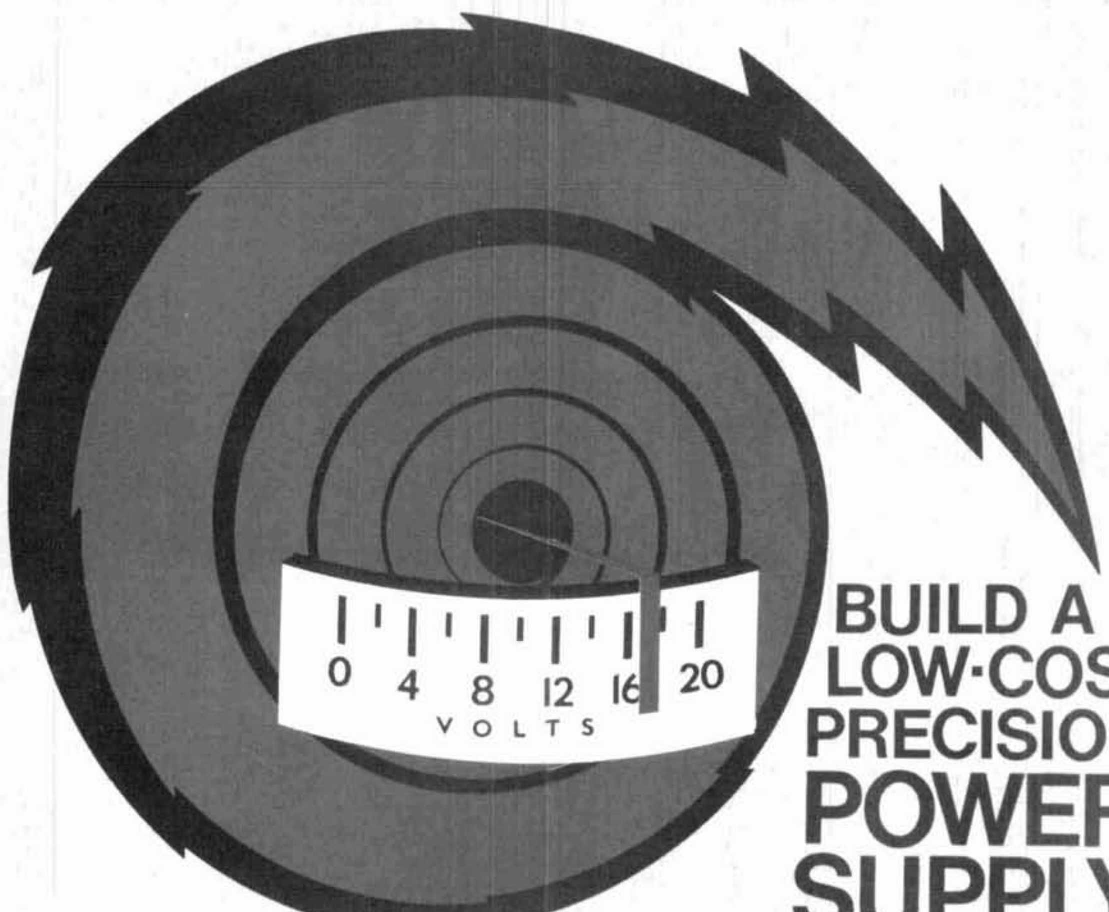
OCTOBER 1984 / $2.50

ham radio magazine



BUILD A LOW-COST PRECISION POWER SUPPLY

the magic jar: origin of the Hertzian antenna • low-cost UHF tower • custom-built trap antenna • "smart" frequency counter • top-band, top-loaded vertical • VHF/UHF power dividers • Yagi algorithms • L/C measurement technique • quick Smith chart impedance matching

hr

focus on communications technology

ICOM IC-27H

Ultra Compact 45 Watt, 2-Meter Mobile!

Now ICOM offers the best choices in compact 2-meter FM mobiles...the IC-27H 45-watt compact (1⅝"H x 5½"W x 9⅜"D) and the IC-27A 25-watt super compact mobile. The IC-27A and IC-27H are the smallest full-featured 2-meter mobile transceivers available, and feature an internal speaker for easy installation. For the ultimate portable station, the IC-37A 220MHz and IC-47A 440MHz 25 watt compact mobiles are also available.

45 Watts. The IC-27H provides 45 watts of output power, while the IC-27A provides 25 watts of output power.

32 PL Frequencies. The IC-27A and IC-27H come complete with 32 PL frequencies ready to go and are controlled from the front panel knob. Each PL frequency may be selected by the main tuning knob and stored into memory for easy access along with frequency and offset.

9 Memories. The IC-27A and IC-27H have nine memories available to store receive frequency, transmit offset, offset direction, and PL tone. Memories are backed up by a lithium backup battery, which will store memories for up to seven years.

Speech Synthesizer. As an added plus, the IC-27A/H features an optional speech synthesizer to verbally announce the receiver frequency of the transceiver through the simple touch of a button.

Scanning. Included with the IC-27A/H is a scanning system which allows scanning of the entire band.

Priority Scan. Priority may be selected to be either a memory channel or a VFO channel. By using sampling techniques, the operator can determine if a frequency of interest is free or busy.

See the IC-27A/H compact mobile transceivers at your local ICOM dealer. For superb performance, reliability, and the ultimate in a VHF mobile radio, your only choice is an ICOM.

The IC-25A 2-meter 25-watt mobile and its 45-watt companion, the **IC-25H**, are also available.

IC-HM23
Scanning mic
with DTMF pad

IC-27H
45 Watts
1⅝"H x 5½"W x 9⅜"D

IC-27A
25 Watts
1⅝"H x 5½"W x 7"D

Also Available: IC-37A 220MHz and IC-47A 440MHz Compact Mobiles

ICOM
The World System

ICOM America, Inc., 2112-116th Ave NE, Bellevue, WA 98004 / 3331 Towerwood Drive, Suite 307, Dallas, TX 752

KENWOOD

...pacesetter in amateur radio

TM-201A/TM-401A

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

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

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

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

TW-4000A

TW-4000A FM "Dual-Bander"

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

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

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

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

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

ham radio magazine

OCTOBER 1984

volume 17, number 10

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

subscription rates

United States:
one year, $19.95; two years, $32.95; three years, $44.95
Canada and other countries (via surface mail):
one year, $22.95; two years, $41.00; three years, $58.00
Europe, Japan, Africa (via Air Forwarding Service): one year, $28.00
All subscription orders payable in U.S. funds, via international postal money order or check drawn on U.S. bank

international subscription agents: page 150

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

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

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

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

ham radio
magazine

contents

MFJ ACCESSORIES

300 WATT ANTENNA TUNER HAS SWR/WATTMETER, ANTENNA SWITCH, BALUN. MATCHES VIRTUALLY EVERYTHING FROM 1.8 TO 30 MHz.

$99.95 MFJ-941D

NEW FEATURES

MFJ's fastest selling tuner packs in plenty of new features!
- **New Styling!** Brushed aluminum front. All metal cabinet.
- **New SWR/Wattmeter!** More accurate. Switch selectable 300/30 watt ranges. Read forward/reflected power.
- **New Antenna Switch!** Front panel mounted. Select 2 coax lines, direct or through tuner, random wire/balanced line or tuner bypass for dummy load.
- **New airwound inductor!** Larger more efficient 12 position airwound inductor gives lower losses and more watts out. Run up to 300 watts RF power output. Matches everything from 1.8 to 30 MHz: dipoles, inverted vee, random wires, verticals, mobile whips, beams, balanced and coax lines. Built-in 4:1 balun for balanced lines. 1000V capacitor spacing. Black. 11x3x7 inches. Works with all solid state or tube rigs. Easy to use, anywhere.

RTTY/ASCII/CW COMPUTER INTERFACE

MFJ-1224 **$99.95**

Free MFJ RTTY/ASCII/CW software on tape and cable for VIC-20 or C-64. Send and receive computerized RTTY/ASCII/CW with nearly any personal computer (VIC-20, Apple, TRS-80C, Atari, TI-99, Commodore 64, etc.). Use Kantronics or most other RTTY/CW software. Copies both mark and space, any shift (including 170, 425, 850 Hz) and any speed (5-100 WPM RTTY/CW, 300 baud ASCII). Sharp 8 pole active filter for CW and 170 Hz shift. Sends 170, 850 Hz shift. Normal/reverse switch eliminates retuning. Automatic noise limiter. Kantronics compatible socket plus exclusive general purpose socket. 8x1¼x6 in. 12-15 VDC or 110 VAC with adapter, MFJ-1312, $9.95.

RX NOISE BRIDGE

Maximize your antenna performance! **$59.95** MFJ-202B

Tells whether to shorten or lengthen antenna for minimum SWR. Measure resonant frequency, radiation resistance and reactance.
New Features: individually calibrated resistance scale, expanded capacitance range (±150 pf). Built-in range extender for measurements beyond scale readings. 1-100 MHz. Comprehensive manual. Use 9 V battery. 2x4x4 in.

INDOOR TUNED ACTIVE ANTENNA

NEW! IMPROVED! with higher gain **"World Grabber" rivals or exceeds reception of outside long wires!** Unique **tuned** Active Antenna minimizes intermode, improves selectivity, reduces noise outside tuned band, even functions as preselector with external antennas. Covers 0.3-30 MHz. Telescoping antenna. Tune, Band, Gain, On-off bypass controls. 6x2x6 in. Uses 9V battery, 9-18 VDC or 110 VAC with adapter, MFJ-1312, $9.95. **MFJ-1020A $79.95**

POLICE/FIRE/WEATHER 2 M HANDHELD CONVERTER

Turn your synthesized scanning 2 meter handheld into a hot Police/Fire/Weather band scanner! **$39.95** MFJ-313

144-148 MHz handhelds receive Police/Fire on 154-158 MHz with direct frequency readout. Hear NOAA maritime coastal plus more on 160-164 MHz. Converter mounts between handheld and rubber ducky. Feedthru allows simultaneous scanning of both 2 meters and Police/Fire bands. No missed calls. Crystal controlled. Bypass/Off switch allows transmitting (up to 5 watts). Use AAA battery. 2¼x1½x1½ in. BNC connectors.

MFJ/BENCHER KEYER COMBO

MFJ-422 **$109.95**

The best of all CW worlds- a deluxe MFJ Keyer in a compact configuration that fits right on the Bencher iambic paddle! MFJ Keyer - small in size, big in features. Curtis 8044-B IC, adjustable weight and tone, front panel volume and speed controls (8-50 WPM). Built-in dot-dash memories. Speaker, sidetone, and push button selection of semi-automatic/tune or automatic modes. Solid state keying. Bencher paddle is fully adjustable; heavy steel base with non-skid feet. Uses 9 V battery or 110 VAC with optional adapter, MFJ-1305, $9.95.

VHF SWR/WATTMETER

MFJ-812 **$29.95**

Low cost VHF SWR/Wattmeter! Read SWR (14 to 170 MHz) and forward/reflected power at 2 meters. Has 30 and 300 watts scales. Also read relative field strength. 4x2x3 in.

1 KW DUMMY LOAD

MFJ-250 **$39.95**

Tune up fast, extend life of finals, reduce QRM! Rated 1KW CW or 2KW PEP for 10 minutes. Half rating for 20 minutes, continuous at 200 W CW, 400 W PEP. VSWR under 1.2 to 30 MHz, 1.5 to 300 MHz. Oil contains no PCB. 50 ohm non-inductive resistor. Safety vent. Carrying handle. 7½x6¾ in.

24/12 HOUR CLOCK/ ID TIMER

MFJ-106 **$19.95** NEW

Switch to 24 hour UTC or 12 hour format! Battery backup maintains time during power outage. ID timer alerts every 9 minutes after reset. Red LED .6 inch digits. Synchronizable with WWV. Alarm with snooze function. Minute set, hour set switches. Time set switch prevents mis-setting. Power out, alarm on indicators. Gray and black cabinet. 5x2x3 inches. 110 VAC, 60 Hz.

DUAL TUNABLE SSB/CW/RTTY FILTER

MFJ-752B **$99.95**

Dual filters give unmatched performance! The primary filter lets you peak, notch, low pass or high pass with extra steep skirts. Auxiliary filter gives 70 db notch, 40 Hz peak. Both filters tune from 300 to 3000 Hz with variable bandwidth from 40 Hz to nearly flat. Constant output as bandwidth is varied. Linear frequency control. Switchable noise limiter for impulse noise. Simulated stereo sound for CW lets ears and mind reject QRM. Inputs for 2 rigs. Plugs into phone jack. Two watts for speaker. Off bypasses filter. 9-18 VDC or 110 VAC with optional adapter, MFJ-1312, $9.95.

ORDER ANY PRODUCT FROM MFJ AND TRY IT-NO OBLIGATION. IF NOT DELIGHTED, RETURN WITHIN 30 DAYS FOR PROMPT REFUND (LESS SHIPPING).
- One year **unconditional** guarantee • Made in USA.
- Add $4.00 each shipping/handling • **Call or write for free catalog, over 100 products.**

MFJ

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

TO ORDER OR FOR YOUR NEAREST DEALER, CALL TOLL-FREE
800-647-1800. Call 601-323-5869 in Miss. and outside continental USA
Telex 53-4590 MFJ STKV

VISA
MasterCard

✓ 166

presstop de W9JUV

A PROPOSAL TO REALLOCATE 220 MHZ AMATEUR FREQUENCIES TO LAND MOBILE was made in late July by Sideband Technology, Inc., a manufacturer of Amplitude Compandored Sideband (ACSB) equipment. In its Petition for Rule Making, RM-4831, Sideband Technology proposes that the bottom two megacycles of the 220-225 MHz Amateur band plus the adjacent 216-220 MHz Inland Waterways Communications Service band be allocated to ACSB Land Mobile users.

Opposition To The Growing Pressure On 220 Has Developed Rapidly, highlighted by a teleconferencing net August 2 that carried the story throughout the country via many VHF and UHF repeaters, plus a few SSB relays to the HF bands. The net, hastily organized and led by 220 Notes publisher K9XI, did an excellent job of reviewing the growing 220 problem and what could be done about it. It was particularly valuable in alerting Amateurs to file Comments on both this petition and the earlier one by the Land Mobile Communications Council (see September Presstop). Comments closed on the LMCC petition in August, but a legal question has delayed the closing date on RM-4831 indefinitely.

A Reallocation Of This Importance Is Highly Unlikely without going through a formal Notice of Proposed Rule Making procedure, but rumors of high-level FCC support for the change have been circulating. (See this month's Reflections for more on the 220 issue).

AN ELECTION OF UNIONIZING ARRL EMPLOYEES WAS HELD August 23 in Newington, and the union effort lost by a very large margin. Staff dissatisfaction over ARRL's return to the five-day work week and other work-related matters had triggered the effort to set up a collective bargaining agent at League headquarters, but a very strong, well-organized opposition effort by management defeated the attempt. However, the problems that caused the unionizing effort have still not been resolved. That, coupled with the deterioration in relations between staff and management—and within those groups as well—that developed during the unionizing efforts of the past few months make it likely that morale will continue to be a problem in Newington for some time to come.

420-450 MHZ USERS IN GEORGIA AND TEXAS FACE POWER RESTRICTIONS following the addition of two new "Military Protected Zones." After September 12, Amateurs within a 124 mile radius of Warner Robbins AFB in Georgia or Goodfellow AFB in Texas who plan to run more than 50 watts ERP will be required to coordinate their operations on the 70 cm band with both the nearest FCC Engineer-In-Charge and the military Area Frequency Coordinator.

OSCAR 10'S OPERATING SCHEDULE HAS BEEN CHANGED, due primarily to the onset of an eclipse period which deprives the spacecraft solar panels of sunlight for up to 1 1/2 hours at a time. The 145.810 General Beacon schedule has also been changed; bulletins now start on the hour and half hour with five minutes of CW, followed by 10 minutes of PSK telemetry, then RTTY bulletins (50 baud) for another five minutes. PSK telemetry occupies the final 10 minutes of each half-hour sequence. For schedule updates check the AMSAT nets.

The 75-Meter AMSAT Net Frequencies Have Been Changed to permit General licensees to take part in the Tuesday night nets following the September 1 phone band expansion. At first the 0100Z (Wednesday, GMT) nets moved to 3855 kHz, but problems with an existing operation on that frequency caused a further move. Look for them around 3856-3860 kHz.

ACSB Experiments Through OSCAR 10 began August 24 in a cooperative AMSAT, ARRL, and Project OSCAR effort. Expected benefits include improved signal-to-noise ratios (narrower bandwidth) and easier tuning since ACSB receivers lock onto a pilot carrier and thus automatically track doppler shift. ACSB can be received with a normal SSB receiver, despite the 3.1 kHz pilot carrier. Sideband Technology is supplying the ACSB equipment.

AMATEUR ACCESS TO THE NEW 24 MHZ WARC BAND MAY NOT BE TOO FAR OFF. There had even been some thought that the FCC would begin 24 MHz implementation before the Commissioners went on August recess, as there seems to be no problem with current band occupants. On the other hand, the 18 MHz band still supports considerable commercial activity so is not likely to be reallocated very soon.

902-928 MHz's Availability Is Also Likely in the near future, and the ARRL VHF-UHF Advisory Committee has a band plan worked up for it. However, before either 18 or 902 MHz becomes available specifics such as modes and subbands must be established through an NPRM.

COMBINING METEOR SCATTER WITH PACKET RADIO could prove a viable mode for Amateur communications, suggests ARRL's QEX. WØRPK is on 50.505 MHz from central Iowa, and K1HTV planned some 145.05 MHz tests during the August Perseids shower. W1AW may also gear up for both 10 and 6 meter meteor scatter packet radio experiments in the near future.

ARRL IS SUPPLYING ANSWERS TO ALL AMATEUR EXAM QUESTIONS in an attempt to establish uniform exams throughout the country. They distributed Element 3 (Tech/General) questions complete with distractors to other VECs and Amateur Radio publishers in August, and expect to have the Advanced and Extra sets out soon. Whether those VECs who've already invested considerable time and effort in working up their own answer/distractor sets will be willing to change at this time remains to be seen, however.

REFLECTIONS

the endangered spectrum:
220 MHz under fire

I. Who's on 220?

The 1-1/4 meter Amateur band — covering 220-225 MHz — is in imminent danger of being lost to commerical interests.

So what? Who operates there anyway?

This is the substance of the argument presented by Sideband Technology, Incorporated, in its petition to the FCC (RM-4831). STI, who manufactures amplitude compandored sideband (ACSB) equipment for the land mobile industry, is suggesting that because hams hardly use 220-222 MHz, that segment of the band should be reserved for land mobile purposes instead. A second group, the Land Mobile Communications Council (LMCC) has also petitioned the FCC (in RM-4829), suggesting that the *entire* band should be exclusively reserved for land mobile use.

"T'aint so!" For all practical purposes, the band is divided into two parts. 220-222 MHz is used by Radio Amateurs doing pioneering radio work (EME, propagation beacons, weak-signal communications, packet radio, and experimental and control links, etc. 222-225 MHz is used for FM repeater and general CW/SSB operation.

Just how did the commercial interests get the impression that the lower portion of the band — where the bulk of Amateur experimentation is being carried out — was unoccupied? *They conducted an exhaustive study by consulting a* ***repeater directory.***

What can *you* do?

1. Take this threat SERIOUSLY.
2. Read the additional information provided by W9JUV and W1JR on these pages.
3. Weigh the facts — check to see what activity exists in your area — and then . . . *be ready to respond* ***rapidly*** *in writing to the FCC if it gets to the NPRM (Notice of Proposed Rule Making) stage.**

Though the formal comment period for one of the petitions ended as this issue was going to press August 29, we believe the FCC would still find your comments valuable. If you do respond, be sure to indicate that you wish them to accept this as a *late comment*, and that your comment is ***in opposition*** to a specific petition (either RM-4829 or RM-4831). State your name, call sign, class of license, and the year you were first licensed. Provide as much information about 220 MHz activity in your area — repeaters, control links, weak-signal work, etc. — as possible. Type (double-space) and stick to the facts.

You will have an opportunity to file a formal comment when and if an NPRM on the reallocation of the 220-MHz band is issued by the FCC. If this occurs, a well documented, logical argument will carry the greatest weight.

Ham radio will keep you informed of late-breaking events, as will other news services; follow *Westlink Report* (via mail or repeater), the *W5YI Report*, *ARRL letter*, and ARRL bulletins. Do your homework, be prepared, and respond formally at the appropriate time.

Rich Rosen, K2RR
Editor-in-Chief

*A comprehensive report on all aspects of this situation, including those parts of the actual petitions pertaining to land mobile interest in the 220 band is available in the latest issue of *220 Notes*. (308 Eastgate Court, New Lenox, Illinois 60451 — single copy, $1.25; yearly subscription, $5.)

II. How We Got There — A Brief History

The 1-1/4 meter band has survived a number of changes since its establishment just before World War II. Before the war, everything above 110 MHz was designated "Amateur and experimental." During the war, the spectrum from about 200 MHz up was used for the primitive radars of that period, radio altimeters, and radio navigation aids. Shortly afterwards, the U.S. phased out most of its use of the frequencies just above 220 MHz; Amateurs were temporarily allocated a band at 235 to 240 MHz and then moved to 220 to 225 MHz in the late 1940's. In much of the world, however, military use of the band continued, and Amateurs outside of the Americas never did get a post-war 1-1/4 meter band.

Because the U.S. wanted to keep 220 to 225 — adjacent to its 225 to 400 MHz military aircraft frequencies — available for expansion, it permitted Amateur use of the band on a secondary basis. This became the standard for ITU Region 2, while the rest of the world continued to use the band for radiolocation and/or land mobile. During the 1960's and 1970's other services cast frequency-hungry eyes on 220 to 225 MHz, but were discouraged by the government's continued intention to hold on to the band, with Amateurs acting in a "caretaker" role.

WARC 79 wrought a change with far-reaching implications for Region 2 Amateurs. The U.S. government relinquished interest in the band, and the Conference reallocated these frequencies to Amateurs and fixed mobile services on a co-equal basis. Thus the die was cast.

In an FCC study conducted several years ago, 220 to 225 MHz was mentioned in passing as a possible source of land mobile frequencies. This past June, the band was again cited by the LMCC in a frequency survey submitted to the Commission. However, the first direct attack on continued Amateur use of the band came in July when S.T.I. filed its petition.

To the horror of both FM equipment manufacturers and FM land mobile users, the FCC has proposed putting ACSB channels *between* existing land mobile FM channels. Indeed, some 150 MHz equipment has been licensed by the FCC on a temporary basis and is already in operation; ACSB promoters, however, would prefer to see it occupy a place where it could be exercised without interference to or from other communications modes. 220 to 225 MHz seems to be the answer to their prayers.

Can this threat be stopped before it reaches the status of a Notice of Proposed Rule Making? Perhaps not. By rejecting the "no-code" license, we lost our chance to ensure that 220 to 225 MHz would be "off limits for commercial encroachment for years to come; most of the no-code supporters had recommended that at least part of the 220 to 225 MHz range be allocated to no-code license holders. A few voices in the wilderness even pointed out the value of new licensees to frequency preservation of that band. Had no-code been adopted, it is inconceivable that the Commission would have turned its back on the new class of Amateur license it had just created by giving that class's prime frequencies to another service. With that opportunity gone, the industry's conception of the 220 to 225 MHz frequency range is that it is under-utilized, with significant activity only in major urban areas and then on only a few repeater pairs. *"Use it or lose it"* has never been more true than it is today.

— Joe Schroeder, W9JUV

two petitions before the FCC threaten yet another Amateur band

III. Why Amateur Radio Needs 220 MHz

Despite the lack of commercially available equipment and worldwide participation, 220 has seen continued growth over the years. This growth has taken two directions — weak signal operation in the lower segment and FM operation in the upper portions of the band. The latter is understandable in terms of severe crowding in the 2 meter and 70 cm (440-450 MHz) bands — and because foliage attenuation decreases the lower you go in frequency, 135 cm (220 MHz) is preferred to 70 cm in suburban areas.

The 220 band plan written by the ARRL VUAC (VHF/UHF Advisory Committee) in 1978 (**table 1**) designated 222-225 MHz for the use of FM repeaters. This has been widely accepted. 220-222 MHz was divided up into two portions: weak-signal on 220-220.5 and FM repeater links, remote bases and control links on 220.5-222 MHz. Information on the latter stations is rarely published in order to prevent unauthorized control of the repeaters. (If STI and the LMCC had done their homework, they would have been aware of this. — Ed.)

The lower portion has been extensively used by weak-signal operators for the exploration of new propagation modes. Despite the band's claimed similarities to 2 meters, there are important differences between the two. For example, in meteor burst communication cutoff frequency is often just below or slightly above the 220 band. (It wasn't until 1968 that a 220 meteor scatter QSO was completed.) To this day, weak-signal operators are experimenting to find the cutoff frequency for the slower speed meteor showers. *Further research is essential.* For EME communication, 220 is a practical frequency because the antenna size required and the sky noise present is just about 50 percent of that at 2 meters. Auroral propagation, seldom seen at the higher frequencies such as 70 cm, is often possible.*

It was the 220 band that accounted for the 2500-mile DX contact between California (W6NLZ) and Hawaii (KH6UK) in the late 1950's via a tropo-ducting mode. More recently, in 1983, the trans-equatorial path was finally conquered when KP4EOR worked LU7DJZ over a 3670 mile (5906 km) path. Still to be explored are the FAI (Field Aligned Irregularities) and mid-latitude sporadic-E modes, which while theoretically possible have not yet been successfully used to establish two-way contact. This unique frequency range should be left intact for Radio Amateurs to further the state-of-the-art in radio wave propagation.

(Why wasn't all this activity obvious to those conducting a study on band occupancy? Perhaps the survey was performed during the regular work-week, while weak signal operators were busy working at their regular jobs, and not on the air. Also, weak-signal operators employ highly directional antennas, and would not be detected unless those conducting the survey were directly between the sending and receiving antennas.)

Nationwide activity on this band is apparent by the achievement of the WAS (50 states) award last year by a number of Amateurs. It's also easy to check the number of entries in the various VHF/UHF contests, 220 standings of active stations listed in *QST's* "The World Above 50 MHz" or correspondence in the dedicated newsletter: *220 Notes*. That weak-signal interest and activity exists is obvious, even though it may be most evident during special propagation openings, contests, and net nights. Haphazard monitoring of the band results in inaccurate data. To obtain a valid indication of 220 activity, monitoring would have to be done nationwide, and over a longer period of time; one would assume the land-mobile industry would have done so before making rash (and incorrect) statements claiming that the lower portion of the 220 band is not well used.

Only a year ago Amateurs received FCC permission to experiment with Packet Radio on the VHF FM bands. The overcrowding of 2 meters and the requirements for additional bandwidth to support 9600 baud and higher data rates make 220 a natural. (Part 97 of the FCC regulations prohibits high baud rates below 220.5 MHz. — Ed.) In the New England area, several stations using Packet Radio in the 221-222 MHz region have just become active.

This frequency range is not without problems. Amateurs in the vicinity of TV channel 13 experience video beats across the weak-signal portion of the 220 band. This is further complicated by radiation from TV set local oscillators, which often radiate into the lower portion of the 220 band when tuned to TV channel 7. No *fixed* commercial service would care to operate in the vicinity of these interfering sources. (Amateurs, on the other hand, are frequency-agile and can attempt to minimize these effects. In addition, radiation from the second harmonic of the local oscillator of the ubiquitous frequency scanners can fall within the 220 band, affecting any and all services. — Ed.)

Where can the land-mobile interests go? Considering how outdated the present FCC allocation of TV channels is, a better idea might be to go *entirely* to the UHF spectrum and make the VHF spectrum (land mobile allocated frequencies) available for point-to-point and mobile-to-base station use. The FCC could probably allocate more spectrum by taking advantage of the unused TV channels in the UHF spectrum, eliminating all channels below channel 25. (The LMCC petition, in fact,

(continued on page 119)

table 1. Proposed 220 to 225 MHz band plan. (Submitted by Joe Reisert, W1JR, Chairman VUAC.)

frequency (MHz)	allocation
220.0-220.05	EME (Earth-Moon-Earth)
220.05-220.06	propagation beacons
220.06-220.1	weak signal CW
220.1	calling frequency (Note 1)
220.1-220.5	general weak-signal, rag chewing and experimental communications
220.5-221.9	experimental and control links
221.9-222.0	weak-signal guard band (Note 2)
222.0-222.05	EME (Note 2)
222.05-222.06	propagation beacons (Note 2)
222.06-222.1	weak-signal on CW (Note 2)
222.1	calling frequency (Notes 1 and 2)
222.1-222.3	general operation CW or SSB etc. (Note 2)
222.3-222.38	FM repeater inputs (Note 3)
222.42-223.9	FM simplex (Note 4)
223.94-225.0	FM repeater outputs (Note 3)

Notes:
1. After establishing contact QSY at least 10 kHz up or down for general rag chewing or weak-signal operation.
2. This area is primarily needed where TV channel 13 spillover and long-distance search radars are in operation (e.g., California area).
3. This is the existing ARRL Repeater Plan, 1.6 MHz splits.
4. 223.5 is the national calling frequency for FM simplex. Alternative frequencies in 20 kHz increments in this region.

Kantronics Quality at a Knockout Price

$99.95

The new **Kantronics Challenger** makes you the winner with superior performance at a knockout price. The **Challenger** terminal unit is designed for RTTY/ASCII/AMTOR operation with any of the Kantronics software programs. Compare our specifications with the competition, then check the price.

Challenger's four pole switched capacitance filter gives sensitivity and selectivity found in units costing much more. And with only 5mvRMS of audio required to drive **Challenger**, you can really chase the weak signals. With features like Scope Outputs, Direct FSK or Crystal Controlled AFSK, and an Extruded Aluminum Case, you know this is Kantronics quality.

If you really want to work RTTY/ASCII/AMTOR without breaking the budget, get **Challenger** and a Kantronics software program. Kantronics currently offers programs for Apple, Atari, TRS-80C, VIC-20, TI-99, and Commodore 64 computers.

Kantronics Software

Hamsoft — Send/Receive CW, RTTY, ASCII ★ Split Screen Display ★ Message Ports ★ Type-Ahead Buffer ★ Printer compatibility.

Hamtext — Includes all features of Hamsoft plus Text Editing ★ Receive Message Storage ★ Variable Buffer sizes ★ Diddle ★ Word Wraparound ★ Time and Text Transmission.

Hamsoft/Amtor — Includes all features of Hamsoft plus communication in all three modes of AMTOR.

Amtorsoft — Includes all the features of Hamtext but is for use with AMTOR ONLY. The Apple program is available only as a Hamtext/Amtorsoft combination.

Supertap — Receive Only CW, RTTY, ASCII, AMTOR ★ Decode inverted, bit inverted, and unusual bit order ★ Multiple line display ★ "SCOPE" feature for baud rate measure.

Specifications

Input Filter — Four pole Switched Capacitance Filter with 170Hz Shift RTTY bandwidth of 260Hz nominal. Copies any shift.

Audio Input — Minimum level 5mvRMS. Input impedance is 600 ohms unbalanced. Accepts baudot or ASCII code up to 300 baud. Max input level is 12VRMS.

AFSK Output — Crystal controlled. Mark-2125Hz; Space-2295Hz (170 shift). Level 100mvpp (35mvRMS) standard. Optional 500mvpp (175mvRMS). Output impedance 600 ohm unbalanced.

FSK Output — Open Collector +40 VDC Max. Polarity can be reversed.

Scope Output — 10K ohm output impedance.

PTT Output — Open Collector +40 VDC Max.

Computer Connection — TTL Compatible. Inputs also RS232 level compatible.

Power Requirements — 11 to 15 VDC (12VDC nominal) 75ma

Construction — Precision Extruded Aluminum Alloy Case

Dimensions — 1.9"H x 5.9"W x 7"D

Weight — 1¾ lbs.

Kantronics
1202 E. 23rd Street
Lawrence, Kansas 66044

MAXUM™ 007

a good deal more for a good deal less

MANUFACTURED BY WESTERN & EASTERN SATELLITE

WESTERN SATELLITE
916-337-6202
Orders only — 800-243-3019

EASTERN SATELLITE
904-224-8965

✓ 217

DOCTOR DX™ BY AEA

Work The World With No Antenna

- No Antenna!
- No Radio Required!
- No TVI!
- No Landlord Problems!
- Operate Anytime You Want!
- Go On DX'Pedition From Your Shack!

For the active CW operator, there is nothing more fun than operating with the "Doctor DX" CW DX simulator. For the person who has never liked CW, Doctor DX will show you what real fun is. Doctor DX has something for everyone from the aspiring Novice to the experienced Amateur Extra Class licensee. And you need no FCC license to operate Doctor DX!

With Doctor DX, all you need is a Commodore-64 computer, a key (or keyer), and a TV set. There is no need for an expensive transceiver, amplifier and antenna farm to enjoy the thrill of working "rare DX." No more TVI or dead bands! Doctor DX is more than the most sophisticated CW trainer ever developed, it is your DXpedition ticket to anywhere in the world at a very affordable price.

Doctor DX simulates real H.F. CW band conditions. All the stations you will work are generated by the computer. As you tune up and down the particular band you have selected, you will hear realistic sounding stations in contact with other stations (some within your skip zone). There is also the normal QRN and QRM one would expect to hear in the real world. All call letters heard are totally random (subject to the country's callsign assignment rules). The prefixes are weighted according to the Amateur Radio population density, with 304 possible countries represented. The speed of stations operating in the lower portion of the bands is much faster than those operating in the upper band segments. The "operators" are also more polished in the lower portion of the bands.

Radio propagation (programmed for each band) represents what you would expect to hear on a good propagation day at the peak of the sunspot cycle. The propagation follows the internal real-time clock that you set before beginning operation. All the simulated stations you hear (with proper prefixes) are at distances you would expect to hear for the time of day and band selected.

You can learn and enhance your CW operating skills with Doctor DX. Doctor DX will not reward bad habits. AEA even offers an awards program to owners of Doctor DX that work all zones, 100 countries, 5 band Dr DXCC, or Doctor DX Honor Roll.

The Doctor DX CW trainer is a totally new concept in Amateur Radio. See what all the excitement is about. Send for full details, and see your dealer for a demonstration.

Send Us Your QSL Today And We Will Rush Full Details!

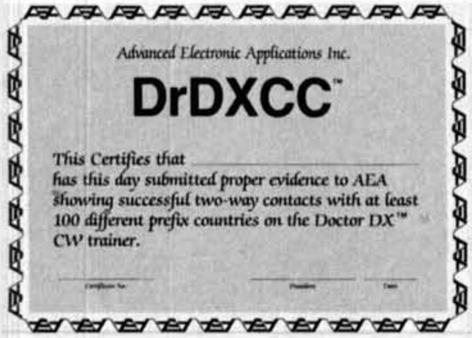
Advanced Electronic Applications, Inc.

P.O. BOX C-2160 • LYNNWOOD, WA 98036
(206) 775-7373 • TELEX: 152571 AEA INTL

AEA Brings you the Breakthrough!

Doctor DX™ Challenge

BY AEA


Advanced Electronic Applications Inc.

DrDXCC™

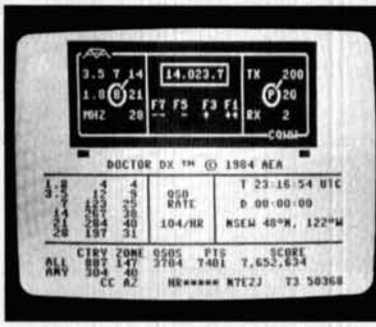
This Certifies that ______________

has this day submitted proper evidence to AEA showing successful two-way contacts with at least 100 different prefix countries on the Doctor DX™ CW trainer.

DOCTOR DX CONTEST BOX

TOP SPRINT SCORES	TOP MARATHON SCORES
1. ________	1. ________
2. ________	2. ________
3. ________	3. ________
4. ________	4. ________
5. ________	5. ________

WILL YOUR CALL APPEAR HERE?



For good clean, competitive fun, Doctor DX™ shows your score and QSO rate for continuous monitoring of your improved CW operating skills. The DDX-64 can be a vehicle for fairly settling those club rivalries by competing with your friends under identical operating conditions.

AEA also has two on-going CW contests that you can enter with Doctor DX as your own schedule permits. The AEA SPRINT CONTEST is a timed non-stop eight hour event and the AEA MARATHON CONTEST is a timed 24 hour non-stop event. The top 5 contest scores will be published in our future advertisements and upgraded periodically as new higher scores are achieved.

In addition to the two AEA contests, we are offering award certificates for achieving certain milestones. You will be automatically alerted when you have achieved these milestones by a display at the bottom of the monitor screen.

AEA DrDXCC is achieved when you have worked 100 different countries, regardless of the frequency band or the amount of time operated. DOCTOR DX WAZ can be earned by working all 40 CQWW zones of the world, without regard to the band or duration of operating time. The DOCTOR DX HONOR ROLL is reserved for top notch operators capable of working 250 countries without regard for band or operating time. Additional endorsement awards are available for each additional 10 countries worked up to 300 (out of 304 possible) countries. AEA 5 BAND Dr DXCC is a very difficult award to achieve. It requires working 100 countries on each of five different bands, without regard for the amount of operating time.

Each award can be obtained by filling out a photocopy of the award application form (supplied) along with the score information and qualifying check sum from your screen display. Please enclose $3.00 to cover handling costs for each certificate ($1.00 for Honor Roll endorsements). Awards will only be granted to owners having a Doctor DX warranty card on file.

There is no need to ever be bored with your hobby again just because the bands are dead or you are apartment bound. Try Amateur Radio's own version of Solitaire - DOCTOR DX.

Advanced Electronic Applications, Inc.

P.O. BOX C-2160 • LYNNWOOD, WA 98036
(206) 775-7373 • TELEX: 152571 AEA INTL

AEA

Brings you the Breakthrough!

✓ 104

a six-output power supply

Build a low-cost lab-quality voltage source

This power supply construction project will provide a valuable addition to the workbench of most Amateurs. The unit includes three positive and three corresponding negative outputs consisting of a dual-tracking pair, a positive and negative independently adjustable pair, and a positive and negative programmable voltage standard pair. A detailed set of drawings for construction is provided. The total cost of completing the project is surprisingly low, mainly because the unit is built around nine op amps that cost approximately fifty cents each.

independently adjustable supply

Any voltage regulator or voltage regulated power supply must have five parts: a voltage reference, an error amplifier, a feedback mechanism, a series-pass transistor or means of current-buffering and, usually, an optional current-limiting or self-protection circuit. This power supply includes all five of these elements. In circuit B (CKTB) of **fig. 1**, diode D5,* a 1N754 6.8-volt zener, provides a 6.8-volt input to the noninverting (+) input of op amp U1. The (−) or inverting input will consequently also have +6.8 volts on it through normal op amp action (feedback). The voltage reference provided by op amp U1 is impressed across pot R6, a 10K pot. This variable voltage of from 0 to +6.8 volts is again applied to the noninverting (+) input of op amp U2, a 741 or LM101 type bipolar amplifier. Gain is determined by:

$$E_{out} = E_{in}\frac{(R10 + R11) + R12}{R12}$$

$E_{in} = 6.8$ volt reference voltage and is derived by pot R6 from 0 to 6.8 volts.

If you work through the numbers, you will derive an output of from approximately 0 to 16.5 volts with output adjust trimmer pot, R11, set halfway at 2500 ohms.

The op amps themselves have internal current

*Note that "D", rather than *ham radio's* customary "CR", is used to designate diodes in this article and accompanying artwork.

By **Vaughn D. Martin**, 114 Lost Meadows, Cibolo, Texas 78108, and **Dean Davis, WB5ZKU**, 6206 Ridge Oak, San Antonio, Texas 78250

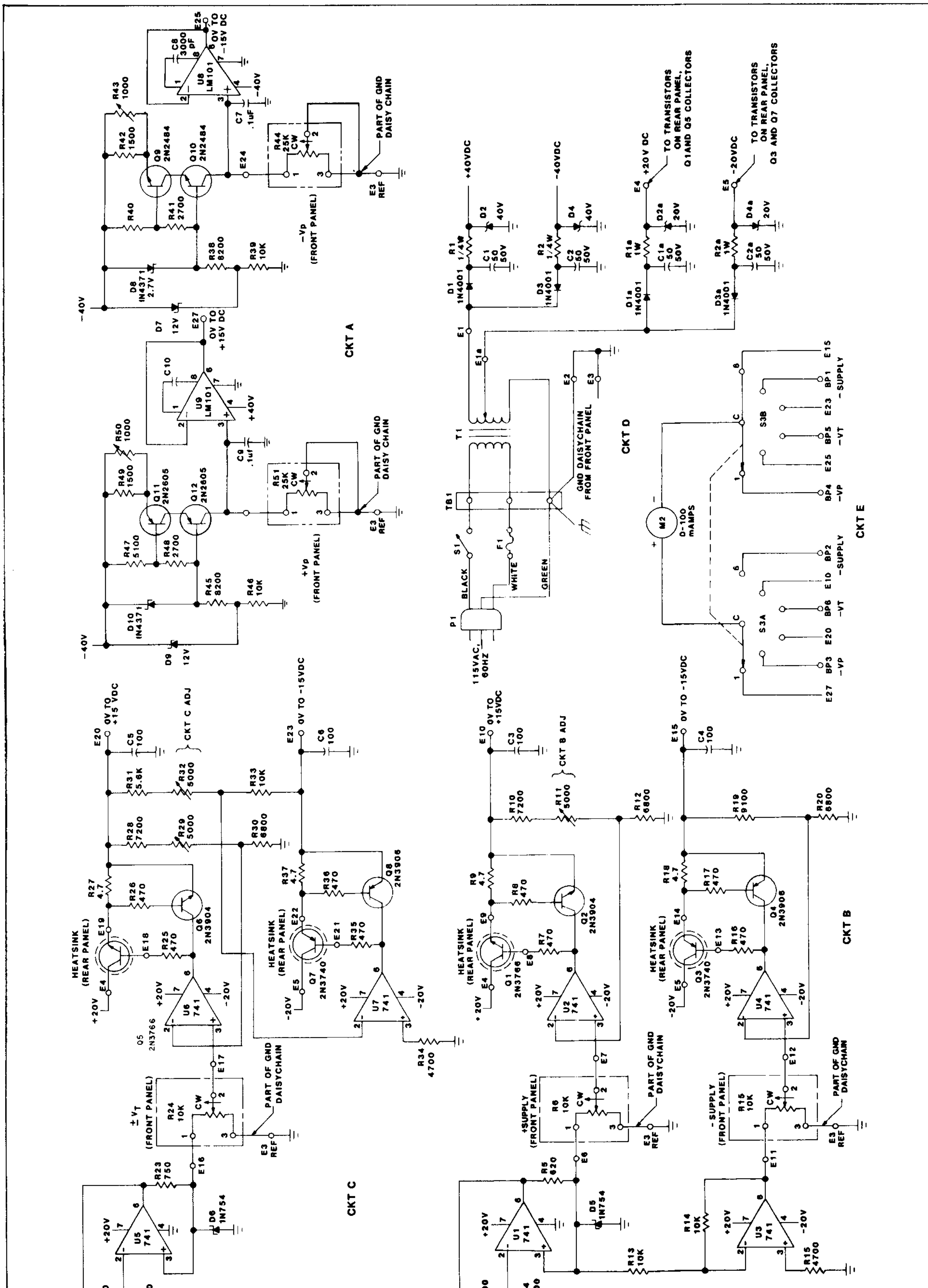


fig. 1. Six-output power supply schematic. In this schematic all capacitors are microfarads unless otherwise noted.

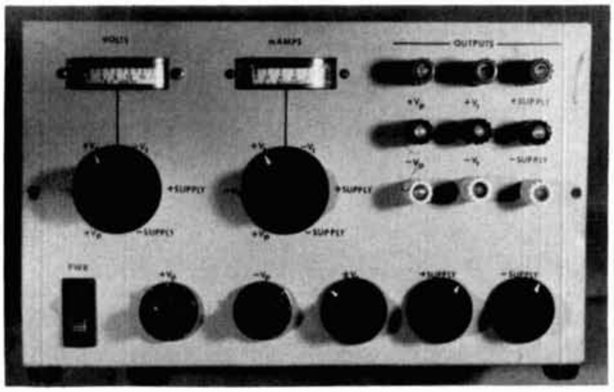


fig. 2. Front panel controls and indicators.

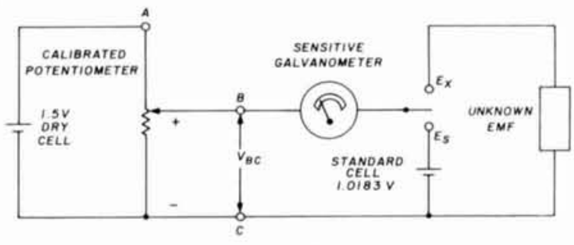


fig. 3. A typical application of a precision Weston electrochemical voltage standard cell.

limiting, and with the output series-pass transistors Q1 and Q2, providing the needed current drive, all five previously listed requirements of a voltage regulator are satisfied.

negative independently adjustable supply

The complementary negative portion of circuit B (CKTB) is composed of op amps U3 and U4 and associated circuitry. The reference voltage from the 6.8 volt zener diode D5 provides the input to an inverting amplifier (U3) with a gain of 1. The ratio of the input resistor (R13) divided by the feedback resistor (R14) establishes the gain, and since they are equal, the gain is 1. Therefore, amplifier U3 has a −6.8 volt output, which like its positive counterpart, is applied to front panel control pot R15 (− supply); refer to **fig. 2**. This negative input voltage is fed to the noninverting amplifier, U4, and amplified for a gain of from zero to approximately 2.5 as a result of the feedback resistor ratio from R19 to R20. The transistors Q3 and Q4 provide current buffering only — no voltage gain.

dual tracking power supply

This circuit, CKTC, is a composite and slight variation of previously developed and discussed circuits. Amplifier U5 has a +6.8 volt voltage reference in the form of zener diode D6 applied to the noninverting (+) input pin 3. This voltage is applied across front panel control pot ($\pm V_T$) R24. This 0 to +6.8 volts is then applied to noninverting amplifier U6, as described above. Amplifier U7 and transistors Q7 and Q8 form a negative regulator that is slaved to and therefore "tracks" the positive portion of this circuit, but naturally has an output equal in magnitude but opposite in polarity.

programmable power supplies

These two positive and negative power supplies are precision voltage sources and do not deliver power. They can deliver only approximately 4 mA of current, the capacity of an op amp itself. They are used primarily as precision stable voltage sources. Those readers old enough to remember the Weston cell that characterized most instrument labs some 20 years ago or more will recall that these were electrochemical voltage standards intended for use with very high resistance pots. They were typically employed with

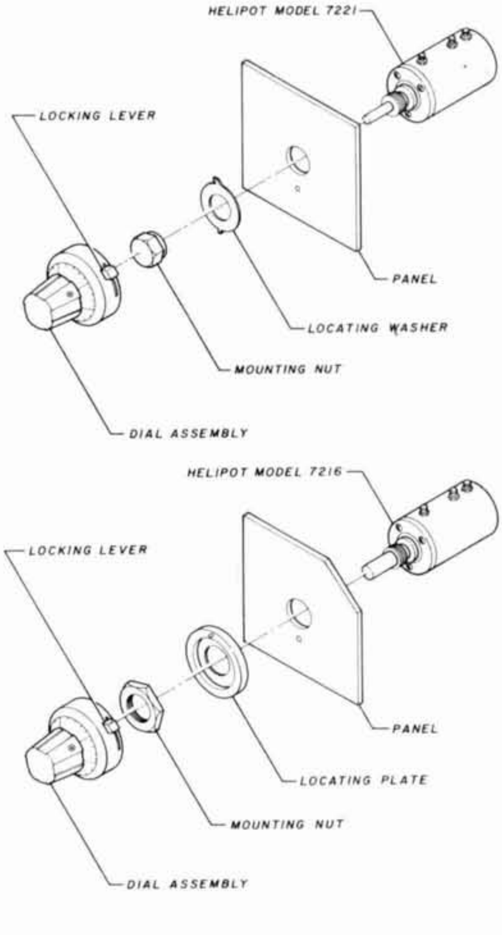


fig. 4. Mounting and functions of a multi-turn pot and matching turns counting dial.

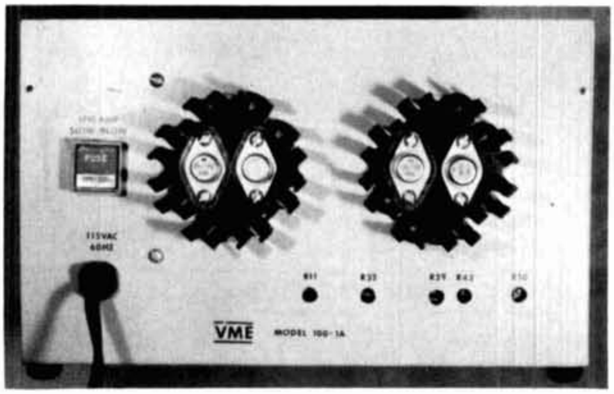


fig. 5. Rear view of case shows easy access to PC board trimmers.

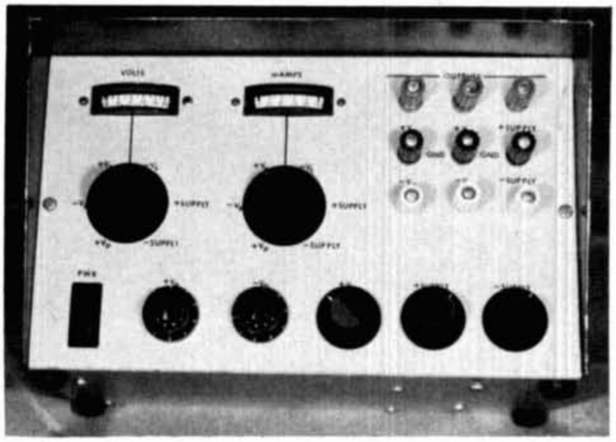


fig. 6. Six-output power supply.

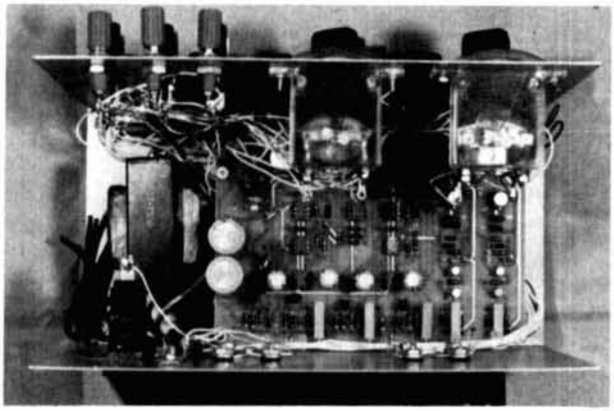


fig. 7. Interior view of power supply.

galvanometers in "balancing schemes" to indirectly determine to several significant figures the accuracy of an unknown voltage source (see **fig. 3**). Today we have 6 1/2-digit DVMs that will do this with equal or better accuracy and with much more convenience than that cumbersome hookup configuration. The Weston standard cells nonetheless developed an open-circuit voltage of 1.0183 volts as a result of the precise predictable nature of the electrochemical reactions within. But they could never be used to operate even a small lamp or similar low current demand device because irreparable damage would result, and their accuracy and repeatability could never again be trusted. However, these two precision low current circuits, using LM101 op amps, are nearly short-circuit proof.

The positive and negative programmable power supplies are simple (see **fig. 1**, CKTA). Both use complementary pair transistors to form an accurate current source that can provide 1 mA of current. This current, run through a 25-kilohm pot, generates a +25 volt fullscale output (positive power supply).

The pot, R51, is a 10-turn pot with a 10-revolution turns counting dial, (see **fig. 4**). For each revolution, up to and including the tenth turn, the pot will have 2.5 kilohms of resistance. Therefore, if you were to turn the pot to 4, you would have 4 turns at 2.5 kilohms each for 10 kilohms of resistance with 1 mA of current flowing through it for 10 volts DC of positive very precise voltage generated. You will note that this very precise positive voltage source goes to the input of U9 which is an op amp used as a voltage follower. More specifically, it is just an amplifier with a gain of +1 with a bit of current buffering. The noninverting input denoted by a (+) sign on U9 has an input impedance of at least 10 megohms, so very little, if any, voltage division occurs at this point.

The negative programmable power supply is the mirror image of its positive complementary counterpart. The +12 volt zener establishes bias on the bases of a complementary pair of transistors, Q9 and Q10, which produce a constant 1 mA current. This current is adjusted by a multi-turn PC mountable pot placed at the rear of the PC board (see **fig. 5**). Adjust R43 until four turns of the pot (10K) produce exactly 10 volts. A DVM can be used to check this. Make sure you do not load down this output. Op amp U8, like all nine op amps used with this project, is an LM101. If you have the TO-100 version, use it; its pin configurations is identical (pin 8 is the pin underneath the tab).

construction

The Bud box selected and specified in the parts list is ideal for this application in terms of cost and shape. The top of the enclosure slides down over the metal frame in a clamshell fashion. **Fig. 6** illustrates the finished product with the top in place. **Fig. 7** shows the project with the lid removed.

The actual detailed dimension of the box and the holes are provided in **fig. 8**. It should be noted that the two holes holding the shafts of the multi-turn pots can be either 1/8 or 1/4 inch, depending on the pot shaft diameter and corresponding turns counting dial

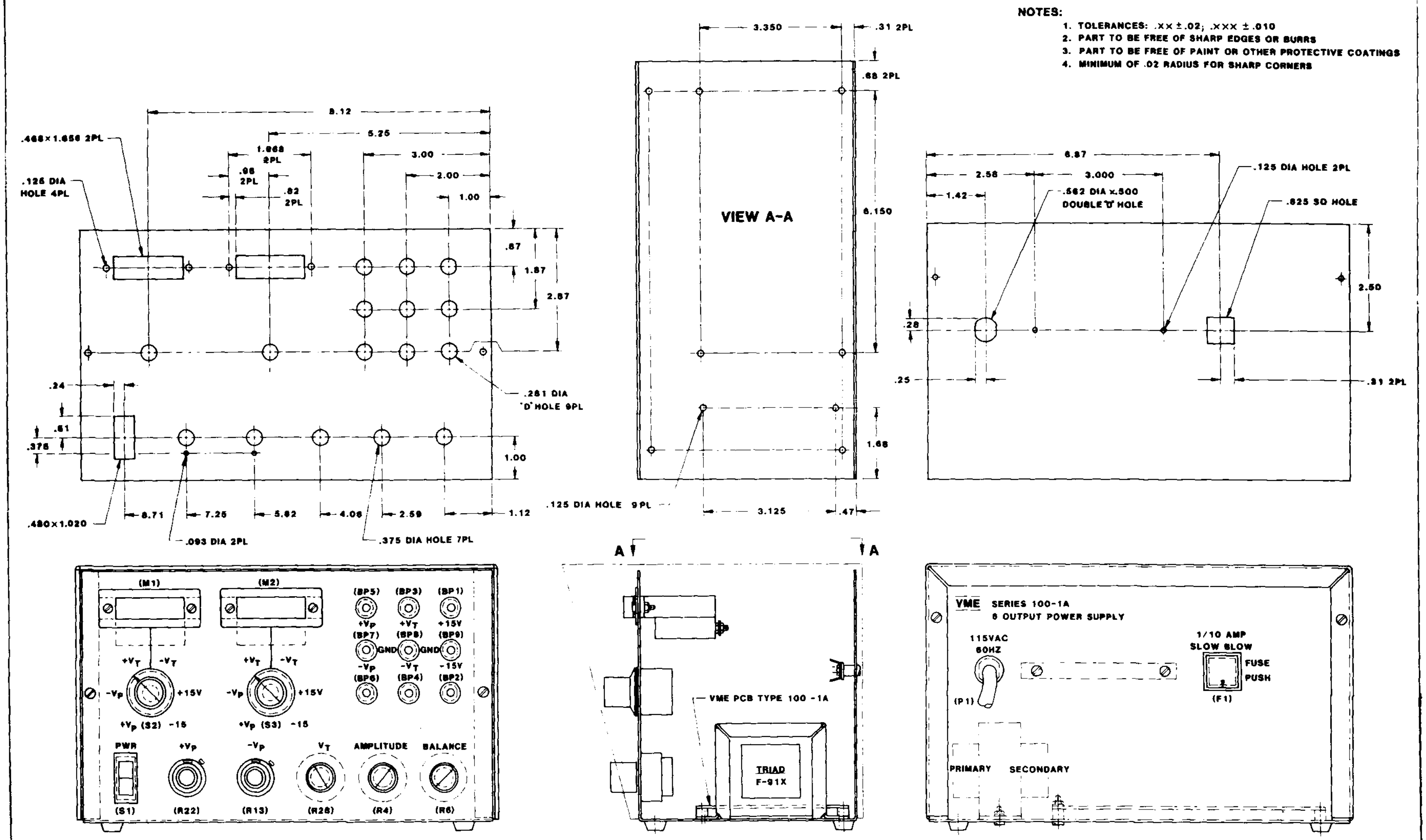
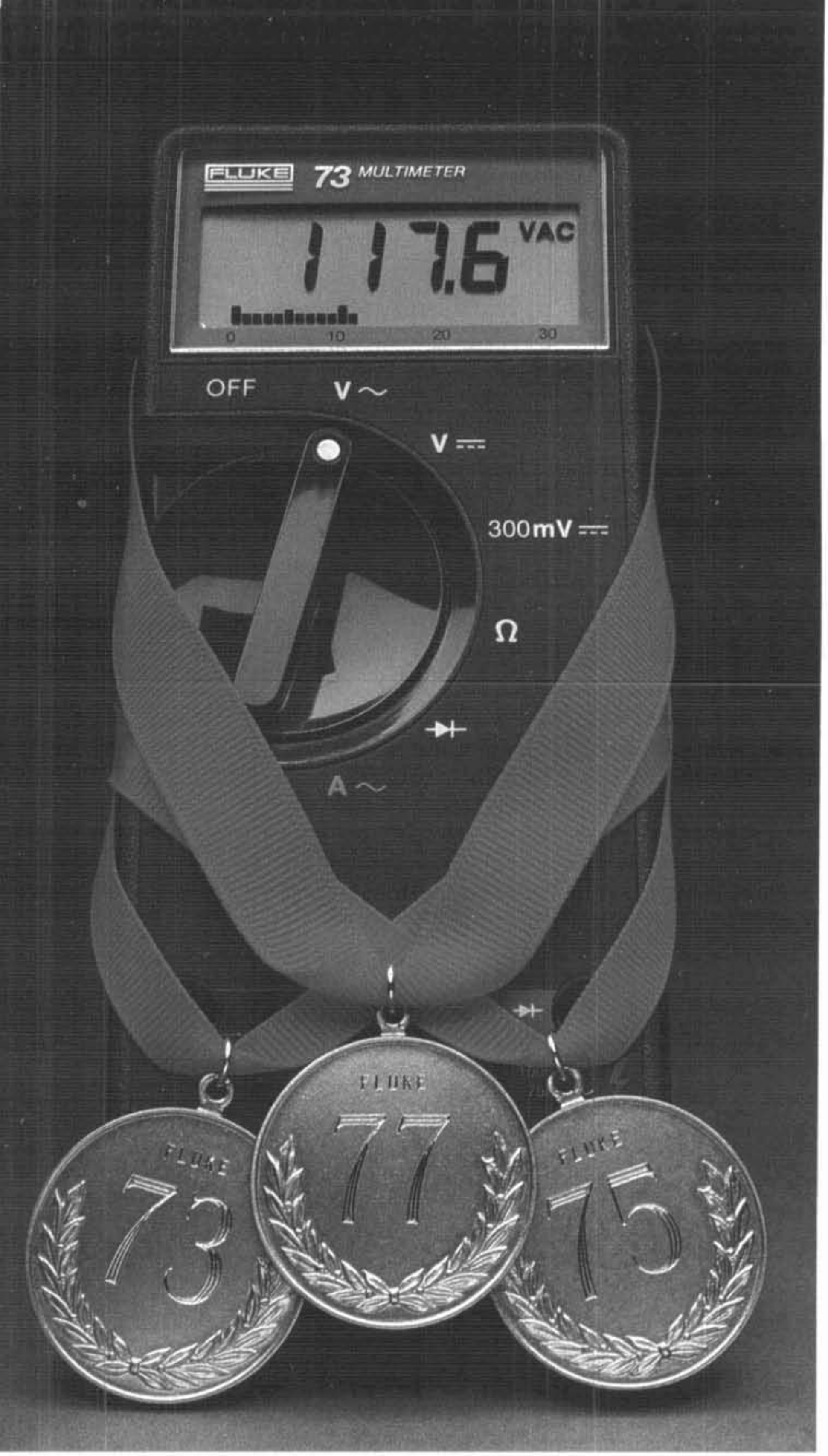


fig. 8. Drawing illustrates case drilling pattern.



Take home a world champion.

$85* gets you a technical knockout.
The Fluke 70 Series.
Winners of the digital vs. analog battle.

Since their debut, they've become the worldwide champions of the industry.

Never before have such tough, American-made meters offered so many professional features at such unbeatable prices.

Each comes with a 3-year warranty, 2,000+ hour battery life, and instant autoranging.

You also get the extra resolution of a 3200-count LCD display, plus a responsive analog bar graph for quick visual checks of continuity, peaking, nulling and trends.

Choose from the Fluke 73, the ultimate in simplicity. The feature-packed Fluke 75. Or the deluxe Fluke 77, with its own protective holster and unique "Touch Hold" function** that captures and holds readings, then beeps to alert you.

So don't settle for just a contender. Take home a world champion.

For your nearest distributor or a free brochure, call toll-free anytime **1-800-227-3800, Ext. 229.** From outside the U.S., call 1-402-496-1350, Ext. 229.

FROM THE WORLD LEADER IN DIGITAL MULTIMETERS.

FLUKE 73	FLUKE 75	FLUKE 77
$85*	$99*	$129*
Analog/digital display	Analog/digital display	Analog/digital display
Volts, ohms, 10A, diode test	Volts, ohms, 10A, mA, diode test	Volts, ohms, 10A, mA diode test
Autorange	Audible continuity	Audible continuity
0.7% basic dc accuracy	Autorange/range hold	"Touch Hold" function
2000+ hour battery life	0.5% basic dc accuracy	Autorange/range hold
3-year warranty	2000+ hour battery life	0.3% basic dc accuracy
	3-year warranty	2000+ hour battery life
		3-year warranty
		Multipurpose holster

* Suggested U.S. list price, effective July 1, 1984.
** Patent pending

FLUKE®

ICOM IC-471H

75 Watt 430-450MHz Base

ICOM presents the IC-471H 430-450MHz base station transceiver with a 75-watt *transmitter and high dynamic* range, low noise receiver. With FM, CW or SSB modes plus the most advanced 10Hz PLL system, the IC-471H has features which give you maximum UHF operation.

75 Watts. With 75 watts of power, the IC-471H provides the power required for simplex or repeater operation. Power is adjustable in all modes from 10 to 75 watts. This enables adjusting the drive level to a linear amplifier for higher power uses such as moonbounce.

Receiver. An extremely low-noise, professional-grade receiver and a high signal-to-noise ratio PLL which allows the IC-471's synthesizer to lock to 10Hz, provide receiver performance unparalleled by other UHF receivers. A mast-mounted preamp is switchable from the front panel and provides an easy-to-use option for weak signal work.

