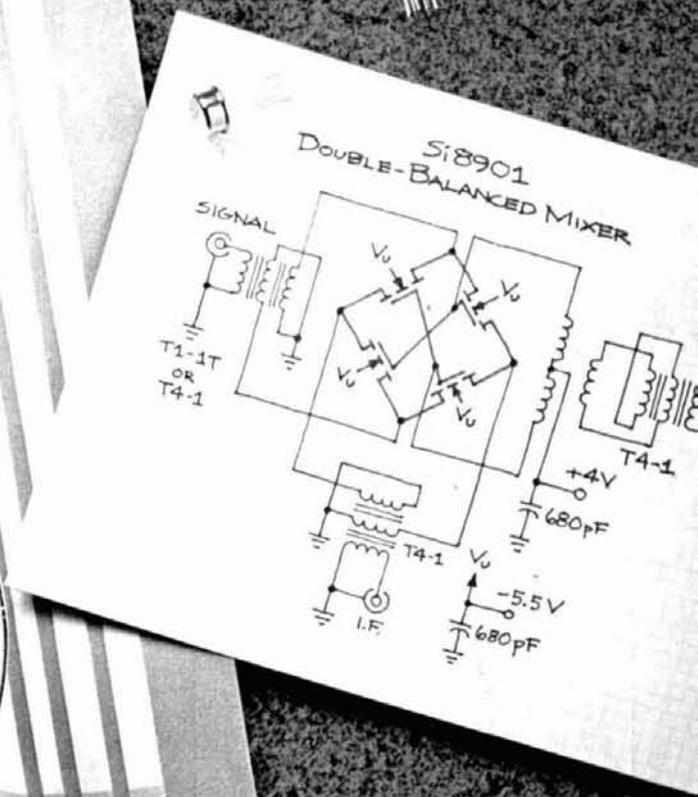


MARCH 1998 / \$2.50

20th Anniversary Issue  
Preview of IC-781

# ham radio magazine

high dynamic  
range mixing



**hr**  
focus  
on  
communications  
technology

# ICOM

# Mobiles



# YOU'RE LOST WITHOUT IT

Whether you're trying to find your way to an unfamiliar location or need assistance in an emergency, ICOM mobiles help you find your way. ICOM's dependable mobiles steer you to a friendly voice or a helping hand.

### Most Popular Mobiles.

ICOM's popular mobiles include the 2-meter **IC-28A** and **IC-28H**, 220MHz **IC-38A**, 440MHz **IC-48A** and 2-meter/70cm dual band **IC-3200A**.

### 21 Memories.

Store frequency, offset and tone, with an offset check button on the front panel. The IC-3200A features 10 fully tunable memories.

### Packet Perfect.

The IC-28/38/48 series includes a high speed microprocessor and switching circuit for superb packeting!

### Top Features.

- Band and Memory Scanning
- Compact Size
- All Subaudible Tones Built-In
- Backlit LCD Readout with Dimmer
- DTMF Mic Included



**"I feel any company willing to build radios as survivable as my IC-28A deserves my ham radio dollars..."**

-Jonathan Starr AH6GJ  
After tropical storm in which he was instrumental in the rescue of stranded residents. Kahului, Hawaii

### Options.

Options include the UT-28 digital coded squelch, SP-10 speaker, HS-15/HS-15SB boom mic and PTT switchbox and PS-45 AC power supply.

### ICOM Mobiles.

Don't be lost without them. Find them at your local ICOM dealer.



**IC-28A and IC-28H**  
Rx 138-174MHz  
Tx 140.1-150MHz

**IC-38A**  
220-225MHz

**IC-48A**  
440-450MHz

**IC-3200A**  
140-150MHz and  
440-450MHz

214

**ICOM**  
ICOM America, Inc.

2380 116th Avenue N.E., Bellevue, WA 98004, **Customer Service Hotline (206) 454-7619**  
3150 Premier Drive, Suite 126, Irving, TX 75063 • 1777 Phoenix Parkway, Suite 201, Atlanta, GA 30349  
ICOM CANADA, A Division of ICOM America, Inc., 3071 - #5 Road, Unit 9, Richmond, B.C. V6X 2T4  
All stated specifications subject to change without notice or obligation. All ICOM radios significantly exceed FCC regulations limiting spurious emissions. Mobiles188.

