute, *Transmission Lines*, McGraw-Hill, Inc., 1972 edition, pages 11-23.
4. S.A. Schelkunoff, "Theory of Antennas of Arbitrary Size and Shape," Institute of Radio Engineers Proceedings, September 1941, pages 493-520.
5. Frederick W. Grover, "Methods, Formulas, and Tables for the Calculation of Antenna Capacity," Bureau of Standards, volume 22, 1927-1928, page 588.

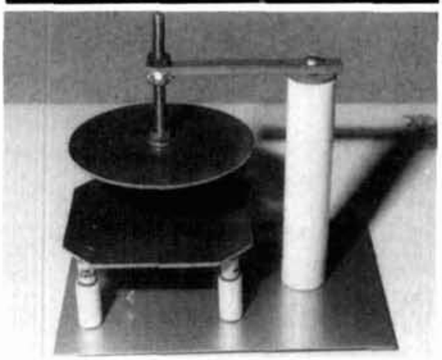


Ham Notebook

Homebrew Neutralizing Capacitor

Most of us now have transceivers with an output of 100 watts. This is ideal for driving a high-power triode amplifier. Such an amplifier isn't difficult to build and can be quite economical if you have some 250Ts, 833As, etc. stored away somewhere. Perhaps you have a ham friend who works at a broadcast station. Stations often remove tubes from service that are perfectly good for Amateur use, especially for CW. Some of the other components, however, may be difficult to find or too expensive. The neutralizing capacitor need not fall into this category.

PHOTO A



Example of a completed Neutralizing Capacitor.

My list of materials isn't cast in concrete. Use what you have on hand and calculate the capacity range from the formula in *The ARRL Handbook*. The items specified will result in a capacity of 1 pF at 3.0″ spacing to 5.6 pF at 0.5″ spacing.

Construction

Use pc board material with copper on one or both sides. Make the top plate using a circle cutter. Cut the bottom plate 4″ square and then trim off the corners. Round the edges with a file and polish them with fine sandpaper or crocus cloth. You can mount the bottom plate on just one center insulator, but I used four to make it sturdier. Countersink the top plate center hole and fasten on the 3″ brass bolt with a lock washer and nut. Solder the bolt head to the pc board copper. This is the only tricky part of the entire project. Be careful not to make the countersink too deep. If you do, there will be a gap between the bolt head and the copper foil. It will be very difficult (I might even say nearly impossible) to bridge that gap with solder. Saw a slot in the other end of the 3″ bolt for screwdriver adjustment.

PARTS LIST

1 - 4" diameter piece of pc board
1 - 4" square piece of pc board
1 - 1/4-20 3" long flat-head brass bolt
3 - 1/4-20 brass nuts
1 - 1/4" lock washer
1 - 3/16"×3/8"×4" brass bar
1 - 1"×5" ceramic insulator
4 - 1/2"×1.5" ceramic insulators
Fiber washers and brass machine screws for the insulators

The support for the top plate is a piece of brass 1/8″×5/16″×4″. If you use hollow brass, solder on a 1/4-20 brass nut after you drill a clearance hole for the 3″ brass bolt. If the brass is solid, you can drill and tap it for the 3″ brass bolt. You also need to countersink the four flat-head machine screws holding the bottom plate flush with the pc board copper.

Ken Leiner, N4LC

Adding 10 MHz to the HyGain HyTower

Although it's an older antenna, the HyGain HyTower is still in use in the United States, Canada, and around the world. The HyTower is basically a quarter-wave vertical. The antenna incorporates various tuning stubs; these decouple it for bands other than 40 and 80 meters. For 160 meters, the antenna uses a base-loading coil.

I've operated with the HyTower at W5UOJ for almost 16 years, and it was *used* when I got it! It's never failed on 160, 80, or 40 meters. Because I have beams for 20, 15, 10, etc., I never installed the stubs for 20, 15, and 10 meters on this particular antenna.

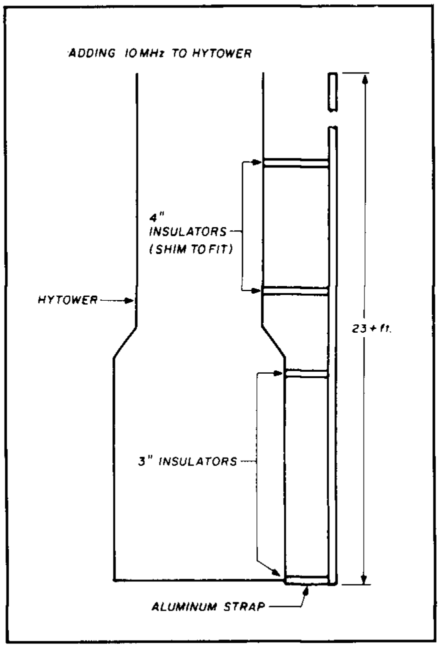
After the 30-meter band (10.100 to 10.150 MHz) opened, I tried the HyTower with an old Collins S-Line. The SWR was relatively low and it worked after a fashion. Because there's a coil for 160 installed in the 80-meter line (mostly shorted out for 80 meters), I could vary the SWR by moving the tap on the coil. Apparently the antenna was working as a three-quarter wavelength vertical.

I didn't get very good signal reports with the antenna this way. It worked, but...! I decided to add a matching section for the 30-meter band.

I garnered several pieces of aluminum from the antenna graveyard and pieced them together. Most of my matching section addition was 1-inch tubing. I inserted a shorter piece of 7/8-inch tubing into the end for tuning.

I started with a total length of just over 23 feet, and tuned the antenna for the best SWR by telescoping the 7/8-inch section up and down inside the 1-inch section. I installed two 3-inch stand-off insulators along the first section of tower and two 4-inch insulators on the second section (see **Figure 1** for details). I shimmed them with small sections of plastic from margarine tubs to bring the 23+ foot section vertical. This took care of almost 16 feet; I left the remaining 7 feet freestanding.

FIGURE 1



Mechanical details for attaching the 23-foot matching stub to the Hygain Hytower.

Next I strapped the bottom of the newly added stub to the bottom of the tower leg with a scrap of aluminum. (You could probably use heavy wire.) Then I adjusted the antenna for minimum SWR. Because my antenna is mounted next to the house, I could make these adjustments with the stub mounted permanently. If your HyTower is mounted away from a building, put up the lowest and highest insulators and make the tuning adjustments by moving the antenna stub up and down. You can mount the stub permanently when the SWR is the lowest.

My stub was just short of 23 feet; the actual length of yours may differ. Because the antenna is mounted next to the house, and since the stubs for 20, 15, and 10 meters aren't installed on it, the final stub length could vary. Always check the SWR before finalizing your work!

The stub adds a third antenna in parallel with the existing 80 and 40-meter sections. With a good ground system this antenna can easily work the world. Stateside contacts are also much easier to make.

I spent less than an hour on this modification, and the time was well spent. It cost me nothing because I had all the materials on hand. Even if you have to purchase everything, it should cost less than $20 — and probably less than $10. Of course, the modified HyTower isn't a beam. But considering that many stations working the 30-meter band are using dipoles and even long wires, it does make for a better-than-average antenna! See you on 30!

Glen Zook, W5UOJ

The N5NBU "Nice but Ugly" $1.29 Antenna

Living in an apartment presents special challenges for Amateur Radio operators. Limited space and landlord rules pose difficulties, particularly when it comes to antennas. When I was told that my ground plane had to come off the balcony, I decided enough was enough and the "Nice but Ugly" $1.29 antenna was born. (See **Figure 1**.)

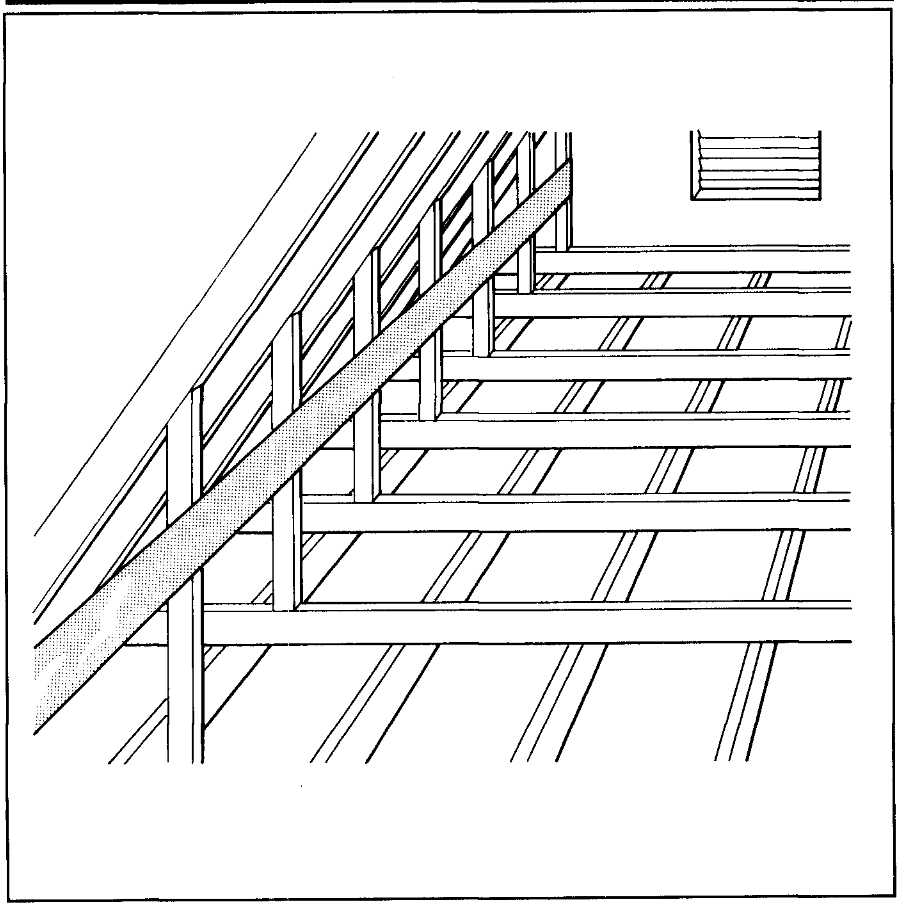
My requirements were simple. I needed to put up an antenna that was as effective as possible within the space available. Then the XYL added another constraint: "Try not to spend any money on it."

I tried and discarded gems like "The Bedroom Wall Quad" (two square wire loops on opposite walls of the bedroom) and "The Guillotine" (a long wire strung throughout the place, which was a real adventure in the dark!).

Then, by sheerest chance, I saw some light at the end of the tunnel — or rather, in the ceiling. While replacing a light bulb in the closet, I noticed an access panel in the ceiling. I lifted it up and, lo and behold, space! A whole attic just waiting for an antenna installation! I immediately sat down and started contemplating antenna designs.

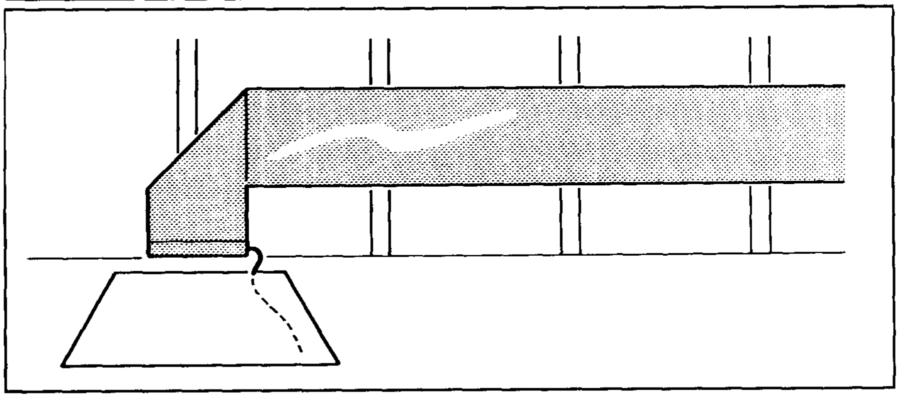
I made a couple of trips into the attic with measuring tape in hand and my plan began to take shape. Because I had severe budgetary restrictions, the antenna had to be simple and built with materials I had around the house. What's cheap, long, and conductive...?

FIGURE 1



Installed view.

FIGURE 2



End-feed view.

Eureka! Aluminum foil! Because the antenna would be installed in the attic there wouldn't be any wind loading, and there were convenient vertical supports (roof trusses) running the length of the attic. I went into the kitchen, got out the roll of foil, and measured off 66 feet (the length of my attic, and two full waves at 10 meters — how convenient) plus a little bit for anchoring purposes. I decided an end-fed antenna would be perfect as it involved just a single wire to my tuner.

After measuring out the foil and locating my box of tacks, I once again climbed into the attic. Starting at the far end, I rolled and flattened about a foot of foil for a good strong anchor, held it vertical, and thumbtacked it to the support on the far end of the attic. Working my way back to the access hatch, I unrolled the foil and tacked it to every fourth vertical. They're spaced about 18 inches apart. I continued this rather tedious process (tedious because the foil is quite delicate) until I came to the access panel. Then I folded the foil over to bring it down to the edge of the access. To connect the antenna to the tuner, I scraped off about 2 feet of insulation from an 18-foot piece of no. 16 enameled wire, then soldered it (sort of) to a piece of foil about a foot long using "the bigger the blob, the better the job" method. I rolled this up into the end of the antenna, flattened it, tacked it down to the edge of the access, and connected the wire to my MFJ Deluxe Versa Tuner II. (See **Figure 2**.)

Now it was time for the acid test. I tuned the transmitter up into the dummy load, switched to the antenna, and heard the (new and thrilling) sounds of DX stations. After finding a clear spot on 10 meters to finish my tune-up, I called CQ and immediately got my own mini-pileup. The SWR meter said I was matched up with a 1:1 ratio, and the stations I was talking to were giving me S9+20 reports. It was the same story with CW on 15 and 40 meters. On 80 meters I have a problem with RF "bites," but a good ground should cure that problem. I've greatly alleviated and almost eliminated my TVI. My primary problem was fundamental overload. Now just turning the rabbit ears parallel with the plane of the antenna greatly reduces and just about gets rid of TVI on channel 2 (my problem channel).

I hope you'll try my Nice but Ugly antenna. Just remember basic safety precautions regarding power lines, etc. and you'll have a safe and trouble-free installation.

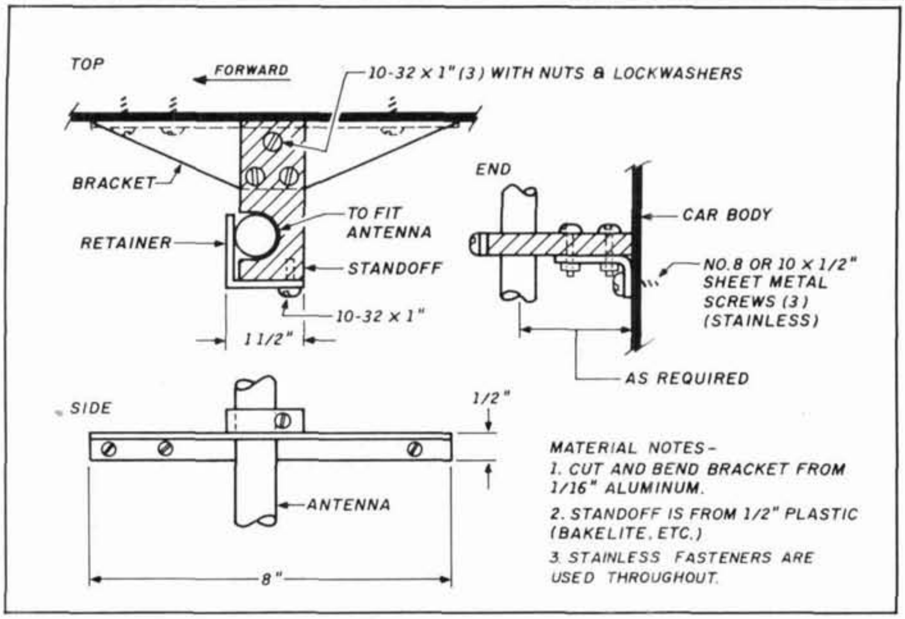
Now, I wonder if I can do something with these tin cans...

Don Lane, N5NBU

Mobile Antenna Anti-rotate Device

Mounting your low-band mobile antenna on your bumper is the easiest method — mechanically. It's also best for performance. But this mount is impossible on many station wagons and "three door" cars. Side mounts are apt to rotate, unless they include a rugged anti-rotate device. I used a standard ball mount, which rotated even when minimal force was applied. My solution for this rotation problem is shown in **Figure 1**.

FIGURE 1



Anti-rotate bracket for side-mounted mobile antennas.

I attached the aluminum bracket to my car with stainless steel sheet metal screws available from most hardware stores. My installation fits two different diameter antennas, so I cut the hole in the standoff for the larger one. I bushed out the smaller antenna with a 4-inch length of clear plastic hose, also from the hardware store. I split it lengthwise and attached it with a hose clamp. I added the L-shaped retainer at the front of the mount to prevent rotation in the forward direction (less likely). You'll need to vary my dimensions to fit your car and antenna(s).

This device has stood the test of several thousand miles and many QSOs. Thanks to Bob, W1KSK, for his original suggestion.

George Wilson, W1OLP

Tom McMullen, W1SL

OSCILLATORS

Oscillators have been a part of radio since the use of spark transmitters. The waves spark transmitters generated weren't the clean waveforms available with modern circuitry, but they *were* radio waves. They weren't self-sustaining; they reached an energy peak when first started, and each successive peak was weaker (because of circuit losses) until the wave died out completely. These were known as "damped" waves.

The vacuum tube saved the day. It allowed for the addition of enough power to the circuit to overcome the losses and maintain the waveform as long as voltage was applied. Vacuum tubes were standard in many types of oscillator circuits for many years, and are still the mainstay when you need more than a few watts of RF power to drive the next stage.

Transistors are prevalent in modern equipment. These small, quiet, relatively cool devices perform well as oscillators from audio frequencies up into the microwave region. But whether the oscillator is a tube or transistor, the thing that makes it perform is feedback.

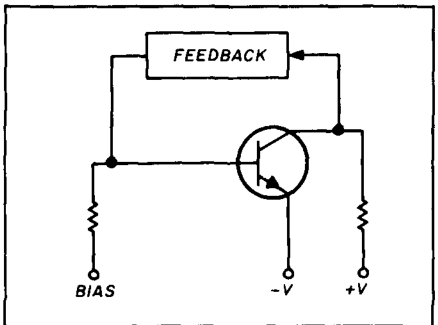
Feedback — the vital ingredient

Basically, an oscillator is an amplifier with some of its output signal fed back to the input in a proper phase relationship. If the waveform phase adds to the input waveform, the circuit will oscillate; if it tends to cancel the input waveform, it won't.

Feedback that tends to cancel the input waveform is called negative feedback, and this very characteristic has been used in many circuits to improve their operation. For example, negative feedback is used in high-quality audio amplifiers to reduce distortion and prevent overload. In RF circuits, negative feedback is called *neutralization* and is used to *prevent* oscillation. Circuit designers can use phase-shifting networks and filters to tailor feedback for almost any situation.

Here's an example of how feedback gets things started. **Figure 1** shows a simple transistor circuit with a black box called "feedback" connected between the output (collector) and input (base) of a transistor. (Don't worry about what's in the box right now.)

FIGURE 1



An oscillator is an amplifier with controlled feedback. Here, the "black-box" between the collector and base provides the voltage feedback and phase shift needed to keep oscillation going.

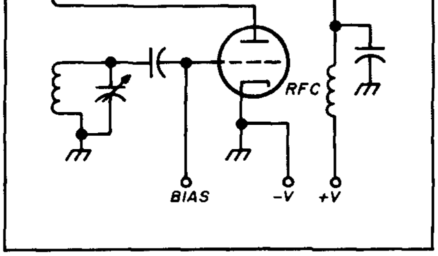
Let's say that the AC voltage on the collector reaches 10 volts, and that the transistor provides a voltage gain of 20 (that's simple voltage gain, not decibels). All the black box needs to do is supply 0.05 volts to the base. The transistor will amplify that by 20, and maintain the required 10 volts on the collector. A good design adds an extra fraction of a volt to the feedback to take transistor aging, low supply voltage, and other troubles into account — just to be safe. The phase of the voltage must be "aiding," that is, near 0 or 360 degrees. But applying too much feedback voltage isn't good. It can overdrive the transistor, causing the waveform to distort and create harmonics. The transistor will also draw more current than needed, and may overheat.

What's in the box?

You can obtain feedback in many ways, and electronic handbooks often show a dozen or more types of oscillators. **Figure 2** represents an old standby used for many years in various commercial and Amateur applications. It's a tube circuit with a small coil in the plate circuit located near the windings connected to the grid. This was once called a "tickler" coil.

The amount of feedback was adjusted by moving the coil closer to or further from the input circuit. The phase was determined by having the winding start and finish properly connected in the plate circuit. The old rule of thumb was: "If it doesn't oscillate, reverse the feedback windings." Some oscillators in early receivers had a feedback coil that could be rotated, letting you fine tune the strength of oscillation. (A few of these oscillators were known as "regenerative receivers.") This isn't a very elegant method of

FIGURE 2



An early "brute force" type of feedback used a plate coil located so that its magnetic field was coupled to the grid tuned circuit.

THE FUTURE OF AMATEUR COMMUNICATIONS

Once in a lifetime, a transceiver is introduced that's so extraordinary and innovative that it opens a totally new era in HF communications. ICOM's pacesetting IC-781 proudly exhibits that hallmark achievement with futuristic designs and features of true legendary proportions. Whether DX'ing, contesting, pioneering new interests or enjoying unquestionable top-of-the-line performance, the IC-781 is indeed today's standard of excellence!

Multi-Function Five Inch CRT. Displays frequencies, modes, memory contents, operating notes, RIT, two menu screens, plus a panoramic view of all signals in a selected range. A portion of the screen also serves as a display for data modes like RTTY, AMTOR, and PACKET.

Unique Spectrum Scope. Continuously indicates all signal activities and DX pileups with your operating frequency in the center. Selectable horizontal frequency spans of 50, 100, and 200KHz for each side of the frequency you're listening to. Vertical range indicates relative signal strengths. A contester's dream!

Dual Width Noise Blanker includes MCF filter plus **level and width controls** to eliminate pulse and woodpecker noise with minimum adjacent-signal interference.

Incomparable Filter Flexibility. Independent selection of wide and narrow SSB filters plus CW filters. Second and third CW IF filters are independently selectable!

Dual Watch. Simultaneously **receives two frequencies in the same band!** Balance control adjusts VFO A/B receive strength levels. You can check additional band activity, even tune in your next contact, while in QSO without missing a single word!

DX Rated! 150 watts of exceptionally clean RF output. Easily drives big amplifiers to maximum power.

Twin Passband Tuning with **separate controls for second and third IF stages!** Increases selectivity and narrows bandwidth, independently varies low and high frequency response, or functions as IF shift. **It's DX'ing Dynamite!**

A Total Communications System! Includes built-in 100% duty AC supply, high speed automatic antenna tuner, iambic keyer, semi-automatic or full QSK CW break-in to 60 wpm, Audio Peaking Filter (APF), RF speech processor, multiscanning, 105dB dynamic range, all-band/all-mode receiver with general coverage, and much more!

ICOM Dependability. The phenomenal IC-781 is built for action and backed with the most extensive warranty in the industry.

See the IC-781 at your local ICOM dealer.

ICOM

First in Communications

ICOM America, Inc., 2380 116th Avenue N.E., Bellevue, WA 98004
Customer Service Hotline (206) 454-7619
3150 Premier Drive, Suite 126, Irving, TX 75063
1777 Phoenix Parkway, Suite 201, Atlanta, GA 30349
ICOM CANADA, A Division of ICOM America, Inc.,
3071 - #5 Road, Unit 9, Richmond, B.C. V6X 2T4

All stated specifications subject to change without notice or obligation. All ICOM radios significantly exceed FCC regulations limiting spurious emissions. 781188.

✓ 140

PLAN YOUR SPRING ANTENNA WORK NOW!

THE ARRL ANTENNA BOOK Written by members of the ARRL Technical Department staff and sixteen well-known outside authors, all of whom have done much to contribute to the state-of-the-art in antenna and transmission line theory and practice. The recently published 15th Edition presents the best and most highly regarded information on antenna fundamentals, propagation, transmission lines, Yagis and quads, as well as all of the popular wire antenna designs. You'll find antennas for limited space, portable, mobile, VHF, UHF, microwave and space communications. Contains over 700 pages and 987 figures. **Chapter lineup:** Safety First, Antenna Fundamentals, The Effects of Earth, Selecting Your Antenna System, Loop Antennas, Multielement Arrays, Broadband Antennas, Log Periodic Arrays, Yagi Arrays, Quad Arrays, Long Wire and Traveling Wave Antennas, Direction Finding Antennas, Portable Antennas, Mobile and Maritime Antennas, Repeater Antennas Systems, VHF and UHF Antenna Systems, Antennas for Space Communications, Spacecraft Antennas, Antenna Materials and Accessories, Antenna Supports, Radio Wave Propagation, Transmission Lines, Coupling the Transmitter to the Line, Antenna and Transmission Line Measurements, Smith Chart Calculations, Topical Bibliography on Antennas, Glossary and Abbreviations. Edited by Gerald L. Hall, K1TD, *QST* Associate Technical Editor. Copyright 1988, #2065 $18*.

*For postage and handling add $2.50 ($3.50 for insured parcel post or UPS, please specify)

YAGI ANTENNA DESIGN is based on the series in *Ham Radio* Magazine by the late Dr. James L. Lawson, W2PV. Jim designed and built a highly competitive and successful Amateur Radio contest station. 210 pages cover the following subjects: Performance Calculations, Simple Yagis, Performance Optimization, Loop Antennas, Ground Effects, Stacking, Practical Designs, Designs for 7 through 28 MHz. Hardcover, Copyright 1986. #0410 $15*.

NOVICE ANTENNA NOTEBOOK At last, an antenna book written for the beginner! Don't let the lack of an antenna keep you from getting on the air. With this book you can choose which wire, vertical or beam antenna suits your needs, and you'll be ready for all of the fun of seeing that the antenna you put up really works! Contains pictorial drawings that show dimensions for Novice and Technician band use. Written by W1FB in his usual plain language style that makes him so popular as a *QST* author. Copyright 1988, #2073 $8*

ANTENNA COMPENDIUM We don't have room for all of the good antenna articles that are submitted to *QST;* so we have packed this volume with new material on verticals, quads, loops, Yagis, reduced-size antennas, baluns, Smith Charts, antenna polarization and other interesting subjects. 176 pages, Copyright 1985. #0194 $10*

LOW BAND DXING John Devoldere, ON4UN completely explores the 160, 80, and 40-meter bands. A large portion of this book is devoted to propagation characteristics and design and building of efficient antennas for these bands. 210 pages, Copyright 1987, #047X $10*

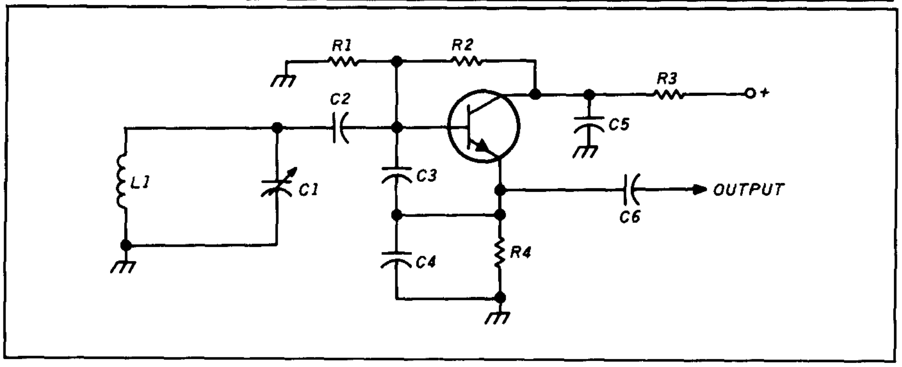
HF ANTENNAS FOR ALL LOCATIONS was written by L.A. Moxon, G6XN for the RSGB. Contains 264 pages of practical antenna information. This book is concerned primarily with small wire arrays, but you'll find descriptions of some aluminum antennas as well. Copyright 1982, #R576 $15*.

TRANSMISSION LINE TRANSFORMERS At last there is a source of practical design data covering the use of these devices for both commercial and amateur applications. Written by Dr. Jerry Sevick, W2FMI, this book covers types of windings, core materials, fractional-ratio windings, efficiencies, multiwinding and series transformers, baluns, limitations at high impedance levels and test equipment. Hardcover, 128 pages, Copyright 1987. #0471 $10*.

W1FB'S ANTENNA NOTEBOOK Not everyone has a great deal of real estate to put up a forest of aluminum. Doug DeMaw tells how to get the best performance out of unobtrusive wire antennas and verticals and how to build tuners and SWR bridges. 122 pages, Copyright 1987, #0488 $8* For shipping and handling add $2.50 ($3.50 for insured parcel post or UPS)—please specify.

ARRL, 225 MAIN ST., NEWINGTON, CT 06111

FIGURE 3



A modern circuit uses feedback from the emitter to base of a transistor via C3. C3 and C4 form a voltage divider; R1 and R2 provide base bias. The collector is bypassed to ground for RF, and output is taken from the emitter via C6.

providing feedback, but it works. Because physical vibration and temperature cause problems in oscillators, it follows that a circuit with two coils prone to vibration and heat will be more unstable than a circuit with only one.

Figure 3 takes another approach to feedback. In a more modern transistorized circuit, a capacitive voltage divider couples some of the energy from the emitter circuit to the base circuit. The value of the capacitors from base to emitter and emitter to ground determines the strength of the feedback signal. The resonance of the tuned circuit sets the frequency of oscillation. The collector circuit is bypassed for RF, which completes the signal path back to the emitter.

You may wonder how the oscillation gets started in the first place. When power is first applied to an oscillator, the rush of current through the transistor (or tube) and the tuned circuit starts the "store energy/release energy" cycle. This cycle peaks at the circuit's resonant frequency. The action creates a small signal at the base (or grid, in a tube). Because the circuit is an amplifier, this small signal is amplified. A portion of it is then fed back to the input to further enhance the oscillation and be amplified again, and so it goes. The whole procedure requires only a few cycles to reach full strength.

Audio oscillators get started in a similar fashion, except that most depend upon a resistance/capacitance phase-shift network to determine the frequency of oscillation. The voltage change across the output load resistor creates a starting signal, which is fed back, amplified, and so on. It's possible to use a transformer to obtain inductively coupled feedback for an audio oscillator, but why lug the heavy iron around if you can use something else?

Back to the RF circuits. **Figure 4** shows two oscillators that use crystals as their frequency-determining element. In **Figure 4A**, the crystal is connected from base to ground. It serves the same purpose as the tuned circuit in **Figure 3**, by forming a parallel-resonant circuit at the base. In **Figure 4B**, the crystal is a series-resonant type and provides feedback at the crystal frequency directly from collector to base.

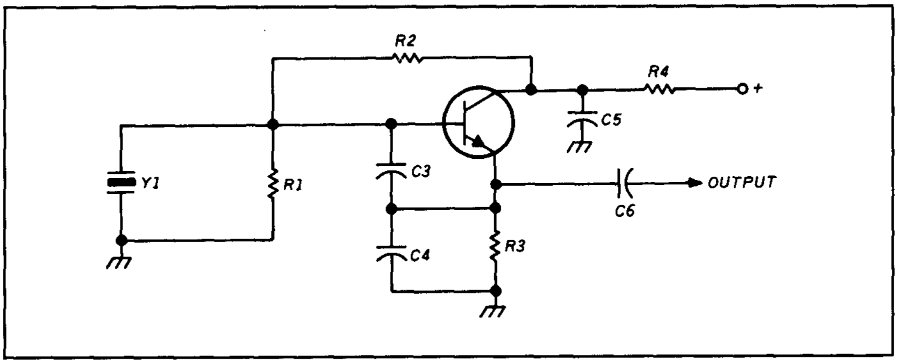
There are many variations of these circuits; some have names associated with their inventors. **Figures 3** and **4A**, for example, are versions of what is often called a Colpitts oscillator; **Figure 4B** is a Pierce oscillator.

In **Figure 5**, you'll notice one of those voltage-variable capacitors I explained in last month's column. It looks like a cross between a capacitor and a diode, and changes its capacitance in proportion to the DC voltage applied. In the circuits used last month, I varied the negative (-) voltage applied to the diode to change the capacitance. Instead of using two supplies, one negative and one positive, this circuit simply reverses the diode and varies the positive (+) voltage to tune the circuit by means of R1.

What makes an oscillator unstable?

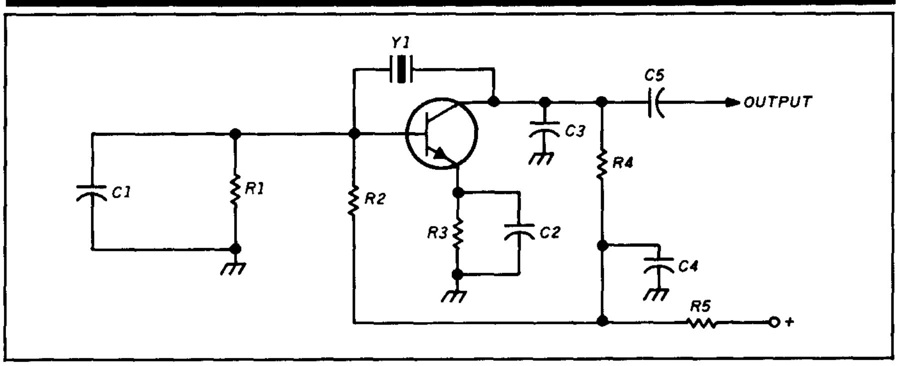
Frequency stability is one of the

FIGURE 4A



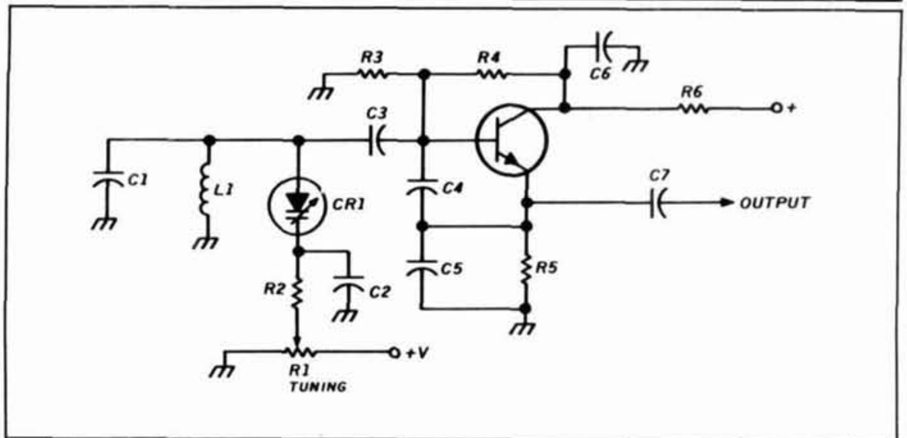
A Colpitts-type crystal oscillator.

FIGURE 4B



A Pierce-derivative crystal oscillator. This crystal provides feedback at its natural frequency. C1 and C3 are small-value capacitors used to stabilize the amount of feedback, preventing overdrive to the transistor and crystal.

FIGURE 5



A VFO circuit using a voltage-variable capacitor as the tuning element. This can also be called a voltage-controlled oscillator (VCO).

prime goals in designing and building an RF oscillator of any type. Mechanical stability is a close second.

It's almost impossible to design an oscillator that ignores temperature changes, but there are tricks that help you come close. Because many components cause frequency changes when the circuit gets warmer, it's possible to use temperature-compensating capacitors to provide an opposing characteristic when they warm up. If you select the proper values, the result will be an almost temperature-stable oscillator.

Of course, keeping the entire circuit away from other elements that produce heat makes your task much easier. Power supply rectifiers, transformers, and sometimes filter capacitors plus power-amplifier stages all heat up their surroundings, and you should avoid them when placing an oscillator on a chassis. Ventilate the enclosure to let heat escape or, if that isn't possible, use good heat-sink material to get the heat out of the box and into the free air where it won't harm anything. Good design also calls for keeping the current drawn by the oscillator device as low as possible. Current passing through resistors (and tubes or transistors) produces heat, so the less heat produced, the less heat there is to be dissipated.

Mechanical instability is evident in two forms. One form is called microphonics. If you tap on the enclosure and hear a "boing" when listening to the oscillator in a receiver, you have microphonics. The other form is a noise or a jump in frequency when you tune the oscillator. The microphonic type is caused by something moving in the RF field of the oscillator-tuned circuit. It may be the walls of the enclosure, a nearby component with long leads, or even the tuned circuit components (loose windings and air-variable capacitors are prime suspects). The cure is to mount everything very rigidly, and allow space between the coil and other components so that the RF field doesn't intercept a loose or vibrating part. Heavy or rigid oscillator-enclosure walls and chassis help too.

Noise and frequency jumps are usually caused by dirty contacts in the variable capacitor of the tuned circuit. Even the voltage-variable capacitor isn't immune, because the potentiometer that changes the voltage can become noisy just as volume controls do in an audio circuit. Clean contacts are the answer for the variable capacitor. There are chemical solutions that you can use to cure the problem in both capacitors and variable resistors. If all else fails, replace the noisy part with a new one. It's worth noting that even oscillators that vary the inductance rather than the capacitance are not immune to this problem, because anything that is in the RF field of the coil can induce noise (and temperature instability) into the circuit. hr

SHORT CIRCUIT HOTLINE

Building a current *ham radio* project? Call the Short Circuit Hotline any time between 9 AM and Noon, or 1 to 3 PM — Eastern time — *before* you begin construction. We'll let you know of any changes or corrections that should be made to the article describing your project.

(See "Publisher's Log," April, 1984, page 6, for details.)

603-878-1441

IMPEDANCE MATCHING TRANSFORMERS AND LADDER LINE

Simple schemes for matching 50-ohm coax to ladder line

By Peter H. Anderson, KZ3K, 915 Holland Road, Bel Air, Maryland 21239

Hams enjoy experimenting with antennas. Simple wire types require a minimal investment, and the parts (consisting of nothing more than wire and insulators) are readily available. I've been working with 1:4 impedance transformers and ladder-line transmission line and would like to share what I've learned.

Introduction

A number of years ago I won my one and only door prize at a hamfest. It was an all-band "dipole-like" antenna consisting of 130 feet of wire center fed with 450-ohm transmission line. I couldn't wait to put up my new "toy" and give it a try. Imagine my disappointment when I found that it didn't work.

My preference for 450-ohm line used in conjunction with 1:4 ferrite transformers began with that antenna. I solved my impedance-matching problems using those transformers, and the antenna still works well today. I've since changed the feeds for all my other HF antennas to 450-ohm ladder line using the type of 1:4 impedance transformers shown in **Photo A**.

Ladder line has a lot to recommend it over coaxial cable. For instance, it's inexpensive and very light. Many of us depend on the smallest of twigs at the top of a tree to achieve maximum height when erecting a dipole. Anyone who has attempted to hoist the end of a dipole that's center fed with RG-8 can attest to the frustration of having those twigs break. The entire antenna falls, and you end up with a "V" shaped dipole.

Unlike coax, ladder line doesn't fill up with water, and I take a bit of comfort in being able to "see" whether the line is intact. Ladder line is also balanced and relatively lossless. Within hours of putting up a new antenna, I usually find myself wanting a bit more bandwidth than it can provide. Ladder line gives me flexibility in using a tuner that coaxial cable does not.

The difficulty with using ladder line seems to be in matching the 50-ohm rig to the 450-ohm tramsmission line and the transmission line to even the simplest of dipoles.* This drawback has become more apparent with the wide proliferation of solid-state rigs with a fixed 50-ohm output.

General analysis of 1:4 impedance transformer

Take a look at the general 1:4 impedance-matching autotransformer in **Figure 1**. It includes some practical implementations. Note that the output ("b" side) may be balanced or unbalanced depending on where ground is supplied on the input ("a" side).