Mast-Mounted Preamplifier

32 Full-Function Memories. Each tunable memory holds frequency, offset, offset direction, mode and subaudible tone. Each parameter is selected by rotating the main tuning knob in conjunction with the other controls on the front panel.

Subaudible Tones. Included as a standard feature are 32 built-in subaudible tones which are easily selected by rotating the main tuning knob. PL tones may be stored into memory.

Size. Only 11¼ inches wide by 4⅜ inches high, the IC-471H is engineered for ease of operation.

IC-PS30 Power Supply

Scanning. The IC-471H can scan its 32 memories sequentially or selectively by mode and by programmed sections of the band. Mode-S scan can be used to scan only memories with a particular mode.

Fluorescent Display. ICOM's high-visibility and easy-to-read display gives all the information necessary for logging a contact. Frequency, mode, duplex, offset direction, RIT frequency, memory channel number and PL tone can be displayed.

Other Standard Features. To facilitate the operation of the IC-471H, ICOM has incorporated a duplex check switch, all-mode squelch, receive audio tone control, S-meter, center meter, seven-year lithium battery memory backup, accessory connector and microphone.

Optional Features. IC-471H options are: AG-35 switchable mast-mounted preamplifier, UT-15 CTCSS encoder/decoder, CT-10 computer interface and EX-310 voice synthesizer. A variety of optional power supplies are available: the IC-PS30 base station supply, IC-PS15, and the internal IC-PS35.

IC-471H Shown with internal power supply, IC-PS35

The IC-471A. The 25-watt IC-471A is also available and has the same outstanding features as the IC-471H, plus an optional IC-PS25 internal power supply for portable operation.

Also available to complete your VHF/UHF base station, are its 2-meter companions, the 100-watt IC-271H and 25-watt IC-271A.

See the IC-471H and other ICOM equipment at your local authorized ICOM dealer.

ICOM
The World System

✓ 159

ICOM America, Inc., 2112-116th Ave NE, Bellevue, WA 98004 / 3331 Towerwood Drive, Suite 307, Dallas, TX 75234

All stated specifications are approximate and subject to change without notice or obligation. All ICOM radios significantly exceed FCC regulations limiting spurious emissions. 471H784 *parts list*

resistors

item	description
R1,R2,R9,R18,R27,R37	4.7 ohms
R1a,R2a	4.7 ohms 1 watt
R3,R21	1.8 K
R4,R12,R20,R22,R30	6.8 K
R5	620 ohms
R6,R15a,R24	10 K front panel pot-single turn
R7,R8,R16,R17,R25 R26,R35,R36	470 ohms
R10,R28	7.2 K
R11,R29,R32	5 kilohm 15 turn 3/4" rectangular PC board mountable trimmer pot
R13,R14,R33,R39,R46	10 K
R15,R34	4.7 K
R19	9.1 K
R23	750 ohms
R31	5.6 K
R38,R45	8.2 K
R40,R47	5.1 K
R41,R48	2.7 K
R42,R49	1.5 K
R43,R50	1 kilohm 15 turn 3/4" rectangular PC board mountable trimmer pot
R44,R51	25 K ten-turn front panel pot

Note: all resistors are 1/4 watt, 5 percent tolerance unless otherwise noted.

capacitors

item	description
C1,C1a,C2,C2a	47 μF, 50 V
C3,C4,C5,C6	100 μF, 50 V
C7,C9	0.1 μF, 50 V
C8,C10	3,000 pF, 50 V ceramic dielectric

Note: all capacitors 47 μF and above require radial leads.

diodes

D1,D1a,D3,D3a	1N4001 or equivalent
D2,D4	40-volt zener or two in series to equal 40 V. A 39-volt zener (1N5366B) is available from Active Electronics; another, (1N4754A) is available from Circuit Specialists.
D2a,D4a	1N4747A
D5,D6	1N754
D7,D9	1N4742A
D8,D10	1N4371

transistors

Q1,Q5	2N3766 mounted on rear panel heatsink
Q2,Q6	2N3904
Q3,Q7	2N3740 mounted on rear panel heatsink
Q4,Q8	2N3906
Q9,Q10	2N2484
Q11,Q12	2N2605

op amps

U1 through U9	LM101 or equivalent

meters

Modutec edgewise 2-inch meters: part No. 13505 for a 1 mA (shunt for 100 mA); part No. 13537 for a 0-30 VDC meter. Both available from Sintec for $10.20 and $8.80 respectively. A 1 mA edgemeter (No. MET-1) is available for $4.50 from All Electronics Corp. Another is offered by Circuit Specialists (No. 20-905) for $6.07.

switches

item	description
2	6-position rotary switches
1	SPDT (single-pole double-throw) 115 VAC 1 amp

hardware

9	binding posts
1	fuseholder (a round one, if desired), part No. F150145-ND ($2.31) or F004-ND ($1.95), available from Digi-Key Another fuse holder (part No. FHPM-3), is panel-mounted, and fits 3AG-type fuses; it's available from All Electronics Corp.
2	matching 10-turns turns-counting dial (No. 411), $11.50, available from Circuit Specialists
1	10k 10-turn pot (No. 73JA), $7.50, available from Circuit Specialists
cabinet	Bud part No. SE3030

PC board, drilled and etched. Available from the authors for $14.00 ppd. Contact Speciality Electronics Services, Inc., P.O. Box 3320, San Antonio, Texas 78211.

6' flat line cord, 18 gauge, 3-prong (No. FDAC-3) is available from All Electronics Corp.

Note: a 10k pot is usable on the two programmable voltage sources if a 0 to 10 VDC full-scale output is sufficient.

parts suppliers:

Active Electronics
P.O. Box 8000
Westborough, Massachusetts 01581

All Electronics Corporation
905 South Vermont Avenue
Los Angeles, California 90006

Circuit Specialists
P.O. Box 3047
Scottsdale, Arizona 85257

Digi-Key Corporation
Highway 32 South
Thief River Falls, Minnesota 56701

Sintec Electronics
28 8th Street
Frenchtown, New Jersey 08825

selected. Also, the cutout in the back, made with a Greenlee 5/8-inch square punch accommodates a rather fancy fuseholder. You may have greater luck finding a round standard MIL-M-14 type CFG fuseholder with a 0.440-inch diameter round hole. The 1:1 scale foil pattern are shown in **fig. 9**. Note that the side with far fewer runs (lands) is the *component* side. Kits are available (see **fig. 10**) for lifting a pattern directly from a magazine page such as this one. The drill diameter schedule shown in **fig. 11** is a must for this method; even if you purchase the pre-drilled board, you will nonetheless still need this drawing as a component placement guide.

When mounting the parts on the PC board, be sure to observe the polarity of all the diodes and polarized electrolytic capacitors. Also, be sure to note that the op amps have pin 1 indicated by a dimple adjacent to the notch. The PC board has a small dot above pin 1 on the foil side of the board. Failure to observe these guidelines will result in destruction of the op amps. The smaller TO-100 type of transistors that do not go on the rear panel in the heatsinks can be properly oriented onto the PC board by a "tick" mark denoting where the alignment of the case's tab should be. Diode symbols are on the board; there are also (+) signs for proper placement of electrolytics.

The meter circuit is optional because only one supply at a time can be used when the current meter is in use.

turns-counting dials

Refer to **fig. 4** when placing the turns counting dial and multi-turn pot on the front panel. Select a dial that matches the pot's shaft diameter; the two most common shaft diameters are1/4 and 1/8 inch. The turns counting dial that matches it will probably have its inner scale marked in gradients of hundredths of a turn. The outer scale counts the number of turns (usually up to 15) completed.

To mount the pots and dials, refer to **fig. 4** again and follow the procedure described below, prepared originally for the Helipot™ Duodial™ series of pots and multiple turns counting dials:*

- Locate positions for holes "A" and "B" on panel. "B" for lug on locating washer is 9/32 inch below center of hole "A".
- Drill 9/32 inch hole "A" in panel for pot bushing.
- Drill 5/64 inch hole "B" in panel for lug on locating washer.
- Turn potentiometer shaft against its counterclockwise stop. Insert shaft into center hole "A" in panel.

*Courtesy Beckman Instruments, Inc., 2500 Harbor Blvd., Fullerton, California 92634.

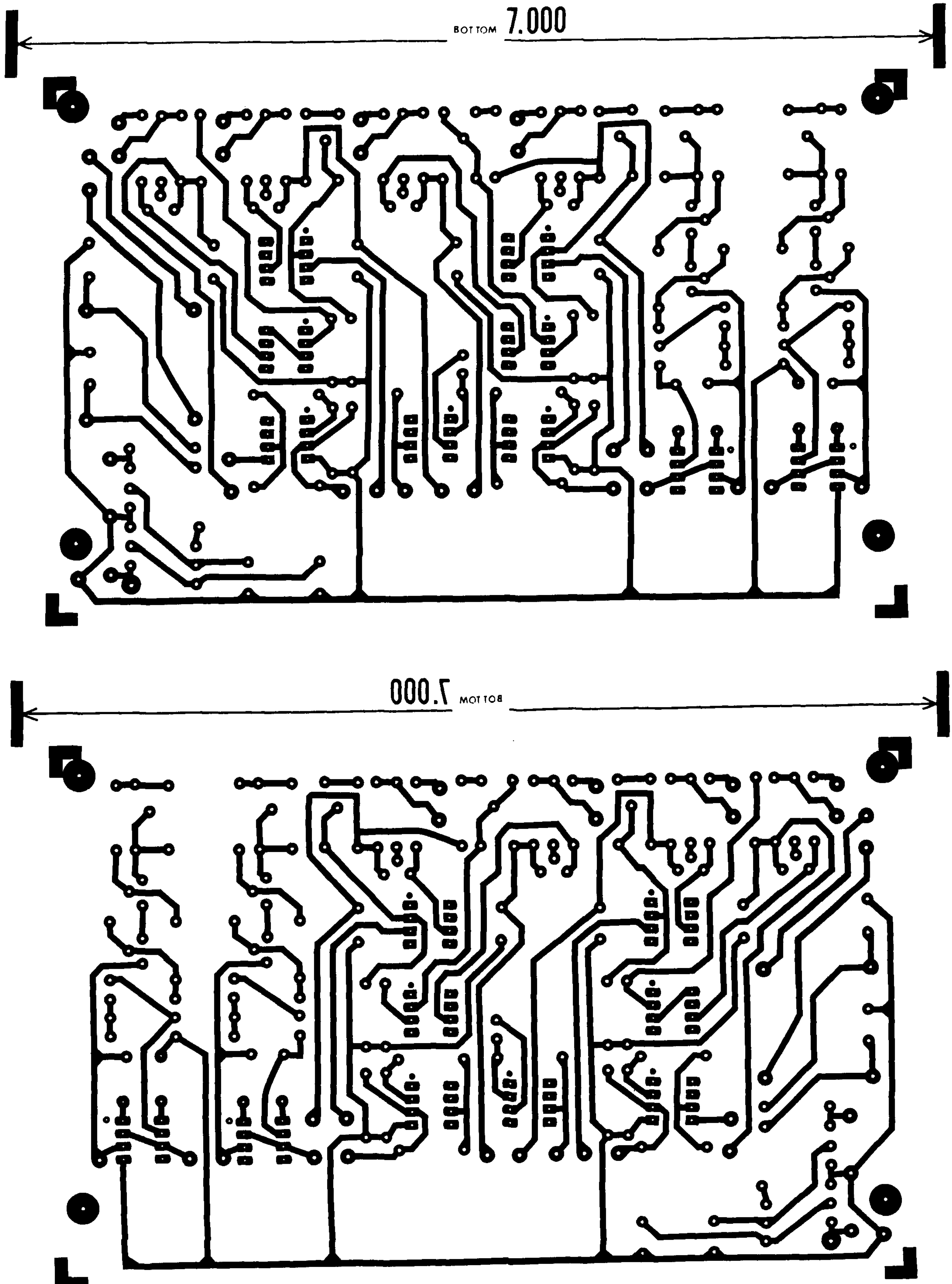
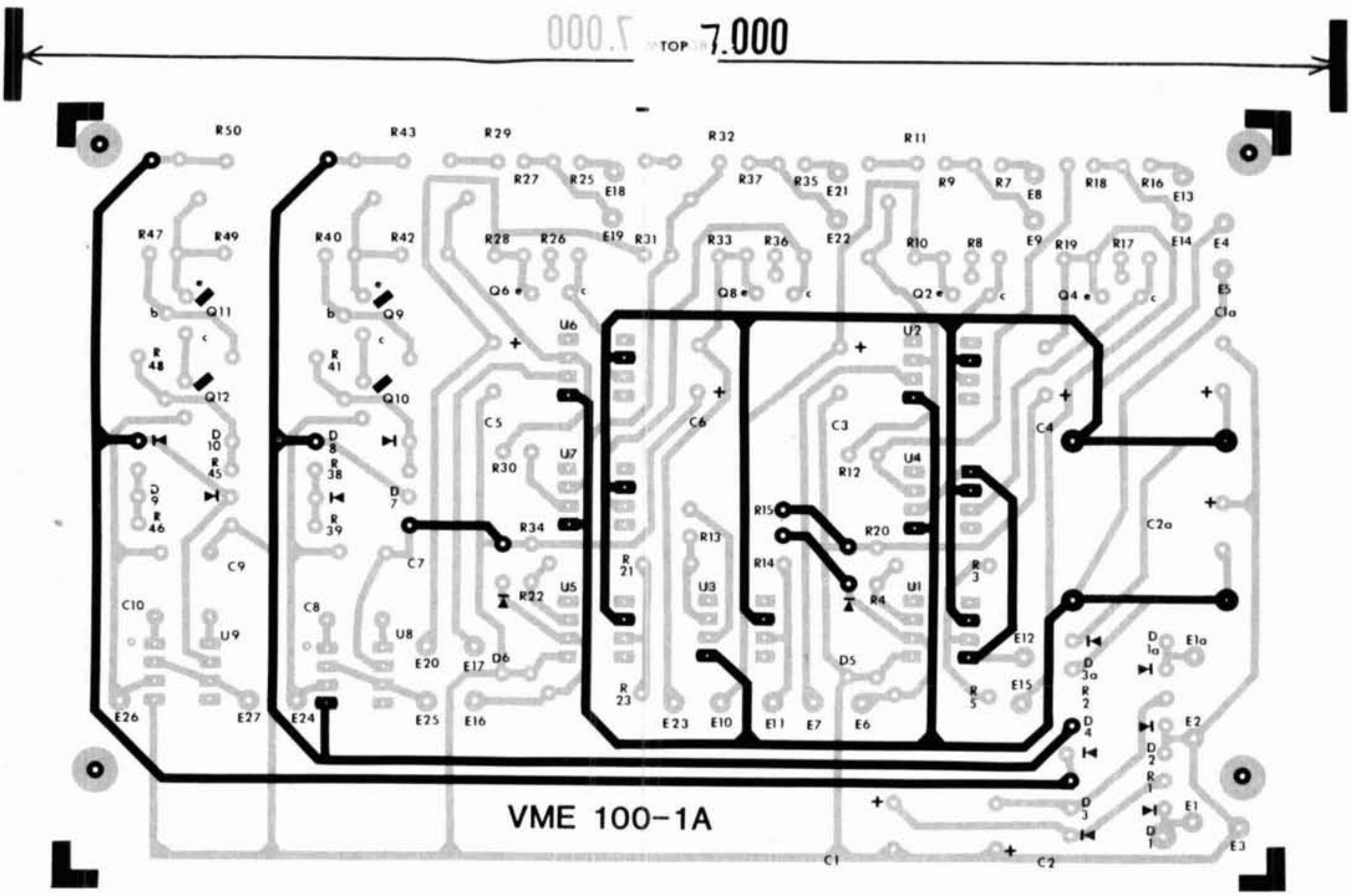


fig. 9. Double-sided PC board artwork.



• Slip locating washer over shaft and seat lug on locating washer in hole "B".
• With a wrench, firmly tighten mounting nut onto potentiometer bushing. Note that the nut supplied is reversible. For thick panels, use as shown in drawing. For thin panels, reverse the nut. If the Duodial is used with a device other than a Helipot potentiometer, an appropriate mounting nut may have to be obtained. This must fit within the 3/8-inch diameter 13/64-inch deep recess in model 2601 DUODIAL.
• With locking lever in OFF (UP) position, slip dial assembly over potentiometer shaft. Be sure lug at top of locating washer seats in slot in back of dial, and that the whole dial assembly sets lightly against the panel.
• Turn dial knob counter-clockwise until the zero of the outer scale is in the center of the window. Now turn slowly until the scale reads between 10 and 20 at the index line. Tighten the set screw until a very slight drag on the shaft is felt. Turn knob very slowly until both zeros line up with the index line. Tighten the set screw firmly.

parts — and where to get them

Components. This design purposely uses components that are easy to obtain. Several suggested sources are listed at the end of this article.

fig. 10. Typical kits available today to nonphotographically "lift" a PC board from magazine pages.

Zener diodes. Four are used in the input power conditioning circuit off the transformer. The two 20-volt zeners are 1N4747As, available from Digi-Key. The 40-volt zeners must be obtained elsewhere. However, two 20-volt zeners may be connected in series to achieve the same result. The other six low-power zener diodes consist of: two 2.7-volt zeners, two 6.8-volt zeners, and two 12-volt zeners. If the 2.7-volt zeners are hard to find, 1N5226B 3.3-volt zeners may be used in their place. If this substitution produces more than a 1 mA output from the constant current sources, then trim pots R43 and R50 can be adjusted accordingly for a 1 mA output. The two 12-volt zeners can

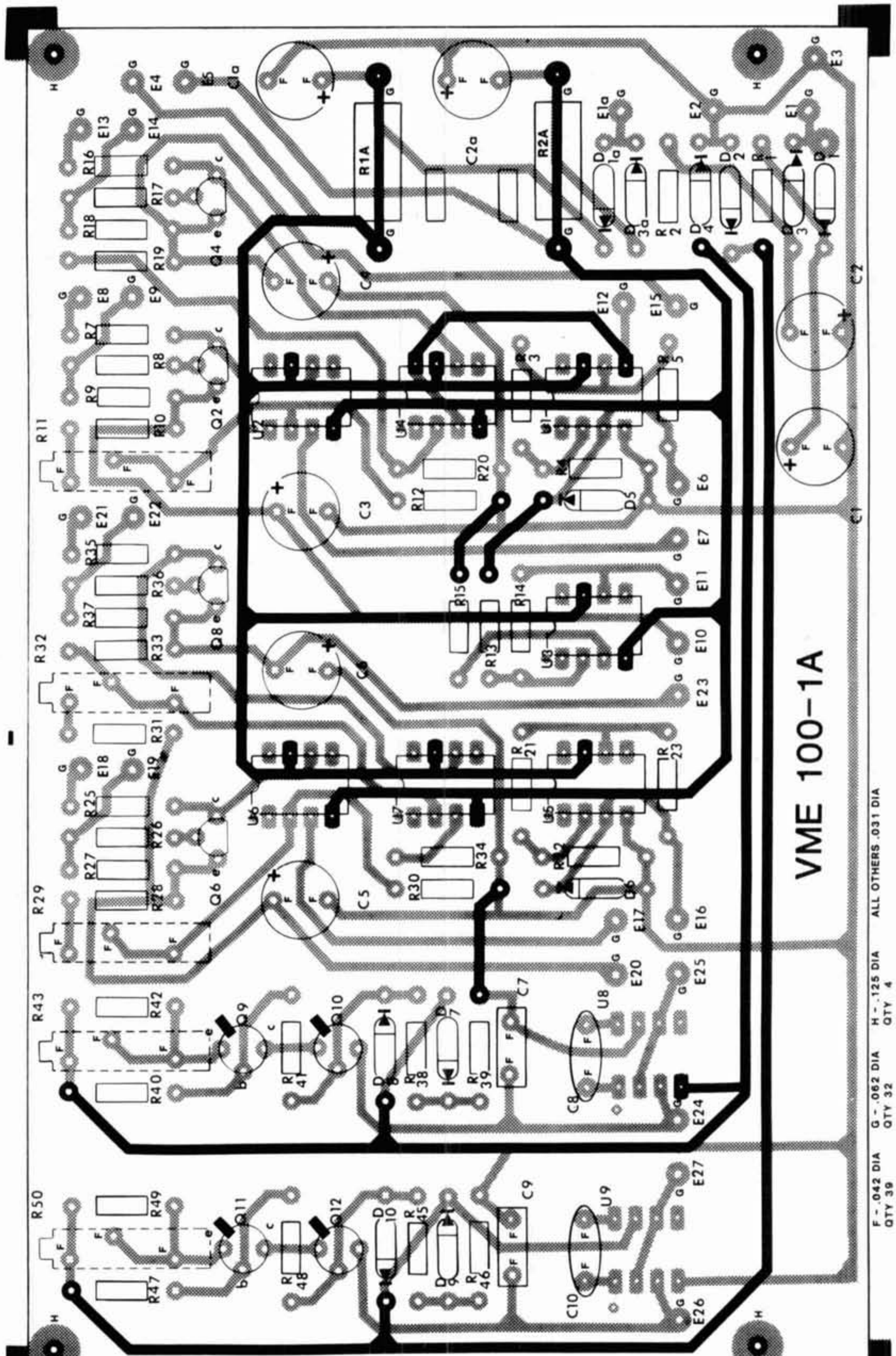


fig. 11. A combination drill pattern/component placement drawing.

be 1N963, 1N5242B, or 1N4742As. The 6.8-volt zeners establishing reference input voltages, namely D5 and D6, can be either 1N957B, 1N5235B, or 1N4736As.

Rectifier diodes. The rectifier diodes are 1N4001s. You may also use any of the 1N4000 series up to and including 1N4007, 1000 PIV diodes.

Capacitors. All capacitors that are polarized aluminum electrolytics are radial rather than axial lead devices, which are designed to lie flat on the PC board.

Meters. Edgewise meters have been selected to minimize the amount of front panel space required and to avoid a cluttered look.

Trim pots. All five cermet trimming pots are 3/4-inch rectangular ones with three staggered pins coming out their underside. All five are available from Digi-Key for $1.20 each. The three 5K pots are part No. 01B53 and the two 1K pots are No. 01B13.

Op amps. It is the nine LM101 or 107-type bipolar operational amplifiers that give this project its appeal in the form of some exceptional performance parameters.

National Semiconductor, the leader in op amp and linear IC manufacturing, has adopted a parts numbering convention now almost universally accepted throughout the industry, with variations occurring only in prefixes to denote the different styles of case available. "L" in the prefix "LM" stands for "linear," the "M" stands for "monolithic," (as opposed to "H", which stands for "hybrid"). The first digit — a 1, 2, or 3 — signifies whether the part is military, industrial, or commercial grade. A "3", or commercial grade product, is sufficient for this project and is less expensive than a grade 1 or 2 part.

Transformer. The Triad F-91X specified will adequately power this project and its ±100 mA outputs. However, if 2 amp outputs are required, you must increase the transformer's capacity along with the output power transistors' drive capability into 12 amp Darlington or single-cased direct-coupled transistor pairs. The two NPN transistors, which are now 2N3766's must then be 2N6057's or equivalents. The two PNP transistors, which are now 2N3740's, must then be 2N6050's or PNP Darlington pairs. Housed in TO-3 cases, both require heatsinking. Detailed thermal design information is available in references 1 and 2.

references

1. Vaughn D. Martin, "Cooling Semiconductors: Part One," *ham radio*, July, 1984, page 33.
2. Vaughn D. Martin, "Cooling Semiconductors: Part Two,": *ham radio*, August, 1984, page 52.

ham radio


taking
out
the
guess work...
ELECTRO-SCAN 84

Leyden's magic jar: the derivation of the Hertzian and Marconi antennas

From "electrical fire" to today's "rubber duckie"

In 1745, Ewald Jurgen von Kleist literally held in his hand the ancestor of most radio antennas in use today. Von Kleist was not a radio engineer; radio wasn't even discovered until 43 years later. Dean of the Cathedral of Kamin in Pomerania, Kleist enjoyed investigating the strange phenomenon of "electrical fire" in his spare time. Realize, now, that this was long before there was an electric light bulb, electro-magnet, or even a battery with which to power them. Von Kleist was not seeking to discover anything about antennas — he'd never even heard of them. He was just enjoying himself, as many experimenters do, by playing with and studying electricity. In doing so, he unwittingly discovered the world's first electrical "condenser" or capacitor. And believe it or not, this discovery led to antennas as we know them today.

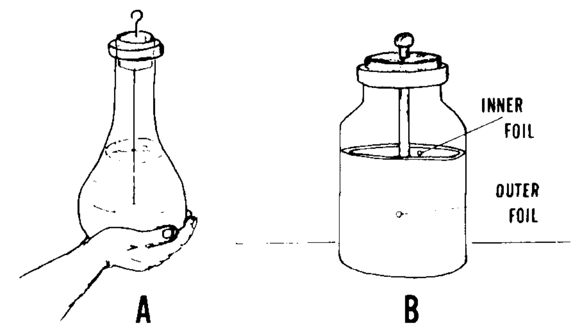


fig. 1. (A) An example of a capacitor such as von Kleist discovered; (B) A Leyden jar (occasionally called a "Kleistian jar).

As you know, a capacitor consists of two conductors called "plates" which are separated by an insulator called a "dielectric." Such a device can accept and store an electrical charge. First Kleist filled a glass flask with water. Then, holding the flask in one hand, he inserted a wire into the water in the flask and charged the wire with sparks of static electricity. As shown in **fig. 1A**, the water in the flask formed the inside plate of the world's first capacitor. The glass of the flask formed the dielectric, and von Kleist's hand served as the other plate of the capacitor! Touching the wire, von Kleist literally got the "shock of his life." He told others who played with electricity about his "shocking" discovery; one of them, a man named Graylath, succeeded in replicating the effect. According to Heilbron,[1] Graylath reported that his device for storing "electrical fire" could knock children of 8 or 9 "off their feet."[1] Such was the remarkable beginning of what we commonly refer to as the "Leyden jar." The term "Leyden" derives from the town of Leyden in the Netherlands, where in 1746, Pieter van Musschenbroek and his student Cuneaus further developed the early capacitor while trying to replicate and improve upon von Kleist's work. Obviously, one could not continue to use one's own hand as one plate of this potentially dangerous device. In the Leyden jar, the experimenter's hand on the outside of the flask was replaced with a coating of metal foil. The water on the inside of the flask — the inner plate of the capacitor — was

By W. Clem Small, KR6A, 26530 Parkside Drive, Hayward, California 94542

175

replaced by a second piece of foil. These two foil plates were separated by the glass wall of the Leyden jar, just as the glass of the flask had separated the water and von Kleist's hand in the original device. **Fig. 1B** shows the Leyden jar invented by Musschenbroek.

As the early physicists continued to pursue the elusive electrical phenomena of the day, more discoveries were uncovered. Ruhmkorff developed the induction coil or transformer. Induction coils equipped with the battery, invented by Volta, were capable of producing very high voltages continuously and giving impressive sparks across gaps in conductors. It was also found that the induction coil would give a much more powerful spark at a spark-gap if a Leyden jar or two were connected across the gap. Another finding quite important to the discovery of radio was that the discharge of a Leyden jar across a spark-gap was actually an oscillating current rather than just one pulse of current as it appears to the eye. Then along came Heinrich Hertz, bringing these discoveries together to confirm Maxwell's predictions of the possibility of radiating electromagnetic waves through space. As part of the apparatus used in demonstrating this remarkable phenomenon, he employed an induction coil and spark-gap to create a transmitter similar to that of **fig. 2**.

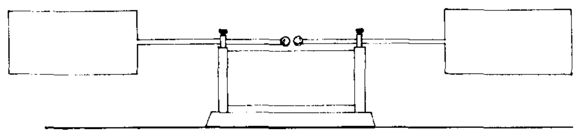


fig. 2. An example of a spark-gap transmitter with dipole antenna and capacitance plates.

Aitken has noted that the metal plates on the ends of Hertz's dipole antenna (**fig. 2**) were essentially Hertz's way of "unrolling" the foils of the Leyden jar and thereby increasing the capacitance across the spark-gap of his transmitter.[2] Hertz, of course, knew that a Leyden jar discharging through a spark-gap produced an oscillating electric current. What he had to do was to somehow "open up" that circuit so that it could produce the suspected radiation of electromagnetic waves that Maxwell had predicted. In discussing the evolution from Leyden jar-plus-wire-loop oscillator to wire-plus-metal-plate antenna, Aitken says, "The two foil surfaces of the Leyden jar, opened outward and transformed, became Hertz's radiating dipole antenna."[2] Hertz at times dispensed with the foils, and used as his antenna only the rods to which the foils were attached. (In some instances he selected dipole lengths that put his electromagnetic radiations near the 2-meter Amateur band of today!) Thus did the Leyden jar evolve into the dipole or doublet antenna as we now know it.

Subsequently, Guglielmo Marconi, while vacationing in the Italian Alps, read an announcement of the death of Hertz. The same article recounted Hertz's astounding achievements in demonstrating the possibility of transmitting electromagnetic waves through space. Marconi was struck with the potential such a discovery might hold for the communication of information across more than just the few feet of laboratory space which Hertz had done. He cut short his vacation and returned home to begin work on what was to become the wireless telegraph, or what we now call radio. Marconi soon began experimenting with antenna placement and eventually came to connect one side of the spark-gap in his transmitter to a vertical antenna (see **fig. 3**) and the other side of the gap to the earth or ground.

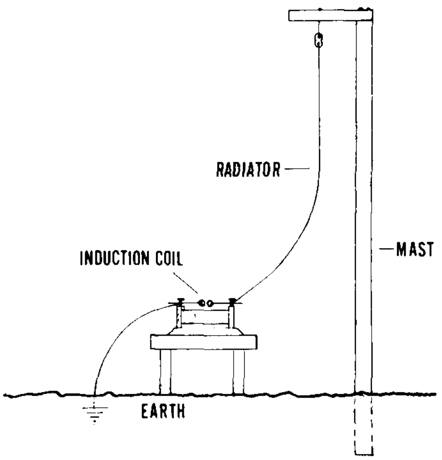


fig. 3. A Marconi antenna connected to a spark-gap transmitter. The left side of the spark-gap is connected to the earth.

Hertz had found that he had to make the length of his dipole equal to one-half the wavelength of the frequency which he desired to radiate. Marconi, on the other hand, found that with the earth substituting as half the dipole, he could use one-fourth of the wavelength as the length of his vertical radiator. With this configuration was born the grounded vertical antenna, ancestor to the common quarter-wave vertical ground-plane antenna as well as AM broadcast towers and many other vertical antennas. Although antennas didn't look much like a capacitor or a Leyden jar by Marconi's time, the idea of the antenna as a capacitor did not die with Hertz's opened-out Leyden jar. Early technical books on radio routinely discussed antennas as being large capacitors and explained their functioning in those terms. For instance, in a 1922 revision of the U.S. Army Signal Corps radio handbook,[3] we find the following: "There are two general types of antennas, those which act primarily as electrical condensers and those which act primarily as electrical inductances. The first type is usually referred to simply as an 'antenna.' The second type is usually referred to as a 'coil antenna,' 'coil aerial,' 'loop,' or when used for a particular purpose, as a 'direction finder.' " Of course today we realize that an antenna has capacitance (as well as inductance and resistance), but are more likely to conceptualize an antenna as a resonant circuit than as a capacitor.

terminology

Notice that in **fig. 2**, Hertz's antenna is oriented with its radiating conductor in the horizontal plane. Thus the electron flow on the radiator, and the electrical wave radiated into space, would naturally be horizontal. For this reason, Hertz's antenna is described as a horizontally polarized antenna. Terms still in use for common horizontally polarized antennas, in particular the $1/2\lambda$ dipole or doublet, are "Hertz" or "Hertzian" antennas. On the other hand, in Marconi's $1/4\lambda$ antenna, note the vertical orientation of the antenna's wire radiator. Here the current flow on the radiator, and the electrical wave radiated into space, are vertically oriented. It's not hard to see why, even today, vertically polarized antennas worked against a groundplane are sometimes referred to as Marconi antennas. For example, in the 1982 edition of the RSGB's *HF Antennas*, Moxon refers to ". . . the Marconi antenna . . . which can be regarded as one-half of a dipole, the other half being the image in the ground."[4] Shrader, in *Electronic Communication*,[5] wrote, "Any antenna complete in itself and capable of self-oscillation, such as a half or full wavelength, is known as a *Hertz* antenna. When an antenna utilizes the ground (earth) as part of its resonant circuit, it is a *Marconi* antenna." To me, it seems fitting that the two most common antenna configurations we have today still bear the names of their illustrious discoverers.

The next time you whip the ol' rubber duckie past your ear as you put your HT on the air, give a little thought to the debt we owe those old-timers for the pleasures we enjoy today. If the thought makes the hair on the back of your neck stand up a little, it might just be that the spirit of old von Kleist is back there with a charged flask, still playing with his "electrical fire."

references

1. J.L. Heilbron, *Electricity in the 17th and 18th Centuries*, University of California Press, 1979, Chapter XIII.
2. H.G.J. Aitken, *Syntony and Spark*, John Wiley, New York, 1976, pages 53 and 56.
3. *The Principles Underlying Radio Communication*, 2nd edition, U.S. Army Signal Corps, 1922, page 304.
4. L.A. Moxon, *HF Antennas for All Locations*, Radio Society of Great Britain, 1982, page 103.
5. R.L. Shrader, *Electronic Communication*, 2nd edition, McGraw-Hill, New York, 1967, page 439.

ham radio

low-cost UHF antenna tower

Chimney-mounted perforated tubing provides accessible 57-foot skyhook

This article describes a design for a UHF antenna tower that can be constructed very simply and at a price most hams should be able to afford — less than $200.00. This type of tower is ideal for Amateur Fast Scan Television applications, among others.

Before the design was begun, several ground rules were established:

- The tower should be attached to the chimney of the house. (The advantage is obvious; the chimney would serve as the base for the tower and also provide extra height.)

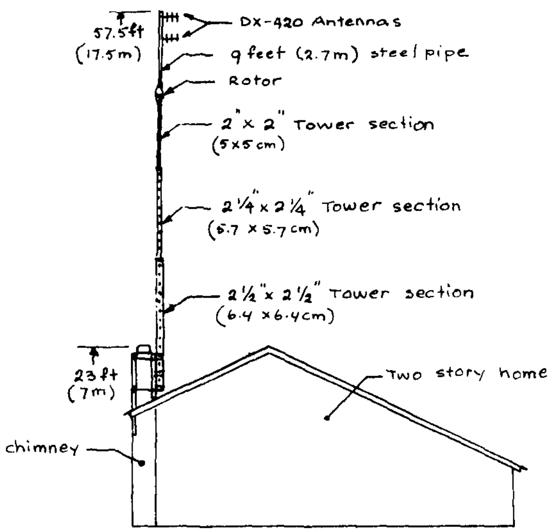


fig. 1. Tower and antenna assembly measures 57.5 feet (17.5 meters) from ground.

- For aesthetic reasons, no guy wires were to be included. This meant that the tower had to be strong enough to withstand 80-mile per hour (128 km per hour) winds with an antenna area of 2 ft^2 (0.19 m^2), which is sufficient for two or more UHF-type antennas.
- For ease of maintenance, the tower must be a tiltover.
- The tower sections had to be light enough to allow construction and assembly to be carried out without the need for a crane.

the chimney must take the load

The first order of business was the necessity of establishing the strength factor of the chimney for a given side load. This is very important; not all chimneys are strong enough to support a mast. At this site, the chimney is constructed from an inner column of tube segments surrounded with a brick-cemented outer shell. The space between the brick shell and the tube segments is filled with concrete reinforced with four 1/2-inch (1.27-cm) steel rods. This is common practice in Southern California. A check with the county masonry society revealed that this type of chimney should be capable of sustaining a side load of 1000 pounds (454 kg).

The next step requires calculating the strength specifications for the tower itself. Because no guy wires were planned to support the tower above the chimney, the combined strength of the tower, the rotator mounted on top, and the antennas above the rotator must be sufficient to sustain violent winds up to 80 miles per hour, or 128 km per hour. (A detailed analysis is included at the end of this article.)

The tower and antenna assembly consists of a set of chimney mounting brackets; three lengths of square tubing sections, each successively smaller in diameter and fitting inside the previous tube; a rotator; and a

By Nick Klos, KA6GVY, 15421 Vassar Street, Westminster, California 92683

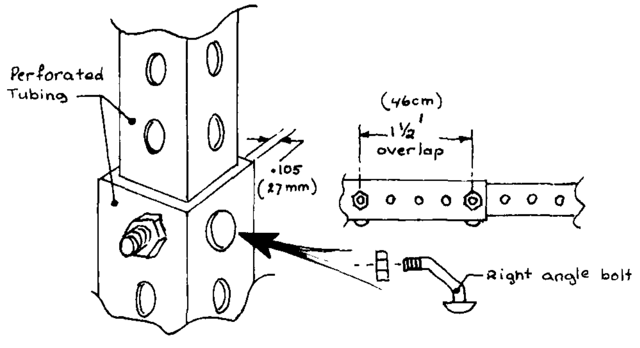


fig. 2. Right angle bolts connect tubing sections.

9-foot (2.74 meters) long, 16-gauge (2 mm) galvanized steel 1-5/8 inch (4.1-cm) I.D. tube with two DX-420 Cushcraft antennas mounted to it. The total height, measured to the tip of the antenna mounting tube is 57.5 feet (17.5 meters) above the ground. This includes the 23-foot (7-meter) high chimney. (See **fig. 1**).

construction details of tower and chimney mounts

The tower was assembled from three lengths of Telespar perforated tubing. This type of tubing was designed for sign posts, storage racks, and benches. Of the many unique properties of the tubing, its modularity makes it most useful for antenna mounting. Each segment of tubing was designed to fit into the next larger tube diameter. Right angle bolts provided by the supplier fasten the sections of tubes together. (See **fig. 2**). An overlap of 1-1/2 feet (46 cm) should be maintained to allow for sufficient strength. Since cost and simplicity were of primary concern, no elaborate motor driven or other type of mechanism to lower or raise the tower was included. Access to the antennas was achieved by making it a tiltover assembly with a hinge.

The brackets are of an all-welded construction. A detailed drawing (**fig. 3**) outlines the construction features of the front bracket which supports the tower.

The rear bracket is almost the same as the front bracket, with the exception that no tower brackets are included. The author chose to make the bracket longer, reaching further down the chimney for added strength and to provide a better stress distribution in the chimney. Each chimney width will be different; thus the inside bracket dimension will be unique for each installation. The 4.5-foot (137-cm) bracket height should be maintained in order to provide adequate base support. Remember, the tower, rotator, boom, and antennas weigh approximately 150 pounds (68 kg). The front bracket weighs approximately 80 to 100 pounds (36 to 46 kg) and the rear bracket approximately 70 to 90 pounds (32 to 41 kg).

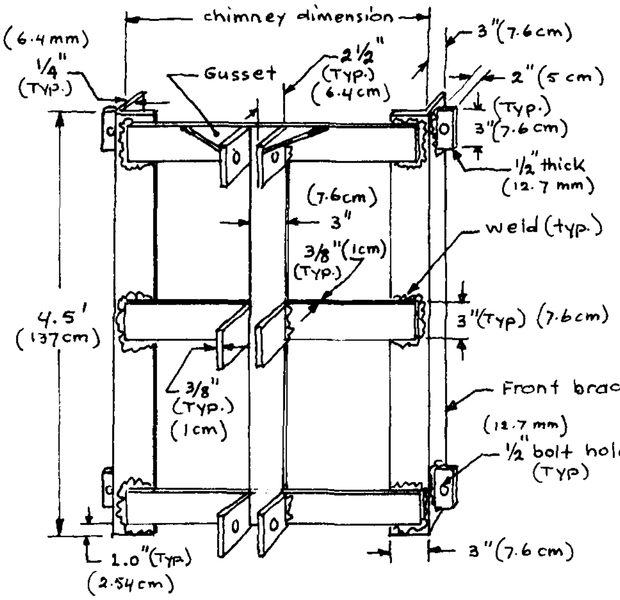


fig. 3. Construction details of front bracket assembly.

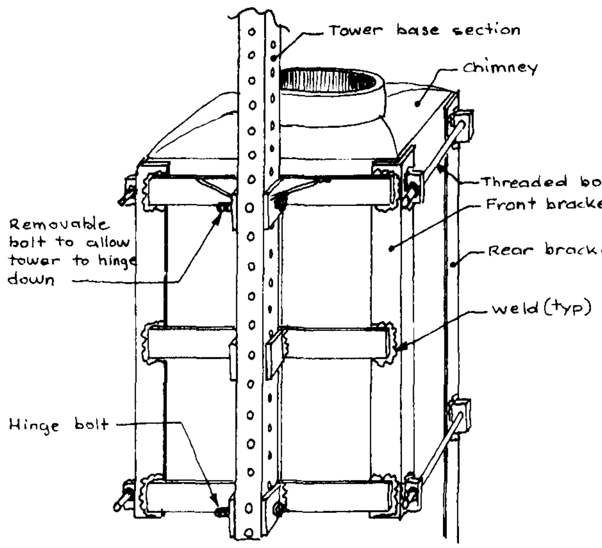


fig. 4. Hinge assembly, consisting of a front and rear bracket, is fastened with two 2-foot long threaded bolts.

After the brackets are completed, apply rust preventing paint and measure the width of the chimney accurately; the welded bracket assembly cannot be readjusted to fit the chimney. (A bolted construction may work loose or cause twisting in heavy winds.)

The sandwich mounting of the front and rear brackets, using 1/2-inch (12.7-mm) bolts, serves two purposes: first, it eliminates the need for drilling into masonry and mounting of lag bolts, which are unreliable in this application; second, it helps prevent the failure of masonry between the bricks. If the chimney is not straight you may have to insert shims between the brackets and the chimney for stability.

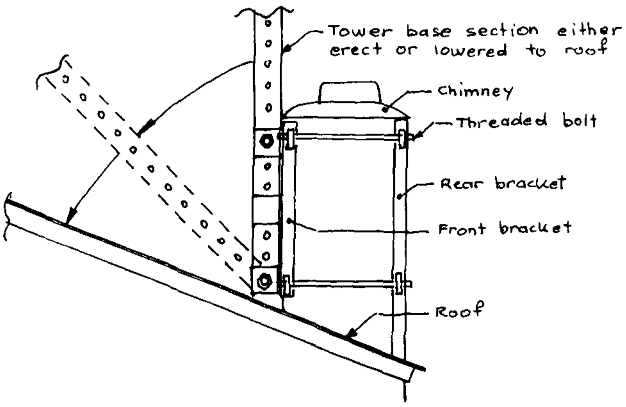


fig. 5. Remove upper mast bolt to lower tower to roof.

parts list

tower parts

quantity	part number	description
1	24F12*	perforated tubing 2-1/2 × 2-1/2 inches (6.4 × 6.4 cm), wall thickness 0.105 inch (2.7 mm), 12-feet (3.7 m) long, pre-galvanized steel
1	22F12*	perforated tubing 2-1/4 × 2-1/4 inches (5.7 × 5.7 cm), wall thickness 0.105 inch (2.7 mm), 10-feet (3 m) long, pre-galvanized steel
1	20F12*	perforated tubing 2 × 2 inches (5 × 5 cm), wall thickness 0.105 inch (2.7 mm), 10-feet (3m) long, pre-galvanized steel
2	TL070*	right angle bolt, electro-galvanized finish
2	TL050*	right angle bolt, electro-galvanized finish
1		tubing 1-5/8 inch (4.1 cm) ID, wall thickness 1/16 inch (1.6 mm), 9-feet (2.7 m) long

*Telespar parts can be obtained from the Unistruct Corporation, 14600 South Marquardt Avenue, Santa Fe Springs, California 90670.

bracket parts

quantity	description
2	angle iron 3 × 3 × 1/4 inch (7.6 cm × 7.6 cm × 6.4 mm), 52 inches (1.37 m) long
2	angle iron 3 × 3 × 1/4 inch (7.6 cm × 7.6 cm × 6.4 mm), 6 to 8 feet (1.8 to 2.4 m) long
6	flat cold rolled steel plate 3 inches (7.6 cm) wide, 3/8 inch (1 cm) thick, length dependent on chimney width
6	flat cold rolled steel plate 3 × 2-1/2 × 3/8 inches (7.6 × 6.4 × 1 cm)
8	flat cold rolled steel plate 3 × 2 × 1/2 inch (7.6 cm × 5 cm × 1.27 cm)
2	galvanized steel bolt 5 inches (12.7 cm) long × 1/2 inch (1.27 cm) thick
8	galvanized steel nut for 1/2 inch (1.27 cm) bolt
4	galvanized threaded bolt 3 feet (91 cm) long — dependent on chimney dimensions
1	flat cold rolled steel plate 3 inches (7.6 cm) wide, 3/8 inch (1 cm) thick, 52 inches (1.3 m) long

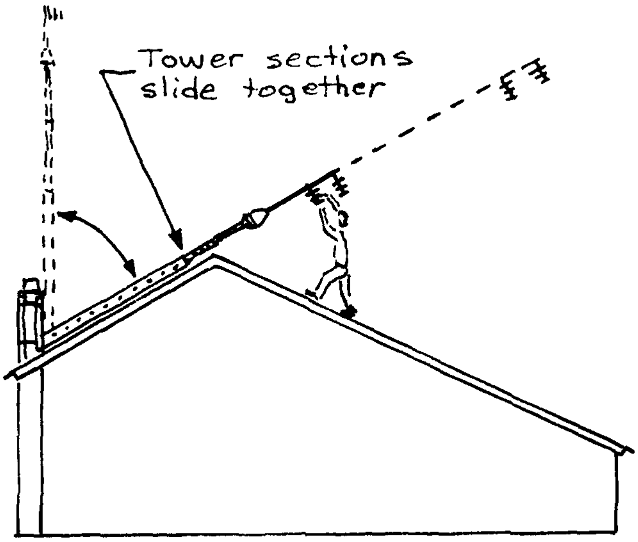


fig. 6. To reach antennas, simply remove bolts joining sections, sliding one section inside the other.

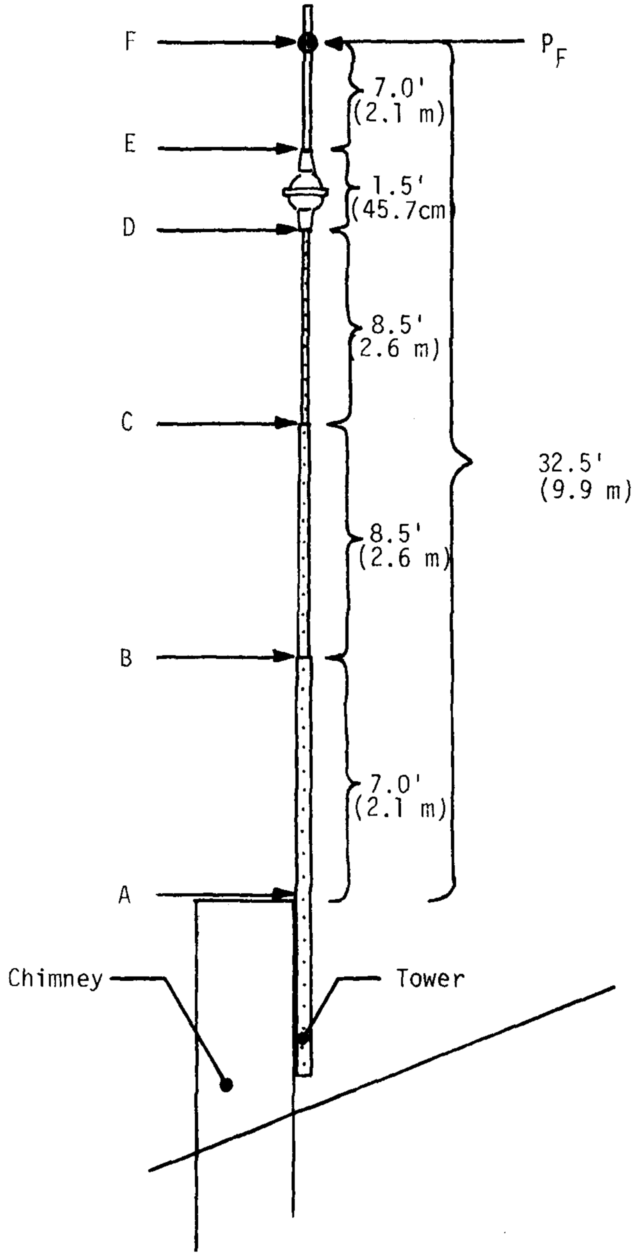


fig. A1. Tower/antenna configuration.

Designed to be part of a welded bracket straddled around the chimney, the hinge is fastened together with 1/2-inch (12.7-mm) two-foot long threaded bolts available at most hardware stores. (See **fig. 4.**) **Fig. 5** illustrates how the tower can be lowered to the roof by removing the upper mast bolt.

If you have a pitched roof, how do you reach the antennas after the mast is hinged down? The mast is 39.5-feet (12-meters) long, measured from the hinge point. It overhangs the rooftop by 27 feet (8.2 meters). *Therefore, the design includes the sectional feature* shown in **fig. 6**. Since three square tubes slide together, merely removing the two sets of bolts that hold the sections together allow shortening the mast to the point where the antennas can be easily reached.

In terms of the rotator, antennas, and tubes supporting these antennas, each individual must consider the options available and choose the most appropriate configuration. The tower constructed by the author was tested involuntarily when *seven* major storms swept through the Los Angeles area with wind velocities up to 100 miles per hour (160 km) during the winter of 1982-1983. The tower, brackets, and antenna sustained no damage; the tower is still perfectly vertical, and no stress cracks or other minor damage has been observed on the brackets or tower.

acknowledgement

My sincere thanks to Bob Provost for providing the mechanical analysis for the tower design.

appendix

antenna tower stress analysis

The following is a stress analysis of an antenna tower attached to a chimney. This analysis may be used as a guideline for any tower configuration. The simplified approach assumes a cantilever beam with a projected antenna surface area of 2 feet^2 (0.19 meter^2). The object of the analysis is to determine the wind velocity a given tower/antenna configuration can endure without damage.

The configuration of the tower/antenna model is shown in **fig. A1**.

First, one needs to determine the moment of inertia (I_{SQ}) of sections "*A*" through "*F*," using equation:

$$I_{SQ} = 1/12\ (O.D.^4 - I.D.^4) \qquad \textbf{(A1)}$$

$$I_A = 1/12\ [(2.50)^4 - (2.29)^4] = 0.9635\ in.^4$$

Next, the *bending stress* (σ) as a function of wind force (P) needs to be determined.

$$\sigma = \frac{MC}{I} \qquad \textbf{(A2)}$$

where M = moment (arm)
C = distance to neutral axis of cross section
I = moment of inertia

For section "*A*" the bending stress is:

$$\sigma_A = \frac{(32.5\ ft)\ (P\ lb)\ [(1/2 \cdot 2.50\ in)]\ (12\ in/ft)}{0.9635\ in^4}$$

$$\sigma_A = 506.0\ (P)\ lb/in^2$$

The following table summarizes the results:

section	CG distance	tower cross section (inches)	wall thick (inches)	I	σ PSI
F	—	—	—	—	—
E	7.0	1-5/8 × 1-5/8	1/16	0.1592	428.7 P
D	8.5	*	—	—	—
C	17.0	2 × 2	0.105	0.4778	426.9 P
B	25.5	2-1/4 × 2-1/4	0.105	0.6925	497.1 P
A	32.5	2-1/2 × 2-1/2	0.105	0.9635	506.0 P

*Extra strong section used, calculation not necessary.

As can be seen from the table, Section *A* experiences the largest stress for a given wind force (Section *C*, the least). (In other words, Section *A* would be the first section to break.) The maximum wind force a section can withstand is based on the strength of the material.

The yield strength of the tower material is $\sigma\ yield = 33\ ksi$ (33,000 lb/in^2). Any bending stress less than 33 ksi applied to the cross section will *not* permanently deform the tower section.

The ultimate strength of the tower material is $\sigma\ ultimate = 52\ klb/in^2$. Any bending stresses from 33 to 52 klb/in^2 applied to the cross section may result in permanent deformation. Stresses above 52 klb/in^2 will cause the tower section to break.

Solving for the unknown wind force yields:

$$506.0\ P = 33\ klb/in^2$$

$$P = 65.22\ lbs$$

Wind force is related to wind velocity as follows:

$$P = \frac{A \varrho V^2}{g} \qquad \textbf{(A3)}$$

where A = antenna area
ϱ = density of air (0.076 lbm/ft^3 at 66°F)
V = wind velocity
g = gravitational acceleration

$$P = \frac{(2ft^2)\ (0.076\ lbm/ft^3)\ [(V\ miles/hr)\ \frac{1}{3600}\ \frac{hr}{sec}\ (5280\ ft/mile)]^2}{32.186\ [ft/sec^2\ (lbm/lbf)]}$$

$$P = 0.01016\ V^2\ lbs \text{ or } V = \sqrt{\frac{P}{0.01016}}$$

Therefore, the maximum wind velocity cross section "*A*" can withstand is:

$$V_{yield} = \sqrt{\frac{65.22}{0.01016}} = 80\ mph$$

and

$$V_{ultimate} = \sqrt{\frac{103.64}{0.01016}} = 101\ mph$$

Although the simplified calculations show a V_{yield} of 80 mph, winds up to and over 100 mph have not resulted in tower material yield at this location. It appears that using the equations outlined above should provide a conservative means of calculating the strength of a tower.

(The same analysis in metric units is available. Send an SASE . . . **Editor.**)

ham radio

John Marshall Haerle, WB5IIR

The Amateur Radio community was recently saddened to learn of the untimely death of John Haerle, WB5IIR, in an automobile accident August 1.

A popular author and lecturer active on 160 meters, John had been affiliated with Gates Radio as chief engineer for sales, and later with Collins Radio, where he served as director of advertising and public relations and also headed that organization's broadcast division.

Surviving are his wife, Rose; a son, Dan; and a granddaughter.

A scholarship fund has been established in John's name at North Texas State University; checks may be made payable to the North Texas State University Scholarship Fund and sent to the Dallas Amateur Radio Club, P.O. Box 173, Dallas, Texas 75220.

— ham radio

THE MOST AFFORDABLE REPEATER

ALSO HAS THE MOST IMPRESSIVE PERFORMANCE FEATURES

(AND GIVES THEM TO YOU AS STANDARD EQUIPMENT!)

JUST LOOK AT THESE PRICES!

Band	Kit	Wired/Tested
10M,6M,2M,220	$680	$880
440	$780	$980

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

CALL OR WRITE FOR COMPLETE DETAILS.

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

FEATURES:

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

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

HIGH-PERFORMANCE RECEIVER MODULES

R144 Shown

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

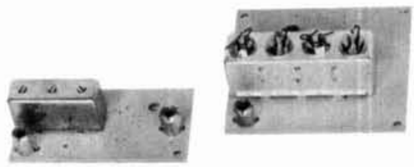
hamtronics®

TRANSMITTERS

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

- **T451 UHF FM EXCITER** 2 to 3 Watts on 450 ham band or adjacent freq. Kit only $78.
- **VHF & UHF LINEAR AMPLIFIERS.** Use on either FM or SSB. Power levels from 10 to 45 Watts to go with exciters & xmtg converters. Several models. Kits from $78.
- **A16 RF TIGHT BOX** Deep drawn alum. case with tight cover and no seams. 7 x 8 x 2 inches. Designed especially for repeaters. $20.

ACCESSORIES



- **HELICAL RESONATOR FILTERS** available separately on pcb w/connectors.

HRF-144	for 143-150 MHz	$38
HRF-220	for 213-233 MHz	$38
HRF-432	for 420-450 MHz	$48

- **COR-2 KIT** With audio mixer, local speaker amplifier, tail & time-out timers. Only $38.
- **COR-3 KIT** as above, but with "courtesy beep". Only $58.
- **CWID KITS** 158 bits, field programmable, clean audio, rugged TTL logic. Kit only $68.
- **DTMF DECODER/CONTROLLER KITS.** Control 2 separate on/off functions with touchtones®, e.g., repeater and autopatch. Use with main or aux. receiver or with Autopatch. Only $90
- **AUTOPATCH KITS.** Provide repeater autopatch, reverse patch, phone line remote control of repeater, secondary control via repeater receiver. Many other features. Only $90. Requires DTMF Module.
- **NEW – SIMPLEX AUTOPATCH** Use with any transceiver. System includes DTMF & Autopatch modules above and new Timing module to provide simplex autopatch and reverse autopatch. Complete patch system only $200/kit. Call or write for details.

NEW LOW-NOISE PREAMPS

Hamtronics Breaks the Price Barrier!

*

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

FEATURES:

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

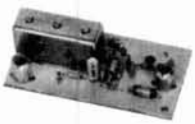
MODEL	TUNES RANGE	PRICE
LNG-28	26-30 MHz	$49
LNG-50	46-56 MHz	$49
LNG-144	137-150 MHz	$49
LNG-220	210-230 MHz	$49
LNG-432	400-470 MHz	$49
LNG-40	30-46 MHz	$64
LNG-160	150-172 MHz	$64

ECONOMY PREAMPS

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

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

HELICAL RESONATOR PREAMPS



Our lab has developed a new line of low-noise receiver preamps with helical resonator filters built in. The combination of a low noise amplifier and the sharp selectivity of a 3 or 4 section helical resonator provides increased sensitivity while reducing intermod and cross-band interference in critical applications. See selectivity curves at right. Gain = approx. 12 dB.

Model	Tuning Range	Price
HRA-144	143-150 MHz	$49
HRA-220	213-233 MHz	$49
HRA-432	420-450 MHz	$59
HRA-( )	150-174MHz	$69
HRA-( )	450-470 MHz	$79

RECEIVING CONVERTERS

Models to cover every practical rf & if range to listen to SSB, FM, ATV, etc. NF = 2 dB or less.

VHF MODELS	Antenna Input Range	Receiver Output
Kit with Case $49	28-32	144-148
Less Case $39	50-52	28-30
Wired $69	50-54	144-148
	144-146	28-30
	145-147	28-30
	144-144.4	27-27.4
	146-148	28-30
	144-148	50-54
	220-222	28-30
	220-224	144-148
	222-226	144-148
	220-224	50-54
	222-224	28-30

UHF MODELS	Antenna Input Range	Receiver Output
Kit with Case $59	432-434	28-30
Less Case $49	435-437	28-30
Wired $75	432-436	144-148
	432-436	50-54
	439.25	61.25

SCANNER CONVERTERS Copy 72-76, 135-144, 240-270, 400-420, or 806-894 MHz bands on any scanner. Wired/tested Only $88.

SAVE A BUNDLE ON VHF FM TRANSCEIVERS!

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

Cabinet Kit, complete with speaker, knobs, connectors, hardware. Only $60.

REPEAT OF A SELLOUT!

While supply lasts, get $60 cabinet kit free when you buy an FM-5 Transceiver kit. Where else can you get a complete transceiver for only $178

TRANSMIT CONVERTERS

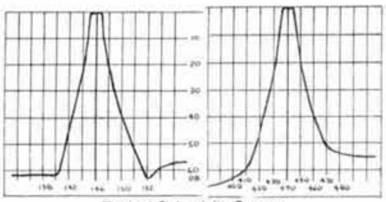
For SSB, CW, ATV, FM, etc. Why pay big bucks for a multi mode rig for each band? Can be linked with receive converters for transceive. 2 Watts output vhf, 1 Watt uhf.

	Exciter Input Range	Antenna Output
For VHF,	28-30	144-146
Model XV2	28-29	145-146
Kit $79	28-30	50-52
Wired $149	27-27.4	144-144.4
(Specify band)	28-30	220-222*
	50-54	220-224
	144-146	50-52
	50-54	144-148
	144-146	28-30
For UHF,	28-30	432-434
Model XV4	28-30	435-437
Kit $99	50-54	432-436
Wired $169	61.25	439.25
	144-148	432-436*

*Add $20 for 2M input

VHF & UHF LINEAR AMPLIFIERS. Use with above. Power levels from 10 to 45 Watts. Several models, kits from $78.

LOOK AT THESE ATTRACTIVE CURVES!



Typical Selectivity Curves of Receivers and Helical Resonators.

IMPORTANT REASONS WHY YOU SHOULD BUY FROM THE VALUE LEADER:

1. *Largest selection of vhf and uhf kits in the world.*
2. *Exceptional quality and low prices due to large volume.*
3. *Fast delivery; most kits shipped same day.*
4. *Complete, professional instruction manuals.*
5. *Prompt factory service available and free phone consultation.*
6. *In business 21 years.*
7. *Sell more repeater modules than all other mfrs. and have for years. Can give quality features for much lower cost.*

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

hamtronics, inc.

65-E MOUL RD. • HILTON NY 14468
Phone: 716-392-9430
Hamtronics ® is a registered trademark

design your own trap antenna

Operate wherever you want with this efficient antenna

Even though the trap antenna seems to be simple, designing one — on paper or by cut-and-try — can be tedious. It's possible, however, to take the tedium out of the process by using a home computer or a programmable calculator. The antenna described in this article should perform acceptably on first use, and should be easy to adjust.

The basic concept underlying the trap vertical, dipole, or beam antenna is simple: the bottom (or half center) section is simply 1/4 wavelength long at the highest frequency. A parallel-resonant trap tuned to this operating frequency effectively isolates the rest of the antenna. On the next lower band, the bottom section will be less than 1/4 wavelength long (physically). This length is electrically extended by the loading coil effect of the below resonance trap (looks like an inductance), and the combination must be brought to 90 degrees effective (electrical) length by a second section of tubing. A trap resonant at this lower frequency can now be added if more bands are needed, or the antenna simply "stopped." Each additional band requires a trap, plus an extended metal section. At low frequencies, a loading coil can also be added to reduce section length.

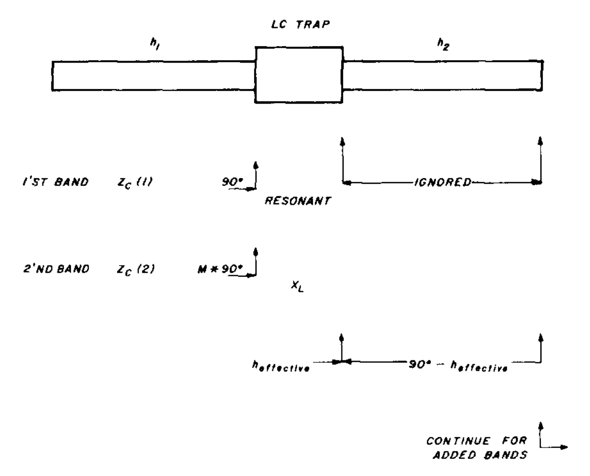


fig. 1. Organized approach to trap antenna design.

The challenge of trap antenna design lies in the fact that conversion from the physical length of sections to electrical length depends on the ratio of section diameter to wave length, so that the values must be recalculated for *each* band. Also, the trap-to-loading coil effect must be redone for each band, with conversion from reactance to effective length also considered. Unless an organized approach is used, it's easy to get lost.

For Amateur Radio purposes, the key to this organized approach is a series of articles by Boyer, W6UIH. The following summarizes the calculation steps involved and the equations used. (For explanations of the individual steps, refer to the Boyer series.)