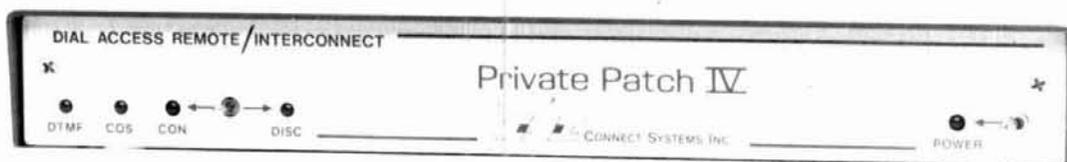
# THE ALL NEW PRIVATE PATCH IV BY CSI HAS MORE COMMUNICATIONS POWER THAN EVER BEFORE

- Initiate phone calls from your HT or mobile
- Receive incoming phone calls

NEW!

- Telephone initiated control . . .

- ✓ Operate your base station with complete control from any telephone
- ✓ Change frequencies from the controlling telephone
- ✓ Selectively call mobiles using regenerated DTMF from any telephone
- ✓ Eavesdrop the channel from any telephone
- ✓ Use as a wire remote using ordinary dial up lines and a speaker phone as a control head.



The new telephone initiated control capabilities are awesome. Imagine having full use and full control of your base station radio operating straight simplex or through any repeater *from any telephone!* From your desk at the office, from a pay phone, from a hotel room, etc. You can even change the operating channel from the touchpad!

Our digital VOX processor flips your conversation back and forth fully automatically. There are no buttons to press as in phone remote devices. And you are in full control 100% of the time!

The new digital dialtone detector will automatically disconnect Private Patch IV if you forget to send # (to remotely disconnect) before hanging up. This powerful feature will prevent embarrassing lock-ups.

The importance of telephone initiated control for emergency or disaster communications cannot be overstated. Private Patch IV gives you full use of the radio system from any telephone. And of course you have full use of the telephone system from any mobile or HT!

To get the complete story on the powerful new Private Patch IV contact your dealer or CSI to receive your free four page brochure.

Private Patch IV will be your most important investment in communications.

✓ = NEW FEATURE

- ✓ \* /# or multi-digit connect/disconnect
- ✓ Fully regenerated tone dialing
- Pulse dialing
- Toll protection
- Secret toll override code
- Busy signal disconnect
- ✓ Dialtone disconnect
- CW identification
- Activity timer
- Timeout timer
- ✓ Telephone initiated control
- ✓ Regenerated DTMF selective calling
- Ringout
- ✓ Ringout or Auto Answer on 1-8 rings
- Busy channel ringout inhibit
- ✓ Status messages
- ✓ Internally squelched audio
- MOV lightning protection
- ✓ Front panel status led's
- ✓ Separate CW ID level control
- ✓ 24 dip switches make all features user programmable/selectable

- Connects to MIC and ext. speaker jack on *any* radio. Or connect internally if desired.
- Can be connected to any HT. (Even those with a two wire interface.)
- Can be operated simplex, through a repeater from a base station or connected directly to a repeater for semi-duplex operation.
- 20 minutes typical connect time
- Made in U.S.A.

## OPTIONS

1. 1/2 second electronic voice delay
2. FCC registered coupler
3. CW ID chip



**CONNECT SYSTEMS INC.**  
23731 Madison St.  
Torrance CA 90505  
Phone: (213) 373-6803

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

**BARRY ELECTRONICS CORP.**  
New York NY

**EGE, Inc.**  
Woodbridge VA

**ERICKSON COMMUNICATIONS**  
Chicago IL

**HAM RADIO OUTLET**  
Anaheim CA, Burlingame CA,  
Oakland CA, Phoenix AZ,  
San Diego CA, Van Nuys CA,  
Atlanta GA

**HENRY RADIO**  
Los Angeles CA

**INTERNATIONAL RADIO SYSTEMS**  
Miami FL

**JUNS ELECTRONICS**  
Culver City CA

**MADISON ELECTRONICS SUPPLY**  
Houston TX

**MIAMI RADIO CENTER CORP.**  
Miami FL

**MIKES ELECTRONICS**  
Ft. Lauderdale, Miami FL

**N&G DISTRIBUTING CORP.**  
Miami FL

**OMNI ELECTRONICS**  
Laredo TX

**PACE ENGINEERING**  
Tucson AZ

**THE HAM STATION**  
Evansville IN

**WESTCOM**  
San Marcos CA

**CANADA:**  
**CARTEL ELECTRONIC**  
**DISTRIBUTORS**  
Surrey B.C.

**COM-WEST RADIO SYSTEMS, LTD.**  
Vancouver B.C.

# KENWOOD

...pacesetter in Amateur Radio

ALL NEW!