A rigorous analysis of the network, which assumes only that the two coils are tightly coupled with one another, results in the following expression:**

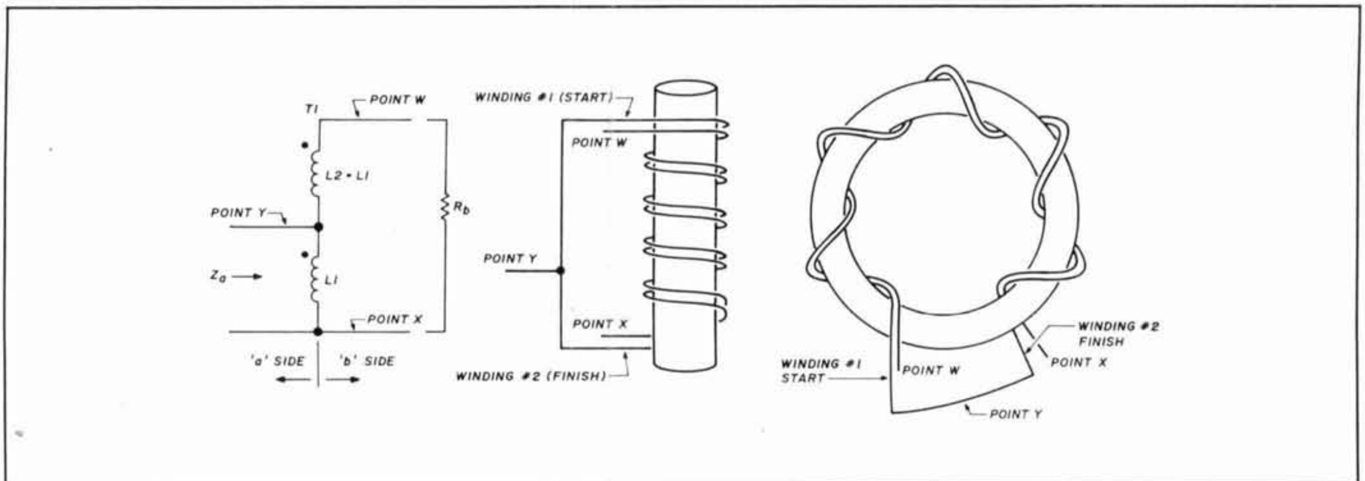
$$Za = \frac{Rb}{4.0 - j\,\dfrac{Rb}{Xl}} \qquad (1)$$

The j operator in the denominator indicates that the second term adds to the first at right angles, as shown in **Figure 2**. Note that if $2\pi fL1$ (the inductive reactance) is "large"

*Of course, the actual impedance ratio for transforming 50-ohm coax to ladder line is 1:9. I was unsuccessful in winding a 1.9 transformer that would provide satisfactory results. If you're interested in trying, you could use a pair of 1:3 transformers at either end to provide a closer 1:9 impedance transformation. Because of the low loss nature of 450-ohm ladder line, the additional loss due to impedance mismatch has negligible effects on the total power transformer.

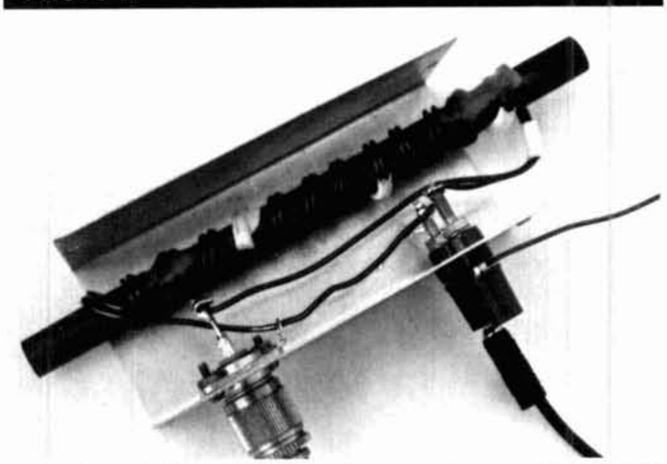
**Detailed derivations are available from the author for an SASE with one unit of postage. Computer analysis routines were written in Turbo Pacsal, Version 4.0 for IBM compatibles; a complete library of source code is available on 5-1/4" diskette for $5.00. You must have Turbo Pascal Version 4.0 (or later) and Turbo Graphix to support Version 4.0 to compile and execute these files. Hard copies of the source code listings are available for an SASE with three units of postage.

FIGURE 1



Schematic representation of 1:4 impedance transformer and implementations using a rod and toroid. The dots refer to the relative positioning of the windings. Each bifilar turn consists of two conductors tightly coupled to one another.

PHOTO A



An implementation of a 1:4 transformer using a ferrite rod. The design shown is unbalanced; ground is applied to one side of the transformer versis the center. Small applications of epoxy hold the rod in place.

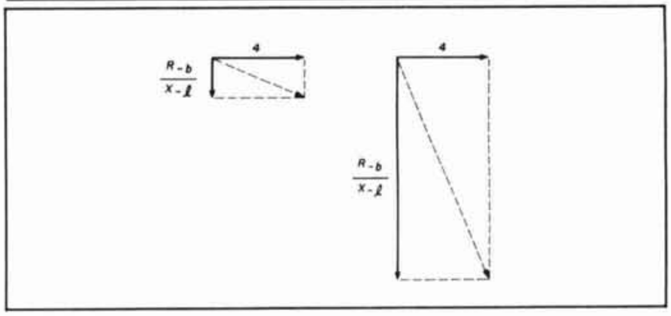
in relation to Rb, the first term in the denominator swamps the second and the expression reduces to:

$$Za = Rb/4 \quad \textbf{(2)}$$

The input impedance is Rb/4 and is purely resistive. The fact that the inductive reactance is large in relation to Rb is particularly important. It raises questions about how large "large" is, and about what happens if the inductive reactance isn't "large" enough.

Figures 3A and **B** provide a graphical analysis of **Equation 1**. **Figure 3A** shows that the ratio of the resistive portion of Za to Rb approaches 0.25 as the frequency increases for all values of Rb divided by L1 — that is, as the inductive reactance becomes "large" in relation to Rb. You'll note that at a particular frequency the ratio approaches 0.25 as Rb decreases in relation to L1, or as L1 increases in relation to Rb. **Figure 3B** is interesting because it shows that the

FIGURE 2



The j operator indicates the quantities add at right angles. If Rb/Xl is small in relation to 4.0, the denominator is close to 4.0. However, if Rb is large in relation to 4.0, the denominator is Rb/Xl.

reactive component seen on the "a" side may either increase or decrease with increasing frequency. Note that the reactive component is always positive (inductive).

Analysis of an inadequate design

The following example shows how to use **Figures 3A** and **B** to analyze the performance of an impedance transformer.

As one of my earliest projects, I attempted to match my 50-ohm transmitter to an end-fed wire which was about 135 ohms resistive at 3.5 MHz (see **Figure 4**). I reasoned that 135/4 wasn't 50, but it was close enough. I wasn't prepared for the 10 ohms plus the substantial reactive component which resulted, and I dropped the project in frustration.

I used the T-200-2 iron powder core (usually red in color).* It's probably the most common toroid-type core used at high HF power levels by the Amateur fraternity.

Consider a nine-bifilar turn arrangement at 3.5 MHz:

$$L1 \text{ (in } \mu H) = (turns/100)^2 \times Al \quad \textbf{(3)}$$

where Al is in μH per 100 turns.

The ARRL Handbook discusses toroid inductors in its "Electrical Fundamentals" chapter. It doesn't deal specifically with ferrite rods. The formulas for calculating inductance and turns are the same as the ferrite toroids mix 61, except that Al is 49.

Wide Dynamic Range and Low Distortion — The Key to Superior HF Data Communications

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

ST-8000 HF Modem

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

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

Write or call for complete ST-8000 specifications.

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

✓ 144

ALINCO
ALINCO
PTT L
V/U DUP
OFFSET
STEP
CH
1M
100K
10K
MW
REV
DIAL
MEMO
TONE
F SET

$$L1\ (in\ \mu H) = (9/100)^2 \times 120$$
$$= 0.972\ \mu H \qquad (4)$$

Therefore, the inductive reactance at 3.5 MHz is:

$$Xl = 2\pi \times 3.5E \times 10^6 \times 0.972E \times 10^{-6}$$
$$= 21.4\ ohms \qquad (5)$$

This falls far short of the requirement that Xl be "large" in relation to Rb, which in this case was 135 ohms.

You can quickly calculate the resistive component of Za seen by the transmitter by referring to **Figure 3A**. Rb/L1 is nominally 138 ohms per μH. Using the curve for 150 ohms per μH as a guide, you can interpolate that the resistive part of Za/Rb at 3.5 MHz is nominally 0.075. This makes the resistive ratio of Za to Rb 1:13 — a far cry from 1:4. Additionally, the input resistance seen by the transmitter is close to 10 ohms.

Find the reactive component using **Figure 3B**. By picturing a curve between Rb/L1=100 and 200 you can estimate the reactive component ratio to be nominally 0.1. That is, 0.1×135 ohms=13 ohms. This means that at 3.5 MHz, the 135-ohm resistance is "reflected" to the transmitter as 10 ohms resistive plus 13 ohms reactive. Note that the reactive element is inductive. All in all, mine was not a successful venture.

Developing a workable design for an end-fed wire

Your next step is to design a functional transformer for this antenna. According to **Figure 3A**, you need an Rb/L1 ratio of less than 15 ohms per μH to get close to a 1:4 impedance ratio at 3.5 MHz. Because Rb is equal to 135 ohms, L1 must be larger than 135/15=9 μH. **Figure 3B** shows that the reactive component at 3.5 MHz is 0.04×135≈5.4 ohms, which is probably acceptable in relation to 33 ohms resistive. Use the relationship for iron powder toroids to find the number of turns required:

$$Turns = 100 \times \sqrt{(desired\ L1\ in\ \mu H/Al)}$$
$$= 100 \times \sqrt{(9/120)}$$
$$= 27.4\ turns \qquad (6)$$

Note that each turn is bifilar consisting of two wires. Getting 55 single turns of no. 12 or 14 enameled wire on a T-200 core isn't possible. My own experience is that 15 bifilar turns is a practical maximum.

If you are confronted with the same problem at 7.0 MHz, look at **Figure 3A** and you'll see that an Rb/L1 of 25 ohms per μH is sufficient. Consequently, L1 must be a minimum of 135/25≈5.4 μH. I calculated the number of bifilar turns to be 21.

Now that I've gone through an analysis and design example, I'd like to offer some generalizations:

> On 3.5 MHz a ratio of Rb/L1 of 15 ohms per μH is adequate. At 7 and 14 MHz, ratios of 25 and 50 are adequate. Clearly, a broadband transformer designed using these criteria for one band will also perform on the higher ones.

So far I've considered an Rb of 135 ohms. We hams are usually interested in transforming Rb values on the order of several hundred ohms, and I concluded that the T-200-2 is very difficult to use on the lower HF bands. More than 21 bifilar turns simply don't seem to fit and I'm suspicious of parasitic capacitance; however, there's an easier alternative.

FIGURE 3A

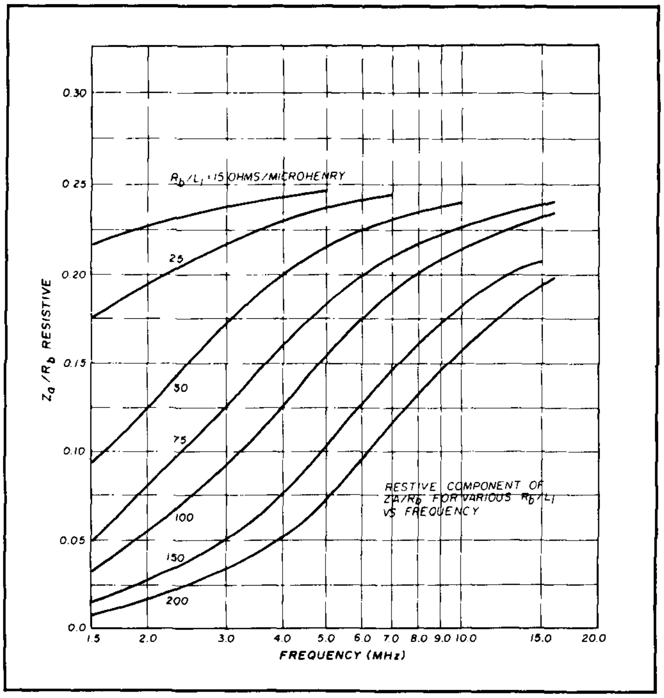
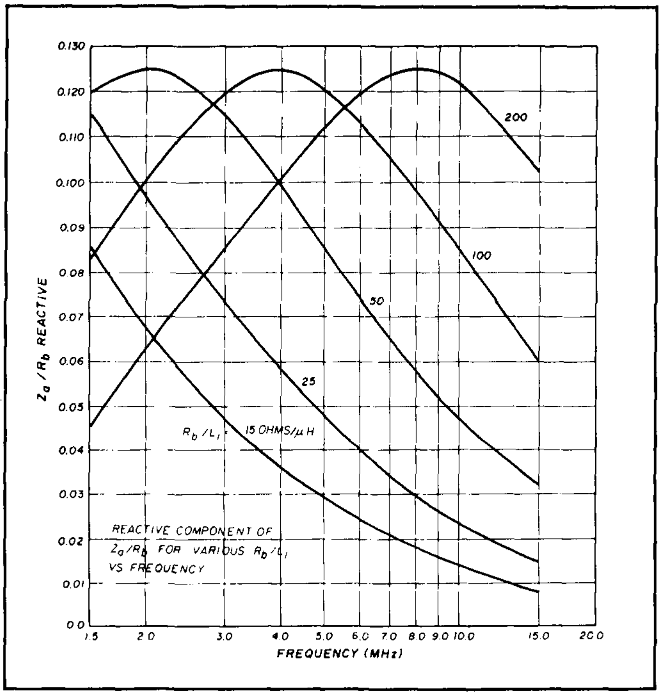


FIGURE 3B



Graphical analysis of *Equation 1.*

want to experiment with a toroid, the FT-240-61 might be a good prospect.

Consider a 13-bifilar turn arrangement at 3.5 MHz:

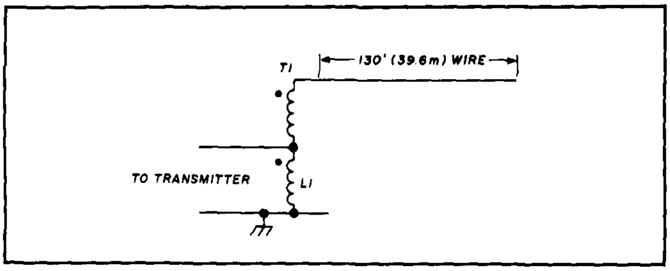
$$L1\ (in\ mH) = (turns/1000)^2 \times Al \qquad (7)$$

Where Al is in mH per 1000 turns.

$$L1\ (in\ mH) = (13/1000)^2 \times 49 \qquad (8)$$
$$= 8.28\ \mu H$$

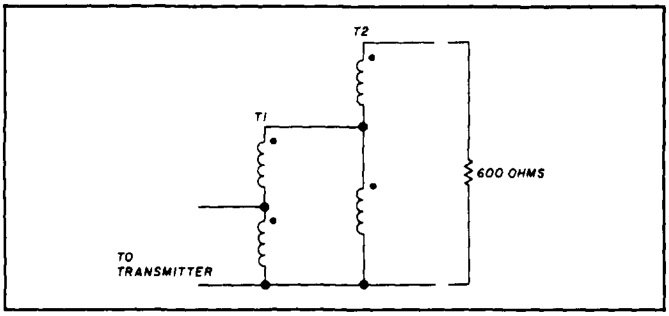
Assuming Rb is 135, the Rb/L1 ratio is 16.3 ohms per μH. Using the Rb/L1=15 ohms per μH curve in **Figure 3A** as

FIGURE 4



Using a noise bridge I determined the impedance of a 130-foot end-fed wire was nominally 135 ohms resistive. The transformer reflected this to present a 135/4 = 34 ohms load to the transmitter.

FIGURE 5



For large impedances two 1:4 transformers may be cascaded to realize a 1:16 impedance transformer. However, the inductive reactance of T2 must be large in relation to the load impedance. (See text.)

Ferrite toroids appear to be the answer. Unfortunately, they're relatively expensive and more susceptible to core saturation. I focused on the R61-050-750 ferrite rod; if you want to experiment with a toroid, the FT-240-61 might be a good prospect.

Consider a 13-bifilar turn arrangement at 3.5 MHz:

$$L1 \text{ (in mH)} = (\text{turns}/1000)^2 \times Al \quad \textbf{(7)}$$

Where Al is in mH per 1000 turns.

$$L1 \text{ (in mH)} = (13/1000)^2 \times 49 = 8.28\ \mu H \quad \textbf{(8)}$$

Assuming Rb is 135, the Rb/L1 ratio is 16.3 ohms per μH. Using the Rb/L1=15 ohms per μH curve in **Figure 3A** as a guide, you can calculate the resistive Za/Rb ratio at 3.5 MHz to be 0.23. This means the resistive portion of Za seen by the transmitter is 0.23×135=33 ohms, very close to 135/4. The reactive component, taken from **Figure 3B**, is less than 5 ohms.

As the frequency increases, the 2πfL1 becomes increasingly larger in relation to the Zb of 135 ohms, and the transformer operates correctly as a 1:4 transformer. The finished product is shown in **Photo A**.

Using cascaded 1:4 transformers for matching to larger impedances

You can modify this basic approach to match impedances exceeding 400 ohms to a nominal 50 ohms. See **Figure 5** for the circuit.

Consider a 600-ohm feedpoint impedance. A 1:16 impedance transformer consisting of two cascaded 1:4 transformers changes the impedance to 600/16=37.5 ohms, which is "close" to 50 ohms. Note that the Rb seen by the second tranformer is 600 ohms. To meet a requirement of Rb/L1 greater than 15, L1=600/15=40 μH (or 0.04 mH). The number of bifilar turns on a ferrite rod are calculated by:

$$\text{Turns} = 1000 \times \sqrt{(0.04/49)} = 28.5 \text{ bifilar turns (57 conductors)} \quad \textbf{(9)}$$

This is tight, but not impractical. But the 58 bifilar turns (116 conductors) that would be required on a T-200-2 powder iron toroid, are simply not possible.

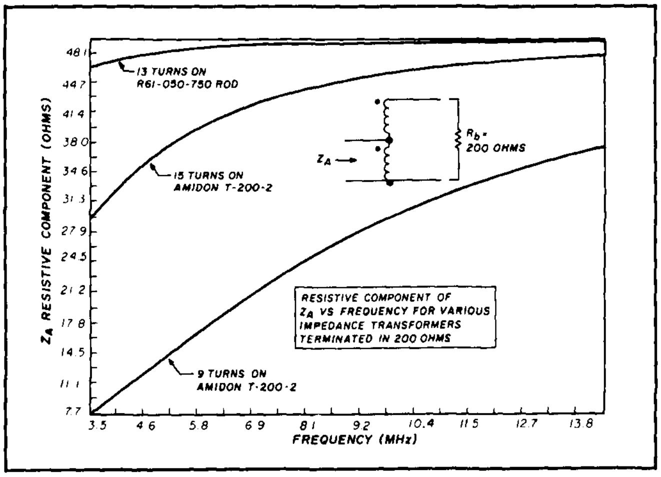
Note that the first transformer sees an Rb of 600/4=150. This tranformer can be implemented simply by using the 13 turns on a ferrite rod discussed above.

Observations

Plots of the resistance and the reactance seen on the "a" side for a number of different 1:4 transformers terminated in 200 ohms are shown in **Figures 6** and **7**. Using a noise bridge, I found that actual resistance measurements agreed closely with this theoretical performance.

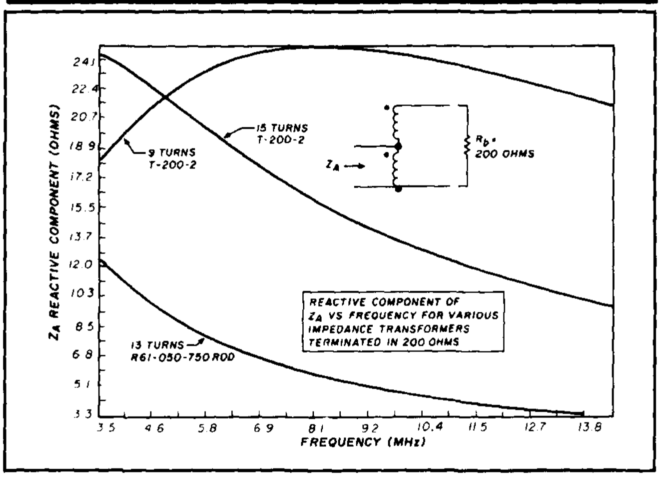
The results speak for themselves. If you want to match several hundred ohms on the 40 and 80-meter bands,

FIGURE 6



Resistive component response for various transformer materials.

FIGURE 7



Reactive component response for various transformer materials.

remember that the T-200-2 is not a Zb/4 transformer. The resistive portion of the impedance seen on the "a" side isn't anywhere close to one quarter and there's a substantial reactive component. On the other hand, the ferrite rod gives pretty good performance as a 1:4 arrangement across the HF spectrum from 80 meters up, and it might prove usable on 160 meters.

This doesn't rule out the T-200-2 as a matching transformer. You could null out the reactive component with a series capacitor, and use the "1:4 tranformer" to achieve the ratio you want by controlling the number of turns. For example, if you have a 300-ohm termination that you want to reflect as 50 ohms at 7.0 MHz, 50/300=0.167. Using **Figure 3A**, locate the point at X coordinate (7 MHz) and Y coordinate (0.167). I estimate that an Rb/L1 of nominally 130 ohms per μH passes through this point. Therefore L1=Rb/130=300/130=2.3 μH. Using a T-200-2 iron powder toroid:

$$Turns = 100 \times \sqrt{(2.3/120)} = 13.8 \quad (10)$$

To determine the reactive component use **Figure 3B**. At 7.0 MHz and Rb/L1=130, the reactive Za/Rb is nominally 0.11. Therefore, Zb reactive=0.110×300=33 ohms. This inductive component might be nulled by using a series capacitor on the "a" side: $C=1/(2\pi \times 7 \times 10^6 \times 33)=688$ pF.

Such an arrangement will probably work well across the 40-meter band. However, it won't work on higher frequency bands. You're simply using the deficiency of the 1:4 arrangement to obtain a 1:6 match at a specific frequency.

Use of 1:4 transformers with ladder line

Using my new-found knowledge, I set up the circuit in **Figure 8**. I put two 1:4 transformers (like the ones mentioned above) back to back. A 100′ length of 450-ohm ladder line stretching out the back door, around the house, in the front door, and back to the shack provided me with access to both the "transmit" and "antenna" sides for power measurements.

Theoretically, the 50-ohm dummy load is reflected (transformed) as 200 ohms, and on the other side of the line the 200 ohms is reflected as 50 ohms. This results in a relatively high VSWR on the transmssion line, but relatively little power dissipation.

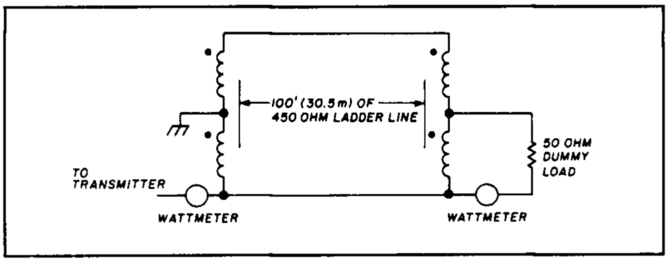
The results seemed too good to be true. The loss in the transmission line from the low end of 80 meters through the high end of 20 meters was less than 10 percent — including the two transformers. Viewed at the transmitter side of the arrangement, the SWR was better than nominally 2:1. On 160 meters the SWR was high, but correctable with a tuner. Even on 160 there was relatively little transmission line loss! Results on the 15 and 10-meter bands were difficult to interpret; this might be due to a less than ideal dummy load.

I have subsequently run tests on various lengths of ladder line and seem to be able to repeat my results. This leads me to conclude that most of the lost power is dissipated in the transformers. However, the efficiency of each transformer appears to be 95 percent.

Putting it all together

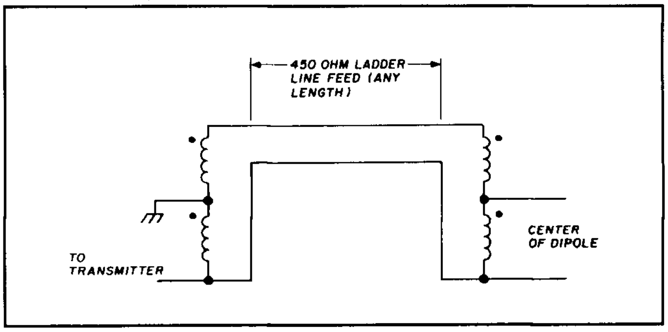
My next step was to apply this "discovery" to feeding dipole antennas normally fed with 50-ohm coaxial cable.

FIGURE 8



Two 1:4 transformers were connected back to back on the two sides of a 100-foot length of 450 ladder line. Ninety percent of the power delivered by the transmitter with a 50-ohm output impedance was delivered to the dummy load for 160 through 20 meters.

FIGURE 9



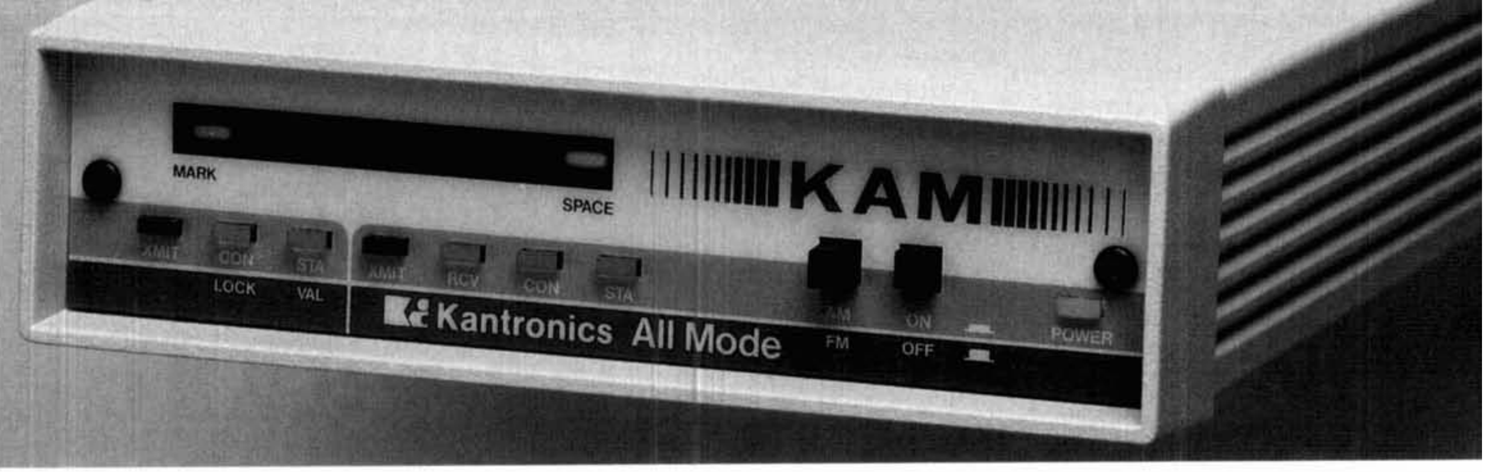
It appears feasible to feed 50-ohm loads using any length of ladder line terminated at each end with a 1:4 ferrite rod transformer over the HF bands from 80 meters and up. Note that the ladder line is balanced, transmitter ground is applied at the center of the transformer.

My previous attempts to feed dipoles with ladder line had drawbacks. One of my techniques involved terminating the ladder line directly at the center of the antenna, and on the transmitter side using a tuner capable of assuming different configurations. This let me load the antenna with "brute force."* The technique worked well, but I'm a firm believer in having a lot of antennas and I can't afford the space or money necessary to devote a tuner of this type to each antenna. My other technique was to use a delta match consisting of wires fanning down to meet the transmission line. I never had much luck with this method, and the family was forever getting entangled in wires that fell from the sky.

The arrangement in **Figure 9** has proven successful in feeding simple antennas without a tuning arrangement. The 1:4 transformer between the rig and the transmission line is an unbalanced-to-balanced arrangement, and ground is fed to the center of the transformer. The second transformer is mounted at the center of the dipole.

The results have been good. I've used this approach with standard dipoles on 80, 40, and 20 meters. The 40-meter dipole also performed well on 15 meters. **Figure 10** shows summarized results. In all cases except on 80 meters the SWR was better than 2:1 across the entire band. Using a very simple fixed series L/fixed shunt C tuner arrangement, I was able to obtain a match of close to 2:1 across the entire 80-meter band.

*Both matching techniques are discussed in detail in Doug DeMaw's book *W1FB's Antenna Notebook*, ARRL, 1987.



If You Want the Most Advanced TNC Today...

In 26 countries around the world, tens of thousands of amateurs know that Kantronics is the leader in bringing tomorrow's technology to their stations today. They also know they will always be among the first to incorporate just-introduced features and modes with Kantronics software and firmware updates.

And, they know that Kantronics is unique in its ability to seek out, develop and incorporate the most advanced features into each of five different TNC models before anyone else. Why? Because every program Kantronics writes, and every unit Kantronics designs and produces are born right here at the factory in the U.S.A.

Meet Your Mailman

In this agè of telco LANS, E-mail and FAX,

PBBS is just one of the firsts Kantronics delivered.

you will know you have mail in your **Personal Packet Mailbox**™ when your KAM "STA" LED is blinking. New firmware level 2.85 has also added a handy automatic mailbox user-connect. So save your computer and monitor life by turning them off when you are away, and never miss a beat on the airwaves.

Version 2.85 KAMs have increased Packet Cluster™ compatibility, **KA-NODE**™ path preservation, KA-NODE recognition of the "NET" nodes and HF baud rates from 50 through 300! And there are three new mailbox commands: *List Mine, Read Mine* and *Kill Mine.*

and Tomorrow...

Will the Real Dual-Port Please Stand Up?

Read our lips. **The KAM™ is the only true dual- port when it comes to packet.** Your Personal Packet Mailbox™ is accessible from both HF and VHF! Version 2.85 has dual-port compatibility with RLI/MBL boards and KISS mode for both ports. You can monitor HF and VHF packet operations at the same time. Users can even gateway from HF to VHF (or in reverse) through your KAM.

Kantronics **All-Mode**™ (KAM) has Packet, WEFAX, ARQ, FEC, RTTY and CW reception. But we have five models to suit your particular taste. **Ask your dealer for the best choice today...and tomorrow.**

Kantronics
RF Data Communications Specialists
1202 E. 23rd Street Lawrence, Kansas 66046
(913) 842-7745

✓ 147

Sixteen Ways To Start A Great Conversation.

1 **Maximum singleband HT performance.** Yaesu's compact, 2-meter FT-411 gives "sophisticated HT operation" a whole new meaning. With 49 memories. Dual VFOs. Keyboard frequency entry. Automatic repeater shift. DTMF autodialer (10 memories, 15 digits each). Built-in PL encode/decode. Extended receive. "Do-re-mi" audible command verification. Backlit display and keypad. Battery saver. Automatic power-off feature. Rotary channel selector. 2.5-watt battery pack (optional 5-watt pack available). Much more.

2 **Mini HT packs big performance.** Choose Yaesu's miniature FT-23R Series for serious pocket-size performance. 2-meter, 220-MHz, and 440-MHz models. Includes 10 memories (7 store odd splits). Memory scan at 2 frequencies per second. High/low power switch. LCD power output and "S"-meter display. Lots of PL features. Auto battery saver. Aluminum-alloy case. Water-resistant seals. Variety of battery packs available, from 2 to 5 watts. More.

3 **Interchangeable HT options.** To help save you a bundle of money, many HT options are interchangeable throughout Yaesu's HT line. Choose the FNB-12 12-volt, 500-mAh battery pack. The miniature FNB-9 7.2-volt, 200-mAh battery pack. FBA-9 battery case for 6 AAA-size cells. FBA-10 battery case for 6 AA-size cells. DC car adapter/charger. Mobile hanger bracket. External speaker/microphone. Battery chargers. More.

4 **FM Repeaters.** Looking for a repeater? Look no further. Our 2-meter and 440-MHz models feature 10 watts output. Glass-epoxy circuit boards. Plus they're FCC type accepted and ready for 19″ rack mounting. Yaesu repeaters are the perfect building block for a complete repeater station.

5 **Space Station.** Work satellites, moonbounce, troposphere, aurora, and meteor scatter with our FT-736R VHF/UHF base station. SSB, CW, and FM on 2 meters and 70 cm (430-450 MHz!) standard. Slots for optional 50-MHz, 220-MHz, or 1.2 GHz modules. Crossband full duplex capability. Satellite frequency tracking function. 25 watts on 2 meters, 220 MHz, and 70 cm (10 watts on 6 meters and 1.2 GHz). 100 memories. RF speech processor. IF shift. IF notch filter. CW and FM wide/narrow IF filters. VOX. Noise blanker. Three-position AGC selection. Much more.

6 **Mobiles that double as answering machines.** Our FT-212R Series mobiles take messages just like an answering machine (with DVS-1 option)! 2-meter and 440-MHz models. 45 watts output (35 on 440-MHz). Autodialer DTMF mic with 10 memories (22-digit memory each). 18 memories. Multiple scanning routines. "Do-re-mi" audible command verification. High/low power switch. Oversize amber display. Much more.

7 **Mobiles you can take on foot.** Our FT-290R Mark II Series (2-meter, 430-450 MHz, and 6-meter models) come standard as mobiles. But remove the heat sink and snap-on the optional battery pack, and you're ready to take your operation on foot! Mobile operation: 25 watts output (10 watts, 6 meters). Battery pack: 2.5 watts output. With SSB, CW and FM. 10 memories. Dual VFOs. LCD display. Offset tuning. Relative power-output/S meter. More.

Prices and specifications subject to change without notice. PL is a registered trademark of Motorola, Inc. Specifications guaranteed only within amateur bands.

8 **Dual-band mobile with remote control head.** The FT-4700RH mounts almost anywhere—the "brains" on your dash, visor, or door, the "muscle" under your seat. 50 watts output on 2 meters, 40 watts on 70 cm. Full crossband duplex. Simultaneous monitoring of each band. Volume balance control for dual receive operation. 9 memories (each band). Extended receive coverage. Reverse repeater shift. Bright dual-band display. 10 memory autodialer mic (option). More.

HF price/performer. Don't let the FT-747GX's affordable price fool you. This rig 9 really works the DX! 100 watts RF output on 160 to 10 meters. Continuous receive from 100 kHz to 30 MHz. LSB, USB, CW, and AM. Slot for optional FM unit. 20 memories. Split-frequency operation. CW and AM filters. Plus one-touch noise blanker. All-mode squelch. RIT. 20-dB attenuator. Great receiver with superb overload protection. More.

10 **HF field-day favorite.** Contesters appreciate the portability and performance of Yaesu's FT-757GX Mark II. 100-watt output. 10 memories. Dual VFOs. Slow/fast tuning selection. IF notch filter. Iambic keyer. 600-Hz CW filter. AF speech processor. 500 kHz to 30 MHz receive. 10 to 160 meters transmit, including WARC bands. All-mode coverage. QSK operation. Continuous RTTY operation up to 30 minutes. More.

11 **Flex your RF muscle.** Cut through pile-ups with our FL-7000 power amplifier. 160 to 15 meter coverage. Built-in power supply. Automatic tuner. Fast turnaround for break-in (QSK) CW, HF packet, and AMTOR. 70 watts excitation for full output, 1200 watts PEP input. More.

World's first HF/VHF/UHF base station. Talk about complete. The FT-767GX gives you 160 to 10-meter transmit standard. Optional plug-in modules for 6-meter, 2-meter and 70-cm operation. 100 kHz to 30 MHz 12 receive. AM, FM, SSB, CW, AFSK modes built in. 10 memories for frequency, mode, and CTCSS info. Dual VFOs. VFO tracking. Digital display in 10 Hz steps. Slow/fast main dial tuning. Synthesizer step programming at up to 99.99 kHz per step. Digital RF power/SWR meter. Built-in RF preamplifier. And these are just a few highlights!

13 **Serious VHF/UHF Receiver.** Our FRG-9600 is a smart way to monitor. 60 to 905 MHz coverage. USB, LSB, CW, AM, FM wide and narrow. Optional NTSC video module. Scanning steps of 5, 10, 12½, 25 and 100 KHz. 99 memories store frequency and mode. Memory scan (also scans between memories). Keyboard frequency entry. 24 hour clock. Multiplexed output. Fluorescent readout. Signal strength graph. AC power adapter. Much, much more.

World-class HF receiver. 14 The FRG-8800's perfect for keeping up with the world. Continuous coverage from 150 KHz to 30 MHz. Expanded coverage with optional 118-174 MHz VHF converter. USB, LSB, CW wide/narrow, AM wide/narrow, FM. 12 memories. Also programmable scanning routines. Keyboard frequency entry. LCD display. SINPO signal graph. Computer interface capability. Two 24-hour clocks. Recording functions. Much more.

Antenna rotators for your application. 15 Our G-1000DX, G-800SDX/G-800S, and G-400RC models feature 360° "radio compass" control heads, and are compatible with most tower-plate configurations. Plus G-1000SDX and G-800SDX models feature 450° rotation and presets.

AZ-EL rotators for space applications. 16 Into OSCAR or moonbounce? Choose our G-5400B or heavy-duty G-5600B AZ-EL rotator. Each is compatible with many vendors' tracking software. And for stand-alone elevation control, choose our G-500A elevation rotator.

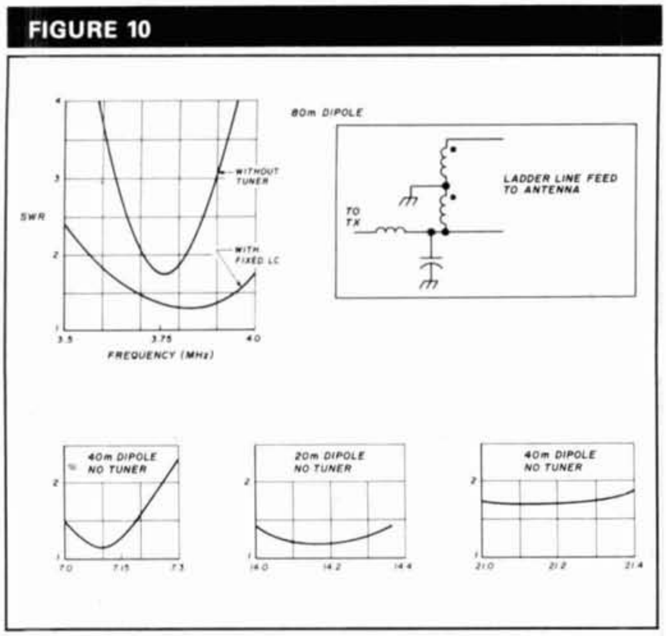
Visit your Yaesu dealer. And discover the full range of Yaesu radios, accessories and options firsthand.

Yaesu. Where great conversations always begin.

YAESU

✓ 152

Yaesu USA 17210 Edwards Road, Cerritos, CA 92701 (213) 404-2700. **Brochure Info:** (800) 999-2070. **Repair Service:** (213) 404-4884. **Parts:** (213) 404-4847.



Three separate dipoles (80, 40, and 20 meters) were erected, each with separate feeds consisting of ladder line terminated with ferrite rod transformers. The 40-meter dipole was also used on 15 meters. Performance on 40, 20, and 15 was excellent with an SWR consistently less than 2:1 across the entire band. No tuner was required. On 80 meters, the bandwidth was relatively narrow and a very simple tuner consisting of a series L, shunt C was inserted on the transmitter side of the transformer.

One of the beauties of ladder line is that it's relatively lossless. Most of us don't have enough property to run 500 feet from the shack to that ideal antenna location — but some may, and this is the way to go.

Many hams want to ragchew on 3.9 MHz and also work CW or the DX window on the low end of the band using the same antenna. This poses a problem when feeding an 80-meter dipole with coax. You must choose a compromise resonant frequency and use a tuner for frequencies far removed from it. You can measure full power at the tuner, but the loss in the coaxial feed will be high. By using the ladder line in conjunction with the 1:4 tranformers at each end, you can use a tuner on the transmitter side of the transformer and have confidence that most of the power is reaching the antenna.

I've run all my dipoles at 700-watts output CW for several months with no evidence of flashover, saturation, or core heating. Even so, use some care. Attempting to load an 80-meter dipole on 40 meters presents the transformer with an impedance of several thousand ohms. This results in very high potentials, which may saturate the core and cause the windings to flash over.

Construction notes

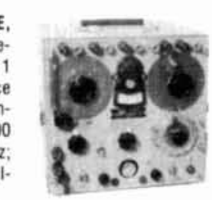
The design which uses 13 turns on a ferrite rod has become my standard 1:4 transformer for impedances less than 400 ohms. The designs intended for indoor use may be either self-supporting or mounted on any miscellaneous mini box. The outdoor design is packaged in 3/4" PVC pipe. I used epoxy to secure the end caps and sealed the seams externally with RTV silicone. I fastened the entire assembly to a conventional ceramic insulator using cable ties.

Electrical parts are relatively easy to find. But I would stay away from miscellaneous toroids sold at hamfests. The computer industry manufactures many types of toroids to suppress the electromagnetic interference caused by high-speed switching noise, and these seem to have flooded the market. They are not suitable for this transformer application. There appears to be no standard color coding of ferrite toroids; unless you have a lot of faith in the seller, I wouldn't waste my time.

Three *Ham Radio* advertisters carry toroids and rods: Amidon, Palomar, and Radiokit. Amidon and Radiokit also carry the Scotch no. 27 glass tape I used to bind the two conductors tightly together. They also have a complete line of heavy Thermaleze™ insulated wire; I used 14 gauge.

Summary

I've provided a way to design and analyze 1:4 impedance transformers and given examples of some successful designs. I've had great success feeding dipoles with ladder line in the same way I'd feed them using coaxial cable. The materials are inexpensive and readily available. You don't need special tools, exotic metalwork, complex instrumentation, or large amounts of money. Give these designs a try, extend them to other types of antennas, and let me know your results. hr



RAMSEY ELECTRONICS

Quality Test Gear & Electronic Kits for Professionals and Hobbyists

COM-3

$2495.00 THE COMMUNICATIONS SERVICE MONITOR THAT WORKS HARDER FOR LESS.