INPUT the design parameters:

- Number of bands
- Operating frequencies, f_n, (highest first, in order)
- Section diameters, D_n
- Trap capacity or inductance, C_n or L_n

CALCULATE for specified frequencies:

- Trap inductance or capacitance, and reactance, X_n
- Section characteristic impedance, Z_0

CALCULATE by looping:

- Set first section length h to 90 degrees
- Loop for each band and for each trap
- Calculate the wave length = 11808/f inches
- Calculate the section impedance
  $Z_n = 60\ (L_n \cdot \lambda_n / D_n - 1)$
- Calculate the ratio of trap frequency to operating frequency $f_n / f_n' = m$
- Calculate effective section length $h' = mh$
- Calculate normalized trap reactance $X_L' = X_L\ (1/m - m)/Z_n$
- Add reactances $X' = X_L' + X$
- Convert to length $h = tan^{-1}\ X'$
- Determine section length when all traps and sections have been considered.

$S = 90° - h$

By R.P. Haviland, W4MB, 1035 Green Acres Circle, N., Daytona Beach, Florida 32019

```
  10 REM TRAP ANTENNA
  20 FAST
  30 PRINT "ENTER NUMBER OF BAND
S"
  40 INPUT J
  50 DIM F(J)
  60 DIM D(J)
  70 DIM L(J)
  80 DIM C(J)
  90 DIM T(J)
 100 DIM H(J)
 110 DIM Z(J)
 200 PRINT "ENTER TRAP KNOWN,L,C
,OR T IF COAX"
 210 INPUT K$
 220 PRINT "STARTING WITH HIGHES
T BAND,IN        ORDER,ENTER"
 230 FOR N=1 TO J
 240 PRINT AT 6,0;"FREQ ";N,
 250 INPUT F(N)
 260 PRINT F(N),"SECTION DIA ";N
;
 270 INPUT D(N)
 280 PRINT D(N),"TRAP ";N;" L-UH
,C-PF","OR 0 FOR COAX",
 290 INPUT TEMP
 300 IF K$="L" THEN LET L(N)=TEM
P
 310 IF K$="C" THEN LET C(N)=TEM
P
 320 IF K$="T" AND TEMP<>0 THEN
GOTO 280
 330 PRINT TEMP
 335 SCROLL
 336 SCROLL
 337 SCROLL
 338 SCROLL
 339 SCROLL
 340 SCROLL
 350 NEXT N
 360 IF K$<>"T" THEN GOTO 600
 400 REM COAX TRAP
 410 PRINT AT 10,0;"ENTER TRAP D
IA, ONLY 7/8 OR 1.5 (INCH FORM D
IA.USING RG-58 COAX)"
 420 INPUT TRP
 430 FOR N=1 TO J-1
 440 IF TRP=7/8 THEN LET T(N)=13
5.7*F(N)**-0.91
 450 IF TRP=1.5 THEN LET T(N)=68
.9*F(N)**-0.86
 460 IF NOT (TRP=7/8 OR TRP=1.5)
 THEN GOTO 410
 470 LET L(N)=(TRP+0.2)**2*T(N)*
*2/(18*(TRP+0.2)+8*T(N))
 480 NEXT N
 600 REM DO L OR C
 610 FOR N=1 TO J-1
 620 IF K$="L" OR K$="T" THEN LE
T TEMP=2*PI*F(N)*L(N)
 630 IF K$="C" THEN LET TEMP=10*
*6/(2*PI*F(N)*C(N))
 640 IF K$="L" OR K$="T" THEN LE
T C(N)=10**6/(2*PI*F(N)*TEMP)
 650 IF K$="C" THEN LET L(N)=TEM
P/(2*PI*F(N))
 660 NEXT N
 800 REM DO SECTION Z
 810 FOR N=1 TO J
 820 LET TEMP=11808/F(N)
 830 LET Z(N)=60*(LN (TEMP/D(N))
-1)
 840 NEXT N
1000 REM MAIN LOOPS
1005 LET DEG=0
1010 LET H(1)=PI/2
1020 FOR N=2 TO J
1030 FOR P=1 TO N-1
1040 LET M=F(N)/F(P)
1050 LET DEG=DEG+H(P)*M
1060 LET REACT=2*PI*F(P)*L(P)/((
1/M-M)*Z(N))
1070 LET REACT=REACT+TAN DEG
1080 LET DEG=ATN REACT
1090 NEXT P
1100 LET H(N)=PI/2-DEG
1110 LET DEG=0
1120 NEXT N
2000 REM OUTPUT
2010 CLS
2020 PRINT "FREQ DIA LUH CPF HDG
  HIN "
2030 IF K$="T" THEN PRINT AT 0,2
7;" TRNS"
2040 FOR N=1 TO J
2050 PRINT TAB 0;F(N);
2060 PRINT TAB 5;D(N);
2070 PRINT TAB 8;(INT INT (10*L(
N)))/10;
2080 PRINT TAB 13;INT (C(N)+0.5)
;
2090 PRINT TAB 17;(INT (10*H(N)*
180/PI))/10;
2100 LET FACT=0.673*Z(N)**0.053
2110 LET FACT=FACT*11808/F(N)
2120 LET FACT=FACT*H(N)/2/PI
2130 PRINT TAB 22;(INT (10*FACT)
)/10;
2140 IF K$="T" THEN PRINT TAB 28
;(INT (10*T(N)))/10
2150 NEXT N
3000 REM RERUN
3010 PRINT ,,,"FOR RERUN ENTER C
ONT"
3020 STOP
3030 CLS
3040 PRINT "ENTER SECTION NO WIT
H CHANGE"
3050 INPUT N
3060 PRINT "ENTER,DIRECT MODE,QU
ANTITIES/VALUES TO CHANGE, THEN
CONT"
3070 STOP
3080 GOTO 350
4000 REM SAVE
4010 SAVE "TRAP AN█"
4020 GOTO 10
```

fig. 2. Trap antenna program for ZX-81. (For copy of program written for Commodore 64, send SASE to *ham radio*.)

coax can be used for traps

There is a special feature used in the program. This is a routine to calculate the number of turns of RG-58U coaxial cable required to resonate as a trap, as described by Johns, W3JIP,[2] and to calculate the inductance. If other coil diameters are needed, some experimental coils should be constructed and their frequency measured. The number of turns required:

$N = 135.7f^{-0.91}$ on 7/8 inch form
$N = 68.86f^{-0.86}$ on 1.5 inch form

The inductance is calculated from Wheeler's formula,

$$L = \frac{(D + 0.2)^2 N^2}{18 (D + 0.2) + 8N}$$

where the 0.2 is the diameter of RG-58. These relations must all be changed if coax of another diameter and capacity per foot is used.

The final step in the program is conversion of the dimensions and printing the results. The sketch of **fig. 1** should aid in keeping the quantities organized. (In the above equations, a prime is equivalent to changing a subscript).

program listing

The BASIC program for the calculation is given in **fig. 2**. Each section is set off by an REM statement to correspond to the program outline. The program is in Sinclair BASIC, but should run on any common home computer with minor changes. (A version for the Commodore 64 is available from *ham radio*; send SASE.)

```
FREQ DIA LUH CPF HDG  HIN   TRNS
28.5 1   0.6 46  90   94.3  6.4
21.2 1   0.9 60  18.5 26.2  6.4
14.2 1   1.4 86  22.3 47.3  12.1
7.1  1   2.9 169 36.3 155.1 22.7
3.8  1   0   0   35.2 282.2 0

FOR RERUN ENTER CONT
```

fig. 3. Sample run of ZX-81 program for five-band trap antenna using 7/8 inch coax coils.

Fig. 3 shows a sample run. A five-band version using only one-inch tubing would be difficult to build, mechanically, but could be done by using glass-fiber lines for support. A three-band version using two traps is very practical. The writer, as experimental station KK2XJM, uses a six-band version covering 10, 12, 15, 18, 20, and 30 meters.

The main calculation routine is also available for use on the HP 67/97/41 series of calculators.[3]

construction hints

Note that these programs can be used for dipoles by entering wire diameter and by considering that the base section is measured from the center of the dipole to the first trap. When designing antennas using these programs, it is usually best to set the capacitance, since it is most difficult to change. Typical values for dipoles would be 25, 35, 50, and 100 pF for the 10-40 meter traps.

The *ARRL Antenna Handbook* has some hints on construction, and there have been many articles on construction of both integral traps for beams and discrete ones for dipoles. Lately, the author has used only the coaxial trap design for HF. Trap tuning in all cases is by changing coil turn spacing. Sections should be built to allow some length adjustment — about four inches. If necessary, sections can be cut shorter, but the need for this should be rare.

To avoid making up new sections if they must be lengthened, a form of "capacity hat" may be used. This can be two lengths of small tubing clamped to the section to be lengthened at 90 degrees to each other. Tuning is accomplished by moving the "hat" toward or away from the top end of the section. The total length of each added section of tubing should be about twice the added length of section needed.

If the section lengths are excessive, the required lengths can be reduced by using the "capacity hat," a loading coil, or both. To calculate the effect of a loading coil, introduce a dummy frequency, a few percent lower than the value of the next higher band frequency, and use a trap inductance equal to the value of the loading coil contemplated. It will probably be necessary to make several trials to arrive at reasonable values (see sidebar).

Note that these programs are also usable for resonant single-band antennas because the length of these is equivalent to the length of the first section of the trap antenna. Boyer's articles provide information that allows calculating the SWR versus frequency for these trap antennas.

operate both phone/CW

Most trap verticals commercially available require separate settings in order to operate the phone or CW segments of the 40 and 80-meter bands. The following design provides a low VSWR at both sections of each band. Overall length is just under 50 feet.

FREQ	DIA	L-UH	C-PF	H-DEG	H-IN
7.2	1.5	6.5	75	89.9	376
7.025	1.5	6.8	75	1.3	5
3.795	1.5	17.5	100	23.9	191
3.525	1.5	0	0	2.9	25

A more manageable height (38.8 feet) is achieved by using a loading coil for the 3.5 MHz portion:

FREQ	DIA	L-UH	C-PF	H-DEG	H-IN
7.2	1.5	6.5	75	89.9	376
7.025	1.5	6.8	75	1.3	5
6.75	1.5	55.5	10	1.5	7
3.795	1.5	17.5	100	7.8	62
3.525	1.5	0	0	1.4	12

A small further reduction in height can be obtained by changing the section above the last trap to a top hat: the diameter should be about one-half the length of the section. If still further reduction in height is needed, another loading coil could be placed near the top of the 40-meter section.

The trap quality in these designs must be very good. The coil should be about twice the diameter of the section, made of large wire or small tubing, and spaced to give a length about equal to the diameter. The 7.025 MHz trap and the loading coil can be wound as one coil, tapped for the capacitor connection.

These designs have not been tested. Because of the closeness of trap frequencies, expect to do some adjustment after construction.

references

1. Joseph M. Boyer, W6UYH, "The Multi-Band Trap Antenna," *CQ*, February, March, April, May, 1977, pages 26, 51, 46, 22 respectively.
2. Robert H. Johns, W3JIP, "Coaxial Cable Antenna Traps," *QST*, May, 1981, page 15.
3. R.P. Haviland, "Trap Antenna," *HP Library Program 97-04766-2*, Corvallis, Oregon.

ham radio

If you thought you were priced out of the satellite television market, Relax

We've got your System!

World View Electronics has made owning a satellite television receiving system affordable with a choice of products manufactured by the most reputable names in the satellite TVRO industry.

Now you can choose the system that fits your needs and your pocketbook by ordering directly from World View Electronics.

For your convenience, we've packaged five systems together (Systems 1 through 5). Or if you wish, you can mix and match components to your own specifications.

Worried about installation? Relax. Installation is simple because each system we sell includes an installation guide that makes installing your system a breeze.

So call us today. With World View Electronics you don't have to give up quality for price.

Nice Price & Good Advice
1-502-781-6715

World View Electronics

✓ 219

1527 US 31 West Bypass, Bowling Green, KY. 42101

the "smart" frequency counter

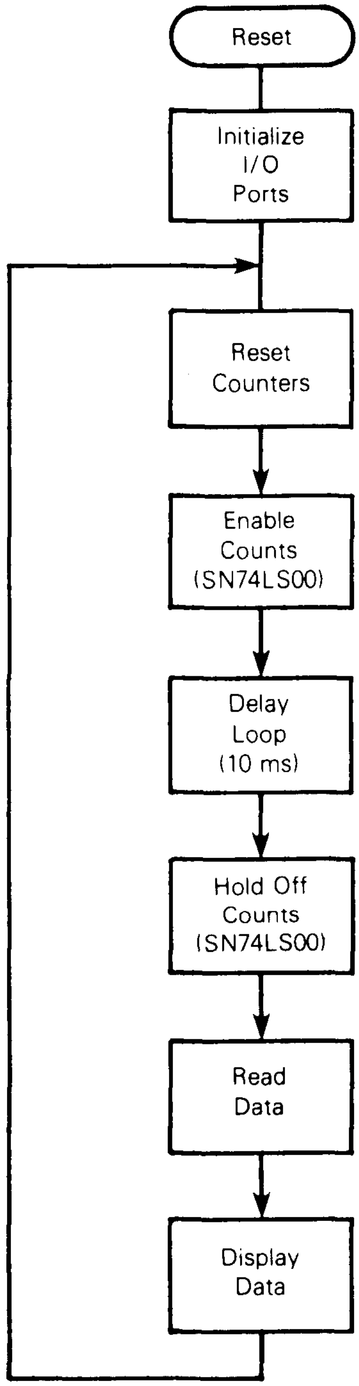


fig. 1. Flowchart for basic frequency counter.

Build a versatile test instrument with digital display and microprocessor control — for less than $50

Digital displays for radios have been around for several years, and most people have grown quite used to their appearance and operation. After purchasing an inexpensive HF transceiver without a digital display, I actually felt a little lost because I had been used to seeing the digits flicker as I tuned across the band. So I decided to add a digital display to my unit that would also function as a normal frequency counter.

This article describes not only how to build a general-purpose microprocessor-controlled frequency counter, but also provides some routines that will allow the counter to be used as a digital display for a radio. In production quantities, this frequency counter could be built for about $10.00 or $15.00. In single quantities, a price of less than $40.00 to $50.00 would be more realistic. A parts list at the end of the article provides prices and quantities required.

In trying to determine the actual operating frequency of a radio, several problems can arise. Depending on the type of radio (single conversion, dual conversion, direct conversion, etc.), different counting methods must be used to determine operating frequency.

It's easiest to provide a digital display for a *direct conversion* type because the actual VFO frequency is the operating frequency. In fact, any frequency counter may be used to measure the operating frequency.

On *single conversion* radios, the frequency to be counted is either the sum or difference of the VFO and HFO. In this configuration, several things must be considered: if selectable sideband operation is required,

By Tim Ahrens, WA5VQK, Motorola MS OE 39, William Cannon at US 290 West, Austin, Texas 78762

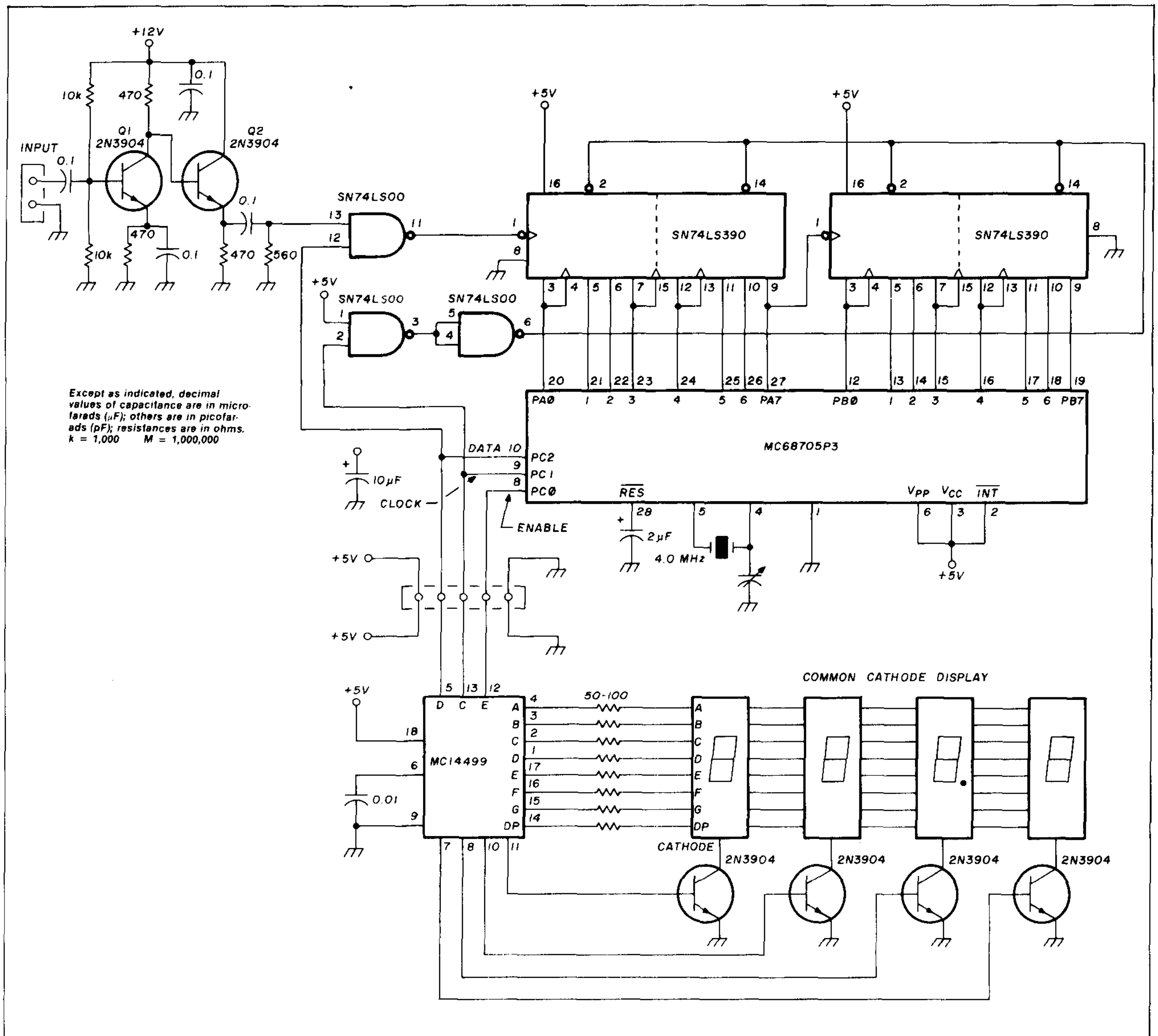


fig. 2. Basic frequency counter schematic.

some provision must be incorporated to allow shifting of the displayed frequency. Generally, this is an additional wafer on the mode switch. Also, in counting the frequency, the MHz may or may not be valid (with respect to the operating frequency), but the 100 kHz (and down) digits would be correct. To provide a correct MHz reading, an additional wafer on the bandswitch is required. One alternative is to read the HFO, read the BFO, and either add or subtract the two, depending upon which is necessary.

On *double conversion* types of radios, the counter must be preset to get the correct frequency, and the mode taken into account. On both the single and double conversion radios, it is obvious that some necessary "smarts" must be incorporated by the counter to make it display the proper frequency. A normal frequency counter could not easily be modified to provide these features; instead, a microprocessor would be an ideal choice for this function.

description

The heart of the counter is the MC68705P3 microprocessor, an EPROM, which means that a user can erase the internal program using ultraviolet light, and reprogram it many times. (In a production-type environment, a mask-programmed part would be used. Mask programming is done as a one-time shot at the factory, and is much less expensive than the EPROM part.)

Programming the EPROM is a simple task that may

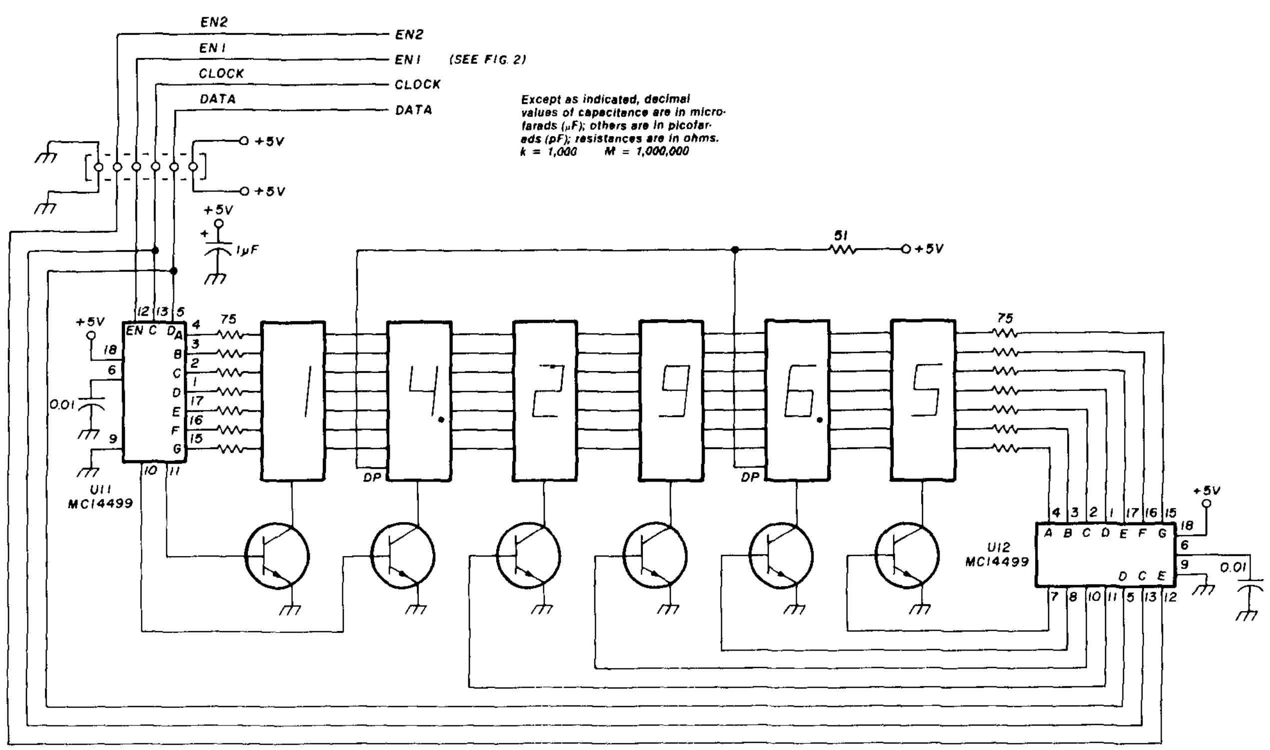


fig. 3. The serial display can be separated from the microprocessor.

be done by anyone; *Motorola's Application Note AN-587* and the accompanying data sheet contain instructions.

operation

Most frequency counters use a high frequency time base, divide it down, and use it to allow a certain number of input pulses to go into some BCD counters. These counters then feed the normal latches and BCD to 7-segment decoder drivers for the display. In the MCU (microcomputer unit) version of the frequency counter, the MCU controls the actual time base generation, latching of data, and driving of an external display. A basic block diagram of the system is shown in **fig. 1**.

The inputted analog signal is conditioned and amplified, which means it's turned into a digital signal that the computer system can use. A two-input NAND gate is fed by both this signal and another generated by the computer. The computer-generated signal actually inhibits the input signal from propagating through the counters. Only by having the capability of turning off the frequency source can an accurate count be made. The output of the gate (NAND) is fed into the BCD counters, which do the actual counting. These counters have a "clear" input on them which allows them to start at a count of 0000. This signal is, of course, controlled by the MCU. After being cleared, the LS390s count until the 10 millisecond period (generated by the MCU) has been completed. At this time, the MCU disables the gate, reads the data in the counters, and sends that information serially to the display drivers.

The most critical component of any frequency counter is the time base, and this device is no different. A 4 MHz crystal is used as the clock for the MCU, which in turn controls the actual 10 millisecond gate period. To adjust the counter, the highest frequency to be counted should be measured by an external frequency counter, and the trimmer capacitor on the crystal should be adjusted to give an identical reading. For further stability, an external temperature compensated oscillator may be used. Do not try to count the time base by measuring one of the crystal pins. Even an extra load of 5 pF is sufficient to shift the time base frequency and degrade the accuracy of the counter.

The basic frequency counter schematic (**fig. 2**) can be easily added to a radio such as the Ten-Tec Argosy. Note that while the MHz display option may be incorporated through the addition of a bandswitch, further cost reductions may be realized by only having four digits displayed, with the MHz being read off the band switch.

reducing computer-generated noise

In any system that uses a computer, some noise is

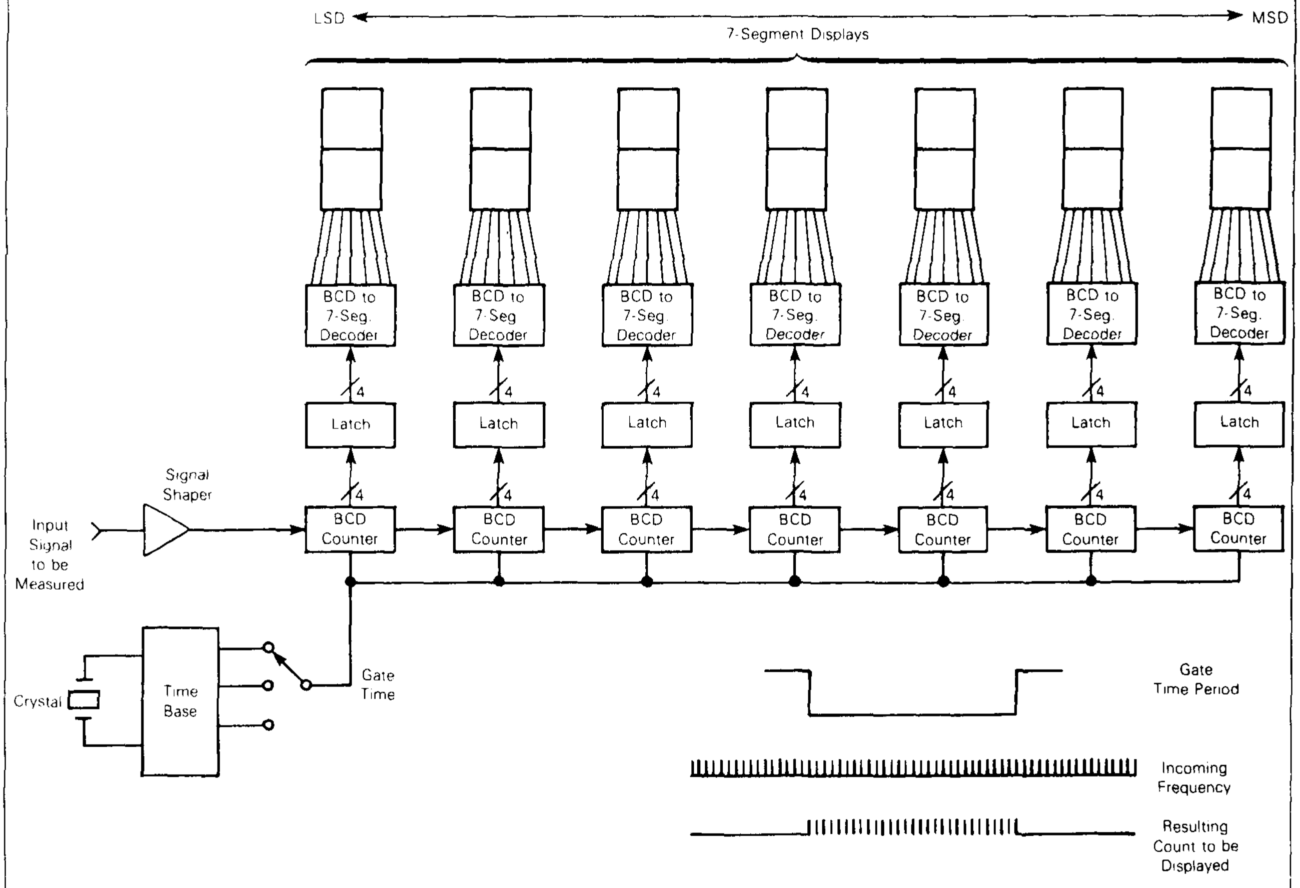


fig. 4. Basic frequency counter block diagram.

generated. Even with an MCU, which has most of the noisy circuitry inside the ceramic package, fast transitions of the I/O lines will cause some RFI. I recommend that any computer used in a radio environment be shielded. This may be done in several ways. One method employs thin PC board or copper flashing to make a box that totally shields the MCU. This cuts down on most noise that may be generated from the computer. This is especially necessary when the computer is of the "wire-wrap" or hand-wire construction.

expandability in a single chip MCU

With the advent of single-chip microcomputers, many new "peripheral" parts (those which do some function external to that of the main computer chip) are being designed to "talk" serially. By sending the data down lines in a serial bit stream, many extra I/O pins may be saved for other functions. That is the name of the game in an MCU environment, because once all I/O lines have been used, sometimes a total re-design of the system is required to get "just one more." A good example of this concept of serial peripherals is shown in the schematic of **fig. 2.**

The display device used, the MC14499, is of this serial variety (saving I/O pins). Each device is capable of driving a total of four seven-segment LEDs, but the first counter example requires only one. In more sophisticated systems, two 499s could be used to provide a total of six digits. The MC14499 is a simple part to use, and the only external components required are eight current limiting resistors (seven for the segments, and one for the decimal point), four transistors, and a small capacitor. This makes for an easy layout, and since the data is sent serially, the display can be remote from the actual MCU. **Fig. 3** shows the display schematic and required hardware.

To re-emphasize the importance of serial-type peripheral devices, consider the number of I/O lines which are required to drive four digits of LEDs. To do this directly, at least sixteen lines are required. This would really be a waste! By using the serial format (data, clock, and enable), only three lines are needed for the first display driver. To add additional drivers, add only one more enable line for each device. The data and clock lines are common.

alternate displays

If an LCD type of display is desired, an MC145000

```
                 *
                        NAM    CNTR
                        OPT    PAG
                 *
0000             PORTA  EQU    $000
0001             PORTB  EQU    $001
0002             PORTC  EQU    $002
                 *
0004             PADDR  EQU    $004
0005             PBDDR  EQU    $005
0006             PCDDR  EQU    $006
                 *
0040             SAVEA  EQU    $040
0041             SAVEB  EQU    $041
0042             TEST   EQU    $042
                 *
0784                    ORG    $784
                 *
0784 07          MOR    FCB    $07          CRYSTAL MODE
                 *
                 * BEGINNING OF CODE
                 *
0080                    ORG    $80
                 *
0080 3F 04       START  CLR    PADDR        ALL INPUTS
0082 3F 05              CLR    PBDDR        HERE TOO
0084 A6 0F              LDA    #$0F         ALL OUTS
0086 B7 06              STA    PCDDR
                 *
0088 12 02       CONTIN BSET   1,PORTC      CLEAR OUT COUNTERS
008A 13 02              BCLR   1,PORTC
                 *
008C 14 02              BSET   2,PORTC      ENABLE COUNTER
                 *
                 * BEGINNING OF TIMING LOOP
                 *
008E A6 ED              LDA    #$ED
0090 9D          LOOP   NOP
0091 9D                 NOP
0092 3A 42              DEC    TEST
0094 3A 42              DEC    TEST
0096 3A 42              DEC    TEST
0098 3C 42              INC    TEST
009A 3C 42              INC    TEST
009C 4A                 DECA
009D 26 F1              BNE    LOOP
                 *
                 * A LITTLE MORE FINE TUNING
                 *
009F 3C 42              INC    TEST
00A1 3C 42              INC    TEST
00A3 3C 42              INC    TEST
00A5 3C 42              INC    TEST
00A7 3C 42              INC    TEST
00A9 9D                 NOP
                 *
                 * FINALLY, ALL COUNTED
                 *
00AA 15 02              BCLR   2,PORTC HOLD OFF ANY MORE COUNTS
                 *
                 * NOW WAITED 10 MS
                 *
00AC B6 00              LDA    PORTA        GET LS DIGITS
00AE B7 40              STA    SAVEA
                 *
00B0 B6 01              LDA    PORTB        GET MS DIITS
00B2 B7 41              STA    SAVEB
                 *
                 * SEND OUT DATA TO DISPLAYS
                 *
00B4 11 02       SNDDTA BCLR   0,PORTC      ENABLE = 0
00B6 12 02              BSET   1,PORTC      CLOCK = 1
                 *
00B8 AE 05              LDX    #$05         NUMBER TO ROTATE
00BA A6 20              LDA    #$20         DECIMAL POINT HERE
00BC AD 0E              BSR    CLOCK1
                 *
00BE B6 41              LDA    SAVEB        GET LSB FIRST
00C0 AD 08              BSR    CLOCK
                 *
00C2 B6 40              LDA    SAVEA        NOW MSB
00C4 AD 04              BSR    CLOCK
                 *
00C6 10 02              BSET   0,PORTC      NOW ENABLE IT
                 *
00C8 20 BE              BRA    CONTIN       CONTINUE COUNTING
                 *
                 *
00CA AE 08       CLOCK  LDX    #$08
00CC 49          CLOCK1 ROLA
00CD 24 0A              BCC    ZERO
00CF 14 02              BSET   2,PORTC
00D1 13 02       CLOCK2 BCLR   1,PORTC      SHIFT IN ONE BIT
00D3 12 02              BSET   1,PORTC
00D5 5A                 DECX
00D6 26 F4              BNE    CLOCK1
00D8 81                 RTS
                 *
00D9 15 02       ZERO   BCLR   2,PORTC      MAKE A ZERO
00DB 20 F4              BRA    CLOCK2       GO CLOCK IT
                 *
                 * RESTART VECTORS
                 *
07F8                    ORG    $7F8
                 *
07F8 00 80       TIMER  FDB    START
07FA 00 80       EXTINT FDB    START
07FC 00 80       SWIINT FDB    START
07FE 00 80       RESET  FDB    START
                 *
                        END
```

fig. 5. Software for the MC68705P3.

may be used to drive a six-digit multiplexed LCD. The data format is a bit different than that of the 14499, but it is also a serial device and quite easy to use.

Several other serial parts — and microcomputers to talk to them — are becoming available. The MC144110 is a 6-bit D to A converter; the MC144102 is a 16 × 16 bit RAM; and the MC145157, 58, and 59 are serially-controlled PLLs. Look for more functions to be available in the future which use this type of data transfer.

The ability to use these serial devices is greatly enhanced by the instruction set of the M6805 family of processors. Through the use of the "Bit Set/Bit Clear" instructions, any I/O pin or RAM bit may be set or cleared with a single instruction. (This is in contrast to other, generally older, microprocessors that need to get the entire 8-bit port into a single register, and then do an appropriate Boolean instruction to set or clear the bit — AND, OR, XOR, etc. The entire word then had to be stored back to that port. This required several instructions and a lot of time to implement.) With true bit-manipulation, any type of serial data transfer is easy; several other instructions also simplify work in a controller environment. The "Branch if bit Set/Branch if bit clear" instruction uses this bit manipulation architecture in a branching situation to do things that depend on what an individual bit's state is.

software

A flow chart of the "simple" 4-digit counter is shown in **fig. 4**, and the actual software for the MC68705P3 is shown in **fig. 5**.

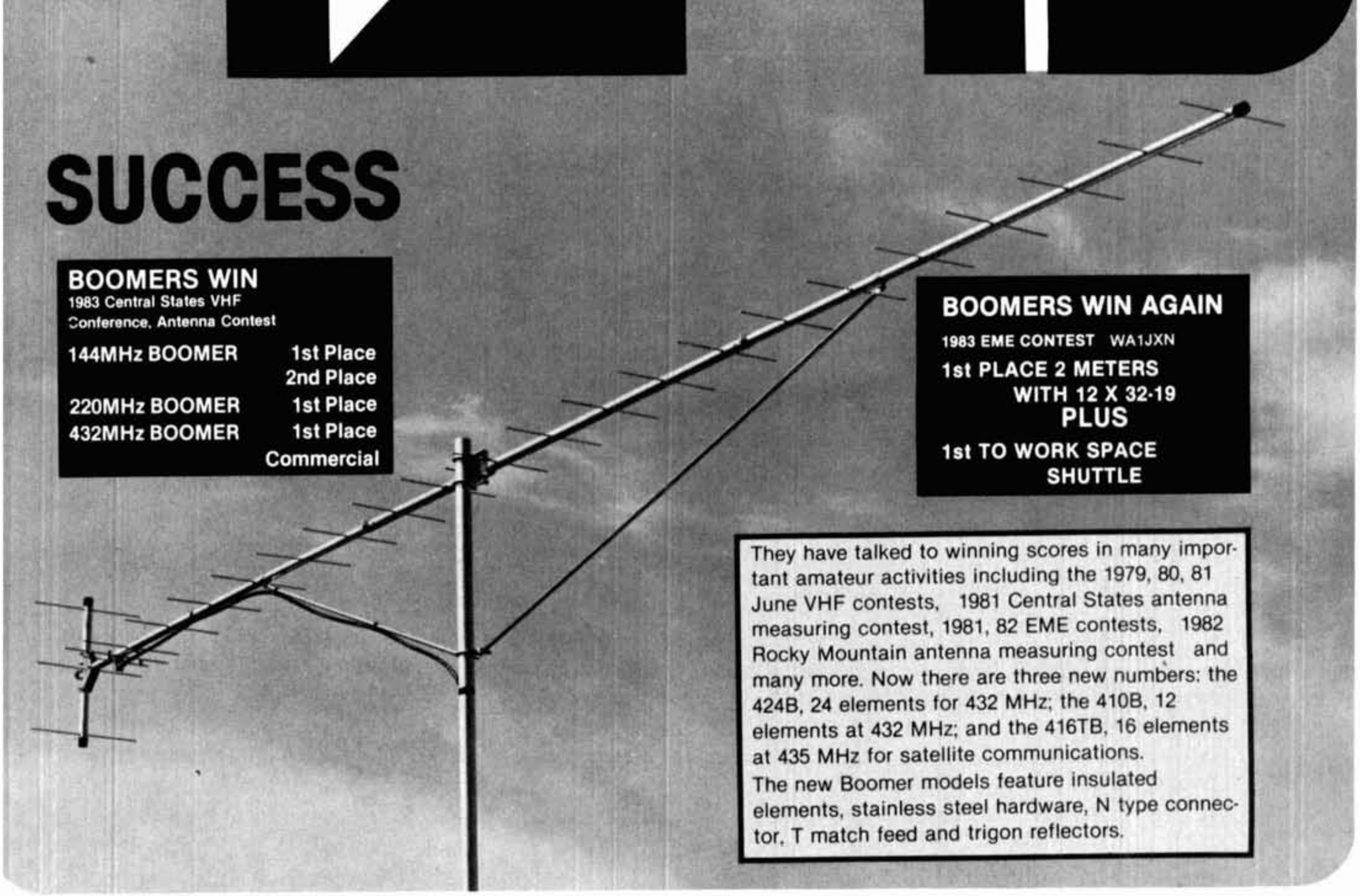
future developments

From the discussion above, it can be seen that increasing the range of the counter is quite simple. Additional counters, prescalers, or other range-extending devices may be implemented. By placing these prescalers in front of the 74LS000 gate, frequencies greater than 1500 MHz may be counted. Or how about a full-function DVM & frequency counter all in one small package? By using the MC68705R3, which also incorporates an 8-bit A to D system on chip, a complete DVM could be implemented with appropriate scaling resistors.

ham radio

Our numbers talk

424B



SUCCESS

BOOMERS WIN
1983 Central States VHF Conference, Antenna Contest

144MHz BOOMER	1st Place
	2nd Place
220MHz BOOMER	1st Place
432MHz BOOMER	1st Place
	Commercial

BOOMERS WIN AGAIN
1983 EME CONTEST WA1JXN
1st PLACE 2 METERS
WITH 12 X 32-19
PLUS
1st TO WORK SPACE SHUTTLE

They have talked to winning scores in many important amateur activities including the 1979, 80, 81 June VHF contests, 1981 Central States antenna measuring contest, 1981, 82 EME contests, 1982 Rocky Mountain antenna measuring contest and many more. Now there are three new numbers: the 424B, 24 elements for 432 MHz; the 410B, 12 elements at 432 MHz; and the 416TB, 16 elements at 435 MHz for satellite communications.
The new Boomer models feature insulated elements, stainless steel hardware, N type connector, T match feed and trigon reflectors.

SPECIFICATIONS AND FEATURES

424B:
424-435 MHz, 7.6λ, gain *maximized, F/B ratio *excellent, beamwidth 19°, length 17.42 ft. 5.2 m.

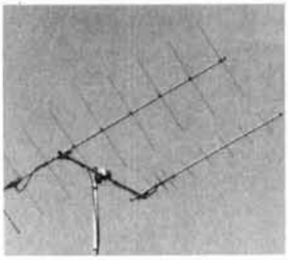
410B:
424-435 MHz, 2.2λ, gain *maximized, F/B ratio *excellent, beamwidth 33°, length 6 ft. 1.83 m.

416TB:
428-438 MHz, Circular Polarization 2.2λ gain *maximized, F/B *excellent, beamwidth 34°, length 6.7 ft. 2.03 m.

MORE BOOMER NUMBERS

32-19	144-146 MHz	19 elements
214B	144-146 MHz	14 elements
214FB	145.5-148 MHz	14 elements
228FB	145.5-148 MHz	28 elements
220B	220-223 MHz	22 elements
617-6B	50-51 MHz	6 elements

*estimated average retail price
*Gain and F/B ratio cannot be published in QST. They are included in Cushcraft specification sheets and other publications.



OSCAR BOOMERS

Enjoy the thrill of OSCAR 10 with a Cushcraft antenna system, featuring the fabulous 416TB BOOMER, giving more performance through better electrical design and superior construction.

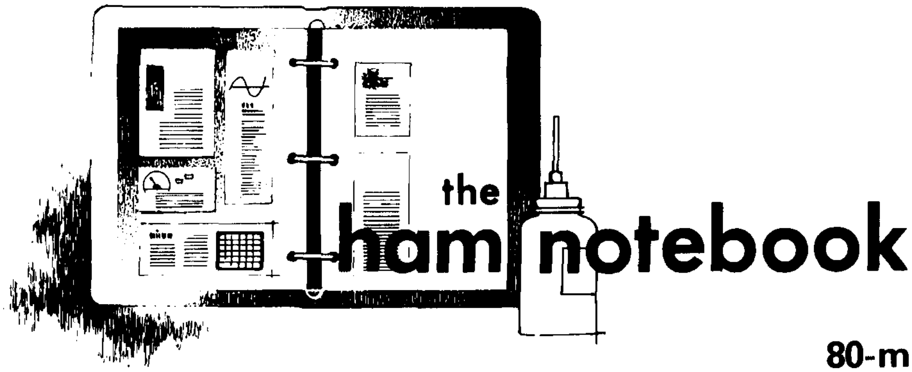
Order a complete package as shown left: 416TB, A144-20T and A14T-MB. For less than $200.00* you'll enjoy the thrill of worldwide OSCAR communications.

A LEADER FOR OVER 30 YEARS

cushcraft CORPORATION

THE ANTENNA COMPANY
48 Perimeter Road, P.O. Box 4680
Manchester, NH 03108 USA

TELEX: 953050
CUSHSIG



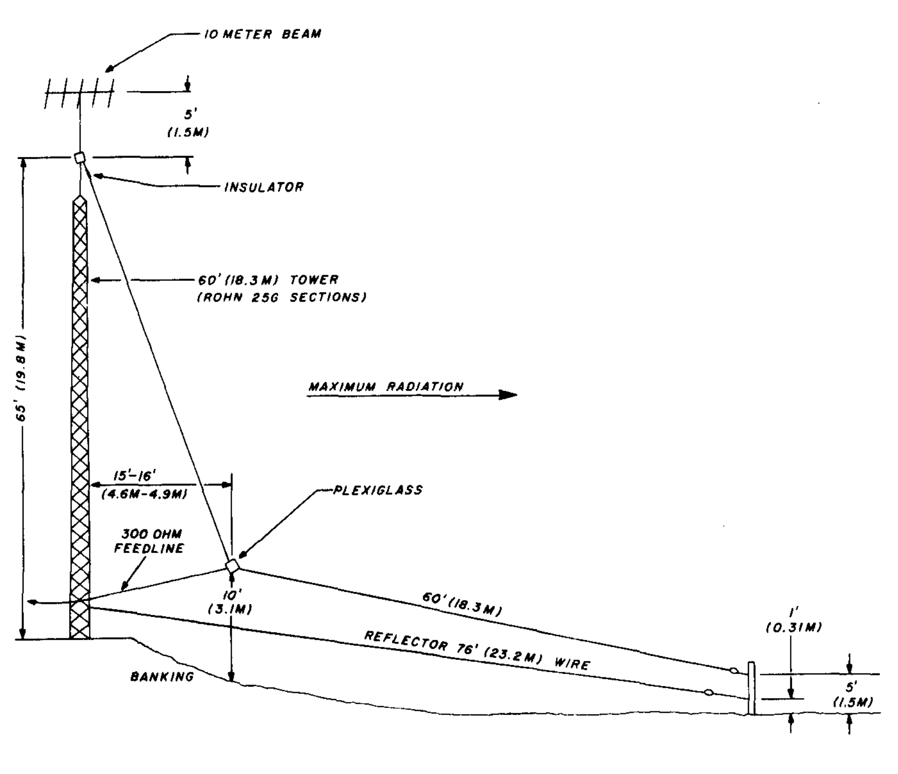


fig. 1. Two element 80 λ parasitic array produces low-angle radiation. (The tower is guyed with Dacron rope. If wire is used, insulate every 15 to 20 feet with egg strain insulators.)

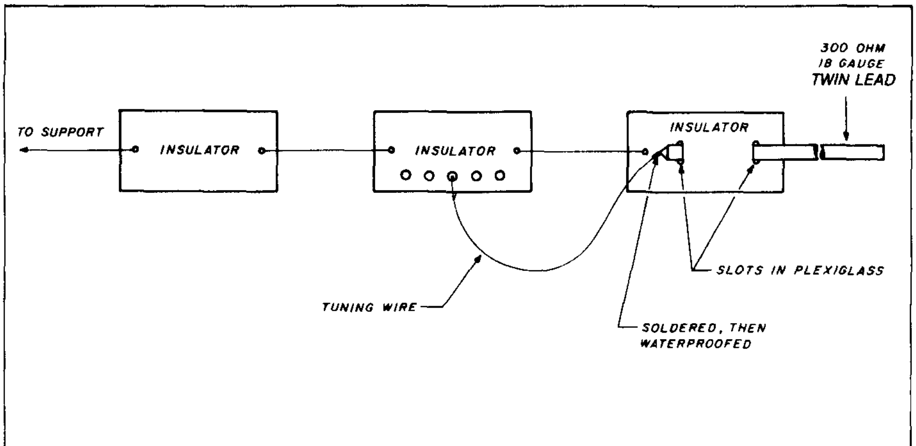


fig. 2. Fine length adjustment for resonance uses single tuning wire at antenna ends.

80-meter half-wave sloper uses reflector

This antenna was the result of a desire to work 80-meter DX running low power. Many excellent reports have been received, including long path to VK, ZL, and JA.

The antenna, basically a dog-legged, 1/2-wave sloper, uses a full-length reflector (**fig. 1**). The reflector is the tower plus enough wire hooked to the base and extended out under the sloper to give a full-length (1/2 plus 10 percent) reflector. The driven element is a folded dipole which can be fed with 300-ohm feedline or used 50-ohm line when a 4:1 balun is inserted (I used the 300-ohm feedline). Because the amount of doglegging affects the feed impedance, it should be adjusted for minimum SWR. (The closer the antenna is to the tower, the lower the impedance). I used 18 gauge 300-ohm ribbon for QRP; later, when I ran 800 watts, no heating was noted. 18 gauge can easily handle 2 amperes, or 1200 watts at 300 ohms; open wire 300-ohm line is a better choice if available. The dog-legging causes the pattern to "squint" in the direction of the dipole. I estimate the gain (over a dipole) to be 4 to 6 dB. The angle is low enough to produce good long path results. (The author has been able to consistently contact VK6LK-Robin almost throughout the entire year — **Ed.**)

Use very good end insulators for the driven element to prevent arc-over or leakage. Plexiglas (1/4-inch thick) works very well and is easy to obtain as scraps from manufacturers or others working with it. With the feedline connected to the physical center of the antenna, the portion of the dipole toward the tower may have to be shortened 6 to 15 inches in order to maintain electrical symmetry. The end of the folded dipole is connected to a single wire to facilitate tuning (see **fig. 2**). Last but not least, use a rope and pulley to connect it to the top of your tower unless you really like to climb.

Bruce Clark, KO1F

Argonaut 509 conversion for 30 meters

As declining HF propagation renders the 10-meter band less of a dependable mainstay for the QRP operator, the new allocation at 10 MHz is coming into its own for this mode of activity. The operating restrictions imposed upon 30 meters actually help rather than hinder QRP operation.

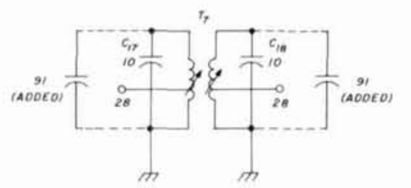


fig. 1. Modification of the Argonaut Model 509 transmitter section only requires adding two capacitors to the T7 tuned circuit on the 80262 board.

The Ten-Tec Argonaut 509 may easily be modified to cover 30 meters with the same performance found on its five bands. All that is required for the modification is five minutes of time, four components, and a jumper wire.

Ten-Tec uses a 9-MHz IF with appropriate VFO frequencies. On 10 meters, the VFO ranges from 19 to 21 MHz. If we use the difference mixer product, rather than the sum, as in the original design, output occurs on 10 MHz rather than 28 MHz. Since the 509's transmitter stages are broadband amplifiers, the only changes required for 10 MHz transmit are to re-resonate the appropriate bandpass filter, composed of T7 and capacitors C17 and C18 on the 80262 front-end board (see **fig. 1**). Shunt C17 and C18 each with an additional 91 pF of capacitance. Depending upon component tolerances, retweaking T7 cores may be necessary for adequate output. The addition of the two 91-pF capacitors completes transmitter modification.

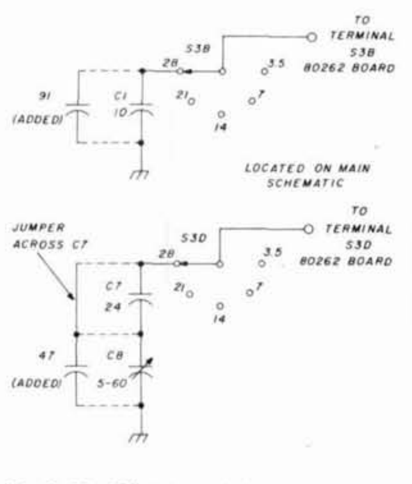


fig. 2. Modification of the receiver section of the Argonaut 509 requires minor additions to components switched by S3B and S3D.

The receiver will function with much reduced performance without modification by turning the receive preselector completely counterclockwise, as mentioned in the 509 manual for WWV reception. To improve 10 MHz performance the receiver front end needs additional capacitance.

C1, on the main schematic, is switched across T1 to resonate at the desired band. For our purposes, C1 needs to be shunted with another capacitor, again of 91 pF, as seen in **fig. 2**. T2, on the other end of the RF amplifier front end, must also be resonated at 10 MHz. Shorting C7 with a piece of tinned bus wire and parallelling variable C8 with an additional 47 pF completes our modification.

The modification is simple and quick. Lifting one end of each added component easily restores 10-meter operation when the sunspot activity increases.

Modification of the newer Model 515 is identical. The rig that began it all, the 505, is not broadbanded on transmit.

Raymond Henry, AA4LL

audio oscillator to pulse generator conversion

Here is a quick, simple method for converting an audio oscillator into a pulse generator that has served well on bench digital projects. (See **fig. 1**.)

To cover the full range from 10 Hz to 1 MHz, C1 and R1 may be either fixed in values with C1 from 0.1 to 0.001 μF and R1 from 10 k to 1 megohm, or C1 fixed at 0.1 and a 1 megohm pot used for R1. The drive input from the oscillator should be 1.5 to 3.5-volts rms if Q1 is a 2N2222 and a 0.75-volt rms if Q1 is an MPF6515.

The pulse width is directly related to the oscillator frequency, with the narrowest being 0.6 μs. For applications requiring fast pulse triggers, the similar circuit using Q2 and the unused two sections of IC1 will provide a fine 1 μs pulse with polarity selected from the IC1 outputs as shown.

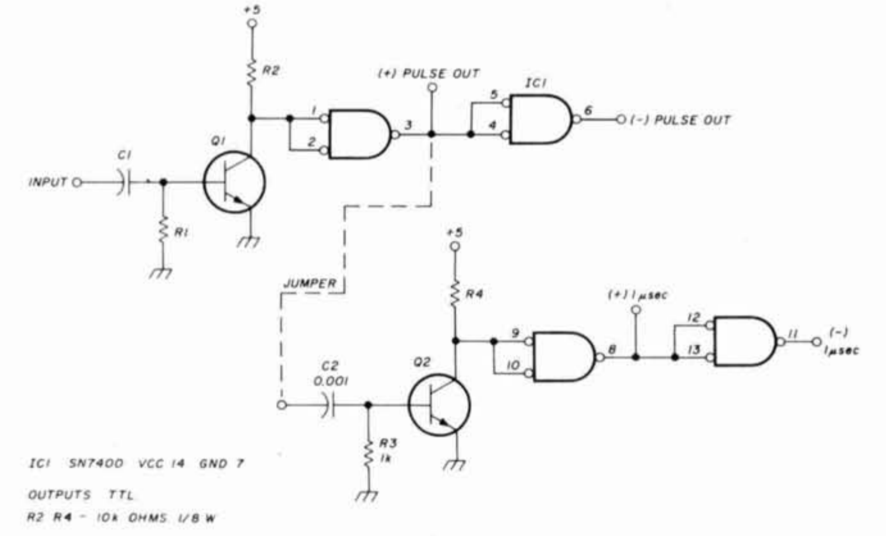


fig. 1. Audio oscillator conversion schematic.

Assembly can be accomplished on a piece of perf board with direct pin wiring in about 30 minutes.

Gene Shapiro, WØDLQ

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

Ham MasterTapes™

THE N2NY HAM RADIO COURSE ON VIDEOTAPE

PRESENTS: THE ONLY HAM RADIO COURSE ON VIDEOTAPE

Ham MasterTapes brings the best possible personalized Ham Radio license preparation right into your own living room. If you, a friend or family member wants the best help available to get past the FCC test hurdle, it's available now in Beta or VHS home video format.

Larry Horne, N2NY brings his 33 years of Ham Radio teaching experience right to your home. Each of the 26 video lessons has close-up details of components and systems along with superb graphic drawings. Each lesson has important points superimposed over the action and reviewed at the end of each section. This makes note-taking a snap! Miss something? Didn't get it the first time? Just back up the tape and run it again or freeze-frame it for detailed close-up study!

Larry's classroom is a real ham shack. Lee, a 13-year-old boy, and Virginia are led through the learning process. The questions that they ask are the ones Larry knows you would ask if you were there in person. You soon feel like you're part of an ideal small class.

The topics covered will not only get you through the Novice test— General class theory is covered also. By the time you get your Novice license, you will be able to upgrade to General or Technician!

Larry's technique of involving the viewer with the demonstrations makes the most difficult topics easy to understand. Understanding—not mere memorization—is what makes Ham MasterTapes so effective. When you study the 700 possible FCC questions, the answers will be obvious.

Larry doesn't stop with just test-passing. All the proper techniques of operating practices and courtesy are demonstrated. The instruction manual for that new rig won't be a mystery! Larry becomes your own personal instructor to help you on that first set-up and contact!

The Ham MasterTapes series is produced in one of New York City's top commercial studios. Not only is the production crew made up of real professionals but many of them are also licensed amateurs. Everybody puts in obvious extra effort to make the production a classic.

The 6-hour course is available on three 2-hour Beta II or VHS-SP cartridges for $199.95, for individual, home or nonprofit Ham Club use. (High schools or colleges must order our Scholastic licensed version, $499.95 for Beta or VHS and $750 for 3/4" U-matic.)

To order, call or write Larry Horne, N2NY at Ham MasterTapes, 136 East 31st Street, New York NY 10016. Phone 212-685-7844 or 673-0680. MasterCard and Visa accepted. New York state residents add appropriate sales tax.

↙ 151

SOME OF THE TOPICS COVERED INCLUDE

AMPLITUDE MODULATION
DOUBLE SIDEBAND
SINGLE SIDEBAND
FREQUENCY MODULATION
PHASE MODULATION
SIDEBANDS
BANDWIDTH LIMITS
ENVELOPE
DEVIATION
OVERMODULATION
SCATTER
FREQUENCY TRANSLATION
ANTENNAS AND FEEDLINES
YAGI ANTENNAS
QUAD ANTENNAS
POLARIZATION
FEEDPOINT IMPEDANCE
HALF-WAVE DIPOLE
QUARTER-WAVE VERTICAL
RADIATION PATTERNS
DIRECTIVITY
MAJOR LOBES
CHARACTERISTIC IMPEDANCE
STANDING WAVES
ATTENUATION
ANTENNA-FEEDING MISMATCH
STATION ID
CALL SIGNS
LOGGING REQUIREMENTS
POWER LIMITATION
CONTROL OP REQUIREMENTS
R-S-T REPORTING SYSTEM
TELEGRAPHY SPEED
ZERO-BEATING SIGNAL
TRANSMITTER TUNE-UP
TELEGRAPHY ABBREVIATIONS
RADIO WAVE PROPAGATION
SKY WAVE AND SKIP
GROUND WAVE
HARMONIC INTERFERENCE
SWR READINGS
SIGNALS AND EMISSIONS
BACKWAVE
KEY CLICKS-CHIRPS
SUPERIMPOSED HUM
SPURIOUS EMISSIONS
COMPUTERS
OSCAR
ATV-SSTV
OPERATING COURTESY
RULES AND REGULATIONS
OPERATING PROCEDURES
RADIO WAVE PROPAGATION
AMATEUR RADIO PRACTICE
ELECTRICAL PRINCIPLES
CIRCUIT COMPONENTS
PRACTICAL CIRCUITS
SIGNALS AND EMISSIONS
RADIO WAVE PROPAGATION
EMERGENCY COMMUNICATIONS
TRANSMITTER POWER LIMITS
STATION-ID REQUIREMENTS
THIRD-PARTY PARTICIPATION
FREQUENCY BANDS
SELECTION OF FREQUENCIES
R.C. MODELS
PROHIBITED PRACTICES
RADIOTELEPHONY
RADIO TELEPRINTING
REPEATERS
VOX TRANSMITTER CONTROL
BREAK-IN TELEGRAPHY
ANTENNA ORIENTATION
INTERNATIONAL COMMUNICATION
EMERGENCY-PREP DRILLS
IONOSPHERIC LAYERS D-E-F
MAXIMUM USEABLE FREQUENCY
IONOSPHERIC DISTURBANCES
SUNSPOTS
SCATTER, DUCTING
LINE-OF-SIGHT
TROPOSPHERIC BENDING
SAFETY PRECAUTIONS
TRANSMITTER PERFORMANCE
TWO-TONE TEST
NEUTRALIZING AMPLIFIERS
POWER MEASUREMENT
TEST EQUIPMENT
OSCILLOSCOPES
MULTIMETERS
SIGNAL GENERATORS
SIGNAL TRACERS
AUDIO RECTIFICATION
REFLECTOMETERS - SWR
SPEECH PROCESSORS
ANTENNA-TUNING UNITS
S-METERS
WATTMETERS
IMPEDANCE
RESISTANCE
REACTANCE
INDUCTANCE
CAPACITANCE
IMPEDANCE MATCHING
OHM'S LAW
AMPS AND VOLTS DIVIDERS
POWER CALCULATIONS
SERIES AND PARALLEL
FILTERS

Ham MasterTapes T.M.

THE N2NY HAM RADIO COURSE ON VIDEOTAPE

136 East 31st Street
New York, New York 10016
(212) 685-7844 • 673-0680

VHF/UHF WORLD

Joe Reisert W1JR

VHF/UHF frequency calibration

Have you ever wondered whether you're really on frequency — especially when you don't hear the station you're scheduling? This is a constant problem for the VHF/UHFer, especially during meteor scatter or EME schedules. Because the focus of this issue is on test equipment, I thought it would be a good time to discuss frequency accuracy and offer some advice on accurately determining frequency. Then I'll describe a secondary frequency standard or calibrator you can build to satisfy most of the needs and pretty much guarantee that you're at least on the frequency you think you're on!

frequency determination

There are several ways to determine frequency. You can:

- read the frequency indicator on the gear in use;
- trust the frequency of the crystal in your up or down converter;
- have a reliable friend measure your transmitted frequency;
- buy or build a good frequency counter; or
- build or buy a good secondary frequency reference standard.

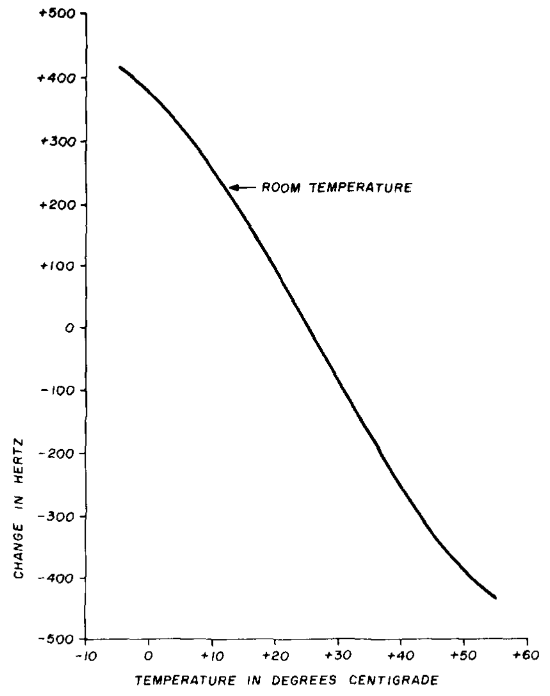


fig. 1. Typical frequency drift versus temperature for a 48-MHz overtone oscillator.

All of the above methods have advantages and disadvantages. While you may laugh at the thought of just reading your dial or frequency indicator, some modern commercial gear transmits CW at an offset frequency that may not be directly indicated.

Recently I tested one of the latest state-of-the-art VHF/UHF multi-mode transceivers complete with a built-in digital frequency readout. To my amazement, the frequency indicated was off by almost 1 kHz in the first 15 minutes; even after an hour the frequency indicated on UHF was off by over 0.5 kHz — admittedly not a serious problem, but one worth examining if frequency accuracy would affect the success of a QSO or the accuracy of measuring someone else's transmitted frequency.

crystal oscillators are used everywhere

All modern converters or transverters use crystal oscillators in one form or other. However, if 1.0 kHz accuracy is required at UHF, the cost of a crystal is prohibitive. Furthermore, the accuracy of the oscillator is also a function of the oscillator circuit and the temperature of the crystal. Some designs use small trimmers to tweak the frequency to the marking on the crystal, but this can have disastrous effects on phase noise, not to mention decreased temperature stability or drift.[1]

All crystals, regardless of price, suffer from a problem called "aging." This means that a crystal will always be drifting slightly away from its marked frequency even after it has been burned in for a predetermined time. (The typical commercial standard is full power for 30 days.)