## Double Vision



ACTUAL SIZE FRONT PANEL

### TM-721A Deluxe FM dual bander

The Kenwood TM-721A re-defines the original Kenwood "Dual Bander" concept. The wide range of innovative features includes a dual channel watch function, selectable full duplex operation, 30 memory channels, extended frequency coverage, large multi-color dual digital LCD displays, programmable scanning, and more with 45 watts of output on VHF and 35 watts on UHF. TM-721A—Truly the finest full-featured FM Dual Band mobile transceiver!

- Extended receiver range (138,000-173,995 MHz) on 2 meters; 70 cm coverage is 438,000-449,995 MHz. (Specifications guaranteed on Amateur bands only. Two meter transmit range is 144-148 MHz. Modifiable for MARS/CAP. Permits required.)
- 30 multi-function memory channels. 14 memory channels and one call channel for each band store frequency, repeater offset, CTCSS, and reverse. Channels "A" and "b" establish upper and lower limits for programmable band scan. Channels "C" and "d" store transmit and receive frequencies independently for "odd splits."

#### Optional Accessories:

- RC-10 Multi-function handset/remote controller
- PS-430 Power supply
- TSU-6 CTCSS decode unit
- SW-100B Compact SWR/power/volt meter
- SW-200B Deluxe SWR/power meter
- SWT-1 2m antenna tuner
- SWT-2 70 cm antenna tuner
- SP-40

- Separate frequency display for "main" and "sub-band"
- 45 Watts on 2 meters, 35 watts on 70 cm. Approx. 5 watts low power.
- Call channel function. A special memory channel for each band stores frequency, offset, and sub-tone of your favorite channel. Simply press the CALL key, and your favorite channel is selected!
- Automatic Band Change (A.B.C.) Automatically changes between main and sub-band when a signal is present.
- Dual watch function allows VHF and UHF receive simultaneously.
- CTCSS encode/decode selectable from front panel or UP/DWN keys on microphone. (Encode built-in, optional TSU-6 needed for decode.)
- Balance control and separate squelch controls for each band.

- Dual antenna ports.
- Full duplex operation.
- Programmable memory and band scanning, with memory channel lock-out and priority watch function.
- Each function key has a unique tone for positive feedback.
- Illuminated front panel controls and keys.
- Dimmer control.
- 16 key DTMF mic. included.
- Handset/remote control option (RC-10).
- Frequency (dial) lock.
- Supplied accessories: 16-key DTMF hand mic., mounting bracket, DC cable.

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



TM-721A shown with optional RC-10

- Compact mobile speaker
- SP-50B Deluxe mobile speaker
- PG-2N DC cable
- PG-3B DC line noise filter
- MC-60A, MC-80, MC-85 Base station mics.
- MA-4000 Dual band mobile antenna (mount not supplied)
- MB-11 Mobile bracket
- MC-43S UP/DWN hand mic.
- MC-48B 16 key DTMF hand mic.

## KENWOOD

KENWOOD U.S.A. CORPORATION  
2201 E. Dominguez St., Long Beach, CA 90810  
P.O. Box 22745, Long Beach, CA 90801-5745

# ham radio

magazine

**MARCH 1988**

volume 21, number 3

**T. H. Tenney, Jr., W1NLB**  
publisher

**Rich Rosen, K2RR**  
editor-in-chief  
and associate publisher

**Terry Northup**  
assistant editor

Tom McMullen, W1SL  
Joseph J. Schroeder, W9JUV  
Alfred Wilson, W6NIF  
associate editors  
Susan Shorrock  
editorial production

**editorial review board**

Peter Bertini, K1ZJH  
Forrest Gehrke, K2BT  
Michael Gruchalla, P.E.  
Bob Lewis, W2EBS  
Mason Logan, K4MT  
Vern Riportella, WA2LQQ  
Ed Wetherhold, W3NQN