Introducing COM-3 . . . the new service monitor designed by service technicians for service technicians. It works harder for less . . . giving you advanced testing capabilities at a very affordable price. FEATURES • Direct entry keyboard with programmable memory • Audio & transmitter frequency counter • LED bar graph frequency/error deviation display • 0.1-10,000 μv output levels • High receive sensitivity, less than 5 μv • 100 KHz to 999.9995 MHz Continuous frequency coverage • Transmit protection, up to 100 watts • CTS tone encoder, 1 KHz and external modulation

PR-2 COUNTER PREAMP

$49.95 wired includes AC adapter PR-2 kit $39.95

The PR-2 is ideal for measuring weak signals from 10 to 1,000 MHz • flat 25 db gain • BNC connectors • great for sniffing RF • ideal receiver/TV preamp • 3 db NF

PS-2 AUDIO MULTIPLIER

$69.95 wired PS-2 kit $49.95

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

PS-10B 1.5 GHz PRESCALER

$89.95 wired includes AC adapter

Extends the range of your present counter to 1.5 GHz • 2 stage preamp • divide by 1000 circuitry • super sensitive (50 mV typical) • BNC connectors • 1.5 GHz in, 1.5 MHz out • drives any counter.

ALL NEW KITS

PERSONAL SPEED RADAR

Complete kit SG-7 **$89.95**

New low cost microwave doppler radar kit "clocks" cars, planes, boats, horses, bikes, baseballs, models, runners or virtually anything that moves. Operates at 2.6 GHz with over 1/4 mile range. LED digital readout displays speeds in miles per hour, kilometers per hour or feet per second! Earphone output permits listening to actual doppler shift. Uses two 1 lb coffee cans for antenna (not included) and runs on 12 VDC. Easy to build—all microwave circuitry is PC stripline. Kit includes deluxe ABS plastic case with speedy graphics for a professional look. A very useful and full-of-fun kit.

RADIOS

40 & 80 METERS HAM RECEIVERS

Sensitive all mode AM, CW, SSB receivers for 3.5—4.0 or 7.0—7.5 MHz. Direct conversion design using NE602 IC as featured in QST and ARRL handbooks. Less than 1 μv sensitivity, varactor diode tuned, 50 mw audio output. Runs on 9VDC, has RF gain control. This kit is very easy to build, lots of fun and educational—ideal for the beginner or the old pro. The optional matching case kit features a rugged ABS plastic case with screened graphics. Included are machined aluminum knobs for a well-finished professional look.

40 Meter receiver kit, HR-4 **$24.95** 80 Meter receiver kit, HR-8 **$24.95** Receiver case kit, CHR **$12.95**

QRP TRANSMITTER KITS, 40 & 80 METERS

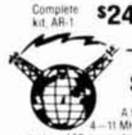
Operate a mini ham shack. These little CW rigs are ideal mates to our 40 and 80 meter receivers. Features include smooth variable tuning, one watt output and excellent keying characteristics. Runs on 12 VDC and is VSWR protected. See how far you can stretch your signal with one of these mini rigs. Optional ABS cases are available.

40 meters QRP rig, QRP-40 **$24.95** 80 meters QRP rig, QRP-80 **$24.95** Case kit, CQRP **$12.95**

AIRCRAFT RECEIVER KIT

Hear exciting aircraft communications—picks up planes up to 100 miles away. Receives 110—136 MHz AM air band, varactor tuned superhet design with AGC, ceramic filter and adjustable squelch. Runs on 9V battery, 50 mw audio output, 1 μv sensitivity. Optional matching ABS plastic case lets you take it anywhere, features screened graphics and machined aluminum knobs for a real professional look. Compact—great for airshows or for just plain hanging around the airport.

Complete kit, AR-1 **$24.95** Receiver case kit, CAR-1 **$12.95**



SHORTWAVE RECEIVER KIT

A fantastic receiver that captures the world with just a 12" antenna! Receives 4—11 MHz in 2 MHz bands, varactor tuned, superhet design with AGC, RF gain control, and 50 mw audio output. Uses new Signetics mixer chip for less than a microvolt sensitivity, runs on 9V battery. This is a fascinating scout, school or club project, and will provide hours of fun even to the most serious DX er. Add the optional case kit and you have a real nice looking shortwave set.

Complete kit, SR-1 **$24.95** Receiver case kit, CSR-1 **$12.95**

PACKET RADIO

Commodore C64/128 packet radio interface. Uses famous German Digicom software. Features EXAR IC chip set for reliable operation—runs HF or VHF tones. Includes FREE disk software, PC board, all necessary parts and full documentation.

Complete kit, PC-1 **$49.95**

FM COMMUNICATIONS/2 METER RECEIVER

Sensitive superhet FM receiver tunes any 5 MHz segment from 135—175 MHz. Listen to 2 mtr ham operations, high band police calls, weather or mobile phone calls! Easy to build receiver features varactor tuning, IC mixer stage, ceramic IF filters and dual conversion design with adjustable squelch. Less than 1 μv sensitivity, runs on 9 V battery, with 50 mw audio output. Optional ABS case with screened graphics and machined aluminum knobs provide a nice professional look.

Complete kit, FR-7 **$29.95** Receiver case kit, CFR-7 **$12.95**

FREQUENCY COUNTERS

CT-70 7 DIGIT 525 MHz

$139.95 WIRED INCLUDES AC ADAPTER

CT-90 9 DIGIT 600 MHz

$169.95 WIRED INCLUDES AC ADAPTER

CT-50 8 DIGIT 600 MHz

$189.95 WIRED INCLUDES AC ADAPTER

CT-125 9 DIGIT 1.2 GHz

$189.95 WIRED INCLUDES AC ADAPTER

Ramsey Electronics has been manufacturing electronic test gear for over 10 years and is recognized for its lab quality products at breakthrough prices. All of our counters carry a full one year warranty on parts and labor. We take great pride in being the largest manufacturer of low cost counters in the entire USA. Compare specifications. Our counters are full featured, from audio to UHF, with FET high impedance input, proper wave shaping circuitry and durable high quality epoxy glass, plated-thru PC Board construction. All units are 100% manufactured in the USA.

ACCESSORIES FOR COUNTERS

Telescopic whip antenna—BNC plug	$ 8.95
High impedance probe, light loading	16.95
Low pass probe, audio use	16.95
Direct probe, general purpose use	13.95
Tilt bail for CT-70, 90 & 125	3.95
Nicad pack for CT-70, 90 & 125	8.95

MODEL	FREQ RANGE	SENSITIVITY	ACCURACY	DIGITS	RESOLUTION	PRICE
CT-70	20 Hz-550 MHz	< 50 mv To 150 MHz	1 PPM	7	1 Hz, 10Hz, 100Hz	139.95
CT-90	10 Hz-600 MHz	< 10mv To 150 MHz < 150mv To 600 MHz	1 PPM	9	0.1Hz, 10Hz, 100 Hz	169.95
CT-50	5 Hz-600 MHz	LESS THAN 25 mv	1 PPM	8	1Hz, 10Hz	189.95
CT-125	10 Hz-1.25 GHz	< 25mv @ 50 MHz < 15mv @ 500 MHz < 100mv @ 800 MHz	1 PPM	9	0.1Hz, 1Hz, 10Hz	189.95
CT-90 WITH OV-1 OPTION	10 Hz-600 MHz	< 10mv To 150 MHz < 150mv To 600 MHz	0.1 PPM	9	0.1Hz, 1Hz, 10Hz	229.90

MINI KITS—EASY TO ASSEMBLE—FUN TO USE

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**

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 110VAC. ML-1 Kit **$8.95**

VIDEO MODULATOR 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 **$7.95**

FM WIRELESS MIKE 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**

LED BLINKY KIT Alternately flashes 2 jumbo LEDs. Use for name badges, buttons, warning panel lights. Runs on 3 to 15 volts. BL-1 Kit **$2.95**

MAD BLASTER 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**

40 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, 5 W in for 40 W out. Max output of 50 W, incredible value, complete with all parts, less case and T-R relay. PA-1, 40 W pwr amp kit **$27.95** TR-1, RF sensed T-R relay kit **6.95**

VOICE ACTIVATED SWITCH Voice activated switch kit provides switched output with current capability up to 100 mA. Can drive relays, lights, LED or even a tape recorder motor. Runs on 9 VDC. VS-1 KIT **$6.95**

UNIVERSAL TIMER 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**

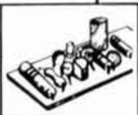
WHISPER LIGHT An interesting kit, small mike picks up sounds and converts them to light. The louder the sound, the brighter the light. Includes mike, controls up to 300 W, runs on 110 VAC. WL-1 Kit **$6.95**

SIREN Produces upward and downward wail. 5 W peak audio output, runs on 3-15 volts, uses 3-45 ohm speaker. Complete kit, SM-3 **$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 2W rms output, runs on 6 to 15 volts, uses 8-45 ohm speaker. BN-9 Kit **$5.95**

60 Hz TIME BASE Runs on 5-15 VDC. Low current (25ma). 1 min/month accuracy. TB-6 Kit **$5.50** TB-6 Assy **$9.95**

TELEPHONE TRANSMITTER Low cost with professional performance. Features include: self phone line powered, tunable from 76 to 100 MHz, polarity antisensitive, compact size (1" x 1¼"), easily installs anywhere on the phone line or inside the instrument itself. PB-1 KIT **$14.95**



FM RECEIVER For built-in applications or hobby experimentation. Full fledged superhetrodyne receiver, microvolt sensitivity, 10.7 MHz IF, Integrated Circuit detector, 50 mw audio amplifier, 9V external power source, operation on standard FM broadcast band as well as large portions on each side, compact (6" square), for bug detection or reception. FR-1 KIT **$14.95**

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 **19.95**

NEW

MICROWAVE INTRUSION ALARM A real microwave doppler sensor that will detect a human as far as 10 feet away. Operates on 1.3 GHz and is not affected by heat, light or vibrations. Drives up to 100 ma output, normally open or closed, runs on 12 VDC. Complete Kit, MD-3 **$16.95**

NEW

SPEECH SCRAMBLER Communicate in total privacy over your telephone or radio. This scrambler kit features full duplex operation using frequency inversion. Runs on a 9 volt battery. Both mike and line or speaker output/inputs. Easy to connect to any radio—telephone use requires no direct connection! Easy to build, uses IC DBM circuitry. Can also be used to descramble most com. scramblers. Complete kit, SS-7 **$29.95** Case kit, CSS-7 **12.95**

NEW MINIKITS—NEW MINIKITS

BROADBAND PREAMP A sensitive all purpose preamp, ideal for scanners, TV sets, VHF, UHF rigs, counters, etc. Features low noise, 4 db NF, 20 db gain, 100 KHz—1 GHz operation. Runs on 9—12 VDC, 50 ohms input. Complete kit, SA-7 **$12.95**

LIGHT BEAM COMMUNICATORS Transmits modulated infrared light up to 30 feet without lenses, up to 1/4 mile using lenses. Uses 30 KHz carrier for hum-free operation, transmits thru windows, etc. Ideal for "bugs" or listening to IR remote controls. Transmitter has sensitive mike input, receiver uses PIN detector and drives speaker output. Units operates on 9—12 VDC. Transmitter kit LB-6 **$8.95** Receiver kit LB-5 **$9.95**

HIGH POWER FM WIRELESS MIKE A high power unit that will transmit up to 1/2 mile to any FM broadcast radio. Sensitive input accepts any type of mike, will pick up normal voices 10 feet away using the available mini-electric mike cartridge. Operates on 9—12 VDC. FM-4 kit **$9.95** Sensitive microphone cartridge **$2.95**

2 MTR & 220 BOOSTER AMP

Here's a great booster for any 2 meter or 220 MHz hand-held unit. These power boosters deliver over 30 watts of output allowing you to hit the repeaters full quieting while the low noise preamp remarkably improves receptions. Ramsey Electronics has sold thousands of 2 mtr amp kits but now, we offer completely wired and tested 2 mtr as well 220 MHz units. Both have all the features of the high priced boosters at a fraction of the cost.

- 30 WATTS OUTPUT
- LOW NOISE PREAMP
- LOW COST
- RUGGED CAST ALUMINUM CASE
- ONE YEAR WARRANTY

PA-10 2 MTR POWER BOOSTER (10 X power gain) Fully wired & tested $59.95
PA-20 220 MHz POWER BOOSTER (8 X power gain) Fully wired & tested $59.95

TERMS: • satisfaction guaranteed • examine for 10 days; if not pleased, return in original form for refund • add 6% for shipping and insurance to a maximum of $10.00 • foreign add 15% for surface mail • COD add $2.50 (COD in USA only) • orders under $20.00 add $1.50 • NY residents add 7% sales tax • 90 days parts warranty on all kits • 1 year parts & labor warranty on all wired units.

PHONE ORDERS CALL 716-586-3950

FAX 716-586-4754

RAMSEY ELECTRONICS, INC., 2575 Baird Rd., Penfield, N.Y. 14526

A NOVEL METHOD FOR MEASURING CABLE ATTENUATION

By A. E. Popodi, OE2APM/AA3K, Moosstrasse 7, A-5020 Salzburg, Austria

The simplest way to determine cable loss is to measure the difference between input and output power with an RF wattmeter. A more accurate method is to measure the cable input and output voltages with an RF voltmeter and calculate the cable loss in nepers from the formula $\alpha = log_E \frac{Vin}{V\ell}$ where Vin is the input voltage and $V\ell$ the output (load) voltage. Both methods require a power source with an output impedance matching that of the cable and a known characteristic impedance Zo. Accuracy suffers if there is a matching error. Ground currents in the test setup can cause false readings. This method becomes very unreliable if α is small (i.e., the cable is short). If you want to measure the loss of a 2-meter length of RG-213 cable at a frequency of 28 MHz using this method, you'll find that the input and output voltage differ by only 0.89 percent. It's very difficult to make credible and meaningful measurements on short cables because of this small input/output voltage differential.

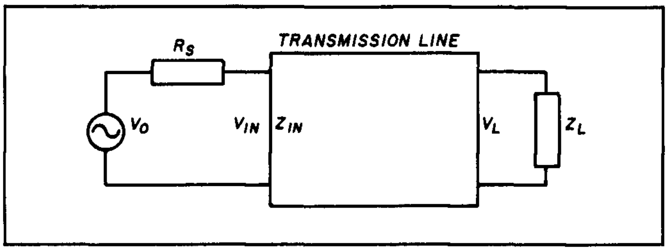
The method I've developed doesn't suffer from this shortcoming. It's based on the unique properties of an unterminated, quarter-wavelength transmission line driven from a low-impedance source. (See **Figure 1**.)

At the quarter-wavelength frequency, the cable input impedance (Zin) is very low — typically less than 1 ohm. The input voltage (Vin) is at minimum and the cable output voltage ($V\ell$) is high. Resistor Rs is the source impedance of the voltage source Vo.

The general expression for the ratio of input to output voltage is given in **Equation 1**:

$$\frac{Vin}{V\ell} = cosh\ (\alpha + j\beta) + \frac{Zo}{Z\ell} sinh\ (\alpha + j\beta) \qquad \textbf{(1)}$$

FIGURE 1



Block diagram of the setup for measuring cable attenuation.

where Zo is the characteristic impedance, $Z\ell$ is the load impedance, α is the cable attenuation in nepers, and β is the cable length in radians — in our case $\frac{\pi}{2}$. For the ideal case of the unterminated cable, this expression reduces to:

$$\frac{Vin}{V\ell} = cosh \left(\alpha + j \frac{\pi}{2}\right)$$

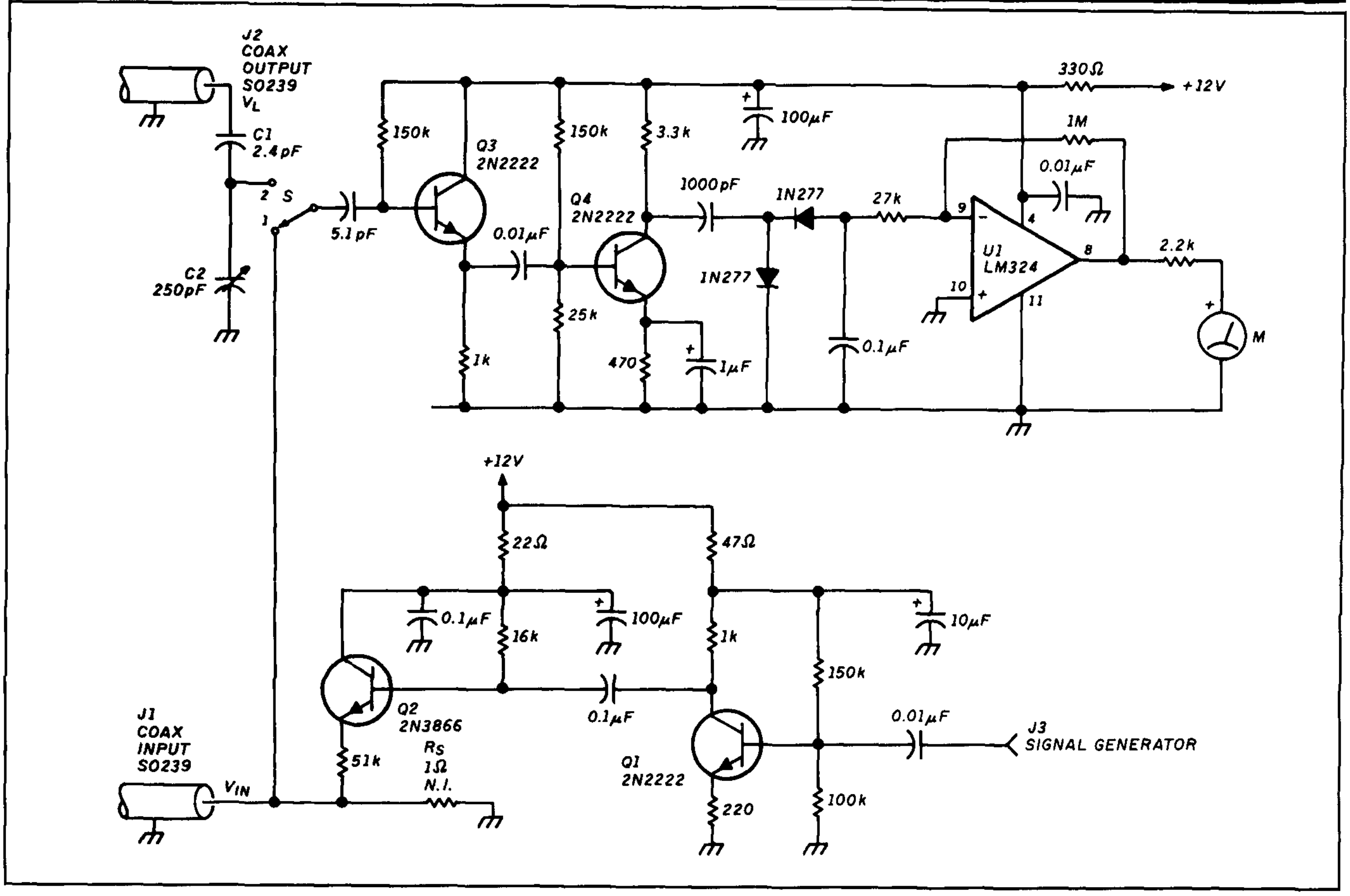
Using the formula cosh(α + j β) = cosh α cos β + jsinh α sin β we have:

$$\frac{Vin}{V\ell} = j\ sinh\ \alpha \qquad \textbf{(2)}$$

Since α is a small number, sinh α is nearly equal to α. (For example, if α = 0.147 neper, the error caused by this simplification is only 0.5 percent.) The operator (j) indicates a 90-degree phase shift between the two signals. Using absolute values, you have:

$$\frac{Vin}{V\ell} = \alpha\ in\ nepers \qquad 1\ neper = 8.6859\ dB. \qquad \textbf{(3)}$$

FIGURE 2



Schematic of the complete test circuit for determining the voltage ratio for accurately determining the cable attenuation.

The cable attenuation in nepers is very nearly equal to the ratio of the two voltages. As a result, Vℓ may be 50 times larger than Vin, depending on cable loss.

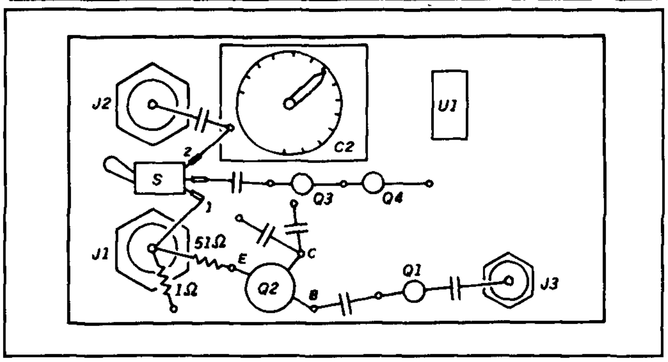
Equation 2 is only valid if load impedance Zℓ is infinitely high. In practice, you have a capacitive load impedance (Zℓ) and a slightly inductive source impedance (Rs). That means you must use **Equations 1** and **6** to evaluate the effect on the voltage ratio $\frac{Vin}{V\ell}$.

You don't need a precision RF voltmeter to measure this voltage ratio if you use a capacitive voltage divider for Vℓ and compare the divided voltage with Vin in a simple voltage comparator. This gives you the advantage of being able to make Zin very high. **Figure 2** shows the schematic of the complete test circuit.

A signal generator is connected to the input of isolation amplifier Q1 that feeds the emitter follower and cable driver Q2. Resistor Rs is a noninductive 1-ohm resistor that presents a low source impedance to the cable input at terminal J1. At the cable output (J2), there is a capacitive voltage divider consisting of a small 2.4-pF fixed capacitor (C1) and a 250-pF variable capacitor (C2). Switch S alternately connects Vin (position 1) or the divided voltage Vℓ (position 2) to a post-amplifier (consisting of emitter follower Q3 and amplifier Q4) with high input impedance. The rectified RF signal is amplified in operational amplifier U1 that drives indicator instrument M.

You must *carefully* choose the biasing of transistor Q1 and emitter follower Q2 to avoid waveform distortion in Q2. Because the cable output waveform is always better than a possibly distorted input signal, voltage comparison may be degraded due to waveform differences between the two signals. **Figure 3** shows a recommended layout for the test fixture.

FIGURE 3



Component layout of the cable-attenuation test circuit.

Switch S is mounted between connectors J1 and J2. (I recommend using a silver-plated brass plate as the mounting surface in order to reduce the effect of ground loops.) It's important that the lead lengths to and from capacitor C1 be as short as possible to obtain a frequency-independent capacitive voltage divider.

here is the next generation Repeater

2 meters - 220 - 440

MARK 4CR

The only repeaters and controllers with REAL SPEECH!

No other repeaters or controllers match Mark 4 in capability and features. That's why Mark 4 is the performance leader at amateur and commercial repeater sites around the world. Only Mark 4 gives you Message Master™ real speech • voice readout of received signal strength, deviation, and frequency error • 4-channel receiver voting • clock time announcements and function control • 7-helical filter receiver • extensive phone patch functions. Unlike others, Mark 4 even includes power supply and a handsome cabinet.

Call or write for specifications on the repeater, controller, and receiver winners.

Create messages just by talking. Speak any phrases or words in any languages or dialect and *your own voice* is stored instantly in solid-state memory. Perfect for emergency warnings, club news bulletins, and DX alerts. Create unique ID and tail messages, and the ultimate in a real speech user mailbox — only with a Mark 4.

MICRO CONTROL SPECIALTIES

Division of Kendecom Inc.

23 Elm Park, Groveland, MA 01834 (508) 372-3442

TELEX 4932256 Kendecom

FAX 508-373-7304

✓ 159

PacComm

• *Advanced Technology* • *Enduring Value*

9600 Baud Packet System

SEE YOU AT DAYTON — BOOTHS 277-279

Introducing the next generation in packet performance: A complete line of affordable 9600 baud packet equipment to support both network nodes and local packet users. The modem is based on PacComm's successful 9600 baud commercial modem design (exclusively licensed from James Miller, G3RUH). It is a high performance FSK design using innovative signal processing techniques to comply with FCC bandwidth limitations on the 6 and 2 meter amateur bands as well as higher frequencies. The modem connects to the radio internally and may not be suitable for use with all existing radios.

Other packet manufacturers plan to offer equipment compatible with the PacComm 9600 Packet System.

We accept major credit cards. Order Toll Free:
1-800-223-3511
Technical support line: (813) 874-2980

MODEM CARD - Add on internal modem card for TNC-2 and clones, and all PacComm TNCs... $99.95 fully tested and ready to install. (Avail. Now)

EXTERNAL MODEM - Encased 9600 baud modem with front panel LED displays and cabling for most popular packet controllers including the PK-232... $159.95 (Avail. late April)

HIGH SPEED DIGITAL RADIO - Digital transceiver consisting of digital 2-5 watt RF deck and 9600 baud modem. $329.95 to $399.95 (Avail. in May)

COMPLETE HIGH SPEED PACKET UNIT - Integrated digital transceiver, packet TNC, and 9600 baud modem ready to attache to your computer or terminal and antenna... $449.95 to 519.95 (Avail. in June)

PacComm • *3652 West Cypress Street* • *Tampa, Florida 33607*

Please send info on: ☐ ____________ ☐ *FREE Catalog*

Name ____________ Call ____________

Address ____________

State ______ Zip ______ Card# ____________ Exp. Date ______

MONEY BACK GUARANTEE! *Add $4.00 shipping/handling per order. FL residents add 6% sales tax. Major Credit Card give number, expiration and signature.* FAX 813-872-8696

U.S. AMATEUR RADIO MAIL LISTS

Labels, floppy disks, CD-ROM, mag tape.

- Newly licensed hams
- *All upgrades*
- Updated each week

BUCKMASTER PUBLISHING
Route 3, Box 56
Mineral, Virginia 23117
703/894-5777 visa/mc 800/282-5628

✓ 196

QuicKit™ G5RV, Loop, & Dipole Kits

Fast & Easy to Build
- Everything included
- Failsafe visual instructions
- No measuring / cutting
- Finish antenna in minutes

Quality Components
- Presoldered Amphenol PL259
- Kinkproof Superflex wire
- Fully insulated, wx sealed, no-corrode, low noise design

Fastest Antennas in the West

- Full Size G5RV dipole coverage 80-10 — $34.95
- Half Size G5RV dipole coverage 40-10 — $24.95
- Quarter Size G5RV dipole coverage 20-10 — $19.95
- Marconi Adapter kit — $ 4.95
- Antenna Launcher kit — $14.95
- 200' Dacron 250# line — $11.95
- Loops, dipoles, feedlines, etc.

Add $5 Shipping & Handling
Catalog $1 by 1st class mail

AntennasWest
(801) 373-8425 Box 50062-H, Provo, UT 84605

✓ 161

SHORT CIRCUIT HOTLINE

603-878-1441

Huge pileups, big city QRN, no spare parts, and a long way to anywhere. You probably couldn't find a better test of the new SB-1400 All-Mode Transceiver than Heath's expedition to Taipei in the Republic of China.

When working DX, you need sensitivity to dig for the weak ones, but still need dynamic range so the guy down the block doesn't clobber you in the middle of a QSO. Sure, the SB-1400 worked the S9 + 30 signals, but out of the pile-ups it also worked a number of stateside stations running 5 watts or less! And that's not bad for a short path distance of 7600 miles!

SB-1400 A proven transceiver.

The technology that worked the world can work for you, too, in your own ham shack. The SB-1400 is a fully assembled all-band, all-mode (FM optional), continuous duty, 100-watt transceiver. It incorporates an impressive general coverage receiver with dual VFOs for split operation and 20 memories to store your favorite frequencies. The unit includes standard SSB filter plus a narrowband 500 Hz CW filter and wideband AM filter. It also features clarifier (RIT), front panel AGC, noise blanker, all mode squelch, 20 dB attenuator, computer interface, and a clean, "operator preferred" front panel layout.

The transmitter's PA is cooled by a quiet, thermostatically controlled internal fan and is enclosed in its own diecast aluminum heat-sink chamber, which allows for full power operation in CW, SSB, FM and RTTY, AMTOR, SSTV, and Packet.

"Thanks for the new country (Taiwan)! Your Heath gear sounds great!"

K3YGU, Maryland

Heath offers you more.

In addition to the SB-1400, Heath offers a full line of pre-assembled or build-it-yourself amateur radio equipment to completely outfit your ham shack or upgrade your system.

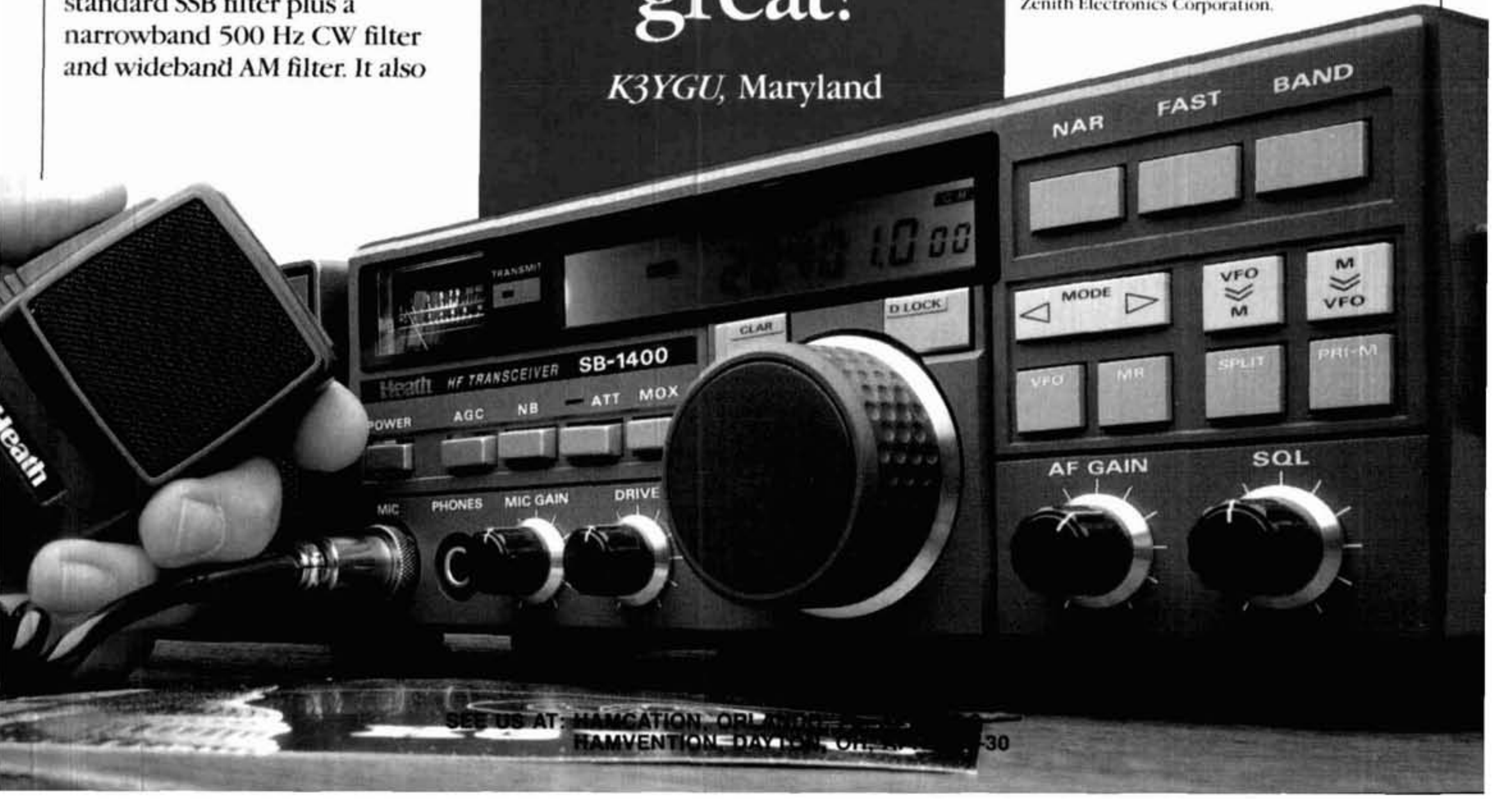
You can also prepare for your next exam (Novice, Technician, General, Advanced or Extra class) with Heath study courses.

Finally, as a Heath-equipped ham, you can get answers to your technical questions from our tech consultants, who are licensed ham operators, on the Heath Tech Assistance line.

For more information on the SB-1400 or Heath's complete line of amateur radio equipment, call for a FREE catalog: **1-800-44-HEATH (1-800-444-3284)**

Best to start with.
Best to stay with.

Heath Company
Benton Harbor, Michigan 49022



Test procedure

Connect the cable to J1 and J2. Put switch S in position 1 and adjust the signal generator near the estimated quarter-wave frequency for an input voltage minimum, with a meter deflection of perhaps 80 percent. With the switch in position 2, adjust variable capacitor C2 for equal meter deflection. Capacitor C2 must be measured in the circuit with a capacitance bridge, with capacitor C1 disconnected, and with switch S in position 2. You can calibrate the dial of C2 directly in nepers or picofarads. Calculate the divider ratio from **Figure 4**. If, for instance, C2 = 153 pF and C1 = 2.4 pF, the voltage ratio is:

$$\frac{V\ell}{Vin} = \frac{153}{2.4} + 1 = 64.75$$

and the cable loss is:

$$\alpha = \frac{1}{64.75} = 0.0154 \text{ neper or } 0.133 \text{ dB.}$$

How to find cable loss at other frequencies

Unfortunately, my method supplies cable loss for only one frequency. But if you make a second measurement at three times the frequency (pertaining to a three-quarter wavelength cable), you now have two sets of attenuations $\alpha 1$ and $\alpha 2$ and two frequencies F1 and F2. Using the interpolation method described by K2BT,[1] you can calculate the loss at any other frequency with the following procedure:
First calculate two constants, m and n:

$$m = \frac{\alpha 1 F2 - \alpha 2 F1}{F2\sqrt{F1} - F1\sqrt{F2}} \qquad n = \frac{\alpha 2\sqrt{F1} - \alpha 1\sqrt{F2}}{F2\sqrt{F1} - F1\sqrt{F2}}$$

The cable loss $\alpha 3$ at the frequency F3 is then:

$$\alpha 3 = m\sqrt{F3} + nF3 \qquad \textbf{(4)}$$

Here's a practical example:
Coaxial cable RG-213, 1 = 9.58 meters. The full-wave frequency of the 9.58-meter cable is:

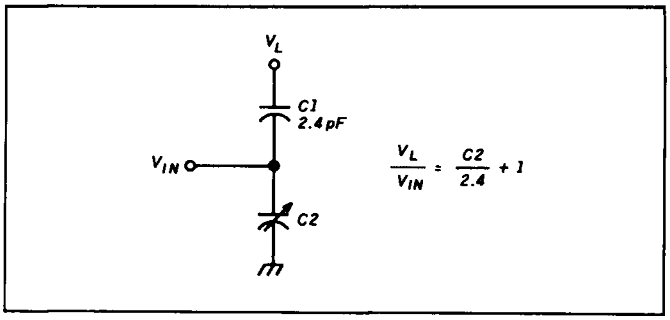
$$\frac{300}{9.58} \cdot 0.66 = 20.668 \text{ MHz}$$

assuming a velocity constant of 0.66. This means that for a frequency of 5.167 MHz the cable is a quarter wavelength long. This brief calculation only helps you find the approximate value of the measurement frequency. Its exact value depends on the minimum value of Vin. The next minimum occurs at the three-quarter wavelength frequency of 15.417 MHz. In general, the first measurement frequency is the lowest frequency on the frequency dial where Vin has its first minimum.
Assuming that the minimum of Vin occurs at 5.116 MHz, the capacitor settings are: C2 = 153 pF and C1 = 2.4 pF.

$$\frac{V\ell}{Vin} = \frac{153}{2.4} + 1 = 64.75 \qquad \alpha 1 = \frac{1}{64.75} = 0.0154 \text{ N}$$

The measurement at frequency F2 = 15.348 MHz is: C2 = 79 pF and C1 = 2.4 pF.

FIGURE 4



Capacitive voltage divider circuit used in the test circuit at the output end of the coax under test.

$$\frac{V\ell}{Vin} = 33.91 \qquad \alpha 2 = 0.0295 \text{ N}$$

Calculating factors m and n from $\alpha 1$ = 0.0145 N, F1 = 5.116 MHz, and $\alpha 2$ = 0.0295 N, F2 = 15.348 MHz gives m = 0.00582 and n = 0.000436.
If you want the loss at frequency F3 = 28 MHz:

$$\alpha 3 = m\sqrt{F3} + nF3 = 0.043 \text{ N.}$$

Measurement accuracy

Now you need to find out how large an error results if you assume the simple relationship $\frac{Vin}{V\ell} = \alpha$ which the test set is delivering.

In reality, the source impedance Rs, even when purely resistive, affects the tuning frequency for minimum input voltage Vin. The load impedance $Z\ell$ is not infinitely large, and also affects the tuning. In our example, capacitor C1 = 2.4 pF has a capacitive reactance of $Z\ell = -j2962$ ohms at 5116 MHz using **Equation 1** you get:

$$\frac{Vin}{V\ell} = \cosh(\alpha + j\beta) + j\,0.003857 \sinh(\alpha + j\beta) \qquad \textbf{(5)}$$

According to the test procedure, you must adjust the frequency for minimum input voltage. You can calculate Vin from **Figure 1** to:

$$Vin = Vo\,\frac{Zin}{Zin + Rs}$$

Since

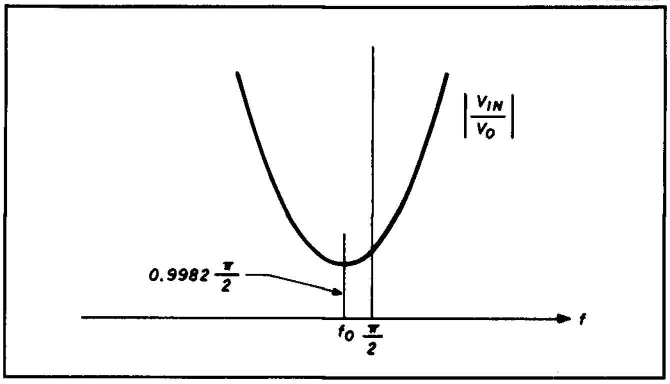
$$Zin = Zo\,\frac{Z\ell + Zo\tanh(\alpha + j\beta)}{Zo + Z\ell\tanh(\alpha + j\beta)}$$

we can calculate $\frac{Vin}{Vo}$ to:

$$\frac{Vin}{Vo} = \frac{Zin}{Zin + Rs} = \qquad \textbf{(6)}$$

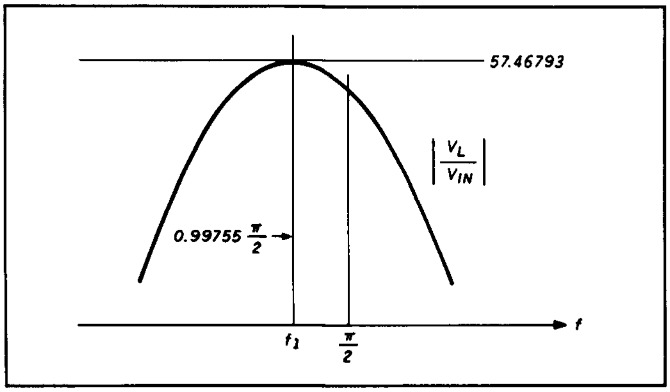
$$Zo\,\frac{1 + \frac{Zo}{Z\ell}\tanh(\alpha + j\beta)}{Zo\; 1 + \frac{Zo}{Z\ell}\tanh(\alpha + j\beta) + Rs\,\frac{Zo}{Z\ell} + \tanh(\alpha + j\beta)}$$

FIGURE 5



Typical plot for the results of *Equation 6*.

FIGURE 6



Plot of *Vℓ/Vin* versus frequency for Z1 = −j12962 ohms and α=0.0174 nepers.

A typical plot of **Equation 6** is shown in **Figure 5** which is drawn for Rs = 1 + j0.2 ohms, Zℓ = −j12962 ohms, and α = 0.0174 N. It can be shown that the input voltage minimum occurs to the left of the $\frac{\pi}{2}$ point (frequency Fo) if there's a capacitive load Zℓ and resistive Rs. If you have a slightly inductive source impedance Rs and an infinitely high Zℓ, the voltage minimum will occur to the right side of the $\frac{\pi}{2}$ point. Which effect dominates determines the location of the minimum. However, the deviations are very small. Plots 5 and 6 are frequency independent; the point π denotes the quarter-wavelength frequency. All voltage ratios are in absolute values.

Having found the frequency Fo from **Figure 5** by using **Equation 6**, you must insert its value into **Equation 5** to find $\frac{V\ell}{Vin}$. **Figure 6** is the plot of $\frac{V\ell}{Vin}$ versus frequency for Zℓ = −j12962 ohms and α = 0.0174 N (resistor Rs doesn't affect this ratio).