Suppose a friend measured your

transmitted frequency. Did he or she tune you in properly on SSB? on CW? Was he or she at true zero-beat? Even if the measurement is accurate, how do you account for local ambient temperature changes, aging or drift and component changes in your own gear at a later time and date? How long does it take to properly warm up your gear?

Frequency counters are great, but until recently they were beyond the reach of most Amateurs. Several are now available, but suitable ones use a reference standard and a proportional control oven that takes time to stabilize — perhaps 15-30 minutes — and usually cost about as much as a typical multi-mode transceiver! Furthermore, frequency counters that read higher than 600 MHz are even more expensive.

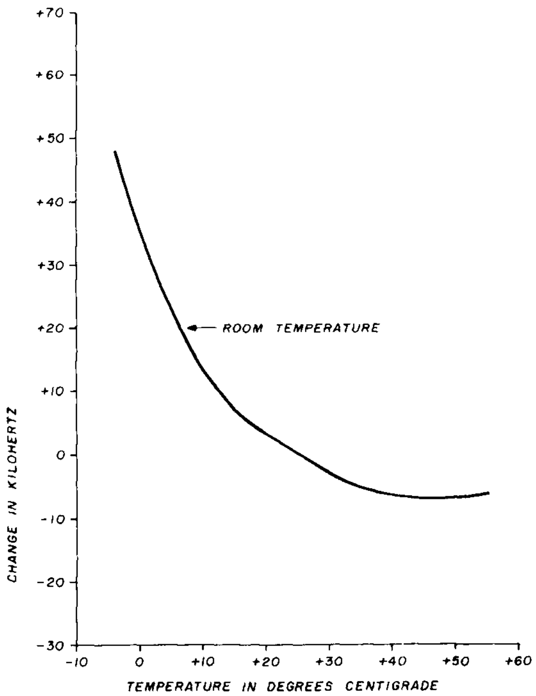


fig. 2. Typical frequency drift versus temperature for a 1.000 MHz secondary frequency standard.

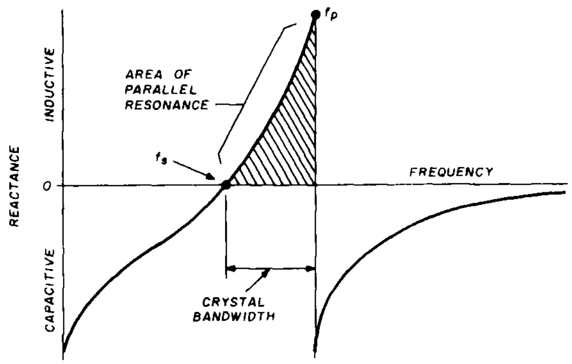


fig. 3. Typical impedance versus frequency variation for a quartz crystal operating in the fundamental mode. "f_s" is the series resonant frequency and "f_p" is the parallel or antiresonant frequency. The typical bandwidth is 5-10 kHz at 4.000 MHz. The parallel resonant frequency can be varied by the use of an external capacitor in series or parallel with the crystal.

there is another way

A good method that seems to have been almost forgotten by the users of modern rigs is the secondary frequency standard or crystal calibrator. If one is available with a comb generator (a device which generates many harmonics of the input frequency), it can be used up through UHF with surprising accuracy.[2]

After evaluating all these alternatives to accurate frequency determination at VHF/UHF frequencies, I decided many years ago that the least expensive and most accurate way to measure my frequency was to build a secondary frequency standard. Before designing one, I listed the features I wanted to include:

- convenient marker frequency in each VHF/UHF band above 6 meters
- good short and long-term stability, 1 to 2 parts per hundred million (0.01-0.02 ppm)
- easy adjustability to the correct frequency
- high harmonic output through 2304 MHz
- battery operation
- fast warmup
- reasonable size, including built-in antenna
- easy construction
- low cost

This is indeed quite a "wish list!" However, after some trial-and-error (over a period of 15 years) such a unit has evolved.

The most important consideration for a secondary standard is crystal stability. First, I tried a third-overtone 48-MHz crystal oscillator. Harmonics were no problem, but stability, the very property I wanted to measure, was no better than the local oscillators in my receiver or transmitter — about 3 to 4 parts in 10 million per degree Centigrade (**fig. 1**). Also, the only usable harmonics were on 144, 432, and 1296 MHz.

Next, a 1.000-MHz calibrator was tried, but proved quite unsatisfactory for several reasons.[2] First, it is difficult to produce sufficient harmonics to reach the lower UHF bands. After all, for 70 cm (432 MHz), that is the 432nd harmonic! Second, and more important, the frequency stability of a good 1-MHz crystal versus temperature is quite poor. I measured such a unit at typically 500 to 600 parts per million per degree Centigrade (see **fig. 2**).

After discussing this with crystal manufacturers I discovered that reasonably priced, stable crystals and oscillators can be designed and built without an oven if you choose an "AT" cut fundamental crystal in the 3 to 10 MHz region (more on this later). 4 MHz was chosen because harmonics would be present on all of the VHF bands above 6 meters, lending itself to easy calibration with WWV on a 20-MHz HF receiver. Later I built a 5-MHz unit to be used on 6 meters and other multiples of 5 MHz.

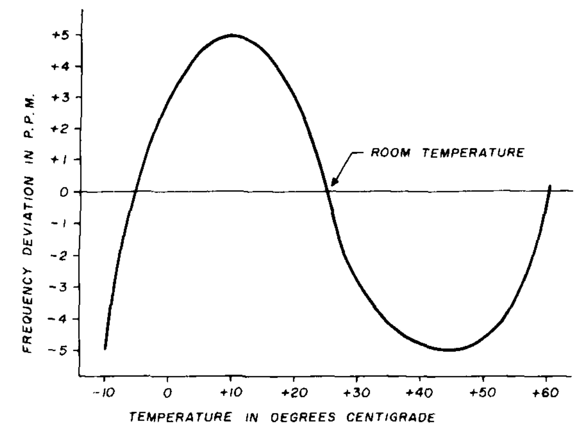


fig. 4. Typical frequency drift versus temperature for an "AT" cut high-accuracy crystal at 4.000 MHz.

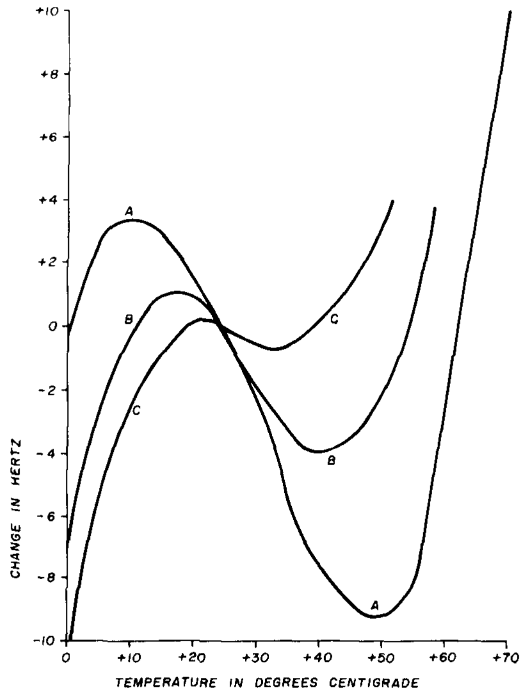
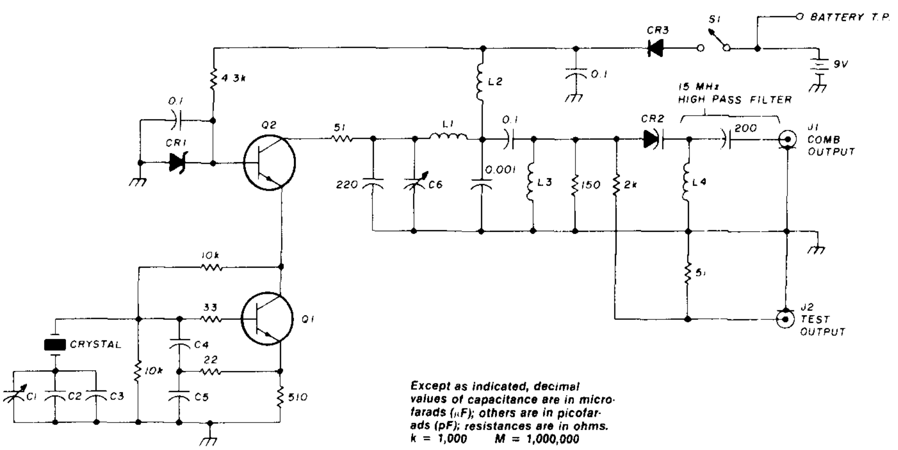


fig. 5. Frequency versus temperature variation of the 4.000 MHz calibrator in fig. 6. For various amounts of temperature compensation "A" is undercompensated while "B" and "C" are optimum versus desired temperature range, toward either cold or hot.

the circuit you choose is important

Crystals are usually classified as either fundamental or overtone. Because of cost and stability constraints, fundamental crystals are usually used below and overtones above 22 MHz. Each fundamental crystal has two basic resonances, a series and a parallel or anti-resonance. The series resonant frequency is typically a few kHz below the parallel resonant frequency and is very difficult to externally move or adjust. However, the parallel mode resonant frequency can be easily adjusted by placing a capacitor either in parallel or series with the crystal. These characteristics are shown in **fig. 3**. A parallel mode oscillator was chosen for this reason. The Pierce oscillator circuit was first used because it is reputed to be the most stable, but the parasitics of the active device in the oscillator are prominent. Therefore, a modified Colpitts oscillator circuit was later chosen because it was only slightly less stable than the Pierce oscillator, but more easily adjustable, and uses swamping capacitors to minimize the parasitics of the active device.

"AT" cut crystals have a known frequency versus temperature characteristic that is "S" shaped (**fig. 4**). Hoff has pointed out that if you want to operate only over a small temperature range such as experienced in most ham shacks, the frequency change is



item	description
C1	1-10 pF air variable capacitor. Johanson 5200 series or equivalent
C2,C3	10 pF N750 ceramic disc capacitor (see text)
C4,C5	390 pF NPO ceramic disc capacitor (see text)
C6	5-50 pF small ceramic or mylar variable capacitor
CR1	4.7 volt zener diode. 1N750 or equivalent
CR2	SRD, Microwave Associates No. MA44310, Hewlett-Packard No. 5082-0180, or equivalent (see text)
CR3	light emitting diode
J1,J2	BNC chassis mounted connector
L1	6.8 μH RF choke
L2,L3	27 μH RF choke
L4	0.47 μH RF choke
Q1,Q2	2N2222 transistor
S1	small toggle switch
crystal	4.000 MHz parallel mode 20 pF crystal (see text)

fig. 6. Schematic diagram for a 4.000 MHz secondary frequency standard.

quite linear and can be decreased over a small temperature range (perhaps 10 to 40 degrees Centigrade) by simply placing a temperature compensating capacitor in series or parallel with the crystal.[3]

Indeed, this is what I did. First an NPO (which has close to zero temperature drift) temperature compensating ceramic disc capacitor (in parallel with a tweaking capacitor) was placed in series with the crystal in an oscillator. Then the frequency versus temperature was measured in a laboratory oven in 5-degree Centigrade steps and the frequency was remotely measured with a good frequency counter having a proportional control oven. The NPO capacitor was then replaced with various combinations of 10 pF N750 type temperature compensating ceramic disc capacitors and data taken again. It soon became obvious that the temperature drift could be minimized by the right choice of temperature compensation. This is illustrated in **fig. 5** for a typical 4.000-MHz crystal oscillator.

now for those harmonics

Now that I had the oscillator working, I tried various schemes to generate a comb of harmonics. Integrated circuits were discarded because they required considerable current and did not extend high enough in frequency. Tunnel diodes were also tried but did not meet the UHF harmonic requirements.[2]

SRDs (step recovery diodes), properly chosen, fit the desired requirements. Furthermore, if used in the proper circuit, they required low RF drive and could generate power through 2304 MHz. Oscillator-multiplier isolation is required so that frequency stability or calibration is not affected by the multiplier or output circuitry. This was accomplished by using a separate amplifier or buffer stage between the oscillator and multiplier.

values are now chosen

Several solid-state devices and circuit configurations were tried. JFETs and MOSFETs were eventually discarded in favor of bipolar transistors since the variation from unit to unit necessitated additional tweaking for proper bias and compensation. An oscillator-amplifier approach was used in the first few calibrators but eventually replaced by a cascade bipolar transistor circuit that provided the required oscillator to multiplier isolation with low power consumption and could be powered by a 9-volt transistor radio type battery.

A schematic of the final circuit is shown in **fig. 6**. The modified Colpitts oscillator uses a bipolar transistor, Q1. The trimmer, C1, should be a high quality air dielectric variable with a multi-turn fine adjustment screw. C2 and C3 are the temperature compensating disc ceramic capacitors. The typical oscillator required 20 pF N750 capacitors and in the extreme case required 20 pF N1500 compensation. The feedback capacitors, C4 and C5, should be NPO-type ceramic disc capacitors. Do not use silver mica capacitors here; they have a positive temperature coefficient that will increase the drift!

Crystal specification is most important. Beware of bargain basement or computer-type crystals. They may be specified for series resonance or have a poor temperature coefficient, which will make it nearly impossible to tune or compensate the calibrator at the desired frequency. International Crystals* sells a "HA" (high accuracy) crystal that should meet the requirements. The price may be higher than you're used to paying for a crystal, but because you'll probably use this secondary reference standard for many years the crystal will pay for itself many times over. Remember to specify the crystal as *parallel* resonant with 20 pF of capacitance. The temperature tolerance should be ±0.0005 percent from −30 to 60 degrees Centigrade. The calibration tolerance can be ±0.0025 percent. Over-specifying the actual calibration frequency is a waste of money because the trimmer will adjust you precisely to zero-beat.

*International Crystals, P.O. Box 26330, Oklahoma City, Oklahoma 73126.

reducing supply voltage dependency

A recent addition to the circuit was a zener diode in the amplifier stage. This provides a good reference voltage to the oscillator over a wide battery voltage range with very little extra power consumption. A standard 9-volt transistor radio type of battery, preferably the longer life type, is all that is required because the current drain is typically 4 to 5 milliamperes. Another recent innovation is the LED (light emitting diode) in series with the battery. This provides a low-power indicator to remind you to turn off the calibrator when not in use. A battery test point is also provided so that you won't have to open the box to measure the battery voltage.

The multiplier circuit also evolved over the years. A simple pi-network matches the amplifier output to the SRD. The SRD chosen should be of the long lifetime type, typically 100 nanoseconds minimum, since 4 MHz is a very low input frequency for many SRD's. Other types of diodes will probably not work well. C6 peaks the circuit, which matches the amplifier to the SRD. The output of the SRD passes through a 15 MHz high-pass filter, suppressing the fundamental frequency of the comb output. Therefore a calibrator output circuit was added in case you desire to measure frequency directly (such as with a frequency counter) at 4.000 MHz. The typical comb generator output power versus frequency curve is shown in **fig. 7**.

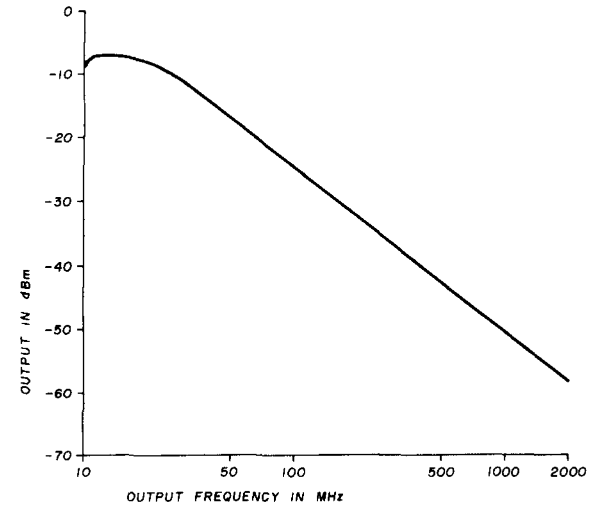


fig. 7. Typical output power versus frequency from a secondary frequency standard comb generator.

construction

The entire circuit including battery can be built *on the cover* of a Pomona model 2901 or equivalent cast box. First a double-clad printed circuit board about 1-7/8 × 3 inches (48 × 76 mm) is attached to the cover of the box and held in place by the output connectors, switch, trimming capacitor, and LED. A suitable battery clip is mounted on the remaining available space on the box cover. Two insulated standoff terminals are used to hold the crystal leads and associated temperature compensation capacitors. The wiring is done point-to-point in space, as suggested in previous articles.[1]

initial testing and calibration

If you don't want to go through the temperature calibration procedure described, just use 10 pF N750 capacitors for C2 and C3 and you should be very close. A small 2-meter quarter-wave pull-up type whip makes a suitable radiating antenna for the entire spectrum of interest. The calibrator is now ready for testing. This can be easily done by listening for the 7th harmonic on a 28-MHz HF receiver (the signal may not be strong at this frequency) or the 36th harmonic at 144 MHz on a 2-meter receiver. First peak C6 for maximum output on a 2-meter or higher receiver. Next, vary the calibration trimmer, C1, and check that the frequency varies a few hundred Hertz and that it is approximately correct. If the frequency is too low, either C2 or C3 will have to be decreased by perhaps 5 pF.

To verify adequate temperature compensation, you'll have to measure the output, preferably with an accurate frequency counter, or zero-beat it with WWV at 20 MHz using a suitable HF receiver. The entire circuit can then be placed in a refrigerator, (typically about 41 degrees Fahrenheit or 5 degrees Centigrade). Measure the frequency after it's been in the refrigerator for 15 to 30 minutes. Compare the reading to the one made earlier at room temperature. After a few tries, you will see if the calibration is adequate. If the temperature drift when the calibrator is cold causes the frequency to go *below* the room reference frequency, too much compensation is being used, and vice versa. (See **fig. 5** for further information.) Also, whenever you change a capacitor, allow at least 15 minutes for its temperature to stabilize before taking data.

Zero-beating to WWV can be tricky. It's best to move the calibrator around the room until the proper amount of injection is experienced. Also try to zero-beat during the interval when the tones are not present (usually the last 15 seconds of each minute). Watching the "S" meter can be quite helpful. When close to zero-beat, the meter will waiver noticeably and the beat will sound like a chirping canary. When the meter moves once per second, *you are within 1 Hertz* of the correct frequency. One beat every 15 to 30 seconds is very satisfactory. Be aware that because of atmospheric effects the accuracy of WWV on the HF spectrum is good only to about 1 part per hundred million. However, this should be

short circuit

VHF/UHF World

A chart in **fig. 9** (page 88) of W1JR's "VHF/UHF World" column in April, 1984, made reference to "Note 1." Unfortunately, Note 1 was not included at the bottom of the figure, as the author intended. Note 1 should read, "Not used on this frequency."

more than sufficient for Amateur work.

using the calibrator

At first, it will be worthwhile to test the accuracy of the calibrator several times during the first few months of operation because some aging will inevitably occur. This will also let you develop confidence in its use. After initial burn-in, I usually test calibration against WWV about once a year. One caution is advised: *Do not place the calibrator where it will be subjected to temperature variations such as on top of another piece of electronic gear.* I usually place mine on a table or desk one or two meters away from the receiver in use. This yields more than adequate injection even at 2304 MHz. Typical warmup is 15 seconds. To conserve battery life, don't forget to turn the calibrator off when not in use!

summary

Even though the state-of-the-art in accurate frequency determination has advanced significantly in recent years, a secondary frequency standard is still useful for verification of true frequency. The calibrator just described is easy to construct and adjust, relatively inexpensive, very stable, and portable. I now have six of these units operating on different frequencies and always carry one along on expeditions. Once you have one, you'll never want to be without it.

references

1. Joe Reisert, W1JR, "VHF/UHF World: VHF/UHF Receivers," *ham radio*, March, 1984, page 46.
2. Mike Metcalf, W7UDM, "A VHF-UHF Marker Generator," *VHFer Magazine*, May, 1965, page 3.
3. Irvin M. Hoff, W6FFC, "The Mainline FS-1 Secondary Frequency Standard," *QST*, November, 1968, page 34.

VHF/UHF coming events

October 6: *Mid-Atlantic States VHF Conference, Warrington, Pennsylvania. (Contact W3CCX for information.)*
October 6-7: *International Region I UHF/SHF Contest. (Contact RSGB for information.)*
October 20 and 21: *ARRL International EME Contest* (second weekend).
October 20: *Predicted peak of Orionids Meteor Shower at 0515 UTC*
October 24: *EME Perigee*

ham radio

ONE TIME OFFER!
3CX1200A7 Manufacturer's Discount
$350.00 Introductory Price

The first 300 people to send this card in with a check made payable to Varian EIMAC will receive the new 3CX1200A7 amateur radio power tube at a low introductory price. Offer *includes* an EIMAC SK-410 socket and SK-436 chimney.

SEE REVERSE FOR RESTRICTIONS

☐ Yes! Enclosed is my check for $350.00. Send me the EIMAC 3CX1200A7 tube, socket and chimney.

Name ______________________ Company ______________________

Address ____

City ______________________ State __________ Zip __________

- Offer good to first 300 cards received and time dated at Varian EIMAC.
- Valid in the United States and Canada only.
- Check or Money Order payable to Varian EIMAC must accompany card.
- Allow 12 weeks for delivery.
- Void where prohibited by law.

varian

Send this order to:
Varian EIMAC Attention: C. Cane
1678 S. Pioneer Road/Salt Lake City/UT 84104
Telephone: 801 • 972-5000

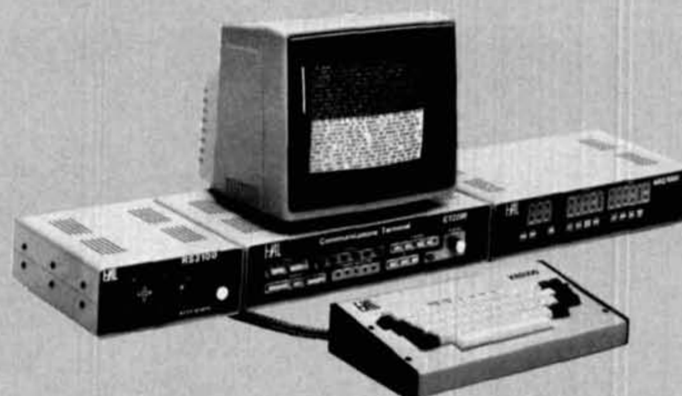
RTTY FOR ALL

MPT3100 + DSK3100 + ST6000:

MPT3100—the acknowledged top-of-the-line system for both commerciál and serious amateur RTTY and CW stations. HAL pioneered the radio mailbox technique with the MPT3100, and now the new DSK3100 disc drive option gives you 326,000 characters of message storage. The system is designed particularly for the amateur, commercial, or military operator who has to handle a large amount of traffic. You can collect, edit, and retransmit traffic perfectly with a minimum of effort. The ST6000 is renowned for its weak-signal performance ana reliability. Add the ARQ1000 for full AMTOR operations, including an AMTOR mailbox. If you are serious about your code and need high performance and reliability, this system is the proven world leader.

CT2200 + KB2100 + ARQ1000 + RS2100 + KG12:

The CT2200 and KB2100 give you an integrated system that includes video, RTTY demodulators (high, low, modem low, and modem high tones), and many advanced features. Operate Baudot or ASCII at 45-1200 baud and CW at 5-99 w.p.m. Add the ARQ1000 for ALL AMTOR features (not just *some* of them). The RS2100 RTTY Scope gives you the acknowledged best tuning indicator for a complete RTTY system. Also included in the CT2200 is selective-call ASCII printer output, split screen, 36 or 72 characters per line, smooth scroll, and 2 or 4 pages of display memory. In addition, the CT2200 has 2 HERE IS and 8 large "brag-tape" memories that are programmable and non-volatile. *This is our most popular system, used by thousands of amateurs around the world.*



CRI-200:

At last, a computer interface that *really* works and has an accurate tuning indicator. Take advantage of HAL's years of experience in RTTY and see how good computer RTTY can be. Best of all, it's universal and you can select the computer and software of your choice. Why be frustrated with computer RTTY? Hookup the CRI-200 and work ALL the stations!

CWR6850:

Have a space problem or want portable RTTY? The CWR6850 is a one-package complete RTTY system. All you need is your transceiver and 12 VDC—the rest is in the CWR6850, including the screen. The high-performance RTTY demodulator for all shifts and either high or low tones is built-in. AND, the system is expandable! Add the ARQ1000 for AMTOR, the RS2100 RTTY Scope, and an ASCII printer, and you have a no-compromise base station for all modes.

HAL COMMUNICATIONS CORP.
BOX 365
URBANA, IL 61801 • (217) 367-7373

✓ 149

a high-efficiency top-loaded vertical

You don't need traps, coils, or vast acreage to get good performance on 160, 80, or 40 meters

The efficient, easy-to-build antenna described in this article requires no radials, traps, or loading coils. The reader with an appetite for low-band DX should be able to duplicate or better my results on 160 meters and, by appropriate scaling, on 80 and 40 meters as well.

Like any serious low-band DXer, I wanted to join the "big boys" using a vertically polarized signal because it has long been demonstrated that horizontals, unless raised to astronomical heights, are unable to do much more than take up space at the bottom of the pile-ups.[1] The customary current-fed, 1/8- or 1/4-wave type verticals require an immense radial ground system to be efficient and competitive — yet my terrain consists of deep ravines, gullies, and cliffs that make the installation of radials, or even elevated counterpoise systems, virtually impossible. To add to the misery, the soil at my QTH is almost 100 percent hard sandstone and as such approaches pure silicon in conductivity. Obviously a "non-standard" approach to an antenna was necessary. After reviewing many texts and articles I decided that some form of "ground independent" antenna would be required, particularly one that had its feed point at ground level. The "Bobtail Curtain"[2,3] version of ground-independent systems met the basic requirements, but for 160 or even 80 meters the dimensions become truly heroic; in addition, my requirement was for unidirectional transmission. My first step was to contact my old friend Woody Smith, W6BCX, who had fathered the fabulous Bobtail, in order to get firsthand information on the "care and feeding" of this type of system.

My call to Woody obviously struck a responsive chord and after a few thousand well-chosen words and equations, we agreed upon the novel form of vertical that this article describes. Sparing you the background — which covered inverted ground planes, slopers, center-fed loaded dipoles, and of course the Bobtail itself — the general parameters decided upon were that the new vertical design should require supports no higher than 70 feet (21.34 meters) for the 160 meter version or 35 feet (10.67 meters) on 80; should not need more than 95 feet (28.96 meters) spacing between supports on 160 and half that on 80; should be highly efficient in power transfer; should exhibit a high impedance feed point at the bottom of the vertical radiator and should be relatively easy to construct

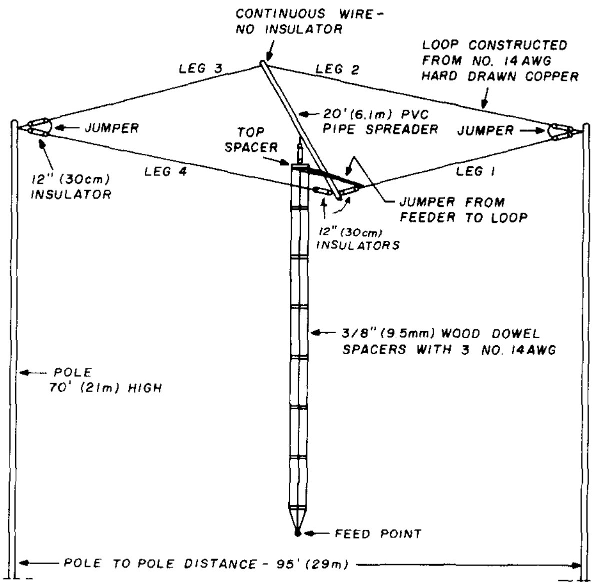


fig. 1. Efficient top-loaded vertical dimensioned for 160-meter operation.

By Howard F. Shepherd, W6US, c/o Hypercom, P.O. Box 768, Del Mar, California 92014

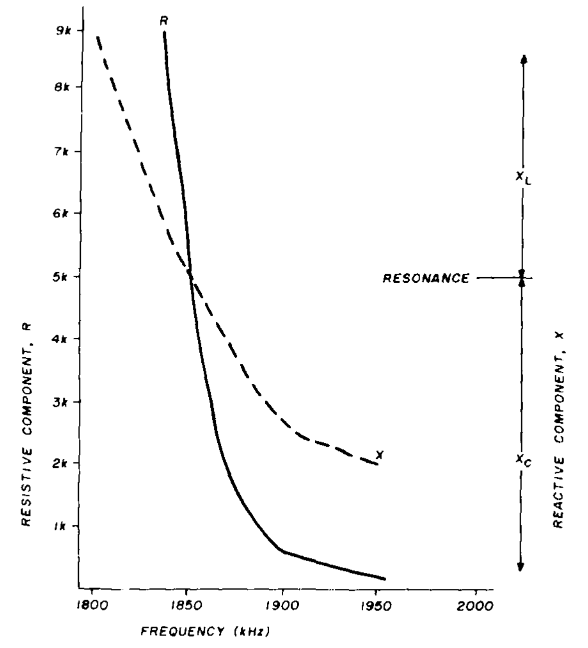


fig. 2. Plot of resistive and reactive component of 160-meter top-loaded vertical versus frequency.

item	description
L1	40 turns No. 10 AWG spaced 0.2 inch per turn, 4 inch diameter
L2	7 turns No. 10 AWG spaced 0.2 inch per turn, 5-1/4 inch diameter
C1	two 500 pF, 2000 volt variable capacitors in parallel
C2	500 pF, 500 volt variable capacitor with 0.002 μF mica in parallel
C3	100 pF, 20 kilovolt fixed vacuum capacitor

Note: For upper portion of 160 meter band, L1 is tapped down 8 turns by HV relay and 0.002 μF mica is disconnected from C2 by another relay.

and test using easily obtained materials. How did it work out? If you're not one of the fortunate few who already have a full 1/2-wave vertical on 160 complete with at least 120 radials or a solid silver-plated copper ground sheet of comparable size, read on!

Fig. 1 shows the physical layout of the W6US 160-meter vertical. No. 14 AWG copper wire is used throughout. The vertical radiator uses three wires spaced 1 foot (30.48 centimeters) apart by 3/8-inch (0.95 cm) diameter wooden dowels. Because the wires are at the same potential, no special treatment is required for the dowels electrically, but a coat of varnish or wax enhances their weatherability. The use of a four- or six- wire cage feet (1.22 meters) in diameter would be helpful as far as increased bandwidth is concerned; however, unless the effective conductor diameter of the diamond-shaped single-turn top loop is also increased by paralleling wires, don't expect to greatly widen the frequency response.[4] It should be noted that if the vertical radiator is so increased in electrical length, the physical length of the loop will have to be decreased, and provision made for the increased weight of the cage system.

how does it work?

The general theory of operation presents little mystery, but despite the W6US system's resemblance to the usual "top-loaded" short vertical, the reader will note that in essence the feedpoint is at the end of an electrical 1/2-wave of conductor and represents a point of high radiation resistance and impedance. This becomes paramount when the efficiency of this antenna is compared to that of the usual top- or bottom-loaded systems.[5]

$$\text{antenna efficiency} = \frac{R_{rad} \times 100}{R_{rad} + \text{all circuit resistance}} \tag{1}$$

where R_{rad} = the radiation resistance of the antenna and "all circuit resistance" represents the resistance of the ground system, the loading inductors, wire resistance and *any other resistances present which dissipate power as heat.*

A resonant 1/4-wave vertical exhibits a R_{rad} of about 36 ohms with 10 ohms representing the total resistance of the ground system, coupling circuit, and other loss elements. Inserting these two numbers in **eq. 1** produces an efficiency of 78.26 percent. On 160 that 1/4-wave vertical would be about 130 feet (36.92 meters) tall. If instead a 60-foot vertical (1/8-wavelength high) is used, the R_{rad} drops to around 4 ohms and the efficiency diminishes to 28.57 percent![6] For 100 watts transmitter output, only 28.57 watts would be radiated — about one-third of the radiation from the full size 1/4-wave vertical, assuming the losses were identical (which is really not the case because the shortened vertical would require more coupling inductance and consequently more power would be consumed in the coupling circuit instead of reaching the antenna).

This is where the W6US ground independent system enters the race with a big lead. From **fig. 2**, which depicts the variation in measured antenna resistance and reactance of the system shown in **fig. 1** note that at resonance — i.e., zero reactance — the resistance is close to 5000 ohms. Applying this number in **eq.1** and assuming for the moment that the "all circuit resistance" figure stays at 10 ohms, the efficiency is 99.8 percent — almost four times the indicated

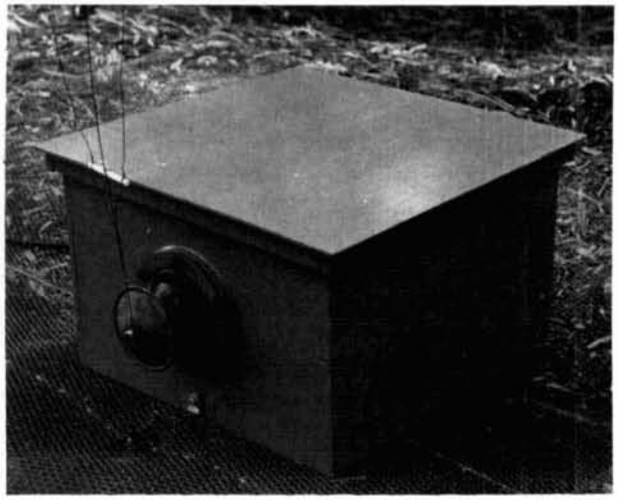


fig. 3. Coupler houses high voltage matching circuit components.

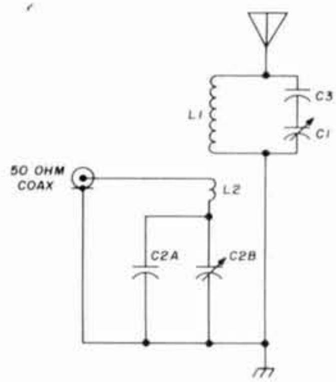


fig. 4. Coupler provides match between high impedance seen at antenna terminals and 50-ohm coax line.

efficiency of the usual 60-foot vertical radiator! This type of effect is exactly what makes the Bobtail and its other cousins such real winners. Best of all, this is achieved without an extensive ground radial system. In this case a 10 × 10 foot (3.05 × 3.05 meter) square of galvanized poultry wire is all that is necessary. A 1/2-inch (1.3 cm) 8-foot (2.43 meter) copper pipe is driven into the ground at the center of the wire screen for lightning protection. The small "coupler house" is placed on this screen as shown in **fig. 3** with the ground portions of the coupling circuit strapped to the pipe, which in turn is bonded to the poultry wire.

The resistance/reactance graph shown in **fig. 2** illustrates that these curves are steep with respect to frequency. Obviously, this antenna is very high "*Q*" and the bandwidth of antenna plus coupler is 6.7 kHz on 160 between the 1.2:1 VSWR points. Because of the narrow bandwidth, I provided for remote adjustment of the tuning capacitor in the coupling network with a 90-volt 60-Hz selsyn pair. The complete coupler circuitry, a parallel tank circuit consisting of L1 and C1 in series with C3 which resonates at the desired frequency, is shown in **fig. 4**. The tank is inductively coupled to the series circuit L2 and C2 into which the 50-ohm coax feedline terminates.[7] Not shown in **fig. 4** is a relay switching arrangement whereby L1 is tapped down and the value of C2 is decreased to provide for a wider total tuning range on 160. The interior view of the coupler housing in **fig. 5** shows the location of all the components. Remote adjustment of the coupler is obtained by having a selsyn drive the capacitor C1 via a reduction ratio chain drive which allows the use of a ten turn dial on the selsyn in the shack. The dial includes a small chart that provides a quick dial versus frequency reference for setting.

The use of the C1-C3 series combination in the coupler was dictated by the very high voltage developed at the base of the antenna at full legal power input. C3 is a 100 pF, 20,000-volt fixed vacuum capacitor that receives most of the voltage across the tank because C1 is varied from its full capacity of1000 pF to about 300pF to cover the tuning range. This combination also provides some degree of bandspread, helpful in view of the sharpness of tuning. I would suggest that you use high quality insulation, and plenty of it, both at the coupler and diamond loop ends of the antenna. With the impedance ranges involved, the voltages are awesome at all but the lowest power input.

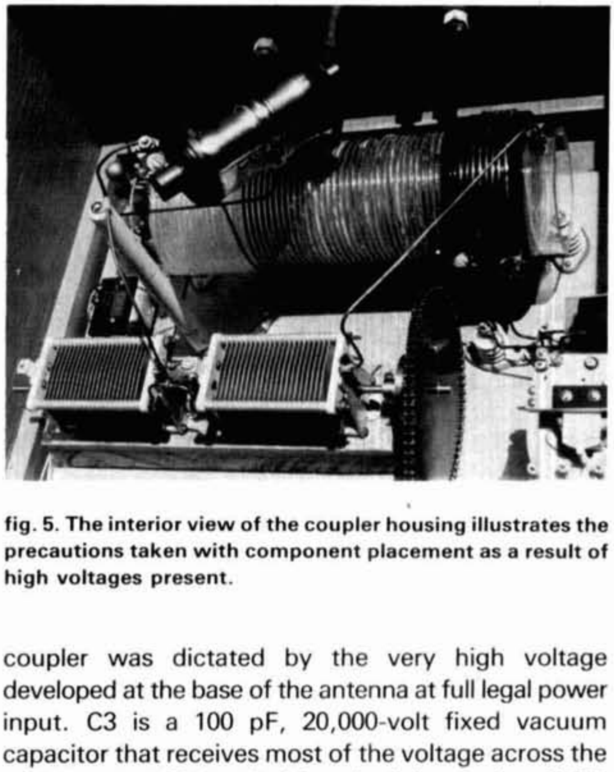


fig. 5. The interior view of the coupler housing illustrates the precautions taken with component placement as a result of high voltages present.

adjusting loop to resonance

Once you've assembled the antenna and set it in place, the next step is the adjustment of the length of the diamond loop to achieve resonance. It is assumed that you will have set the overall length to a half-wave according to the usual equation; $468/f_{MHz}$. For 1850 kHz this figures out to 252.97 feet (77.11 meters). There are a variety of ways to determine whether resonance has been achieved, ranging from loosely coupling a grid dip oscillator to the bottom of the vertical radiator to using an accurate RF impedance bridge, which was the method I used (see **fig. 6**). Another method that is quite easy to use is to resonate the tank circuit in the coupler using a GDO to your desired frequency without having it connected to the antenna. Then attach the antenna temporarily about halfway up the tank inductor from ground. If the antenna is resonant at that frequency, the tank circuit will still resonate with the GDO at the same setting. If not, as almost always is the case, you will have to adjust the GDO to find the dip again. Then try a different diamond loop length and go through the process once more. By noting the movement of the dip, you can easily tell if the antenna length adjustment was made in the right direction. By successive tries you'll find a length for the diamond loop that will closely approximate resonance. The antenna is then connected to the hot end of the tank circuit for adjustment of the VSWR and operation.

It is well to note that the above antenna pruning method can also be used to determine the harmonic resonance by setting up a temporary parallel tuned circuit that will resonate on the harmonic. If this antenna is to be used on both 160 and 80, or 80 and 40, you may wish to choose resonant frequencies that cover the band segments of interest. As shown in **fig. 2**, my antenna has its primary resonance at about 1854 kHz. Testing has shown its second harmonic to be close to 3949 kHz.

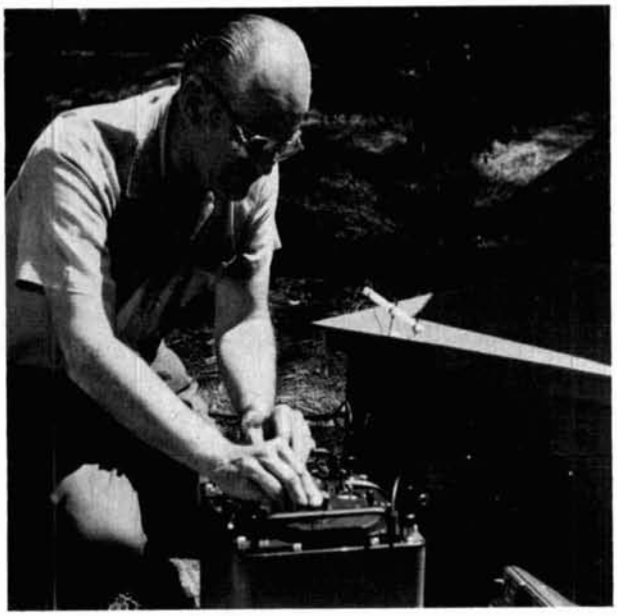


fig. 6. W6US determines the verticals resistive and reactive components with a General Radio GR1606A RF bridge.

If you are seriously interested in this type of ground-independent antenna, I would suggest some reading in books and articles that deal with VLF antenna systems.[8] Some of the earlier systems closely parallel the dimensions of the antenna described here. I would also be interested to learn of your experiences with the W6US antenna on other bands — for example, on 10 meters, where the vertical radiator would be a magnificent 4.32 feet (1.32 meters) high and the total span about 11.88 feet (3.62 meters)! Also left to your experimentation is the question of whether the addition of a conventional radial system might enhance this antenna for DX.

The sticky point in this investigation is probably whether the raising of the current maximum by the ground independent approach lessens the need for radials to lower the angle of radiation. The Bobtail does not seem to profit by them, but here the vertical radiator is only half as long. At least it seems well established that the increased efficiency goes a long way toward successful long-haul DX.

testimonial

No antenna article is complete without a relatively rosy exposition of the superlative reports received and the choice DX worked. To maintain tradition, I will therefore note that compared with a great variety of 160-meter systems previously used, this W6US ground independent system has been a real winner for me. A substantial number of solid QSOs have been logged with stations 500 miles or more distant while running just 10 watts transmitter output on SSB. Believing that more of a good thing is even better, I am presently working on a second version of this antenna. I sincerely hope that those who try this approach will provide still more data to benefit us all.

references

1. Mark Bacon, WA9VWA, "Verticals over Real Ground," *ham radio*, January, 1984, page 35.
2. Woody Smith, W6BCX, "Bet My Money on a Bobtail Curtain," *CQ*, March, 1948, page 21.
3. Woody Smith, W6BCX, "Bobtail Curtain Follow-Up," *ham radio*, March, 1983, page 28.
4. Edmund Laport, *Radio Antenna Engineering*, McGraw-Hill, 1952, page 249.
5. *Antenna Book*, ARRL, 14th Edition, page 2-4, 25.
6. Henry Jasik, *Antenna Engineering Handbook*, page 20-4.
7. *Antenna Book*, ARRL, 14th Edition, page 4-3.
8. Edmund Laport, *Radio Antenna Engineering*, McGraw-Hill, 1952, pages 13 to 76.

bibliography

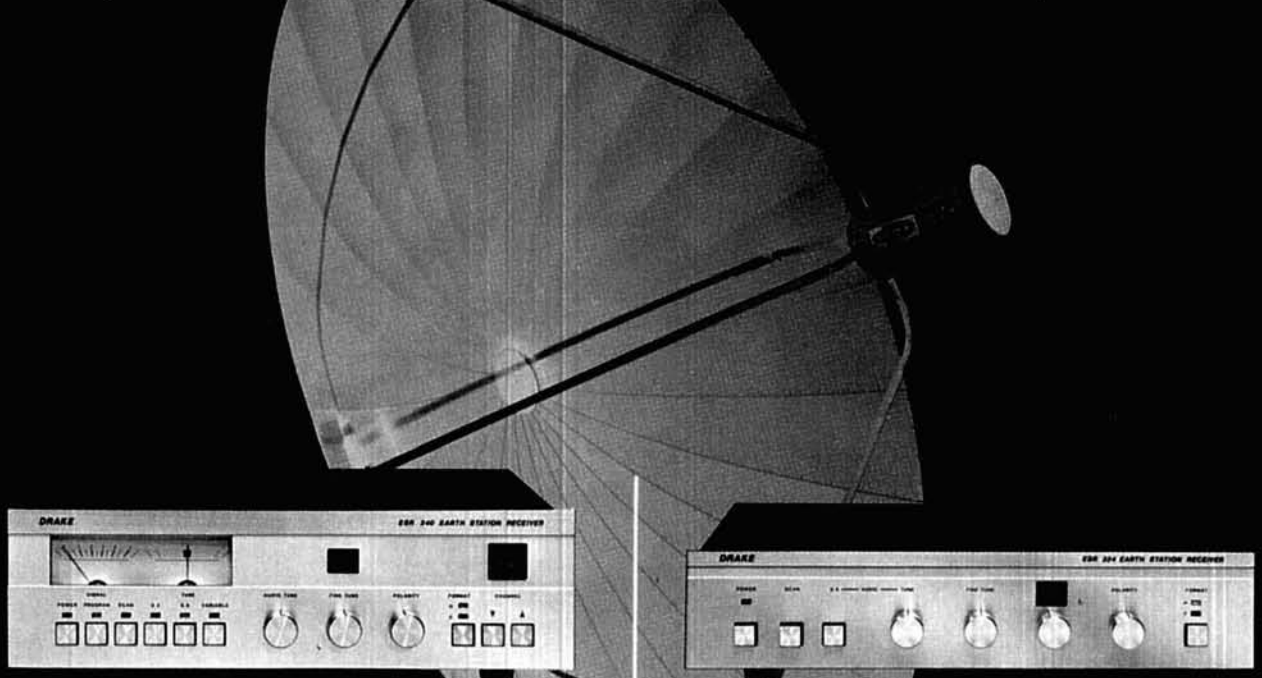
Frank E. Terman, *Radio Engineering Handbook*, 1943.

Rosen, Rich, K2RR, *From Beverages thru OSCAR — A Bibliography* (Lists all technical articles on vertical antennas that have appeared in the ham journals since 1945; available directly from the publisher, Rich Rosen, K2RR, P.O. Box 350, Greenville, New Hampshire 03048.)

ham radio

The First Name In Satellite TV...

When you invest in a **DRAKE** Earth Station Receiver, you've chosen the very finest. Elegantly designed with the latest engineering concepts in solid-state techniques, every **DRAKE** is characterized by superb performance and versatility. **DRAKE**. . . world-class leader in satellite television reception.



ESR240 EARTH STATION RECEIVER

- Infrared Remote Control
- Digital Channel Readout
- Preset 6.2/6.8 and Variable Audio Tuning

ESR324 EARTH STATION RECEIVER

- Digital Channel Readout
- Detent Channel Tuning
- Preset 6.8 and Variable Audio Tuning

...The Last Word In Performance!

DRAKE®

R.L. Drake Company
540 Richard Street; Miamisburg, Ohio 45342, USA
Phone: (513) 866-2421
Telex: 288-017

PIONEER MEMBER OF SPACE

Available NOW! The Olympiad™ I

Plug into Profits . . .

The New Olympiad I home satellite receiver represents a back-to-basics approach to earth station design, that captures high quality video performance in an inexpensive receiver package.

The Olympiad's simplistic internal circuitry and built-in polarotor interface allow for maximum dependability and easy installation. Features include a built-in modulator, fully tunable (5.5–7.5 MHz) audio, pushbutton polarity selection, polarity skew control, and KLM's innovative single conversion image/reject circuitry.

For details on how you can plug into profits with the New Olympiad I, contact your local Distributor or write for our free color brochure.

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

PIONEER MEMBER OF SPACE

✓ 162

THE BETTER MOUSE TRAP FOR AC WALL OUTLET LIGHTNING AND SURGE PROTECTION JUST $29.95

The Alpha Delta ACTT AC Transi-Trap™ is a plug-in-the-wall surge protector that has two 120 volt grounded sockets, status light, circuit breaker and a unique 3 stage protection circuit.

The ACTT gives you both transverse and common mode protection with a high speed, self restoring, 6000 volt/2000 amp surge discharge circuit. This circuit goes from hot to neutral and ground and neutral to ground. Several competitive devices use only a single stage 100 amp protector. Plug a distribution box into the ACTT and everything downline is protected. The ACTT is UL listed and is available from either Alpha Delta dealers or Alpha Delta direct. Please add $2.00 for shipping and handling.

The ACTT is designed to reduce the hazards of lightning and induced surge voltages. It is not for direct strike protection.

ALPHA DELTA COMMUNICATIONS, INC.
PO Box 571
Centerville, OH 45459
(513) 435-4772

✓ 109

Your Ham Tube Headquarters!

TUBES BOUGHT, SOLD AND TRADED
SAVE $$$—HIGH $$$ FOR YOUR TUBES

Call Toll Free 800-221-0860

Tubes

3-400Z	$85.00	7360	$10.00
3-500Z	85.00	7735A	27.50
4-400A	80.00	8122	110.00
4CX250B	50.00	8156	12.50
572B	55.00	8643	82.50
811A	12.00	8844	26.50
813	30.00	8873	175.00
6146B	6.50	8874	195.00
6360	4.25	8877	500.00
6883B	6.75	8908	12.50

MAJOR BRANDS ON RECEIVER TUBES
75% off list

Semiconductors

MRF 245/SD1416	$30.00	SD1088	19.95
MRF 454	14.95	2N3055	75¢
MRF 455	10.95	2N6084	12.50

RF Connectors

PL259	10/$4.95	M358	2.50 ea.
PL258	10/8.95	M359	1.75 ea.
UG 175/176	10/1.60	Type "N" Twist on	
UG255/u	2.50 ea.	(RG8/u)	$4.75 ea.
UG273/u	2.25 ea.	Minimum Order $25.00	

Allow $3.00 min. for UPS charges ✓ 129

CeCo COMMUNICATIONS, Inc.
2115 Avenue X Brooklyn, NY 11235
SERVING THE INDUSTRY SINCE 1922 Phone (212) 646-6300
Call CECO For Your CCTV Security And Color Production Requirements

Looking for The Interface for Your Home Computer & Transceiver?

YOU FOUND IT!

Put your computer on-the-air with either Interface II or the new Kantronics Universal Terminal Unit.

Interface II is designed for use with the Apple, Atari, TI-99/4A, TRS-80C, VIC-20, or Commodore 64 computers. Suggested Retail 269.95

The Universal Terminal Unit is compatible with IBM, Kaypro, TRS Model III and IV, and many other computer systems. Suggested Retail 199.95

Interface II

Interface II is the unit for the serious amateur. When used with Kantronics software, Interface II gives the sensitivity and versatility asked for by our users. Interface II gives you the following features:

- Six pole switched capacitance prelimiter filters for optimum performance on shift selected; CW or RTTY 170, 425, 850.
- Limiter or limiterless operation means only 2-7 millivolts of audio are necessary to drive the unit.
- Two channel operation allows simultaneous hook-up of both HF and VHF transceivers.
- Our unique tuning system displays both Mark and Space tones. Scope outputs are also available.
- Stable quartz generated tones give clean AFSK output on all standard shifts.
- RS-232 or TTL level compatible. No modification kit required.

Universal Terminal Unit

UTU is Kantronics newest interfacing development. Now any computer with an RS-232 port and a terminal program can interface with your transceiver.

UTU requires no additional decoding software as an internal microcomputer gives UTU data processing capabilities to send and receive in four coded amateur formats. A short terminal program or communications program is used to link the computer and UTU. This allows the operator to taylor his terminal program with desired features.

The UTU package includes:

- Sample terminal programs for IBM, Kaypro, TRS-80 Models III and IV.
- Tuning bar graph displaying both Mark and Space tones. Additional LED's to indicate Lock and Valid during Amtor.
- RS-232 and TTL level compatible.
- Send and Receive CW(6-99 WPM), RTTY(60, 67, 75, 100,132 WPM), ASCII(110, 150, 200, 300 baud), and Amtor modes A, B, and L.

Kantronics Software

	Hamsoft	Hamsoft/ Amtor	Hamtext	Amtorsoft	Supertap
Apple	●		●	●	
Atari	●	●	●		
VIC-20	●	●	●	●	●
Comm-64		●	●	●	●
TRS-80C	●	●			
TI-99/4A	●				

For more information contact an authorized Kantronics dealer, or write

Kantronics
1202 E. 23rd Street (913) 842-7745
Lawrence, Kansas 66044

✓ 164

✓ 112

extended/expanded power dividers

Try copper water pipe, hobby-shop brass tubing for quality RF components

In weak signal VHF/UHF work (EME and various scatter modes)* nothing can be more frustrating than the inability to read faint signals you know are present but are largely obscured by noise.† The problem is often solved by increasing the size and/or number of antennas; when properly combined in a low loss system, doubling the number of antennas will yield very close to the theoretical 3 dB gain. But there is little to be gained in capturing a weak signal unless it is nurtured with great care on its way to the preamplifier. To do this, one should use the best quality feedline, cut as short as possible, to the power dividers. Ideally, the power dividers should be constructed to facilitate the use of short lines; unfortunately, most are either 1/4 or 1/2 wavelength long, as illustrated in **fig. 1**. With stacking distances between antennas as great as two wavelengths, these dividers do not permit the use of short feedlines.

theory

While most readers are probably familiar with the power divider basics, this section has been included for the benefit of those who may not be, and for the further purpose of showing the evolution of extended power dividers.

Power dividers use the *"Q"* section used as a means of matching the load of more than one antenna to the feedline. A quarter wavelength of feedline will match the impedance of feedlines of the same type (coaxial or parallel) but having different impedances when the impedance of the matching section is: $Z = \sqrt{Z_1 Z_2}$ and is known as a *"Q"* section. (This discussion is limited to coaxial feedlines; all loads are assumed to be equal.)

When two or more loads, in the form of antennas or other power dividers, are fed from one transmission line, they appear to be in parallel. Four 50-ohm loads represent a combined load of 12.5 ohms. In order to arrive at the impedance of the matching section we divide the impedance of one load by the number of loads, and this becomes Z1. Z2 will be the impedance of the input feedline. If the matching section is to be divided into two or more branches, as shown in **fig. 1B**, then its impedance should be multiplied by the number of branches so that the combined value is the originally calculated impedance.

design

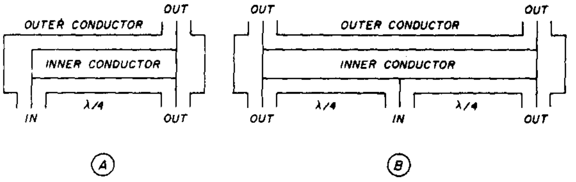
The power divider shown in **fig. 2** is a combination of the two types of dividers shown in **fig. 1**. The center portion of **fig. 2**, section A, is a 1/2-wave power divider or matching section that matches the input impedance to the impedance of the two B sections. In theory, section B could be any impedance that would fit into the overall design, but as a practical matter it should be close in value to the output impedance. The two C sections at each end are 1/4 wave dividers that match section B to the two output ports at each end. I am presently using two of these in my 144 MHz EME array and have been more than satisfied with their performance.

A different method of accomplishing the same thing is shown in the power divider illustrated in **fig. 3**. Simpler in design, and easier to construct, this one

*See "The VHF/UHF Primer: An Introduction to Propagation," by Joe Reisert, W1JR, *ham radio*, July, 1984, page 14, for a comprehensive survey of the VHF/UHF modes.

†HFers experience that same frustration. — **Editor.**

By George Chaney, W5JTL, 218 Katherine Drive, Vicksburg, Mississippi 39180



Note 1: 1/4 wave power divider:

$Z = \sqrt{Z_{IN} Z_{OUT}/N}$

where Z_{OUT} = impedance of one output port, and N = the number of output ports.
Center conductor = $\lambda/4$ = $2952/F_{MHz\text{-}IN}$

Note 2: 1/2 wave power divider:

$Z = 2\sqrt{Z_{IN} Z_{OUT}/N}$

where Z_{OUT} = impedance of one output port, and N = total number of output ports.
Center conductor = $\lambda/2$ = $5904/F_{MHz\text{-}IN}$

Note 3: Impedance of air dielectric coax with round outer and inner conductor:

$Z = 138 \log \frac{D}{d}$

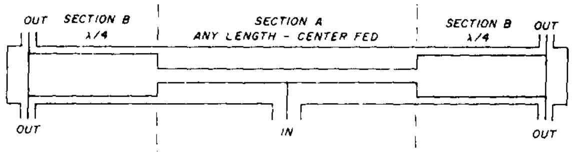
where D = I.D. of outer conductor
and d = O.D. of inner conductor

Note 4: Square outer, round inner:

$Z = 59.96 \ln (1.0787 \frac{W}{D})$

(See ham radio, March, 1981, page 64, Meyer, W6GGV)
where W = inside dimension of one side of square outer
and D = O.D. of inner conductor.

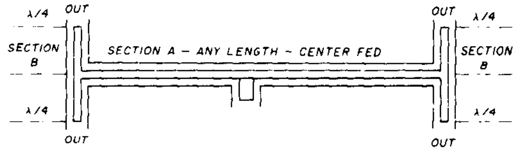
fig. 1. Forms of conventional power dividers. (A) 1/4 wave power divider, and (B) 1/2 wave power divider.



Section A: Z = 100 ohms, D/d = 5.3 Section B: Z = 50 ohms, D/d = 2.3

Note: The 50-ohm input is split into two 100-ohm loads. The "Q" section (Section B) transforms the 100-ohm portion to the 25-ohm load presented by the two 50-ohm outputs at each end. This design is NOT suitable for 75-ohm feed systems, for reasons explained in the text.

fig. A1. 50-ohm 4-way power splitter.



Note. The impedance of this power divider is 100 ohms throughout and provides a perfect match for 50 ohms in, 4 × 50 ohms out. While the same design for 75 ohms appears satisfactory on paper, it is NOT so in the actual use.

fig. A2. The "One Hundred OHM" 4-way 50-ohm power divider.

should perform equally as well as the others. At each end of a 1/2 wave four-way power divider, the impedance is one-half the impedance of each output port. This will be 25 ohms for 50 ohm feedline or 37.5 ohms for 75 ohms feedline. We simply extend the matching section, at each end equally, to the desired length, at the impedance of $Z_{OUT}/2$. (I will be using this design in my 432 MHz EME array now under construction.)

common materials are all that's needed

I use copper water pipe, straight and hard drawn, for the outer conductor of my power dividers. It is available in three wall thicknesses for each nominal diameter: type K, thick wall: L, medium wall; and M, thinwall. **Table 1** shows the nominal size, O.D., and I.D. of copper pipe in sizes from 1/2 inch (12.7 mm) through 1-1/2 inch (38.1 mm). For the center conductor, I use brass tubing, available in hobby shops, in diameter increments of 1/32 inch (0.8 mm) from 1/16 inch (1.6 mm) through 21/32 inch (17 mm), having a wall thickness of 0.014 inch (0.36 mm) and sold in lengths of 1 foot (30 cm) or 3 feet (91 cm). It is easily spliced by soldering a short section of the next smaller diameter as an internal sleeve.

Square aluminum tubing is also good for the outer conductor, but I haven't been able to find it in lengths greater than 8 feet (2.4 meters), which isn't long enough for widely spaced 2-meter arrays, though it is easy to work with. Coaxial cable connectors can be held in place with small sheet metal screws, or the tubing may be drilled and tapped.

good performance requires careful construction

In layout, measurement and assembly, accuracy and uniformity are essential. After first determining the desired overall length, find and mark the exact center of the outer conductor, making a very light cut around the circumference with a tubing cutter. At points equidistant from the center, and 3/4 inch (19 mm) from each end, make a similar mark. These are the points at which the connectors or sleeves will be located, as well as the center and each end of the center conductor. Drill holes 180 degrees apart, on opposite sides of each end of the outer conductor, and one at the center, to accept the coaxial cable, connectors or sleeves. The center hole should be either in line with two end holes on one side, or at 90 degrees, depending on the orientation of your feedline. A 3/8 inch (9.5 mm) hole is drilled to one side of the center hole, just close enough that it will not run out and overlap the center hole. This is for the purpose of being able to have access for soldering the center conductor to the coaxial connector.

In preparing the different sections of the center conductor, the smaller diameter piece should be long enough for about a 3 inch (76.2mm) overlap into the larger size tubing to which it is to be joined. A reducing sleeve is made by telescoping together short sections of brass tubing, about 3 inches (76.2mm) long, so as to fill the space between the smaller and larger pieces to be joined, and to keep them straight and concentric. If the center conductor is to be made in one piece, insulating spacer washers should be put in place before the sections are soldered together.

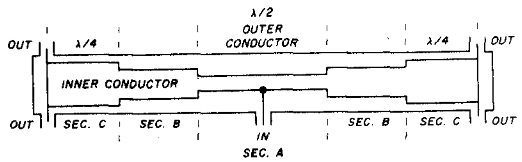
I use teflon spacer washers* to prevent sag in the center conductor and to maintain concentricity. These are placed on the smaller diameter portion at each point of change in diameter, at the center and on each end. The spacers should fit tightly on the center conductor and loosely in the outer conductor. My center conductors were assembled in two pieces divided at the center. This permits setting the spacers in place on the smaller diameter portions after the soldering is done. They are joined in the center with an internal sleeve after being inserted in the outer conductor. The center conductor should be cleaned and polished after assembly and handled with paper towels or tissue during insertion in the outer conductor. If the inside of the outer conductor is not bright and shiny it should likewise be polished. A small notch or "Vee" should be cut out of each teflon spacer, at the perimeter, to permit the flow of air through the power divider; this is important to prevent the accumulation of moisture.

After inserting the center conductor into the outer conductor, the coaxial connectors are ready to be installed. I recommend the use of UG-58/U connectors with teflon insulators. (Other types of insulation will not withstand the heat generated during the soldering process.) The flange of the UG-58/U should be removed — with a lathe, grinder, or otherwise — to facilitate soldering. A 7/16 inch hole in the outer conductor will provide a neat fit for the portion of the UG-58/U below the flange.

I use coaxial connectors only at the center or input port. At the output ports, I use copper sleeve couplers sized to fit 3/8-inch (9.5 mm) copper pipe. They are about 0.502 inch (12.75 mm) I.D. and provide a very good fit for the shield of the RG-331 hardline leads to the antennas. The sleeves are tinned on the inside. A small stainless steel wormscrew hose clamp is put around the sleeve after the hardline is installed.

After all soldering, assembly, and installation have been done, the ends and the center access hole should be sealed. It is not necessary to solder the coverings in place, but they should be held in place with a good sealant and wrapped tightly with stretch tape. All points of possible moisture entry — even the solder joints — should likewise be sealed.

The dimensions given in **fig. 2** will yield impedances very close to the calculated ideal. Preliminary calculations indicate that 3/4 inch (19 mm) type M tubing would be a better choice for outer conductor in the **fig. 3** design, using brass tubing for the center conductor.