**publishing staff**

**J. Craig Clark, Jr., N1ACH**  
assistant publisher

**Rally Dennis, KA1JWF**  
director of advertising sales

**Dorothy Sargent, KA1ZK**  
advertising production manager

**Susan Shorrock**  
circulation manager

**Therese Bourgault**  
circulation

**Farm Color**  
cover

**Siliconix**  
cover art

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

**subscription rates**

United States  
one year, \$22.95; two years, \$38.95; three years, \$49.95  
Europe (via KLM air mail), \$40.00  
Canada, Japan, South Africa and other countries (via surface mail),  
one year, \$31.00; two years, \$55.00; three years, \$74.00

All subscription orders payable in U.S. funds, via international  
postal money order or check drawn on U.S. bank

**international subscription agents:** page 89

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

Copyright 1988 by Communications Technology, Inc.  
Title registered at U.S. Patent Office

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

Send change of address to ham radio  
Greenville, New Hampshire 03048 0498



## contents

**10 high dynamic range mixing  
with the Si8901**

Ed Oxner, KB6QJ

**17 the IC-781**

**ICOM's newest transceiver**

J. Craig Clark, Jr., N1ACH

**21 optimizing gain in Yagi antennas**

Dave Donnelly, K2SS

**26 homebrewing equipment  
from parts to metal work**

Paul A. Johnson, W7KBE

**29 automatically switched  
half-octave filters: part 2**

Cornell Drentea, WB3JZO and

Lee R Watkins

**45 frequency calibration  
using 60 kHz WWVB**

John A. Cowan, W4ZPS

**53 ham radio techniques:  
the "radio ground" on 160 meters"**

Bill Orr, W6SAI

**56 amateur packet radio  
networking and protocols: part 2**

Johnathon L. Mayo, KR3T

**65 practically speaking:  
parametric amplifiers**

Joe Carr, K4IPV

**71 VHF/UHF world: microwave  
components and terminology: part 1**

Joe Reisert, W1JR

**98 Elmer's notebook: transmission lines**

Tom McMullen, W1SL

**98 advertisers index**

**9 comments**

**78 DX forecaster**

**83 flea market**

**88 ham mart**

**81 new products**

**4 publisher's log**

**98 reader service**

**6 reflections**



### **I was just dreaming the other day.**

Ya know, a big push is being made to get Novices on 220 MHz. Thousands of dollars are being spent on promotional campaigns, training programs, and the like. Volunteer instructors, the *heroes* of Amateur Radio, have missed countless meals, sleep, and other obligations to bring the message of Amateur Radio to potential new Novices.

As I turn the pages of Amateur magazines from around the world, I see numerous examples of some of the finest solid-state engineering ever done — hf, VHF, UHF and above; multiband, multi-mode — everything.

### **But...**

In this age of Novice enhancement, to get on 2 and 1.35 meters, you need to buy two different radios.

### **Why?**

For years, radios have been available that cover both 2 and .75 meters. Technically it is relatively easy to do: divide by 3 ( $440 \text{ MHz}/3 = 146.67 \text{ MHz}$ ). A simple tripler circuit in the PLL and a few rf deck modifications and you're ready to go. While in many areas .75 meters is a very useful band, up here in the hinterlands repeater coverage is spotty at best. I tried a multiband radio for a while but 440 really did little for me. On the other hand, 1.35 meters has very interesting possibilities. Coverage is more like 2 meters and there are several very good 220-MHz machines in the area.

With all the advances in solid-state design, it really shouldn't be too hard to come up with a single box to cover both 2 and 1.35 meters. The tricky part will be engineering the PLL. My guess is that the rf deck would be relatively straightforward and easy to build. However, I will leave that to the experts.

Besides tapping a potentially large market, this new radio would stimulate additional activity on both bands and, through increased usage on 220 MHz, help Novices join in the mainstream of Amateur activity.

We have a responsibility to ensure that Novices learn to be the good hams we want them to be. All too often it has been said that giving Novices 1.35 meter privileges does not enhance the Amateur licensing one bit. Wrong. Novices are using their voice privileges daily around the United States. It has already been shown that they can be integrated into a broader spectrum of Amateur frequencies without a major disruption in overall operation.