The maximum value of $\frac{V\ell}{Vin}$ occurs at the frequency F1 of 0.99755 $\frac{\pi}{2}$, giving a $\frac{V\ell}{Vin}$ value of 57.46793, whereas the true voltage ratio for the cable attenuation of α = 0.0174 N is:

$$\frac{V\ell}{Vin} = \frac{1}{0.0174} = 57.47126$$

This represents an error of only 0.0058 percent for the ideal case when the minimum of Vin occurs at the same frequency as the maximum of $\frac{V\ell}{Vin}$. This isn't always the case, but the deviation is small. You must measure Vℓ at the frequency where Vin has its minimum, not at the frequency where Vℓ has its own maximum, because the maximum of Vℓ doesn't coincide with the maximum of $\frac{V\ell}{Vin}$.

In reality, the frequency Fo may deviate slightly from this ideal F1 value, depending on the canceling effect of Rs and Zℓ. This error-reducing effect is a welcome and unexpected benefit, since Rs is always slightly inductive because of the difficulty in realizing a noninductive 1-ohm resistor.

In the example, the frequency Fo for the lowest input voltage is 0.9982 $\frac{\pi}{2}$. The corresponding $\frac{V\ell}{Vin}$ ratio, as calculated from **Equation 5**, is 57.3697. This amounts to an error of only 0.18 percent. The error would be 0.4 percent without the capacitive load. In other words, the "minimum Vin" method is quite accurate, and its accuracy depends mainly on the capacitive voltage divider. It shows that the measurement error in the practical case of capacitive load and inductive source impedance is even smaller than that of the ideal case with infinitely high load impedance.

If you make a direct RF voltage measurement of Vin and Vℓ without the test set, you must connect a capacitor whose value is equal to the meter capacitance at the cable output while you adjust the frequency for minimum input voltage. Remove this capacitor when you measure Vℓ with the meter, but don't alter the frequency setting. Even if you don't make this substitution, the loss measurement is still accurate enough for most applications.

Summary

Accurate and credible measurement of cable loss (calculated as the difference between input and output power) is difficult if the loss is small (for a short cable or at low frequencies).

The ratio of output to input voltage of a transmission line that is unterminated and driven from a low source impedance has a maximum value when measured at odd multiples of the quarter-wave frequency. The reciprocal of this ratio is very nearly equal to the cable loss in nepers within an error of less than 1 percent.

There are two ways of finding this maximum. The first involves the direct measurement of Vin and Vℓ with a calibrated RF voltmeter. The second is based on the voltage comparison between the capacitively divided output voltage and the input signal; it doesn't require a calibrated RF voltmeter. The capacitor dial can be calibrated in picofarads or directly in nepers.

By repeating the measurement at the three-quarter wavelength frequency, you'll get two sets of attenuation and frequency values. You can find the cable loss at any frequency between the measuring points by using a simple interpolation method. However, actual tests show that the equations also render excellent results for frequencies much higher than the measuring frequency. The two error sources of this method, the inductive source impedance and the capacitive load, tend to cancel each other and the measurement accuracy is mainly dependent on the accuracy of the capacitive voltage divider.

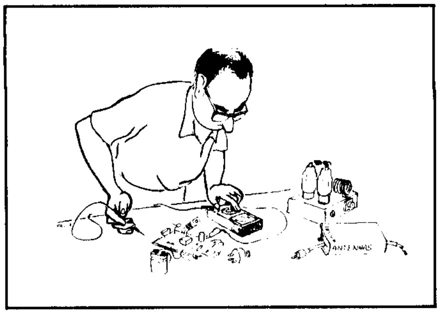
One great advantage of this method is that you don't have to know the characteristic impedance of the cable or its velocity factor; therefore, no mismatching error exists. The method is especially useful when the cable loss is small, making conventional loss measurement unreliable. Even a piece of coax as short as 1 meter can be measured accurately.

Practical cable tests, together with the interpolation method, produced excellent agreement with published data sheets. **hr**

REFERENCE

1. Forrest Gehrke, K2BT, "Real Coax: Impedance and Phase Relationships," *Ham Radio*, April 1987, pages 8-14.

Ham Radio Techniques



Bill Orr, W6SAI

ANTENNA TIME

Spring is just ahead and it's time to start thinking about worthy antenna projects. I've received a number of letters about unusual antennas that I think are interesting. Here are some of them for your consideration.

The 10-meter "Hentenna" loop

Harold Muensterman, N9DEO, sent me data on this clever little antenna developed by JE1DEU of Sagamihara City, Japan. Local hams were amused by the loop; hence the name — "hen" means curious in Japanese. "Hen-antenna" was quickly shortened to "Hentenna." It's shown in **Figure 1**. This antenna's virtue is that it has very little "wingspread" and is quite unobtrusive.

The array has two one-sixth wave radiators separated vertically by a half wavelength. To feed them, connect the tips and tap the vertical wires with a coax feedline. Polarization is horizontal.

Hentenna construction is simple. You use a single mast; try a TV-style push-up one. Make your horizontal sections out of 5/8-inch diameter aluminum tubing bolted to a mounting plate, and attach the plate to the mast with U-bolts. Use enamel-coated copper wire for the antenna's vertical sections.

Feed the Hentenna with a balun and coax line. Run your feed wires from the balun to the vertical wires. Adjust for lowest SWR by moving the feed wires up or down the vertical wires. Copper alligator clips are ideal for this; you can remove them and make joint solders when you find the correct points. The points should be about 36 inches above the bottom tube for 10 meters.

The Hentenna provides a figure-eight pattern at right angles to the antenna plane. Gain is estimated at about 2.5 dB over a dipole. Bandwidth is very broad. By changing the length of the vertical wires, you can move the design frequency to any point in the 10-meter band.

A hanging unipole antenna for 160 meters

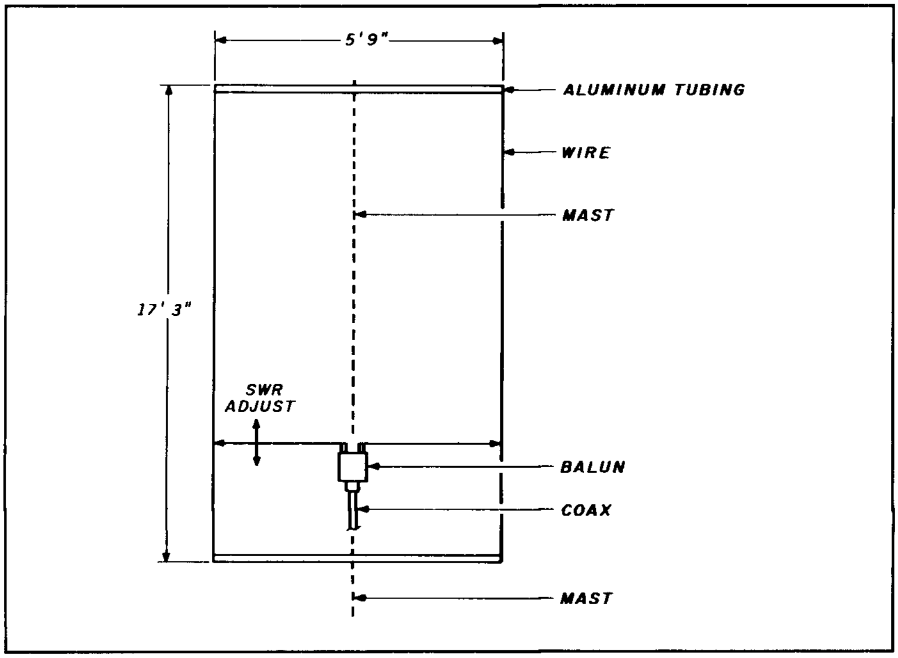
Phil Morgan, WDØP, uses a simple folded monopole for 160 operation (**Figure 2**). Phil says, "Being a cheapskate, I put up this antenna made out of Radio Shack loudspeaker cable. I used a tree limb about 46 feet above the ground. I zipped 45 feet of this wire down the middle, soldered the leads together at one end and spaced it down its length with a half-dozen spreaders made of 6-inch pieces of 1/2-inch PVC tubing. I grounded one wire at the bottom and fed the other. Since the antenna was too short for 160 operation, I soldered a single wire to the top of the vertical portion and trimmed its length to resonate the whole works in the middle of the 160-meter band. I use my Heath SA-2060 Transmatch to give me access to the whole band.

"I have a pretty good ground system — an old, abandoned underground water tank, plus four 50-foot radials made of 2-foot wide chicken wire fencing laid on the ground. I'm not a big DXer, but have worked Hawaii and Cape Verde Islands on 160 using this lash-up. If you change the length of the single wire, the antenna will also work on 80 meters."

Any information on GFI?

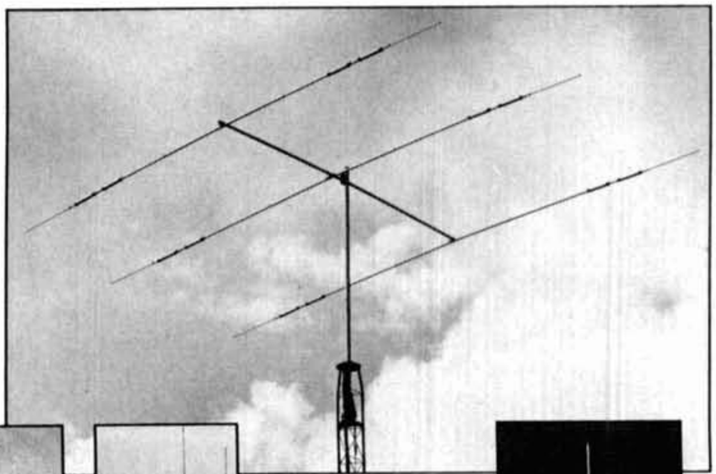
In closing, Phil asks if anyone has

FIGURE 1

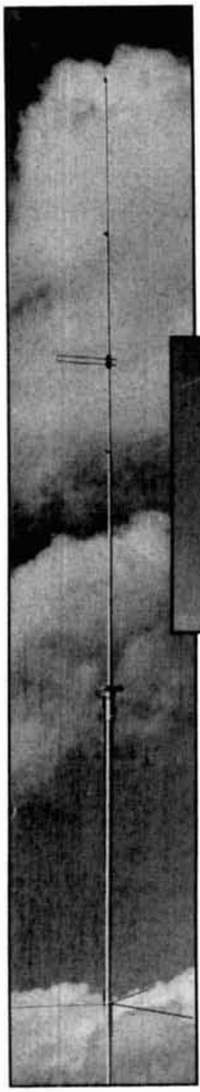


"Hentenna" for 10 meters. Adjust tap points for lowest SWR.

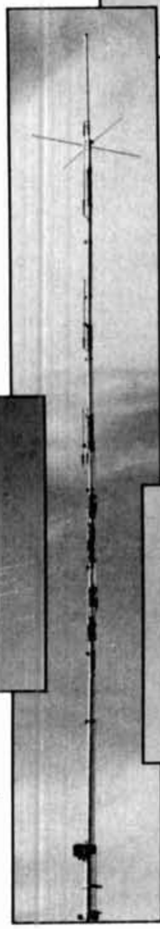
Tuned In To Amateur Radio

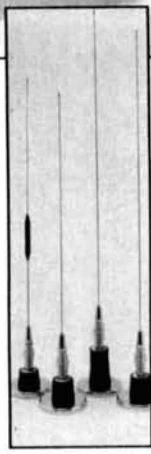


From Novice to Extra Class Cushcraft has the antenna you need.



Cushcraft offers high performance antennas to make every phase of your ham radio activity more satisfying. We have been creating innovative and exciting new products for more than 35 years. Call or write for a free copy of our full line antenna and accessory catalog or see your local dealer.

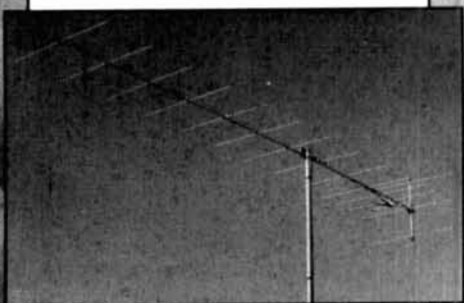


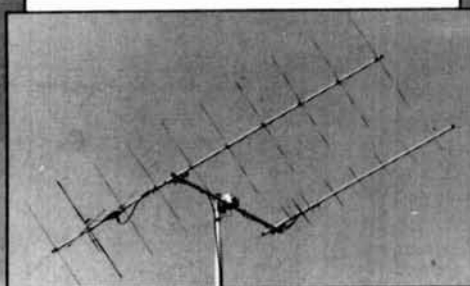


HF TRIBAND BEAM. *A3.* The most popular compact 10,15, 20 meter beam. *A4S.* A high performance 18' long wideband beam with all stainless steel hardware. 40 meter add on kits for each

CUSHCRAFT / SIGNALS MOBILES *"The choice of professionals"* can improve your mobile performance. Models for 70 cm, 2 and 6 meters.

AP8 VERTICAL. Covering 10,12, 15, 17, 20, 30, 40, 80 Meters. Great choice for Novice to Extra class.





BOOMERS. The contest winners and distance record holders. Computer enhanced design for better gain, pattern and strength. There are VHF and UHF models for SSB, FM and other activities.

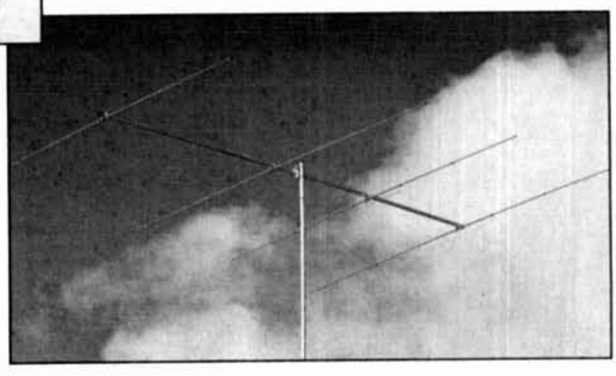
RINGO RANGER II. Still the world's favorite 2 meter, 70 cm or 220 MHz omni antenna, with more gain. A must for your FM or packet station.

OSCAR PACK. A complete antenna system for satellite users. Includes 70 cm uplink, 2 meter downlink antennas and mounting kit.

R4 HALFWAVE 10, 12, 15, 20 METER VERTICAL. Amazing performance in a small space without ground radials. Automatic broadband operation.

FAST ACTION GAS TUBE LIGHTNING ARRESTERS. Protect your valuable radio equipment. High and low power models with SO-239 or N connectors.

SKYWALKER MONOBAND. 10, 12, 15 and 20 meter yagis for more contacts, less waiting and a better signal. Preferred by contesters and DX-Peditions.



cushcraft CORPORATION

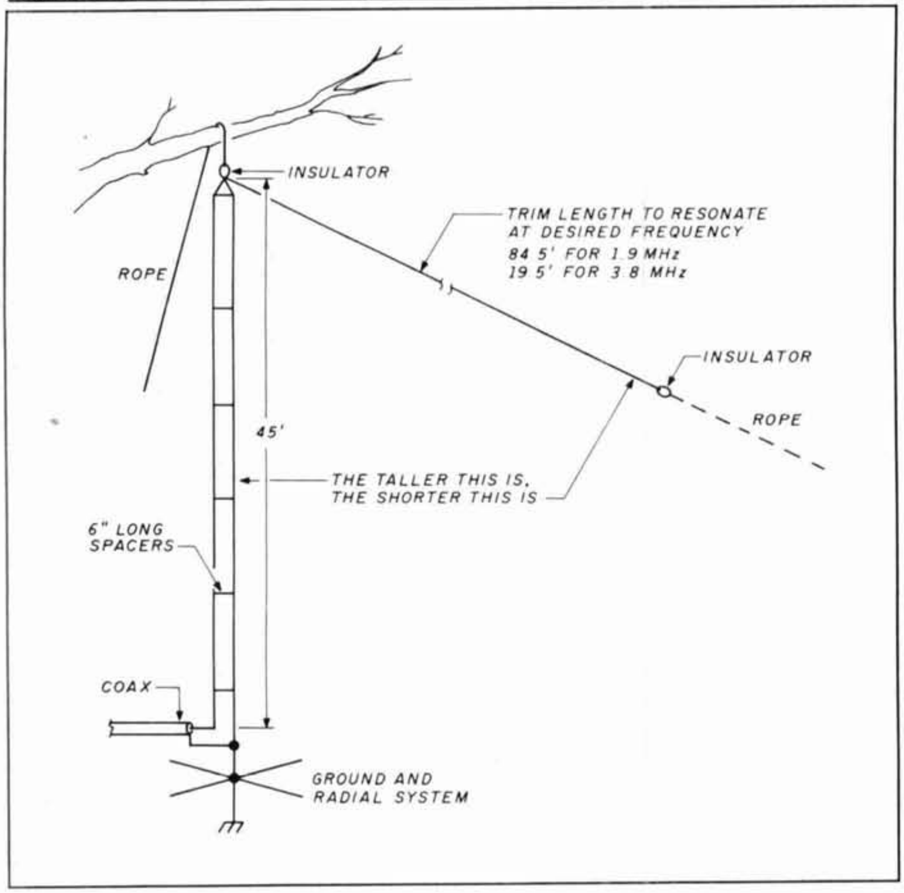
THE ANTENNA COMPANY

P.O. Box 4680, 48 Perimeter Road, Manchester, NH 03108 USA
Telephone: 603-627-7877 / Telex: 4949472 / FAX 603-627-1764

AVAILABLE THROUGH DEALERS WORLDWIDE

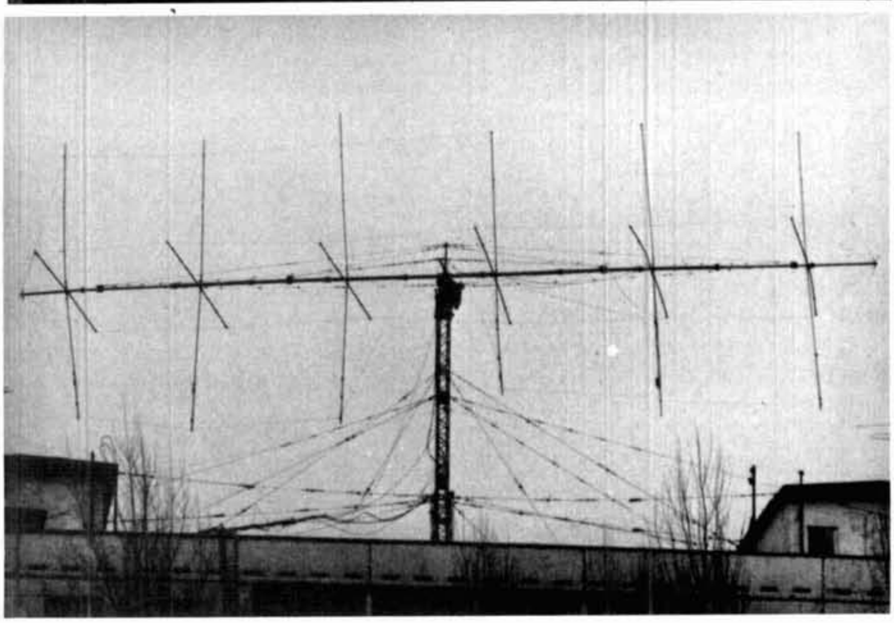
✓ 168

FIGURE 2



The 160/80 meter antenna at WD0P.

PHOTO A



The 6-element, 14-MHz Quad at UA6LA is built on an 80-foot, trussed boom.

information on Ground-Fault-Interrupter interference (GFI). He's run into these pesky devils in trailer parks and finds they're very sensitive to RF. He notes that the slightest tap of the key or word spoken into the mic will cause these GFIs to trip. Phil has also found GFIs on boat docks, so hams operating around a marina may have the same problem. Any answers to this? Write me if you have a solution.

A six-element quad on an 80-foot boom!

I received a note and photo from Victor Trachenco, UA6LA, Rostov-on-Don, USSR. He's the proud owner of a six-element, 20-meter quad (**Photo A**). This monster is built on a well-trussed 80-foot boom. So when you hear the blockbuster signal from UA6LA, you'll know it comes from this giant antenna!

The K6WZ tilt-over tower

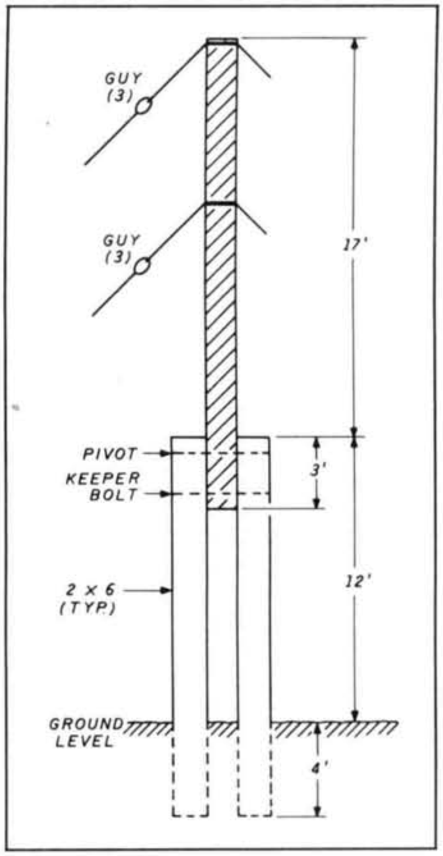
I mentioned in a previous column that I'd seen a lot of tilt-over towers in New Zealand, but not many in the United States. Some of you have been kind enough to send me information on homemade tilt-over towers. Here are two interesting designs.

Carl Steavenson, K6WZ, of Herington, Kansas, built the wood tower shown in **Photo B** and **Figure 3**. It's about 30 feet high. The fixed, bottom portion is made of two 2 × 6 pieces of pressure-treated lumber 16 feet long. They are treated, before assembly, with Thomson's Waterseal. The 2 × 6's are sunk about 4 feet in the ground.

The top tilt-over portion of the tower is made of a single section of 2 × 6 material 20 feet long. It's pivoted near the top of the two lower sections with a heavy bolt. The pivot point on the top section is placed so that about 17 feet extend above the lower supports, and there's a 3-foot lever arm below the pivot point. The pivot is made of a short piece of half-inch pipe with a heavy bolt running through it.

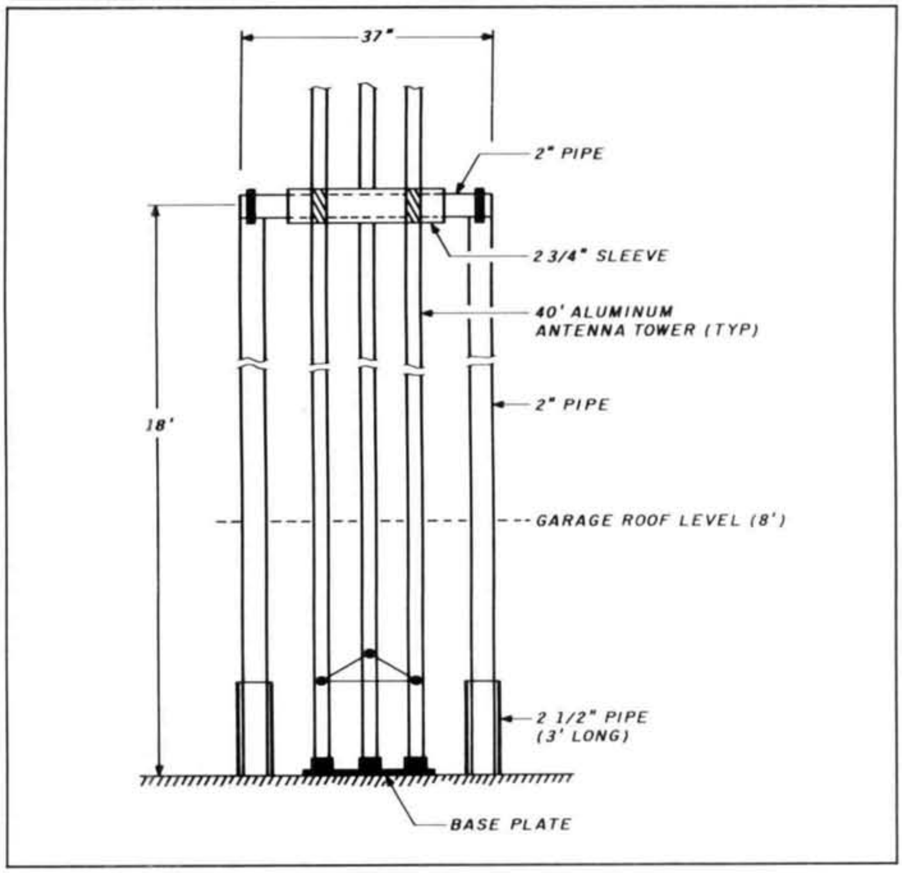
A rotating mast of 10-foot TV mast sections runs up the wood mast. The rotor is about 8 feet above ground and turns the mast sections which support the antenna. The mast sections are attached to the wood tower by large eye bolts whose "eyes" are opened just enough to pass the rotating metal mast. The rotor sits on a small metal shelf bolted to the tilt-over section. To counterweight the tower, a few pieces

FIGURE 3



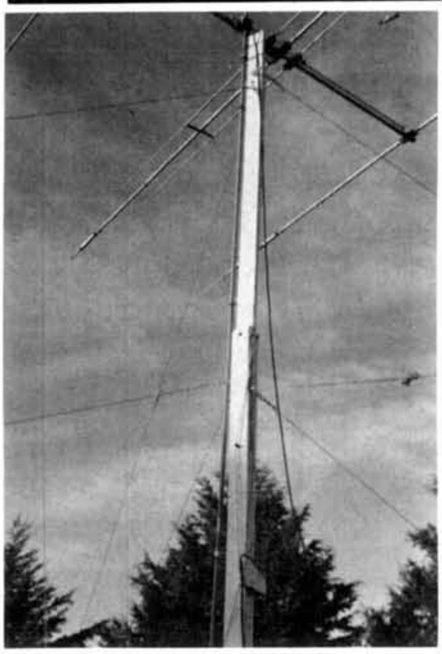
Layout of K6WZ tilt-over tower.

FIGURE 4



Tilt-over tower support at K9BX.

PHOTO B



The tilt-over tower at K6WZ. Made of 2 × 6 lumber. The tower is about 30 feet high. Rotor is placed near ground level and antenna is turned by supporting pipe.

of scrap metal are bolted to the shelf below the rotor.

To tilt the tower, Carl loosens two top back guys and removes the keeper bolt. He uses a little care and safety ropes, and over it comes!

Carl built the original tower in California 15 years ago. It was so successful that he built a duplicate when he moved to Kansas. He's worked 214 countries on RTTY with this low-cost, simple tilt-over antenna system, using a small triband beam!

The K9BX tilt-over tower

"Doc" Roberts, K9BX, of Rothschild, Wisconsin, has adapted a commercial tower to a tilt-over design (**Figure 4**). He's had this arrangement for 20 years and is very pleased with it.

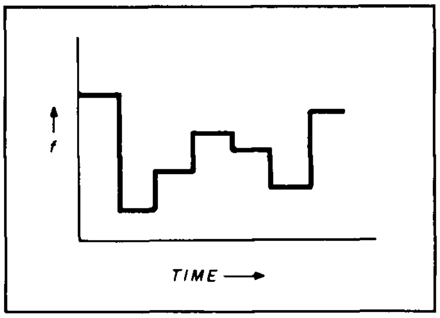
The tilt-tower support frame is 18 feet tall and made of salvaged pipe. Each arm is built from 2-1/2 inch schedule 40 pipe on the bottom section, and 2-inch pipe on the top section. Running across the top of the tower is a 37-inch crossarm of 2-inch pipe welded into ears at the tops of the vertical legs. A 2-3/4 inch pipe, about 24 inches long, fits over the crossarm of the tower and functions as a pivot point. It is fastened to the tower.

The base of the tower (a 40-foot aluminum model) is bolted into a base mount anchored in concrete. The tower sits alongside a flat-roofed garage; two of the vertical legs are anchored to the garage about 8 feet above ground.

To lower the tower, a pulley and rope system is attached to the bottom, the bolts anchoring the tower to the base plate are removed, and the tower is lowered manually. When the tower reaches a horizontal position, the rope is secured. The tower is then about 7 feet above the roof level, and the antenna is in an ideal position to work on. (Doc has a two-element quad on the tower.)

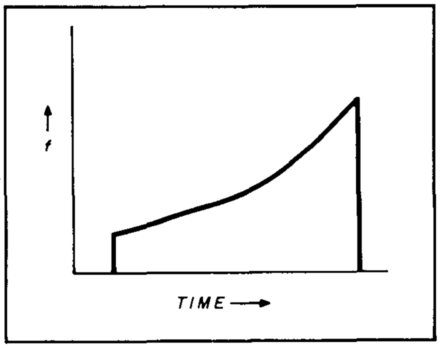
Doc says that after 20 years of wind action on the tower, the bolt holes near the tilt-over joint have become slightly elongated. He's reinforced these points and has added a set of top guy wires. Up to this time, it had been a freestanding tower, anchored only at the top of the garage.

FIGURE 5



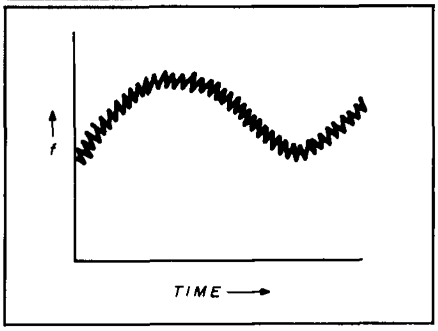
Frequency-agile ("hopping") signal.

FIGURE 6



Radar "chirp" signal.

FIGURE 7



"Jitter" signal.

Things that go "bump" in the night!

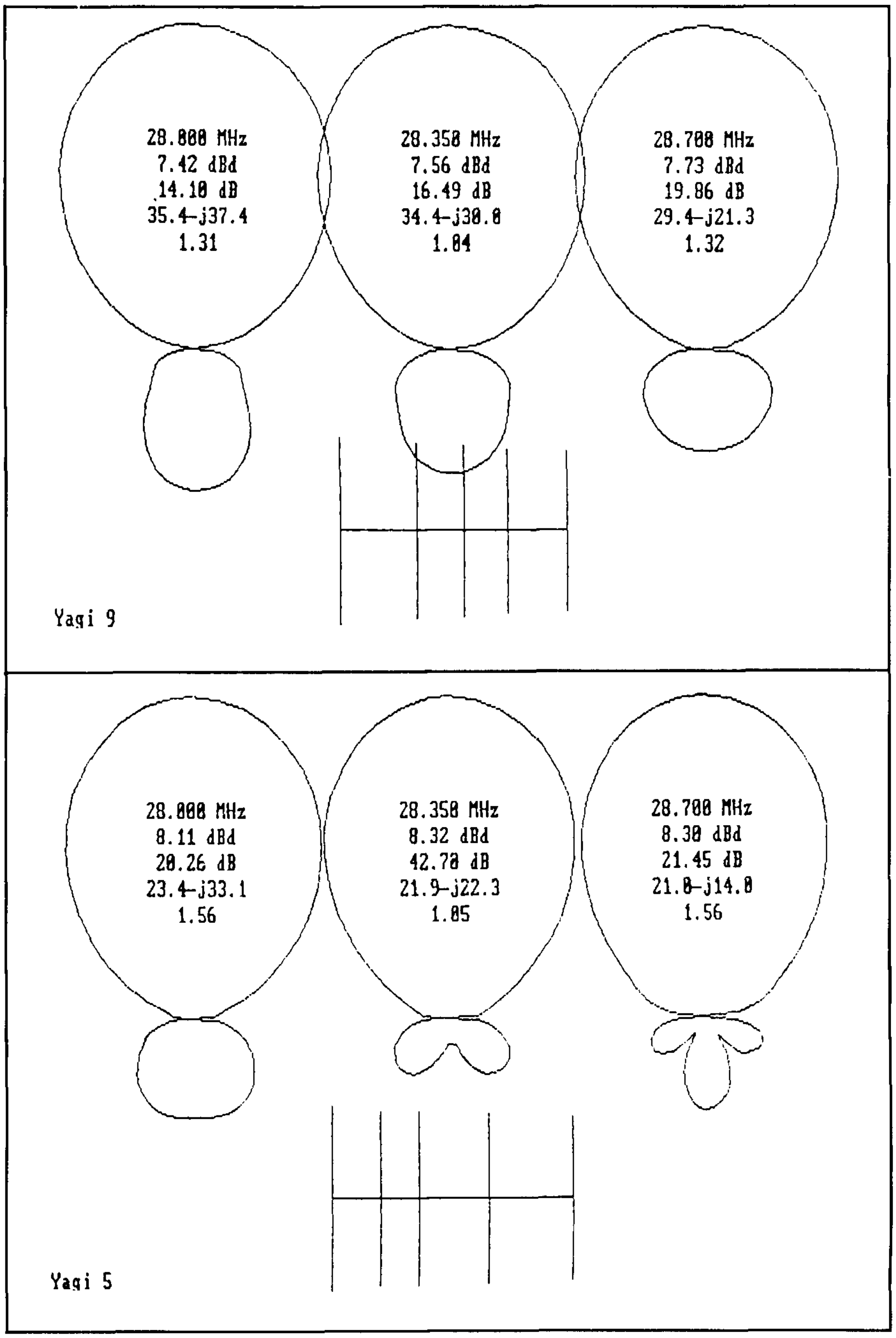
Back in the "good old days," emission was either phone or CW. As time went on, things became more complicated. A0 Emission was unmodulated carrier, A1 was CW, A2 was tone-modulated CW, A3 was phone, A4 was facsimile, and A5 was television. There were also "F-type" emissions covering FSK, FM, and so on. Things were getting confusing!

Today there's a half-page of "emission classifications" in the *ARRL Handbook*! Single sideband, suppressed carrier (SSB) is listed as J3E (formerly A3J). That's simple enough. But if you're running "angle modulation" (FM) with 5-kHz deviation and a maximum modulation frequency of 3 kHz, your emission classification is 16K0F3EJN. If you use phase modulation, your classification is 16K0G3EJN. And poor old Morse code is now 150HA1AAN (if you're sending 60 wpm).

What this means is that hams now hear a lot of funny signals in and out of the ham bands. They may or may not have emission classifications but, for the most part, they certainly aren't ham signals. Here are some of the more interesting ones.

Figure 5 is a sketch of a frequency-agile ("hopping") signal which varies frequency in a predetermined manner, with the receiver locked to the rapidly

FIGURE 8



Top: Commercial 10-meter beam. Bottom: Commercial beam optimized. Constants listed are frequency, gain, F/B ration, input impedance, and SWR.

ICOM KENWOOD YAESU

IC-781

HF Equipment	List	Juns
IC-781 Super Deluxe HF Rig	$5995.00	Call $
IC-765 New, Loaded with Features	TBA	Call $
IC-761 Loaded With Extras	2699.00	Call $
IC-735 Gen. Cvg Xcvr	1099.00	Call $
IC-751A Gen. Cvg. Xcvr	1699.00	Call $
IC-725 New Ultra-Compact Xcvr	949.00	Call $
IC-575A 10m/6m Xcvr	1399.00	Call $
Receivers		
IC-R7000 25-1300 + MHz Rcvr	1199.00	Call $
IC-R71A 100 kHz-30 MHz Rcvr	999.00	Call $
VHF		
IC-228A New 25w Mobile	509.00	Call $
IC-228H New 45w Mobile	539.00	Call $
IC-275A All Mode Base w/PS	1299.00	Call $
IC-275H All Mode Base 100w	1399.00	Call $
IC-28A FM Mobile 25w	469.00	Call $
IC-28H FM Mobile 45w	499.00	Call $
IC-2GAT, New 7w HT	429.95	Call $
IC-900 Six Band Mobile	639.00	Call $
UHF		
IC-475A All Mode 25w	1399.00	Call $
IC-475H All Mode 75w	1599.00	Call $
IC-48A FM Mobile 25w	509.00	Call $
IC-4GAT, New 6w HT	449.95	Call $
IC-4AT FM HT	349.00	Call $
IC-04AT FM HT	449.00	Call $
IC-448A, 25w Mobile	TBA	Call $
IC-32AT Dual Band Handheld	629.95	Call $
IC-3210 Dual Band Mobile	739.00	Call $
220 MHZ		
IC-375A All-Mode, 25w, Base Sta.	1399.00	Call $
IC-38A 25w FM Xcvr	489.00	Call $
IC-37A FM Mobile 25w	499.00	Call $
IC-3AT FM HT	349.00	Call $
1.2 GHz		
IC-12GAT Super HT	529.95	Call $

TS-940S

HF Equipment	List	Juns
TS-940S/AT Gen. Cvg Xcvr	$2499.95	Call $
TS-440S/AT Gen. Cvg Xcvr	1449.95	Call $
TS-140S Compact, Gen. Cvg Xcvr	949.95	Call $
TS-680S HF Plus 6m Xcvr	1149.95	Call $
TL-922A HF Amp	1649.95	Call $
Receivers		
R-5000 100 kHz-30 MHz	1049.95	Call $
R-2000 150 kHz-30 MHz	799.95	Call $
RZ-1 Compact Scanning Recv.	599.95	Call $
VHF		
TS-711A All Mode Base 25w	1059.95	Call $
TR-751A All Mode Mobile 25w	669.95	Call $
TM-231A Mobile 50w FM	TBA	Call $
TH-215A, 2m HT Has It All	399.95	Call $
TH-25AT 5w Pocket HT NEW	369.95	Call $
TM-721A 2m/70cm, FM, Mobile	729.95	Call $
TM-621 2m/220, FM, Mobile	729.95	Call $
UHF		
TS-811A All Mode Base 25w	1,265.95	Call $
TR-851A 25w SSB/FM	771.95	Call $
TM-431A Compact FM 35w Mobile	TBA	Call $
TH-45AT 5w Pocket HT NEW	389.95	Call $
TH-55 AT 1.2 GHz HT	524.95	Call $
TM-531A Compact 1.2 GHz Mobile	TBA	Call $
220 MHZ		
TM-3530A FM 220 MHz 25w	519.95	Call $
TH-31BT FM, 220 MHz HT	299.95	Call $
TM-321A Compact 25w Mobile	469.95	Call $
TH-315A Full Featured 2.5w HT	419.95	Call $

FT-767GX

HF Equipment	List	Juns
FT-747 GX New Economical Performer	$889.95	Call $
FT-757 GX II Gen. Cvg Xcvr	1129.95	Call $
FT-767 4 Band New	1929.00	Call $
FL-7000 15m-160m Solid State Amp	1995.00	Call $
Receivers		
FRG-8800 150 kHz - 30 MHz	759.95	Call $
FRG-9600 60-905 MHz	699.95	Call $
VHF		
FT-411 New 2m "Loaded" HT	399.95	Call $
FT-212RH New 2m, 45w mobile	459.95	Call $
FT-290R All Mode Portable	599.95	Call $
FT-23 R/TT Mini HT	344.95	Call $
UHF		
FT-712RH, 70cm, 35w mobile	499.95	Call $
FT-711RH FM Mobile 35w	449.95	Call $
FT-2311R 10w, 1.2 GHz, FM	559.95	Call $
VHF/UHF Full Duplex		
FT-736R, New All Mode, 2m/70cm	1749.95	Call $
FEX-736-50 6m, 10w Module	259.95	Call $
FEX-736-220 220 MHz, 25w Module	279.95	Call $
FEX-736-1.2 1.2 GHz, 10w Module	539.95	Call $
FT-690R MKII, 6m, All Mode, port.	569.95	Call $
Dual Bander		
FT-4700RH, 2m/440 Mobile	889.00	Call $
220 MHZ		
FT-312 RM, Mobile	TBA	Call $
Repeaters		
FTR-2410 2m Repeaters	1269.95	Call $
FTR-5410 70cm Repeaters	1289.95	Call $

Call For These Quality Brand Names

MFJ AEA concepts MIRAGE KLM TE SYSTEMS

JUN'S ELECTRONICS

800-882-1343

JUN'S BARGAIN BOX

LIMITED QUANTITIES

SPECIAL SALE PRICES

ICOM

IC-37A **NOW $299.95**

regularly **$499.95** Limited Quantity

YAESU

FT-726R w/430 Module & Sat'l. Module only **$899.95**

Cash Only - Very Limited Quantity

• AMATEUR • TWO WAY • MARINE • SE HABLA ESPANOL
• Free U.P.S. Cash Order • (Most Items, Most Places)

(213)390-8003 3919 Sepulveda Blvd. Culver City, CA 90230

✓ 170

HI-PERFORMANCE DIPOLES

Antennas that work! Custom assembled to your center freq. ea. band - advise ht. of center and each end - hang as inverted "V" - horizontal, vert. dipole, sloping dipole - commercial quality - stainless hardware - legal power - no-trap, high-efficiency design.
Personal check, MO or C.O.D. ($3)

MPD-5*	80-40-20-15-10M max-performance dipole 87' long	$105ppd
MPD-2	80-40M max-performance dipole, 85' long $62	95'-$66 ppd
HPD-3*	160-80-40M hi-performance dipole 113' long	$79 ppd
SSD-6*	160-80-40-20-15-10M space saver dipole 71' long	$125 ppd
SSD-5*	80-40-20-15-10M space-saver dipole-specify L. 42'-$105	52'-$108 ppd
SSD-4*	80-40-20-15M space-saver dipole-specify L. 46'-$93	60'-$ 96 ppd

*9-bands with wide-matching-range tuner.