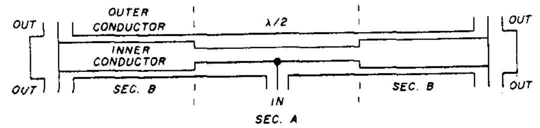


Note: This power divider may be any length greater than one wavelength. Section A is a two-way 1/2 wave power divider. $Z = 2\sqrt{Z_{IN}Z_B}$. Sections B may be any length, but must be equal. The impedance may be any value within practical limitations. Sections C are 1/4 wave two-way power dividers. $Z = \sqrt{Z_B Z_{OUT}/2}$ With an outer conductor of 1-inch type L straight, hard drawn copper water tube (1.025 inch I.D.) impedance of sections A, B, and C and diameter of center conductors will be:

Performance parameters of multisection power dividers.

		section A		section B		section C	
Z_{IN} (ohms)	Z_{OUT} (ohms)	Z (ohms)	diameter (inch)	Z (ohms)	diameter (inch)	Z ohms	diameter (inch)
50	4 × 50	71	5/16	51	7/16	36	9/16
50	4 × 75	85	1/4	71	5/16	51	7/16
75	4 × 75	102	3/16	71	5/16	51	7/16

fig. 2. Long power divider.



Note: Section A has the same impedance as a four-way power divider, as illustrated in fig. 1B. In the case of 4-way dividers of this type the simplified formula is $Z = \sqrt{Z_{IN}Z_{OUT}}$. where Z_{OUT} is the impedance of one output port. Sections B may be any length and of equal dimension. The impedance is $Z = Z_{OUT}/2$. Typical applications:

Z_{IN} (ohms)	Z_{OUT} (ohms)	section impedances (A)	(B)
50	4 × 50	50	25.0
50	4 × 75	61	37.5
75	4 × 75	75	37.5

fig. 3. Another form of long power divider.

table 1. Nominal size, O.D. and I.D. of different grades of copper water pipe.

nominal size (inches)	O.D. (inches)	I.D. type K (inches)	L (inches)	M (inches)
1/2	0.625	0.527	0.545	0.569
5/8	0.750	0.652	0.666	0.690
3/4	0.875	0.745	0.785	0.811
1	1.125	0.995	1.025	1.055
1-1/4	1.375	1.245	1.265	1.291
1-1/2	1.625	1.481	1.505	1.527

what to expect

It is said that 1 dB is the least amount of change in sound that can be detected by the human ear. In a noise-free environment, this is probably correct. But in EME work, I question its accuracy. Often we can detect a change in the pitch of the "white noise" as we tune our receivers across a given frequency. Even though there's a signal present, the dits cannot be distinguished from the dahs. Perhaps if this were 0.9 dB, the signal would jump right out of the noise and be readable if we could supply the additional 0.1 dB? The low-loss feed system described herein may make such a thing possible.

*Available from the author at nominal cost.

appendix

other designs for power dividers

In each of the power dividers previously described, a "*Q*" section is employed at the input port. This is not necessary in *all* cases. The input may be split into two branches, each of which is twice the impedance of the input feedline, with no resulting mismatch. The "*Q*" sections may be placed at each end, in either 1/4 or 1/2 wave form.

Figures A1 and **A2** illustrate this design in each of these forms. I have designated the first device as a "splitter" to distinguish it from the one in **fig. 3**. This design is not suitable for a 75-ohm feed system, which would require splitting into 150-ohm branches. The D/d ratio for 150 ohms would be 12.2, resulting in a center conductor much too small to be practical.

The "hundred OHM" (**fig. A2**) divider is particularly appealing to me, because it involves no change in diameter of the center conductor. The idea for this one occurred to me about a month ago, and I hastily assembled two of them for my 2-meter EME antenna (8 x 2.2 wavelength NBS Yagis). Initial results are very encouraging: SWR is very good, and my own SSB echoes from the moon were readable with a sky temperature of about 400 degrees K. (Below 300 degrees K is considered "quiet sky.")

construction details for the "hundred OHM" divider

Outer conductor: 3/4 inch (19 mm) copper pipe, type D, 0.833 *inch (21.2 mm) I.D., if available*. Type M, 0.811 inch (21.2 mm) I.D., is satisfactory substitute.

Inner conductor: 5/32 inch (4 mm) brazing rod or brass tubing. *Tubing is preferred because of its usefulness as internal coupling sleeves.*

Center and end Tee's: 3/4 inch (19 mm) copper plumbing Tee's.

Center conductor splices: 5/32 inch (4 mm) I.D. brass tube. Miniature Tee's fabricated from same material at each end. (I used brazing rod center conductor.)

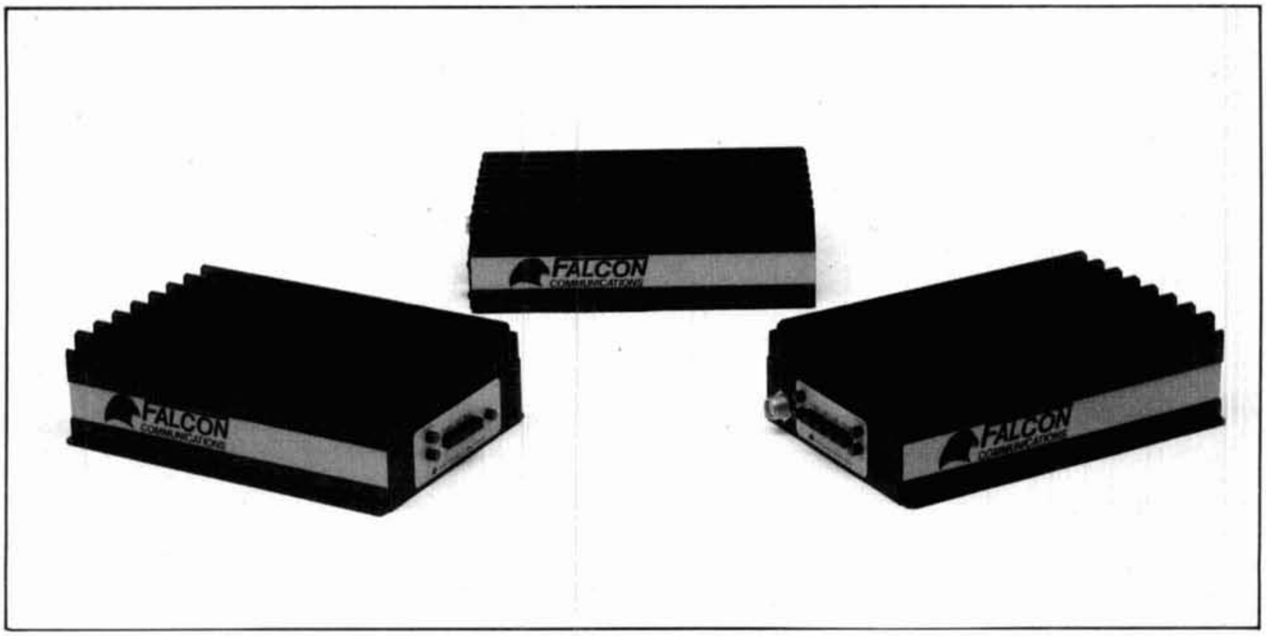
Coax connectors: UG-58 with teflon insulation, flanges turned to fit pipe, soldered.

ham radio

FALCON COMMUNICATIONS

P.O. Box 620625 Woodside, CA 94062 (415) 851-8779

The only manufacturer offering Amateurs the advantages of MOSFET RF Power Amps



MOSFET Mobile Power Amplifiers

4101 Complete 2 Meter Handie Talkie Accessory - All mode RF power amp., 2 Watts in = 25 Watts out, 50 Watt max.. Regulated power supply, with adjustable current limit, for HT power or battery charge. 4 Watt speaker amplifier. Optional plug-in receive preamp. You must fabricate a cable to connect to HT; plug supplied. **$215**

4102 Complete 2 Meter Handie Talkie Accessory - All mode RF power amp., 2 Watts in = 100 Watts out. Regulated power supply, with adjustable current limit, for HT power or battery charge. 4 Watt speaker amplifier. Optional plug-in receive preamp. You must fabricate a cable to connect to HT; plug supplied. **$325**

4103 All Mode 100 Watt 2 Meter Amplifier - 10 Watts in = 90 Watts out, 2 Watts in = 30 Watts out. No harm with 25 Watt transceivers. Optional plug-in receive preamp. Optional #4106 remote control. **$245**

4104 All mode 100 Watt 220 MHz amplifier - 10 Watts in = 70 Watts out, 2 Watts in = 25 Watts out. No harm with 25 Watt transceivers. Optional plug-in receive preamp. Optional #4106 remote control. **$245**

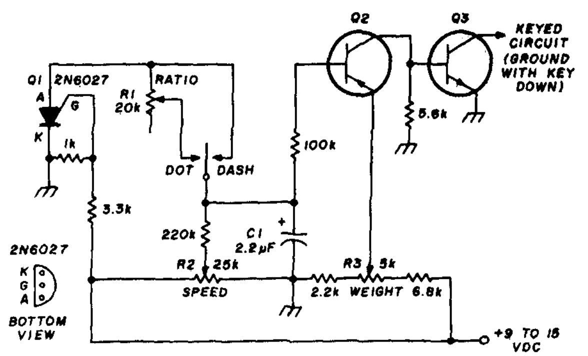
4105 All mode 100 Watt 2 Meter amplifier - 2 Watts in = 100 Watts out. Optional plug-in receive preamp. $295

Also come to FALCON for your MOSFET Repeater Amplifiers

More Details? CHECK—OFF Page 152

the weekender

simple, compact QRP keyer



Q2 PNP SILICON TRANSISTOR 2N3906 OR SIMILAR

Q3 NPN SILICON TRANSISTOR 2N3904 OR SIMILAR

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

fig. 1. Simple QRP keyer uses unijunction transistor for timing.

I recently built a QRP CW transceiver and decided to use one small cabinet to house the radio, rechargeable batteries, and a keyer. After completing the transceiver and squeezing in the batteries I found I had left myself less than two square inches of board space for the keyer circuitry.

Because contemporary electronic keyers use one or more ICs and quite a few additional components, I needed to find a simpler, more compact approach. I also wanted self-completing characters and very low battery drain. Dot and/or word memory and digital precision were features I could do without in this application.

The circuit that evolved, shown in **fig. 1**, does the job very nicely, fits easily on 1.5 square inches of board space, and consumes less than 4 mA, key-down, at 12 VDC.

In lieu of the usual digital clock, this keyer uses one of the unijunction family of devices as the basic timing device. Unijunction devices (UJTs), which have been around almost as long as the basic transistor, have several unique characteristics that make them quite different from those of the conventional two-junction transistor. These features include stable triggering voltage, very low value of firing current, high pulse current capability, and low cost.

The circuit (**fig. 1**) uses these characteristics of the UJT to generate a precisely timed sawtooth waveform. This is formed by the exponential voltage build-up across capacitor C1, and the abrupt discharge of this voltage when the UJT "fires," or triggers. Dashes and dots are self-completing because the UJT has no effect on the capacitor charge until the triggering point is reached. Potentiometer R2 controls the rate of charge of C1 — hence the keying speed. R1 sets the ratio for the generation of dots.

The sawtooth waveform is applied to a PNP transistor, Q2, where it is shaped and amplified. The output of Q2 is direct-coupled to Q3, the switching or keying transistor. R3, the "weight" potentiometer in the emitter of Q2, controls the switching threshold (the on-off periods) of Q2 and Q3.

I use the collector of Q3 (which goes to ground when the key is down) to key the emitter of the transmitter driver transistor that draws about 20 mA. You can, of course, key any circuit that requires ground to transmit provided you stay within the current and voltage capabilities of Q3.

A relay with a DC coil resistance of 500 to 3000 ohms can be used in the collector of Q3. The relay coil is connected between the collector of Q3 and +12 VDC as shown in **fig. 2.** This arrangement will increase the current drawn by the keyer another 5 to 25 mA, depending on the relay coil DC resistance. Reed relays are recommended and work well for keying small, non-inductive current loads. An inductive load such as an iron-core choke in series with the keying lead will generate an inductive charge. If not damped, this charge will quickly weld together the contacts of the reed relay.

limitations

The limitations of simple circuits such as this are often overlooked or glossed over by enthusiastic authors, with resultant heavy mail and telephone traffic to the publication and/or author. To minimize such communication, let me say that this simple keyer will work very well if the following precautions are taken.

First and most importantly, the DC supply voltage must be constant (either through regulation or a stable source) because the timing of the sawtooth generator as well as the switching thresholds of Q2 and Q3 are a direct function of the supply voltage. Poor voltage

By Jack Najork, W5FG, 3728 East 85th Place, Tulsa, Oklahoma 74136

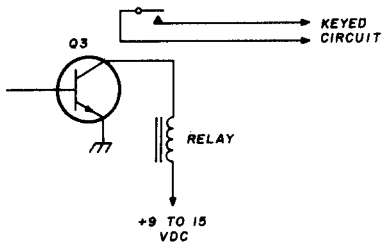


fig. 2. Reed relay can be driven by Q3 for keying circuit isolation.

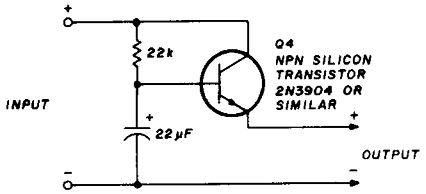


fig. 3. Decoupler circuit helps to reduce AC power supply ripple from DC line.

regulation will cause erratic characters. Long-term changes in supply voltage from, for example, 12 volts to 10 volts, will drastically affect the weight of the characters, and to a lesser extent, the speed. The keyer will work well with supply voltages of 9 to 15 volts. Once the operating voltage is selected it must remain at that value; if it does not, all controls will require re-adjustment.

I use heavy duty batteries to avoid these problems. If an AC supply is used, the simple regulator-decoupler shown in **fig. 3** does a good job of cleaning up the supply voltage source.

With the possible exception of C1 and Q2, component tolerances are not critical. C1 must be 2.2 microfarads. (1µF is too small and 3.3 µF is too large.) Q2 should have a fairly high beta — at least 60 or 70 — so either avoid the unknown junk-box types entirely or use a socket and make sure your choice works properly. The 2N6027s appear to be non-critical. All six of mine, from two different manufacturers, worked well with no noticeable variation in the characteristics needed for this application.

Finally, if a relay is used, try to use a reed type or one with a short, snappy armature throw. The keying waveform coming out of Q3 is more triangular than rectangular. A sloppy relay will generate satisfactory dashes but skimpy dots, and you won't be able to compensate for this with the "weight" or "ratio" controls.

ham radio

FM-2033

2m C-MOS MICROPROCESSOR CONTROLLED DIGITAL SYNTHESIZER FM TRANSCEIVER

Shown actual size.

6 in 1!

Exclusive KDK 6 in 1 control is now joined by 6 exciting new KDK features:

NEW! % Soft Orange background Liquid Crystal Display (LCD) for direct sunlight viewing plus lighting for night viewing.

NEW! % Offset (+, −, S) stored in memory along with the frequency information.

NEW! % Frequency coverage of 142.000 to 149.995 MHz for M.A.R.S. and C.A.P. usage.

NEW! % Chrome front panel with accent knobs and lighter color on case to match today's auto decor.

NEW! % Scan for signal now has 3-second delay before resume after loss of signal.

NEW! % Repositioned controls for more convenient operation.

The Exclusive KDK 6 in 1 Knob.

- Only memories with data are scanned; blanks are skipped.
- Complete memory back-up with power unplugged. Re-chargeable Ni-Cd with capability of several months back-up of memory.
- Single frequency sub-audible tone generator included as a standard feature.
- Tone unit switch on front panel to prevent "humming" on the wrong channel.
- Repeater input monitor capability with the push of a single momentary switch.
- Solid-state level meter for both output level and input level monitoring.
- User programmable initial characteristics for band limits, channel step size, etc.
- Odd repeater splits can be handled with the memory in the AxB mode.
- Programmable band-scan limits are stored in protected RAM.
- Modular construction with pluggable interconnecting wiring.
- Touch-Tone* microphone TM-2 is standard with each radio.
- Change channels, skip-scan or step up and down the band from TM-2 microphone.
- Audible beep for end-of-band or last memory location for better "eye's off" operation.

The KDK FM-2033 represents a significant advance in user convenience and simplicity of operation for the radio user. The KDK '33' series of transceivers provides excellent readability in any lighting condition for either the operating frequency or the memory channel number in use. The use of a warm orange background for the LCD displays improves the readability by providing an easy on the eyes contrast improvement.

Simplicity of operation has always been the mark of the KDK design team and the FM-2033 is no exception. From the single knob frequency and memory selection to the automatic recall of the desired repeater offset from memory, the FM-2033 continues to provide relaxed, comfortable mobile operation.

Once the 10 memory frequencies have been selected, a single knob is all that is required for operation on the standard simplex or repeater channels. Using the audible beep as the end of memory marker allows setting to a particular channel without even looking at the radio.

In the scan mode, scanning for a busy memory or pre-programmed band scan keeps you up to date on the happenings in the area. Very busy frequencies can be skipped by using the up key on the TM-2 microphone. If a full 10 memories are not used, the unused ones can be marked for scan skip so that no time is wasted checking them.

The FM-2033 provides a clean 25 watt output signal across 142 - 149.995 MHz to operate in balance with most repeater signals and provide quieting on the simplex operations. M.A.R.S. (NAVY too!) and C.A.P. frequencies are also accommodated.

You want convenience, reliability and easy operation for your mobile station and a tough to beat dollar value. Check out the FM-2033 at your local dealer TODAY or send a QSL for specifications.

* Touch Tone is a Registered Trade Mark of American Telephone and Telegraph.

Specifications are nominal and are subject to change. All KDK transceivers meet or exceed FCC regulations regarding spurious emissions.

KDK

Distributed by
Encomm, Inc.
2000 Avenue G, Suite 800, Plano, Texas 75074
Phone (214) 423-0024 TLX 79-4783 ENCOMM DAL

144

applied Yagi antenna design part 6: the model and a special teaching tool

Understanding and using the FORTRAN program

In this concluding article, the FORTRAN code used in the model is discussed on terms of its organization and logic flow, and an interesting teaching example also presented.

A copy of the program is available from *ham radio* (send an SASE with 37¢ postage). Please note that the program, designed to run on a mainframe computer, requires a FORTRAN 77 compiler or its equivalent. While a knowledgeable programmer can convert this program to BASIC, an understanding of the "architectural" differences between FORTRAN and BASIC is essential, as is familiarity with the use of both radians and degrees, as well as the rules of complex (vector quantity) arithmetic. A careful rereading of the first two articles in Lawson's series[1,2] is also recommended.

FORTRAN program structure

The program consists of seven logical parts, as depicted in **fig. 1**. The Driver contains array definitions, constant declarations, and the control logic for the five main subroutines. Each subroutine's name is an accurate description of what it does. The mathematics library contains the functions used in computing impedance components. The model's code has been carefully written to minimize execution time. This is especially true for the reactance calculations because they can be executed tens of thousands of times in a single session of Yagi iterations.

The Driver contains the Poynting vectors necessary for pattern calculations. These vectors are listed as constants in an extended DATA statement. As the vector values for the second 90 degrees follow from those of the first 90 degrees, a DO loop makes this assignment. This same loop adjusts the vector values slightly so a dipole has a calculated gain of 2.14 dBi. Further manipulation of the 0.997 multiplier leads to degraded pattern calculations. This is followed by calculation of the dipole pattern constants for each of 180 degrees. All of the Driver code to this point is executed only once — at the start of the initial run. Now the five subroutines can be called to calculate Yagi performance parameters. If a series of iterations similar to those in the first five parts of this series is desired, the nested DO loops begin at this point.

For those articles a primary loop was used to iterate reflector length. A secondary loop iterated director length within each discrete reflector measurement. For tapered directors a tertiary loop was used to apply the tapering constant to the second and subsequent directors. By definition, the first director cannot be tapered. If spacing is to be iterated, the loops for spacing can also be placed here, either in place of the length loops, or within them. When a frequency scan of a specific Yagi design is desired, element length, spacing and diameter are set as constants, and a frequency DO loop is coded. Element diameter (ELDIAM) is usually a constant, but this parameter can also be iterated.

GETDATA originally served to prompt for and accept the individual Yagi design approach parameters. After obtaining calculations for the Yagis in use at WB3BGU, the decision was made to write this six-part

*We regret that neither the author nor the staff of *ham radio* can provide software assistance or consultation.

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

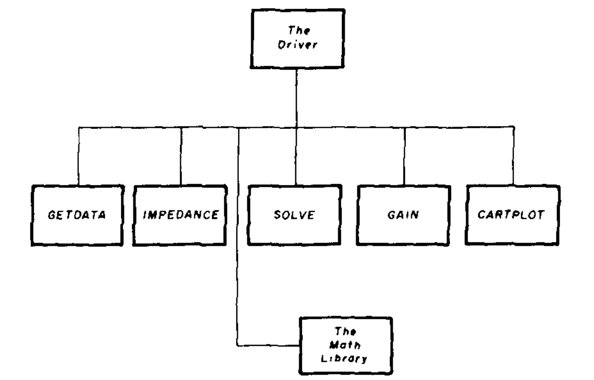


fig. 1. Internal organization of the Yagi analysis program.

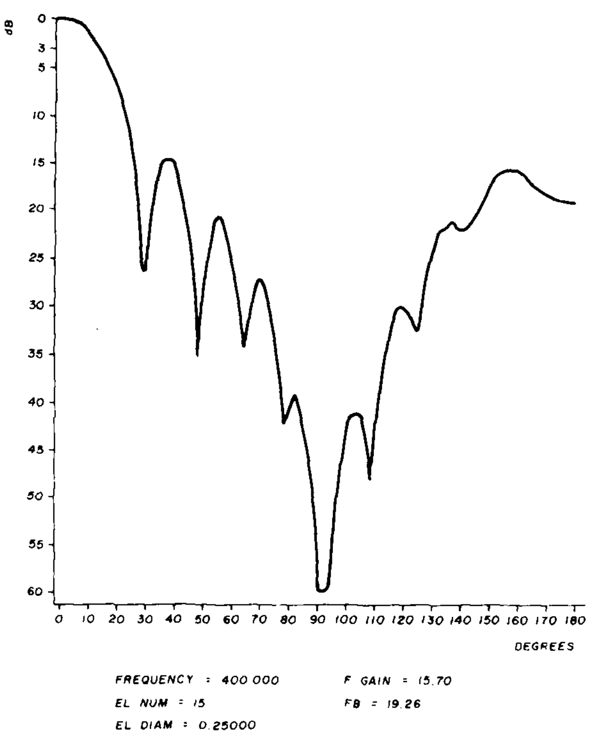


fig. 2. E-plane plot of the NBS 4.2 wavelength Yagi.

series of articles. Hence the need arose for either massive amounts of data input or the nested DO loops described above. This routine then became the place where ELDIAM, frequency (FREQ), and element spacing (ELSPACE) from the reflector were defined at each run's start. In the version provided, this routine sets the design parameters for the NBS family of Yagis. Experience indicates that most of the errors leading to erroneous output from the iterations can be traced to typos made in this routine. The importance of "sanity checks" on how a Yagi's design approach is described to the model cannot be overstated. Until experience is gained in working with the model, the user should consider printing the design parameters before the iterations begin.

IMPEDANCE calculates the self and mutual impedances among the Yagi's elements. The self-resistance of all elements is assumed to be 73 ohms, and the self-reactances are calculated from Lawson's approximations. The self-impedance of the driven element needs to be 73 + j0 for best results. While the third article in this series was being prepared, it became obvious that this constant could be assigned to the driven element, eliminating the need for calculating its zero reactance length to 0.000001 inch. Hence the second element's self-impedance is set to 73 + j0 ohms. If another element is to serve as the driven element, the user has to change the test made on index J. Mutual impedances are calculated in the manner stated by Lawson, using the Kraus formulas.[3] Instead of Kraus' power series or Lawson's less-than accurate approximations, the Sine and Cosine integral routines from the IONCAP program are used. They are also three orders of magnitude faster than either of the other methods. IMPEDANCE also makes good use of the fact that the mutual impedance between elements i and j is the same as between elements j and i, and calculates this value only once while storing it in both matrix locations. DO loop indices I and J have an unusual implicit relationship that allows for reducing the number of calculations in a manner proportional to the number of Yagi elements.

SOLVE provides the complex current solutions for each Yagi element. It is basically a routine that solves simultaneous linear equations. An array with one more column than number of rows is necessary because this extra column contains the solved complex current values. The second element is assumed to be the driven element and is driven with 10 + j0 volts. If as was described before, a different element is to be the driven element (or in the case of multiple driven elements), the user has to make the appropriate modifications. It is also possible to obtain exactly the same gain and F/B results with any other driven element voltage value, provided that zero phase is used. Because a digital computer is being used, an assumption has to be made for the value of "digital zero;" this is the value used to test the complex matrix members for being equal to zero. This routine uses 0.00001 for this value. Smaller values may increase the number of iterations necessary for solving the matrix and not add anything measurable to the calculated gain and F/B. Up to this point the FORTRAN routines can be assumed to execute instantaneously. This was found to be true for Yagis with up to 20 elements. The two subroutines that follow consume the vast majority of the time necessary for a given Yagi's iterations.

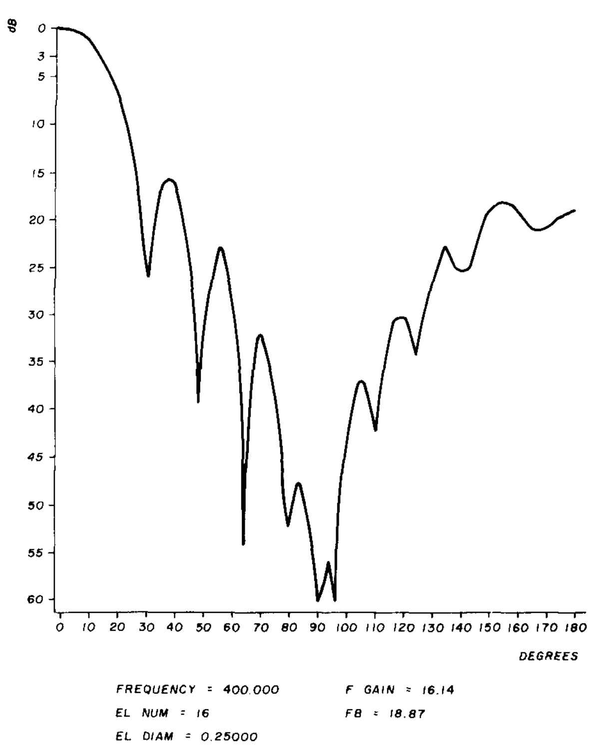


fig. 3. E-plane plot of the NBS 4.2 wavelength Yagi with an additional 0.424 wavelength-long director spaced 0.37 wavelengths from the reflector.

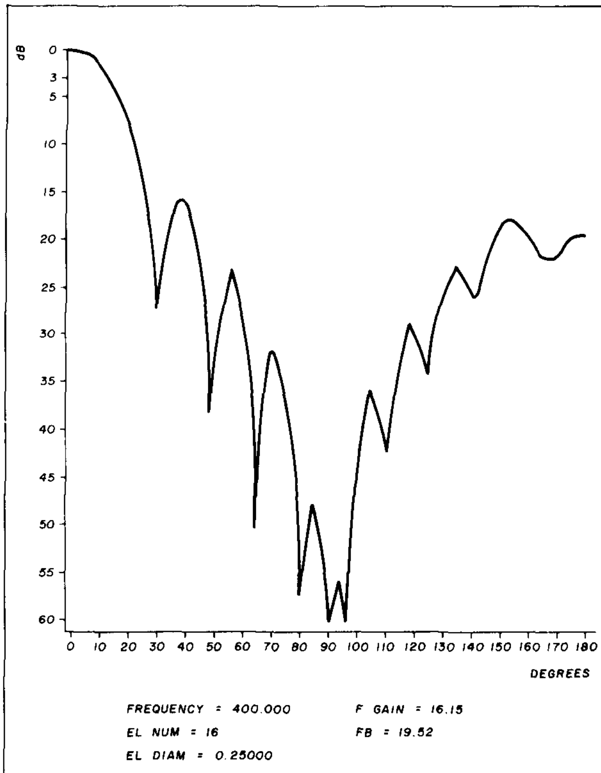


fig. 4. E-plane plot of the NBS 4.2 wavelength Yagi with an additional 0.430 wavelength-long director spaced 0.36 wavelengths from the reflector.

They contain multiple sets of nested loops that iterate each of 180 degrees within each Yagi element, or vice versa.

GAIN converts the complex current solutions in the matrix to complex voltages whose phase is in radians. A test is made for elements with zero current because they cause ATAN2 to fail. They also represent Yagis whose performance levels are undesirable. These Yagis are labelled as such and no further processing takes place. Yagi gain is calculated as a summation of each element's contribution in the forward (zero degree) direction as well as through the Poynting vectors. These values are saved for use during pattern generation and F/B calculation.

CARTPLOT calculates the F/B and either the E-plane or H-plane pattern. These patterns are then printed as normalized Cartesian plots. While coded to print only the E-plane pattern, the H-plane parameters are still computed. The user can adjust this routine to print either plane. The 180-degree intermediate values from the gain calculations are used with the dipole pattern to produce the E or H-plane plots, and to calculate F/B. If only the gain and F/B values are wanted (PLOTKEY = 0.0), a single line of output results. If a plot is wanted with full information on the Yagi (see the plots in any of the previous parts of this series), PLOTKEY is set to any non-zero value before calling CARTPLOT. Every second degree is plotted, and dB values are from zero to 60 dB. Values in excess of 60 dB are shown as 60 dB. To reliably print this many lines per page, hands-on control of the printer is almost a necessity. The user may want to change the code so the maximum dB value is 55 dB. Nulls of this magnitude are rarely achieved in practice, and are of informational value at best. To signify "off-page" values, the user may also want to change the code to print asterisks, periods, or some other symbol when these values are calculated. Because a line printer is a discrete device in terms of being able to print only in (many) fixed positions on the page, calculated dB values are rounded to the nearest integer value. The use of a pen plotter would circumvent this problem. It is also possible to use some sort of periodicity to emphasize small changes between predetermined dB values.

The **MATH LIBRARY'S** four functions are used by IMPEDANCE to calculate the mutual impedances. The resistive component is calculated by RMUT, and the reactive component by XMUT. SI and CI are the sine integral and cosine integral routines, respectively, from IONCAP. An IF statement has been added to CI to

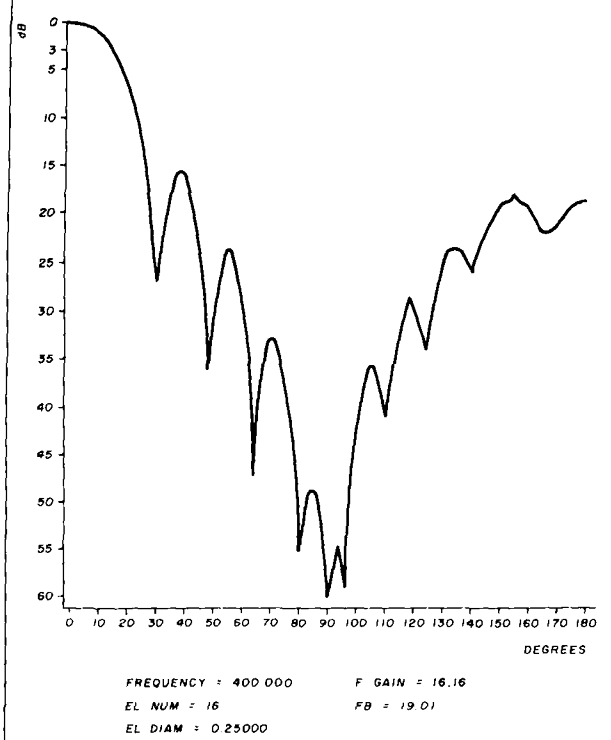


fig. 5. E-plane plot of the NBS 4.2 wavelength Yagi with an additional 0.435 wavelength-long director spaced 0.36 wavelengths from the reflector.

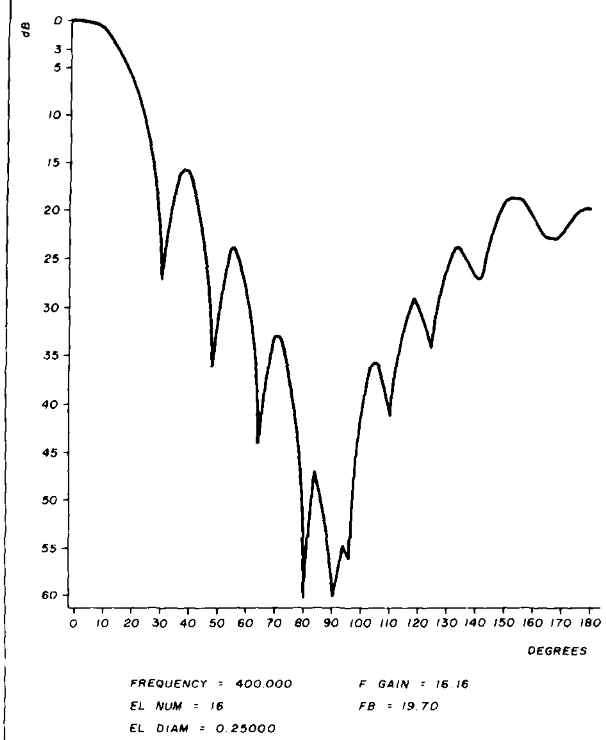


fig. 6. E-plane plot of the NBS 4.2 wavelength Yagi with an additional 0.440 wavelength-long director spaced 0.35 wavelengths from the reflector.

protect against an attempt to compute the LOG of zero. This will cause a software failure, and a small value is substituted for the zero. In actual practice a zero value cannot occur, but a simple precaution is easily taken. As with any program of this complexity, an example is in order. The 4.2 wavelength (15 element) NBS Yagi will serve as the teaching tool. In this example the model will be used to apply a long Yagi technique to this Yagi in an attempt to increase the calculated gain.

further optimizing the NBS 4.2 wavelength Yagi

Long Yagi techniques include placing one or more directors between the driven element and the first of the wide spaced directors. Up to this point the first of the wide spaced directors was the first director. Depending on the design approach used to implement long Yagi techniques, this same director may become the second, third, or even the fourth director. The Tilton/Greenblum Yagis, and to a greater extent the Knadle and Kmosko-Johnson Yagis that were examined earlier in this series, typify what is meant by long Yagi techniques. This new director (or directors) is generally believed to increase the Yagi's gain on what is substantially the same boomlength as before. This belief was shown to be true as a result of comparing computer-iterated Yagis that employed long Yagi techniques with the equal director spaced NBS Yagis of similar boom length.[4,5,6,7]

To accommodate an extra director and the spacing iterations to be done only for this director, the **DRIVER** code has to be slightly modified. The DO statement before the calls to the five subroutines is eliminated, but the associated CONTINUE is kept. GETDATA is called as before, but the NBS parameter is replaced with the integer constant 15. Code is now inserted to read the new director's length in wavelengths, and this is converted to a physical measurement at 400.0 MHz. A DO statement is now inserted to control the execution of the remaining subroutines. Its indices will serve to move the new director (element 16) between the driven element and element 3, the old first director. The driven element is 0.2 wavelengths from the reflector, and the old first director is 0.508 wavelengths from the reflector. A range of 0.21 to 0.45 wavelengths from the reflector for the extra director was selected and coded as follows:

```
DO 97 N=21,45
ELSPACE(16)=FLOAT(N)/100.0
```

STEP UP TO telrex

NOW FACTORY DIRECT!!!

Professionally Engineered Antenna Systems

TB5EM

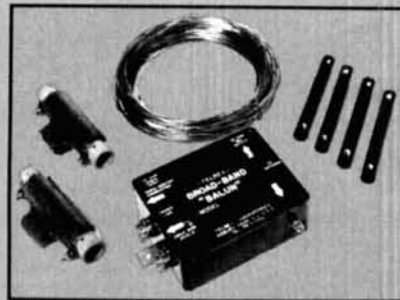
Only Telrex provides!

- Easy assembly **(within 2 hrs)**
- **100 mph** wind rating.
- **Heavy wall** tubing.
- **Stainless Steel** electrical hardware.
- **Exceptional** Gain and F/B ratio.

YOUR PRICE
$465.00
Value $555.00

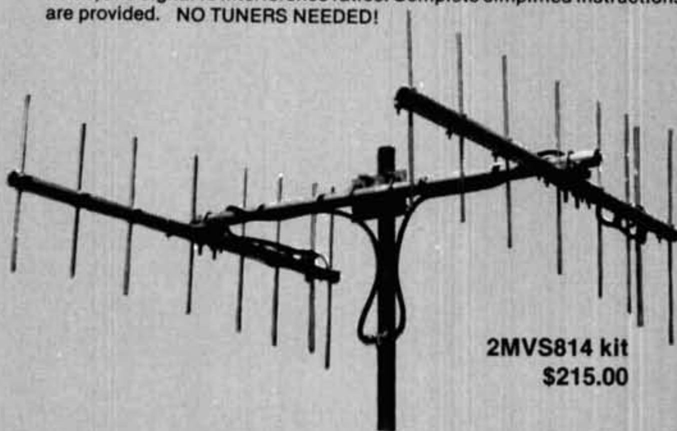
By the only test that means anything . . . on the air comparison . . . Telrex Tri-Bands continue to support the fact that they are designed to out-perform all competition . . . as they have for over 3 decades. Here's why . . . Telrex uses a unique trap design employing Hi-Q 7500 V ceramic condensers, 3 optimum-tuned reflectors to provide maximum gain and true F/B Tri-Band performance.

MIVD/2 frequencies
$89.50 Post Paid (U.S.)



A Telrex "Balun" fed "Inverted-Vee" kit is the ideal hi-performance inexpensive and practical to install low-frequency mono or multiple band, 52 ohm antenna system.

Better than optimum full sized Dipole performance in an antenna which can be set up within the hour, needing a minimal support structure (existing tower, house, tree, etc.). The "Inverted-Vee" produces a low-angle "Balanced" Omni-Directional pattern, which increases the signal to noise, and signal to interference ratios. Complete simplified instructions are provided. NO TUNERS NEEDED!

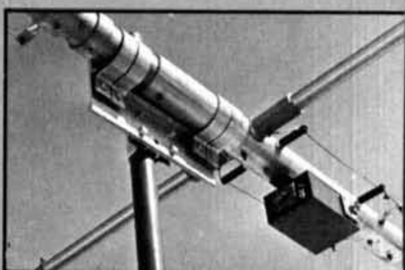


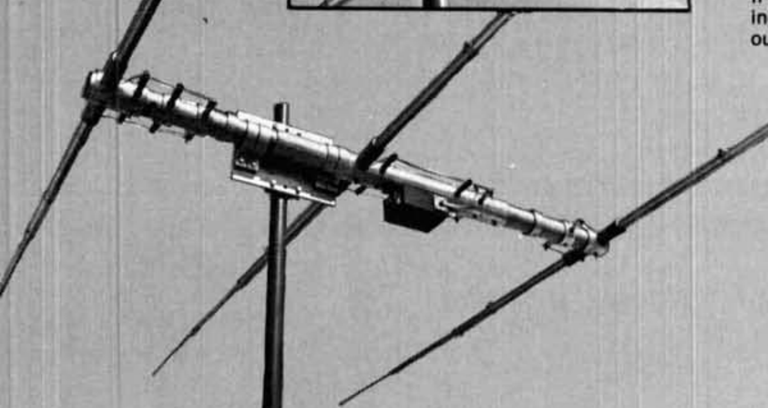
2MVS814 kit
$215.00

Special N-type coaxial connectors, solid rod elements (driven thru the boom), tinned connecting lugs, and s/s electrical hardware provide you with peace of mind for many years!

If top 2 Meter performance is your requirement, the 2MVS814 kit consisting of 2 ea. phased 2 Meter "Balun" fed precision tuned 8 element Arrays outperform even quad stacked antennas of other makes.

40M346
$1675.00
Value $2000.00

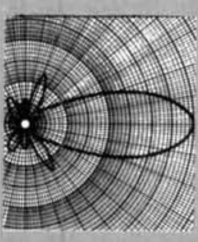




A FEW OF THE WORLD'S FINEST!

MODEL	Description	GAIN	Value	PRICE
2M1528C	2 Meter 15 element	(17 DBD)	175.00	**145.00**
10M523	10 Meter 5 element	(13 DBD)	352.00	**295.00**
10M636	10 Meter 6 element	(14.6 DBD)	745.00	**625.00**
15M532	15 Meter 5 element	(13 DBD)	555.00	**465.00**
15M845	15 Meter 8 element	(15 DBD)	1120.00	**925.00**
20M536	20 Meter 5 element	(12 DBD)	660.00	**550.00**
20M646	20 Meter 6 element	(14 DBD)	1130.00	**945.00**
40M214	40 Meter 2 element	(5.6 DBD)	750.00	**625.00**
40M329	40 Meter 3 element	(8.3 DBD)	1145.00	**965.00**
40M346	40 Meter 3 element	(9 DBD)	2000.00	**1675.00**
TB4EC	10, 15, 20M Tri-Band	(5.5 DBD)	252.00	**215.00**
TB5ES	10, 15, 20M Tri-Band	(8.5 DBD)	408.00	**340.00**
TB6EM	10, 15, 20M Tri-Band	(10 DBD)	755.00	**580.00**

T L I



ANTENNAS DESIGNED TO LAST!

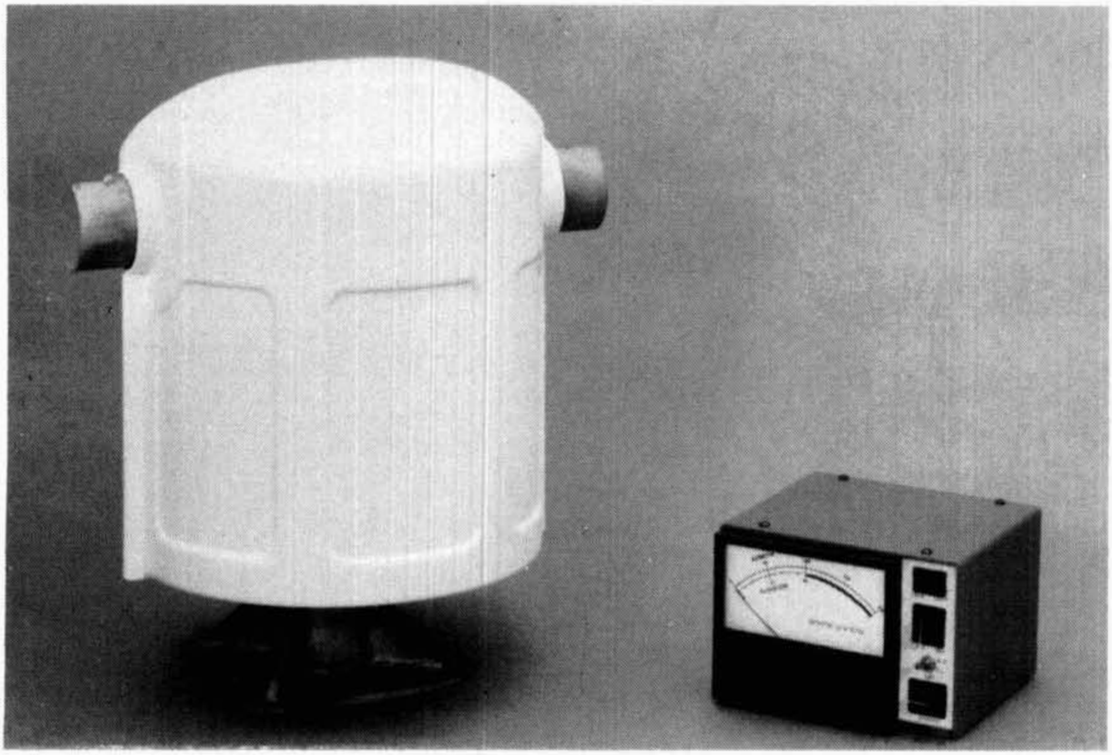
Communications Antennas Since 1921

Phone . . . 201-775-7252 (nights, weekends, holidays and leave your address) or write Telrex - P.O. Box 879, Asbury Park, N.J. 07712, for your free copy of the latest Telrex UHF, VHF, HF Antenna, and Rotator Catalog.

telrex LABORATORIES
P.O. Box 879 - Asbury Park, N.J. 07712 Phone 201-775-7252

MasterCard VISA

NEW! OSCAR 10
Dual Axis Rotor



As a leading manufacturer of precision motor drive systems, we believe the newly developed DR10 is the finest dual drive system for satellite antennas. To provide you the highest level of performance and convenience, the DR10 Dual Axis Rotor features:

- **COMPACT CONTROL UNIT WITH SELF CONTAINED AC POWER SUPPLY**
- **SINGLE DUAL SCALE METER (AZIMUTH/ELEVATION)**
- **SINGLE 8 WIRE CONTROL CABLE (BELDEN TYPE)**
- **STANDARD TOWER TOP MOUNTING**
- **ACCEPTS 1½ INCH ANTENNA BOOM**
- **SERVICEABLE WITHOUT ANTENNA REMOVAL**
- **DYNETIC SYSTEMS' HIGH TORQUE, PRECISION GEARMOTORS**

LIST PRICE LESS THAN TWO CONVENTIONAL ROTORS

NOW AVAILABLE

Our DR10 will out-perform any combination of conventional rotors popularly used, and is supplied ready to mount, including the rotor, control unit, and all stainless steel mounting hardware. (less cable)

✓ 142

For immediate ordering information, individuals and dealers call or write

612-441-4303

DYNETIC SYSTEMS
19128 INDUSTRIAL BOULEVARD
ELK RIVER, MN 55330

table 1. A comparison between the original NBS 4.2 wavelength Yagi's calculated performance parameters and the gain maximas for a series of similar Yagis with a director added as indicated.

length of additional director (λ)	spacing of additional director from reflector (λ)	Gain (dBi)	F/B (dB)
—	—	15.70	19.26
0.424	0.37	16.14	18.87
0.430	0.36	16.15	19.52
0.435	0.36	16.16	19.01
0.440	0.35	16.16	19.70
0.445	0.35	16.16	18.95
0.450	0.34	16.15	19.44
0.455	0.34	16.14	18.28
0.460	0.33	16.10	18.29

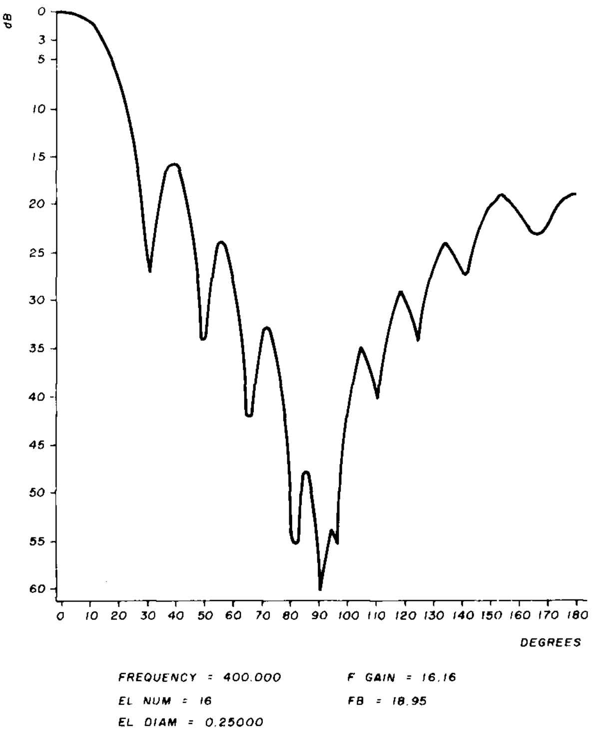


fig. 7. E-plane plot of the NBS 4.2 wavelength Yagi with an additional 0.445 wavelength-long director spaced 0.35 wavelengths from the reflector.

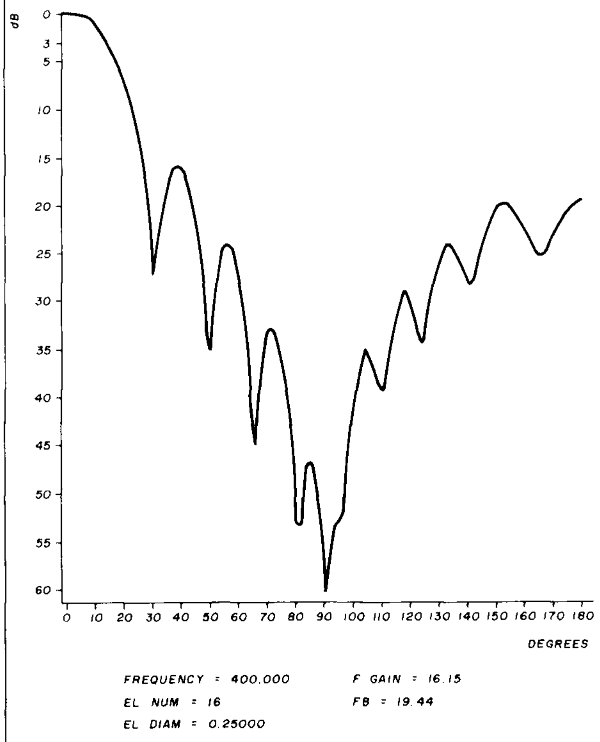


fig. 8. E-plane plot of the NBS 4.2 wavelength Yagi with an additional 0.450 wavelength-long director spaced 0.34 wavelengths from the reflector.

The remaining subroutines are called as before, but their NBS parameters are all replaced with the integer constant 16. The DO loop index should be printed during each iteration so as to identify the particulars for each line of gain and F/B calculations.

A summary of the test results of selected iterations is presented in **table 1**. Up to 0.46 dB of additional calculated gain is available by applying long Yagi techniques to this NBS Yagi. This is a significant part of the claimed 0.75 dB gain from the use of the NBS trigonal reflector, and without the additional elements on each side of the boom's plane and the attendant extra hardware.[8] **Figs. 2** through **10** contain E-plane plots for each Yagi summarized in **table 1**. While the increased forward gain is difficult to detect in the width of the main lobe, the main lobe's sharper definition through a deeper null and the reduction of many side lobe amplitudes, are visible. The calculated F/B ratios are more or less similar to that of the original Yagi and to each other. **Table 1** also indicates that as directors are moved closer to the driven element, they tend to become longer for optimal results. The new director

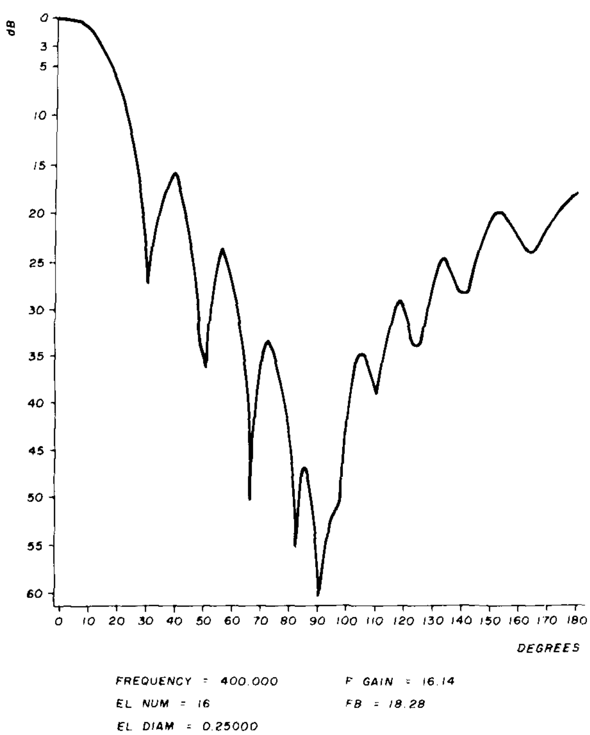


fig. 9. E-plane plot of the NBS 4.2 wavelength Yagi with an additional 0.455 wavelength-long director spaced 0.34 wavelengths from the reflector.

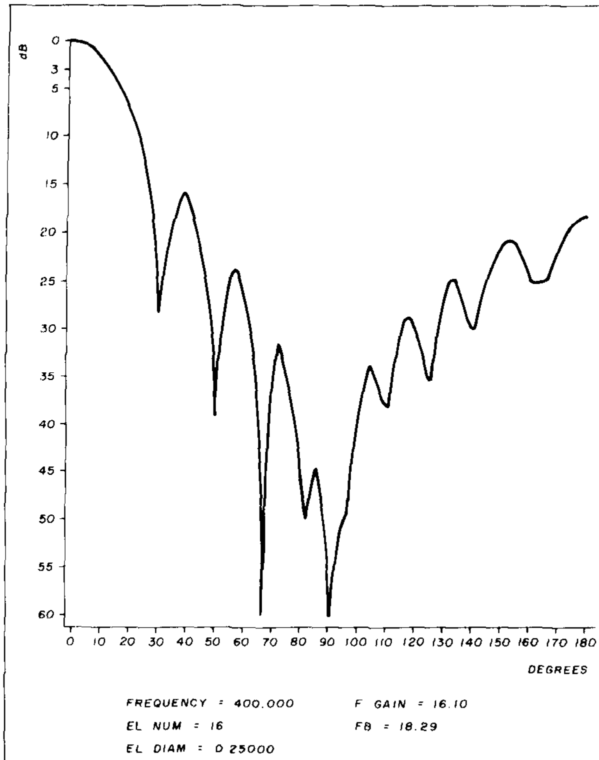


fig. 10. E-plane plot of the NBS 4.2 wavelength Yagi with an additional 0.460 wavelength-long director spaced 0.34 wavelengths from the reflector.

lengths used in these iterations begin with the length for the first director specified by NBS, and proceed in regular increments. Beyond 0.46 wavelength, Yagi performance deteriorates rapidly. With only one exception, the application of this long Yagi technique to the other NBS Yagis resulted in reduced gain. That exception produced an increase of 0.02 dB. The more experimentally inclined reader may want to iterate the model for the 4.2 wavelength Yagi with a second or even a third additional director.

conclusion

This six-part series has applied and made available a computer model for Yagi antenna design and analysis. Various Yagi design approaches were explored in terms of gain, F/B, and overall pattern, with preferable designs being selected for each band from 50 MHz to 432 MHz. The antenna is the most important part of a VHF/UHF station, and the careful selection of an antenna that is also well matched to a low-loss feedline is the single greatest step a Radio Amateur can take toward effective VHF/UHF communications. The Yagi antenna remains the most effective antenna in terms of achievable gain and minimum size. While the cost of transceivers, transverters, amplifiers, and pre-amplifiers continues to increase, very effective long Yagis can be constructed for comparatively little. This series has served to enable the VHF/UHF Radio Amateur to design that antenna with reasonable precision and with an accurate indication of how well that antenna will perform. VHF/UHF weak signal operators are basically experimenters, and it is with great interest that I look forward to future issues of *ham radio* to read the results of the experimental Yagi designs that other Amateurs produce with this model.

references

1. James P. Lawson, W2PV, "Yagi Antenna Design: Performance Calculations", *ham radio*, January, 1980, page 22.
2. James P. Lawson, W2PV, "Yagi Antenna Design: Experiments Confirm Computer Analysis", *ham radio*, February, 1980, page 19.
3. John D. Kraus, W8JK, *Antennas*, McGraw-Hill Book Company, Inc., New York, 1950.
4. Stanley Jaffin, WB3BGU, "Applied Yagi Antenna Design, part 1: A 2-Meter Classic Revisited", *ham radio*, May, 1984, page 14.
5. Stanley Jaffin, WB3BGU, "Applied Yagi Antenna Design, part 2: 220 MHz and the Greenblum Design", *ham radio*, June, 1984, page 33.
6. Stanley Jaffin, WB3BGU, "Applied Yagi Antenna Design, part 3: 432 MHz with Knadle and Tilton," *ham radio*, July, 1984, page 73.
7. Stanley Jaffin, WB3BGU, "Applied Yagi Antenna Design, part 4: 50 MHz as a Tilton/Greenblum Finale," *ham radio*, August, 1984, page 103.
8. Peter Viezbicke, W0NXB, "Yagi Antenna Design," *NBS Technical Note 688*, U.S. Department of Commerce, Washington, D.C., 1976, page 2.

ham radio

B. G. MICRO

P. O. Box 280298 Dallas, Texas 75228
(214) 271-5546

122

74LS

LS00	.29	LS162	.65
LS01	.24	LS163	.50
LS02	.29	LS164	.65
LS03	.27	LS165	.90
LS04	.29	LS166	.99
LS05	.25	LS169	1.25
LS08	.29	LS174	.60
LS09	.27	LS175	.50
LS10	.24	LS181	1.99
LS11	.24	LS191	.90
LS12	.30	LS192	.80
LS13	.50	LS193	.80
LS14	.50	LS194	.65
LS15	.32	LS195	.65
LS20	.27	LS196	.75
LS21	.28	LS197	.85
LS27	.28	LS221	.80
LS30	.30	LS240	1.00
LS32	.38	LS241	1.00
LS33	.50	LS242	1.00
LS37	.33	LS243	1.00
LS38	.34	LS244	1.25
LS42	.50	LS245	1.50
LS51	.24	LS251	.50
LS54	.25	LS253	.55
LS55	.27	LS257	.55
LS73	.35	LS258	.55
LS74	.45	LS259	2.50
LS85	.75	LS260	.50
LS86	.39	LS266	.50
LS90	.50	LS273	1.25
LS93	.55	LS279	.45
LS97	2.00	LS280	1.50
LS107	.37	LS283	.60
LS109	.39	LS290	.85
LS112	.39	LS293	.85
LS122	.45	LS298	.89
LS123	.75	LS299	1.60
LS124	2.75	LS323	2.60
LS125	.50	LS348	.75
LS126	.49	LS366	.45
LS132	.50	LS367	.50
LS133	.55	LS368	.40
LS138	.65	LS373	1.30
LS139	.65	LS374	1.35
LS151	.50	LS375	1.00
LS153	.50	LS377	1.49
LS154	1.75	LS378	.85
LS155	.50	LS390	1.19
LS156	.55	LS393	1.19
LS157	.60	LS399	1.25
LS160	.65	LS670	1.50
LS161	.60		

25LS2569 3.00

6500

6502	4.50	6545	7.50
6522	6.95	6551	7.50

STATIC RAM

2016-2KX8 200 n.s.	8/32.00
2101-1 - 256X4 500 n.s.	.75
21L02-1 350 n.s.	.65
2102AL-4 L.P. 450 n.s.	.49
2111-1 256X4 500 n.s.	2.00
2114L-3 1KX4 300 n.s.	1.50
	8/10.00
2125A-2 1KX1 70 n.s.	2.20
2142-3 1KX4 300 n.s.	1.50
TMS4044 (MCM6641 C-25) 4KX1 250 n.s.	8/6.00
5101 - 256X4 - CMOS	$1.00
6116P-4-2KX8 200 n.s. CMOS	8/37.50
6501-5 256X4 - CMOS	1.00

TTL

7400	.22	74121	.27
7402	.22	74123	.40
7408	.24	74125	.49
7410	.19	74151	.50
7413	.33	74153	.50
7420	.22	74154	1.19
7425	.25	74157	.50
7427	.25	74160	.80
7428	.25	74162	.60
7432	.27	74163	.60
7433	.25	74164	.80
7440	.19	74165	.80
7442	.40	74166	1.00
7451	.20	74173	.75
7473	.34	74174	.85
7474	.40	74175	.80
7483	.45	74185	1.70
7485	.55	74192	.70
7486	.30	74193	.80
7490	.35	74195	.80
7493	.33	74273	1.75
7496	.40	74367	.60
74107	.28	74390	1.40
74109	.45		

6800

6800	2.50	6821	2.95
6802	5.00	6840	10.00
6803	10.00	6845P	7.50
6809EP	10.00	6850	2.60
6810	2.00	68A21	4.95
6820	3.25	68B45	17.50

EPROM

2708 1KX8 450 n.s.	2.20
27A08 1KX8 350 n.s.	3.95
2758 1KX8 +5V 450 n.s	2.50
2716 2KX8 450 n.s.	3.20
2716-1 2KX8 350 n.s.	4.95
2732 4KX8 450 n.s.	4.75
2732A-3	5.70
2732A-35	5.20
2532 4KX8 450 n.s.	4.00
2764-3	5.95

4K STATIC RAMS

LESS THAN 50¢ EACH
MK4104J-4 - 250 N.S. 18 Pin Ceramic Computer Mfg. Surplus. PRIME. Fully Static. Easy to Use. Has Same Pin Out as TMS4044, but slightly different timing. With Specs. (Mostek)

8 for 5.00 32 for 15.95
VERY LOW POWER!

EPROM SPECIAL

We bought a large quantity of 2708s from a computer manufacturer who redesigned their boards. We removed them from sockets, erased and verified them, and now we offer the savings to you. Complete satisfaction guaranteed.

2708
$1.49 or 10/$12.00

SPECIAL

AY3-8910
W/60 Page Manual
New Price — $7.00

DYNAMIC RAM

2108-4 8KX1	1.50
2118-4 16KX1-5Volt	1.50
4027-4KX1-250 n.s.	.80
4116-16KX1-250 n.s.	8/8.00
4116-16KX1-200 n.s.	8/11.50
4116 16KX1-150 n.s.	8/12.95
4164- +5v 64K 200 n.s.	8/42.00
MK4516-15 16KX1-5Volt	1.50
5280N-5 (2107B-4 • TMS4060) 4KX1	8/3.95

UART

TR1602B (COM 2017)	2.20
1863 +5v	2.95
IM6402-+5v High speed UART-AY5-1013 pin out	2.95
INS 8250B	9.95

Z80

Z80 2.5 MHZ CPU	3.50
Z80CTC	3.75
Z80DMA-DMA	9.95
Z80PIO	3.95
Z80SIO/O	11.50
Z80A-4MHZ CPU	4.00
Z80A DART	9.95
Z80A-PIO	4.00
Z80A SIO/O	19.95
Z80B 6 MHZ CPU	9.50

F.D. CONTROLLERS

1771 Single Density	15.00
1791 Double Density	20.00
1793	22.00
1797	24.95
2793	35.95

CONTROLLER SET

THREE CHIP SET
1797, 2143-03, 1691 by W.D.
Compare at up to 86.85.
B.G. SPECIAL
All 3 for only $29.95

8000

Z8002	29.95	8085A	5.95
8035	5.00	8086-2	24.95
8039	5.00	8087-3	175.00
8080A	2.00	8088	20.00

8200

8202A	15.95	8251	4.20
8212	1.50	8257	6.00
8214	2.00	8259A	4.95
8216	1.75	8275	19.95
8228	3.25	8287	5.75
8237-5	10.50	8288	24.95
8250B	9.95		

SPECIALS

1408L8	2.00
1941L	5.95
LM311	.40
LF353	.60
LF356	.60
TL494	2.50
LM555	.30
733	.60
9401	5.00
DS8835	1.50
MC4024P	2.50
NE592	1.75
LM319	1.00
MC1350	1.00
LM2917	1.50
LM339	.50

SOCKETS

Low Profile SOLDER TAIL

6 Pin	14/1.00
8 Pin	13/1.00
14 Pin	10/1.00
16 Pin	8/1.00
18 Pin	8/1.00
20 Pin	7/1.00
24 Pin	6/1.00
28 Pin	6/1.00
40 Pin	5/1.00

BUY $10
GET $1.00 - FREE CHOICE

2114 SPECIAL!

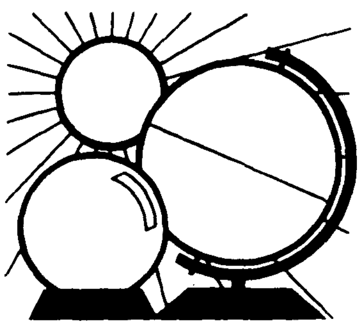
COMPUTER MANUFACTURERS EXCESS INVENTORY SALE!
PRIME! 2114-300 n.s.
INCREDIBLE PRICE!
YOU SAVE!
8/$9.00
GUARANTEED

CRYSTALS

32.768 Khz SPECIAL	.65
262.144	.75
300.000	1.00
307.200	1.25
1.5432 Mhz	.75
1.8432	2.49
2.000000	2.49
2.560	1.49
3.000	1.15
3.120	1.20
3.2	1.49
3.4560	1.49
3.579545 - HC18	1.00
4.000	2.49
4.194304	1.50
4.433618	.75
4444.000	1.25
4.9152	2.49
4.916 Bd. Rate	1.25
5.000000	1.50
5.0688	3.75
5.616	1.59
6.000	2.49
6.176	1.49
7.164112	1.49
7.3728	1.49
8.000	1.99
9.000	1.49
9.90000	1.25
10.69425	3.75
10.8864	1.49
10.920	1.49
11.088	1.59
12.000	2.75
13.440	1.00
14.31818	2.49
15.2	1.10
16.00000	1.50
16.5888	1.49
17.430	2.49
18.2259	1.00
20.000	3.75
21.87108	1.00
22.092	1.00
32.000	2.49
40.000	2.00
87.3333	1.00
91.000	1.00
104.8	1.00

TERMS: (Unless specified elsewhere) Add $1.50 postage, we pay balance. Orders over $50.00 add 85¢ for insurance. No C.O.D. Texas Res. add 6% Tax. 90 Day Money Back Guarantee on all items. All items subject to prior sale. Prices subject to change without notice. Foreign order - US funds only. We cannot ship to Mexico. Countries other than Canada, add $3.50 shipping and handling.