How about it, manufacturers? Can you do it? You'll sell a lot of radios and get more of us on 220 MHz. It's a win-win situation.

What do you readers think? I'm very interested. Let me know.

**J. Craig Clark, N1ACH**  
**Assistant Publisher**

# KENWOOD

...pacesetter in Amateur Radio

NEW!

## Affordable DX-ing!

### TS-140S

HF transceiver with general coverage receiver.

Compact, easy-to-use, full of operating enhancements, and feature packed. These words describe the new TS-140S HF transceiver. Setting the pace once again, Kenwood introduces new innovations in the world of "look-alike" transceivers!

- Covers all HF Amateur bands with 100 W output. General coverage receiver tunes from 50 kHz to 35 MHz. (Receiver specifications guaranteed from 500 kHz to 30 MHz.) Modifiable for HF MARS operation. (Permit required)
- All modes built-in. LSB, USB, CW, FM and AM.
- Superior receiver dynamic range Kenwood DynaMix™ high sensitivity direct mixing system ensures true 102 dB receiver dynamic range.



- New Feature! Programmable band marker. Useful for staying within the limits of your ham license. For contesters, program in the suggested frequencies to prevent QRM to non-participants.
- Famous Kenwood interference reducing circuits. IF shift, dual noise blankers, RIT, RF attenuator, selectable AGC, and FM squelch.

- M. CH/VFO CH sub-dial. 10 kHz step tuning for quick QSY at VFO mode, and UP/DOWN memory channel for easy operation.
- Selectable full (QSK) or semi break-in CW.
- 31 memory channels. Store frequency, mode and CW wide/narrow selection. Split frequencies may be stored in 10 channels for repeater operation.
- RF power output control.
- AMTOR/PACKET compatible!
- Built-in VOX circuit.
- MC-43S UP/DOWN mic. included.

#### Optional Accessories:

- AT-130 compact antenna tuner • AT-250 automatic antenna tuner
- HS-5/HS-6/HS-7 headphones
- IF-232C/IF-10C computer interface
- MA-5/VP-1 HF mobile antenna (5 bands)
- MB-430 mobile bracket • MC-43S extra UP/DOWN hand mic • MC-55 (8-pin) goose neck mobile mic • MC-60A/MC-80/MC-85 desk mics
- PG-2S extra DC cable • PS-430 power supply
- SP-40/SP-50B mobile speakers • SP-430 external speaker
- SW-100A/SW-200A/SW-2000 SWR/power meters • TL-922A 2 kW PEP linear amplifier (not for CW QSK) • TU-8 CTCSS tone unit
- YG-455C-1 500 Hz deluxe CW filter, YK-455C-1 New 500 Hz CW filter



### TS-680S

All-mode multi-bander

- 6m (50-54 MHz) 10 W output plus all HF Amateur bands (100 W output).
- Extended 6m receiver frequency range 45 MHz to 60 MHz. Specs. guaranteed from 50 to 54 MHz.
- Same functions of the TS-140S except optional VOX (VOX-4 required for VOX operation).
- Preamp for 6 and 10 meter band.



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

## KENWOOD

KENWOOD U.S.A. CORPORATION  
2201 E. Dominguez St., Long Beach, CA 90810  
P.O. Box 22745, Long Beach, CA 90801-5745



# REFLECTIONS

## A Passionate Plea

Whatsa matter? Haven't we supplied you with enough information on matching your transmitter to your antenna without having to put a full gallon and a half on the air while loading up? Must you have that *last* milliwatt going into your antenna system? Don't you hear the cries of anguish from 30 guys writhing in pain as they scramble to cut back on their gain controls after having fully advanced it for that extremely weak HL5?

About once a year it seems necessary to remind a few of you that there are other ways to make certain that maximum power transfer occurs during operation, without having to first load up on the air.

Let's take it in steps. First let's find that 50-ohm setting on your amplifier or exciter. This is where a dummy load comes in. There are several good commercial units available or you can make one with a 50 or 100 watt noninductive resistor immersed in a gallon can of oil. Second, connect your transmitter or amplifier to this 50-ohm load (put a power meter in line if you happen to have one) that will take the power for at least a few seconds. Then adjust the tune and load controls until your output and other meter indications are what they should be for the given operating mode and tube ratings. Keep in mind that you don't want your SSB performance to suffer by trying to get out that last possible watt of power. Once you've determined the correct settings mark them with tape or crayon, or jot down the numbers off the apron of the knobs or mechanical readout for each band and segment that you intend to operate.