SASE for catalogue of 30 dipoles, slopers, and space-saving, unique antennas

312-394-3414 W9INN ANTENNAS BOX 393 MT. PROSPECT, IL 60056

✓ 171

"ONLINE" U.S. CALL DIRECTORY

Hamcall service gives you *all* hams via your computer & modem. Updated each month! Only $29.95 per year. Unlimited use - you pay for phone call.

BUCKMASTER PUBLISHING
Route 3, Box 56
Mineral, Virginia 23117
703/894-5777 visa/mc 800/282-5628

✓ 172

Toroid Cores.
Iron Powder & Ferrite.
Ferrite Beads.
Ferrite Rods.

Free catalog and winding chart on request.

PALOMAR ENGINEERS

Box 455, Escondido, CA 92025
Phone: (619) 747-3343

shifting signal. The hopping sequence often lands the signal in a ham band; you hear a quick burst of voice or other modulation, and the signal is gone. Does anyone know who the "hopper" is? I don't.

Figure 6 shows a representation of a "chirp" emission. This is often used with a radar, where the frequency varies with time. Figure 7 illustrates a "jitter" signal. The jitter varies with frequency, within a predetermined time frame.

There are other weird signals including: the well-known Soviet "Woodpecker", OTHR (Over-the-Horizon Radar), and Soviet missile tracking radars that occasionally pop up in the 10 and 12-meter bands. American OTHR is also on the air, but hops about randomly, and so far has caused no lasting interference in the hams bands. Other OTHRs on the air in various countries sometimes appear in an Amateur band.

Countless other curious things (like single-letter beacons) abound, and they often cause QRM in and out of the ham bands. There are also mysterious "numbers" stations, which repeat coded number groups throughout the HF range.

All of these signals cause QRM in an already jammed radio spectrum. Unfortunately, it's often easy to turn them on but not so easy to turn them off! Happy listening!

The Yagi optimizer disk

Brian Beezley, K6STI, has come up with another interesting disk for IBM-PC and compatible users. It's called the "Yagi Optimizer, YO version 1.00." This program automatically optimizes a Yagi antenna for maximum forward gain, best pattern, and minimum SWR. The package includes models for matching networks, element tapering, element-to-boom mounting plates, frequency scaling, and element taper scaling.

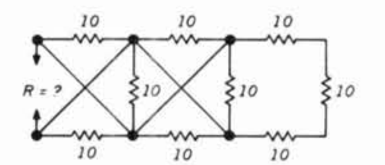
The YO program also plots antenna radiation patterns at the central design frequency and at the band edges. Best of all, YO has been designed to work alone or in conjunction with MININEC3, the high-accuracy general purpose antenna analysis program. This makes it convenient to analyze and optimize a Yagi previously analyzed with MININEC3.

Figure 8 shows an example of "before" and "after" optimization of a commercial 5-element 10-meter Yagi. Interested? Write to Brian (507-1/2 Taylor Street, Vista, California 92084) for full details.

The Dead Band Contest

I appreciate all the letters and cards I've received in response to this little exercise. Thank you all very much! This month's quiz is an easy one. I'll give the answer next month. Find the input resistance to the network in Figure 9. Each resistor is 10 ohms.

FIGURE 9



What is input resistance?

176

177

178

HAM-COM 1989
ARRL "DIAMOND JUBILEE" NATIONAL AMATEUR RADIO CONVENTION
JUNE 2-4, 1989
ARLINGTON CONVENTION CENTER
ARLINGTON, TEXAS

NAME ______________________ CALL ____________

ADDRESS ______________________________

CITY ______________ STATE ________ ZIP ________

PHONE (________) ______________________

_______ Single Ham-Com Pre-Registration, $7.00 Each .... $________
_______ Family Pre-Registration for 1 Ham & ___ Non-Hams (Max of 3) in my immediate Family, $10.00 .... $________
_______ Flea Market Tables - Max of Three, $15.00 Each .... $________
_______ Additional Flea Market Tables, tables in addition to your first three, $25.00 Each .... $________
_______ Flea Market Electrical Outlet, $25.00 Each .... $________
_______ Tour #1, Shopping Tour to Dallas Galleria Mall and Olla Podrida Center, $12.00 .... $________
_______ Tour #2, Tour to Dallas' Old City Park and Historical West End Market Place, $17.00 .... $________
_______ Saturday Morning DX Breakfast, $8.85 Each .... $________
_______ Sunday Morning QCWA Hospitality Continental Breakfast, $3.50 Each .... $________
_______ ARRL Saturday Night Banquet & Program, $16.00 Each .... $________

I have enclosed my check or money order in the amount of .... $________

Registration and Hotel Information .... (214) 423-7636
Flea Market Information .... (214) 437-3578
Exhibit and General Information .... (214) 521-9430

PRE-REGISTRATION DEADLINE MAY 26, 1989

Mail Your Check or Money Order To:
Ham-Com, Inc.
P.O. Box 861829
Plano, Texas 75086

R-7000 Widespan Panadaptor

Panadaptor especially designed for the R-7000 receiver. For use with a standard scope. Variable span width from 1 to 10 Mhz. Uncover unknown elusive signals. Complete with all cables, & 90 day warranty. $349.95 Shipped. Pa. res. add 6%.

GTI Electronics
RD 1 BOX 272
Lehighton, Pa. 18235
717-386-4032

✓ 183

THE RF CONNECTION

"SPECIALIST IN RF CONNECTORS AND COAX"

Part No.	Description	Price
321-11064-3	**BNC 2 PST 28 volt coaxial relay, Amphenol Insertion loss: 0 to 0.75GHz, 0.10dB Power rating: 0 to 0.5GHz, 100 watts CW, 2 kw peak Isolation: 0.1 GHz/45db, 0.2 GHz/40db, 0.4 GHz/35db**	**$25 used tested**
83-822	PL-259 Teflon, Amphenol	1.75
PL-259/ST	UHF Male Silver Teflon, USA	1.50
UG-21D/U	N Male RG-8, 213, 214, Amphenol	3.25
UG-21B/U	N Male RG-8, 213, 214, Kings	4.00
9913/PIN	N Male Pin for 9913, 9086, 8214 fits UG-21D/U & UG-21B/U N's	1.50
UG-21D/9913	N Male for RG-8 with 9913 Pin	3.95
UG-21B/9913	N Male for RG-8 with 9913 Pin	5.75
UG-146A/U	N Male to SO-239, Teflon USA	6.00
UG-83A/U	N Female to SO-239, Teflon USA	6.00

"THIS LIST REPRESENTS ONLY A FRACTION OF OUR HUGE INVENTORY"

THE R.F. CONNECTION
213 North Frederick Ave. #11
Gaithersburg, MD 20877

(301) 840-5477
VISA/MASTERCARD: Add 4%
Prices Do Not Include Shipping

✓ 182

VHF-UHF POWER DIVIDERS

RF power dividers provides the best way to feed in-phase 2 and 4 antenna arrays to maximize system gain and at the same time reduce losses to a minimum. Covering 144 thru 1296 MHz, this series of VHF/UHF power dividers are premier RF devices designed for a long service life with low SWR and broad operating bandwidth.

Extruded aluminum body with a durable enamel finish in addition to silicon sealing at connector flanges results in a ruggedized unit for all array installations. Available with N-type connectors only, these units are unconditionally guaranteed for 2 years.

MODEL	CONFIG.	PRICE
144-2P	(2 ports)	$54.00
144-4P	(4 ports)	$61.00
220-2P	(2 ports)	$53.00
220-4P	(4 ports)	$60.00
430-2P	(2 ports)	$51.00
430-4P	(4 ports)	$59.00
902-2P	(2 ports)	$51.00
902-4P	(4 ports)	$59.00
1296-2P	(2 ports)	$52.00
1296-4P	(4 ports)	$60.00

SHIPPING NOT INCLUDED

STRIDSBERG ENGINEERING, CO.
P.O. Box 7973 • Shreveport, LA 71107 • USA
Phone: (318) 865-0523

✓ 181

Tell 'em you saw it in HAM RADIO!

THE MICROFARAD COUNTER

By Hans Evers, PAØCX, Wintererstrasse 3, D-7800 Freiburg, W. Germany

You can often find second-hand electrolytic capacitors at amazingly low prices at flea markets and surplus stores. The reason? Nobody trusts them (the capacitors, that is).

It isn't always easy to check the quality of a polarized capacitor. The number of microfarads may exceed the range of your measuring bridge, and it's rather unusual to find provisions for applying the necessary DC polarization during the measurement. Also, a quick assessment of possible leakage in a large capacitor could lead to problems.

With these considerations in mind, I decided to build a basic test box. My efforts resulted in an almost suspiciously simple schematic diagram. Yet the test box (though small enough to fit in your pocket) measures not only how many microfarads there are with reasonable accuracy, but whether the capacitor under test leaks. Although the circuit consists of only a few discrete components, it boasts an elementary "digital display."

The amount I spent for materials (practically all were supplied by my modest junkbox) was rapidly paid off when I used my new gadget to sort a shoe box full of old, partly used electrolytic capacitors. The contents of the box had become the subject of more and more distrust over the years, and I was actually at the point of throwing the whole lot overboard.

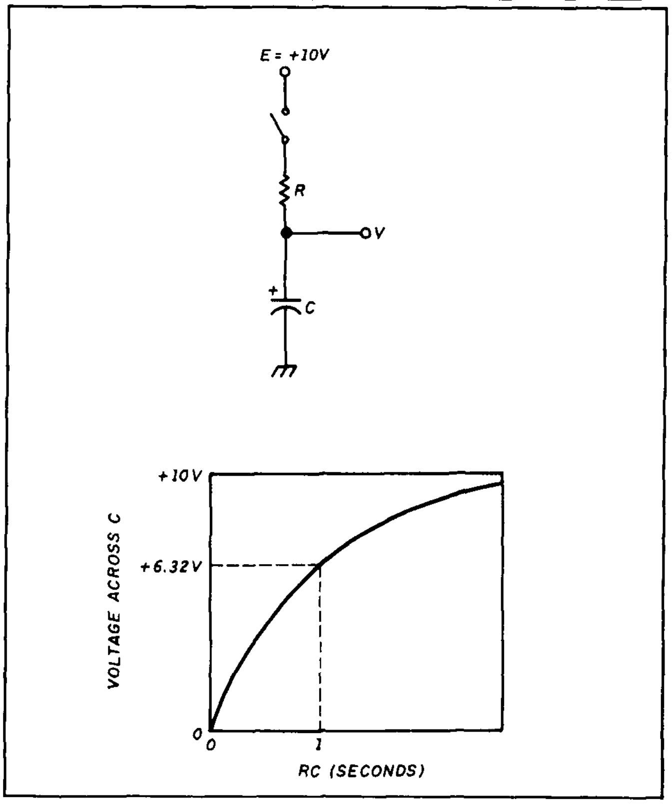
The principle

The principle of the microfarad counter is that of a capacitor charged through a resistor. When voltage is applied, the capacitor voltage builds up exponentially starting from zero, just as the textbooks specify. Something interesting occurs when the elapsed time (in seconds) becomes equal to R (in ohms) times C (in farads). You'll find the voltage across the capacitor has grown from zero to 63.2 percent of the supply voltage*.

If, for example, the supply voltage is 10 volts and R=1 meg (as shown in **Figure 1**), you reach a voltage of 6.32 across a 1-μF capacitor after 1 second. For an n-μF capacitor this would take n seconds. Thus, microfarads can be measured by counting seconds. It isn't too difficult to give the circuit a different "measuring range." If you make R = 100 k (ten times smaller), each second will represent 10 microfarads.

*$1 - \frac{1}{e}$ times 100 percent, to be exact

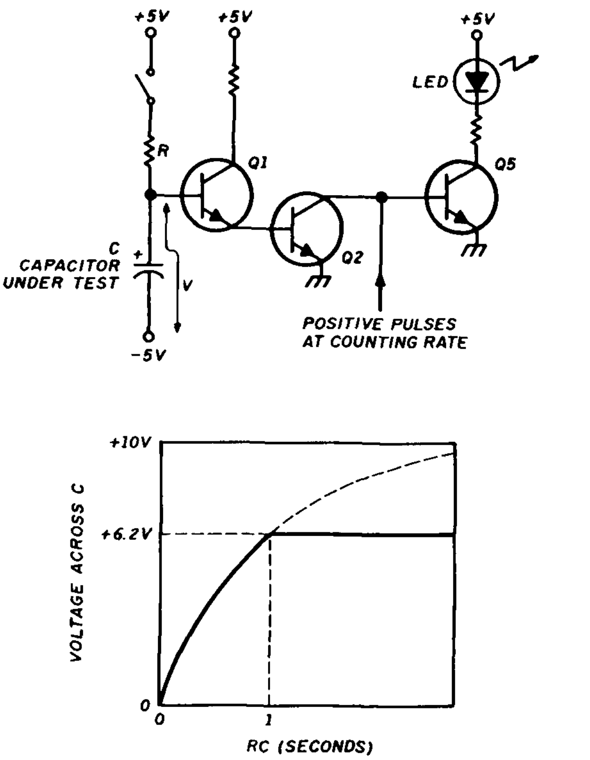
FIGURE 1



Charging a capacitor through a resistor.

Putting this simple principle into practice is altogther something else. The voltmeter necessary to determine the 6.32 volts would unavoidably establish a bypass around the capacitor. This, in turn, would behave like a "leaky" capacitor. Because of the leakage, it would take more time to reach the threshold

FIGURE 2



Principle of the Microfard Counter.

voltage, making the capacitor look larger than it actually is.

You're left with two choices. You can measure the voltage over R and then subtract it from the supply voltage. Or use a voltage indicator that, at least until the threshold is reached, looks like an electrical insulator. I found that the second option was the simplest. A wristwatch (or even a stopwatch) isn't the most practical time indicator in this case.

An improved counting system

There's a better system for counting the seconds. **Figure 2** shows how it's done. The stopwatch has been replaced by a light-emitting diode (LED) that produces light flashes for counting the charging time — or rather the microfarads. This counting mechanism is switched on as soon as the capacitor starts charging, and is switched off when the capacitor voltage reaches 6.2 volts (near enough to the ideal 6.32 volts, for the moment). Q2, the actual switching element, acts as a temporary short across the base of LED driver Q5.

The initial capacitor voltage is zero with the power supply connected. The base of Q1 begins by looking at −5 volts; Q1 blocks the base current of Q2 which, therefore, can't conduct. So while the capacitor starts charging, nothing prevents the LED from blinking.

The capacitor voltage grows, and when the Q1 base voltage arrives at +1.2 with respect to ground, both Q1 and Q2 start conducting because their base-emitter junctions now have the required 0.6 volt across them. The emitter-collector path of Q2 forms a short and the LED stops blinking. When this happens, the capacitor (situated between −5 volts at the bottom and +1.2 volts at the top) has been charged up to 6.2 volts, indicating that t=RC or: $C = \frac{t}{R}$.

Because the base voltage of Q1 remains virtually constant, the voltage across the capacitor doesn't rise, and remains stabilized at 6.2 volts. With the measurement completed, the current through R no longer flows into the capacitor; it finds its way through the transistors to ground instead. The microfarad meter isn't complete yet. As you saw before, the capacitor would cause a false reading if there's leakage. So for the measurement to make sense, it's essential to know whether the capacitor under test is leakproof.

Leakage detection

A conventional leakage-current meter would be quite something to design. Even leakage currents as low as several microamperes can be significant (remember they are DC), especially in smaller sized capacitors. The measured current should be totally independent of charge and discharge currents; this requires that a capacitor voltage remain untouched when the meter circuit is introduced. Fortunately, the concern when using the test box is whether the leakage is serious enough to spoil your measurements. You need not worry about the actual amount of current leaked.

I based my method on the following statement: *"Only if you extract the same amount of electricity from the capacitor as you've put in can you be sure that the capacitor isn't leaking."* In other words, if the capacitor after testing is discharged under the same conditions as it was charged, the charging and discharging processes should take the same amount of time.

You have to use an unusual technique to discharge the capacitor under the same conditions. Instead of being discharged passively across a parallel resistance (a method that would be unsuitable here as the process would follow a different portion of the characteristic), the capacitor is discharged actively when it's supplied with the same current in the opposite polarity.

The capacitor connections (charged to 6.2 volts as the result of the previous microfarad measurement) are reversed with a toggle switch. The positive side of the capacitor is now connected to a point that carries +1.2 volts and the negative side is connected to R (see **Figure 3**).

Initially, the base of Q1 sees a voltage of +1.2 volts in series with −6.2 volts, equaling −5 volts. The current through R discharges the capacitor. When the capacitor is fully discharged, the voltage across it is zero, and the base voltage of Q1 has arrived at +1.2 volts. This stops the process.

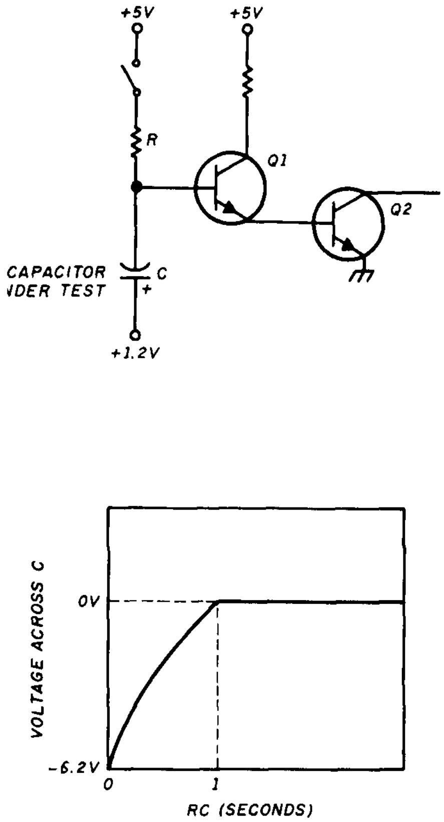
Q1 doesn't differentiate between charging or discharging, and the LED blinks in both cases. When measuring a healthy leak-proof capacitor, the LED blinks the same number of times for discharge as it does for charge. If there are fewer flashes, some of the electric charge was lost and you can conclude that the capacitor leaks.

During the entire charge-discharge cycle, the capacitor is never subjected to any voltage higher than 6.2 volts. The capacitor is left completely discharged after the capacity and leakage check.

The counter

It seemed appropriate to do some basic research before designing the blinking LED mechanism. I found that the once-per-second flashing rhythm would be exasperatingly slow. After doing some experimenting, I decided that a more suitable counting rate would be two flashes per second. The blinking is relatively fast, but not so fast that you risk losing count.

FIGURE 3



How the capacitor under test is discharged.

PARTS LIST

CAPACITORS
1 0.68 μF 25 volt tantalum
1 4.7 μF 25 volt electrolytic or tantalum

POTENTIOMETER
100 k Radio Shack RS271-220

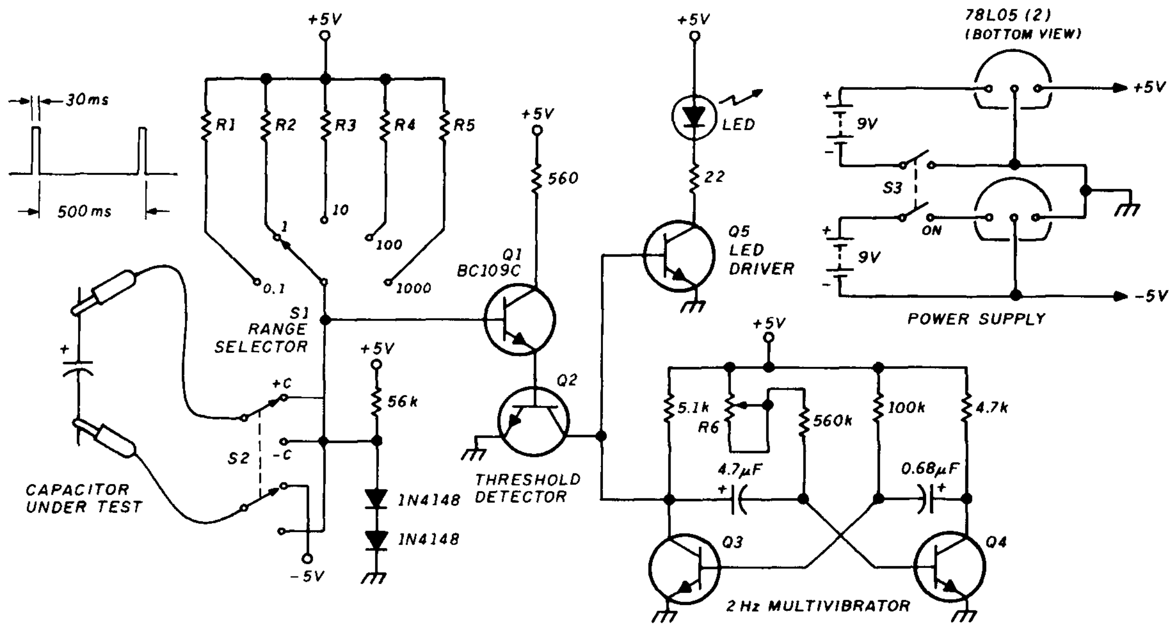
RESISTORS (all resistors 1/4 watt)
R1—R5 see text, 5 percent
1 22 ohm
1 560 ohm
1 4.7 k
1 100 k
1 560 k
1 5.1 k
1 56 k

SEMICONDUCTORS
Q1—Q5 ECG 123AP or equivalent
2 78L05
2 1N4148 or equivalent
1 LED

MISCELLANEOUS
*1 PCB FAR Circuits**
1 DPST miniature toggle switch
1 DPDT miniature toggle switch
1 SP5P rotary switch
2 9-volt battery connectors

All items obtainable from Radiokit, Box 973, Pelham, NH 03076, except as noted.
**18N640 Field Court, Dundee, IL 60118*

FIGURE 4



Schematic diagram.

It's obvious that, with the LED flashing twice as fast, you have to correct the RC time to maintain the principle of one count per microfard. I compensated for this by changing R2 in **Figure 4** from 1 meg to 510 k. Although this is slightly more than the ideal of 0.5 meg, the difference takes care of the approximately 1.5-percent error in the 6.2-volt threshold (which ideally should have been 6.32 volts). I also had to consider the actual light/flash duration. I soon found out that a 50/50, on/off LED ratio isn't convenient for visual counting and that shrinking the length of the light pulse made counting easier. There are limits, of course — you can't make the length so small that visibility begins to suffer. Thirty ms seems to be a good compromise.

The drastic reduction in light/pulse length has more advantages. You can subject the LED to considerably more current than the 20 mA usually recommended. The 68 mA that flows through the LED (mainly determined by 22 ohms in the Q5 collector lead, and to a lesser extent by the collector resistor of Q3) visibly increases the brightness. Nevertheless, the average LED current still isn't more than a very reasonable 4 mA.

Calibration and accuracy

Calibration doesn't require a capacitor of any standard value. The accuracy of calibration depends entirely on the voltages (the output voltages of the 78LO5s, as well as the constant voltage drops over the diodes and transistor junctions), the resistors (R1 and R5 may be as accurate as desired), and the counting time. You can adjust the factor time by shorting the measuring leads (to make the LED flash) and by tuning R6 for exactly two counts per second.

The microfarad counter's total accuracy depends largely on the time you spend on measurement. If you measure a certain capacitor in 5 seconds, the unavoidable uncertainty of the last digit may cause an error of 10 percent. But if you're willing to spend almost a minute on the same measurement by switching to a lower range, and if the capacitor under test is leakproof, the digital error will be limited to 1 percent. In this respect, the elementary counting system of the microfard counter is in good company with other forms of digital displays, which also leave an uncertainty of at least plus or minus one digit.

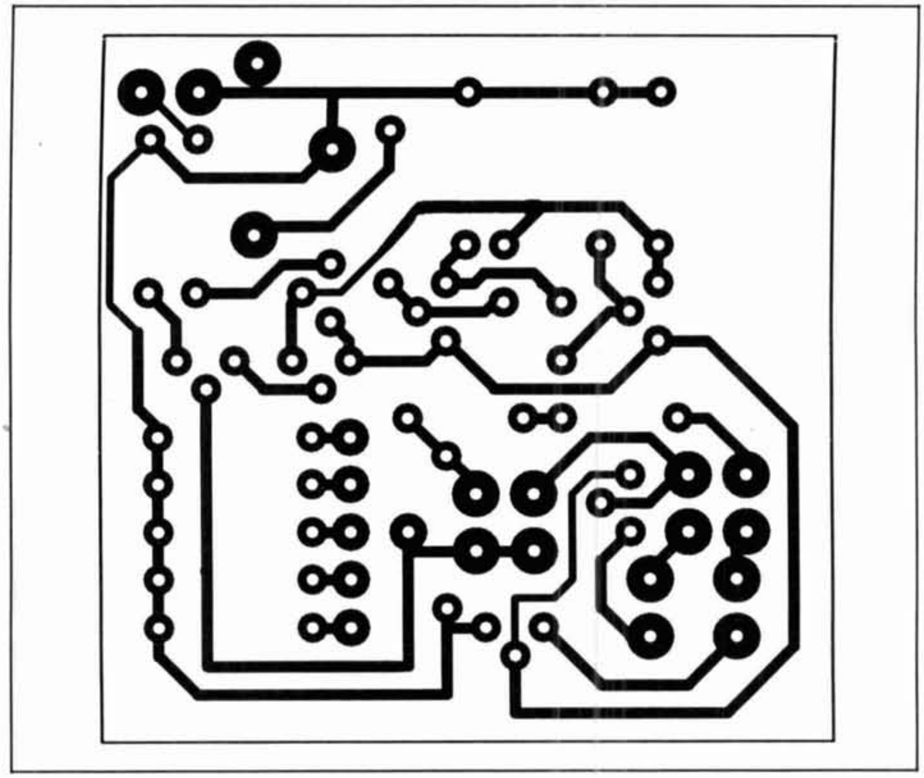
Other design considerations

I designed the circuit with low power supply requirements in mind. See **Figures 5** and **6** for the pc board layout and component placement guide. That's why I chose the LED as an indicator, rather than something like an acoustic bleeper. To ensure long-term battery consumption, it seemed necessary to use two batteries with a double-throw "power" switch. The 78L05 regulators appeared to provide the cheapest solution for maintaining reliable voltages.

The battery for positive supply must deliver an average current of 11.5 mA (it can be as high as 20 mA in the ×1000 position). The battery for the negative supply has to produce 3.5 mA; this means it should last longer.

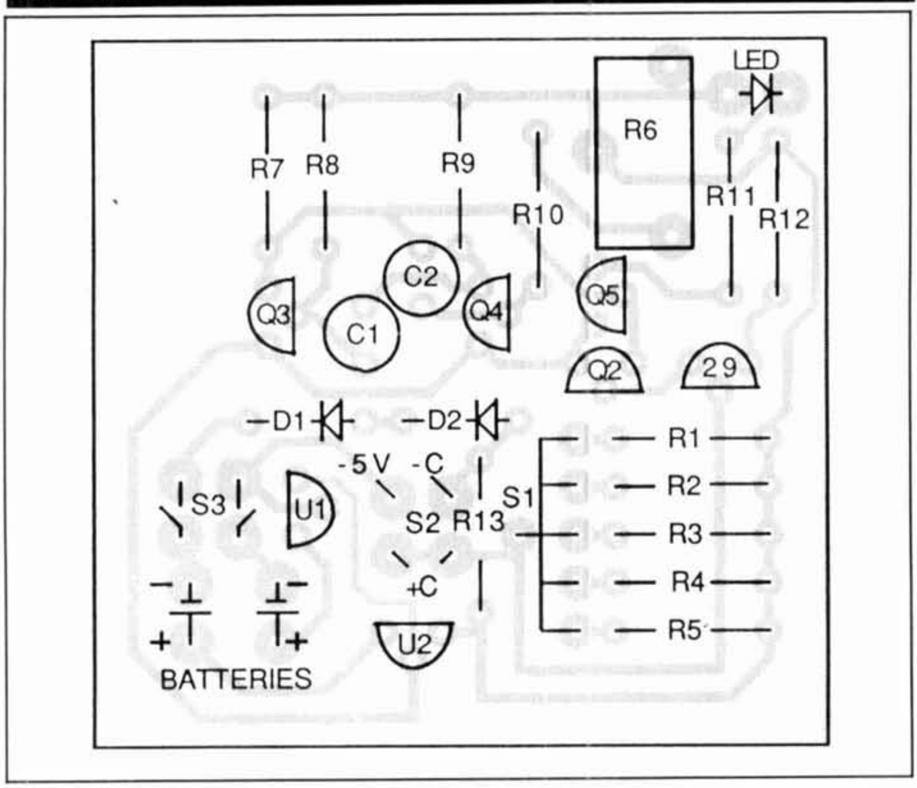
Use any common, low-power, silicone, NPN-type transistors. I used BC 237As from my junkbox. You must make an exception for Q1. A BC 109C works well because of its high beta at very low currents (in the "times 0.1" position the base current is only 0.8 μA!). If you can live without the times 0.1 range, you can use a more conventional transistor for Q1.

FIGURE 5



Foil side of pc board.

FIGURE 6



Component placement guide (component side).

Precautions

Some electrolytic capacitors have a maximum voltage rating lower than 6.5 volts. Don't measure these with the microfarad counter; they may be damaged. Capacitors with maximum voltage ratings at the other end of the scale also require a word of warning. When dealing with high-voltage capacitors, whether they are electrolytic, tantalum, or just ordinary paper-insulated type, you must always be aware of residual electric charges. They can develop *even if the capacitor has been entirely discharged by a complete, long-lasting, full short*. It's a good habit to short any capacitor (even if it's been lying around for some time) before doing something with it.

In any case, it seems advisable to put Q1 and Q2 where they can be easily replaced if disaster strikes.

Operating instructions

WARNING: Residual electric charge on high-voltage capacitors may damage the test instrument. Discharge the capacitor before connecting.

- Connect the capacitor, with the switch in position "−C." Observe correct polarity.
- Set the switch in position "+C." The LED will start flashing. Count the flashes until they stop. Each flash represents 1 µF (or 10 µF, 100 µF, and so on, depending on the position of the range switch).
- Switch to position "−C." The LED will start flashing again. Count the number of flashes until they stop. If the number is less than before, the capacitor is leaking current.

Observations

The use of electrolytic capacitors is usually regarded as an unavoidable evil. Some common problems you may experience with these caps are: limited life expectancy, exaggerated tolerance in value, and excessive leak current. After building my microfarad counter and using it to test a large variety of capacitors, I've found it necessary to reevaluate my opinion. Not only did there appear to be more leakproof electrolytic capacitors in my collection than I dared hope for, but their accuracy was generally much better than I expected. Most stayed within a tolerance of about ±15 percent. **hr**

Wideband Preamp 10-1000 Mhz

Dual GasFet low noise preamplifier for HF, UHF or VHF systems. Just perfect for the R-7000. Excellent for Spec Analyzers, Scanners, etc. Gain 20 Db +/- 1 DB, -3 Db at 2 & 1100 Mhz. 1 Db compression of >10 Dbm. Intercept points >45 Dbm. New shipped price of only $124.95. Pa. residents please add 6% state tax.

GTI Electronics
RD 1 BOX 272
Lehighton, Pa. 18235
717-386-4032

✓ 186

LOGWRITE™

Bring your station into the computer age with **LOGWRITE**, the menu driven, user friendly logging program written by Ed Troy (NG3V). **LOGWRITE** is the perfect accessory for the complete ham station. It simplifies your operation and gives you the competitive edge in contesting and DX'ing. **LOGWRITE** works with all IBM PC's and compatibles.

LOGWRITE's unique split screen feature allows for simultaneous logging and text processing. Logging features include:

- Instant call sign or prefix search
- Print, Edit, or View records
- Plenty of room for notes & addresses
- Automatic time/date stamping

Text processor features automatic word wrap, backspace correct, and scrolling. Throw away your pen and paper!

To order your copy of **LOGWRITE**, complete with instruction manual, send $24.95 (Pa. residents add $1.50 sales tax) to:

Aerospace Consulting
P.O. Box 536, Buckingham, PA 18912
(215) 345-7184

Or call 1-(800) 345-4156 ext. 54 to order with Visa/Master Card. (Please specify 3.5 or 5.25 inch floppy.)

✓ 187

1989 U.S. CALL DIRECTORY
(on microfiche)

Call Directory - by callsign $8
Name Index - by last name $8
Geographic Index - by state/city $8
All three - $20
$3 shipping per order

BUCKMASTER PUBLISHING
Route 3, Box 56
Mineral, Virginia 23117
703/894-5777 visa/mc 800/282-5628

✓ 188

Reader Service CHECK—OFF Page 118

WE SHIP WORLDWIDE

Barry Electronics Corp.

WORLD WIDE AMATEUR RADIO SINCE 1950
Your one source for all Radio Equipment!

For the best buys in town call:
212-925-7000
Los Precios Mas Bajos en Nueva York
WE SHIP WORLDWIDE!

See You May 7th—BARA, Paramus, NJ
May 14th, LIMARC, L.I., NY

KITTY SAYS: WE ARE NOW OPEN 7 DAYS A WEEK.
Saturday & Sunday 10 to 5 P.M.
Monday-Friday 9 to 6:30 PM Thurs. to 8 PM
Come to Barry's for the best buys in town.

ONV Safety belts-in stock

YAESU
FT-767GX, FT-757GXII, FT-747GX, FRG-8800, FT-736R, FRG-9600, FT-4700RH, FT-212/712RH, FT-470

ICOM
IC-R71A, 751A, 781, 28A/H, 38A, 48A, Micro2/4, R-7000, IC-761, IC-375A, 275A/H, 3210A, 475A/H, 735, IC-900, IC-228H, IC448A, IC725

SMART PATCH
CES Simplex Autopatch 510SA Will Patch FM Transceiver To Your Telephone. Great For Telephone Calls From Mobile To Base. Simple Duplex. 510SA/510SAII

PRIVATE PATCH V, Duplex 8000

KENWOOD

Antennas
A.S., AES, Cushcraft, Hy-Gain, Hustler, KLM, METZ, Mosley, MODUBLOX, TONNA, Butternut

TS440S/AT, R-5000, R-2000, TS-940 S/AT, TM-231A/431A, TM-2570A/50A/30A, TR-751A, Kenwood Service Repair, TM-721A, TS-711/811A, TM3530A, TH205AT, TH215A, TM-621A, TM-321A, TS140S, TS680S, RZ-1, TS-790A

YAESU: FT-23/73/33/727R, FT411-811, FT-1903/1123, FTH 2005/7005
ICOM: IC2AT/12AT, IC02AT/32AT, IC2/4GAT, IC-A2/U16

Landmobile HT's
ICOM: U16, H16, V100, U400
MAXON, MOTOROLA
YAESU: FTH 2005/2007
UNIDEN, REGENCY, KING
MARINE ICOM: M5, M55, M700
AVIATION ICOM: A20 TAD

RF Concepts

Budwig ANT. Products
NEL-TECH DVK-100 Digital Voice Keyer
FLUKE 77 Multimeter

TUNERS STOCKED:
NYE MBV-A 3 Killowatt Tuner

ALINCO
DJ-500T, DR-110T

VoCom/Mirage/Alinco
Tokyo Hy-Power/TE SYSTEMS
Amplifiers &
5/8λ HT Gain
Antennas IN STOCK

Computer Interfaces Stocked: MFJ-1270B, MFJ-1274, MFJ-1224, AEA PK-88, MFJ-1278, PK-232 W/FAX

FREQUENCY COUNTERS 1MHz-1.3GHz

COMMERCIAL & HAM REPEATERS STOCKED WRITE FOR QUOTES

KANTRONICS
UTU, KAM, UTU-XT, KPC 2400, KPC IV, KAM

MFJ-989C
SHORTWAVE RECEIVERS STOCKED

Ten-Tec Tuner 229B

MICROLOG-ART 1, Air Disk, SWL, Morse Coach
Soldering Station 48 Watts

AR 900 Hand Held Scanner 100 ch. Covers 27-54, 108-174, 406-512, 800-950 MHz

MOTOROLA AUTHORIZED DEALER
KACHINA COMMUNICATIONS DEALER

AUTHORIZED
SONY
DEALER

COMET ANTENNAS STOCKED

METRON MA-1000 B STOCKED

EIMAC
3-500Z
572B, 6JS6C
12BY7A &
6146B

DIGITAL FREQUENCY COUNTERS
Opto Electronics model 1300H, 0-1300MHz

Long-range Wireless Telephone for export in stock

HEIL EQUIPMENT IN STOCK

SANGEAN Portable Shortwave Radios

BENCHER PADDLES, BALUNS, LOW PASS FILTERS IN STOCK

Hy-Gain Towers & Antennas, and Rotors will be shipped direct to you FREE of shipping cost

AEA 144 MHz
AEA 220 MHz
AEA 440 MHz
ANTENNAS

BIRD
Wattmeters & Elements
In Stock

MIRAGE AMPLIFIERS
ASTRON POWER SUPPLIES
Saxton Wire & Cable, Int'l Wire
OPTO KEYERS STOCKED

New TEN-TEC Corsair II, PARAGON, OMNI V

IIX Towers, Antennas, Mobile Radio mounts stocked. Call

AMERITRON AUTHORIZED DEALER

MAIL ALL ORDERS TO: **BARRY ELECTRONICS CORP., 512 BROADWAY, NEW YORK CITY, NY 10012 (FOUR BLOCKS NORTH OF CANAL ST.)**

New York City's **LARGEST STOCKING HAM DEALER COMPLETE REPAIR LAB ON PREMISES**

"Aqui Se Habla Espanol"
BARRY INTERNATIONAL TELEX 12-7670
MERCHANDISE TAKEN ON CONSIGNMENT FOR TOP PRICES
Monday-Friday 9 A.M. to 6:30 P.M. Thursday to 8 P.M.
Saturday & Sunday 10 A.M. to 5 P.M. (Free Parking)

IRT/LEX-"Spring St. Station". **Subways:** BMT-"Prince St. Station". IND-"F" Train-Bwy Station"
Bus: Broadway #6 to Spring St. Path-9th St./6th Ave. Station.

COMMERCIAL RADIOS STOCKED: ICOM, Motorola, MAXON, Standard, Yaesu. We serve municipalities, businesses, Civil Defense, etc. Portables, mobiles, bases, repeaters

ALL SALES FINAL

We Stock: AEA, ARRL, Alinco, Ameco, Ameritron, Antenna Specialists, Astatic, Astron, B&K, B&W, Bencher, Bird, Butternut, CDE, CES, Cushcraft, Daiwa, Eimac, Henry, Heil, Hustler, Hy-Gain, Icom, KLM, Kantronics, Larsen, MJF, J.W. Miller, Mirage, Nye, Palomar, RF Products, Saxton, Shure, Tempo, Ten-Tec, TUBES, Yaesu, Vibroplex, Duplexers, Repeaters, Scanners, Radio Publications, Uniden, Kenwood, Maxon, RFC.

WE NOW STOCK COMMERCIAL COMMUNICATIONS SYSTEMS
HAM DEALER INQUIRES INVITED. PHONE IN YOUR ORDER & BE REIMBURSED
COMMERCIAL RADIOS stocked & serviced on premises.
Amateur Radio Courses Given On Our Premises, Call
Export Orders Shipped Immediately. TELEX 12-7670

FAX: 212-925-7001

Barry Electronics Commercial Radio Dept. offers the Best in two-way communications for Businesses, Municipalities, Civil Defense, Broadcasting Companies, Hospitals, etc. Sales and Service for all brands: Maxon, Yaesu, Icon, Tad, Octagon, Regency/Wilson, Midland, Standard, Uniden, Shinway, Fujitus, Seas, Spillsbury, Neutec, etc. Call or write for information. 212-925-7000.

Iron Powder and Ferrite

TOROIDAL CORES

Shielding Beads, Shielded Coil Forms
Ferrite Rods, Pot Cores, Baluns, Etc.

Small Orders Welcome
Free 'Tech-Data' Flyer

AMIDON Associates **Since 1963**

12033 Otsego Street, North Hollywood, Calif. 91607

✓ 189

Practically Speaking

Joe Carr, K4IPV

PART 1

HIGH-FREQUENCY DIPOLE ANTENNAS

An unfortunate myth arose in Amateur Radio circles some time ago. People came to believe that large antenna arrays were absolutely necessary for effective communications — especially for DX work. They tend to overlook basic, but effective, antennas that anyone can erect and make work. The simple *dipole* or *doublet* antenna is a case in point. This antenna is sometimes called the *Hertz* or *Hertzian* antenna, because radio pioneer Heinrich Hertz is said to have used it in his experiments.

The dipole is a balanced antenna with two quarter-wavelength radiators (**Figure 1**), making a total of a half wavelength. The antenna is usually installed horizontally, producing a corresponding horizontally polarized signal.

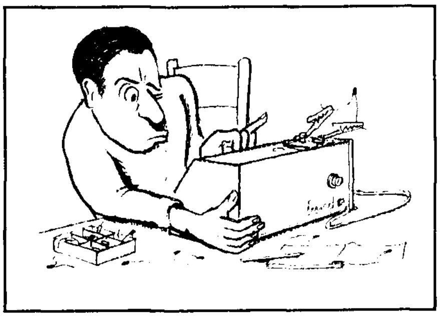
In its most common configuration (**Figure 1**), the dipole is supported at each end by rope and insulators. The rope supports are tied to trees, buildings, masts, or some combination of structures.