More Details? CHECK—OFF Page 152



DX FORECASTER

Garth Stonehocker, KØRYW

solar cycle review/preview

A review of the past six months and a preview of the next few months of the 11-year sunspot cycle (SSN) of solar activity should be useful in forecasting propagation conditions.

The earth's geomagentic field is affected by particle influx from the sun, which in turn depends on the level of solar activity. The sun's output, expressed in flux or SSN, affects both the amount of signal absorption (and consequently the LUF, or lowest usable frequency) and the highest band we can use (the MUF or maximum usable frequency). There is a relationship between variations in signal levels (QSB) and this particle influx.

How will the signal parameters LUF, MUF, and QSB change in relation to the solar cycle by next spring? The solar flux decreased from a maximum last spring to a minimum value in August — not an unusual solar trend for most years. This year's maximum, however, was larger than most annual increases that normally occur in the winter-spring period. In addition, this spring an inflection point (increase) occurred in the recorded values of SSN two thirds of the way down from the maximum. The coincidence of the two produced an SSN level of 80 (flux 128) for the period, (February through May, 1984) about 20 SSN's above normal. This meant that MUF's were about 6 to 7 MHz higher than usual on mid-latitude propagation paths over the four-month period. Now at approximately SSN 32 we should be edging up so that next spring another slight maximum of about 8 to 10 SSNs above the average base value of 36 (flux 87) will be realized. We will check on our SSN cycle status next spring.

What does this mean in terms of working DX over the next few months? The signal strength is expected to increase because of the seasonal affect during winter as the "sun moves south," and the Northern hemisphere turns away from the sun. Not all of the signal increase is due to seasonal changes but also from the annual solar flux increase (the sun is closer to the earth) as well. At the same time, higher MUFs should provide more and longer openings on the higher frequency bands (10 and 15 meters) than at the present time. Particle influx into the polar regions are expected to be small from the minor solar flares, but may be significant from coronal hole activity, though these geomagnetic-ionospheric disturbance effects from the latter source are not intense, they are long — as long as 3 to 5 days. DX signals will probably exhibit fading (QSB) during these disturbed times. On the positive side the clouds of ionization moving around during the disturbance often focuses a weak DX signal from a new location right to you. These enhanced signals are usually from *off*-great-circle propagation paths and are short-lived in time. Be ready to take advantage of them and work them rapidly before the propagation mode quits.

last-minute update

Equinox DX conditions should prevail for October. Expect conditions to rapidly change during this month. As a result of fewer hours of daylight, airmass thunderstorms changing to frontal passage types, midday higher frequency band long-skip replacing short-skip, and some geomagnetic disturbances will all have their effects on the ionosphere. This month the higher frequency bands, 10 to 30 meters, will be best the first and last weeks of the month during high solar flux periods. The two weeks in between will favor the lower frequencies and nighttime DXing. Geomagnetic-ionospheric disturbances may further affect operation on October 3, 8, 13, 18, 22, and 31.

The Orionid meteor shower will be visible from the 15th to 24th of October, with a maximum rate of between ten to twenty per hour on the 20th to 21st of the month. The moon is full on the 9th and perigee occurs on the 23rd.

band-by-band summary

Ten meters will be open to the southeast for a short period before noon, to the south at noon, and to the southwest in the afternoon in local time. The openings will be longer and more frequent when the solar flux is at its 27-day cycle maximum. Even better transequatorial one-long-hop propagation will occur during disturbed periods. Tune in WWV at 18 minutes after the hour and note the geomagnetic field status announcement.

Fifteen and twenty meters, almost always open to some part of the world, will be the main daytime DX bands. Twenty should stay open on long southern paths into the night, while 15 will drop out in the late afternoon. Operate 15 first and move down to 20 meters. DX is 5000 to 7000 miles (8000 to 11,200 km) on these bands and one-long-hop transequatorial propagation is also possible, even more often than on 10 meters.

Thirty and forty meters are both day and night bands. Intermediate distances (1000 to 1500 miles or 1500 to 2200 km) in any direction represents

OCTOBER

WESTERN USA

GMT	2300	2200	2100	2000	1900	1800	1700	1600	1500	1400	1300	1200	1100	1000	0900	0800	0700	0600	0500	0400	0300	0200	0100	0000	
PDT	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	7:00	6:00	5:00	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	7:00	6:00	5:00	
ASIA FAR EAST	20	30	30	30	40	_40_	_40_	_40_*	30	_30_	_30_	_30_	_30_	_30_	_30_	_20_	_20_	20	20	20	20	20	20	20	N
EUROPE	20	20	20	20	20	20	20	20	20	30	30	30	_40_	_40_	_40_	_30_	_30_	_30_	30	30	30	30	20	20	NE
S. AFRICA	15	10	10	10	15	15	15	15	15	15	15	_20_	_20_	_20_	_20_	_30_	_20_	30	20	20	20	20	15	15	E
S. AMERICA	10	15	15	15	15	20*	20	20	20	20	20	20	_20_	_20_	_20_	_15_	15	15	10	10	10	10	10	10	SE
ANTARCTICA	15	15	15	15	15	15	20*	20	_20_	_20_	_20_	_20_	_20_	_20_	_20_	_20_	_20_	_20_	_20_	15	15	15	15	15	S
NEW ZEALAND	10	10	10	15	15	15	15	15	_20_	_20_	_20_	_20_	_20_	_20_	_20_	_20_	_20_	20	15	15	15	10	10	10	SW
OCEANIA AUSTRALIA	10	10	15	15	15	15	20	_20_	_20_	_20_	_20_	_20_	_20_	_20_	_20_	_20_	_20_	15	15	15	10	10	10	10	W
JAPAN	20	20	20	20	20	20	_20_	_20_	_20_	_30_	_30_	_30_	_40_	_40_	_40_	30	30*	20	20	20	20	20	20	20	NW

MID USA

GMT	2300	2200	2100	2000	1900	1800	1700	1600	1500	1400	1300	1200	1100	1000	0900	0800	0700	0600	0500	0400	0300	0200	0100	0000	
MDT	5:00	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	7:00	6:00	5:00	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	7:00	6:00	
ASIA FAR EAST	30	30	30	20	20	20	20	20	20	20	20	20	_30_	_30_	_30_	_30_	_40_	_40_	_40_	_40_	_40_	20	20	20	N
EUROPE	20	20	20	20	20	20	20	20	20	30	30	_30_	_40_	_40_	_40_	_40_	_30_	_30_	30	30	30	30	20	20	NE
S. AFRICA	15	10	10	10	10	15	15	15	15	15	15	20	_20_	_20_	_20_	_20_	_20_	_20_	20	20	20	20	15	15	E
S. AMERICA	15	15	10	10	10	10	10	10	15	15	15	15	20	_20_	_20_	_20_	_20_	_20_	_20_	20	20	20	15	15	SE
ANTARCTICA	15	15	15	15	15	15	20	20	_20_	_20_	_20_	_20_	_20_	_20_	_20_	_20_	_20_	_20_	20	15	15	15	15	15	S
NEW ZEALAND	10	10	10	10	10	15	15	15	_20_	_20_	_20_	_20_	_20_	_20_	_20_	_20_	20	20	20	15	15	15	10	10	SW
OCEANIA AUSTRALIA	10	10	15	15	15	15	20	20	_20_	_20_	_20_	_20_	_20_	_20_	_20_	_20_	20	20	15	15	15	10	10	10	W
JAPAN	20	20	20	20	20	30	_30_	_30_	_40_	_40_	_40_	_40_	_30_	_30_	_30_	_30_	_30_	30	20	20	20	20	20	20	NW
CDT	6:00	5:00	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	7:00	6:00	5:00	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	7:00	

EASTERN USA

GMT	2300	2200	2100	2000	1900	1800	1700	1600	1500	1400	1300	1200	1100	1000	0900	0800	0700	0600	0500	0400	0300	0200	0100	0000	
EDT	7:00	6:00	5:00	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	7:00	6:00	5:00	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	
ASIA FAR EAST	30	30	30	20	20	20	20	20	20	20	20	_20_	_20_	_30_	_30_	_30_	_40_	_40_	_40_*	_40_	_40_	20	20	20	N
EUROPE	20	20	20	20	20	20	20	20	20	20	30	_30_	_30_	_40_	_40_	_40_	_40_	_30_	30	30	30	30	20	20	NE
S. AFRICA	15	10	10	10	10	10	15	15	15	15	15	20*	_20_	_20_	_20_	_20_	_20_	20	20	20	20	20	15	15	E
CARIBBEAN S. AMERICA	15	15	10	10	10	10	10	10	15	15	15	15	15	_20_	_20_	_20_	_20_	_20_	_20_	20	20	20	20*	15	SE
ANTARCTICA	15	15	15	15	15	15	20*	20	_20_	_20_	_20_	_20_	_20_	_20_	_20_	_20_	_20_	20	20	15	15	15	15	15	S
NEW ZEALAND	10	10	10	10	15	15	15	15	_20_	_20_	_20_	_20_	_20_	_20_	_20_	20	20	20	20	15	15	15	15	10	SW
OCEANIA AUSTRALIA	10	10	15	15	15	15	20*	20	_20_	_20_	_20_	_20_	_20_	_20_	_20_	_20_	20	20	15	15	15	10	10	10	W
JAPAN	20	20	20	20	20	30	_30_	_30_	_40_*	_30_	_40_	_40_	_30_	_30_	_30_	_30_	30	30	20	20	20	20	20	20	NW

The italicized numbers signify the bands to try during the transition and early morning hours, while the standard type provides the MUF during "normal" hours.

*Look at next **higher** band for possible openings.

daytime DX. Nighttime DX on these bands may be expected to offer greater distance than on 80 meters and, like 80, follow the darkness path across the sky. Reduced midday signal strengths and distances may occur on days of high solar flux values, with 30-meter openings disappearing in the pre-dawn hours on the morning after the high radio-flux value has occurred.

Eighty and one-sixty meters will exhibit short skip propagation during daylight hours and lengthen for DX at dusk. These bands follow darkness, opening to the east just before your sunset, swinging more to the south near midnight, and ending up in the Pacific areas during the hour or so before dawn. The 160-meter band opens later and ends earlier. Coastal stations and those with good low-angle radiating systems (good, long ground radials under a high vertical antenna) will usually have the edge for working rare DX. Some nights, QRN will be as low as during the wintertime DX season except when a frontal thunderstorm moves by your QTH.

ham radio

ham radio
Reader Service

For literature or more information, locate the Reader Service number at the bottom of the ad, circle the appropriate number on this card, affix postage and send to us. We'll hustle your name and address to the companies you're interested in.

101	113	125	137	149	161	173	185	197	209	221	233	245	257	269	281	293	305	317	329	341
102	114	126	138	150	162	174	186	198	210	222	234	246	258	270	282	294	306	318	330	342
103	115	127	139	151	163	175	187	199	211	223	235	247	259	271	283	295	307	319	331	343
104	116	128	140	152	164	176	188	200	212	224	236	248	260	272	284	296	308	320	332	344
105	117	129	141	153	165	177	189	201	213	225	237	249	261	273	285	297	309	321	333	345
106	118	130	142	154	166	178	190	202	214	226	238	250	262	274	286	298	310	322	334	346
107	119	131	143	155	167	179	191	203	215	227	239	251	263	275	287	299	311	323	335	347
108	120	132	144	156	168	180	192	204	216	228	240	252	264	276	288	300	312	324	336	348
109	121	133	145	157	169	181	193	205	217	229	241	253	265	277	289	301	313	325	337	349
110	122	134	146	158	170	182	194	206	218	230	242	254	266	278	290	302	314	326	338	350
111	123	135	147	159	171	183	195	207	219	231	243	255	267	279	291	303	315	327	339	
112	124	136	148	160	172	184	196	208	220	232	244	256	268	280	292	304	316	328	340	

Limit 15 inquiries per request.

NAME ______________________________ CALL ____________

ADDRESS ____

CITY ______________________ STATE __________ ZIP __________

Please use before November 30, 1984

October 1984

AFFIX POSTAGE
OR
POST OFFICE
WILL NOT
DELIVER

ham radio magazine

READER SERVICE CENTER
P.O. BOX 358
ARLINGTON, MA 02174

ATTN: Reader Service Dept.

More Details? CHECK—OFF Page 152 ✓ 155

ham radio TECHNIQUES

Bill Orr W6SAI

the beverage antenna

As old as the spark-gap and the Alexanderson alternator is the Beverage antenna. Even today it retains its popularity as a good, low-noise receiving antenna for 160 meters. Basically, the Beverage is a long wire (one to three wavelengths) suspended 10 to 15 feet above ground. Its maximum received signal level is from stations collinear with the wire (**fig. 1**). The Beverage can be made unidirectional by placing a resistive termination at the far end of the wire toward the direction of interest. Front-to-back ratios as high as 20 dB can be achieved. The value of the resistor falls between 200 and 500 ohms, depending upon the ground conductivity and the height of the wire above ground.

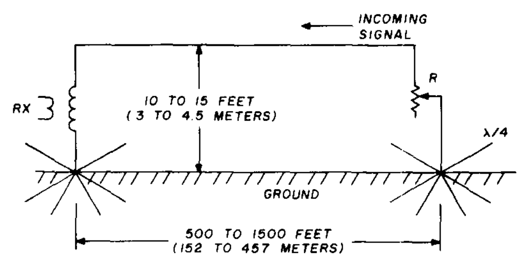


fig. 1. Single-wire, terminated Beverage antenna provides good results on 160 meters. Resistor R is adjusted for best front-to-back ratio.

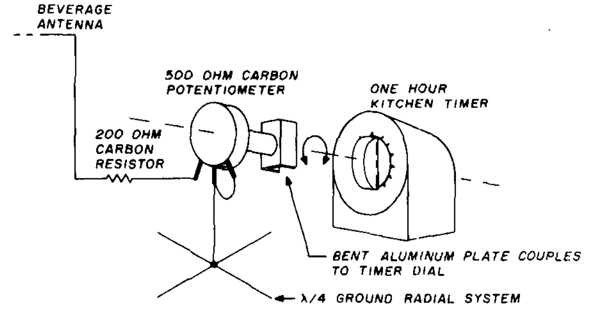


fig. 2. Simple U-plate of bent aluminum couples potentiometer to kitchen timer. Start timer and check value of front-to-back ratio of Beverage antenna over a period of an hour.

How does one determine the optimum value for this resistor? Bill Pfaff, K2GNC, has solved this problem with the device shown in **fig. 2**. His arrangement consists of a 500-ohm carbon potentiometer attached to a 1-hour kitchen timer by means of a bent aluminum coupling plate. The receiver is tuned to a broadcast station at the high end of the band and located off the back of the Beverage antenna. The experimenter now plots received signal strength against time, as measured on the timer. All that's necessary is to coordinate timer readings with the position of the potentiometer when the S-meter reading is lowest. This indicates the proper resistance (as measured on an ohmmeter) for best front-to-back ratio. The potentiometer is then replaced with a fixed resistor of the proper value.

Bill recommends that this test be run during the season of the year in which the antenna is to be used the most (probably winter), because the value of optimum resistance changes with the condition of the soil.

the K2GNC rotary ground plane antenna

Would I fool you? That's right — Bill also has a rotary ground plane. And if you don't believe me, just look at **fig. 3**. (Well, it's not *exactly* a ground plane, but I sure got your attention!)

The antenna is a modified 2-element Yagi beam working against a quarter-wave radial system. Quarter-wave elements are used as a radiator and a reflector, an idea developed by VK2ABQ. In this design, both elements are grounded to the center of the radial system and the radiator is shunt-fed by a gamma matching system. The elements are mounted in the vertical plane at an angle of about 70 degrees to each other.

Bill has made 40, 20, 15, and 10-meter versions of this simple beam. He reports it has good directivity but adds, of course, that he has no means of checking signal gain but says he gets good reports with it. The ground-mounted 40-meter version uses buried radials instead of ground-plane wires.

Standard 2-element beam dimensions, cut in half, are used in all antennas tested.

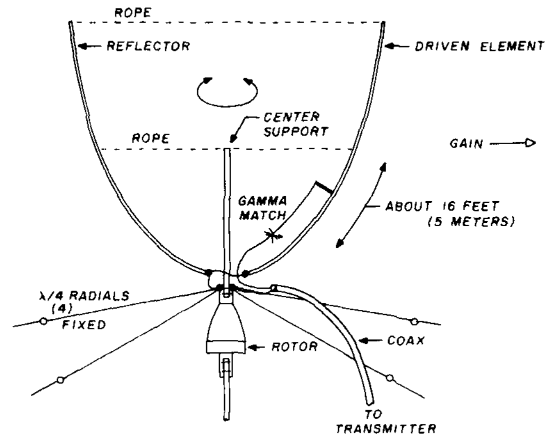


fig. 3. The K2GNC "rotary ground plane." This interesting vertically polarized array consists of a 1/4-wave driven element and reflector working against four 1/4-wave radial ground wires. The driven element is fed with a gamma match. All elements are connected to the tower (or mast) at center point, as are the radial wires.

the K2GNC 160-meter top-loaded vertical

Still another interesting antenna concept from K2GNC is a 160-meter antenna that uses the top loading system popularized by the British Marconi Company (**fig. 4**).

The vertical antenna consists of three sections of aluminum irrigation pipe, 4, 3, and 2 inches in diameter. Its overall height is 88 feet (26.8 meters).

Bill uses 130 radials, with an average length of 100 feet (30.4 meters), and a simple matching network to feed the antenna. The antenna works, as Bill's record of WAC and 115 countries to date on the "top band" proves!

(It's always a pleasure to hear about interesting antennas; I'll be looking forward to receiving more information from readers of this column.)

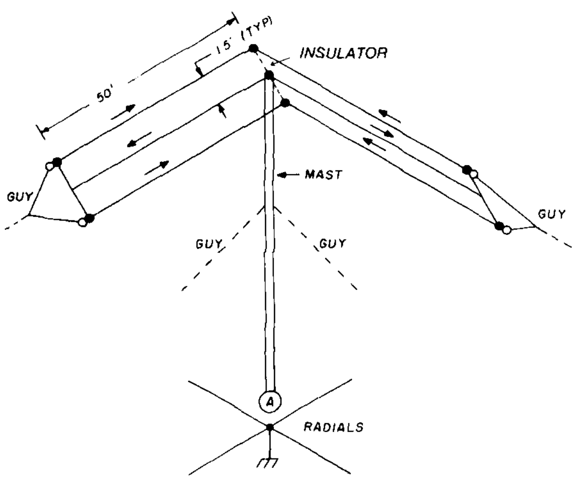


fig. 4. The K2GNC top-loaded vertical antenna for 160 meters. Flat-top currents essentially cancel and majority of radiation comes from 88-foot vertical element. Antenna is base-fed at point A via coaxial line and simple L-network. Spacing between wires is about a foot.

the world according to JA

We're all familiar with the Great Circle Maps centered on the United States. But have you ever seen a Great Circle map with Japan as the center point? Look at **fig. 5**. Most of the countries that we consider "real DX" are within a single ionospheric hop of Japan. Such prefixes as UJ8, AP, XZ and other goodies are right in the back yard of the JA hams. On the other hand, their "tough" DX spots (on an over-the-pole shot) are such commonplace locations as VP2, HH, KV4, FY7 and the eastern tip of Brazil. Note, too, that South America runs from about 10 degrees west of North to 150 degrees south of North. And Africa is stretched out in a similar manner to the West of Japan. In Japan, as in the United States, "DX is where you find it".

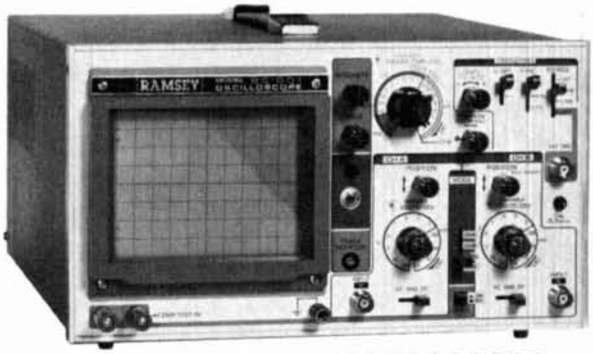
SSB voice quality

I've written in the past about the poor audio quality that seems to abound in SSB communication. Must this be so? Improved response in new microphones and auxiliary speakers tend to make voices sound a bit more realistic, but some sideband signals still seem very hard to tune for good voice quality.

Maybe there's more to this than meets the eye. Intrigued by what he

RAMSEY

THE FIRST NAME IN ELECTRONIC TEST GEAR

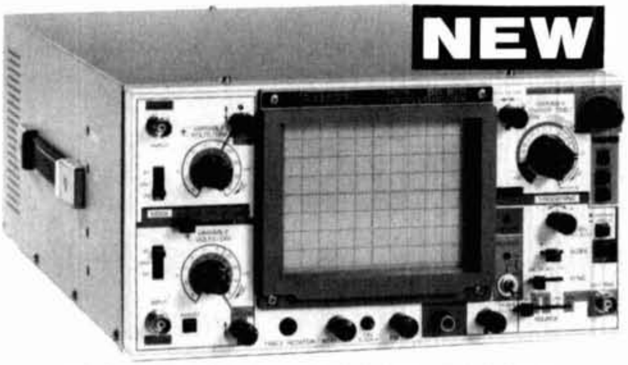


20 MHz DUAL TRACE OSCILLOSCOPE

Unsurpassed quality at an unbeatable price, the Ramsey oscilloscope compares to others costing hundreds more. Features include a component testing circuit for resistor, capacitor, digital circuit and diode testing. • TV video sync filter • wide bandwidth & high sensitivity • internal graticule • front panel trace rotator • Z axis • high sensitivity x-y mode • regulated power supply • built-in calibrator • rock solid triggering

$399.95 high quality hook on probes included

NEW



45 MHz DUAL SWEEP OSCILLOSCOPE

The Ramsey 625 is a dual time base, delayed sweep unit that includes a built in signal delay line to permit clear viewing during very short rise times of high frequency waveforms. Other features include: variable trigger holdoff • 20 calibrated sweep time ranges from 0.5 s/div to 0.2 µS/div. • fully adjustable sweep time • X5 sweep magnification • five trigger sources, CH1, CH2, LINE EXTernal and INTernal (V mode) • front panel x-y operation, Z axis input • sum difference of CH1, and CH2 waveforms displayed as single trace • sweep gate and sweep output • auto focus • single sweep

$799.95 high quality hook on probes included

RAMSEY D-1100 VOM MULTITESTER

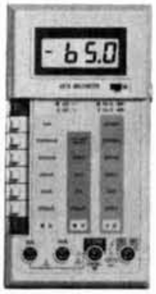
Compact and reliable, designed to service a wide variety of equipment. Features include • mirror back scale • double-jeweled precision moving coil • double overload protection • an ideal low cost unit for the beginner or as a spare back-up unit.

$19.95 test leads and battery included

NEW RAMSEY 1200 VOM MULTITESTER

Check transistors, diodes and LEDs with this professional quality meter. Other features include: decibel scale • 20K volt metering system • 3½" mirrored scale • polarity switch • 20 measuring ranges • safety probes • high impact plastic case

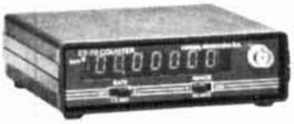
$24.95 test leads and battery included



RAMSEY D-3100 DIGITAL MULTIMETER

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

$49.95 test leads and battery included



CT-70 7 DIGIT 525 MHz COUNTER

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

$119.95 wired includes AC adapter

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

CT-90 9 DIGIT 600 MHz COUNTER

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

$149.95 wired includes AC adapter

CT-90 kit $129.95
OV-1 0.1 PPM oven timebase 59.95
BP-4 nicad pack 8.95

CT-125 9 DIGIT 1.2 GHz COUNTER

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

$169.95 wired includes AC adapter

BP-4 nicad pack 8.95

CT-50 8 DIGIT 600 MHz COUNTER

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

$169.95 wired

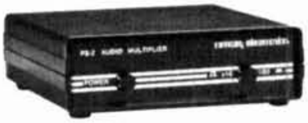
CT-50 kit $139.95
RA-1 receiver adapter kit 14.95

DM-700 DIGITAL MULTIMETER

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

$119.95 wired includes AC adapter

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



PS-2 AUDIO MULTIPLIER

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

$49.95 wired

PS-2 kit $39.95

PR-2 COUNTER PREAMP

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

$44.95 wired includes AC adapter

PR-2 kit $34.95

PS-1B 600 MHz PRESCALER

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

$59.95 wired includes AC adapter

PS-1B kit $49.95

ACCESSORIES FOR RAMSEY COUNTERS

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

VISA MasterCard

PHONE ORDERS CALL
716-586-3950
TELEX 466735 RAMSEY CI

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 • overseas add 15% for surface mail • COD add $2.50 (COD in USA only) • orders under $15.00 add $1.50 • NY residents add 7% sales tax • 90 day parts warranty on all kits • 1 year parts & labor warranty on all wired units.

RAMSEY

RAMSEY ELECTRONICS, INC.
2575 Baird Rd.
Penfield, N.Y. 14626

✓ 193

heard on the bands, Willie Sayer, WA6BAN, decided to run audio measurements on some of his SSB equipment. He did this by feeding the transmitter with an audio signal generator and sweeping the audio spectrum as he measured the power output of the transmitter into a dummy load. The results of this simple test may show why some rigs sound different than others.

Fig. 6 shows the microphone-to-antenna audio characteristics of an ICOM-730 run on upper sideband. Audio response is smooth with a passband of 2128 Hz between the -6 dB points of response. The audio oscillator is swept through the range and readings logged at the points indicated on the graph.

Fig. 7 shows an old Collins KWM-1 transceiver with a Collins F-455N-20 filter in it. The curve is run on upper sideband. The response shows a characteristic filter ripple of about plus or minus 1 dB, except for a dip in the curve at about 1500 Hz. Audio passband is 1842 Hz between the -6 dB points.

Fig. 8 shows a TS-830 with a Fox-Tango filter installed. The curve is run on upper sideband. The response shows a characteristic filter ripple of about plus or minus 1dB. Audio passband is 1992 Hz between the −6dB points.

The interesting fact is that all of these transmitters sound pretty good on the air, even though the passband filters have several decibels of ripple in the audio passband. Does the IC-730 sound better on the air than the TS-830? It's hard to tell, unless exacting tests are run with the same voice, microphone, etc.

But I do know that a true audiophile would frown at a passband with even a fraction of a decibel of ripple in it!

It remains to be seen when passband filters having smoother in-band responses become available whether voice transmissions on the Amateur bands will sound more lifelike and realistic.

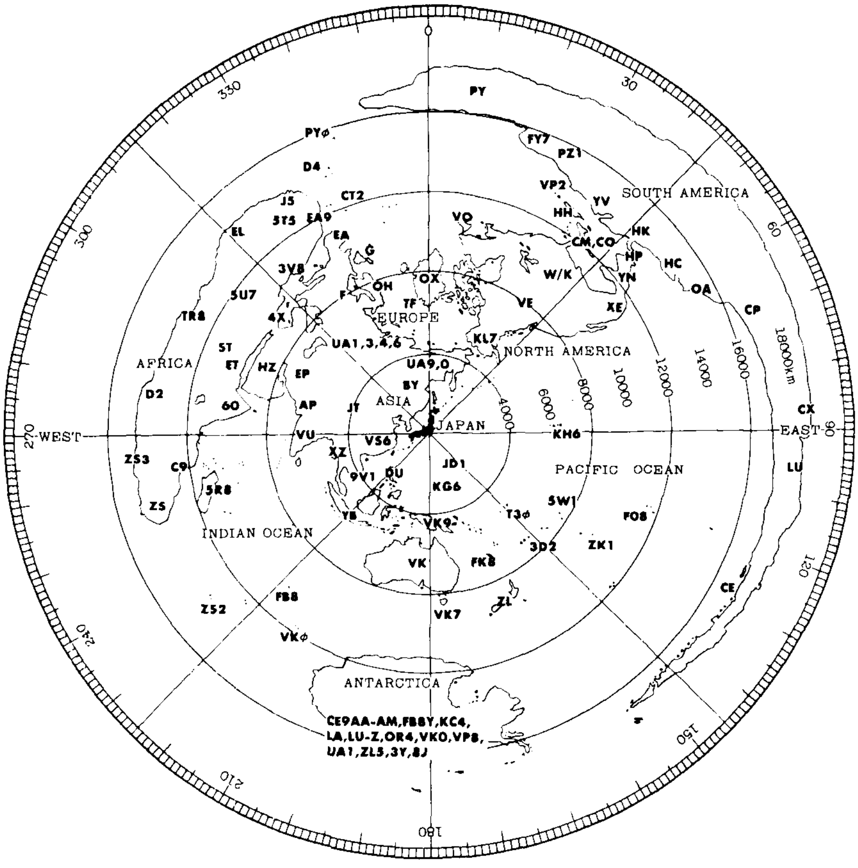


fig. 5. The DX world as viewed from Japan — Great Circle map centered on Tokyo. (Courtesy *CQ-ham radio* magazine.)

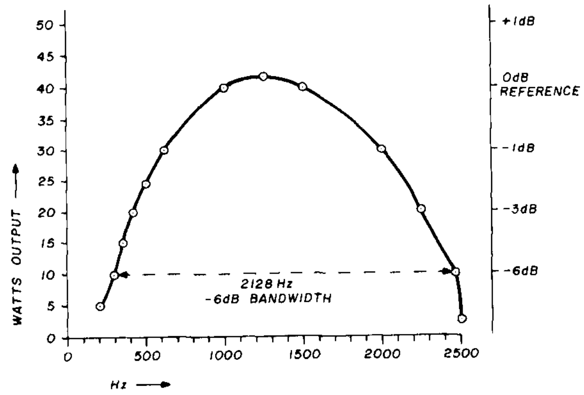


fig. 6. Passband of ICOM-730. Note smooth response with little or no cusps. Audio oscillator was swept over range of 200-2500 Hz.

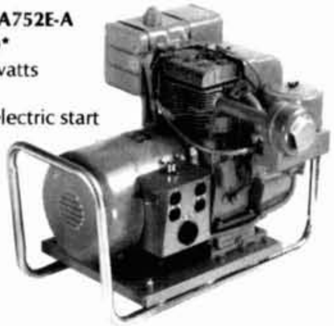
It's easy to examine the audio passband of your transmitter. The test setup of **fig. 9** will do the job. Reduce transmitter power by 3 dB (half power). This lets the equipment run cooler during testing and prevents the introduction of signal distortion that would invalidate the test results.

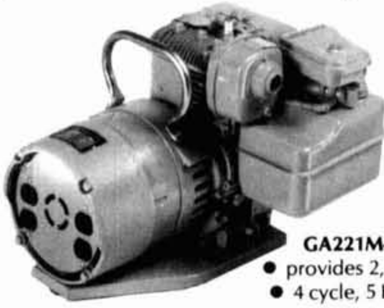
DON'T GET CAUGHT IN THE DARK

Sommer Emergency Home Generators 2250W to 7500 watts-as low as $395.00*

These compact, lightweight, portable power generators provide dependable emergency electricity at a very economical price. All Sommer power generators feature air-cooled gasoline driven, Briggs & Stratton engines, and field-tested, rugged alternators. Performance is backed by a One Year Engine Warranty and a Two Year Alternator Warranty.

Model GA752E-A
$1050.00*
- 7500 watts
- 16 HP
- with electric start





Model GA221M-$395.00*
- provides 2,250 watts
- 4 cycle, 5 HP engine

Built and rated for continuous service, superior performance and minimum maintenance, Sommer power generators are available in a variety of sizes. Model GA502M-A delivers 5,000 watts for $795.00*, and Model GA402M-A, 4000 watts for $675.00*.

PROTECT YOUR HOME AND FAMILY

Unexpectedly, you could be without power...from natural causes, such as snowstorms, tornados, ice, floods or hurricanes; or from electrical system failures. Today, power outages are becoming all too frequent. Not only does a power failure cause inconvenience but it can result in costly damage to your home. It doesn't take long for pipes to freeze, basements to flood or food to spoil. Be prepared. By having your own Sommer emergency power generator, you'll never have to worry about damaging your valuable belongings or equipment.

ORDER YOURS TODAY
Call: 1-312-956-1222

VISA

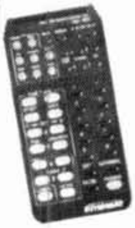
Illinois residents, add 7% sales tax
Charge it to your Visa or Master Card

MasterCard

SOMMER
ELECTRIC CO., INC
1430 Louis
Elk Grove Village, IL. 60007
(312) 956-1222

***DELIVERED PRICE TO ANYWHERE IN THE CONTINENTAL U.S.**

✓ 198



Use Your Wireless Control FROM ANY ROOM!!!

Works with most infrared remote control receivers

LIKE HAVING A SATELLITE RECEIVER, VCR, CABLE TV, AND VIDEO DISC IN EVERY ROOM!

- Remote control Satellite Receiver, VCR, Cable TV, and Video Disc can now be used long distance
- Install on any TV to access all your remote control video components
- Makes non-remote TVs remote controllable with remote control VCR, Cable Selector, or Satellite Receiver
- No fancy wiring needed uses existing coaxial wiring between TVs
- No extra controls to buy! Uses the hand held remote controllers you already have
- No tools required. Easily installed in minutes.

XTRA-LINK™
MODEL 170 XL

$79.95
Plus $3.00 shipping & handling

608-493-2291

DEALER INQUIRIES WELCOME

MERRIMAC SATELLITE
327 Palisade St. Merrimac WI 53561

SPACE · MasterCard · AMERICAN EXPRESS · VISA

✓ 170

HOBBY KITS®

EXPERIMENT — LEARN ELECTRONICS
BUILD AND DESIGN YOUR OWN AM, FM, CW, OR SSB RECEIVERS, TRANSMITTERS AND ETC. WITH OUR MINI-LINEAR CIRCUIT KITS
All kits Come Complete With Etched and Drilled Circuit Boards and All Parts Needed To Function As Described

AFA-1	AUDIO AMP. LM-380 1-2 Watts 4-16 OHM Output	$4.95
AFP-1	AUDIO PREAMP. Dual Audio Preamp — For Mike Etc	$3.95
BMD-1	BAL. MIX. LM 1496 Mixer — S.B. Modulator Tuned Output	$9.95
DET-1	AM DET. Am Envelope Detector With AGC Output	$3.95
DET-2	FM DET. LM 3065 FM Detector (455 KHZ or 4-11 MHZ)	$7.95
DET-3	SSB DET. LM 1496 SSB Detector (Needs OSC-1 or OSC-4)	$9.95
DET-4	DETECTOR CW/SSB using a dual gate FET transistor	$4.95
IFA-1	IF AMP. CA 3028 30 DB Gain, Optional AGC (455 KHZ or 9-11 MHZ)	$6.95
FLS-9	SSB FILTER 9 MHZ/2.1 KHZ BW with USB XAL for OSC-1	$49.95
IFA-2	IF AMP. CA 3028 30 DB Gain 1-100 MHZ Optional AGC	$6.95
MBA-1	FREQ. MULT. Tuned Output Buffer-Mult.-Amplifier To 250 MHZ	$5.95
OSC-1	CRYSTAL OSC. 100 KHZ — 20 MHZ Not Tuned	$3.95
OSC-2	CRYSTAL OSC. Ov. 18-200 MHZ Tuned Output	$4.95
PSV-1	POWER SUPPLY LM 723 With Pass Transistor, 3 amps max	$7.95
PLL-2	TONE DETECTOR LM567 PLL Tone Detector	$5.95
RF/MIX-1	RF-AMP/MIXER CA 3028 — Tuned RF AMP/Mixer 1-100 MHZ	$7.95
RF/MIX-2	RF-AMP/MIXER 3N204 Tuned RF AM/Mixer 1 — 250 MHZ	$7.95
VCO-3	VARIABLE HI STAB. OSC. Varactor tuned. 400 to 600 Khz output	$7.95
VCO-4	VARIABLE HI STAB OSC. Varactor tuned, 3 to 20 Mhz output	$7.95

Add $2.00 For Shipping & Handling — Send For FREE Brochure
SEND $2.00 FOR FULL MANUAL WITH CIRCUIT DIAGRAMS AND TYPICAL RECEIVER AND TRANSMITTER HOOK-UPS
MANY OTHER MODULES AVAILABLE

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

✓ 178

keying a linear amplifier with the TS-930

Ron Nail, K5HUI, ran into some problems when he tried to key a linear with his TS-930 Kenwood transceiver. Here's his story:

"When I bought my Kenwood TS-930 transceiver a few years ago, I was disappointed to find that it would not operate the antenna changeover relay in my linear amplifier. Kenwood's solution was to send me a reed relay, which I installed. However, using the relay produced annoying relay clicks and also introduced a slight time lag in an otherwise excellent full break-in system incorporated in the transceiver. In addition, arcing of the antenna relay contacts was observed.

"The solution to the keying problem (shown in **fig. 10**) was to install a solid-state relay that switches in microseconds instead of milliseconds, as does the reed relay. In addition, this scheme is absolutely quiet.

"The diode bridge eliminates polarity problems on the keying line and, with the optical isolation, the circuit performs in a normal fashion, with the *ability to switch up to* 120 VAC or 125 VDC without regard to polarity or ground.

"A pre-packaged diode bridge (or individual diodes) can be soldered directly to the solid-state relay pins. With double-sided tape, the little unit can be attached to the chassis side panel of the TS-930, underneath the autotuner. Keying for the amplifier is pin no. 7 of the remote connector and ground."

VTR-RFI

"If you go into a contest for 48 hours and run an appreciable amount of power, you're going to meet your neighbors." That's the unhappy prediction of "Bip," W6BIP, after a de-TVI session with a video tape recorder (VTR).

Bip has spent countless hours working on his (and his neighbors') VTRs, trying to prevent his signal from entering the units. He's almost succeeded.

Because of the nature of the beast, and the lack of internal shielding, the

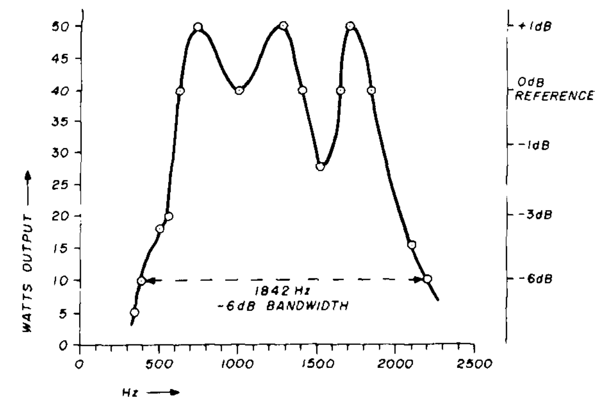


fig. 7. Passband of Collins KWM-1 transceiver with F-455N-20 filter. Note the "notch" at about 1500 Hz.

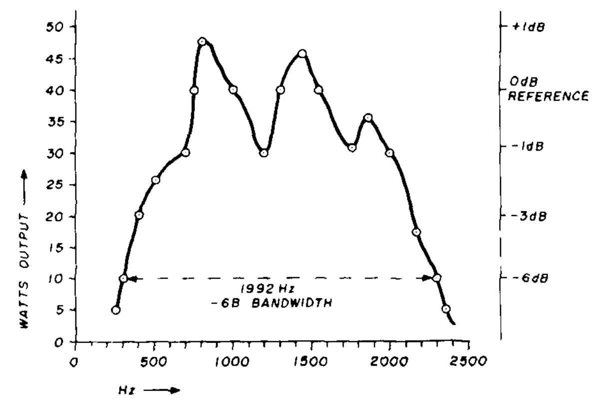


fig. 8. Passband of TS-830 with Fox-Tango filter installed.

fig. 9. Test set-up used to run audio response curves of SSB transmitter. Audio signal is inserted in microphone jack.

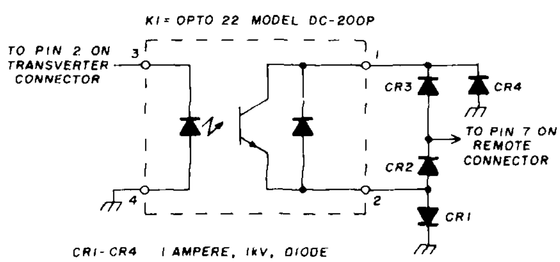


fig. 10. The TS-930 keyer of K5HUI. (The solid-state relay K1 is made by OPTO 22, 15461 Springdale Street, Huntington Beach, California 92649.)

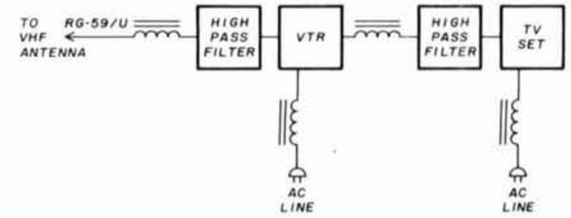


fig. 11. The W6BIP solution to VTR-RFI: wrap coaxial line to antenna and power cords to VTR and TV set around 1/2-inch diameter ferrite rods. A suitable rod is the Amidon R33-050-400 or R33-050-750. Rods have a permeability of 800 (No. 33 material).

VTR provides serious RFI (radio frequency interference) problems, particularly during playback of a tape. Interference can be expected from transmitting equipment operating on any frequency, says Bip, but the problem is worst at the low end of 80 meters, which corresponds to video processing frequencies of the unit. Transmitter power as low as 3 watts can raise havoc in the 3.5 MHz region, although it takes upward of 100 watts to cause the same picture degradation when the transmitter is operated at 3.8 MHz.*

Bip sees the challenge and rues the fact that his transmitting antenna is quite near to the TV reception antenna. But what can you do when you live on a narrow city lot?

Bip solved his RFI problem on all bands except 80 meters; on that band he has to run reduced power. But he can now run full power on all other bands up to 30 MHz using the modification of his VTR installation shown in **fig. 11.**

In this modification the TV antenna feed is RG-59/U and the line is wrapped around a ferrite rod just before it enters a highpass filter and the VTR. The power cable to the VTR is wrapped around a second ferrite rod.

The same procedures are used at the TV receiver end. The coaxial lead between the VTR and TV set is wrapped around a ferrite rod and a second highpass filter is installed at the TV set, as close to the tuner as possible. The power lead of the TV receiver is wrapped around a ferrite rod, too.

The combination of highpass filter and ferrite-wrapped coaxial lines isolates both the inner and outer conductors of the line from the strong RF field of the local transmitter. The ferrite-wrapped line cords reduce RF pickup from the power line.

That's about all you can do without digging into the VTR or otherwise modifying it to reduce RF pickup — a formidable task.

Bip points out a possible solution to RFI problems that may be available in the near future. Many problems with stereo, TV receivers, ham gear, and computers arise because the plastic cases in which the units are enclosed are "transparent" as far as RF is concerned. The equipment is completely vulnerable to any strong, nearby RF field. And in the case of the TV receiver and the computer, these devices can radiate RF "hash" that will cause problems on nearby communications receivers. Under test now is an aerosol EMI/RFI coating that can be sprayed on the inside surface of a cabinet and, when properly applied and grounded, will provide up to 75 dB of shielding effectiveness at 100 MHz. The spray adheres to any plastic, glass, or metal surface and dries to about 2 mils thickness, providing a highly conductive coating that restricts radiation through the case. This product should be available before the end of the year. While it won't solve all RFI problems, it will help the experimenter combat direct radiation and unwanted pickup by highly sensitive electronic equipment mounted within a "dust cover" that masquerades as a cabinet.†

18 and 24 MHz revisited

The Radio Society of Great Britain reports that as of January 1, 1984, 42 countries had authorized Amateur operation in the 18-MHz Amateur band. Some countries have excluded small portions of the assignment to protect local communication circuits. The main countries holding up Amateur operation in this band by their citizens are the United States and the Soviet Union.

As for the 24-MHz band, the RSGB reports that as of January 1, 1984, 42 countries had authorized Amateur operation in this band. Only Australia restricts a small segment of the band to protect a local communication circuit. Again, the main countries holding up Amateur operation in this band by their citizens are the United States and the Soviet Union.

Hello, Ivan! We have something in common at last!

*Once again this is the case of a "clean" transmitting signal being received by the VTR . . . Ed.

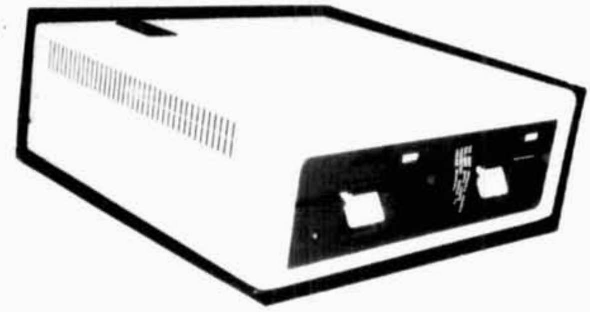
†Shielding can be enhanced by selection of appropriate cabinet materials and use of special EMI/RFI-resistant materials. See "Electromagnetic Interference and the Digital Era," K3PUR, September, 1984, and "EMI/RFI Shielding: New Techniques," by Vaughn Martin, January and February, 1984.

ham radio

John J. Meshna Jr., Inc.

19 Allerton Street • Lynn, MA 01904 • Tel: (617) 595-2275

DUAL FLOPPY DISC DRIVES



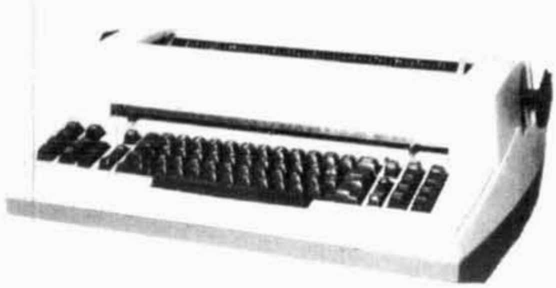
BRAND NEW, single sided, dual floppy disc drives made for Digital Equipment Corp. (DEC). This beautiful piece of computer hardware consists of 2 Shugart compatible TEAC 40 track, double density, 5¼" mini-floppy disc drives brand new in the case with their own regulated, switching power supply, cooling fan & on/off switch. Each unit also comes with a line cord & documentation. These were made for DEC, but are also compatible with other personal computers such as IBM, TRS 80 models I, II, & the Color Computer, and other Shugart compatible interfaces. Naturally, you supply the cables and disc controller card to suit your particular system. The RX-180 AB runs off of 115/230 VAC 50/60 Hz. w/out any modifications to the drives. Each system comes in the original factory box and are guaranteed functional. A blockbuster of a buy !!

Shpg. wt. 21 lb. stock no. RX 180AB $250.00
RX 180 AB modified to run w/ the TI 99/4A $285.00
Disc drive cable for Radio Shack Model I $15.00

HIGH SPEED KSR PRINTER TERMINAL

World famous, high speed G. E. Terminet 1200 RS 232 KSR printer terminals are now in stock ready for shipment to you. This has to be one of the finest letter quality printers ever offered at a bargain price. These terminals can be used as an RS 232 asynchronous communications terminal or used in the local mode as a typewriter. The terminals were removed from service for upgrading. Highlights of these machines are: Standard RS 232, full duplex, asynchronous data comm., fully formed upper and lower case letters, 128 character ASCII set, selectable baud rates of 110, 300, or 1200 BPS, 80 columns on pin feed paper, and less weight & size than an ASR 35 teletype with far less racket. They are virtually electronically foolproof as every pc board is Pico fuse protected. Should your machine not work, just check the on board fuses & 9 out of 10 times that is where the problem lies. Schematics are provided w/ each machine sold. Current price of this machine new is over $2000.00 ! Our meager price for this fantastic printer is only 10% of this: $200.00 each!!! Visually inspected prior to shipment to insure completeness. Shpd. truck freight collect. $200.00

IBM 745 SELECTRIC BASED TYPEWRITER PRINTERS



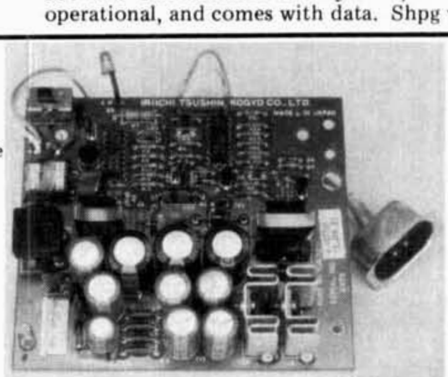
Send S.A.S.E. for free data sheet

These rugged, handsome printers were made for one of the giants of the computer industry. They can be used as a standard typewriter or as a printer in a word processing system for true letter quality printing. Solenoids were added to the selectric mechanism which disabled the manual repeat function but still allows electronic repeat functions. It uses standard IBM typing balls. The voltage requirements are standard 115 VAC, 5 VDC at 100 ma, and 24 VDC at 4 amps. All are new in factory boxes, but may require adjustments. We provide literature and schematics with 1 ribbon and cleaning tools. With the addition of our Centronics to Selectric I/O adapter, you could easily interface this printer to almost any micro computer system.
Typewriter Printer stock no. RE 1000 A $375.00, 745 manual $30.00
Shpg wt approx. 80 Lbs, shpd by truck, collect.

CENTRONICS TO SELECTRIC INTERFACE
This interface will adapt a Redactron Selectric I/O typewriter mechanism to be used as a parallel ASCII compatible printer. The parallel input port provides compatibility to Centronics standards for both "busy" and "acknowledge" protocols. The interface requires only +5 VDC at 350 ma. This interface is fully built, less power supply, is guarenteed operational, and comes with data. Shpg wt. 15 lbs DE 201 A ,$245.00

These compact, lightweight switching power supply boards were originally made for the Texas Instrument 99/4 A micro computer. It measures only 4-3/4 x 4-1/8 x 1-1/4" and puts our +5 VDC @ 1.2 A, −5 VDC @ 0.120 A, and +12 VDC @ .350 A. Input is 14.4 VAC to 21.6 VAC. A simple transformer or plug in the wall adapter will do. Our SPL 461-33 supply listed below is perfect for this board. Each one is new, individually packaged with data. For short money, you can get a nice little power supply or spare parts for your TI 99/4 A. Shpg. Wt. 1 Lb.
Power Supply Board SP-53 A $10.00

AC Adapter for same, Shpg. Wt. 2 Lbs.
SP-461-33 $6.50



REGULATED LOGIC POWER SUPPLY BOARD for TI 99/4A

Phone Orders accepted on MC, VISA, or AMEX
No COD's. Tel. 1-617-595-2275

Surplus Electronic Material

Send for our free 72 page catalogue jam packed with goodies.

L and C measurements

Simple circuit determines values with ease, accuracy

The typical method of measuring small value capacitors and inductors using a grid dip meter and a known value of L or C is effective, but because of circuit loading and dip meter calibration errors the results are not very accurate.

Hams who own a frequency counter can take advantage of the accuracy of this instrument to determine the value of junk box unmarked components. The technique involves measuring the frequency of an LC oscillator and then adding the unknown component to the resonant circuit, again noting the output frequency. The value of the unknown component is easily calculated using these two frequencies.

differential amplifier used as oscillator

The oscillator circuit shown in **fig. 1** uses Q1 and Q2 as a positive feedback differential amplifier. This minimizes the loading on $L1C1$. Q3, a buffer stage, isolates the counter and prevents loading down the oscillator. S1 places the unknown component in parallel with the resonant circuit $L1C1$ for capacitance measurements and in series with $L1$ for inductance measurements. In both modes the output frequency decreases in proportion to the value of the external component.

Once the effective values of $L1$ and $C1$ are known, the unknown values can be calculated from:

$$C_x = \frac{C1\,(f_1^2 - f_2^2)}{f_2^2} \qquad \textbf{(1)}$$

$$L_x = \frac{L1\,(f_1^2 - f_2^2)}{f_2^2} \qquad \textbf{(2)}$$

where f_1 is the original frequency in MHz
f_2 is the new frequency
C is in picofarads (pF)
L is in microhenries (μH)

I calculated a number of values and made up a series of graphs for inductance and capacitance values from 0.1 to 350 μH and for 3 to 700 pF. Agreement with known values is well within normal tolerance levels. My graphs are based on the initial frequency f_1 set to 9.00 MHz. Since this frequency is slightly altered by the position of S1, the core adjustment screw of $L1$ protrudes from the front panel so that f_1 can be trimmed to 9.00 MHz before checking an unknown.

As mentioned earlier, the effective value of $L1$ and $C1$ must be determined as the stray capacitance and inductance in wiring needs to be accounted for. This is easily accomplished with a known value of capacitor and inductor. Set S1 to parallel with the test probes open, adjust $L1$ to 9.00 MHz on the counter, clip on the known capacitor $C2$, and note the new frequency. The value of $C1$ is:

$$C1 = \frac{f_2^2 \times C2}{f_1^2 - f_2^2}$$

To determine the effective value of $L1$, set S1 in series with the test probes shorted and adjust $L1$ until the oscillator is at 9.00 MHz. Attach the known inductor, $L2$, to the test probes and note the new frequency, $L1$ is:

$$L1 = \frac{f_2^2 \times L2}{f_1^2 - f_2^2}$$

Use these values for $C1$ and $L1$ in formulas 1 and 2 for calculating the unknowns.

Construction is not critical; I used an L-shaped piece of aluminum to form the panel and base, and a scored piece of PC board for the oscillator circuit. A 12 inch or so length of small coax with mini-alligator clips was used to connect the unknown components.

I find I'm using this unit on every construction project. It certainly is convenient for checking the minimum and maximum capacity of small trimmers and useful in making it possible to wind a coil to a specified value — a real help when building bandpass and other types of filters.

By Larry Duthie, WB6ZLN, 1305 Lubich Drive, Mountain View, California 94040

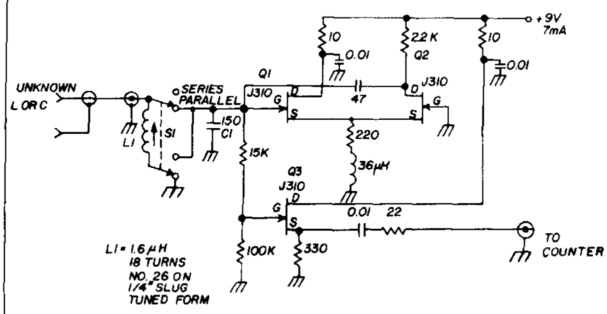


fig. 1. Oscillator circuit uses Q1 and Q2 as a positive feedback differential amplifier.

My thanks to Jim Loring, KA6VVE, for the oscillator circuit; it produces stable output over a very wide range of LC ratios.

ham radio

(continued from page 7)
asks that the 32-MHz land mobile reserved segment of the 800 MHz spectrum be released immediately for their use. — Ed.)

In summary, the 220-MHz band is not only well occupied, even in the weak-signal area, but also *necessary* to Amateur Radio, in order to handle the overflow of all types of operations from 2 meters, which would not be as well served by 70 cm; Packet Radio will also occupy some of the lower frequency regions. The gaps at the bottom are there for a purpose: to eliminate the possibility of overload that frequently hampers weak-signal operation. Weak-signal operators need this valuable portion of the spectrum as a bridge between 2 meters and 70 cm, which is vastly different in radio propagation.

— Joe Reisert, W1JR

*For a thorough description of all the propagation modes effective on 220 see the July and September, 1984, VHF/UHF World columns by W1JR. — Editor.

MOVING?
KEEP HAM RADIO COMING . . .

If possible let us know four to six weeks before you move and we will make sure your HAM RADIO Magazine arrives on schedule. Just remove the mailing label from this magazine and affix below. Then complete your new address (or any other corrections) in the space provided and we'll take care of the rest.

ham radio Magazine
Greenville, NH 03048

Allow 4-6 weeks for correction.

Thanks for helping us to serve you better.

Here's my new address:

Name ____ Call ____
Address ____
City ____ State ____ Zip ____

AFFIX LABEL HERE

SAY YOU SAW IT IN HAM RADIO

Smith Chart impedance matching
on your Commodore 64

Crunch the numbers, plot results with this handy 200-line program

If you have ever tried impedance matching, you've probably been introduced to the Smith Chart. Although it's fashionable to turn to computers to perform a variety of tasks, many RF types prefer to use the slower "graphic approach" because the Smith Chart provides a visual means of analysis not obvious in long columns of numbers.

But using the Smith Chart can be frustrating: *let's see — do I rotate clockwise or counterclockwise? I want a shunt element; do I follow impedance or admittance curves? Do I multiply or divide by Z_0?* Using this program **fig. 1**, the computer will do all the number crunching for you, and display your impedances on the screen within a few seconds. It will even handle errors; if you come up with an incorrect value, just press a key — your last trial *disappears*. If you like the answer, just press another key: the computer then stores that value and you can add another section.

This article assumes that you understand Smith Charts. (If you don't, see the references listed at the end of this article for an explanation.) But even if you don't understand the plot, you can still use this program because all impedances are first printed in tabular form; the plot is an option you can ignore.

program description

This program is written for a Commodore 64 using Simons' BASIC for efficient utilization of graphics commands. If you have a different computer system you can use the equations in **lines 1000 through 7504** and add your own printing/plotting commands. A summary of the major program sections is listed in **table 1**, and a detailed description follows.

Lines 1 through 44 are used for program initialization. In **lines 10-11** you select a smooth or discrete plot. Later, when impedances are plotted on the screen, either selection will print a "+" on the Smith Chart at each frequency; if you select a smooth plot, a line will connect the plots to form a continuous

```
1 SP$="               ":FORJ=1TO23:CL$=CL$+SP$:NEXT
2 PRINT"<CLR><DWN><DWN><BLU>":CENTRE<ROF>"PROGRAM FOR IMPEDA
NCE MATCHING":PRINT"<C=5><DWN><DWN>"
4 CENTRE<ROF>"USING":PRINT
6 PRINT"<DWN><DWN><RED>":CENTRE<ROF>"SMITH CHART"
8 PRINT AT(<ROF>22,20)"<C=4>BY LYNN GERIG<DWN><LFT><LFT><LFT
><LFT><LFT><LFT><LFT><LFT><LFT><LFT>WA9GFR<DWN><LFT><LFT><LF
T><LFT><LFT><LFT>MARCH, 1984":PAUSE<ROF>4
10 PRINT"<CLR>DISCRETE FREQUENCIES (D) OR SMOOTH":INPUT"PLOT
 (S)";D$
11 IF D$<>"D"ANDD$<>"S"THEN10
12 INPUT"<DWN>PLOT WHAT VALUE VSWR CIRCLE";VS:IF VS<1 THEN 1
2:VR=100*(VS-1)/(VS+1)
13 VR=100*(VS-1)/(VS+1)
14 INPUT"WHAT CHARACTERISTIC IMPEDANCE";Z0
15 INPUT"<DWN>HOW MANY FREQUENCIES (1-10)";N
16 FOR J=1 TO N
18 PRINT"<DWN>INPUT FREQUENCY"J;:INPUT"IN MHZ";F(J)
20 PRINT"INPUT RS, XS  OF LOAD AT "F(J)"MHZ":INPUT R(J),I(J)
22 X(J)=R(J):Y(J)=I(J):NEXT
24 PRINT"<CLR> THESE WERE YOUR LOAD IMPEDANCE INPUTS<DWN>"
26 PRINT"<DWN>      FREQ          RS          XS":PRINT
27 FOR J=1 TO N: F$=STR$(F(J))
28 RS$=STR$(R(J)):XS$=STR$(I(J))
29 USE<ROF>"     #####.###",F$:USE<ROF>"     #####.##",RS$:USE<R
OF>"    #####.##",XS$:PRINT:NEXT
30 PRINT AT(<ROF>0,18)""
32 INPUT"ARE YOU SATISFIED (Y=YES)";A$
34 IF A$<>"Y" THEN GOTO 14
38 INPUT"PRINT LOAD VALUES (Y=YES)";A$
40 IF A$="Y" THEN PRINT AT(<ROF>0,18)CL$:HRDCPY<ROF>
42 INPUT"PLOT LOAD IMPEDANCE (Y=YES)";P$
44 XM=1.4:IF P$="Y" THEN GOSUB 8000
50 PRINT"<CLR>    CHOOSE TYPE OF MATCHING SECTION<DWN>"
52 PRINT" 1 SERIES C
54 PRINT" 2 SERIES L
56 PRINT" 3 SERIES TUNED (SERIES L-C)
58 PRINT" 4 SERIES TUNED (PARALLEL L-C)
60 PRINT" 5 SERIES TRANSMISSION LINE
62 PRINT" 6 SHUNT  C
64 PRINT" 7 SHUNT  L
66 PRINT" 8 SHUNT  TUNED (SERIES L-C)
68 PRINT" 9 SHUNT  TUNED (PARALLEL L-C)
70 PRINT"10 SHUNT  TRANSMISSION LINE
72 PRINT"11 TRANSFORMER
74 PRINT"12 SERIES R
76 PRINT"13 SHUNT  R<DWN>
78 PRINT"14 STOP ADDING SECTIONS
80 INPUT"<RED><DWN><DWN><DWN><DWN>CHOICE (1-14)";M:PRINT"<C=
4>"
81 IF M<1 OR M>14 THEN 80
82 CGOTO<ROF> 500*(M+1)
```

fig. 1A. Computer aided Smith Chart design program listing, lines 1-82.