Next, get or make a noise bridge. (We've had several good construction articles like "A Modern Noise Bridge", March 1983, page 50.) Set it for 50 ohms resistive and 0 ohms reactive — or whatever the characteristic impedance of your system is. Connect it to the coaxial output of the transmatch or antenna coupler (the one that's marked 'to the transmitter') and connect the other port of the bridge to your receiver (transceiver). For heaven's sake, don't apply rf power from your transmitter unless you have stock in the noise bridge company. Adjust your antenna coupler until you hear minimum noise in the receiver. Mark down these settings and reconnect your transmitter to your antenna. You should be pretty darn close to match at this point.

I can hear you muttering, "Why did the editor waste all this space on this subject? This is *ham radio* magazine and the majority of readers are technically sharp and know this and other matching procedures forwards and backwards." If this is true, why do I hear so many carriers in the extra and advanced portion of the bands?

One more small point while I've got your attention: *PLEASE* ask first to see if the frequency is occupied before starting a call — CQ, sked, or otherwise. It's possible that while you might not hear the DX station, others do and your bodacious signal will obliterate the weak signals. Recently a certain W2, hell-bent on working a particular contest, called probably 10 CQs in a row without raising any DX while right underneath him an LU2, several JAs, and a Korean station were on. This occurred on 3799 and I'm sure he was oblivious to it. If he had bothered to ask, I can assure you that at least one DX'er would have apprised him of the situation.

I could go on about leaving DX windows clear during contests for very weak signal work, unless of course you are the proverbial shooting fish in the barrel type, but I think you've heard enough from me for this issue. Just please be easy on your fellow ham's ears — those nerves just don't regenerate!

Rich Rosen, K2RR  
Editor-in-Chief

# KENWOOD

...pacesetter in Amateur Radio

New  
220 MHz

## 220: FM for All!



Kenwood brings you a wide range of 220 MHz gear designed for every need. Choose from two types of mobile and two types of HT. The TH-315A is a

TH-315A  
Full-featured HT



full-featured HT covering 220—225 MHz. Ten memory channels and 2.5 watts of power. (5 W with PB-1 or 12 V DC.) Uses the same accessories as the TH-215A for 2 meters or TH-415A 440 MHz. For truly "pocket portability," choose the TH-31BT, a thumb-wheel programmable, 1 watt unit. For mobile use, select the TM-321A or TM-3530A.



The TM-321A is the 25 W, 220 MHz, 14-memory version of the super popular, super compact TM-221A. The 25-watt TM-3530A has 23 memories, a 15 telephone number memory and auto dialer. Direct keyboard frequency entry and front panel DTMF pad enhances operating convenience. Novice to Amateur Extra, these transceivers will put everyone on the air "Kenwood Style"!



TM-321A  
Compact mobile transceiver



TH-31BT/31A  
Pocket-held HT



TM-3530A  
Full-featured mobile transceiver

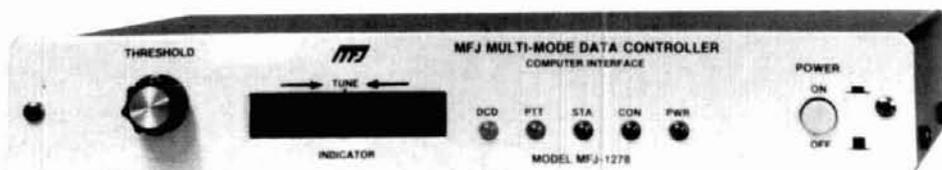
# KENWOOD

The TM-321A comes with 16-key DTMF mic. A complete line of accessories is available for all models.

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

KENWOOD U.S.A. CORPORATION  
2201 E. Dominguez St., Long Beach, CA 90810  
P.O. Box 22745, Long Beach, CA 90801-5745

# MFJ multi-mode data controller



**MFJ shatters the 6 mode barrier and the price barrier with the MFJ-1278 and gives you . . . Packet, RTTY, ASCII, CW, WEFAX, SSTV and Contest Memory Keyer . . . 7 digital modes . . . for an affordable \$249.95**

Amateur radio's newest multi-mode data controller -- the MFJ-1278 -- lets you join the fun on Packet, RTTY, ASCII, CW, Weather FAX, SSTV and gives you a full featured Contest Memory Keyer mode . . . you get 7 modes . . . for an affordable \$249.95.