As I said before, the antenna length is a half wavelength. Remember that the physical length of the antenna and the theoretical electrical length often differ by about 5 percent. In free space, a half wavelength is found from:

$$L = \frac{492}{F_{MHz}}\ feet \qquad (1)$$

Equation 1 gives you the physical length of a perfect, self-supporting antenna that's many wavelengths away from any object. But for real antennas, the length calculated using this equation is too long. The physical length is about 5 percent shorter because of the capacitive effects of the end insulators. A more nearly correct *approximation* (remember that word; it's important) of a half-wavelength antenna is:

$$L = \frac{468}{F_{MHz}}\ feet \qquad (2)$$



Where:

L is the length of a half-wavelength radiator, in feet.

F_{MHz} is the operating frequency in megahertz.

Example 1

Calculate the approximate physical length for a half-wavelength dipole operating on a frequency of 7.25 MHz.

Solution:

$$L = \frac{468}{F_{MHz}}\ feet$$

$$L = \frac{468}{7.25}\ feet = 64.55\ feet$$

or, restated another way:

$L = 64\ feet\ 6.6\ inches$

Unfortunately, a lot of people accept **Equation 2** as a universal truth — perhaps because of books and articles on antennas that fail to tell it all. For example, you must consider *resonance*. An antenna acts like a complex RLC network. At some frequencies it will appear as an inductive reactance (X_l = +jX), and at others as a capacitive reactance (X_C = −jX). At a specific frequency the reactances are equal in magnitude but opposite in sign, so they cancel each other out: $X_l - X_C = 0$. At this frequency the impedance is purely resistive, and the antenna is resonant.

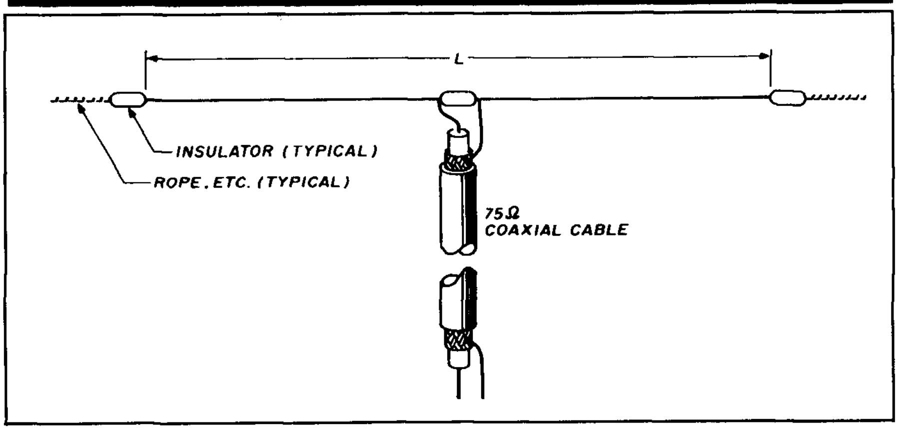
The goal in erecting a dipole is to make the antenna resonant at a frequency that's inside the band of interest — preferably the portion of the band most often used by your station. I'll discuss some of the implications of this later, but for now assume that you have to custom tailor the antenna length. Depending on several local factors (*among them nearby objects*, the antenna conductor's shape, and the conductor's length/diameter ratio), you may have to add or trim the length a bit to reach resonance.

The dipole feedpoint

The dipole is a half-wavelength, center-fed antenna. **Figure 2** shows the voltage (V), current (I), and impedance (Z) distributions along the length of the half-wavelength radiator element. The feedpoint voltage is at a minimum and the current is at a maximum, so you can assume that the feedpoint is a current "loop" or "antinode."

The impedance of the feedpoint at resonance is R_0 = V/I. R_0 is made up of two resistances. First there are ohmic losses that generate nothing but heat when the transmitter is turned on. These losses result because conduc-

FIGURE 1



Standard coaxial cable fed half-wavelength dipole antenna.

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	

NAME ______________________________ CALL ____________

ADDRESS ____

CITY ______________________ STATE __________ ZIP __________

PLEASE USE BEFORE JULY 31, 1989

MAY 1989

AFFIX POSTAGE
OR
POST OFFICE
WILL NOT
DELIVER

HAM
RADIO

READER SERVICE CENTER
P.O. BOX 2558
WOBURN, MASS. 01888

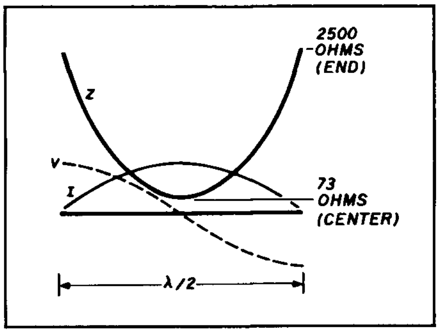
ATTN: Reader Service Dept.

tors have electrical resistance, and because electrical connections aren't perfect (even when properly soldered). Fortunately, in a well-made dipole these losses are almost negligible. The second contributor is the antenna's radiation resistance (R_r). This resistance is a hypothetical concept that accounts for the fact that the antenna radiates RF power. The radiation resistance is the fictional resistance that would dissipate the amount of power radiated away from the antenna.

For example, suppose you're using a large diameter conductor as an antenna, and it has negligible ohmic losses. If you apply 1,000 watts of RF power to the feedpoint, and measure a current of 3.7 A, what is the radiation resistance?

$$R_r = P/I^2$$
$$R_r = (1{,}000\ \text{watts})/(3.7)^2$$
$$R_r = 73\ \text{ohms}$$

FIGURE 2



Plot of current, voltage, and impedance distribution along half-wavelength dipole.

It's important to match the feedpoint impedance of an antenna to the transmission line impedance. Maximum power transfer always occurs when the source and load impedances (in any system) are matched. If some applied power isn't absorbed by the antenna (as happens in a mismatched system), then the unabsorbed portion is reflected back down the transmission line towards the transmitter. This results in standby waves, and the so-called standing wave ratio (SWR or VSWR).

Matching antenna feedpoint impedance may seem easy because the free space feedpoint impedance of a simple dipole is about 72 ohms. You'd think this would be a good match to 75-ohm coaxial cable. Unfortunately, the 72-ohm feedpoint impedance is almost a myth in practical situations. **Figure 3** shows a plot of approximate radiation resistance (R_r) versus height above ground (as measured in wavelengths). As before, you must deal in the approximations found in **Figure 3**; here the ambiguity is introduced by ground losses.

Despite the fact that **Figure 3** is based on approximations, you can see that radiation resistance varies from less than 10 to almost 100 ohms as a function of height. At heights of many wavelengths, this oscillation of the curve settles down to the free space impedance (72 ohms). At the higher frequencies it may be possible to install a dipole many wavelengths high. On the 2-meter band (144 to 148 MHz) one wavelength is around 6.5 feet (2 meters × 3.28 feet/meter), so it's relatively easy to achieve "many" wavelengths at reasonably attainable heights. In the 80-meter band (3.5 to 4.0 MHz), however, one wavelength is about 262 feet, so many wavelengths is a practical impossibility.

There are three tactics you can follow. The first is to ignore the problem altogether. In many installations, the height above ground will be such that the radiation resistance is close enough to present only a slight impedance mismatch to a standard coaxial cable. You'd calculate the VSWR as the ratio (among other ways):

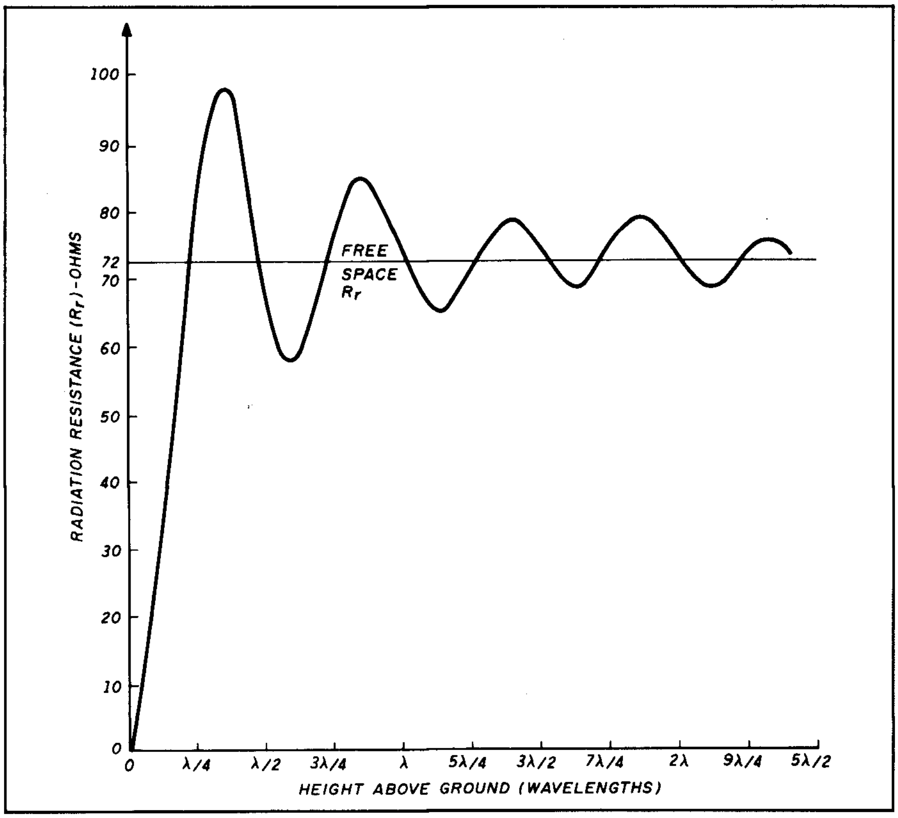
$Z_o > R_r$:
$$VSWR = Z_o/R_r \qquad (3)$$
$Z_o < R_r$:
$$VSWR = R_r/Z_o \qquad (4)$$

Where:
Z_o is the coaxial cable characteristic impedance.
R_r is the radiation resistance of the antenna.

Consider an antenna mounted at a height somewhat less than a quarter wavelength, with a radiation resistance of 60 ohms. While not recommended as good engineering practice, there are many practical reasons why it's necessary to install a dipole at less than optimum height. If so, what are the implications of feeding a 60-ohm antenna with either 52 or 75-ohm standard coaxial cable? Some calculations are revealing:

For 75-ohm coaxial cable:
$$VSWR = Z_o/R_r$$
$$VSWR = 75\ \text{ohms}/60\ \text{ohms} = 1.25{:}1$$

FIGURE 3



Feedpoint impedance versus height above ground.

ATTENTION: WOMEN WHO SOUGHT EMPLOYMENT WITH THE VOICE OF AMERICA (VOA), THE UNITED STATES INFORMATION AGENCY (USIA), OR THE UNITED STATES INTERNATIONAL COMMUNICATION AGENCY (USICA) BETWEEN OCTOBER 8, 1974 AND NOVEMBER 16, 1984.

YOU MAY BE A VICTIM OF SEX DISCRIMINATION ENTITLED TO A MONETARY AWARD AND A POSITION WITH THE AGENCY.

UNITED STATES DISTRICT COURT FOR THE DISTRICT OF COLUMBIA

CAROLEE BRADY HARTMAN, et al., Plaintiffs, v. CHARLES Z. WICK, Defendant	Civil Action No. 77-2019 Judge Charles R. Richey

PUBLIC NOTICE

On November 16, 1984, the United States District Court for the District of Columbia found in this class action lawsuit that the United States Information Agency (USIA or the Agency), including the Voice of America (VOA), is liable for sex discrimination against female applicants for the following positions at the Agency. The USIA was also formerly known as the United States International Communication Agency (USICA). On January 19, 1988, the Court issued its opinion ordering relief in avariety of forms to potential class members. Accordingly, this case is now in the remedial phase.

JOBS COVERED

Specifically, the Court has found that the Agency has discriminated against women in hiring in the following jobs:

- Electronic Technician (Occupational Series 856)
- Foreign Language Broadcaster (Occupational Series 1048)
- International Radio Broadcaster (Other) (Occupational Series 1001)
- International Radio Broadcaster (English) (Occupational Series 1001)
- Production Specialist (Occupational Series 1071)
- Writer/Editor (Occupational Series 1082)
- Foreign Information Specialist/Foreign Affairs Specialist/Foreign Service Information Officer/Foreign Service Officer (Occupational Series 1085 and 130)
- Radio Broadcast Technician (Occupational Series 3940)

WHO IS INCLUDED

All women who sought employment with the Agency in any of the jobs listed above between October 8, 1974 and November 16, 1984 and were not hired may be eligible for relief. Also included are those women who were discouraged from applying for these positions during that time period. Even those women subsequently hired by the Agency in some capacity may be entitled to participate in the remedial phase of this case.

Women who sought employment with the Agency as Foreign Service Officers or Foreign Service Information Officers may be eligible for different kinds of relief depending upon the date of application and whether they sought employment at the entry level or mid-level. Women who sought employment with the Agency as <u>entry</u> level Foreign Service Officers or Foreign Service Information Officers in the years 1974-1977 must use the procedure outlined below. Women who sought employment with the Agency as <u>mid-level</u> Foreign Service Officers or Foreign Service Information Officers in the years 1974-1984 must also use the procedure outlined below. However, women who sought employment with the Agency as <u>entry</u> level Foreign Service Officers or Foreign Service Information Officers in the years 1978-1984 cannot use the procedure outlined below, since the Court has ordered an alternative form of relief for them and selected women in this group will be notified individually as to their rights.

RELIEF AVAILABLE AND HOW TO OBTAIN IT

Relief available to class members may include a monetary award and/or priority consideration for a current position with the Agency. If you think you may be entitled to relief, you <u>must</u> obtain a claim form, complete it fully, and return it to counsel for the plaintiff class, Bruce A. Fredrickson, Esq., Webster & Fredrickson, 1819 H Street, N.W., Suite 300, Washington, D.C. 20006 (202/659-8515), postmarked no later than July 15, 1989.

You may obtain a claim form in person and/or in writing from several sources: counsel for the plaintiff class, whose address is listed above; in person from USIA, Front Lobby, 301-4th Street, S.W., Washington, D.C. (8:15am-5:00pm), Office of Personnel Management (OPM), Federal Job Information Center (First Floor, Room 1425), 1900 E Street, N.W., Washington, D.C. (8:30am-2:30pm), or from area OPM offices throughout the country; in writing, VOA-Hartman, P.O. Box 400, Washington, D.C. 20044. You should carefully consider all questions on the claim form, <u>sign</u> it, and return it to counsel for the plaintiffs. <u>Do not, under any circumstances</u>, return the claim form to the Judge, the Court or the Clerk of the Court. The Judge, the Court and the Clerk of the Court <u>will not accept</u> the claim forms and <u>will not forward</u> claim forms to plaintiffs' counsel.

PROCESSING OF CLAIMS

The process for handling claims has not been finally decided. Thus far, the Court has ordered that responding class members demonstrate their potential entitlement to relief at an individual hearing to be scheduled at a later date. However, the Court has reserved the right to reconsider this procedure in the event the number of claims filed makes this approach unmanageable.

Should individual hearings be used, you will be fully informed as to the date and time of your hearing. Moreover, you will be entitled to legal representation by counsel for the plaintiff class or his designee at no cost to you. Legal counsel will discuss your claim with you prior to your hearing, help you prepare your case and represent you at your hearing. You may, of course, retain your own attorney to represent you, if you so desire.

At the individual hearing, you will be asked to demonstrate your potential entitlement to relief by showing that you applied for one or more of the covered positions during the period October 8, 1974 and November 16, 1984 and that you were rejected, or that you were discouraged from applying. Evidence may be required in the form of testimony, documents, or both. Once you have demonstrated these facts, USIA is required to prove, by clear and convincing evidence, that you were not hired (for <u>each</u> position for which you applied) for a legitimate, non-discriminatory reason, such as failure to possess requisite qualifications. Should USIA make such a showing, you would then be entitled to demonstrate that the Agency's reason is merely a cover for sex discrimination or unworthy of belief.

Following the hearing, the Presiding Official will decide whether you are entitled to relief and, if so, what relief is appropriate. You may be entitled to wages and benefits you would have earned if you had been hired (back pay) from the date of your rejection until the date relief is approved. Under the law, back pay is offset by earnings you may have had during the period. In addition, you may be found to be entitled to front pay (that is, compensation into the future until an appropriate position is afforded you). Similarly, you may be found to be entitled to priority consideration for employment with the Agency. If hired, you may further be entitled to retroactive seniority with the associated benefits and the value of any promotions you would likely have had if you had not suffered discrimination.

REQUIRED STEPS TO FILE YOUR CLAIM

To participate in the remedial phase, <u>you must fully complete the claim form</u> and return it, POSTMARKED NO LATER THAN July 15, 1989, to counsel for the plaintiff class. Your failure to do so will result in your losing all rights you may have in this lawsuit. If you have questions about your rights or procedures available to you, you may contact counsel for the plaintiff class:

Bruce A. Fredrickson
Webster & Fredrickson
1819 H Street, N.W., Suite 300
Washington, D.C. 20006
(202/659-8515)

October 4, 1988
Date

/s/ Judge Charles R. Richey
United States District Court
Judge Charles R. Richey

For 52-ohm coaxial cable:

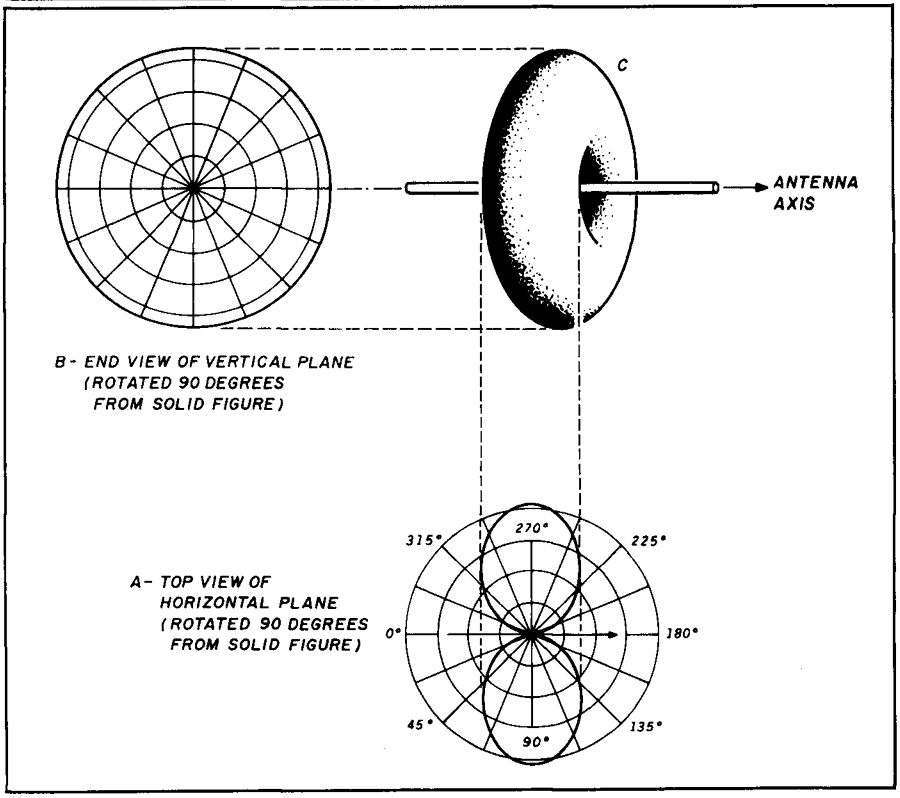
$$VSWR = R_r/Z_0$$
$$VSWR = 60\ ohms/52\ ohms = 1.15:1$$

In neither case is the VSWR created by the mismatch very significant.

The second approach is to mount the antenna at a convenient height and use an impedance-matching scheme to reduce the VSWR. You'll find information on suitable impedance-matching methods (including Q-sections, coaxial impedance transformers, and broadband RF transformers) in any good antenna textbook. Homebrew and commercial transformers can cover most impedance transformation tasks.

The third approach is to mount the antenna at a height (see **Figure 3**) where the expected radiation resistance crosses a standard coaxial cable characteristic impedance. The best height seems to be a half wavelength. The radiation resistance is close to the free space value of 72 ohms, and is a good match for 75-ohm coaxial cable (like RG-11/U or RG-59/U).

FIGURE 4



Radiation pattern of dipole in free space as seen from two planes (A and B), and three dimensionally (C).

The dipole radiation pattern

When discussing antennas I keep returning to the concepts of *directivity* and *gain*, which are actually different expressions of the same fundamental concept. Antenna theory recognizes a point of reference called the *isotropic radiator.* This device is a theoretical construct consisting of a spherical point source of omnidirectional RF radiation. It creates an ever-expanding sphere as the RF wave front propagates outward. Antenna gain is a measure of how the antenna focuses available power away from a spherical wave front in a limited number of directions (two, for a dipole). This is how the concepts of directivity and gain are related.

Always remember that *directivity and gain are specified in three dimensions.* Many times authors (including me) simplify the topic too much by publishing only part of the radiation pattern (i.e., azimuth aspect as seen from above). You, in turn, wind up with a pattern viewed from above that shows the directivity in the horizontal plane. A signal doesn't propagate away from an antenna in an infinitely thin sheet, as such presentations seem to imply, but has an elevation extent in addition to the azimuth extent. Proper antenna evaluation takes both horizontal and vertical plane patterns into consideration.

Figure 4 shows the radiation pattern of a dipole antenna in free space "in the round." When the horizontal plane is viewed from above (**Figure 4A**), the pattern is a "figure eight" that exhibits bidirectional radiation. Two main "lobes" contain the RF power from the transmitter, with sharp nulls of little or no power off the ends of the antenna axis. This is the classic dipole pattern published in most antenna books.

I've also shown the vertical plane pattern for a dipole antenna in free space. Note that the radiation pattern is circular when sliced in this aspect (**Figure 4B**). When the two patterns are combined, you see a three-dimensional doughnut-shaped pattern (**Figure 4C**) that most nearly approximates the true pattern of an unobstructed dipole in free space.

When a dipole antenna is installed close to the ground and not in free space, as is the case at most stations, the pattern is distorted from that of **Figure 4**. You must take two effects into consideration. First and most important is that the signal from the antenna is reflected from the surface and bounces back into space. This signal will be phase shifted by both the reflection and the time required for the transit to occur. At points where the reflected wave combines in phase with the radiated signal, the signal is reinforced; in places where it combines out of phase, the signal is attenuated. Thus the reflection of the signal from the ground alters the pattern from the antenna. The second factor to consider is that the ground is lossy, so not all of the signal is reflected; some of it heats the ground underneath the antenna. Consequently, the signal is attenuated at greater than inverse square law, further altering the expected pattern.

Figure 5 shows patterns typical of dipole antennas installed close to ground. The views in this illustration correspond to **Figure 4B** in that they are looking at the vertical plane from a line along the antenna axis. The antenna is represented by "R" in each case shown. **Figure 5A** shows the pattern for a dipole installed at one-eighth wavelength above ground. For this antenna, most of the RF energy is radiated almost straight up (now very useful). This type of antenna is basically limited to groundwave and very short skip (when available). The second case (**Figure 5B**) shows the pattern when the antenna is a quarter wavelength above the ground. Here the pattern is flattened, but still shows considerable vertically reflected energy (where it is useless). Now look at the pattern obtained when the antenna is installed a half wavelength above the surface. In **Figure 5C**, the pattern is best for long distance work because energy is redirected away from the vertical into lobes at relatively shallow angles.

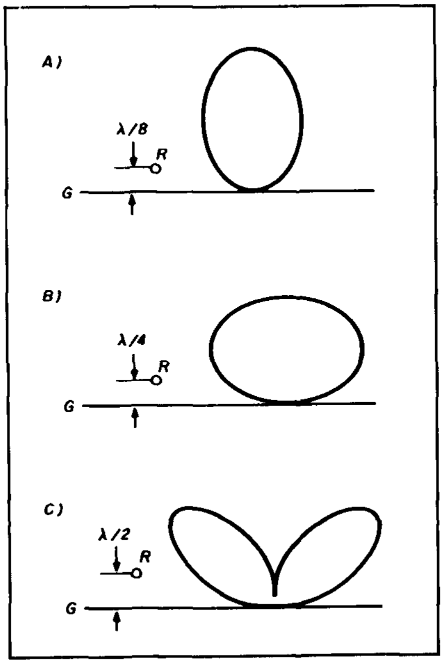
Dipole construction and installation techniques

According to "conventional wisdom," the ideal dipole antenna should be installed at a very high altitude where its performance resembles the free space model. Unfortunately, complying with conventional wisdom is impossible — even for antennas in the higher end of the HF spectrum. Given that the dipole feedpoint impedance is a good match for 75-ohm coaxial cable, and that the pattern is ideal for long distance work when the antenna is installed at a height of a half wavelength above the surface, it's a good idea to try installing the antenna at that height.

Building and installing simple dipoles isn't terribly difficult. **Figure 6** shows the method for building the antenna. First, cut the wire radiator elements to the approximate length indicated by **Equation 2** plus an additional 12 to 24 inches; each element will finally be a quarter wavelength long. The wire can be either hard-drawn copper wire or Copperweld®. The latter is a special tough-service steel core antenna wire coated with copper. The RF resistance of this wire at frequencies above 1 MHz is the same as that of solid copper wire because of the "skin effect" (alternating currents like RF flow on the outer surface of the conductor only). At 160 meters the skin effect depth is only 50 microns (2 mils), while at 10 meters it's only 12 microns (0.5 mils). This means you have the advantage of copper conductivity along with the strength of steel wire.

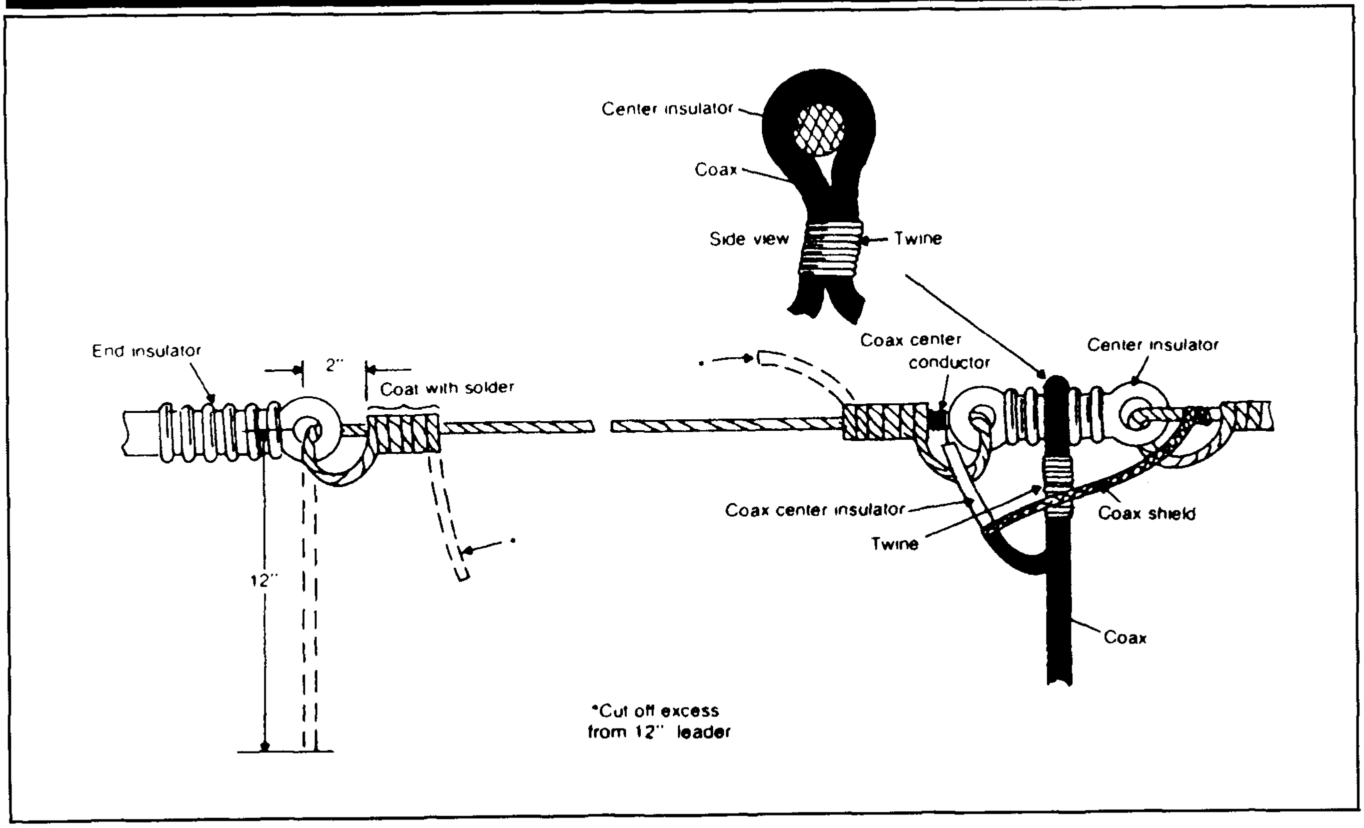
You'll need two end insulators, and both are assembled in the same way. Pass the wire through the hole in the insulator (see **Figure 6**) to a length of about 12 inches. Wrap the wire back on itself and wind it around the portion of the wire that's left on the other side of the insulator. Make this a permanent

FIGURE 5



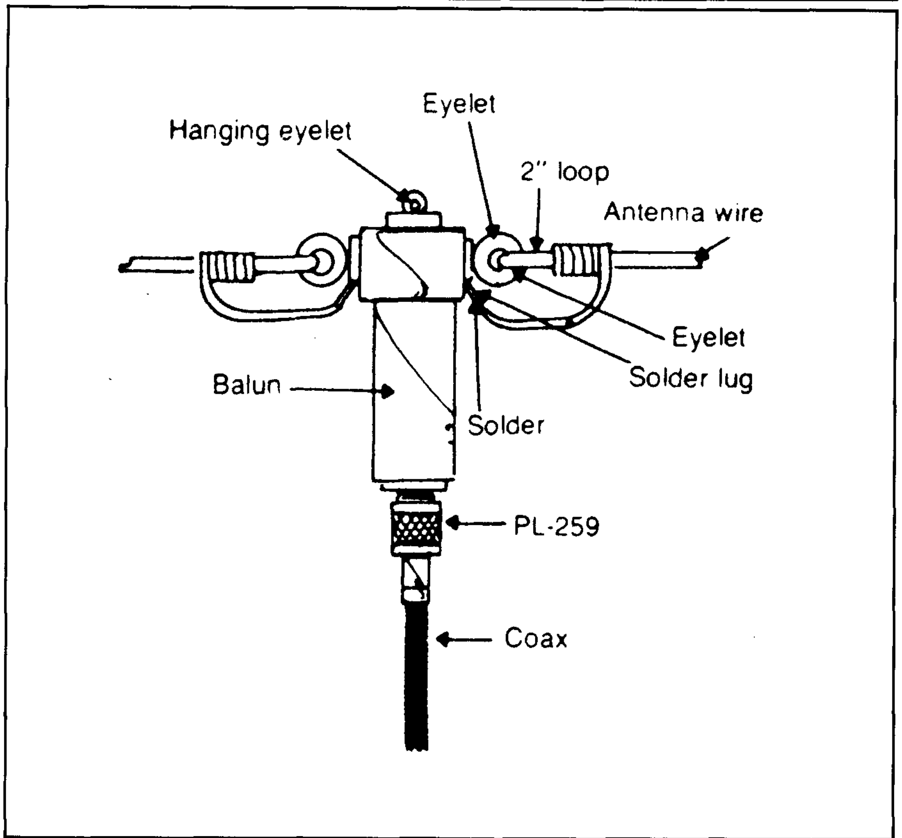
Vertical aspect radiation pattern of dipole close to earth's surface: (A) 1/8-wavelength, (B) 1/4-wavelength, and (C) 12/2-wavelength.

FIGURE 6



Construction details of dipole antenna (from ***TAB Handbook of Radio Communications*** **by J.J. Carr).**

FIGURE 7



Use of a 1:1 balun transformer at the feedpoint (from *TAB Handbook of Radio Communications* by *J.J. Carr*).

connection by soldering it and clipping off the excess wire. The solder *won't* provide mechanical strength. Its purpose is to make a good electrical connection in the presence of corrosion.

Fix the antenna wires to the center insulator in the same way, unless you plan to use one of the special center insulators now on the market. Make these connections temporary until after you've tuned and tested the antenna. You may have to either lengthen or shorten the radiators when tuning your dipole.

Connect the transmission line (usually coaxial cable) to the antenna wire at the center insulator as shown. Attach the center conductor to one radiator element and the shield of the coax to the other. You need to provide strain relief for the coaxial cable; if you don't the cable will break after only a short period of service. The easiest strain relief method is shown in **Figure 6**. Simply wrap the cable once around the insulator and tie it off with twine. Some commercial center insulators offer a strain relief hole or other mechanism. Many people prefer to use a 1:1 balun transformer at the dipole's feedpoint (see **Figure 7**). The transformer has a 1:1 impedance ratio, so it doesn't provide any matching. Instead, it's said to balance the currents flowing in the two radiators, and prevent radiation from reaching the feedline. While this claim has been controversial for some time, and the issue is still not resolved, the best evidence suggests that the pattern of a dipole close to ground is most nearly like the ideal pattern if a 1:1 balun transformer is used at the feedpoint. In **Figure 7** the balun transformer also acts as the center insulator, so no other arrangement is needed.

Next month...

This month I looked at the basic resonant dipole. In part 2, I'll discuss tuning methods for the standard dipole, and some additional variations on the dipole theme. hr

Tell 'em you saw it in HAM RADIO!

Digitar TWR-3 Weather Station

Like most New Englanders, I'm very interested in the weather. I wanted to own weather instruments that would provide good data, but found the cost of most systems prohibitive because of fancy features.

The Digitar series of handheld weather stations meet my standards. The TWR-3, advertised as the world's smallest computer weather station, "packs a wallop" of information including wind speed (3 to 250 mph), wind direction (in degrees, two scales), wind gust record, temperature (−70 to +270 degrees F), high/low temperature record, and has an optional rainfall gauge at extra cost.

The TWR-3 reads in English or metric units and can be programmed to scan through its various functions. It operates on house current, 12-volt DC supply, or its own internal battery support. I installed it easily in less than an hour.

The model TWR-3 is made by Magnaphase Industries, Inc., and is available from Azimuth Weather Star, 11845 W. Olympic Blvd., Suite 1100, Los Angeles, California 90064, for $159.95.

de N1GCF

Circle #301 on Reader Service Card.

Mobile data unit

The TEMPO MPP1 TNC/printer combination is a compact unit for mobile or portable use. The processor portion of the unit is compatible with TAPR TNC 2 and makes use of the complete command set. With 32K ROM and 32K RAM it's possible to:

- store and print all messages received while operating.
- store all messages for printing within the ROM unit.
- store messages to a selected terminal for immediate or delayed printing.

Specifications:

Protocol
  AX.25 level 2
Modem
  AFSK (1200-2200 Hz)
Processor
  Z80 software compatible
Memories
  ROM 32K, RAM 32K (lithium battery backup)
Communication speed
  1200 bps (radio link)
Terminal data rate
  120 bps (300 to 9600 selectable), RS 232C compatible
Power requirement
  13.8 volts DC at 700 mA
Printer
  Thermal Series dot, 40 characters/line, 24 characters/second
Paper
  Thermal, 3-1/8 inch paper tape
Controls
  ON/OFF, manual/auto select, paper feed
Indicators
  POWER on, Tx, Rx, STAtus, CONnected, PTR
Connections Radio interface (5 pin)
Terminal interface (DB-9)
Power DC (2 pin)

The mobile data terminal is shipped complete with cables for connections to a transceiver, computer serial port (RS 232C), and DC power source. Also included are the installation and user's manual and a spare roll of thermal paper. An AC Adapter for supplying DC power from the 117 VAC line and a technical manual complete with schematic are optional. The technical manual is recommended for understanding the circuitry. It's very helpful if you're just getting started in packet, as the installation and user's manual is brief.

Instructions for connecting the unit to your VHF transceiver and computer are straightforward and well documented. You'll have to provide the proper radio and computer plugs to match your equipment, but the MPP1s are already mounted on their cables with the other ends left as flying leads.

I tested the unit with three different transceivers, ICOM-25A, Kenwood TM-221A, and Kenwood TM-621A. The ICOM and Kenwood units had different connections, so I made an adapter to interchange the units easily. I also used two different computers, an IBM PC-XT and a Radio Shack Model 100 (lap top) unit.

Initialization of the MPP1 was easy and well outlined in the manual provided. You must load the terminal's RAM with the proper defaults and your callsign on initial setup. Then your terminal is ready for base or remote use.

I did base station testing with the transceivers connected to a stacked pair of Yagis. I made contacts with stations as far away as Montreal, Canada by using digipeaters. The unit was very tolerant of audio level variations, and did not drop messages during periods of fading or when the audio level was intentionally varied using the gain control. My mobile testing included traveling a route that passed through known weak signal and multipath areas. I copied a couple of bulletin boards without fault and left messages for other users.

This unit is ideal for emergency communications. Amateurs involved in ARES activities should consider it for remote operation. The TNC portion of the unit is a complete processor in itself and directly controls the printer; it can be used as a receive only monitor for messages, with printout activated when convenient.

My only difficulties were due to "cockpit errors" because I have limited packet experience. It's well worth the extra cost to order the technical manual.

I'd like to thank Bill Burden, WB1BRE, for riding copilot and operator during the mobile testing.

The MPP1 sells for $395 and is available from HENRY RADIO, 2050 S. Bundy Drive, Los Angeles, California 90025.

de WA1TKH

Circle #302 on Reader Service Card.

Cushcraft 124WB-element, 2-Meter boomer antenna

Here's a neat compact antenna that can be used in a number of applications. It's perfect for packing to the top of a mountain or high hill; fire it up on 2-meter SSB, or use it for repeater DXing. Apartment dwellers can sneak this antenna into almost any location and get the benefit of directivity and gain. For me, it simplified connecting into the local DX-spotting packet network.

In the past, I had been using either a horizontally polarized antenna or a 5/8-wave vertical. Unfortunately, anytime I rotated the triband beam, I lost the packet network. There was also a 20-dB signal loss between my *horizontal* beam and the packet cluster's *vertically* polarized antenna. The vertical, well, it never worked right.

Cushcraft's 4-element boomer is elegant in it's simplicity. Construction is straightforward and takes just a few minutes. Because of the small size, this antenna can be shoehorned into almost any location.

The 124WB will tune 144-148 MHz with a less than 2:1 SWR. Cushcraft rates the forward gain at 10.2 dBd, with a front-to-back ratio of 19 dB. Assembled wind area is less than 6 inches and the antenna weighs less than three pounds. The retail price is $60. If you want more gain, stacking instructions are included.

From the top of the tower to the attic (where mine is), installation is not a problem and takes just a few minutes. Later this spring, I'll move the antenna to the tower to gain a few additional vertical feet. Now that I'm using the 124WB, I can get into the packet network with ease. The forward gain and directivity gives me a better chance at connecting into the network, even during its busy times.

For further information contact Cushcraft Corp., P.O. Box 4680, Manchester, New Hampshire 03108.

de N1ACH

Circle #303 on Reader Service Card.

Ham Radio's guide to help you find your local Amateur Radio Dealer

CALIFORNIA

A-TECH ELECTRONICS
1033 Hollywod Way
Burbank, CA 91505
(818) 845-9203
New Ham Store and Ready to Make a Deal!

JUN'S ELECTRONICS
3919 Sepulveda Blvd.
Culver City, CA 90230
(213) 390-8003
(800) 882-1343 Trades
Habla Espanol

COLORADO

ALLIED APPLIANCE & RADIO
4253 South Broadway
Englewood, CO 80110
(303) 761-7305
1 (800) 321-7305 (Orders only)
Rocky Mts Amateur/Shortwave Specialists, Ten-Tec, Yaesu, JRC-NRD, Sony , MFJ, KLM, and other fine gear. New and used. Visa/MC. Antennas, books, discount prices too!

COLORADO COMM CENTER
525 East 70th Ave.
Suite One West
Denver, CO 80229
(303) 288-7373
(800) 227-7373
Stocking all major lines
Kenwood Yaesu, Encomm, ICOM

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

AMATEUR & ADVANCED COMMUNICATIONS
3208 Concord Pike
Wilmington, DE 19803
(302) 478-2757
Delaware's Friendliest Ham Store.

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 Mon.-Fri. 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 Mon.-Fri. 9-5:30, Sat. 9-3

HAWAII

HONOLULU ELECTRONICS
819 Keeaumoku Street
Honolulu, HI 96814
(808) 949-5564
Kenwood, ICOM, Yaesu, Hy-Gain, Cushcraft, AEA, KLM, Tri-Ex Towers, Fluke, Belden, Astron, etc.

IDAHO

ROSS DISTRIBUTING COMPANY
78 South State Street
P.O. Box 234
Preston, ID 83263
(208) 852-0830
Mon. 9-2; Tues.-Fri. 9-6; Sat. 9-2
Stock All Major Brands
Over 7000 Ham Related Items on Hand

ILLINOIS

ERICKSON COMMUNICATIONS, INC.
5456 N. Milwaukee Avenue
Chicago, IL 60630
(312) 631-5181
Hours: 9:30-5:30 Mon., Tues., Wed. & Fri.; 9:30-8:00 Thurs; 9:00-3:00 Sat.