By Lynn A. Gerig, WA9GFR, RR #1, Monroeville, Indiana 46773

```
1000 PRINT CHR$(147)"ADD SERIES CAPACITOR
1002 INPUT"WHAT IS VALUE (IN PF)";C
1010 FOR J=1TO N
1015 X(J)=R(J)
1020 Y(J)=I(J)-1/(2*π*F(J)*C*1E-06)
1025 NEXT: GOTO 9000
1500 PRINT CHR$(147)"ADD SERIES INDUCTOR
1502 INPUT"WHAT IS VALUE (IN UH)";L
1510 FOR J=1 TO N:X(J)=R(J)
1520 Y(J)=I(J)+2*π*F(J)*L:NEXT:GOTO9000
2000 PRINT CHR$(147)"ADD SERIES TUNED (SERIES L-C)
2002 INPUT"WHAT IS VALUE OF C (IN PF)";C
2004 INPUT"WHAT IS VALUE OF L (IN UH)";L
2010 FOR J=1 TO N: X(J)=R(J)
2020 Y(J)=I(J)+2*π*F(J)*L-1/(2*π*F(J)*C*1E-06):NEXT:GOTO9000
2500 PRINT CHR$(147)"ADD SERIES TUNED (PARALLEL L-C)
2502 INPUT"WHAT IS VALUE OF C (IN PF)";C
2504 INPUT"WHAT IS VALUE OF L (IN UH)";L
2510 FOR J=1 TO N: X(J)=R(J)
2520 Y(J)=I(J)+(2*π*F(J)*L)/(1-((2*π*F(J))^2)*L*C*1E-06):NEX
T:GOTO9000
3000 PRINT CHR$(147)"ADD SERIES TRANSMISSION LINE
3002 INPUT"WHAT IS LINE IMPEDANCE (OHMS)";Z1
3004 INPUT"WHAT IS VELOCITY FACTOR";V
3006 INPUT"WHAT IS LENGTH (IN INCHES)";LL
3010 FOR J=1 TO N
3015 T=1.2*LL*F(J)/39.37/V
3020 D=(R(J)+Z1)^2+I(J)^2
3025 R=(R(J)^2-Z1^2+I(J)^2)/D
3030 I=2*Z1*I(J)/D
3035 Z=SQR(R*R+I*I)
3040 T=180/π*ATN(I/(R+1E-30))-2*T+180*(R<0)
3045 R=Z*COS(T*π/180)
3050 I=Z*SIN(T*π/180)
3055 D=(1-R)^2+I^2
3060 X(J)=Z1*(1-R^2-I^2)/D
3065 Y(J)=2*Z1*I/D
3070 NEXT:GOTO9000
3500 PRINT CHR$(147)"ADD SHUNT CAPACITOR
3502 INPUT"WHAT IS VALUE OF C (IN PF)";C
3506 FOR J=1 TO N: W=2*π*C*1E-06
3508 D=(1-W*F(J)*I(J))^2+(R(J)*W*F(J))^2
3510 X(J)=R(J)/D
3512 Y(J)=(I(J)*(1-W*F(J)*I(J))-R(J)^2*W*F(J))/D:NEXT:GOTO90
00
4000 PRINT CHR$(147)"ADD SHUNT INDUCTOR
4002 INPUT"WHAT IS VALUE OF L (IN UH)";L
4015 FOR J=1 TO N: W=2*π*F(J)*L
4025 D=R(J)^2+(I(J)+W)^2
4030 X(J)=R(J)*W^2/D
4035 Y(J)=W*(R(J)^2+I(J)^2+W*I(J))/D
4040 NEXT:GOTO9000
4500 PRINT CHR$(147)"ADD SHUNT TUNED (SERIES L-C)
4502 INPUT"WHAT IS VALUE OF C (IN PF)";C
4504 INPUT"WHAT IS VALUE OF L (IN UH)";L
4510 FOR J=1 TO N
4515 W=2*π*F(J)*L-(1E+06)/(2*π*F(J)*C)
4517 D=R(J)^2+(I(J)+W)^2
4520 X(J)=R(J)*W^2/D
4525 Y(J)=W*(R(J)^2+I(J)^2+W*I(J))/D
4530 NEXT J:GOTO 9000
5000 PRINT CHR$(147)"ADD SHUNT TUNED (PARALLEL L-C)
5002 INPUT"WHAT IS VALUE OF C (IN PF)";C
5004 INPUT"WHAT IS VALUE OF L (IN UH)";L
5010 FOR J=1TO N
5015 W=(2*π*F(J)*L)/(1-((2*π*F(J))^2)*L*C*1E-06)
5020 D=R(J)^2+(I(J)+W)^2
5025 X(J)=R(J)*W^2/D
5030 Y(J)=W*(R(J)^2+I(J)^2+W*I(J))/D
5035 NEXT:GOTO9000
5500 PRINT CHR$(147)"ADD SHUNT TRANSMISSION LINE
5502 INPUT"WHAT IS LINE IMPEDANCE (OHMS)";Z1
5504 INPUT"WHAT IS LINE VELOCITY FACTOR";V
5506 INPUT"WHAT IS LENGTH (IN INCHES)";LL
5508 PRINT"OPEN (O) OR SHORTED (S) STUB";
5510 INPUT S$
5512 IF S$<>"O" AND S$<>"S" THEN 5510
5520 FOR J=1 TO N
5525 T=LL*F(J)*1.2/39.37/V
5530 IF S$="S" THEN W=Z1*TAN(T*π/180)
5535 IF S$="O" THEN W=Z1*TAN((T+90)*π/180)
5540 D=R(J)^2+(I(J)+W)^2
5545 X(J)=R(J)*W^2/D
5550 Y(J)=W*(R(J)^2+I(J)^2+W*I(J))/D
5555 NEXT:GOTO9000
6000 PRINT CHR$(147)"ADD TRANSFORMER
6002 INPUT"STEP UP OR DOWN (U OR D)";T$
6004 IF T$<>"U"AND T$<>"D" THEN 6000
6006 INPUT"WHAT TRANSFORMATION RATIO";W
6010 IF T$="D" THEN W=1/W
6020 FOR J=1 TO N: X(J)=W*R(J)
6025 Y(J)=W*I(J): NEXT: GOTO 9000
6500 PRINT CHR$(147)"ADD SERIES RESISTOR
6502 INPUT"WHAT VALUE OF R";RS
6506 FOR J=1 TO N: X(J)=R(J)+RS
6508 Y(J)=I(J):NEXT: GOTO 9000
7000 PRINT CHR$(147)"ADD SHUNT RESISTOR
7002 INPUT"WHAT VALUE OF R";RS
7004 FOR J=1 TO N
7006 D=(R(J)+RS)^2+I(J)^2
7008 X(J)=RS*(R(J)^2+RS*R(J)+I(J)^2)/D
7010 Y(J)=I(J)*RS^2/D: NEXT: GOTO 9000
7500 PRINT CHR$(147);
7501 INPUT "WANT TO RUN ANOTHER ONE";A$
7502 IF LEFT$(A$,1)="Y" THEN 10
7504 PRINT AT(<ROF>14,10)"<BLU>GOOD-BY<C=4>":END
8000 HIRES<ROF> 0,3:XR=100*XM
8002 CIRCLE<ROF> 160,100,XR,100,1
8004 LINE<ROF> 160-XR,100,160+XR,100,1
8008 ARC<ROF> 160+XR,0,180,270,10,XR,100,1
8010 ARC<ROF> 160+XR,200,270,360,10,XR,100,1
8012 CIRCLE<ROF> 160+XR/2,100,XR/2,50,1
8014 CIRCLE<ROF> 160,100,VR*XM,VR,1
```

fig. 1B. Program listing, lines 1000-8014.

```
8016 CHAR<ROF> 158-.67*XR,97,43,1,1
8017 TEXT<ROF> 153-.67*XR,104,".2",1,1,8
8018 CHAR<ROF> 158-.33*XR,97,43,1,1
8019 TEXT<ROF> 153-.33*XR,104,".5",1,1,8
8020 CHAR<ROF> 156+.33*XR,97,43,1,1
8021 TEXT<ROF> 156+.33*XR,104,"2",1,1,8
8022 CHAR<ROF> 156+.67*XR,97,43,1,1
8023 TEXT<ROF> 156+.67*XR,104,"5",1,1,8
8100 CSET<ROF> 2
8105 TEXT<ROF> 10,190,"F7=RETURN",1,1,8
8110 TEXT<ROF> 246,190,"F8=PRINT",1,1,8
8115 FOR J=1 TO N
8120 D=(X(J)+ZO)^2+Y(J)^2
8125 PX(J)=((X(J)-ZO)*(X(J)+ZO)+Y(J)^2)/D*100*XM
8130 PY(J)=-2*Y(J)*ZO/D*100
8140 CHAR<ROF> 157+PX(J),97+PY(J),43,1,1
8150 IF D$="S" AND J>1 THEN LINE<ROF> 160+PX(J-1),100+PY(J-1
),160+PX(J),100+PY(J),1
8160 NEXT
8170 GET A$:IF A$="" THEN 8170
8175 IF A$=CHR$(136) THEN NRM<ROF>:RETURN
8180 IF A$<>CHR$(140) THEN 8170
8185 TEXT<ROF> 10,190,"F7=RETURN",0,1,8
8190 TEXT<ROF> 246,190,"F8=PRINT",0,1,8
8195 COPY<ROF>:NRM<ROF>:RETURN
9000 PRINT"<DWN>      FREQ          RS            XS":PRINT
9005 FOR J=1 TO N
9010 RS$=STR$(X(J))
9015 XS$=STR$(Y(J))
9020 F$=STR$(F(J))
9025 USE<ROF>"    #####.###",F$:USE<ROF>"    #####.##",RS$:USE
<ROF>"    #####.##",XS$:PRINT
9030 NEXT
9050 PRINT AT(<ROF>0,18)"F1=PLOT ON CLEAN SCREEN FOR VIEWING
9055 PRINT"F2=PLOT ON CLEAN SCREEN FOR PRINTER
9060 PRINT"F3=PLOT ON LAST SCREEN
9065 PRINT"F4=SCREEN DUMP TO PRINTER
9070 PRINT"F5=BAD VALUE:  DISCARD THIS TRY
9075 PRINT"F7=GOOD VALUE: KEEP & PROCEED
9100 GET A$:IF A$=""THEN9100
9110 IFA$=CHR$(133)THEN XM=1.4:GOSUB 8000:GOTO9050
9120 IFA$=CHR$(137)THEN XM=.833:GOSUB 8000:GOTO9050
9130 IFA$=CHR$(134)THEN GOSUB 8100:GOTO9050
9140 IFA$=CHR$(138)THEN PRINT AT(<ROF>0,18)CL$;:HRDCPY<ROF>:
GOTO 9050
9150 IFA$=CHR$(135)THEN 50
9160 IFA$=CHR$(136)THEN 9200
9170 GOTO 9100
9200 FOR J=1 TO N:R(J)=X(J)
9210 I(J)=Y(J):NEXT
9215 PRINT AT(<ROF>0,18)CL$;
9220 PRINT AT(<ROF>0,19)"<BLU>YOU NOW MUST MATCH THE IMPEDAN
CES LISTEDABOVE.<C=4>"
9230 PAUSE<ROF> 4:GOTO50
```

fig. 1C. Program listing, lines 8016-9230.

curve. The goal of most impedance matching is to find a result which is within a particular VSWR. In **lines 12-13** you select the value of a VSWR circle to appear on the plot. This makes it easy to check your results; either your plots are within the circle, or you need to refine your circuit. In **line 14** you select the characteristic impedance. This does not affect any calculations or tabular results: it is the value which is at the center of your Smith Chart plot. All impedances are normalized to this before being plotted (**lines 8120-8130**).

You are next asked how many frequencies you wish to work with (**line 15**); you then must input each frequency and the resistive and reactive series components of the starting (load) impedance at each frequency.

After you input all frequencies and load impedances, you are given a chance to start over if you made an error. Then you can choose to print the tabulated load impedances on your printer, plot them on a Smith Chart, or begin matching.

Lines 50-82 present a menu for the type of matching element to select. The program next branches to the correct set of equations for that choice (**lines 1000-7504**), and you are then asked to input those component values. For a detailed explanation of each matching section, see the section on matching network equations in the appendix.

```
THESE WERE YOUR LOAD IMPEDANCE INPUTS

      FREQ              RS             XS

        1.8             7.          -400.

ADD SERIES INDUCTOR
WHAT IS VALUE (IN UH)? 36.9

      FREQ              RS             XS

        1.8             7.             17.32

ADD SHUNT CAPACITOR
WHAT IS VALUE OF C (IN PF)? 4400

      FREQ              RS             XS

        1.8             49.89          -.37
```

fig. 2. The addition of two components converts an 80-meter vertical to 160 meters.

table 1. Major program sections.

line numbers	program content
1-10	Format, select discrete or smooth plot.
12-13	Select VSWR circle to plot.
14	Select characteristic impedance.
15-44	Input resistive & reactive parts of load impedance at each frequency. Print or plot result if desired.
50-82	Select type of matching section to try.
1000-7504	Calculation of impedances according to type of matching section chosen.
8000-8195	Subroutine for graphics plotting of Smith Chart.
9000-9170	Print new impedances in tabular form, then choose whether to print, plot, discard, or keep trial value.
9200-9230	"Good" trial value becomes new impedance to match with next section.

Lines 8000-8195 contain the graphics commands for plotting a Smith Chart on the screen. Most of these lines use graphics commands peculiar to Simons' BASIC: you may choose to write your own plotting subroutine if you have another system. A new chart is drawn in **lines 8000-8023**. If you choose to plot on an old screen, you enter at **line 8100**, which recalls the last graphics screen from memory. The impedance plotting is performed in **lines 8115-8160**. The equations in **8120-8130** convert the impedances to a point on the chart normalized to the previously selected Z_0. The chart y-radius is 100 bits, and the x-radius depends on the value of "XM" (see section on printer interfaces below). **Line 8150** will connect the "+" plots with a line if "smooth plot" was previously selected. The plotted chart will stay on the screen until either function key f7 or f8 is pressed. Pressing f8 will copy your plot to your printer, and f7 will return you to the tabular listing of frequencies and impedances with another menu.

```
THESE WERE YOUR LOAD IMPEDANCE INPUTS

      FREQ              RS             XS

        7.              52.          -110.
        7.1             57.          -100.
        7.2             65.           -90.
        7.3             70.           -80.

ADD SERIES TRANSMISSION LINE
WHAT IS LINE IMPEDANCE (OHMS)? 50
WHAT IS VELOCITY FACTOR? .67
WHAT IS LENGTH (IN INCHES)? 130

      FREQ              RS             XS

        7.               9.74         -25.46
        7.1             11.60         -23.89
        7.2             14.15         -22.96
        7.3             16.49         -21.89

ADD SHUNT TRANSMISSION LINE
WHAT IS LINE IMPEDANCE (OHMS)? 50
WHAT IS LINE VELOCITY FACTOR? .67
WHAT IS LENGTH (IN INCHES)? 100
OPEN (O) OR SHORTED (S) STUB? S

      FREQ              RS             XS

        7.              74.46         -11.64
        7.1             59.70          -8.10
        7.2             51.39          -1.24
        7.3             45.36           2.91
```

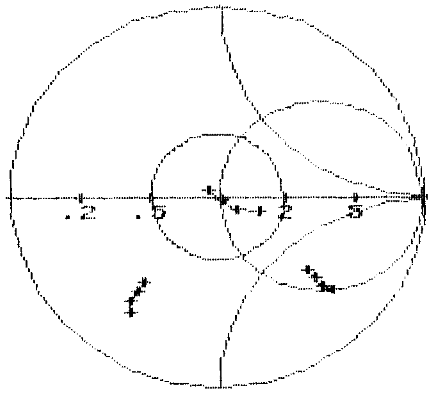
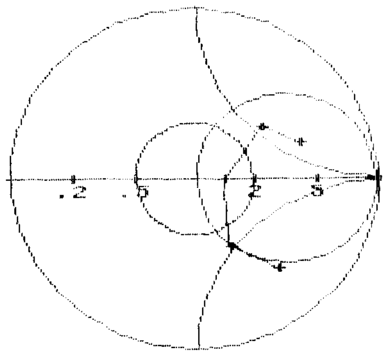


fig. 3. Compensating for tower effect on 40-meter slopers (example 2).

No matter what type of matching section is chosen, after the appropriate impedance calculations are per-

THESE WERE YOUR LOAD IMPEDANCE INPUTS

FREQ	RS	XS
110.	45.	-90.
120.	50.	-50.
130.	70.	0.
146.	80.	60.
160.	140.	90.



ADD SHUNT INDUCTOR
WHAT IS VALUE OF L (IN UH)? .06

FREQ	RS	XS
110.	17.66	60.52
120.	40.56	49.10
130.	23.02	32.88
146.	12.34	37.29
160.	12.07	47.35

ADD SERIES CAPACITOR
WHAT IS VALUE (IN PF)? 60

FREQ	RS	XS
110.	17.66	36.40
120.	40.56	26.99
130.	23.02	12.48
146.	12.34	19.12
160.	12.07	30.77

ADD SHUNT CAPACITOR
WHAT IS VALUE OF C (IN PF)? 30

FREQ	RS	XS
110.	90.94	12.62
120.	40.83	-26.88
130.	28.77	-5.40
146.	36.32	14.31
160.	87.67	-15.88

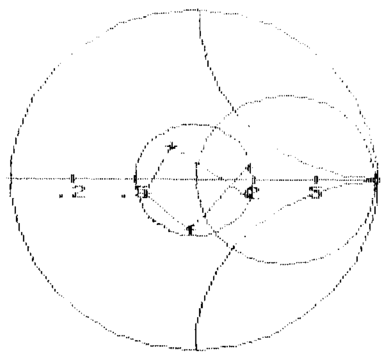


fig. 4. Broadbanding a 2-meter whip (example 3).

formed the program branches to **line 9000** and the new impedances at each frequency are printed on the screen below the values of the network components you chose. A menu appears at the bottom of the screen. You must then press a function key to continue. Pressing f1 or f2 will cause the impedances listed to be plotted on a new "clean" screen (see section on printer interfaces below). Pressing f3 will add the new plot to a previous chart. If you press f4, the tabulated data at the top of the screen is printed on your printer. Pressing f5 causes the computer to erase the bad value you just tried, and f7 causes the trial value to become the next load impedance to be matched (**lines 9200-9230**): you then branch back to the master menu at **line 50**.

examples

The three examples given below demonstrate some of the possibilities available in the program.

Example 1. My 80-meter vertical antenna is electrically "short" at 160 meters and exhibits an impedance of about 7-j400 ohms. What values of L and C do I need to match it to 50 ohms? I know I should start with a series inductor with a reactance of greater than 400 ohms (about 35 μH) then add a shunt capacitor. After experimenting with several values, I ended up with those in **fig. 2.** I only printed tabular results without graphics plot.

Example 2. When I erected my 60-foot tower, I fed the top set of guy wires as 40-meter slopers. Probably because of coupling to the tower, they were not resonant, as was to be expected. The impedances as measured at the shack end of the coax feedline are listed and plotted in **fig. 3.** Although I could have obtained a good match with a series inductor, I wanted to use leftover lengths of coaxial cable for the experience of matching with lines/stubs. The resulting impedances, shown in **fig. 3,** are an example of superimposing several plots on the same chart (using function key f3). I am presently using this network built from RG-58 cables, and the measured results are within 5 percent of those calculated.

Example 3. My 2-meter whip antenna looks like 70 ohms at resonance, including ground losses, with an increasing impedance off resonance. I wish to "broadband" match it and have less than 2:1 VSWR from

110 to 160 MHz for reception of aircraft and public service bands in addition to the 2-meter ham band. The results are shown in **fig. 4**. In this case I printed intermediate tabular results with each new element, but I plotted only the original and final impedances (on separate plots).

entering the program

Enter the program as shown taking the normal precautions to SAVE it before you RUN it, so that if you make a typing error that could cause a lock-up, you'll be able to go back to the saved version without having to retype the entire program. The following is an explanation of the mnemonics printed by my interface:

<CLR> = SHIFT-CLR
<DWN>= cursor down
<LFT> = cursor left
<BLU> = CTRL-7 (blue)
<RED> = CTRL-3 (red)
<C=4> = Commodore-4 (gray 1)

In addition, my interface sometimes prints<ROF> directly following unique Simons' BASIC commands. Ignore this when you type the program. Using Simons' BASIC on the Commodore 64, high-resolution graphics commands permit a BASIC program of only 200 lines, using about 6K of RAM. However, the equations listed are valid for *any* computer or calculator.

If you don't want to type the program yourself, I'll make two verified copies for you. (Just send me a blank tape or formatted disk with a stamped, self-addressed mailer, and a check or money order for $5.00. Use the address shown at the beginning of this article.) Without Simons' BASIC, bank switching for the high-resolution screen and point-by-point plotting needs to be done with additional programming. I also have a version for the Commodore 64 that does not require Simons' BASIC, but it is over 500 lines long and therefore not practical for listing here. I will supply a copy of it, or a similar version specifically for the VIC-20, requiring 32K expansion, under the terms described above.

appendix

The convention I used for the various matching elements and impedances is shown in **fig. A1**. The equations used for each type

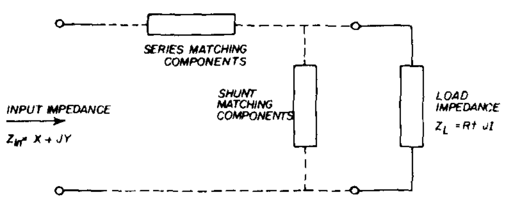


fig. A1. Matching network configurations.

of reactive matching element (used in program lines **1000-7504**) follow in **fig. A2**. These equations can be used on any computer or calculator.

impedance value to Smith Chart plot

Although the Smith Chart looks complicated, it's nothing more than a plot of the reflection coefficient, ϱ, defined as

$$\varrho = \frac{Z - Z_0}{Z + Z_0}$$

where Z_0 = the characteristic impedance you are working with and $Z = X + jY$ (your complex impedance). When plotting an impedance, the following two equations apply:

$$x\text{ - axis value} = \frac{X^2 - Z_0^2 + Y^2}{(X + Z_0)^2 + Y^2}$$

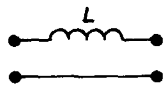
$$y\text{ - axis value} = \frac{2Y\,Z_0}{(X + Z_0)^2 + Y^2}$$

The value obtained will range from 0 (center of chart for $VSWR = 1$) to 1 (outside edge of chart for $VSWR = \infty$). They can be scaled by any value you desire. I multiplied by 100 for a circle with a radius of 100 dots. Equations are found in **lines 8120 - 8130**.

series L-C components

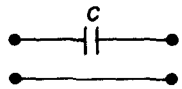
series inductor

$X = R$
$Y = I + 2\pi fL$



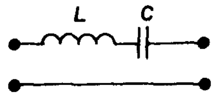
series capacitor

$X = R$
$Y = I - \frac{1}{2\pi fC}$



series L-C in series

$X = R$
$Y = 2\pi fL - \frac{1}{2\pi fC} + I$



series L-C in parallel

$X = R$
$Y = I + \frac{2\pi fL}{1 - (2\pi f)^2 LC}$

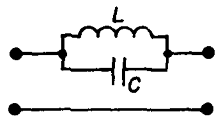


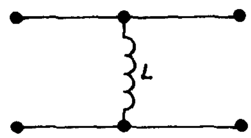
fig. A2. Equations and type of matching section used in program lines 1000-7504.

shunt inductor

$W = 2\pi fL$

$X = \frac{RW^2}{R^2 + (I + W)^2}$

$Y = \frac{W\,(R^2 + I^2 + WI)}{R^2 + (I + W)^2}$

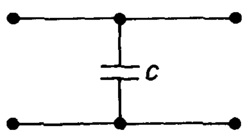


shunt capacitor

$W = \frac{-1}{2\pi fC}$

$X = \frac{RW^2}{R^2 + (I + W)^2}$

$Y = \frac{W\,(R^2 + I^2 + WI)}{R^2 + (I + W)^2}$

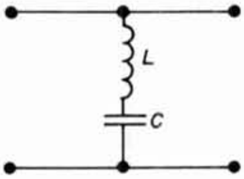


shunt L-C in series

$$W = 2\pi fL - \frac{1}{2\pi fC}$$

$$X = \frac{RW^2}{R^2 + (I + W)^2}$$

$$Y = \frac{W(R^2 + I^2 + WI)}{R^2 + (I + W)^2}$$

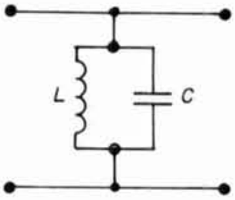


shunt L-C in parallel

$$W = \frac{2\pi fL}{1 - (2\pi f)^2 LC}$$

$$X = \frac{RW^2}{R^2 + (I + W)^2}$$

$$Y = \frac{W(R^2 + I^2 + WI)}{R^2 + (I + W)^2}$$



series transmission line

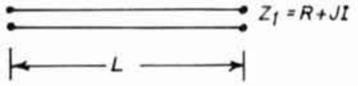
$$W = \frac{1.2\ Lf}{39.37\ V}$$

$$D = \frac{2\ Z_1\ I}{(R + Z_1)^2 + I^2}$$

$$E = \frac{R^2 - Z_1^2 + I^2}{(R + Z_1)^2 + I^2}$$

$$Z = (D^2 + E^2)^{1/2}$$

$$T = \tan^{-1}(D/E) - 2W$$



LENGTH = L(INCHES)
CHARACTERISTIC IMPEDANCE = Z_1
VELOCITY FACTOR = V

Note: *If calculator gives only first and fourth quadrant for $\tan^{-1}$ answers ($-90° < W < 90°$), add 180° to T if D was negative.*

$$X = \frac{Z_1 \{1 - (Z\cos T)^2 - (Z\sin T)^2\}}{(1 - Z\cos T)^2 + (Z\sin T)^2}$$

$$Y = \frac{2\ Z_1\ Z\sin T}{(1 - Z\cos T)^2 + (Z\sin T)^2}$$

shunt transmission line (open or shorted stubs)

$$W = \frac{1.2\ Lf}{39.37\ V}$$

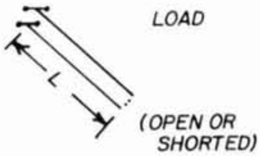
if open stub: $T = Z_0 \tan(W + 90°)$
if shorted stub: $T = Z_0 \tan(W)$

length = L (inches)
characteristic impedance = Z_1
velocity factor = V

length = L (inches)
characteristic impedance = Z_1
velocity factor = V

$$X = \frac{RT^2}{R^2 + (I + T)^2}$$

$$Y = \frac{W(R^2 + I^2 + TI)}{R^2 + (I + T)^2}$$



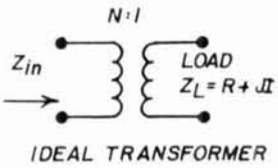
transformer

ideal transformer

N = turns ratio

$X = NR$

$Y = NI$



printer interface

This program was designed to calculate impedances and display them in tabular or graphic form on the screen, so you can use the program even if you don't have a printer. Just don't respond with a "yes" to questions such as "Do you want to print?"

If you do have a printer, you may want to note the two printer commands used; HRDCPY (**lines 40, 9140**) gives a normal screen dump (tabular data), and COPY **line 8195** copies a high-resolution (320 by 200 bits) graphics screen to the printer. Although the commands are optimized specifically for a Commodore printer, the program should run successfully with any printer/interface combination that emulates the Commodore. I use a Star Gemini-10X printer (an Epson responds the same way) with a Tymac Connection for an interface, and reproduction of the full high-resolution plot takes less than a minute. A friend with a Prowriter and Cardco interface gets similar results. Using a Cardco/+G with a Gemini or Epson printer produces the same plot, but a high-res dump takes about 45 minutes, so be patient. If you have another brand, you may need to experiment, but I am not aware of any combination that won't work.

Note: the aspect ratio (relative distance between dots on a line versus distance between lines) is different for the screen than the printer. To draw a circle on the screen, use an X/Y ratio of 1.4 (value of XM in **lines 44, 9110**). This will copy as an oval on the printer. If you want a printed chart (**lines 9055, 9120**), use the ratio 0.833; this produces an oval on the screen, but a circle on the printer. If another brand of printer produces ovals, experiment with the value of XM in **line 9120**. — WA9GFR

references

1. *The ARRL Antenna Book*, 14th edition, American Radio Relay League, Newington, Connecticut, 1982.
2. James R. Fisk, W1HR, "How To Use The Smith Chart," *ham radio*, March, 1978, page 92.
3. Phillip H. Smith, *Electronic Applications of the Smith Chart*, McGraw-Hill, New York, 1969.

ham radio

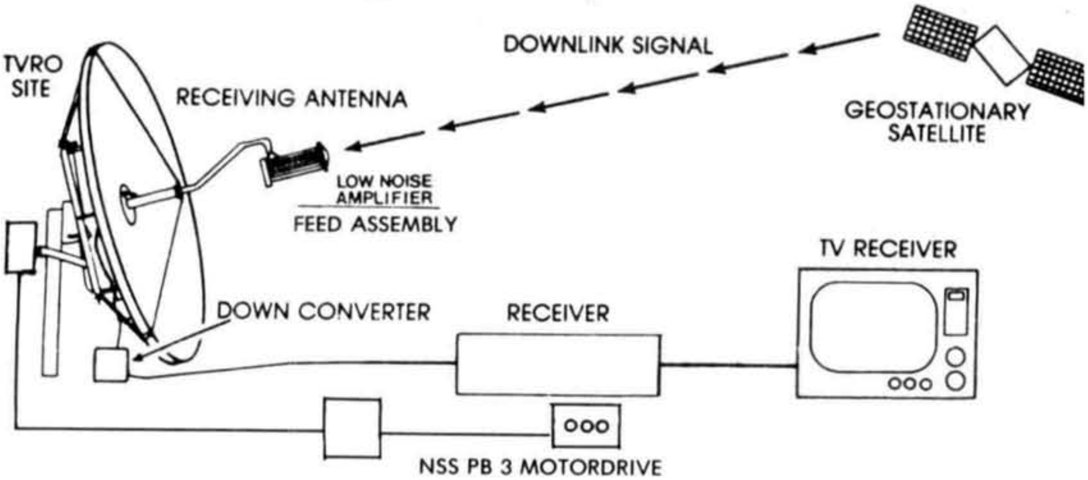
TWO LOCATIONS TO SERVE YOU

In Idaho	In Texas
312 12th Ave. So.	6012 W. 34th St.
Nampa, Idaho 83651	Houston, Texas 77092
(208) 466-6727	(713) 957-5140

Nampa

Complete Satellite Television Systems

MD9 - 9' Dish

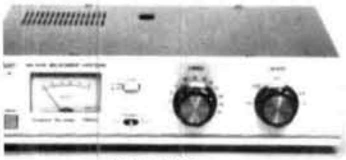


YM1000

WILSON YM1000 SYSTEM

Consists of:
Wilson YM1000, 100° LNA, NSS Deluxe Feed, Wilson MD9 Dish, Feed Assembly, All Cables, Complete Hardware, NSS PB3 Motor Drive, and Instructions . . **Total $1628**

OPTIONS WITH SYSTEM
9 ft. Wilson Mesh ADD **$100**
NSS Memory Tracker ADD **$100**
10 ft. Prodelin ADD **$400** 11 ft. Radarmesh dish ADD . **$250**



YM400,

WILSON YM400 SYSTEM

Consists of:
Wilson YM400, 100° LNA, NSS Deluxe Feed, Wilson MD9 Dish, Feed Assembly, All Cables, Complete Hardware, NSS PB3 Motor Drive, and Instructions . . **Total $1393**

OPTIONS WITH SYSTEM
9 ft. Wilson Mesh ADD **$100**
NSS Memory Tracker ADD **$100**
10 ft. Prodelin ADD **$400** 11 ft. Radarmesh dish ADD . **$250**

NSS PB3 Motor Drive,

✓ 222

Call Toll Free

Nampa, Idaho	Houston, Texas
1-800-654-0795	1-800-521-8300

GaAs, TUNNEL DIODES, ETC.

* R F TRANSISTORS *

TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE
THOMSON CSF							
SD345	$ 5.00	SD1119	$ 5.00	SD1278-5	$18.00	SD1453-1	$48.00
SD445	5.00	SD1124	50.00	SD1281-2	8.00	SD1454-1	48.00
SD1004	15.00	SD1127	3.50	SD1283	10.00	SD1477	48.00
SD1009	15.00	SD1133	14.00	SD1289-1	15.00	SD1478	21.00
SD1009-2	15.00	SD1133-1	14.00	SD1290-4	15.00	SD1480	60.00
SD1012	9.90	SD1134-1	3.00	SD1290-7	15.00	SD1484	1.50
SD1012-3	9.90	SD1135	8.00	SD1300	3.00	SD1484-5	1.50
SD1012-5	9.90	SD1136	15.00	SD1301-7	3.00	SD1484-6	1.50
SD1013-3	13.50	SD1136-2	15.00	SD1305	3.00	SD1484-7	1.50
SD1013-7	13.50	SD1143-1	12.00	SD1307	3.00	SD1488	39.00
SD1014	11.00	SD1143-3	17.00	SD1308	3.00	SD1488-1	28.00
SD1014-6	11.00	SD1144-1	3.00	SD1311	1.00	SD1488-7	27.00
SD1016	15.00	SD1146	15.00	SD1317	10.00	SD1488-8	28.00
SD1016-5	15.00	SD1147	15.00	SD1335	3.00	SD1499-1	39.00
SD1018-4	15.00	SD1188	10.00	SD1345-6	5.00	SD1520-2	18.00
SD1018-6	15.00	SD1189	24.00	SD1365-1	2.50	SD1522-4	33.00
SD1018-7	15.00	SD1200	1.50	SD1365-5	2.50	SD1528-1	24.00
SD1018-15	15.00	SD1201-2	10.00	SD1375	7.50	SD1528-3	34.00
SD1020-5	10.00	SD1202	10.00	SD1375-6	7.50	SD1530-2	38.00
SD1028	15.00	SD1212-11	4.00	SD1379	15.00	SD1536-1	41.00
SD1030-2	12.00	SD1212-12	4.00	SD1380-1	1.00	SD1545	34.00
SD1043	12.00	SD1212-16	4.00	SD1380-3	1.00	SD1561	79.00
SD1043-1	10.00	SD1214-7	5.00	SD1380-7	1.00	SF4557 Mot.	25.00
SD1045	3.75	SD1214-11	5.00	SD1405	40.00	SK3048 RCA	5.00
SD1049-1	2.00	SD1216	12.00	SD1409	18.00	SK3177 RCA	15.00
SD1053	4.00	SD1219-4	15.00	SD1410	22.00	SMS7714 Mot.	2.50
SD1065	4.75	SD1219-5	15.00	SD1410-3	21.00	SRF750 Mot.	36.00
SD1068	15.00	SD1219-8	15.00	SD1413-1	18.00	SRF1018 Mot.	5.00
SD1074-2	18.00	SD1220	8.00	SD1416	50.00	SRF2147 Mot.	22.00
SD1074-4	28.00	SD1220-9	8.00	SD1422-2	24.00	SRF2356 Mot.	38.00
SD1074-5	28.00	SD1222-8	16.00	SD1428	33.00	SRF2378 Mot.	16.00
SD1076	20.00	SD1222-11	7.50	SD1429-2	15.00	SRF2584 Mot.	40.00
SD1077-4	4.00	SD1224-10	18.00	SD1429-3	15.00	SRF2821 Mot.	25.00
SD1077-6	4.00	SD1225	18.00	SD1429-5	15.00	SRF2857 Mot.	20.00
SD1078-6	24.00	SD1228-8	POR	SD1430	12.00	TA8894 RCA	15.00
SD1080-8	6.00	SD1229-7	13.00	SD1430-2	18.00	TIS189/MRF966	3.55
SD1080-9	3.00	SD1229-16	13.00	SD1434-5	30.00	TP312	2.50
SD1084	8.00	SD1232	4.00	SD1434-9	30.00	TP1014 TRW	5.00
SD1087	15.00	SD1240-8	15.00	SD1438	26.00	TP1028 TRW	15.00
SD1089-5	15.00	SD1244-1	14.00	SD1441	91.00	01-80703T04/	
SD1095	15.00	SD1262	12.00	SD1442	15.00	458-949 Mot.Comm.	65.00
SD1100	5.00	SD1263	15.00	SD1444	6.00	TXVF2201 H.P.	450.00
SD1109	18.00	SD1263-1	15.00	SD1444-8	6.00	62803 RCA	100.00
SD1115-2	8.00	SD1272	13.00	SD1450-1	28.00	TA7205/2N5921	80.00
SD1115-3	8.00	SD1272-2	15.00	SD1451	18.00	TA7487/2N5920	75.00
SD1115-7	2.50	SD1272-4	15.00	SD1451-2	18.00	TA7995/2N6267	150.00
SD1116	5.00	SD1278	20.00	SD1452	20.00	SRF2092 Mot.	18.00
SD1118	22.00	SD1278-1	18.00	SD1452-2	20.00	MRF479	8.05

We Can Cross Reference Most RF Transistors, Diodes, Hybrid Modules And Any Other Type Of Semiconductor.

* DIODES (HOT CARRIER, MICROWAVE, PIN, SCHOTTKY, TUNNEL, VARACTOR, GUNN) *

1N21	$ 3.40	1N21B	$ 3.40	1N21BR	$ 3.40	1N21C	$ 3.40
1N21D	4.00	1N21DR	4.00	1N21ER	6.00	1N21RF	5.00
1N21WE	5.80	1N21WG	5.80	1N22	5.00	1N23A	10.00
1N23B	3.40	1N23C	3.40	1N23CR	3.40	1N23D	4.95
1N23DR	4.00	1N23WE	5.00	1N25	7.50	1N25AR	18.00
1N28WE	10.00	1N29	10.00	1N32	20.00	1N53A	55.50
1N76	26.00	1N76R	28.00	1N78	26.00	1N78A	20.00
1N78B	26.00	1N78D	28.00	1N78DR	28.00	1N78R	28.00
1N149	6.00	1N150MR	18.00	1N415	4.00	1N415C	4.00
1N415G	15.00	1N416D	5.00	1N416E	6.00	1N446	10.00
1N831	10.00	1N833	10.00	1N950	4.00	1N1084	2.00
1N2930	15.00	1N2932	15.00	1N3540	15.00	1N3712	11.00
1N3713	18.00	1N3714	11.00	1N3715	16.00	1N3716	10.00
1N3717	14.00	1N3718	10.00	1N3721	14.00	1N3733	10.00
1N3747	21.00	1N4386	20.00	1N4396	15.00	1N4785	11.00
1N4812B	9.00	1N5139A/B	4.25	1N5140A/B	4.25	1N5141A/B	4.25
1N5142A/B	4.25	1N5143A/B	4.25	1N5144A/B	4.25	1N5145A/B	4.25
1N5146A/B	4.25	1N5147A/B	4.25	1N5148A/B	4.25	1N5167	5.50
1N5453	3.75	1N5465	7.65	1N5711	1.00	1N5711 JAN	2.00
1N5713	5.00	1N5767	2.00	1N6263	1.00	1S2199	15.00
1S2200	15.00	1S2208/9	1.00	8B1087/48R869558	65.00	8D3020	65.00
A2X116M Aertech	50.00	BB105B	1.00	BB105G	1.00	BD4/4JFBD4 G.E.	15.00
BL161 Bomac	5.00	CMD514AB C.M.	POR	D4060 Alpha	POR	D4159 Alpha	POR
D4233B Alpha	POR	D4900 Alpha	POR	D4959 Alpha	POR	D4987M Alpha	POR
D5047C Alpha	POR	D5147D Alpa	POR	D5503 Alpha	POR	D5506 Alpha	POR
DGB6158-98 Alpha	POR	DMD6022 Alpha	POR	DMD6460A Alpha	POR	DP20054 Crown	POR
GC1691-89 GHZ	31.35	GC1602-89 GHZ	31.35	GC1607-40 GHZ	31.35	GC2531-88 GHZ	37.40
GC2542-46 GHZ	37.40	GC3208-40 GHZ	37.40	GC17044 GHZ	50.00	HP33644A-H01	125.00
HP5082-0112	14.20	HP5082-0241	75.60	HP5082-0253	105.00	HP5082-0320	58.00
HP5082-0375	POR	HP5082-0386	POR	HP5082-0401	POR	HP5082-0438	POR
HP5082-1028	POR	HP5082-1332	POR	HP5082-2254	POR	HP5082-2302	10.70
HP5082-2303	5.20	HP5082-2696	POR	HP5082-2711	23.15	HP5082-2727	POR
HP5082-2800	1.00	HP5082-2805	4.45	HP5082-2835	1.00	HP5082-2884	POR
HP5082-3039	6.70	HP5082-3040	36.00	HP5082-3080	2.00	HP5082-3188	1.00
HP5082-3379	1.50	HP5082-6459	POR	HP5082-6462	POR	HP5082-6888	POR
HP5082-8016	POR	HP5082-8323	POR	K3A Kemtron	7.00	MA450A	POR
MA475	POR	MA40008	POR	MA41487	POR	MA41765	POR
MA41766	POR	MA43004	48.00	MA43589	POR	MA43622	POR
MA43636	POR	MA45104	27.00	MA47044	POR	MA47051	25.50
MA47100	3.05	MA47202	30.80	MA47771	POR	MA47838*	POR
MA47852	POR	MA49106	37.95	MA49558	POR	MA86731	125.00

* OUR STOCK CHANGES DAILY SO CALL IF IF THE PART YOU NEED IS NOT LISTED

For information call: (602) 242-3037

Toll Free Number
800-528-0180
(For orders only)

"All parts may be new or surplus, and parts may be substituted with comparable parts *if we are out of stock of an item."*

MHz electronics

PRICES SUBJECT TO CHANGE WITHOUT NOTICE

TUBES

TYPE	PRICE	TYPE	PRICE	TYPE	PRICE
2C39/7289	$ 34.00	1182/4600A	$500.00	ML7815AL	$ 60.00
2E26	7.95	4600A	500.00	7843	107.00
2K28	200.00	4624	310.00	7854	130.00
3-500Z	102.00	4657	84.00	ML7855KAL	125.00
3-1000Z/8164	400.00	4662	100.00	7984	14.95
3B28/866A	9.50	4665	500.00	8072	84.00
3CX400U7/8961	255.00	4687	P.O.R.	8106	5.00
3CX1000A7/8283	526.00	5675	42.00	8117A	225.00
3CX3000F1/8239	567.00	5721	250.00	8121	110.00
3CW30000H7	1700.00	5768	125.00	8122	110.00
3X2500A3	473.00	5819	119.00	8134	470.00
3X3000F1	567.00	5836	232.50	8156	12.00
4-65A/8165	69.00	5837	232.50	8233	60.00
4-125A/4D21	79.00	5861	140.00	8236	35.00
4-250A/5D22	98.00	5867A	185.00	8295/PL172	500.00
4-400A/8438	98.00	5868/AX9902	270.00	8458	35.00
4-400B/7527	110.00	5876/A	42.00	8462	130.00
4-400C/6775	110.00	5881/6L6	8.00	8505A	95.00
4-1000A/8166	444.00	5893	60.00	8533W	136.00
4CX250B/7203	54.00	5894/A	54.00	8560/A	75.00
4CX250FG/8621	75.00	5894B/8737	54.00	8560AS	100.00
4CX250K/8245	125.00	5946	395.00	8608	38.00
4CX250R/7580W	90.00	6083/AZ9909	95.00	8624	100.00
4CX300A/8167	170.00	6146/6146A	8.50	8637	70.00
4CX350A/8321	110.00	6146B/8298	10.50	8643	83.00
4CX350F/8322	115.00	6146W/7212	17.95	8647	168.00
4CX350FJ/8904	140.00	6156	110.00	8683	95.00
4CX600J/8809	835.00	6159	13.85	8877	465.00
4CX1000A/8168	242.50*	6159B	23.50	8908	13.00
4CX1000A/8168	485.00	6161	325.00	8950	13.00
4CX1500B/8660	555.00	6280	42.50	8930	137.00
4CX5000A/8170	1100.00	6291	180.00	6L6 Metal	25.00
4CX10000D/8171	1255.00	6293	24.00	6L6GC	5.03
4CX15000A/8281	1500.00	6326	P.O.R.	6CA7/EL34	5.38
4CW800F	710.00	6360/A	5.75	6CL6	3.50
4D32	240.00	6399	540.00	6DJ8	2.50
4E27A/5-125B	240.00	6550A	10.00	6DQ5	6.58
4PR60A	200.00	6883B/8032A/8552	10.00	6GF5	5.85
4PR60B	345.00	6897	160.00	6GJ5A	6.20
4PR65A/8187	175.00	6907	79.00	6GK6	6.00
4PR1000A/8189	590.00	6922/6DJ8	5.00	6HB5	6.00
4X150A/7034	60.00	6939	22.00	6HF5	8.73
4X150D/7609	95.00	7094	250.00	6JG6A	6.28
4X250B	45.00	7117	38.50	6JM6	6.00
4X250F	45.00	7203	P.O.R.	6JN6	6.00
4X500A	412.00	7211	100.00	6JS6C	7.25
5CX1500A	660.00	7213	300.00*	6KN6	5.05
KT88	27.50	7214	300.00*	6KD6	8.25
416B	45.00	7271	135.00	6LF6	7.00
416C	62.50	7289/2C39	34.00	6LQ6 G.E.	7.00
572B/T160L	49.95	7325	P.O.R.	6LQ6/6MJ6 Sylvania	9.00
592/3-200A3	211.00	7360	13.50	6ME6	8.90
807	8.50	7377	85.00	12AT7	3.50
811A	15.00	7408	2.50	12AX7	3.00
812A	29.00	7609	95.00	12BY7	5.00
813	50.00	7735	36.00	12JB6A	6.50

NOTE * = USED TUBE   NOTE P.O.R. = PRICE ON REQUEST

"ALL PARTS MAY BE NEW, USED, OR SURPLUS. PARTS MAY BE SUBSTITUTED WITH COMPARABLE PARTS IF WE ARE OUT OF STOCK OF AN ITEM.

NOTICE: ALL PRICES ARE SUBJECT TO CHANGE WITHOUT NOTICE.

For information call: (602) 242-3037

Toll Free Number
800-528-0180
(For orders only)

"All parts may be new or surplus, and parts may be substituted with comparable parts if we are out of stock of an item."

MHz electronics

PRICES SUBJECT TO CHANGE WITHOUT NOTICE

HEWLETT PACKARD SIGNAL GENERATORS

606A	50KHz to 65MHz in 6 bands +-1%,Output level adjustable 0.1uV to 3V into 50 ohms.Built-in crystal calibrator.400 -1000Hz modulation.	$ 650.00
606B	Same as above but has frequency control feature to allow operation with HP 8708A Synchronizer.	$1100.00
608C	10MHz to 480MHz,0-1uV-1V into 50 ohms,AM,CW,or pulse modulation, calibrated attenuator.	$ 500.00
608D/ TS510	10MHz to 420MHz, 0.1uV-0.5V into 50 ohms,+-0.5% accuracy, built-in crystal calibrator, AM-CW or pulse output.	$ 375.00
608E	Improved version of popular 608C.Up to 1V output.Improved stability,low residual FM.	$1450.00
608F	10MHz to 455MHz in 5 bands +-1% frequency accuracy with built-in crystal calibrator.Can be used with HP 8708A Synchronizer. Output continuously adjustable from .1uV to .5V into 50 ohms.	$1100.00
612A	450-1230MHz ,o.1uV-0.5V into 50 ohms,calibrated output.	$ 750.00
614A	900-2100MHz with many features including calibrated output and all modulation characteristics.	$ 500.00
616A/ TS403	Direct reading and direct control from 1.8 to 4.2GHz. The H.P.616A features +-1.5dB calibrated output accuracy from -3127dBm to -dBm.The output is directly calibrated in micro-volts and dBm with continuous monitoring. Simple operation frequency diad accuracy is +-1% and stability exceeds 0.005%-/ C change in ambient temperature. Calibrated attenuator is within +-1.5dB over entire output band. 50 ohm impedance unit has internal pulse modulation with rep rate variable from 40 Hz to 4KHz,variable pulsewidth(1 to 10usec)and variable pulse delay(3 to 300usec).External modulating inputs increas versatility.	$ 375.00
616B	Same as above but later model.	$ 600.00
618B	3.8 to 7.6GHz range,with calibrated output and selection of pulse-FM or square wave modulation.	$ 600.00
618C	Same as above but later model.	$2200.00
620A	7 to 11GHz range,with calibrated output and selection of pulse-FM or square wave modulation.	$ 750.00
620B	Same as above but later model.	$2200.00
626A	10 to 15GHz,10mw output power with calibrated output and pulse-square wave or FM modulation.	$4200.00
8708A	Synchronizer used with 606B,608F.The synchronizer is a phase-lock frequency stabilizer which provides crystal-oscillator frequency stability to 430MHz in the 608F signal generator.Phase locking eliminates microphonics and drift resulting in excellent frequency stability.The 8708A includes a vernier which can tune the reference oscillator over a range of +-0.25% permitting frequency settability to 2 parts in 10 to the seventh.Provides a very stable signal that satisfies many critical applications. (With HP 606B or 608F) / (Without)	$ 350.00 / $ 450.00
EMC-10	ELECTROMETRICS EMC-10 RFI/EMI RECEIVER Low frequency analyzer covering 20Hz to 50KHz frequency range.Extendable to 500 KHz in wideband mode.	$2500.00
NF-105F	Empire Devices Field Intensity Meter. Has NF-105/TA,NF-105/TX,NF-105/T1,NF-105/T2,NF-105/T3. Covers 14KHz to 1000MHz.	$2100.00

ALL EQUIPMENT CARRY A 30 DAY GUARANTEE.

EQUIPMENT IS NOT CALIBRATED.

UNEX LABORATORIES THS-2 FLEXICOM HEADSET.

these headsets come with data to hook up to a ICOM radios and many other equipment.

Perfect for Airplanes , Helicopters , Mobile Radios , or Just the Telephone.

These Are Factory New In Sealed Boxes. Limited Supply Only $69.95

TERMS: DOMESTIC: Prepaid, C.O.D. or Credit Card
FOREIGN: Prepaid only, U.S. Funds, Money Order, or Cashier's Check Only.

C.O.D.' Acceptable by telephone or mail. Payment from customer will be by Cash, Money Order, or Cashier's Check. We are sorry but we cannot accept personal checks for C.O.D.'s. C.O.D.'s are shipped by air only and thru United Parcel Service.

CONFIRMING ORDERS: We would prefer that confirming orders not be sent after a telephone order has been placed. If company policy necessitates a confirming order, please mark "CONFIRMING" boldly on the order. If problems or duplicate shipments occur due to an order which is not properly marked, the customer will be held responsible for any charges incurred, plus a 15% restock charge on the returned parts.

CREDIT CARDS: We are now accepting MASTERCARD, VISA, AND AMERICAN EXPRESS

DATA SHEETS: When we have data sheets in stock on devices we will supply them with the order.

DEFECTIVE MATERIALS: All claims for defective materials must be made within 30 DAYS after receipt of the parcel. All claims must include the defective material (for testing purposes), a copy of our invoice, and a return authorization number which must be obtained prior to shipping the merchandise back to us. This can be obtained by calling (602) 242-8916 or sending us a postcard. Due to Manufacturer warranties we are unable to replace or issue credit on items which have been soldered to or have been altered in any way. All return items must be packed properly or it will void all warranties. We do not assume responsibility for shipping and handling charges incurred.

DELIVERY: Orders are usually shipped the same day they are placed or the next business day, unless we are out of stock on an item. The customer will be notified by post card if we are going to backorder the item. Our normal shipping method is UPS or U.S. Mail depending on size or the weight of the package. Test Equipment is shipped only by air and is freight collect, unless prior arrangements have been made and approved.

FOREIGN ORDERS: All foreign orders must be prepaid with a Cashier's Check, or Money Order made out in U.S. FUNDS ONLY. We are sorry but C.O.D. is not available to foreign countries and letters of credit are unacceptable as a form of payment. Further information is available on request.

HOURS: Monday thru Friday 8:30 a.m. to 5:00 p.m. Saturdays 8:30 a.m. to 4:00 p.m.

INSURANCE: Please include 25¢ for each additional $100.00 over $100.00, UPS ONLY. All insured packages are shipped thru UPS only. If you wish to have it shipped through the post office there is a $5.00 fee which is additional to the shipping, handling and insurance.

OPEN ACCOUNTS: We regret that we do not issue open accounts.

ORDER FORMS: New order forms are included with each order for your convenience. Additional order forms are available on request.

PARTS: We reserve the right to substitute or replace any item with a part of equal or comparable specification.

POSTAGE: Minimum shipping and handling in the U.S., Canada, and Mexico is $3.00 for ground shipments, all other countries is $5.50. Air rates are available at the time of your order. All foreign orders please include 25% of the ordered amount for shipping and handling. C.O.D.'s are shipped AIR ONLY.

PREPAID ORDERS: Orders must be accompanied by a check.

PRICES: Prices are subject to change without notice.

PURCHASE ORDERS: We accept purchase orders only when they are accompanied by a check.

RESTOCK CHARGES: If parts are returned to MHZ ELECTRONICS, INC. due to customer error, the customer will be held responsible for all fees incurred and will be charged a 15% RESTOCK CHARGE with the remainder in CREDIT ONLY. The following must accompany any return; A copy of our invoice, return authorization number which must be obtained prior to shipping the merchandise back. Returns must be done within 10 DAYS of receipt of parcel. Return authorization numbers can be obtained by calling (602) 242-8916 or notifying us by post card. Return authorizations will not be given out on our 800 number.

SALES TAX: ARIZONA residents must add 6% sales tax, unless a signed ARIZONA resale tax card is currently on file with us. All orders placed by persons outside of ARIZONA, but delivered to persons in ARIZONA are subject to the 6% sales tax.

SHORTAGE OR DAMAGE: All claims for shortages or damages must be made within 5 DAYS of receipt of parcel. Claims must include a copy of our invoice, along with a return authorization number which can be obtained by contacting us at (602) 242-8916 or sending a post card. Authorizations cannot be on our 800 number. All items must be properly packed. If items are not properly packed make sure to contact the carrier so that they can come out and inspect the package before it is returned to us. Customers which do not notify us within this time period will be held responsible for the entire order as we will consider the order complete.

OUR 800 NUMBER IS STRICTLY FOR ORDERS ONLY (800) 528-0180. INFORMATION CALLS ARE TAKEN ON (602) 242-8916 or (602) 242-3037.

master charge VISA AMERICAN EXPRESS Cards Welcome

MHz electronics

2111 W. CAMELBACK ROAD
PHOENIX, ARIZONA 85015

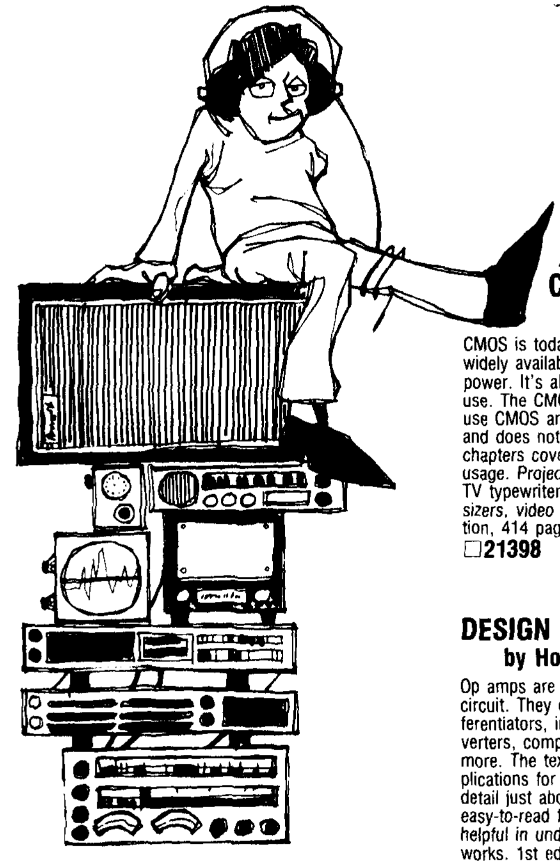
"All parts may be new or surplus, and parts may be substituted with comparable parts if we are out of stock of an item."

Toll Free Number
800-528-0180
(For orders only)

For information call: (602) 242-3037

PRICES SUBJECT TO CHANGE WITHOUT NOTICE.

✓ 167



Ham Radio's BOOK STORE BUILDERS' SPECIAL

CMOS COOKBOOK
by Don Lancaster

CMOS is today's state-of-the-art! It's low cost, widely available and uses an absolute minimum of power. It's also fun to work with and very easy to use. The CMOS Cookbook is written to help you use CMOS and is chock-full of practical circuits and does not dwell on math or heavy theory. Eight chapters cover just about every aspect of CMOS usage. Projects include high-performance op-amps, TV typewriter, digital instruments, music synthesizers, video games and more. ©1977, 1st edition, 414 pages.

□21398 **Softbound $13.95**

IC OP AMP COOKBOOK
by Walter Jung

This second edition is broadly updated in terms of device coverage. It includes the latest in state-of-the-art developments such as J Fet and MosFet in both single and multiple formats. This cookbook is edited into three basic parts. Part I introduces the IC op amp and discusses general considerations. Part II covers practical circuit applications. Part III is an appendix consisting of manufacturers and data sheets and other pertinent information. With the same clear, easy-to-read format of the first edition, you'll find the wealth of information, as well as over 200 practical circuit applications, to be invaluable. ©1980, 2nd edition, 480 pages.

□21695 **Softbound $15.95**

DESIGN OF OP AMP CIRCUITS
by Howard Berlin, W3HB

Op amps are a versatile and inexpensive integrated circuit. They can be used for linear amplifiers, differentiators, integrators, voltage and current converters, comparators, rectifiers, oscillators and more. The text includes 37 different uses and applications for op-amps. Ten complete chapters detail just about every facet of the op-amp in an easy-to-read format. Beginners will find this book helpful in understanding exactly how an op-amp works. 1st edition, ©1977, 221 pages.

□21537 **Softbound $11.95**

RF CIRCUIT DESIGN
by Chris Bowick, WB4UHY

This book has been written for those who desire a practical approach to the design of rf amplifiers, impedance measuring devices and filters. Plenty of projects and design ideas. 7 chapters cover from basics to advanced design concepts. You get a complete design run down for multiple pole Butterworth, Chebyshev and Bessel filters. RF Circuit Design also includes a bibliography of books and technical papers to help further your knowledge of circuit design. ©1983, 176 pages, 1st edition.

□21868 **Softbound $22.95**

MODERN DICTIONARY OF ELECTRONICS — 6th Edition
by Rudolf Graf

This book should be in every ham's library. It has over 20,000 terms unique to electronics and other closely related fields. 3000 additions to the 5th edition and twice the size of the 1st edition! From A or angstrom to zoom lens, you'll find it in this updated dictionary. 6th edition, ©1984, 1152 pages.

□22041 **Hardbound $39.95**

TTL COOKBOOK
by Don Lancaster

Despite the advent of CMOS, there is still plenty of design work being done with TTL circuitry. This book gives you a broad overview of exactly what TTL is, how it works and is full of design ideas and practical circuits. Some areas that receive attention are, flip-flops, clocked logic, counters and counting techniques, noise generators and much more. You also get a complete discussion of practical TTL applications including digital counter, events counter, stopwatch and voltmeter to name just a few. ©1974, 1st edition, 333 pages.

□21035 **Softbound $12.95**

ACTIVE FILTER COOKBOOK
by Don Lancaster

Active filters are unique combinations of integrated circuits, resistors and capacitors. They give excellent performance from sub-audible to ultrasonic frequencies. And they are relatively low in cost, simple to design and construct. This book is written for the user and will help you tailor filters to specific needs or applications. Ten chapters are full of helpful information and are illustrated with plenty of drawings and circuits. ©1975, 1st edition, 240 pages.

□21168 **Softbound $14.95**

DESIGN OF ACTIVE FILTERS WITH EXPERIMENTS
by Howard Berlin, W3HB

Here's an excellent introduction to the theory, implementation and design of active filters using the 741 op-amp. This book starts the reader with an introduction to the 741 op-amp and then progresses to filter design basics. Also covered are first order low and high pass filters, second order voltage controlled voltage source filters, second order multiple feedback filters and more. Throughout the book, experiments are given to enable you to gain first hand experience on just how each filter operates. Great for all levels of electronic interest. 1st edition, ©1977, 239 pages.

□21539 **Softbound $10.95**

DESIGN OF PHASE LOCKED LOOP CIRCUITS WITH EXPERIMENTS
by Howard Berlin, W3HB

Due to prohibitive costs, the phase loop circuit did not become widely used until the development of the monolithic IC and the incorporation of complete PLL circuitry inside these solid state devices. This book serves as an introduction to the theory, design and implementation of PLL using a variety of TTL and CMOS devices. Opening with an introduction of PLL, this book covers in a basic building block approach, the phase detector, voltage controlled oscillator and the loop filter. Appendices include manufacturers design information and description of breadboarding techniques. Experiments are included to ensure the reader fully understands PLL design nuances. 1st edition, ©1978, 255 pages.

□21545 **Softbound $10.95**

MICROPROCESSOR CIRCUITS
by Ed Noll, W3FQJ

Volume 1 presents basic concepts and fundamental circuits of microprocessor systems. Volume 2 presents microprocessor I/O circuits and programmable controllers. Each volume is written and edited in an uncomplicated manner. By using the experience gained from these books, the reader can progress to higher levels of computer complexity with a minimum of problems. Every attempt is made to keep costs down so that experimentation is facilitated. Both books, 1st edition, ©1983.

Vol. 1 Fundamentals & Microcontrollers □21877 **$9.95**

Vol. 2 I/O Interfacing and Programmable Controllers □21977 **$9.95**

ELECTRONIC PROTOTYPE CONSTRUCTION
by Stephen D. Kasten

Here's a great book for either the beginner looking to try electronic prototyping for the first time or the expert looking for a handy reference guide. Areas covered include wire wrap and related techiques such as solder pad and perf. board asembly. When rough schematics are converted to PC boards, this book will help you through all the pitfalls of PC board design. It will also give you handy tips on how to make PC boards simply, with a minimum of fuss. Finally, when the project is nearing completion, you must consider packaging or how to put it all together in an attractive but functional package. Great reference book! 1st edition, ©1983, 399 pages.

□21895 **Softbound $17.95**

PLEASE ADD $2.50 FOR SHIPPING AND HANDLING
FOREIGN ORDERS FOB GREENVILLE ✓ 152

VISA MasterCard

ham radio magazine BOOKSTORE

GREENVILLE, NH 03048 (603) 878-1441

NCG CO.

Just Slightly Ahead

10/160M

THE 10/160M GIVES YOU THAT EXTRA BIT OF QUALITY THAT REALLY GETS YOU THROUGH TO THAT SPECIAL DX STATION, OR JUST ENJOYING A FULLY RELAXED QSO WITH ANOTHER AMATEUR THE OTHER SIDE OF THE COUNTRY. YOUR 10/160M GIVES YOU THE EASE OF OPERATION THAT YOU WANT WITH 4 MEMORYS OR THE 3 WAY AUTO SCAN, DUAL VFO, IF SHIFT, CW-W CW-N, HAND MIC AND BUILT IN AC/DC POWER. ALL BANDS ARE FULLY OPERATIONAL INCLUDING THE NEW WARC BANDS. YOUR CHOICE OF EASY OPERATING USB, LSB, CW OR RTTY IS AT YOUR FINGER TIPS. WITH A FULL 200 WATTS PEP OUTPUT YOUR FINALS ARE PROTECTED FROM HIGH SWR.
YOUR 10/160M IS ALL SOLID STATE WITH MODULAR BOARDS THAT ARE EASY ACCESSIBLE. A BRIGHT BLUE FLUORESCENT DIGITAL DISPLAY IS EASY TO READ AT ALL TIMES.
BEST OF ALL THERE ARE NO EXTRA OPTIONS TO BUY TO GET YOU ON THE AIR, ITS ALL THERE. JUST TAKE YOUR 10/160M HOME AND 1. CONNECT A ANTENNA. 2. PLUG INTO 120V AC OUTLET. 3. TURN THE SWITCH ON. 4. SELECT THE BAND AND FREQUENCY AND YOUR ON THE AIR. YOUR RECEIVING AUDIO IS CRISP AND CLEAR, YOUR TRANSMITTED SIGNAL WILL GET YOU A PRAISE FROM EACH CONTACT. THE 10/160M GIVES YOU A SUPERIOR TRANSCEIVER THAT IS UNCOMPARABLE.

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

15M

15M-MOBILE IS YOURS TO CONTINUE YOUR QSO WITH THAT SPECIAL FRIEND WHEN YOU GO ON A VACATION OR JUST GOING TO OR FROM WORK. A TRULY QRP RIG WITH THE BIG RIG SIGNAL EITHER CW OR USB. THE DIGITAL FREQUENCY DISPLAY IS EASY TO READ AND YOUR 10 WATTS OR 2 WATTS ON USB OR CW WITH A BUILT IN SIDE TONE, HIGHLY EFFECTIVE NOISE BLANKER, AUDIO ALC GIVES DISTORTION FREE TRANSMISSION. THE VFO BALL WITH GEARS ALLOWS HIGH-PRECISION TUNING. DIGITAL DISPLAY OFFSET WHEN RIT IS IN OPERATION (A MODIFICATION THAT TAKES 5 MINUTES CHANGES THE RIT TO A FINE TUNE CONTROL). A LARGE S/RF METER IN THE CENTER AND A TOP 8 OHM .5W SPEAKER, YOUR RECEIVE AUDIO IS DIRECTED UP.
EXTERNAL SPEAKER AND CW JACKS, MOBILE MOUNTING BRACKET AND A 400 OHM PTT DYNAMIC MICROPHONE. FULL 15 METER BAND OPERATION FROM 21 to 21.450 MHZ, YOUR OFFSET FREQUENCY RANGE OR FINE TUNE IS ±4 KHZ. THE SIGNAL TO NOISE SENSITIVITY IS MORE THAN 10DB DOWN AT -6DB INPUT. POWER SOURCE IS 13.8V DC, 3 AMPS. THE SMALL SIZE WILL ALLOW MOBILE OPERATION FROM EVEN THE SMALL CARS, ITS ONLY 9"H x 2.5W x 9.5D, THE LIGHT WEIGHT OF ONLY 5.7 LBS. MAKES THE 15M A POSSIBLE BACK PACKERS DREAM.
WITH YOUR 15M YOU WILL NOT HAVE A BIG EXPENSIVE PIECE OF EQUIPMENT SETTING IN YOUR VEHICLE, IT CAN BE UNDER THE DASH OUT OF SIGHT.

✓ 180

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

product

REVIEW

AEA's "Doctor DX" Morse-code contest trainer

***When I visited the AEA booth** at Dayton several years ago, I sat down with Mike Lamb, AEA's president, to look at a new "mini-transceiver" they had on display. I was quite impressed with its credentials: it had all the bands I would want to work, and the sensitivity and selectivity numbers were good.*

At Mike's urging I put the headphones on and tuned around the bands to see what was going on. Twenty and 15 were hopping with DX and it seemed as if a contest were going on. Mike nudged me in the ribs. "Go ahead," he said, "give one a call." I tuned in a G3 station who was calling CQ. I dumped my call and got an immediate response: "N1ACH de G3XXX UR 599 14 BK." I went back, "G3XXX de N1ACH TNX UR 599 05 73 BK." A bell should have gone off in the back of my mind that something was amiss; there are no contests scheduled for the Dayton weekend. Oblivious to Mike's snickers, I blithely went on. After a few minutes, Mike let me in on his little secret: I was talking to a microcomputer. Needless to say I felt a little foolish. But I knew I was in good company. They'd been able to fool almost everyone who'd stopped by their booth so far. In fact, in their dozens of demonstrations, only two people figured it out.

Mike then explained what they were up to and gave me additional background on the unit. After that, I really didn't hear much about the simulator until the other day when Mike called to tell me about his newest product.

Doctor DX

Doctor DX is a cleverly designed module made up of two custom programmed EPROMs and several AEA designed integrated circuits. It fits into the cartridge port of the Commodore C-64 computer and lets you simulate chasing DX without actually being on the air. You can program Doctor DX to put your QTH anywhere around the world from Albania to Zambia. Other variable parameters are time of day, power output, and frequency of operation.

use

After installing the board into the computer and hooking up a keyer, you have to set a couple of variables before you can begin. The first is to locate your station by longitude and latitude. The second is setting the internal clock for the time of day at which you'd like to be operating. You then set your power output to one of three levels: 2, 20, or 200 watts. Finally, you select the band on which you want to operate.

Propagation is programmed to simulate what you'd hear on a given band at that time of day. For instance during the daylight hours, 10 and 15 meters will be open to DX; 160 and 80 will be dead. At night the opposite will be true: 160, 80, and 40 will be open, with the two higher bands closed. Twenty meters will be open to various parts of the world most all the time.

Another interesting aspect is that AEA has programmed the EPROMs to simulate the propagation conditions that existed during September 1979. At that time the three higher bands (20, 15, and 10) were much better than they are now. *(Gee, if you get depressed listening to 10 meters nowadays, listening to the computer will restore your faith in the band!)* This also means that propagation of the three lower bands 160, 80, and 40 is not as good as we are now experiencing but . . . you can't have everything, can you?

Callsigns are all randomly generated by the computer, with prefixes weighted by Amateur population density in that country. AEA guarantees that at least one station will be on from each of the 304 DXCC countries programmed into the computer. In an effort to replicate conditions as much as possible, stations on the lower end of each band are found working at high-speed CW (30-40 WPM). The higher you go on each band, the slower the stations are. Contacts consist of a signal report followed by CQ WW zones. If you miss an exchange, you can ask the station for a repeat. You can also request that the station speed up (QRQ) or slow down (QRS).

There are four frequency tuning rates with Doctor DX. The function keys on the right of the Commodore keyboard are used to "tune" the receiver up and down frequency. F-1 is FAST UP, to 20 kHz per second, F3 up 2 kHz per second, F5 is FAST DOWN — 20 kHz per second and F7 is down — 2 kHz per second.

So that you can follow your progress with the test, the computer is programmed to constantly display your score and QSO rate. Contest lengths can be varied from a one-hour sprint to a test of several hours' duration.

operation

Now that everything is all hooked up and location, time of day, power, and frequency (160 meters, of course) are all programmed in, it's time to get this mock contest started. The first station worked was a K2, and I even got a 599! Hey, I'm off and running!

The first thing to decide is whether I'm going to find a clear frequency and call CQ or do a "hunt and pounce" contest. Since I want to try both, I start by calling CQ. After two calls, a VE3 comes back with a 589 in zone 5. I quickly work another 10 stations before a VE2 starts calling CQ up a few kHz from mine. However, I hear a weak call, and ask QRZ? By golly, it's my first DX, an HI7. He gives me a 589 and zone 8. I shoot back his report only to have him ask twice for a repeat. Repeat? I am talking to a computer aren't I? After a couple of minutes, I'm not so sure. (Mike's done it again. I actually can believe I'm in the midst of a CQ WW!)

Now it's time to do some looking to see what I can find. I change bands and start at the bottom, looking up frequency. The first station I tune by is running at least 40 WPM. I call him twice only to have him go back to two other computer calls. Finally he calls me and I put another into the log.

After about an hour's worth of operation it's time to see how I've done. I have 28 contacts on three bands, with the majority (22) on 160 meters, 4 on 40 meters, and one TI3 on 80 meters. I'm sure I would have done better during my one-hour sprint if there'd been no phone calls or other interruptions.

My QSO rate varied from 35 to 45 QSOs per hour while I was able to dedicate full time and attention to the test. I feel quite strongly that with a little practice my rate during actual contests would improve dramatically.

There's the real beauty of Doctor DX. No matter where your interest in Amateur Radio lies, using Doctor DX will help improve your CW operating skills. After a couple of hours of use, you'll find that code copy comes much more easily. One of our own Novices stopped by and watched while I was running the test and commented that the real-life simulation offered by Doctor DX would be a tremendous help in improving CW skills and operating confidence in a way that wouldn't be embarrassing to the beginner. Experienced contesters will find operating a contest from EP2 to be quite a change from their normal QTH. I think that many will find the added insight of having worked portable EP2 to give them a tactical edge during actual contests. Doctor DX can be many things to different people. I think that those who use it will find it to be very rewarding and *plenty* of fun.

awards

AEA has gone whole hog here and is offering the following awards:

AEA-CC: for working 100 different countries
AEA-AZ: for working all CQ zones
AEA-DC: for working 100 countries on five bands
AEA-HR: AEA's honor roll for working 250 countries

Handsome certificates will be awarded for each level reached. These awards are endorsable or you add to your totals. AEA will also be keeping a running tally of high claimed scores and will periodically publish the current top five scores in two categories: Marathon (24 hours) and Sprint (8 hours). There is a minimal charge for these awards.

The price of Doctor DX will be $149.95 from AEA dealers and the unit should be available by the time you read this review. It is a perfect Holiday gift for that hard to buy for ham friend. Clubs will also find it quite useful for training in sprint contests or in any number of other applications.

For information, contact AEA, P.O. Box C2160, Lynnwood, Washington 98036.

Circle #301 on Reader Service Card.

de N1ACH

NEW products

"Remote-A-Pad"

Remote control of an HF or VHF station is now possible using the "Remote-A-Pad" from Engineering Consulting. It incorporates the radio's own digital frequency control inputs (keypad) and a simple eight wire connection to the control pad of the radio. The audio from, for example, a two meter rig is decoded and turned into rows and column switches which provide the necessary logic to work in parallel with an existing keypad.

The "tough tones" from your handheld's keypad are transmitted to another receiver which provides the audio link into the "Remote-A-Pad." The tone selected then activates the keypad. If you hit a #1 on the portable then a #1 on the radio to be controlled is activated. When controlling radios like the ICOM-701 and using the RM-2 controller the power of the microprocessor already built into the rig is unleashed. Many other radios can also be used with the "Remote-A-Pad," in fact any radio or rotator (Pro Search for example) having a 3 × 4 or 4 × 4 keypad may be controlled since the rows and columns are found on all keypads which are used to control computerized devices.

Find yourself a radio which is now controlled with a keypad and install a "Remote-A-Pad." Add a phone patch for audio link, and the "Remote-A-Pad" will also turn on and off your link with two on board 4 digit DTMF (touch tone) programmable decoders. You set the code to any series of the 16 DTMF tones. LEDs on the board will tell you the status of the controlled device (on or off). A momentary pulse is also provided and may be used directly into logic to control on-off devices. Relays may be added by using a transistor driver.

The "Remote-A-Pad" is shipped with a 22-(gold) pin card edge connector as well as a 16-pin dip socket ribbon cable for easy installation. Detailed installation instructions and schematics are provided for $149.00.

For further information, contact Engineering Consulting, 583 Candlewood Street, Brea, California 92621.

Circle #302 on Reader Service Card.

satellite converter

The Ten-Tec Model 2510 Mode B satellite station incorporates a complete 435 MHz, 10-watt output, single sideband or CW transmitter and a 2-meter to 10-meter receiving converter, both tuned with a common frequency-adjusting knob.

The transmitter is VFO tuned across the required 435.0 to 435.5 MHz segment and features selections of CW or SSB modes and of upper or lower sideband. The output power level is automatically maintained at a present level (ALC) so that overdrive is not possible. The preset level can be reduced from the factory-set 10-watt level if a linear power amplifier with drive requirements below this level is used.

The receiving converter employs a GaAs FET preamplifier for lowest noise figure and an output frequency of approximately 29.0 MHz. The 10-meter band of any Amateur HF transceiver or receiver, or a high-quality general coverage receiver, can be used in conjunction with the converter. Once the HF receiver is set to the correct frequency, all satellite tuning is performed with the tuning knob. (Transmitter and receiving converter are automatically tracked, thus producing a pseudo-transceiver.)

Provisions are made to allow duplex operation so your transmitted signal can be received simultaneously for system and frequency checks. A front panel SPOT pushbutton switch places the transmitter in operation with carrier inserted.

Priced at $489, the unit simplifies station assembly, reduces the number of separate items and interconnections, eliminates the need to buy separate converters, and converts your HF station into a transceiver type OSCAR station.

For additional information, contact Ten-Tec, Inc., Sevierville, Tennessee 37862.

Thruline® wattmeter elements

A new series of five plug-in elements, each of which offers bi-directional RF power measurement from 20 milliwatts to 100 watts at ±5 percent accuracy of reading, in frequency bands from 25 MHz to 1000 MHz, is available for the Bird Thruline® Wattmeter. Full rated accuracy is maintained over this 5000 to 1 power range, with temperature extremes between 0 and 50 degrees C.

The entire complement of Model 4410 elements — each with seven full-scale power levels instead of one — enables the new wattmeter to service CW and FM systems from 200 kHz to 1000 MHz and from 20 milliwatts (on the 100 mW scale) to 10,000 watts. The desired range is selected instantly by a front-mounted rotary switch. A choice of over 18 quick-change connectors mate with any common RF type.

This sensitive instrument is appropriate for any application where accurate in-line measurements at milliwatts, watts, or kilowatts need to be performed fast, economically, and simply at any skill level, independent of AC line power, in indoor our outdoor environments at freezing or tropical temperatures.

The new low power plug-in elements are priced at $125; the Model 4410 Thruline® Watt-

NEW products

meter (with Quick-Change female N connectors) is $495; other elements are priced from $125 to $175.

For additional information, contact Bird Electronic Corporation, 30303 Aurora Road, Cleveland (Solon), Ohio 44139-2794.

Circle #304 on Reader Service Card.

HF antenna accessories catalog

Microwave Filter's Catalog PC/84 describes baluns, multiband traps, and remote antenna switching relays for the 2 to 1000 MHz communications bands.

The catalog illustrates the construction of single and multiband dipoles in the 1.8 to 30 MHz Amateur and HF communication bands and offers other construction accessories such as end insulators, weatherized center-feed insulators, wire, cable, and connectors.

The system of remote, voltage-controlled antenna switching relays allows selection of up to nine separate antennas through a single coaxial cable as well as direction changing of antenna arrays and automatic pairing of antenna/transmitter sets.

For a copy, contact Microwave Filter Company, Inc., 6743 Kinne Street, East Syracuse, New York 13057.

Circle #308 on Reader Service Card.

simplex autopatch system

Hamtronics, Inc., has offered a Repeater Autopatch in kit form, including the DTMF Tone Decoder/Controller module for several years. They now have a new module that can be used with the Autopatch to allow operation on simplex transceivers. When an autopatch is used on a repeater, the duplex operation of the repeater allows the mobile operator to break into the telephone conversation anytime; when operating simplex — that is, transmitting and receiving on the same frequency — it is necessary to have a method to allow the mobile operator to access the base station receiver even though the base transmitter is on the same frequency.

The new AP-2 Simplex Autopatch Timing Module kit provides the required timing and logic circuits to allow the mobile operator to bring up the autopatch through touch-tone control, and it keys the base station transmitter with an automatic window generator circuit, which breaks periodically to allow the receiver to listen for the mobile station. If the mobile station is on the air, the window generator stops the base transmitter for the duration of the mobile transmission so the mobile operator maintains complete control of the transmit-receive switching of the base transceiver. Window length is automatically adjusted to compensate for the characteristics of the transceiver for minimal disruption of mobile reception by the window in the base transmissions. The new AP-2 module along with the basic Autopatch and DTMF Tone Decoder modules are priced at $200. The system is also available wired and tested.

For more information, contact Hamtronics, Inc., 65 Moul Road, Hilton, New York 14468-9535.

Circle #305 on Reader Service Card.

terminal interface

Terminal Interface sends messages around the world using any personal or home computer. Compatible with any home computer, such as Heath's H-8 or H-89, Commodore, Atari, Radio Shack, Apple, or IBM, it sends or receives ASCII/Baudot RTTY and Morse Code messages at up to 300 Baud using any standard transceiver, TTY terminal or monitor, and a computer with the appropriate software.

Optional six-pole filters for the HD-3030 include a preselect filter that delivers strong, readable tones in the standard 170 Hz shift and print clearly even in a crowded band, as well as filters for 425 and 850 Hz audio shifts. Features include a crystal-controlled AFSK generator, capability for full FSK with equipped transmitters, true mark/space detection, oscilloscope tuning outputs, front panel LED bargraph tuning, and data and status indicators. TTL and RS-232C I/O compatibility and a built-in loop supply are also included. A row of flag-type pushbuttons permits full up-front control of send and receive (including reverse shift) configurations. A convenient autostart relay energizes the rear panel AC receptacle for unattended start of the computer and/or printer, while an internal thershold adjustment sets the desired recognition level.

The Terminal Interface kit includes a mate for the DB-25 socket and a step-by-step assembly manual that supplies a pin-out and criss-cross interconnection chart.

Heath also offers Super CW and Super RTTY Terminal Interface software for use with their H-8 and H-89 computers.

For further details, contact Heath Company, Benton Harbor, Michigan 49022.

Circle #306 on Reader Service Card.

self-contained, transportable HF antenna system

A self-contained, transportable log-periodic HF antenna system has been announced by Telex/Hy-Gain. The system, Model 5025, consists of the antenna, rotator, 60 foot (18.3 meter) telescoping tower, generator, and installation tools and hardware, all stowed on one tandem-axle trailer. The compact design permits all

modes of transportation from towing with a pick-up truck to airlifting on a C-130 aircraft.

The antenna covers the frequency range of 4 to 30 MHz, with a gain of 9 dBi from 4 to 6 MHz, and 12 dBi from 6 to 30 MHz. The electric antenna rotator can be controlled from the base of the tower or remotely with a two-wire remote control unit which is provided. The remote control features a digital display of the antenna azimuth in 10-degree increments.

Maximum use of color coding, captive hardware, and modular construction makes the 5025 the fastest erectable rotating tower/antenna system in its class. The system can be assembled and erected by as few as two persons; a team of four can complete the task in less than two hours. The self-contained 5 kW generator set provides all power necessary for erection and operation of the antenna. A hydraulic tilt-up trolley provides positive control during erection. This feature is said to yield a high level of safety and eliminate the complexity and hazard associated with the manual erection of towers.

For additional information, contact Telex Communications, Inc., Hy-Gain CIM Department, 8601 N.E. Highway Six, Lincoln, Nebraska 68505.

microprocessor controlled repeater

The new SCR2000X microprocessor-controlled repeater from Spectrum Communications includes full autopatch and touch-tone repeater remote control capability and patch AGC for constant levels, as well as phone line and "over-the-air" command modes.

Able to store up to 13 "auto dial" phone numbers, the unit includes a touch-tone to dial pulse converter and offers full 16-digit decoding with crystal controlled decoder IC, allows the use of "A, B, C, and D" characters in control codes. This expands the number of possible codes and increases security.

Touch-tone control of all important repeater functions includes timeout, hang time, patch timeout, transmitter inhibit/reset, patch and reverse patch inhibit/reset, and "PL" ON/OFF (with optional PC board). A built-in battery backup saves microprocessor memory in case of power failure.

The following transmitter options are available: 2 meters: 30 or 75 watts; 220 MHz: 30 or 65 watts; 440 MHz: 40 watts. High power rack mount repeater power amps and power supplies are available to 150 watts.

A high-performance receiver is included, with high sensitivity, selectivity and wide-dynamic range. An 8-pole front end filter is standard as well as a 12-pole IF filter. "Super Sharp" filter options are also available.

For further details, contact Spectrum Communications Corp., 1055 W. Germantown Parkway, Norristown, Pennsylvania 19401-9616.

Circle #310 on Reader Service Card.

MISSOURI RADIO CENTER 1-800-821-7323

ANTENNA SALE

HY-GAIN

TH3RJS	$169
TH5MK2S	$355
TH7BX3S	$410
EXPLORER 14	$269
14AVQB	$59
18AVT/WBS	$95
V2S	$37
V3	$40
V4	$49
66BS	$109
CD45 II	$125
HAM IV	$199
T2X	$245
ALLIANCE HD73	$99

BUTTERNUT

HF6V	$109

HY-GAIN TOWERS

HG37SS
HG5OMT2
HG52SS
HG54HD
HG70HD

CALL FOR SPECIAL PRICING

KLM

KT34A	$329
KT34XA	$479
40M-2	$290
2M-13LBA	$77
2M-14C	$85
435-18C	$59
432-16LB	$65

AEA CALL

CUSHCRAFT

A-3	$209
A-4	$279
40-2CD	$279
R-3	$265
AV5	$98
32-19	$91
214B-FB	$77
ARX-2B	$37
A144-11	$46

LARSEN CALL

HUSTLER CALL

✓ 177

BEARCAT SPECIAL SALE

BC 350	$375.00
BC 300	$339.00
BC 20/20	$279.00
BC 210XL	$219.00
BC 200	$169.00
BC 180	$159.00
BC 260	$249.00
BC 100	$279.00
BC WA	$34.95
*CP2100	$279.00
NEW ALL SOFTWARE	$39.95

MasterCard COD WELCOME VISA

FIRST IN SALES IN SERVICE!!

Call "TOLL FREE" For All Antennas & Accessories

2900 N.W. VIVION RD. / KANSAS CITY, MISSOURI 64150 / 816-741-8118

STUDY TAPES

CODE PRACTICE TAPES FROM HRPG — Practice copying Morse Code anytime, anywhere. Whether you're upgrading your present license or just trying to up your code speed, a large assortment allows you to choose exactly the kind of practice you need.

each tape $4.95 2/$8.95 3/$12.95

CODE PRACTICE TAPES

Here are three different straight code tapes consisting of randomly generated six character groups sent at different speeds. These tapes are excellent for building both the speed and copying accuracy needed for contesting, DXing and traffic handling.

☐**HR-STC1 — $4.95**
7.5 wpm code for 25 minutes
10 wpm code for 25 minutes
15 wpm code for 25 minutes

☐**HR-STC2 — $4.95**
15 wpm code for 50 minutes
22.5 wpm code for 35 minutes

☐**HR-STC3 — $4.95**
25 wpm code for 20 minutes
30 wpm code for 20 minutes
35 wpm code for 20 minutes
40 wpm code for 20 minutes

HI/LO SERIES — Code Study Tapes

In this unique series, characters are sent at high speeds with long pauses between each character. For example, HLC4 (15/2.5 wpm) consists of characters sent at a 15 wpm rate, but with 2.5 wpm spacing between each character. These tapes are excellent for the beginner who wants to practice copying higher speed code without the frustration of constantly getting behind.

☐**HR-HLC1 — $4.95**
22.5/2.5 wpm code for 80 minutes

☐**HR-HLC2 — $4.95**
22.5/5 wpm code for 20 minutes
22.5/7.5 wpm code for 20 minutes
22.5/10 wpm code for 20 minutes
22.5/13 wpm code for 20 minutes

☐**HR-HLC3 — $4.95**
15/5 wpm code for 28 minutes
15/7.5 wpm code for 28 minutes
15/10 wpm code for 28 minutes

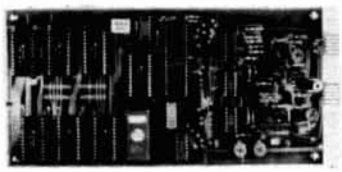
☐**HR-HLC4 — $4.95**
15/2.5 wpm code for 80 minutes

Please add $1 for shipping.

Ham Radio's Bookstore
Greenville, NH 03048

GLB PACKET RADIO CONTROLLER

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



MODEL PK1
(shown with 14K RAM and 8K ROM)

- Ready to operate—wired & tested —**LOW COST**
- Easy to learn, easy to use
- Built-in packet Modem
- Use with computers, terminals, teletype machines
- RS232 serial interface— 45 to 9600 baud
- Uses both ASCII and Baudot
- Programmed for both **AX.25 & VADC** at 1200 or 600 baud
- Automatically recognizes protocol of incoming messages
- Over 60 commands
- Custom call sign option
- Stores received messages until requested at a later time
- "Block" mode for transferring computer data
- Operates as an unattended repeater
- Activates teletype motor to print messages
- Board accepts up to 14K of RAM
- Can be customized for **LANS** and up to 56K RAM

MODEL PK-1 wired & tested w/4K RAM	**$149.95**
Additional memory (up to 14K total)	10.00/2K
Manual only—credited with purchase (add $2.00 for shipping)	9.95
RTTY adapter board	17.95
Custom cabinet kit — includes on/off switch, LED power indicator, reset button & power jack	34.95

Dimensions: 4.5 x 9.5 x 1.5 inches
Pwr required: +12 VDC, approx. 200 ma.

Contact GLB for additional info and available options.

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

GLB ELECTRONICS
1952 Clinton St. Buffalo, NY 14206
716-824-7936, 9 to 4

✓ 148

PRICE SLASHED!

Even Further

WAS $39.95 retail

NOW $9.95

SAVE 75% off the regular retail price

SUPER deal with the publisher allows us to drop the price of the Bill Orr *RADIO HANDBOOK* to the low, low price of just $9.95!

RADIO HANDBOOK by William Orr, W6SAI

Some selected subjects covered include:

Electronic Fundamentals	FM and Repeaters	HF General Purpose Antennas
Semiconductor Devices	RFI	Fixed Directive Arrays
Vacuum Tube Principles	Equipment Design	Rotary Beam Antennas
Special Microwave Tubes	*Transmitter Keying and Control*	VHF & UHF Antennas
Radio Frequency Power Amplifiers	Power Supplies	Test Equipment
SSB Transmission and Reception	*Radiation and Propagation*	*The Oscilloscope*
Amplification of RF Energy	The Transmission Line	Construction Practices
Frequency Synthesis	Antenna Matching Systems	*Electronics Math and Calculations*

This book certainly is one of the finest reference sources available today. The 22nd edition reflects the very latest in state-of-the-art techniques in a comprehensive single source reference book. Invaluable for hams, electronics technicians, design engineers, and hobbyists alike. Over 1,000 pages of information found in earlier editions plus more on antennas, amplifiers, theory, and semiconductors to name just a few of the updated sections. The *Radio Handbook* is chock-full of practical, tested projects that run from high powered RF amplifiers and state-of-the-art equipment to "Weekender" type projects to upgrade overall station performance. This book will be of interest to all levels of electronic expertise. At this special price, you can't afford to pass up a value like this. Order yours today. 1136 pages. ©1981. 22nd edition.

☐**21874 Hardbound** Limited quantities are available. Order now. **$9.95**

Please add $3.00 to cover shipping & handling.

This is the very latest edition. No new edition is about to be issued. This is not a close out.

ham radio *magazine* **BOOKSTORE**

GREENVILLE, NH 03048 **(603) 878-1441**

HAM MART

Ham Radio's guide to help you find your local

California

C & A ROBERTS, INC.
18511 HAWTHORN BLVD.
TORRANCE, CA 90504
213-370-7451
24 Hour: 800-421-2258
Not The Biggest, But The Best — Since 1962.

FONTANA ELECTRONICS
8628 SIERRA AVENUE
FONTANA, CA 92335
714-822-7710
714-822-7725
The Largest Electronics Dealer in San Bernardino County.

JUN'S ELECTRONICS
3919 SEPULVEDA BLVD.
CULVER CITY, CA 90230
213-390-8003
800-882-1343 Trades
Habla Espanol

Connecticut

HATRY ELECTRONICS
500 LEDYARD ST. (SOUTH)
HARTFORD, CT 06114
203-527-1881
Call today. Friendly one-stop shopping at prices you can afford.

Delaware

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 M-F 9-5:30, Sat. 9-3

AMATEUR ELECTRONIC SUPPLY
621 COMMONWEALTH AVE.
ORLANDO, FL 32803
305-894-3238
Fla. Wats: 1 (800) 432-9424
Outside Fla: 1 (800) 327-1917
Hours M-F 9-5:30, Sat. 9-3

AMATEUR RADIO CENTER, INC.
2805 N. E. 2ND AVENUE
MIAMI, FL 33137
305-573-8383
The place for great dependable names in Ham Radio.

Hawaii

HONOLULU ELECTRONICS
819 KEEAUMOKU STREET
HONOLULU, HI 96814
(808) 949-5564
Serving Hawaii & Pacific area for 51 years. Complete lines of Amateur equipment, accessories and parts.

Illinois

ERICKSON COMMUNICATIONS, INC.
5456 N. MILWAUKEE AVE.
CHICAGO, IL 60630
312-631-5181
Hours: 9:30-5:30 Mon, Tu, Wed & Fri; 9:30-8:00 Thurs; 9:00-3:00 Sat.

Indiana

THE HAM SHACK
808 NORTH MAIN STREET
EVANSVILLE, IN 47710
812-422-0231
Discount prices on Ten-Tec, Cubic, Hy-Gain, MFJ, Azden, Kantronics, Santec and others.

Kentucky

L & S RADIO
307 McLEAN AVENUE
HOPKINSVILLE, KY 42240
502-885-8071
Ten-Tec, Azden, Ameritron Sales and Service.

Massachusetts

TEL-COM, INC.
675 GREAT ROAD, RTE. 119
LITTLETON, MA 01460
617-486-3400
617-486-3040
The Ham Store of New England You Can Rely On.

Michigan

ENCON PHOTOVOLTAICS
Complete Photovoltaic Systems
27600 Schoolcraft Rd.
Livonia, Michigan 48150
313-523-1850
Amateur Radio, Repeaters, Satellite, Computer applications.
Call Paul WD8AHO

Nevada

AMATEUR ELECTRONIC SUPPLY
1072 N. RANCHO DRIVE
LAS VEGAS, NV 89106
702-647-3114
Dale Porray "Squeak," AD7K
Outside Nev: 1 (800) 634-6227
Hours M-F 9-5:30, Sat. 9-3

JUN'S ELECTRONICS
460 E. PLUMB LANE — 107
RENO, NV 89502
702-827-5732
Outside Nev: 1 (800) 648-3962
Icom — Yaesu Dealer

NEW YORK

ADIRONDACK ELECTRONICS, INC.
1991 CENTRAL AVENUE
ALBANY, NY 12205
518-456-0203
Amateur Radio for the Northeast since 1943.

BARRY ELECTRONICS
512 BROADWAY
NEW YORK, NY 10012
212-925-7000
New York City's Largest Full Service Ham and Commercial Radio Store.

VHF COMMUNICATIONS
915 NORTH MAIN STREET
JAMESTOWN, NY 14701
716-664-6345
Call after 7 PM and save! Supplying all of your Amateur needs. Featuring ICOM "The World System." Western New York's finest Amateur dealer.

Dealers: YOU SHOULD BE HERE TOO! Contact Ham Radio now for complete details.

Amateur Radio Dealer

Ohio

AMATEUR ELECTRONIC SUPPLY
28940 EUCLID AVE.
WICKLIFFE, OH (CLEVELAND AREA) 44092
216-585-7388
Ohio Wats: 1 (800) 362-0290
Outside Ohio: 1 (800) 321-3594
Hours M-F 9-5:30, Sat. 9-3

UNIVERSAL AMATEUR RADIO, INC.
1280 AIDA DRIVE
REYNOLDSBURG (COLUMBUS), OH 43068
614-866-4267
Featuring Kenwood, Yaesu, Icom, and other fine gear. Factory authorized sales and service. Shortwave specialists. Near I-270 and airport.

Pennsylvania

HAMTRONICS, DIV. OF TREVOSE ELECTRONICS
4033 BROWNSVILLE ROAD
TREVOSE, PA 19047
215-357-1400
Same Location for 30 Years.

LaRUE ELECTRONICS
1112 GRANDVIEW STREET
SCRANTON, PENNSYLVANIA 18509
717-343-2124
Icom, Bird, Cushcraft, Beckman, Larsen, Hustler, Astron, Belden, Antenna Specialists, W2AU/W2VS, AEA, B&W, Amphenol, Saxton, J.W. Miller/Daiwa, Vibroplex.

THE VHF SHOP
BOX 349 RD 4
MOUNTAINTOP, PA 18707
717-868-6565
Lunar, Microwave Modules, ARCOS, Astron, KLM, Tama, Tonna-F9FT, UHF Units/Parabolic, Santec, Tokyo Hy-Power, Dentron, Mirage, Amphenol, Belden

Texas

MADISON ELECTRONICS SUPPLY
1508 McKINNEY
HOUSTON, TX 77010
713-658-0268
Christmas?? Now??

Wisconsin

AMATEUR ELECTRONIC SUPPLY
4828 W. FOND DU LAC AVE.
MILWAUKEE, WI 53216
414-442-4200
Wisc. Wats: 1 (800) 242-5195
Outside Wisc: 1 (800) 558-0411
M-F 9-5:30
Sat 9-3

flea market

RATES Noncommercial ads 10¢ per word; commercial ads 60¢ per word **both payable in advance**. No cash discounts or agency commissions allowed.

HAMFESTS Sponsored by non-profit organizations receive one free Flea Market ad (subject to our editing) on a space available basis only. Repeat insertions of hamfest ads pay the non-commercial rate.

COPY No special layout or arrangements available. Material should be typewritten or clearly printed (**not** all capitals) and must include full name and address. We reserve the right to reject unsuitable copy. **Ham Radio** cannot check each advertiser and thus cannot be held responsible for claims made. Liability for correctness of material limited to corrected ad in next available issue.

DEADLINE 15th of second preceding month.

SEND MATERIAL TO: Flea Market, Ham Radio, Greenville, N. H. 03048.

QSLs & RUBBER STAMPS — Top Quality! Card Samples and Stamp info — 50¢ — Ebbert Graphics 5R, Box 70, Westerville, Ohio 43081.

SOLAR ELECTRIC PANELS at drastically reduced prices! Off-spec and surplus modules from major manufacturers. Up to 50% off list. Styles, outputs vary. Call FREE for details — 800-638-8304. Major credit cards welcome.

"KT5S" Super DX sloper 80-10M only $59.95. "KT5B" Multi-band dipole 160-10M only $59.95. 2-KW roller inductor (28uh) $47.50. Weather boot kit (PL-259) $8.95 pp. Much more! Info available. Kilo-Tec, PO Box 1001, Oakview, CA 93022. Tel: 805-646-9645.

ROHN TOWERS — Wholesale direct to users. All products available. Write or call for price list. Also we are wholesale distributors for Antenna Specialists, Regency, and Hy-Gain. Hill Radio, PO Box 1405, 2503 G.E. Road, Bloomington, IL 61701-0887. (309) 663-2141.

IBM-PC RTTY ASCII/BAUDOT/CW send and receive. Split screen, buffers and features beaucoup. SASE to: E. Alline, 773 Rosa, Metairie, LA 70005.

CX7 REPAIRS. 415-549-9210.

CUSTOM EMBROIDERED EMBLEMS — Enameled pins, your design, low minimum, excellent quality, low prices, free booklet. A.T. Patch Co., Dept. 65, Littleton, NH 03561. (603) 444-3423.

Foreign Subscription Agents for Ham Radio Magazine

Ham Radio Austria
Karin Ueber
Postfach 2454
D-7850 Loerrach
West Germany

Ham Radio Belgium
Stereohouse
Brusselsesteenweg 416
B-9218 Gent
Belgium

Ham Radio Canada
Box 400, Goderich
Ontario, Canada N7A 4C7

Ham Radio Europe
Box 2084
S-194 02 Upplands Vasby
Sweden

Ham Radio France
SM Electronic
20 bis, Ave des Clarions
F-89000 Auxerre
France

Ham Radio Germany
Karin Ueber
Postfach 2454
D-7850 Loerrach
West Germany

Ham Radio Holland
Postbus 413
NL-7800 Ar Emmen
Holland

Ham Radio Italy
Via Pordenone 17
I-20132 Milano
Italy

Ham Radio Switzerland
Karin Ueber
Postfach 2454
D-7850 Loerrach
West Germany

Ham Radio England
c/o R.S.G.B.
Alma House
Cranborne Road
Potters Bar
Herts EN6 3JW
England

Holland Radio
143 Greenway
Greenside, Johannesburg
Republic of South Africa

HAM TRADER WEST classifieds, 25 cents a word for subscribers, $9 a year bimonthly, Canadians $11.50, posted same day as U.S. from Canada. Others 50 cents a word, commercial 75 cents a word. Name, address, and phone free. Ham Trader West, Box 202, Lynden, Wash. 98264.

TRAVEL-PAK QSL KIT — Converts post cards, photos to QSLs. Stamp brings circular. Samco, Box 203-c, Wynantskill, New York 12198.

ULTIMATE CW FILTER: Four pole Gaussian response with variable selectivity and center frequency. Includes audio amplifer. See October 1983 QST, page 14. Complete PC assembly kit only $21 postpaid. Orders or information: Analog Technology, Box 8964, Fort Collins, CO 80525.

RADIO ITEMS before 1930 wanted. Buying battery operated radios, horn and cone speakers, radio tubes and parts, radio literature — books, catalogs, magazines, radio advertising signs, posters. Gary Schneider, 6848 Commonwealth Blvd., Parma Heights, Ohio 44130.

CUSTOM MADE embroidered patches. Any size, shape, colors. Five patch minimum. Free sample, prices and ordering information. Hein Specialties, Inc., Dept. 301, 4202 N. Drake, Chicago, IL 60618.

DIGITAL AUTOMATIC DISPLAYS for FT-101's TS-520's, and most others. Six 1/2" digits. Write for information. Grand Systems, P.O. Box 2171, Blaine, Washington 98230. (604) 530-4551.

SQUIRES SANDERS, SS1R (701 series); SS1V-SS1-S, SS1-MS mint condition. Factory manuals and other parts. Heath HX-10 transmitter with accessories, HO-10 scope. Icom IC-280 FoMoXceiver, Kenwood TR-2400. All in excellent condition with manuals. (616) 382-5401. K8WPQ, 9549 No. 17, Kalamazoo, MI 49007.

RUBBER STAMPS: 3 lines $4.50 PPD. Send check or MO to G.L. Pierce, 5521 Birkdale Way, San Diego, CA 92117. SASE brings information.

FOR SALE: Kenwood TS-520 still in box. Operated once to check out. Great buy $400.00. MFJ antenna tuner $15.00. Hy-Gain 18 AVT vertical antenna $20.00. Ham Radio magazines back to 1980 $1.00 each. Call Warren (617) 335-7756 nights 7 PM to 10 PM. No calls on Sundays please.

FOR SALE: Swan 350 transceiver w/ps $250. SA2040 antenna tuner $125. QF-1A audio filter $50. Kantronics CW/RTTY interface for Vic-20 with programs board + cables $135. Shipping included. Send money order. Package price $500. Write Jim Howell, KA4EBW, 18 Dan St., Salisbury, NC 28144. (704) 637-0313 evenings.

DRAKE TR7 TRANSCEIVER with two optional filters, one fan and hand mike $625. PS7 power supply $200. Will sell rf deck separately. 182 feet of new Belden RG59U coax $30. All mint. You ship. (609) 627-5683.

REPAIR, ALIGNMENT, calibration. Collins written estimates $25; non Collins $50. K1MAN. (207) 495-2215.

AN/PRC-74 AND PRC-104 transceivers, modules and accessories wanted. T. Stroh, N6JSD, 21930 Valerio St., No. 11, Canoga Park, CA 91303.

CHASSIS and cabinet kits. SASE K3IWK.

GET THE FACTS! Let our rf Snitch fill you in. Attach this sensing device to your meter to detect rf power. Use for signal tracing in receivers, and tuning antennae, transmitters, oscillator and rf tank circuits. For additional information write: K8MLN or N8DPW, Engineering Research Assoc., PO Box 170, Ontario, Ohio 44862.

NATIONAL RADIO CO equipment manuals price list SASE. Dust covers, NCX 3 or NCX 5 plus NCX A, pair $8.95 PP. Maximilian Fuchs, 11 Plymouth Lane, Swampscott, MA 01907.

TI 99/4A Random Code practice programs. Dr. Code "General" sends international Morse code and prints on screen; you choose: speed, tone, which characters to be sent, spacing, and more! Dr. Code "Speech" same as "General" with speech; you choose how many characters before speech check. For cassette of both copyrighted programs and conditional copying privileges, send $10.00 plus $3.00 shipping and handling to N5ESF, Rt. 1, Box 1326, Lake Charles, LA 70601.

ELECTRON TUBES: Receiving, transmitting, microwave . . . all types available. Large stock. Next day delivery most cases. Daily Electronics, 14126 Willow Lane, Westminster, CA 92683. (714) 894-1368.

S9 PLUS QTH. 59 acres for antenna farm — elevation above Derry repeater, equals Francestown repeater — south slope Crotched Mountain for wide propagation window, solar exposure and view — spacious 4-room lodge, baths, separate bunkhouse with shop and garage, excellent condition — paved access — privacy — one hour from Nashua or Manchester — $95K — must liquidate. "CW" Farr, Broker, Greenfield, NH 03047. (603) 547-2053.

WANTED: Cash paid for used speed radar equipment. Write or call: Brian R. Esterman, PO Box 8141, Northfield, Illinois 60093. (312) 251-8901.

$$$$ SUPER SAVINGS on electronics parts, components, supplies, and computer accessories. Free 40-page catalog for SASE. Get on our mailing list. BCD Electro, PO Box 830119, Richardson, TX 75083. Or call (214) 690-1102.

WANTED: Old microphones, remote mixers other misc related items. All pre-1935. Box Paquette, 107 E. National Avenue, Milwaukee, WI 53204.

PORTABLE 2-meter Quads and J-Verticals. Write Radio Engineers, 3941 Mt. Brundage Avenue, San Diego, CA 92111.

RECONDITIONED TEST EQUIPMENT $1.00 for catalog. Walter, 2697 Nickel, San Pablo, CA 94806.

FOX-TANGO Newsletters — Since 1972, the prime source of modifications, improvements, and repair of Yaesu gear, free to Club members. Calendar year dues still only $8 U.S., $9 Canada, $12 elsewhere. Includes five year cumulative index by model numbers, or send $1 for index and sample Newsletter. Fox Tango Club, Box 15944, W. Palm Beach, FL 33416.

RTTY-EXCLUSIVELY for the Amateur Teleprinter. One year $7.00. Beginners RTTY Handbook $8.00 includes journal index. P.O. Box RY, Cardiff, CA 92007.

IMRA International Mission Radio Assn. helps missioners — equipment loaned; weekday net, 14.280 MHz, 2-3 PM Eastern. Br. Frey, 1 Pryer Manor Rd., Larchmont, NY 10538.

"HAMS FOR CHRIST." Reach other Hams with a gospel tract sure to please. Clyde Stanfield, WA6HEG, 1570 N. Albright, Upland, CA 91786.

TENNATEST — Antenna noise bridge — out-performs others, accurate, costs less, satisfaction guaranteed, $41.00. Send stamp for details, W8URR, 1025 Wildwood Road, Quincy, MI 49082.

WANTED: Early Hallicrafter "Skyriders" and "Super Skyriders" with silver panels, also "Skyrider Commercial", early transmitters such as HT-1, HT-2, HT-8, and other Hallicrafter gear, parts, accessories, manuals. Chuck Dachis, WD5EOG, The Hallicrafter Collector, 4500 Russell Drive, Austin, Texas 78745.

VERY in-ter-est-ing! Next 4 issues $2. Ham Trader "Yellow Sheets", POB356, Wheaton, IL 60189.

Coming Events

ACTIVITIES

"Places to go..."

PENNSYLVANIA: The Irwin Area ARA will sponsor a Swap & Shop, Saturday, October 20, Circleville V.F.D., off Rt. 30, 3.5 miles west of Pennsylvania Turnpike, exit 7. Talk in on 325/925 and 52. For information: Don Myslewski, K3CHD, 359 McMahon Road, North Huntingdon, PA 15642. (412) 863-0570.

LOUISIANA: The Twin City Hams are sponsoring a Hamfest, Saturday, November 10, Convention Center, West Monroe. Swap tables, new dealers, exams, ladies' events. All indoors. Talk in on 146.25/85. Contact: Benson Scott, AE5V, 107 Contempo, West Monroe, LA 71291.

TENNESSEE: Hamfest Chattanooga and the Tennessee State ARRL Convention, October 27 and 28, Memorial Auditorium, Oak Street at Lindsay Avenue, Chattanooga. Forums, contests and non-ham activities. Amateur exams Saturday morning, October 27, at 8 AM, Tech through Extra. Eight foot flea market tables indoors available $6.00 per day or $10.00 both days. For information: Hamfest Chattanooga, PO Box 3377, Chattanooga, TN 37404 or call Nita Morgan, N4DON. (404) 820-2065.

KANSAS: Sandhills ARC's Swapfest, Sunday, October 7, 4-H Building, Scott County Fairgrounds, Scott City. Doors open 9 AM. Talk in on 146.10/.70. Covered dish lunch.

GEORGIA: Rome Hamfest (the South's oldest) will be held Sunday, October 1, Civic Center, Rome. Starts 8 AM. Talk in on 147.90/30. Contact: T.J. Freeman, (404) 232-2830.

OHIO: The Marion Amateur Radio Club's 10th annual "Heart of Ohio" Ham Fiesta, Sunday, October 28, 0800 to 1600, Marion County Fairgrounds Coliseum. Tickets $3.00 advance, $4.00 door. Tables $5.00. Plenty of parking, food. Check in on 146.52 or 147.90/30. For information, tickets or tables: Paul Kilzer, W8GAX, 393 Pole Lane Road, Marion, Ohio 43302.

NEW MEXICO: The UNM ARC and Westside ARC are cosponsoring a tailgate swapfest, November 3, 10 AM to 2 PM MST, UNM North Campus parking lot, corner of University Blvd. and Tucker Avenue, Albuquerque. No charge. Bring own tables. Talk in on 147.75/147.15 and 449.3/444.3 repeaters. For further information SASE to K8BI, WB5YYX or WA5WHN or via 3.939 MHz, 0100 UTC daily.

MICHIGAN: The Blossomland Amateur Radio Association's 1984 Blossomland Blast, Sunday, October 7, Lake Michigan College Community Center, I-94 exit 30, west of Benton Harbor. 8 AM to 3 PM EDT. Admission $3 per person. Special features: Air Force MARS display, Skywarn training program, RC airplane display. Talk in on 22/82 and 52. For table space: BARA, POB 175, St. Joseph, MI 49085 or Paul, WD8MWT (616) 983-1710.

ILLINOIS: Third annual CCRL Hamfest, Sunday, October 21, 7 AM to 2 PM, American Legion Post #21, 6040 N. Clark St., Chicago. Admission $1.00 advance, $1.50 at door. $2.00 per table. Talk in on 145.030 simplex. For information: Norman Geuder, KA9EZA, John Ibes, KA9FUI or Frank Bonnell, WB9OHN.

MASSACHUSETTS: The Framingham Amateur Radio Association's annual Fall flea market, Sunday, October 28, Framingham Civic League Bldg., 214 Concord Street, Framingham. Doors open 10 AM. Sellers setup 8:30. Admission $2.00. Tables $10.00 pre-registration only. Bargains galore. Talk in on 75/15 and 52. Contact: Jon Weiner, K1VVC, 52 Overlook Drive, Framingham, MA 01701. (617) 877-7166.

NEW ENGLAND: Hosstraders' Fall Tailgate Swapfest, Saturday, October 6, sunrise to sunset at Deerfield, NH Fairgrounds. Admission $2 including tailgaters. Friday night camping at nominal fee after 4 PM. No reservations. Profits benefit Boston Burns Unit of Shriners Hospital. Last Spring's donation $5,813.00. For map to northeast's biggest ham flea market SASE to Norm, WA1IVB, RFD Box 57, West Baldwin, ME 04091.

OPERATING EVENTS
"Things to do..."

OCTOBER 6-14: Special event stations K5MHZ and KN5D will operate during the 13th annual International Hot Air Balloon Fiesta in Albuquerque, New Mexico. Most operations SSB with some RTTY, CW and SSTV. Variable hours. Frequencies: 3900, 7230, 14250, 21350 and 28550 and 147.510 simplex FM. For a special QSL send QSL to PO Box 997, Corrales, NM 87048. Include SASE with sufficient postage.

OCTOBER 6: Southeastern Michigan ARA will sponsor Michigan All Saints Day, 1500Z to 2100Z with stations in all 9 cities named after Saints. Phone only, General portions of 20, 40 and 80 meters plus 147.480 and/or nearest repeater. Look for St. Joseph, KC8JX, St. Helen N8BAR, St. Johns NI8L, St. Clair W8GV, St. Charles WB8TTA, St. Ignace KD8CW, St. Louis WA8AEG, St. James KD8CG and Sault Sainte Marie WA8DLO. QSL once with #10 SASE and log to N8COY, 161 Lothrop, Grosse Pointe, MI 48236 for certificate with endorsements.

OCTOBER 16, 17, 18: Colquitt County Ham Radio Society will operate club station WD4KOW from the site of the 7th annual Sunbelt Agricultural Exposition. 0900 to 1700 EDST each day. Operations: General portion of HF bands. Members will listen for visiting hams on 146.19/.79. For a special QSL card send SASE to: CC Ham Radio Society, PO Box 813, Moultrie, GA 31776.

OCTOBER 27 AND 28: Members of the Rutherford Appleton Laboratory ARC (G3RRS) will be active from VP2MF during this years contest. Operators: G3SJK, G3UKS, GM3YOR, G4BGH, G4JVG, G4XRI, G4XRJ. An award for DX stations working VP2MF on 10-160m during the contest will be issued. QSL via bureau or to G3RRS, c/o Jean Mills, R20, Rutherford Appleton Laboratory ARC, Chilton, Didcot, Oxon, UK.

OCTOBER 20 AND 21: The Armadillo Gang will operate WD5HOR to commemorate the Arkansas Pass "Shrimporee". Operation will be on 10, 15, 20, 40, 80 meters 15kc from lower General band edges. QSL card available via SASE to the Armadillo Gang, WB5YPE, David Stephens, 5709 Bobalo, Corpus Christi, TX 78412.

NOVEMBER 25 AND 26: The BOMB Squad (Best of Mt. Baldy) will operate W6HCP (Hollywood Christmas Parade) from 1600Z, November 25 to 0400Z, November 26. Frequencies: 7.284, 14.284, and 21.284 MHz SSB. SASE to W6GVR for special commemorative QSL.

OCTOBER 14: LARC will operate special event station WA3QGA from 1300Z to 2400Z to commemorate the Bollman Truss RR Bridge — the only one of its kind in the world. Frequencies: 7237, 14285, 21385, 144.250 USB and 147.540 simplex. Certificate available for #10 SASE to LARC, PO Box 3039, Laurel, MD 20708.

OCTOBER 21, 22: JOTA — Scouts 27th annual Jamboree on the Air. Look for K2BSA, the BSA headquarters station in Dallas, Texas and HB9S, the World Scout Headquarters in Switzerland and other special call signs from many countries. Calling frequencies: CW — 3590, 7030, 14070, 21140, 28190. Voice — 3940, 7290, 14290, 21360, 28990. RTTY, SSTV, ATV on usual frequencies. Check Novice frequencies. Do a good turn for Scouting and Ham Radio.

NOVEMBER 3: K4MJN will operate a special events station in Blythewood, SC, to commemorate the birthplace of J. Gordon Coogler, acclaimed by literary critics as the "worst practicing poet in U.S. literary history!". All stations working K4MJN during this second annual festival will receive a handsome certificate with a photo of "The Bard of Blythewood" and some of his poetry. Please send QSL and contact number with large SASE to K4MJN, Rt. 3, Box 154, Blythewood, SC 29016. 14.290 MHz from 1400Z to 1800Z and 21.390 MHz from 1800Z to 2200Z.

OCTOBER 20: The 24th Infantry Division Association will sponsor a special event station K4TF, to commemorate the 40th anniversary of the landing in the Philippines. A special commemorative certificate to any Amateur station making 2-way contact with K4TF during the 24-hour GMT period. Operations will be 10 kHz inside the General portion of each band. For certificate send QSL card and 9 × 12 SASE to K4TF, 1630 Venus Street, Merritt Island, Florida 32953.

AMSAT Technical Symposium and General Membership Meeting, Sunday, November 10, Amfac Hotel, 8601 Lincoln Blvd., Los Angeles, CA 90045. Tech presentations on present/future Amateur satellite projects. General membership meeting following a banquet dinner. For conference registration information SASE to Dennis Dinga, N6DD, PO Box 4111, Diamond Bar, CA 91765.

OCTOBER 13 AND 14: Oregon QSO party sponsored by the Hermiston ARC, 1700Z Oct. 13 to 0800Z and from 1500Z Oct. 14 to 0000Z Oct. 15. Exchange: OR stations, signal report and county. Others signal report and state/province/country. Mixed mode or CW only. You may obtain log sheets from HARC (please SASE). Log sheets must be received by November 12. Mail entries and request log sheets from: Hermiston ARC, PO Box 962, Hermiston, OR 97838.

OCTOBER 13 AND 14: QRP Amateur Radio Club International Fall QSO Contest. 1200 UTC Oct. 13 to 2400 UTC Oct. 14. 24 hours max. operation. Only one mode of operation, CW or SSB may be used. Exchanges: Members give RS(T), state/province/country and QRP ARCI membership number. Non-members give RS(T), state/province/country and power output. Logs must be received by November 12. Send all material to: QRP ARCI Contest Chairman, Gene Smith, KA5NLY, 8201 Chatham Drive, Little Rock, AR 72207.

Advertisers check-off

... for literature, in a hurry — we'll rush your name to the companies whose names you **"check-off"**

Place your check mark in the space between name and number. **Ex: Ham Radio ✓ 234**

Accessory Spec. ____ 101	Kantronics ____ 163, 164
Ace Comm ____ 102	Kenpro ____ 165
ARR ____ 103	Kenwood *
AEA ____ 104, 105, 301	MFJ ____ 166
All Comm ____ 106, 107	MHz Elec. ____ 167
All Elec. ____ 108	Madison ____ 168
Alpha Delta ____ 109	Martin Eng. ____ 169
Aluma ____ 110	Merrimac Sat. ____ 170
AES ____ 111	Meshna ____ 171
Amateur Wholesale ____ 112	Micro Systems ____ 172
ARRL ____ 113	Micro Control Spec. ____ 173
Analog Tech. ____ 114	Microwave Filter ____ 174, 308
Anteck ____ 115	Midwest ____ 175
Atlantic Surplus ____ 116	Mirage ____ 176
ATV Mag. ____ 117	Missouri Radio ____ 177
Audio Amateur ____ 118	Morning Dist. ____ 178
Azimuth ____ 119	Mosley ____ 179, 221
Azotic ____ 120	NCG ____ 180
B & W *	Nampa ____ 181, 222
Barry *	National Satellite ____ 223
Bauman ____ 121	Nemal ____ 182
B.G. Micro ____ 122, 123, 124	N&V ____ 183
BHCo ____ 125	Orbit ____ 184
Bird ____ 304	Paullin ____ 185
Buckmaster ____ 126	P.C. Elec. ____ 186
Burghardt ____ 127	Processor Concepts ____ 187
Butternut *	Pro-Search * ____ 188
C & A Roberts ____ 128	Public Domain ____ 189
CeCo ____ 129	RF Enterprises ____ 190
CES ____ 130	RF Products ____ 191
Centurion ____ 131	Callbook ____ 192
Coaxial Dynamics ____ 132	Ramsey ____ 193
Comm. Concepts ____ 133	Roensch ____ 194
Comm. Spec. ____ 134	Sartori ____ 195
Computer Trader ____ 135	Sat. TV Mag. ____ 196
Cushcraft ____ 136	Scamp Systems ____ 197
Dentron ____ 137	Sommer Electric ____ 198
DEO ____ 138, 139	S.M.C. ____ 199
Discount Discs ____ 140	Spectrum Comm. ____ 310
Doppler ____ 141	Spectrum Int. ____ 200
Drake *	Spectrum West ____ 201
Dynetic Systems ____ 142	Spi-Ro Dist. ____ 202
Electro-Com ____ 143	TNT Radio ____ 203
Encomm ____ 144	Telex *
Eng. Cons. ____ 145, 146, 302	Telrex ____ 204
Falcon *	Teltone ____ 205
Fluke *	Ten-Tec *
Fox Tango ____ 147	Texas Towers ____ 206
Gem Quad *	Transleteronic ____ 207
GLB Elec. ____ 148	UNR-Rohn *
Hal Comm. ____ 149	Universal Elec. ____ 208
Hal-Tronix ____ 150	University Microfilms *
Ham MasterTapes ____ 151	VHF Comm. ____ 209
HRB ____ 152	Vanguard ____ 210
HR Mag. ____ 153	Varian ____ 211
Ham Shack *	Vector Radio ____ 212
Hamtronics, N.Y. ____ 154, 305	Walter Test Equip. ____ 213
Harrison ____ 155	Webster Comm. ____ 214
Harvey ____ 156	Westcom ____ 215
Hatry ____ 157	Western Elec. ____ 216
Heath ____ 306	Western Satellite ____ 217
ICOM ____ 158, 159	Wheeler *
I.C.M. ____ 160	Williams ____ 218
J&J Satellite ____ 161	World View ____ 219
KLM ____ 162	Yaesu ____ 220

*Please contact this advertiser directly.

Limit 15 inquiries per request.

October 1984

Please use before November 30, 1984

Tear off and mail to
HAM RADIO MAGAZINE — "check off"
Greenville, N. H. 03048-0498

NAME ....

CALL ....

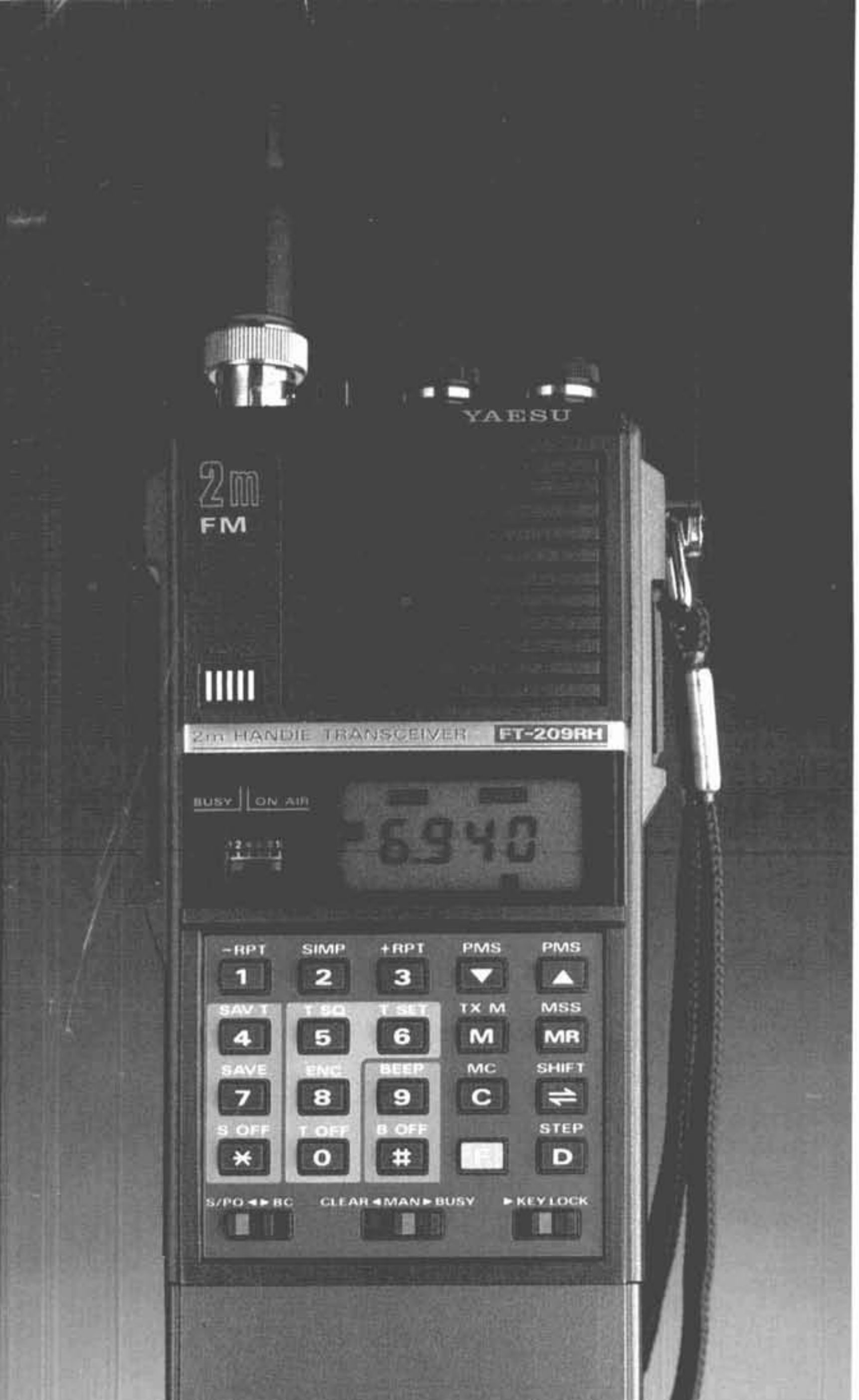
STREET ....

CITY ....

STATE .... **ZIP** ....

✓ 168

Advertisers index



FT-209RH shown actual size.

FT-203R transceiver.

The Yaesu FT-209RH. 5 watts that your batteries can live with.

Have the power you need when you need it with Yaesu's new 5-watt, 2-meter handheld. Power to get out in situations where ordinary HTs just won't make it.

We designed our HT with a unique user-programmable Power Saver that puts the rig to "sleep" while you're monitoring and "wakes it up" when the squelch breaks. So you can listen for hours and still have plenty of power to hit those hard-to-reach repeaters when you need to.

With the FT-209RH there's no need to fiddle with knobs when you change from one memory channel to another. That's because you can independently store everything you need in each of the ten memories: receive frequency, standard or non-standard offset, even tone encode/decode with an optional module. And then recall any channel at the touch of a button.

It's easy to hear what's happening on your favorite repeaters or simplex frequencies. Just touch a button and scan all memory channels, or selected ones. Or all frequencies between any two adjacent memories. Use the priority feature to return automatically to your special frequency when it becomes active.

Bring up controlled-access machines with the optional plug-in subaudible tone encoder/decoder, independently programmed from the keyboard for each channel. Listen for tone-encoded signals on selected channels—without having to hear a bunch of chatter—by enabling the decode function.

The FT-209RH, which covers 10 MHz for CAP and MARS use, comes complete with a 500-mAh battery, charger and soft case.

For those who want a basic radio without the bells and whistles, consider the compact, lightweight FT-203R. This economical HT features 2.5 watts of power and an optional DTMF keypad. Most all the accessories for the 209 work with the 203, including an optional VOX headset that gives you hands-free operation that's perfect for public service events.

So when you visit your dealer, let him know you won't settle for anything but the best. A radio built by Yaesu.

YAESU

Yaesu Electronics Corporation
6851 Walthall Way, Paramount, CA 90723
(213) 633-4007

Yaesu Cincinnati Service Center
9070 Gold Park Drive, Hamilton, OH 45011
(513) 874-3100

Prices and specifications subject to change without notice.