INDIANA

THE HAM STATION
220 N. Fulton Avenue
Evansville, IN 47710
(800) 523-7731
(812) 422-0231
ICOM, Yeasu, Ten-Tec, Cushcraft, Hy-Gain, AEA & others.

MARYLAND

MARYLAND RADIO CENTER
8576 Laureldale Drive
Laurel, MD 20707
(301) 725-1212
Kenwood, Ten-Tec, Kantronics. Full service dealer.
Mon.-Fri. 10-7, Sat. 9-5

MASSACHUSETTS

TEL-COM, INC.
675 Great Road, Rte. 119
Littleton, MA 01460
(508) 486-3400
(508) 486-3040
The Ham Store of New England You Can Rely On.

MISSOURI

MISSOURI RADIO CENTER
102 NW Business Park Lane
Kansas City, MO 64150
(800) 821-7323
Missouri: (816) 741-8118
ICOM, Kenwood, Yaesu
Same day service, low prices.

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

NEW HAMPSHIRE

RIVENDELL ELECTRONICS
8 Londonderry Road
Derry, N. H. 03038
(603) 434-5371
Hours Mon.-Sat. 10-5; Thurs. 10-7
Closed Sun/Holidays

NEW JERSEY

ABARIS SYSTEMS
276 Oriental Place
Lyndhurst, NJ 07071
(201) 939-0015
Don WB2GPU
ARRL, Astatic, Astron, B&W, Belden, Bencher, Hustler, Kenwood, Larsen, RF Concepts, Tonna and much, much more!
Tues.-Fri. 10AM-7:30PM
Thurs. 10AM-9:00PM
Sat. 10AM-4:00PM
Visa/MC

KJI ELECTRONICS
66 Skytop Road
Cedar Grove, NJ 07009
(201) 239-4389
Gene K2KJI
Maryann K2RVH
Distributor of: KLM, Mirage, ICOM, Larsen, Lunar, Astron. Wholesale - retail.

HAM MART

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
280 Tiffany Avenue
Jamestown, NY 14701
(716) 664-6345
Open 8:00 AM till 5:30 PM
Evenings, Saturday and Sunday by appointment. Western New York's finest Amateur dealer. Featuring ICOM "The World System."

OHIO

AMATEUR ELECTRONIC SUPPLY
28940 Euclid Avnue
Wickcliffe, OH 44092 (Cleveland Area)
(216) 585-7388
Ohio Wats: 1 (800) 362-0290
Outside Ohio: 1 (800) 321-3594
Hours Mon.-Fri. 9-5:30, Sat. 9-3

DEBCO ELECTRONICS, INC.
3931 Edwards Road
Cincinnati, OHIO 45209
(513) 531-4499
Mon.-Sat. 10AM-9PM, Sun.12Noon-6PM
We buy and sell all types of electronic parts.

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 over 30 Years

TEXAS

K COMM dba THE HAM STORE
5707A Mobud
San Antonio, TX 78238
(512) 680-6110
(800) 344-3144
Stocking all major lines. San Antonio's Ham Store. Great Prices — Great Service. Factory authorized sales and service.
Hours: Mon.-Fri. 10-6; Sat. 9-3

MADISON ELECTRONICS SUPPLY
3621 Fannin
Houston, TX 77004
(713) 520-7300
Christmas?? Now??

MISSION COMMUNICATIONS
11903 Aleif Clodine
Suite 500 (Corner Harwin & Kirkwood)
Houston, Texas 77082
(713) 879-7764
Now in Southwest Houston—full line of equipment. All the essentials and extras for the "ham."

WISCONSIN

AMATEUR ELECTRONIC SUPPLY
4828 W. Fond du Lac Avenue
Milwaukee, WI 53216
(414) 442-4200
Wisc. Wats: 1 (800) 242-5195
Outside Wisc: 1 (800) 558-0411
Mon.-Fri. 9-5:30, Sat. 9-3

Dealers:
YOU SHOULD BE HERE TOO!
Contact Ham Radio now for complete details.

✓ 197

Reader Service CHECK—OFF Page 118

Ultra-compact IC-725 HF transceiver

ICOM has introduced a new compact IC-725 HF transceiver. The all-mode IC-725 features:

- USB/LSB/CW transmitting and receiving, AM receiving. Optional module no. UI-7 for FM transmit/receive and AM transmit.
- 26 tunable memories with band stacking registers.
- DDS (Direct Digital Synthesizer) system.
- Built-in AH-3 controller. Optional AH-3 automatic antenna tuner available.
- Three scanning systems: programmable, memory, and selected mode scan.
- Priority watch.
- 105-dB dynamic range receiver.
- 160 through 10-meter operation. Short-wave reception from 30 kHz to 33 MHz.

Other features include: Panel-selectable RF preamp and attenuator, dual VFOs, noise blanker, RIT, semi-break in CW, selectable AGC, full-duty cycle, and optional narrow CW filter.

The suggested retail price of the IC-725 is $949.

For more information contact ICOM America, Inc., 2380 116th Ave. N.E., PO Box C-90029, Bellevue, Washington 98009-9029.

Circle #304 on Reader Service Card.

Handheld frequency counter

Optoelectronics, Inc. introduces its new handheld frequency counter model 2210. It has low frequency coverage down to 10 Hz and microwave coverage up over 2.2 GHz. The counter runs on internal NiCd batteries and comes with a metal cabinet and precision quartz timebase oscillators. A full line of accessories includes antennas, probes, and carry case.

Input sensitivity is less than 10 mV from 10 Hz to 2 GHz; 3 mV is typical. Accuracy is 1 PPM with temperature compensated crystal oscillators. Resolution is 1 Hz below and 100 Hz above 12 MHz. A full 16-hour recharge yields 2 hours of battery operation. Use an AC adapter/charger to operate when recharging.

The model 2210 sells for $189 complete with NiCd batteries and charger. The model TA-100S telescoping whip antenna is $12 and the vinyl carry case is $10. For more information contact Optoelectronics, Inc., 5821 N.E. 14th Avenue, Fort Lauderdale, Florida 33334.

Circle #305 on Reader Service Card.

Super performance battery packs

Periphex, Inc. offers battery packs that are compatible with the following Yaesu radios: FT-727R, 109RH, 209R/RH, 709R, 103R, 203R and 703R.

The FNB-4SH, 12-volt 1-Ah battery is double the capacity of the original FNB-4/4A battery pack, and is compatible with the Yaesu NC-15 base charger. The FNB-4SH is priced at $71.

The FNB-4SL, 12-volt 0.75-Ah battery has 150 percent of the capacity of the original FNB4/4A battery pack, and is also compatible with the Yaesu NC-15 base charger, NC-18B, and PA-3 trickle charger. This pack is priced at $65.

The FNB-3S, 9.6-volt 1.2-Ah battery is almost triple the capacity of the original FNB-3/3A battery, and is designed as a long-life battery pack. The FNB-3S is completely compatible with the Yaesu NC-15 base charger, NC-18B, and PA-3 trickle charger. The price of the FNB-3S is $60.

All battery packs include overcharge, over temperature, short-circuit protection, and a 1-year warranty.

For more information contact Periphex, Inc., 149 Palmer Road, Southbury, Connecticut 06488.

Circle #306 on Reader Service Card.

New free catalog from MFJ

MFJ Enterprises, Inc. announces their new full-line 16-page 1989 MFJ *Amateur Radio Accessories Catalog.*

Over 80 Amateur Radio accessories are featured, including the MFJ-1278 Multi-mode Data Controller, the MFJ-931 Artificial RF Ground, and over ten new MFJ products.

Also featured is MFJ's full line of keyers, filters, packet radio controllers, computer interfaces, dummy loads, ham software, antenna switches, speaker, wattmeters, R-X noise bridge, antenna bridge, antenna current probe, code practice oscillator, clocks, and other ham equipment.

To receive your free copy call toll free 800-647-1800 or write MFJ Enterprises, Inc., PO Box 494, Mississippi State, Mississippi 39762.

Circle #307 on Reader Service Card.

Macintosh WeFaxWorks

WeFaxWorks is a program for the Apple Macintosh computer that allows reception of weather maps and charts on a standard Macintosh using Kantronics' KAM, all-mode interface. During live reception, the screen scrolls automatically. Synchronization is simple; point the mouse at the sync mark and click once. This causes the received and displayed signal to be aligned with the left edge of the Macintosh screen.

The entire picture is saved into a buffer as it's being received. Once you exit the receive mode, you can select the buffer display, and the captured picture will appear on the screen.

The buffer contents can be saved to disk by choosing "Save..." from the File menu, and a saved WeFaxWorks map can be recalled from disk with the "View File..." selection. The buffer contents are erased when you enter the "Receive Live" mode, or when a map is recalled from the disk.

Maps are printed with MacPaint format files. The portion you want to print is brought to the screen using the Display Buffer mode and scroll bar. These files are in MacPaint format and can be opened, touched up, and printed with MacPaint.

For more information contact Kantronics at 1202 E. 23rd Street, Lawrence, Kansas 66046.

Circle #308 on Reader Service Card.

BATTERIES "R" US...

You've bought our replacement batteries before...
NOW YOU CAN BUY DIRECT FROM US, THE MANUFACTURER!

ICOM
CM2, PB2 7.2v @ 500MAH
CM5, PB5 10.8v @ 500MAH
SUPER 7S & 8S
13.2v @ 1100MAH
9.6v @ 1200MAH
(base charge only - 1" longer)
Introductory Offer!
SUPER 7S & 8S - $64.95 each

MAY SPECIAL!

YAESU complete battery packs 10% off sheet price for May only.

EXTRA SPECIAL THIS MONTH:
Inquire: CAMCORDER battery replacements available now.

Look for June special.

YAESU/MAXON
*FNB-10 7.2v @ 600MAH
FNB-12 12v @ 500MAH
*FNB-10(S) 7.2v @ 1000MAH
*same size case as FNB-12

Introductory Offer!

P4W 11v @ 500MAH - $22.63
FNB-2 11v @ 500MAH - $22.63

CUSTOM MADE BATTERY PACKS & INSERTS
Made to your specifications.
Introductory Offer!
KENWOOD INSERTS
PB-21 - $13.75, PB-25 - $20.00, PB-26 - $20.00
ICOM INSERTS
BP-5 - $23.00, BP-3 - $18.95, BP-7, BP-8

Prices subject to change without notice.

MasterCard VISA

MasterCard and Visa cards accepted. NYS residents add 8¼% sales tax. Add $3.50 for postage and handling.

1 SOURCE FOR ALL YOUR COMMUNICATION BATTERY REPLACEMENT NEEDS.

W & W ASSOCIATES

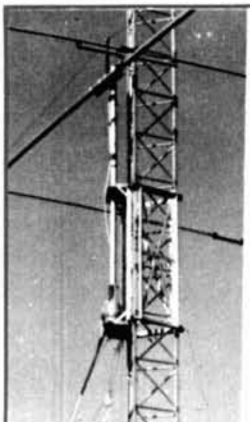
29-11 Parsons Boulevard, Flushing, N.Y. 11354

WORLD WIDE DISTRIBUTORSHIPS AVAILABLE. PLEASE INQUIRE.

SEE US IN DAYTON BOOTHS 558 & 559, FOR SHOW SPECIALS!

In U.S. & Canada Call Toll Free (800) 221-0732 • IN NYS (718) 961-2103 • Telex: 51060 16795 • FAX: (718) 461-1978

✓ 200



SAVE TIME and MONEY with THE HAZER

Bring things down for safety and convenience.

Never climb your tower again with this elevator system. Antennas and rotator mount on HAZER, complete system trams tower in vertical upright position. Safety lock system operates while raising or lowering. Never can fall.

Complete kit includes winch, 100 ft. of cable, hardware and instructions. For Rohn 20 and 25 G Towers.

Hazer 2-Heavy duty alum. 12 sq. ft. load	$311.95 ppd.
Hazer 3-Standard alum. 8 sq. ft. load	$223.95 ppd.
Hazer 4-Heavy galv. steel 16 sq. ft. load	$291.95 ppd.

NEW for ROHN 45 and 55 Towers

Hazer 8-Heavy duty galv. steel 16 sq. ft. load	CALL
Ball Thrust Bearing TB-25 for any of above	$69.50 ppd.

Send for free details of aluminum towers specifically engineered for use with the Hazer. Two sizes; M-13 (13" wide) and M-18 (18" wide). All bolted construction, no welds. Easy to install hinge base, walk up erection. Complete tower UPS or air freight shippable. Pre-assembled or kit form.

Satisfaction guaranteed. Call today and charge to Visa, MasterCard or mail check or money order.

GLEN MARTIN ENGINEERING INC.
Rte 3, Box 322
Boonville, MO 65233
(816) 882-2734 FAX 816-882-7200

✓ 201

NEMAL ELECTRONICS

- Complete Cable Assembly facilities MIL-STD-45208
- Commercial Accounts welcome- Quantity pricing • Same day shipping most orders
- Factory authorized distributor for Alpha, Amphenol, Belden, Kings, Times Fiber

Call NEMAL for computer cable, CATV cable, Flat cable, semi-rigid cable, telephone cable, crimping tools, D-sub connectors, heat shrink, cable ties, high voltage connectors.

HARDLINE 50 OHM

FXA12 1/2" Aluminum Black Jacket	.89/ft
FLC12 1/2" Cablewave corr. copper blk jkt	1.69/ft
FLC78 7/8" Cablewave corr.copper blk jkt	4.25/ft
NM12CC N conn 1/2" corr copper m/f	25.00
NM78CC N conn 7/8" corr copper m/f	54.00

COAXIAL CABLES (per ft)

1180 BELDEN 9913 very low loss	.55
1102 RG8/U 95% shield low loss foam 11ga	.36
1110 RG8X 95% shield (mini 8)	.17
1130 RG213/U 95% shield mil spec NCV jkt	.39
1140 RG214/U dbl silver shld mil spec	1.85
1705 RG142B/U dbl silver shld, teflon ins	1.50
1310 RG217/U 50 ohm 5000 watt dbl shld	.98
1450 RG174/U 50 ohm .100" od mil spec	.14

ROTOR CABLE-8 CONDUCTOR

8C1822 2-18ga and 6-22ga	.25
8C1820 2-18ga and 6-20ga	.39

CONNECTORS-MADE IN USA

NE720 Type N plug for Belden 9913	$3.95
NE723 Type N jack for Belden 9913	4.95
PL259AM Amphenol PL259	.89
PL259TS PL259 teflon ins/silver plated	1.59
PL258AM Amphenol female-female (barrel)	1.65
UG175/UG176 reducer for RG58/59 (specify)	.22
UG21DS N plug for RG8,213,214 Silver	3.35
UG83B N jack to PL259 adapter, teflon	6.50
UG146A SO239 to N plug adapter, teflon	6.50
UG255 SO239 to BNC plug adapter, Amphenol	4.29
SO239AM UHF chassis mt receptacle,Amphenol	.89
UG88C BNC plug RG58, 223, 142	1.45

GROUND STRAP-GROUND WIRE (per ft.)

GS38 3/8" tinned copper braid	.40
GS12 1/2" tinned copper braid	.50
GS200 1-1/2" heavy tinned copper braid	2.00
HW06 6ga insulated stranded wire	.39
AW14 14ga stranded Antenna wire CCS	.14

Prices do not include shipping, $3 minimum, Visa/Mastercard $30 min, COD add $3.00
Call or write for complete price list. Nemal's new 40 page CABLE AND CONNECTOR SELECTION GUIDE is available at no charge with orders of $50 or more, or at a cost of $4 with credit against next qualifying order.

NEMAL ELECTRONICS, INC. 12240 NE 14th Ave. N. Miami, FL 33161
(305) 893-3924 Telex 6975377 24hr FAX (305)895-8178

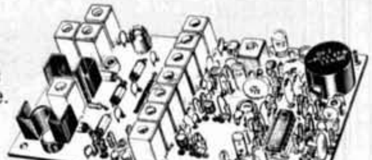
Tell 'em you saw it in HAM RADIO!

THE MOST AFFORDABLE REPEATER
ALSO HAS THE MOST IMPRESSIVE PERFORMANCE FEATURES
(AND GIVES THEM TO YOU AS STANDARD EQUIPMENT!)

KIT, ONLY $675
WIRED $975
VHF OR UHF

FEATURES:
- **SENSITIVITY SECOND TO NONE! GaAsFET front end** on vhf models gives 12dB SINAD of 0.12uV (vhf), 0.15uV (220). UHF model 0.25uV std, 0.1uV with optional helical resonator preamp.
- **SELECTIVITY THAT CAN'T BE BEAT!** Both 8-pole xtal filter & ceramic filter for > **100dB at only ±12kHz.** Helical resonator front end to combat desense & intermod.
- **CLEAN, STABLE TRANSMITTER,** up to 18W output standard; 50W with accessory power amplifier.
- **FCC TYPE ACCEPTED** for commercial high band and uhf.
- **Courtesy beep,** field-programmable CWID, flutter-proof squelch, automatic frequency control to compensate for off-frequency transmitters (all standard features).
- **Full range of options** available, such as autopatch, phone line or radio remote control, sub-audible tones, duplexers.

HIGH PERFORMANCE TRANSMITTERS & RECEIVERS FOR REPEATERS AUDIO & DIGITAL LINKS, TELEMETRY, ETC.



- **FM EXCITERS:** Kits $99, W/t $179. 2W continuous duty. TCXO & xtal oven options available.
- **TA51 for 10M, 6M, 2M, 150-174, 220 MHz.**
- **TA451 for uhf.** FCC type accepted for commercial bands.
- Call for latest information on 900 MHz transmitters.
- **VHF & UHF AMPLIFIERS.** For FM, SSB, ATV. Output from 10 to 50 Watts. Several models, kits starting at $79.

- **R144/R220 FM RECEIVERS** for 2M, 150-174, or 220 MHz. **GaAs FET** front end, 0.12uV sensitivity! Both crystal & ceramic filters plus helical resonator front end for exceptional selectivity: > 100dB at ±12kHz (best available anywhere)! Flutter-proof squelch. AFC tracks drifting transmitters. Kit $149, w/t $229.
- **R451 UHF FM RCVR.** Similar to above. Tuned line front end, 0.25uV sens. (0.1uV with optional hel. res. preamp). Kit $149, w/t $229.
- **R901 FM RCVR FOR 900 MHZ.** Triple-conversion, GaAs FET front end, 0.2uV sens. Kit $169, w/t $259.
- **R76 ECONOMY VHF FM RCVR** for 10M, 6M, 2M, 220. Without hel res or afc. Kits only $129.
- **Weather satellite & AM Aircraft receivers also avail.**

FCC TYPE-ACCEPTED TRANSMITTERS & RECEIVERS AVAILABLE FOR HIGH-BAND AND UHF. CALL FOR DETAILS.

GaAs FET PREAMPS
at a fraction of the cost of comparable units!

LNG -(*)
GaAs FET PREAMP

ONLY $59!
Wired/tested

FEATURES:
- **Very Low Noise:** 0.7dB VHF, 0.8dB UHF
- **High Gain:** 13-20dB, depending on frequency
- **Wide Dynamic Range:** to resist overload
- **Stable:** new-type dual-gate GaAs FET

** Specify tuning range desired: 26-30, 46-56, 137-150, 150-172, 210-230, 400-470, or 800-960 MHz.*

LNW -(*)
MINIATURE GaAs FET PREAMP

ONLY $24/kit,
$39 Wired/tested

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

** Specify tuning range desired: 25-35, 35-55, 55-90, 90-120, 120-150, 150-200, 200-270, or 400-500 MHz.*

LNS-(*)
IN-LINE PREAMP

ONLY $79/kit,
$99 Wired/tested

GaAs FET Preamp with features similar to LNG series, except **automatically switches out of line during transmit.** Use with base or mobile transceivers up to 25W.

**Specify tuning range desired: 120-175, 200-240, or 400-500 MHz.*

HELICAL RESONATOR PREAMPS

Low-noise preamps with helical resonators **reduce intermod & cross-band** interference in critical applications.
MODEL HRA-(*), $49 vhf, $84 uhf.

** Specify tuning range desired: 142-150, 150-162, 162-174, 213-233, 410-454, or 454-475.*

ACCESSORIES

COR-3 REPEATER CONTROLLER kit. Features adjustable tail & time-out timers, solid-state relay, courtesy beep, and local speaker amplifier. $49

CWID kit. Diode programmed, adjustable tone, speed, and timer, to go with COR-3. .... $59

NEW **COR-4** kit. Complete COR and CWID all on one board for easy construction. CMOS logic for low power consumption. Many new features. EPROM programmed; specify call letters.. $99

NEW **TD-3 SUBAUDIBLE TONE DECODER/ENCODER** kit. ... $24

TD-2 DTMF DECODER/CONTROLLER kit. Full 16 digits, with toll-call restrictor, programmable. Can turn 5 functions on/off. Great for selective calling, too! $79

AP-3 AUTOPATCH kit. Use with above for repeater autopatch. Reverse patch and phone line remote control are std. $79

AP-2 SIMPLEX AUTOPATCH Timing Board kit. Use with above for simplex operation. $39

MO-202 FSK DATA MODULATOR kit. Run up to 1200 baud digital signals through any fm transmitter with full handshakes. Radio link computers, telemetry gear, etc. $39

DE-202 FSK DEMODULATOR kit. For receive end of link. $39

9600 BAUD DIGITAL RF LINKS. Low-cost packet networking system, consisting of new MO-96 Modem and special versions of our 220 or 450 mHz FM Transmitters and Receivers. Interface directly with most TNC's. Fast, diode-switched PA's output 15 or 50W. *Call for info on the right system for your application!*

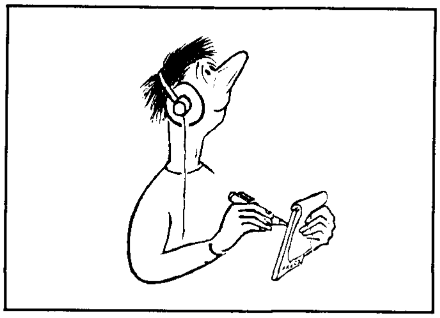
RECEIVING CONVERTERS

		Antenna Input Range	Receiver Output
		28-32	144-148
		50-52	28-30
		50-54	144-148
VHF MODELS		136-138	28-30
		144-146	28-30
		145-147	28-30
Kit with Case	$59	146-148	28-30
Kit less Case	$39	220-222	28-30
		220-224	50-54
Wired w/case	$89	222-224	28-30
UHF MODELS		432-434	28-30
		435-437	28-30
Kit with Case	$69	432-436	144-148
Kit less Case	$49	432-436	50-54
Wired w/case	$99	439.25	61.25
		902-928	422-448
		902-922	430-450

See catalog for full line of 2w transmitting converters for vhf & uhf. Kits only $79. Linear Amplifiers avail. up to 50 w.

- **Send $1 for 36 page catalog by return mail.** (Send $2.00 or 4 IRC's for overseas mailing)
- **Order by phone or mail • Min $3 S & H per order**
- **Use Visa, Mastercard, Check, or UPS COD.**

Our 26th Year
hamtronics, inc.
65-H MOUL ROAD•HILTON NY 14468-9535
Phone: 716-392-9430 *Hamtronics® is a registered trademark*



Garth Stonehocker, KØRYW

1988 PROPAGATION SUMMARY

September 1986 was definitely the month of sunspot minimum, with the smoothed sunspot number (SSN) equal to 12.3. That makes 1988 the second year of solar cycle 22. The solar flux minimum of 67.6 occurred in June 1986, but September of that year also brought the smoothed value minimum of 72.9, along with the sunspot minimum. In 1988, the sunspot number started out at 58 and ended at about 137 while the solar flux started at 108 and ended at 200. These numbers made it the steepest climbing year of the cycle as SSN and solar flux are expected to taper off to a maximum of 185 for SSN and 225 for the solar flux near the end of 1989. While the 1987 values were slightly above the highest in cycle 19, the 1988 values' slope crossed cycle 19's, so these forecast values are probably reasonable.

In 1988, midlatitude noontime maximum usable frequencies (MUFs) monthly median increased from 19 to 27 MHz for a 3000-km hop. The increase wasn't linear throughout the year because the summer F2 layer was 15 percent less than it was the rest of the time, with the equinoxal periods having the highest MUF. This increase in MUF levels off for SSNs greater than 150, as does the solar flux. Most solar flux to SSN conversion formulas don't take this into account. This also shows how the MUF follows solar flux values above 150 instead of the SSN; this will be the condition during 1989. The MUF formula for monthly medians is $MUF = 2.65 \times (0.0165 \times SSN + 8.4)$.

During 1988, propagation was affected adversely by several periods of geophysical events. In March I discussed how to forecast propagation conditions a day or two in advance using the trend in solar flux and geomagnetic A values. Now I'd like to show how MUFs correlated with flux and A indexes during several large events in 1988. The first occurred on February 20th during a decreasing solar flux (107 to 102). A small solar flare started a high-latitude geomagnetic event which spread down to the midlatitudes by the 22nd. The A value went to 67 and decreased MUFs 48 percent to 10 MHz. The MUFs were 25 percent on the 23rd, 19 percent on the 24th, and 15 percent on the 25th before recovering. On March 25th, a small flare was probably the cause of a polar cap absorption and small geomagnetic disturbance. The MUF increased 33 percent over the first two days, then decreased 17 percent for the next two. The solar flux had just increased 7 units, but was level during the disturbance. A corresponding increase in MUF occasionally occurs as it did here, when the solar flux is on the increase or if the disturbance starts as the sun is rising on the propagation path. The next notable event began with a gradual disturbance of unknown cause on April 3rd through the 7th, which dropped the MUFs 46 percent during an A of 57. The solar flux was decreasing from 128 to 115.

Another large disturbance (A index = 63) began gradually near the end of May 5th and lasted one day. The MUF decreased 66 percent before it was over. The solar flux decreased 5 units during this period. The last significant event affecting propagation was on October 10th, caused by a small solar flare and solar flux burst. The geomagnetic disturbance measured 57 on the A index and the MUF decreased nearly 40 percent as the solar flux was going down. You'll notice that most of these events happened as the solar flux was decreasing and that the MUF decrease was greater at those times than it was during those disturbances when the solar flux was increasing. The MUF decrease averages 2 percent per A unit when the solar flux is decreasing, as opposed to a 0.8-percent MUF decrease per A unit when the solar flux is level or increasing. The solar flux factor for the beginning of 1988 was 1 percent MUF change per unit of solar flux; later in the year it increased to 2 units of solar flux for a 1-percent MUF change.

You can use these factors during this phase of the SSN cycle to predict the best band for daily operation. There are more bands to jump to now and in July. Good luck!

Last-minute forecast

The higher frequency bands (10 to 30 meters) are expected to have the best openings the first and the last week and a half of May. These openings may include some 6-meter long skip when WWV solar flux values indicate the very peak of the 27-day solar cycle. Transequatorial (TE) single long-hop openings will probably be available towards the evening early in May; these openings are scarce during June, July, and August. Periods of disturbance around the 5th and 13th may enhance the possibility of TE openings. Another expected disturbance date, the 22nd, may come too late to help TE but may affect east-west paths on the lower bands. These lower bands should be best the second and third weeks of the month, when the solar flux is expected to be at minimum. The higher minimums restrict daytime DX distance from weak signals.

The full moon occurs on the 20th; the lunar perigee is on the 3rd and 31st. An Aquarid meteor shower (for meteor scatter and meteor burst DXers) peaks between May 4th and 6th, with rates of 10 and 25 per hour for the northern and southern hemispheres, respectively.

Band-by-band summary

Ten, 12, 15, 17 and 20 meters will support DX propagation from most areas of the world during daylight hours and into the evening, with long skip out to 2000 miles (3500 km) per hop. Signals on the upper three bands will be strongest from the southern countries and occur near local noon.

MAY

WESTERN USA

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

MID USA

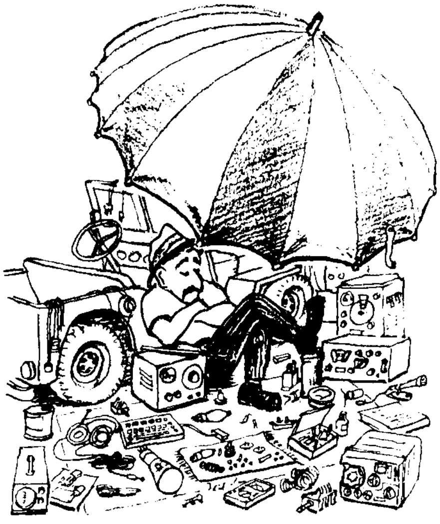
GMT	MDT	N Asia Far East	NE Europe	E S. Africa	SE S. America	S Antarctica	SW New Zealand	W Oceania Australia	NW Japan	CDT
0000	6:00	15	20	15	10	12	10	10	10	7:00
0100	7:00	15	20	15	10	12	10	10	10	8:00
0200	8:00	15	20	20	12	15	10	10	12	9:00
0300	9:00	15	20	20	12	20	10	10	12	10:00
0400	10:00	15	20	20	12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

EASTERN USA

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

The propagation direction will follow the sun across the sky. It will be to the east in the morning, the south at midday, and the west in the evening. Sporadic-E short skip will be available at local noon on some days toward the end of the month.

Thirty, 40, 80, and 160 meters are the nighttime DXers' bands. The direction of propagation follows the darkness path across the sky: evening to the east, around midnight to the north and south, and toward the west in the predawn hours. Distances will generally decrease to 1000 miles (1600 km) for skip on these bands. Sporadic-E openings will be most frequently observed around sunrise and sunset toward the end of the month.



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.

BEGINNER'S RADIO CLEARINGHOUSE. On a space available basis, we are going to offer you, OUR SUBSCRIBER, free of charge, a chance to find a home for your used equipment with a new Ham. Please send us a short description of what you want to sell along with price, name, address and phone number. We'll run it once in a special section of the classified ads under the heading of BEGINNER'S RADIO CLEARINGHOUSE. Please limit your ad to 20 words or less.

NATIONAL Radio Manual and NCL-2000 factory parts lists. SASE. Max Fuchs, 11 Plymouth Lane, Swampscott, MA 01907.

ELECTRONIC KITS & ASSEMBLIES. For our latest catalog send a large SASE (45 cents) to: A & A ENGINEERING, 2521 W. LaPalma, #K, Anaheim, CA 92801.

IBM-PC SOFTWARE FOR PK-232. New CompRtty II/PK is the complete communications program for the PK-232/HK-232. Uses host mode of PK-232 for complete control. Text entry via built-in screen editor! Adjustable split screen display, including optional Triple Split ™ in Packet mode. Instant mode/speed change. Hardcopy, diskcopy, break-in buffer, select calling, text file transfer, customizable full screen logging, 24 programmable 1000 character messages, mailbox facility. Ideal for MARS and traffic handling. Requires 256k PC compatible. $65. Non-PK-232 version still available. Send call letters (including MARS) with order. David A. Rice, KC2HO, 144 N. Putt Corners Rd, New Paltz, NY 12561.

COMMODORE/AMIGA CHIPS (eg. 6510-$12.55, 6526-$13.50, 6567-$19.95, 6581-$14.85, 82S100-$15.75, 901 ROM Series-$12.50), PARTS, DIAGNOSTICS, HARD TO FIND ITEMS. Authorized service center. Fast REPAIRS, low cost (eg. C64-$49.95 plus UPS). Heavy duty power supplies for the C64-$27.95 plus UPS. Kasara Microsystems (Division of QEP), Route 9W/Kay Fries Drive, Stony Point, NY 10980, 1-800-248-2983 (outside NY) or 914-942-2252.

THE NATIONAL HAM SHOPPER. A monthly buy, sell, trade publication (starting in April). Ads are quickly answered and published for fast results. $12/per year. $24/per 2-year subscription rate. Send: PO Box 10738, Elmwood, CT 06110.

R-290A Receiver Parts: Info SASE. CPRC-26 military Manpack Radio, 6 meter FM, with antenna, crystal, handset: $22.50, $42.50/pair. CPRC-26 Radio-only: $9.50. Add $4.50/piece shipping, $9 maximum. Baytronics, Box 591, Sandusky, OH 44870.

AZDEN SERVICE by former factory technician. Rush service available. PCS 300 Nicad $36.95. Southern Technologies Amateur Radio, Inc, 10715 SW 190 St, #9, Miami, FL 33157. (305) 238-3327).

SENIOR FIELD ENGINEER: Cellular One of Galveston seeking technical Manager with knowledge of cellular, microwave, and telephony. Minimum 3 years experience. FCC/NABER a plus. Relocation required. Resumes to 3128 Broadway, Galveston, TX 77550.

COMMUNICATIONS BATTERIES: Clone Packs! Ready-for-use. ICOM: BP5 $44.95, BP-3S 2X cap. BP3 "Wall Chargeable" $43.95, BP-7S 2X BP7 (5W only) or BP8S (BP8 + 50%) (Base Chg-only) $67.95, YAESU: FNB2 $22.95, FNB10S (10 + 60%) $49.95, SANTEC 142 $23.95. * Repair Inserts * ICOM: BP2 $18.95, BP3 $16.95, P5 $24.95, BP7/BP8 $29.95, KENWOOD: PB21 $13.95, PB24 $21.95, PB25/26 $25.95, YAESU: FNB4/4A $33.95, TEMPO: S1,2,4,5,15/450 $23.95, AZDEN: 300 $21.95. * E.P. Porta-Pac & Chgr 12V/5Ahr $44.95 * * Rebuilding * Send pack—free estimate. * Antennas * Ducks/BNC $8.95, 2mtr 5/8-Tel/BNC $18.95. SASE Catalog. PA + 6%. $3 Shipping/order. VISA-M/C + $2. (814) 623-7000. CUNARD ASSOCIATES, Dept H, RD 6, Box 104, Bedford, PA 15522.

ENGINEER WANTED. With Ham experience to develop Ham products. Exciting proposition for the right person. Box 498, Greenville, NH 03048.

450 MHz SPECTRUM ANALYZER. Adapted from Nov 85 QST article by Al Helfrick, K2BLA. Use your low frequency scope for the display portion. Log output calibrated in 10 db steps. For complete kit, order #450-KIT $459.95 plus $4.50 s/h. Calif. residents add 6% sales tax. Foreign orders add 15% for shipping. For additional information send large SASE to: A & A ENGINEERING, 2521 W. LaPalma, #K, Anaheim, CA 92801 or call (714) 952-2114.

FOR SALE: Browning Golden Eagle Mark IV AM/SSB citizen's band receiver. Superb performance—tube-type double conversion, low noise, two tunable bands or crystal controlled. Use on CB, retune for 10 meters, or use as tunable IF for 2 meter, satellite or microwave receiver. Missing top cover, otherwise complete and working, with schematic. $100.00. Peter Ferrand, WB2QLL, 65 Atherton Avenue, Nashua, NH 03060. (603) 889-1067.

WANTED: All types of Electron Tubes. Call toll free 1-800-421-9397 or 1-612-429-9397. C & N Electronics, Harold Bramstedt, 6104 Egg Lake Road, Hugo, MN 55038.

100 QSL CARDS $8. $3 thereafter. Grid square printed free. Shipped postpaid within two weeks. Guaranteed correct! Free samples. Shell Printing, KD9KW, Box 50B, Rockton, IL 61072.

SCHEMATICS. Devices, modules and components. Catalog $1.00 refundable. Free flyer LSASE. George Whitmore, 5746 Aberdeen Angus Way, Las Cruces, NM 88001.

N6SR/KX6: Anyone who has worked me as /KX6 has worked an illegal station. Anyone hearing that call please notify me and the FCC immediately.

WANTED: G.E. Mastr-Pro UHF 250 watt base station or amplifier with power supply or amplifier along. K8RUR, (313) 697-8888.

FOR SALE: IC-2AT 5/8 whip, rubber duck ant., mike, IC-BP4 battery pack, IC-DC1, two IC-BP3's with charger. $200. Martin Hanft, POB 199, Gilsum, NH 03448.

UHF PARTS. GaAs Fets, mmics, chip caps, feedthrus, teflon pcb, high Q trimmers. Moonbounce quality preamps. Electronic sequencer boards. Send SASE for complete list or call (313) 753-4581 evenings. MICROWAVE COMPONENTS, PO Box 1697, Taylor, MI 48180.

COMMODORE-128 PROGRAM available to track the Amateur Satellites. Uses Keperlian data supplied by NASA free. Tracks up to 8 satellites simultaneously. Program also supports printing schedules and predictions for satellites. Use it to track MIR and talk to the Cosmonauts. SATRAK128, $26.50 includes shipping. Other information on this or other programs for the C128, requires a business size SASE. Reid Bristor, WA4UPD, PO Box 0773, Melbourne, Florida 32936-0773.

WANT: 32S3 xmtr, 250TL and 304TL tubes. KF6WM, 45300 Royal, King City, CA 93930.

DXERS—CUSTOMIZED PRINTOUT of antenna headings calculated for your location. List includes over 650 worldwide locations. Send Lat/Long coordinates, name, callsign, check for $12.95 U.S. Brian Henderson, VE6ZS, 23 Deermoss Pl SE, Calgary, Alberta, Canada T2J 6P5. (403) 278-2084.

HANDICAPPED NOVICE needs HF equipment donated—anything please. KA3OUE, (412) 531-7443 anytime.

OFFICIAL MILITARY-TYPE ID TAGS. ("Dog Tags")!! Customized with your Call Letters, etc. 5 seventeen space lines. 20" nickel plated chain included. $4.29 postpaid. JPW ENTERPRISES, PO Box 353, Logan, Utah 84321

MAGAZINES WANTED: "Microwave Systems News" (MSN), "RF Design", "PCIM (Power Conversion & Intelligent Motion)" and "QEX" (1980-present). Call collect 519-742-4594 (Ontario) after 6 PM Eastern time.

IMRA International Mission Radio Association helps missionaries. Equipment loaned. Weekday net, 14.280 MHz, 1-3 PM Eastern. Nine hundred Amateurs in 40 countries. Rev. Thomas Sable, S.J., University of Scranton, Scranton, PA 18510.

BACK ISSUES OF HAM RADIO. Have most issues from 1969 to 1974. Mint condition. $3.00 for single issues. WN0G, 319-377-3563.

HAM TRADER YELLOW SHEETS. In our 27th year. Buy, swap, sell ham radio gear. Published twice a month. Ads quickly circulate—no long wait for results. Send No. 10 SASE for sample copy. $13 for one year (24 issues). PO Box 2057, Glen Ellyn, IL 60138-2057 or PO Box 15142, Dept HR, Seattle, WA 98115.

VHF-UHF-SHF. Large SASE. West Coast VHFer, POB 685, Holbrook, AZ 86025.

CHASSIS & CABINET KITS. SASE. K3IWK, 5120 Harmony Grove Rd, Dover, PA 17315.

ANALOG AND RF CONSULTING for the San Francisco Bay area. Commercial and military circuits and systems. James Long, Ph.D., N6YB (408) 733-8329.

RTTY JOURNAL—Now in our 36th year. Read about RTTY, AMTOR, PACKET, MSO'S, RTTY CONTESTING, RTTY DX and much more. Year's subscription to RTTY JOURNAL $10.00, foreign slightly higher. Order from: RTTY JOURNAL, 9085 La Casita Ave., Fountain Valley, CA 92708.

RUBBER STAMPS: 3 lines $5.00 PPD. Send check or MO to G.L. Pierce, 5521 Birkdale Way, San Diego, CA 92117. SASE brings information.

ELECTRON TUBES: Receiving, transmitting, microwave... all types available. Large stock. Next day delivery, most cases. DAILY ELECTRONICS, PO Box 5029, Compton, CA 90224. (213) 774-1255.

"HAMLOG" COMPUTER PROGRAM. Full features, 17 modules. Auto-logs, 7-band WAS/DXCC. Apple $19.95. IBM, CP/M, KAYPRO, Tandy, C128 $24.95. HR-KA1AWH, POB 2015, Peabody, MA 01960.

WANTED: ARC-5 and SCR-274 equipment, parts and accessories, any condition. Ken, WB9OZR, 362 Echo Valley, Kinnelon, NJ 07405. (201) 492-9319.

WANTED: Ham equipment and other property. The Radio Club of Junior High School 22 NYC, Inc. is a nonprofit organization, granted 501(C) (3) status by the IRS, incorporated with the goal of using the theme of Ham Radio to further and enhance the education of young people. Your property donation or financial support would be greatly appreciated and acknowledged with a receipt for your tax deductible contribution. In Dayton, meet the crew from 22 and relax at our flea market tables, check in on 144.30 simplex. Please write us at: PO Box 1052, New York, NY 10002. Or call our round the clock hotline: (516) 674-4072. Thank you!

WANTED: Drake Linear Amp Model MN4439- 1000W (2000 PEP), 1.8-30 MHz. Call Bruno Molino, VE2FLB, 26 Rue Des Anciens, Gatineau, Quebec J8T 3T2. (819) 561-3689.

RECONDITIONED TEST EQUIPMENT $1.25 for catalog. Walter, 2697 Nickel, San Pablo, CA 94806.

COMING EVENTS

Activities — "Places to go . . ."

SPECIAL REQUEST TO ALL AMATEUR RADIO PUBLICITY COORDINATORS: PLEASE INDICATE IN YOUR ANNOUNCEMENTS WHETHER OR NOT YOUR HAMFEST LOCATION, CLASSES, EXAMS, MEETINGS, FLEA MARKETS, ETC, ARE WHEELCHAIR ACCESSIBLE. THIS INFORMATION WOULD BE GREATLY APPRECIATED BY OUR BROTHER/SISTER HAMS WITH LIMITED PHYSICAL ABILITY.

May 5-6: NEBRASKA: Hamboree #11 sponsored by the 3900 Club and the Sooland ARA, Marina Inn, South Sioux City. For reservations write Al Smith, W0PEX, 3529 Douglas Street, Sioux City, IA 51104.

May 7: NEW JERSEY: Annual Indoor Hamfest/Flea Market, sponsored by the Tri-County Radio Association, Passaic Township Community Center, Stirling. 8AM to 2PM. For information/reservations Dick Franklin, PO Box 182, Westfield, NJ 07090. (201) 232-5955.

May 6: NEW YORK: 30th annual Southern Tier Hamfest sponsored by the Southern Tier ARCs (STARC), Tioga County Fairgrounds, Rt 17c, Owego. For information/tickets SASE to STARC, PO Box 7082, Endicott, NY 13760.

May 6: KANSAS: Tailgate Swapfest sponsored by the Flint Hills ARC, Augusta City Park, 20 min east of Wichita. 8AM to 3PM. For information SASE to Zack Wilkerson, K0DVY, Rt 1, Box 90, El Dorado, KS 67042.

May 6: WISCONSIN: The Ozaukee Radio Club will sponsor its 11th annual Swapfest, Circle B Recreation Center, Highway 60, Cedarburg, 8 AM to 1 PM. For information send business SASE to ORC Swapfest, N5415 Crystal Springs Court, Fredonia, WI 53021.

May 6: NEW YORK: The Putnam Emergency Amateur and Radio League will have their PEARLfest at the John F. Kennedy Elementary School, Foggintown Road, Brewster. 9 AM to 4 PM rain or shine. For registration contact Terri Cullum, N2GWF, 40 Mile Hill Road, Highland, NY 12528 or Jim Morgan, KA2FIQ, 39 Overlook Road, Ossining, NY 10562.

May 6-7: MARYLAND: Capital Fest sponsored by the Timex Sinclair Computer Club, Howard Johnson's, Rt 95 & 450, New Carrollton. For information Audrey Curnutt, 10400 Truston Road, Adelphi, MD 20783.

May 5-7: ARIZONA: The Cochise Amateur Radio Association's annual Hamfest, Club training facility, Sierra Vista. tailgating. Handi facilities. For information N7INK (602) 378-3155 after 6 PM or write CARA, PO Box 1855, Sierra Vista, AZ 85636.

May 7: NEW JERSEY: Spring Hamfest sponsored by the Bergen ARA, Bergen Community College, 400 Paramus Rd, Paramus. 8-3. For information Jim Joyce, K2ZO, 286 Ridgewood Blvd, No. Westwood, NJ 07675. (201) 664-6725.

May 6-7: SOUTH CAROLINA: 50th annual Greenville Hamfest sponsored by the Blue Ridge Amateur Radio Society, American Legion Fairgrounds, Greenville. Saturday 8-5; Sunday 8-3. For advanced tickets or information SASE to Blue Ridge ARS, POB 6751, Greenville, SC 29606.

May 13: WISCONSIN: Lakeshore Hamfest sponsored by Mancarad Radio Club, Manitowoc County Expo Center, Hwy 42-151 and I-43 on County Hwy R. Starts 8 AM. Contact: Mancarad Radio Club, PO Box 204, Manitowoc, WI 54220.

May 14: OHIO: Medina County Hamfest sponsored by the Medina 2 Meter Group, Medina County Community Center, 735 Lafayette Road, Medina. 8AM to 2PM. For information/tickets SASE to Medina Hamfest Committee, PO Box 452, Medina, OH 44258. (216) 769-3033 or 725-4492. 10AM to 5PM.

May 14: OHIO: 10th annual Hamfest sponsored by the Athens County ARA, City Recreation Center, Athens. 8AM to 3PM. For information Carl J. Denbow, KA8JXG, 63 Morris Avenue, Athens, OH 45701.

May 19-21: OKLAHOMA: Green Country Hamfest, Expo Square Pavillion, 17th and Louisville, Tulsa. Registration Green Country Hamfest, POB 4283, Tulsa, OK 74135. For information (918) 272-3081.

May 19-21: NEW HAMPSHIRE: The 15th annual Eastern VHF/UHF/SHF Conference, sponsored by the Northeast VHF Association, Rivier College, Nashua. Registration chairman David Knight, KA1DT, 15 Oakdale Ave, Nashua, NH 03062.

May 20: MICHIGAN: Swap and Shop sponsored by the Wexaukee ARA, Cadillac Middle School, 500 Chestnut Street, Cadillac. 8:30AM to 2:30PM. Contact John Craddock, KX8Z (616) 797-5491 or Wexaukee ARA, PO Box 163, Cadillac, MI 49601.

May 20: ARKANSAS: Ozark Hamboree sponsored by the Northwest Arkansas ARC, Rodeo Community Center, Springdale. 8AM to 3PM. For information Randall Spear, WA5QGH, (501) 846-3210.

May 20: ILLINOIS: 3rd annual Hamfest and Electronic Flea Market sponsored by the Lewis & Clark Radio Club, Lewis & Clark Community College, Godfrey. 8AM to 3PM. For information/tickets: Lewis & Clark Radio Club, PO Box 553, Godfrey, IL 62035. (618) 466-1909.

May 20-21: WASHINGTON: Hamfest '89 sponsored by the Yakima ARC, Central Wahington State Fairgrounds, Yakima. Contact Dick Umberger, N7HHU (509) 453-8632 days or 453-3580 evenings. Early bird special Yakima ARC, W7AQ, PO Box 9211 Yakima, WA 98909.

May 20: TEXAS: 4th Annual Armed Forces Day Hamfest, sponsored by the Key City ARC, Abilene Civic Center, Pine St, Abilene. 8AM to 5PM. Wheelchair Accessible. For information Bill Jones, N5DOX (915) 698-4606 or KCARC, PO Box 2;722, Abilene, TX 79604.

May 20: MINNESOTA: Swapfest '89 sponsored by the Arrowhead Radio Amateur Club, First United Methodist Church, 230 East Skyline Parkway, Duluth. 10AM to 3PM. For information/registration John Crow, KA0SYN, 1365 Roland Road, Cloquet, MN 55720. (218) 879-5356.

May 20: GEORGIA: 10th annual Lake Hartwell Hamfest sponsored by the Anderson, Hartwell and Toccoa ARCs, Lake Hartwell Group Camp, Hwy 29, 4 miles north of Hartwell. For information George C. Haddock, KB4HCB, Rt 1, Box 52, Martin, GA 30557 or Carl Davis, College Avenue, Hartwell, GA 30603.

May 20: PENNSYLVANIA: Lancaster County Hamfest, sponsored by the Ephrata Area Repeater Society, Ephrata Senior High School, 803 Oak Blvd, Ephrata. Starting 8AM. For information/reservations Tom Youngberg, K3RZF 215) 267-2514 or EARS, 906 Clearview Ave, Ephrata, PA 17522.

May 20: RHODE ISLAND: Spring Flea Market and Auction sponsored by the RI Amateur FM Repeater Service, VFW Post 6342, Main Street, Forestdale (No. Smithfield). Noon to 5 PM. For information contact Rick Fairweather, K1KYI, Box 591, Harrisville, RI 02830. (401) 568-0566 from 7-9 PM.

May 20: COLORADO: 1989 Swapfest sponsored by the Pikes Peak Radio Amateur Association, Rustic Hills Mall, Palmer Park and academy Blvd, Colorado Springs. For information/reservations Al, N0CMW (719) 473-1660 or write PPRAA Swapfest, PO Box 16521, Colorado Springs, CO 80935.

May 21: PENNSYLVANIA: 15th annual Hamfest sponsored by the Warminster ARC, Middletown Grance Fairgrounds, Penns Park Road, Wrightstown. Gates open 8 AM. For information/registration Bill Cusick, W3GJC, Apt 804, Garner House, Hatboro, PA 19040. (215) 441-8048.

May 21: ILLINOIS: Knox County Hamfest, sponsored by the Knox County Radio Club, Knox County Fairgrounds, Knoxville. Starts 8AM. For tickets/information Keith L. Watson, WB9KHL, 119 South Cherry Street #3, Galesburg, IL 61401-4527. (309) 342-3885 evenings.

May 21: WEST VIRGINIA: The 11th annual TSRAC Wheeling Hamfest/Computer Fair, Wheeling Park. 8 AM to 3 PM. . To reserve space contact Sandi Williams, WC8P, 9 East High Street, Flushing, OH 43977 (614) 968-3652. For tickets TSRAC, Box 240, RD 1, Adena, OH 43901 (614) 5546-3930.

May 21: ILLINOIS: Hamfest sponsored by the Kankakee Area Radio Society, Will County Fairgrounds, Peotone. 8-3. For information write KARS c/o Frank DalCanton, KA9PWW, RR 1, Box 361, Chebanse, IL 60922. (815) 932-6703 after 4 PM or (815) 937-2452 before 4 PM CST.

May 21: ILLINOIS: Mini-Hamfest sponsored by the Chicago ARC, North Park Village, 5801 N. Pulaski, Chicago. 9AM to 3PM. For information contact CARC, 5631 W. Irving Park Road, Chicago, IL 60634. (312) 545-3622.

May 21: CALIFORNIA: HAMSWAP, sponsored by the North Hills Radio Club, Folsom Community Clubhouse, Folsom. 8 AM to 3 PM. Contact NHRC, PO Box 41635, Sacramento, CA 95841 or call Bob, WA6ULL (916) 983-2776.

May 27: NORTH CAROLINA: 10th annual Durhamfest 1989, sponsored by the Durham FM Association, lower rear deck South Square Mall, Durham, rain or shine. 8AM to 4PM. For information Mick Rankin, W4ZUS, 1001 Wedgewood Lane, Durham, NC 27712.

May 28: MARYLAND: Memorial Day Hamfest sponsored by the Maryland FM Association, Howard County Fairgrounds, Rt 144, West Friendship. 8AM to 3PM. For information/reservations Mike Cresap, 1294 Dorothy Road, Crownsville, MD 21032. (301) 923-3829.

June 3: NEW HAMPSHIRE: The Hosstraders Flea Market is back at the Deerfield Fairgrounds. Admission $5 per person. Wheelchair accessible. Questions or map SASE to WA1IVB, RFD Box 57, West Baldwin, ME 04091.

June 4: MICHIGAN: Swap 'N Shop sponsored by the Chelsea ARC. For information Robert Schantz, 416 Wilkinson Street, Chelsea, MI 48118. (313) 475-1795.

June 4: NEW YORK: Lancaster Hamfest sponsored by the Lancaster ARC, Depew Grove, 271 Columbia at French Rd, Depew. 8AM to 5PM. For information WA2CJJ (716) 681-6410 or KE2FM (716) 681-3512.

June 4: PENNSYLVANIA: 35th annual Hamfest sponsored by the Breeze Shooters, White Swan Amusement Park, Rt 60 (Parkway West) near greater Pittsburgh International Airport. For information John Colbert, K3SDL, 1851 Highland Ave, Irwin, PA 15642. (412) 863-5167.

June 4: NEW YORK: Hall of Science Hamfest, sponsored by the Hall of Science ARC, Hall of Science parking lot, Flushing Meadow Park, 47-01-111 Street, Queens. Starts 9 AM. For information Steve Greenbaum, WB2KDG (718) 898-5599 or Arnie Schiffman, WB2YXB (718) 343-0172.

June 10: MICHIGAN: 15th annual Hamfest sponsored by the Central Michigan Amateur Repeater Association (CMARA), Midland Community Center, Midland. 8AM-1PM. For information SASE to CMARA Hamfest, PO Box 67, Midland, MI 48640
June 10: MAINE: 3rd annual Outdoor Hamfest sponsored by the Pine State ARC, Hammond Street Campground, near I95, Bangor. Dawn to 5 PM. For information Ed Richardson, NO1L, 825-4417; Howie Soule, K1CZ, 848-3397.

June 10: ONTARIO: Central Ontario Amateur Radio Flea Market, Bingeman Park, Kitchener, Ont. Contact Ray Jennings, VE3CZE, 61 Ottawa Crescent, Guelph, Ont. N1E 2A8. (519) 822-8342.

OPERATING EVENTS

"Things to do . . ."

April 30: The Clairemont Repeater Assoc. will operate W6FZZ, SAMS DAY, to honor Samuel F.B. Morse. Samuel F.B. Morse III will be operating from this station. For QSL CLARA, Box 7675, Huntington Beach, CA 92615.

May 13-14: Nevada QSO Party sponsored by the Frontier ARA, Las Vegas. 0000Z May 13 to 0600Z May 14. 6-160m, CW/SSB/FM/RTTY/Packet/SSTV. Mail logs to Jim Frye, NW7O, 4120 Oakhill Ave, Las Vegas, NV 89121.

May 20: The Maryland Mobileers ARC will operate WA3PJQ aboard the Submarine U.S.S. Torsk (SSk-423), 1400Z to 2100Z. For certificate send legal SASE to MMARC, POB 784, Severna Park, MD 21146.

May 20: 40th annual ARMED FORCES DAY. In recognition the ARS W4ODR located Northside aboard Naval Air Station Memphis, Millington, TN, will operate from 1300Z to 2300Z. For addition information W4ODR/Navy—Marine Corps MARS Station NNN0NIF, Bldg N-100, NAS Memphis. (901) 873-5134.

May 20: Special event station KM3I will be on the air to commemorate the 145th anniversary of the telegraph message "What Hath God Wrought?", transmitted on an experimental line from Washington, DC to Baltimore, MD. For a commemorative certificate, Amateurs send QSL card, SWL's send QSO details with large SASE to The Bay Area ARS, PO Box 805, Pasadena, MD 21122-0805.

May 20-21: The St. Charles ARC will operate WB0HSI from 1300Z to 2100Z to commemorate Lewis and Clark Rendezvous Days. For certificate send large SASE to St. Charles ARC, PO Box 1429, St. Charles, MO 63302-1429.

May 21-27: Special event station WA4ZIO will be operating from the Alabama Reunion Train. Sponsored by the Heart of Dixie Railroad Museum, Birmingham ARC and ARRL AL section. 80-10m phone and CW. For certificate send QSL and 9x12 SASE to Birmingham ARC, POB 603, Birmingham, AL 35201.

June 3: The Conemaugh Valley ARC will operate WA3WGN to commemorate the centennial of the flood of 1889 in Johnstown, PA. Lower General phone bands, 20, 40m. Novice phone 10m. For QSL send #10 SASE to Conemaugh Valley ARC, 194 Barron Ave, Johnstown, PA 15906.

June 4: The Wireless Institute of Northern Ohio (WINO) an organization sponsored by the Lake County ARA will operate special event station KO8O from a winery in Madison, Ohio, to commemorate Ohio Wine Month. 1500Z to 1900Z 14235 and 21310 kHz. For QSL send legal SASE to KO8O, WINO Weekend, 10418 Briar Hill, Kirtland, OH 44094.

NORTH COAST ARC 1989 LICENSE EXAMS. 12:30 PM, Saturdays February 11, April 15, June 10, August 12, October 14, December 9. N. Olmsted Community Cabin, S of Lorain on W. Park. Novice thru Extra. Walkins allowed. Talk in 145.29 repeater. For information Dan Sarama, KB8A, 15591 Rademaker Blvd, Brookpark, Ohio 44142. 267-5083 or Pauline Wells, KA8FOE, Rick Wells, K8SCI, 777-9460/779-8999.

AMATEUR RADIO CLASSES: For those people interested in obtaining a Novice (basic level) Ham license or upgrading to Tech/General, the Chelsea Civil Defense, in cooperation with QRA Radio Club, will sponsor Amateur Radio Communications classes evenings at Chelsea High School starting MARCH 7, 1989. For more information write Frank Masucci, K1BPN, 136 Grove Street, Chelsea, MA 02150. Please enclose your telephone number.

THE MIT UHF REPEATER ASSOCIATION and the MIT Radio Society offer monthly HAM EXAMS. All classes Novice to Extra. Wednesday, MAY 24, 7 PM, MIT Room 1-150, 77 Mass Avenue, Cambridge, MA. Reservations requested 2 days in advance. Contact Ron Hoffmann at (617) 484-2098. Exam fee $4.50. Bring a copy of your current license (if any), two forms of picture ID, and a completed form 610 available from the FCC in Quincy, MA (617) 770-4023.

Get lightning, EMP and static protection for receivers, transceivers, amplifiers...

With EMP Series Transi-Trap® Surge Protectors

NOW 20,000 amps surge rating — all models

Model R-T and LT **EMP Series** Arc-Plug® cartridges are designed to protect against nuclear electromagnetic pulse (EMP), as well as lightning surge voltages.

The **EMP Series** design is based on the National Communications System Technical Information Bulletin 85-10 covering EMP protection for communications equipment.

All Transi-Trap Protectors feature "isolated ground" to keep damaging arc energy from the chassis.

Don't hook up your coax without one!

The 200 W models are most sensitive, best for RCVRS and XCVRS. 2 kW models designed for amplifiers. For maximum protection use both, with 200 W model between XCVR and AMP. All models include replaceable Arc-Plug cartridge and are designed for 50 ohms.

UHF "T-type" Connectors, for use through 30 MHz:
MODEL LT, 200 W $22.95

Super Ruggedized Super Low Loss Models (0.1 dB at 500 MHz), for use through VHF/UHF, with UHF *connectors:*
MODEL R-T, 200 W $32.95
MODEL HV, 2 kW $35.95

At your Alpha Delta dealer. Or order direct in U.S.: add $3 for postage and handling. MasterCard and VISA accepted. Ohio residents add Sales Tax.

MasterCard VISA See Data Sheet for surge limitations.

ALPHA DELTA COMMUNICATIONS, INC.

P.O. Box 571, Centerville, Ohio 45459 • (513) 435-4772 (AA)

✓ 208

ANTENNA MODELING

Easy to use, with menus, and optional mouse. Enter parameters, and get a color coded sinusoidal projection of a MW or SW antenna. Move over the projection with a mouse or cursor and read the gain at that point.

LONG WIRE PRO models long wires, vee's, dipoles, and rhombics displaying a sinusoidal projection. $40

VERTICAL PRO models single verticals or arrays displaying a sinusoidal projection, a ground wave plot, and the impedance of each element. $80

IBM PC compatible, DOS 2.0 or higher, 256K, CGA or EGA color required. International orders add $5 shipping.

EPSILON CO

Box 715, Trumbull CT, 06611, (203) 261-7694

✓ 209

PACKET PRICE BREAK!
FOR COMMODORE 64/128 USERS

Full HF and VHF Packet Operation
- Multi-connects
- True store and forward digipeating
- Remote access of station
- Mini-BBS/Personal Mailbox
- Plus much more . . .

Featured in 73 Magazine, August 1988

Parts kit with PC board **$49.95**
Assembled/tested unit **$79.95**
Uses 7910 chip – no alignment required
(Both include FREE Digicom 64 software)

Terms: To order send check or M.O. Add $2.50 shipping (USA). SASE for information.

BARRY KUTNER, W2UP
614-B Palmer Lane
Yardley, PA 19067

COMPUTER SOFTWARE

LOW BAND DX-ING COMPUTER PROGRAMS
by John Devoldere, ON4UN - 30 programs for Apple II, MS-DOS, Commodore C-128 and Kaypro CPM Computers

Just about every interest or need is covered—from antenna design and optimization to general operating programs. Antenna programs include: *shunt and series input L network design, feedline* transformer, shunt network design, SWR calculation, plus 11 more! General Ham programs include: sunrise/sunset, great circle distances, grayline, vertical antenna design program, sunrise calendar plus 9 more! © 1986.

- ☐**UN-Apple II** **$39.95**
- ☐**UN-MS (MS-DOS)** **$39.95**
- ☐**UN-CPM/Kaypro** **$39.95**
- ☐**UN-C-128 (COMMODORE C128)** **$39.95**
- ☐**UN-MAC (MACINTOSH)** **$49.95**
- ☐**UN-C64 (COMMODORE C64)** **$39.95**

N6RJ's ELECTRONIC SECOND OP
for MS-DOS computers, V1.01
by Jim Rafferty N6RJ

The world famous SECOND OP is now available in a state-of-the-art computerized data base. This program, written for MS-DOS computers, is a must for DX'ers, contesters and all Amateurs interested in reliable DX communication. Data can be displayed either in columnar format or in full screen displays. Unknown callsigns can be entered and compared to the ITU callsign allocation for easy identification. There's plenty more too such as: postal rates, beam headings and QSL bureaus to name just a few. Great program to have in your shack. Order your's today. ©1988. MS-DOS computers. 5¼ and 3½ versions available. Please specify on your order.

- ☐**CB-RJ** **(MS-DOS Computers)** **$59.95**

HAM DATA By **Chip Lohman NN4U** **FOR C-64**
AMATEUR RADIO COMPUTER SOFTWARE

MASTER LOG New Version

Master Log creates a file of 2100 individual records with up to 13 different entries per record. It can do a search and select based upon time, frequency, mode and keeps track of DXCC and WAS status, prints QSL labels and can search its whole file in less than 5 seconds! Complete documentation is included to help you learn and use this truely state-of-the-art logging program. ©1988.

- ☐**HD-ML (For C-64)** **$28.95**

SUPER LOG

Super Log gives you all the advantages of a computerized data base *without significantly changing the traditional log format.* Super Log also allows you to print out either selected contents or the whole log. Will print QSLs.

- ☐**HD-SL** (For C-64) **$19.95**

CONTEST LOG

This disk contains four different contest programs; ARRL Sweepstakes, Field Day, Universal WW Contest log, plus a dupe checking routine. Automatically enters date, time, band and serial number for each contact. When the contest is over, the program will print your results listing all duped and scored contacts in serial sequence with all the necessary information as well as completed score at the bottom of the page.

- ☐**HD-CL (For C-64)** **$24.95**

DX EDGE MS-DOS AND C-64 software

Particularly helpful in determining long path and grey line openings. Super fast speed and dazzling graphics make this program a treat to use. The MS-DOS version also includes a close up (zoom) feature for detailed examination, a MUF calculator and a great circle bearing routine. All call sign prefixes and coutry names are built into the data base for easy pinpointing of locations. MS-DOS version also color compatible. Requires 2 disk drives, 348k of memory, Hercules, CGA or EGA graphics and DOS 2.1 or later.

- ☐**XN-DOS (IBM or compatible computers)** **$34.95**
- ☐**XN-C64 (C-64 computer)** **$34.95**
- ☐**XN-DX (slide rule version)** **$22.95**

HAM RADIO'S BOOKSTORE

Please enclose $3.75 shipping and handling.

Greenville, NH 03048
(603) 878-1441

Electronic temperature-control soldering station

The Elenco electronic temperature-control soldering station has a circuit which lets you change tip temperature from 300°F (150°C) to 900°F (480°C) without changing the tip or heating element. A temperature sensor located near the tip offers rapid response and little temperature variation. The tip of the unit is isolated from the AC line by a transformer. Low voltage (24 volts) powers the heating element. Completely electronic switching protects voltage and current-sensitive components. This unit has a linear LED array readout which accurately indicates tip temperature. It is priced at $169.

Contact Elenco Electronics, Inc., 150 W. Carpenter Avenue, Wheeling, Illinois 60090 for details.

Circle #309 on Reader Service Card.

Transverter from R N Electronics

R N Electronics of Essex, England announces the new 2 to 6-meter transverter. It can be used with your existing 2-meter transceiver and has 25 watts PEP output. For more information write R N Electonics, 37 Long Ridings Avenue, Hutton, Brentwood, Essex CM131EE, UK.

ICOM's new IC-765 HF transceiver

ICOM announces the new ICOM IC-765 HF transceiver which features:

- Direct Digital Synthesizer (DDS).
- Band stacking registers.
- 99 fully tunable memories.
- CW pitch control.
- Maximum operating flexibility.
- Built-in AC supply.
- Automatic antenna tuner with built-in CPU and memory.
- 10-Hz readout.

The IC-765 is priced at $3,149, and comes with narrow 500-Hz CW filters. The 250-Hz FL-53A and FL-101 are optional filters.

For details contact ICOM America at 2380 116th Avenue N.E., PO Box C-90029, Bellevue, Washington 98009-9029.

Circle #310 on Reader Service Card.

New manuals from Kantronics

Kantronics, Inc. announces its new manual set. The three manuals included are: *Installation Manual*, *Operation Manual*, and *Command Manual*. This set includes instructions for KAM, KPC-2, KPC-2400, and KPC-4.

For more information contact Kantronics, Inc., 1202 E. 23rd Street, Lawrence, Kansas 66046.

Circle #311 on Reader Service Card.

Jensen Tool catalog

A new catalog is offered free by Jensen Tools. Illustrated in full color, the 160-page catalog describes Jensen's full line of over 40 specialty tool kits for field service, plus a new line of products of fiber optics and wire/cable systems. Also included are hand and power tools in English and metric sizes, test equipment, soldering/desoldering stations, static control, lighting/optical aids, carrying cases, shipping containers, and more.

For a copy write Jensen Tools, Inc., 7815 S. 46th Street, Phoenix AZ 85044, or call (602) 968-6231.

Circle #312 on Reader Service Card.

VOICE-ID™ digital voice annunicator

VOICE-ID™ can store and reproduce voice messages and/or CW in any logical combination with various delays. It's an add-on device for repeaters and Amateur Radio stations, and of interest to the DX contester.

High-quality, non-robotic voice reproduction is achieved through voice compression algorithms encoded in a non-volatile EPROM. Voice messages are stored in the EPROM, so no re-recording is necessary after a power failure.

The VOICE-ID™ is field installable, and is suitable for use in remote applications. It may also be battery operated in case of emergency.

For more information contact Time Domain Systems, 5003 Cowell Boulevard, Davis, California 95616.

Circle #313 on Reader Service Card.

Isolator line expanded

Electronic Specialists expands their patented isolator line to include remote power switching, power fail interrupt, and 20-A options. Suppressor performance of all units has been expanded to 39,000 surge amperes for added equipment protection. Isolators, with wideband high attenuation channel filters, are available in commercial, industrial and laboratory grades. Expanded isolator performance and options are available. Prices start at $100.

For details contact Electronic Specialists, Inc., 171 South Main Street, Natick, Massachusetts 01760.

Circle #314 on Reader Service Card.

M-5000 autoranging multimeter

The Elenco M-5000 is a handheld 3-1/2 digit autoranging multimeter. VOM functions, Hi-Low ohms, diode check, 10-A AC/DC current ranges, and audible continuity check are standard. Other features include: data hold, memory, and manual or autoranging.

The M-5000 comes complete with operator's manual, test leads, and battery. It weighs under 7 ounces and is priced at $69.95.

For details contact Elenco Electronics, Inc., 150 West Carpenter Avenue, Wheeling, Illinois 60090.

Circle #315 on Reader Service Card.

ADVERTISER'S INDEX AND READER SERVICE NUMBERS

Listed below are the page and reader service number for each advertiser in this issue. For more information on their products, select the appropriate reader service number make a check mark in the space provided. Mail this form to *ham radio* Reader Service, I.C.A., P.O. Box 2558, Woburn, MA 01801.

Name ______________________ Call __________

Address ______________________

City ______________ State ________ Zip ________

*Please contact this advertiser directly.

Please use before June 30, 1989.

READER SERVICE #		PAGE #
130	Ace Communications, Monitor Div.	36
134	Advanced Computer Controls	41
137	Advanced Receiver Research	42
207	AEA	115
187	Aerospace	91
138	AIE Corporation	42
148	ALINCO	54
208	Alpha Delta Communications Inc	116
169	Aluma Tower Co.	79
131	AMC Sales, Inc	36
167	Ameritron	75
189	Amidon Associates	91
192	AMSAT	100
145	The Antenna Specialists Co.	52
161	Antennas West	42, 68, 103
190	Antennex	101
132	Antique Radio Classified	36
141	ARRL	46
121	Astron Corp	18
*	Amateur Television Quarterly	56
116	AVCOM of Virginia	11
*	Barker & Williamson	25
*	Barry Electronics	91
*	Barry Kutner, W2UP	116
210	Base (2) Systems	118
154	Bilal Company	63
*	Brian Beezley, K6STI	103
*	Buckmaster Publishing	79
172	Buckmaster Publishing	81
188	Buckmaster Publishing	91
196	Buckmaster Publishing	103
122	C&S Sales	24
133	Communication Concepts, Inc	41
198	Communications Specialists	105
197	Creative Control Products	103
202	Crystek Crystals	108
114	CSI	1
168	Cushcraft Corp	76
155	Cygnus-Quasar Books	63
185	Datacom, International	88
*	Delta Loop	79
136	Doppler Systems	43
177	Doug Hall Electronics	83
163	Down East Microwave	73
*	Engineering Consulting	56
209	Epsilon Company	116
156	Fair Radio Sales	63
150	Gallatin Radio Supply	56
135	Gilfer Shortwave	43
183	GTI Electronics	84
186	GTI Electronics	91
144	HAL Communications Corp	53
*	Ham-Com 1989	84
118	Ham Radio Outlet	14, 15
*	Ham Radio's Bookstore	30, 52, 82, 88, 108,
199	Hamtronics, NY	107
*	Hamtronics, PA	101
*	Heath Company	69
*	Heath Company	111
113	ICOM America, Inc	CII
140	ICOM America, Inc	45
*	International Crystal Mfg Co, Inc	79
127	Jan Crystals	37
170	Jun's Electronics	81
147	Kantronics	59
139	KComm, The Ham Store	42
*	Kenwood USA Corporation	2, 5, 7, 51, CIV
117	Larsen Antennas	13
203	Madison Electronics Supply	108
204	Madison Electronics Supply	111
*	Maggiore Electronic Laboratory	31
201	Glen Martin Engineering, Inc	106
193	Richard Measures, AG6K	100
126	John J. Meshna Jr, Inc	35
115	MFJ Enterprises	8
159	Micro Control Specialties	68
157	Mirage Communications	67
206	Mirage Communications	113
211	Missouri Radio Center	119
128	Mobile Mark Inc	36
180	Monitoring Times	89
205	NCG	111
*	Nemal Electronics	106
175	Nuts & Volts	82
212	OPTOelectronics	120
123	P.C. Electronics	25
174	P.C. Electronics	82
160	Pac-Comm Packet Radio Systems, Inc	68
173	Palomar Engineers	81
146	Periphex Inc	52
195	Radiokit	100
119	Radio Shack	23
158	Ramsey Electronics, Inc	64
182	The RF Connection	84
153	RF Enterprises	62
142	Rutland Arrays	48
*	RF Parts	40, 41
194	S-COM Industries	100
176	SCO Electronics Inc	83
*	Sherwood Engineering	42
*	Silicon Solutions	37
166	Software Systems	70
162	Software Systems	73
129	Spectrum International	36
181	Stridsburg Engineering Co	84
184	STV/OnSat	88
149	Synthetic Textiles, Inc	56
164	Tel-Com	70
165	TIC General	70
179	TX RX	89
*	U.S. Information Agency	96
124	Unadilla Antenna Mfg Co	30
*	Universal Radio	48
143	Vanguard Labs	48
120	Varian EIMAC	16
178	VHF Communications	83
200	W & W Associates	106
171	W9INN Antennas	81
151	Wi-Comm Electronics Inc	56
125	Wilmanco	30
152	Yaesu USA	60, 61
213	Yaesu USA	CIII
191	E.H. Yost Co	101

PRODUCT REVIEW/NEW PRODUCT

301	Azimuth	98
???	Cushcraft	98
314	Electronic Specialists Inc	117
309	Elenco Electronics Inc	117
315	Elenco Electronics Inc	104
302	Henry Radio	98
310	ICOM America Inc	117
304	ICOM America Inc	104
312	Jensen Tools Inc	117
311	Kantronics	117
308	Kantronics	104
307	MFJ Enterprises	104
305	OPTOelectronics	104
306	Periphex Inc	104
313	Time Domain Systems	117

ORDER TOLL-FREE 1-800-821-7323
Dependable Service
At The Right Price . . . Everytime
MasterCard—VISA—Discover
Missouri Radio Center
KENWOOD
TS-940 "DX-CELLENCE"
• All Band, All Mode Transceiver
• Direct Keyboard Entry
• Engineered for the DX-Minded and Contesting Ham
• Its Got It All!
YAESU
FT-767GX HF/VHF/UHF BASE STATION
• Add Optional 6m, 2m & 70cm Modules
• Dual VFO's
• Full CW Break-in
• Lots More Features
ICOM NEW!
IC-765 NEW HF TRANSCEIVER
• Built-in Automatic Antenna Tuner and Power Supply
• 99 Memories • 100 W Output
• 160-10M/General Coverage Receiver
• Band Stacking Registers
uniden
HR-2600
• Mobile 10 Meter Transceiver
• SSB/AM/FM/CW
• 25 Watts PEP
• New FM Offsets & PL
KENWOOD
TS-140S AFFORDABLE DX-ing!
• HF Transceiver With General Coverage Receiver
• All HF Amateur Bands
• 100 W Output
• Compact, Lots of Features
YAESU NEW!
FT-736R VHF-UHF BASE STATION
• SSB, CW, FM on 2 Meters and 70 cm
• Optional 50 MHz, 220 MHz or 1.2 GHz
• 25 Watts Output on 2 Meters, 220 and 70 cm
• 10 Watts Output on 6 Meters and 1.2 GHz • 100 Memories
ICOM IC-725 NEW ULTRA-COMPACT HF TRANSCEIVER NEW!
• USB/LSB/CW, AM Receive Optional Module for AM Transmit and FM TX/RX
• 160-10M Operation • 100 W Output
• Receive 30 kHz to 33 MHz
• 26 Memories with Band Stacking Registers
AEA CP-100
Complete Terminal Unit for Morse, Baudot, ASCII, AMTOR
NOW ½ PRICE CLOSEOUT SPECIAL
ONLY $169. DELIVERED
Software Available
Call Now—Don't Delay
KENWOOD NEW!
TM-231A
2 METER FM MOBILE
• 50 Watts Output
• 20 Multi-Function Memories
• Selectable CTCSS Tone Built-in
• Operate 4 Mobile Rigs with Optional IF-20 Interface and RC-20 Controller
Kantronics
KT-Series Mono-Band Radios
10-15-20-30-40-80M MODELS
SAVE BIG $$
Best Price and Complete Selection
Call Today!
ICOM
IC-2GAT
IC-4GAT
2 Meter & 440 Handhelds
• IC-2GAT RX 138-174 MHz TX 140-150 MHz 7 Watts
• IC-4GAT 440-450 MHz 6 Watts
ASTRON
• RS7A . . . . $51 • RS35M . . $167
• RS12A . . . $75 • VS35M . . $179
• RS20A . . . $92 • RS50A . . $209
• RS20M . . $112 • RM50M . $235
• VS20M . . $129 • RM50M . $259
• RS35A . . $149 • VS50M . . $245
KENWOOD
SALE!
TH-25AT POCKET-SIZED AND POWERFUL
• Frequency Coverage: 141-163 MHz (Rx), 144-148 MHz (Tx)
• Front Panel DTMF Pad
• 5 Watts Output
• 14 Memories
• TH-45AT Available for 440 MHz
ALINCO
SUPER SALE
ALD-24T 2m/70cm Dual Band Mobile
$449.00 Delivered
25W, 21 Memories, Dual VFO's At an Unbeatable Price!
ICOM
IC-32AT SUPER DUALBAND FM HANDHELD
• 5 Watts on Both Bands
• Receive 138-174 MHz 440-450 MHz
• Stores Standard and Odd Offsets
MFJ SALE MFJ
LARGEST STOCK OF ALL YOUR MFJ FAVORITE ACCESSORIES
CALL TODAY FOR BEST PRICE
Extra Savings on the MFJ-1278 Multi-Mode Data Controller
102 N.W. Business Park Lane Kansas City, MO 64150
Send SASE For Used List
Call Toll Free—9am - 6pm Mon.-Fri. 9am - 2pm Sat.
In Missouri Call—816-741-8118
MOST ORDERS SHIPPED SAME DAY
• DAIWA • HUSTLER HYGAIN • ICOM • KANTRONICS • KENWOOD • LARSEN • MFJ • MIRAGE/KLM • NYE VIKING • RF CONCEPTS • UNIDEN • YAESU

OPTOELECTRONICS

COUNTER THEORY

Affordable, compact, and ultra-sensitive. More and more people are discovering new applications for our counters than ever before. Now used by technicians, engineers, law enforcement officers, private investigators, two-way radio operators, scanner hobbyists, and amateur radio operators, just to name a few.

Over 15 years of service, quality, experience and dedication has proven you can count on us.

Hand Held Series Frequency Counters and Instruments

MODEL	2210 *New*	1300H/A	2400H	CCA	CCB *New*
RANGE: FROM TO	10 Hz 2.2 GHz	1 MHz 1.3 GHz	10 MHz 2.4 GHz	10 MHz 550 MHz	10 MHz 1.8 GHz
APPLICATIONS	GENERAL PURPOSE AUDIO-MICROWAVE	RF	MICROWAVE	SECURITY	SECURITY
PRICE	$199	$169	$249	$299	$99
SENSITIVITY					
1 KHz	< 5 mv	NA	NA	NA	NA
100 MHz	< 3 mv	< 1 mv	< 3 mv	< .5 mv	< 5 mv
450 MHz	< 3 mv	< 5 mv	< 3 mv	< 1 mv	< 5 mv
850 MHz	< 3 mv	< 20 mv	< 5 mv	NA	< 5 mv
1.3 GHz	< 7 mv	< 100 mv	< 7 mv	NA	< 10 mv
2.2 GHz	< 30 mv	NA	< 30 mv	NA	< 30 mv

ACCURACY ALL HAVE +/− 1 PPM TCXO TIME BASE.

All counters have 8 digit red .28" LED displays. Aluminum cabinet is 3.9" H x 3.5" W x 1" Internal Ni-Cad batteries provide 2-5 hour portable operation with continuous operation from AC line charger/power supply supplied. Model CCB uses a 9 volt alkaline battery. One year parts and labor guarantee. A full line of probes, antennas, and accessories is available.

OPTOELECTRONICS INC.
5821 N.E. 14th Avenue
Fort Lauderdale, FL 33334
(800) 327-5912 IN FL (305) 771-2050

MasterCard VISA

KENWOOD

...pacesetter in Amateur Radio

All New Dual Bander

Two in the Hand!

TH-75A

2m/70cm Dual Band HT

The new TH-75A Dual Band HT from Kenwood is here now! Many of the award-winning features in our dual band mobile transceivers are designed into one hand-held package.

- **Dual Watch** function allows you to monitor both bands at the same time.
- **One watt on 2 meters and 70cm:** **5 watts when operated on 12 VDC (or PB-8 battery pack).**
- **Large dual multi-function LCD display.**
- **10 memory channels** for each band stores frequency, CTCSS, repeater offset, frequency step information, and reverse. A lithium battery backs up memories. Two memories for "odd split" operation.
- **Selectable full duplex operation.**
- **Extended receiver range:** 141–163.995 and 438–449.995 MHz; transmit on Amateur band only. (Modifiable for MARS and CAP. Permits required. Specifications guaranteed on Amateur bands only.)
- **Uses the same accessories as the TH-25AT (except soft cases).**
- **Volume and balance controls, plus separate squelch controls on top panel.**
- **Super easy-to-use!** For example, to recall memory channel, just push the channel number!
- **CTCSS encode/decode built-in!**
- **Automatic Band Change (ABC).** Automatically switches between main and sub band when signal is present.
- **Automatic offset selection on 2 meters.**
- **Tone alert system for quiet monitoring.** When CTCSS decode is on, the tone alert will function only when a signal with the proper tone is received.
- **Four ways to scan,** including ***dual memory scan,*** with time operated or carrier operated scan stop modes, and priority alert.
- **Automatic battery saver circuit extends battery life.**

- **Supplied accessories:** Dual band rubber-flex antenna, PB-6 battery pack, wall charger, belt hook, wrist strap, water resistant dust caps.

Optional Accessories

- **PB-5** 7.2 V, 200 mAh NiCd pack for 1.0 W output • **PB-6** 7.2 V, 600 mAh NiCd pack • **PB-7** 7.2 V, 1100 mAh NiCd pack • **PB-8** 12 V, 600 mAh NiCd for 5 W output • **PB-9** 7.2 V, 600 mAh NiCd with built-in charger • **BC-10** Compact charger • **BC-11** Rapid charger • **BT-6** 6-cell AA battery case • **DC-1/PG-2V** DC adapter • **HMC-2** Headset with VOX and PTT • **SC-22 and SC-23** Soft case • **SMC-30/31** Speaker mics. • **WR-1** Water resistant bag.

KENWOOD

KENWOOD U.S.A. CORPORATION
COMMUNICATIONS & TEST EQUIPMENT GROUP
P.O. BOX 22745, 2201 E. Dominguez Street
Long Beach, CA 90801-5745
KENWOOD ELECTRONICS CANADA INC.
P.O. BOX 1075, 959 Gana Court
Mississauga, Ontario, Canada L4T 4C2

Specifications and prices subject to change without notice or obligation.
Complete service manuals are available for all Kenwood transceivers and most accessories.