Plus you get high performance HF/VHF/CW modems, software selectable dual radio ports, precision tuning indicator, 32K RAM, AC power supply and more.

You'll find it the most user friendly of all multi-modes. It's menu driven for ease of use and command driven for speed.

A high resolution 20 LED tuning indicator lets you tune in signals fast in any mode. All you have to do is to center a single LED and you're precisely tuned in to within 10 Hz -- and it shows you which way to tune!

All you need to join the fun is an MFJ-1278, your rig and any computer with a serial port and terminal program.

You can use the MFJ Starter Pack to get on the air instantly. It includes computer interfacing cable, terminal software and friendly instructions . . . everything you need to get on the air fast. Order MFJ-1282 (disk)/MFJ-1283 (tape) for the C-64/128 and VIC-20 or MFJ-1284 for the IBM or compatible, \$19.95 each.

## Packet

Packet gives you the fastest and most reliable error-free communications of any amateur digital mode.

With MFJ's super clone of the industry standard -- the TAPR TNC-2 -- you get genuine TAPR software/hardware plus more -- not a "work-a-like" imitation.

Extensive tests published in *Packet Radio Magazine* ("HF Modem Performance Comparisons") prove the TAPR designed modem used in the MFJ-1278 gives better copy with proper DCD operation under all tested conditions than the other modems tested.

Hardware DCD gives you more QSOs because you get reliable carrier detection under busy, noisy or weak conditions.

A hardware HDLC gives you full duplex operation for satellite work or for use as a full duplex digipeater. And, it makes possible speeds in excess of 56K baud with a suitable external modem.

Good news for SYSOPs! New software lets the MFJ-1278 perform flawlessly as a WORL/WA7MBL bulletin board TNC.

## Baudot RTTY

You can copy all shifts and all standard speeds including 170, 425 and 800 Hz shifts and speeds from 45 to 300

baud. You can copy not only amateur RTTY but also press, weather and other exciting traffic.

A high performance modem lets you copy both mark and space for greatly improved copy under adverse conditions. It even tracks slightly drifting signals.

You can transmit both narrow and wide shifts. The wide shift is a standard 850 Hz shift with mark/space tones of 2125/2975 Hz. This lets you operate MARS and standard VHF FM RTTY.

You get both the American Western Union and the international CCITT character sets, Autostart for unattended reception and selectable "Diddle".

A receive Normal/Reverse software switch eliminates retuning and Unshift-On-Space reduces errors under poor receiving conditions.

## ASCII

You can transmit and receive 7 bit ASCII using the same shifts and speeds as in the RTTY mode and using the same high performance modem. You also get Autostart and selectable "Diddle".

## CW

You get a Super Morse Keyboard mode that lets you send perfect CW effortlessly from 5 to 99 WPM, including all prosigns -- it's tailor-made for traffic handlers.

A huge type ahead buffer lets you send smooth CW even if you "hunt and peck".

You can store entire QSOs in the message memories, if you wanted to! You can link and repeat any messages for automatic CQs and beaconing. Memories also work in RTTY and ASCII modes.

A tone Modulated CW mode turns your VHF FM rig into a CW transceiver for a new fun mode. It's perfect for transmitting code practice over VHF FM.

An AFSK CW mode lets you ID in CW.

The CW receive mode lets you copy from 1 to 99 WPM. Even with sloppy fists you'll be surprised at the copy you'll get with its powerful built-in software.

You also get a random code generator that'll help you copy CW faster.

## Weather FAX

You'll be fascinated as you watch WEFAX signals blossom into full

fledged weather maps on your printer. Other interesting FAX pictures can also be printed -- such as some news photographs from wire services.

Any Epson graphics compatible printer will print a wealth of interesting pictures and maps.

Automatic sync and stop lets you set it and leave it for no hassle printing.

You can save FAX pictures and WEFAX maps to disk if your terminal program lets you save ASCII files to disk.

Pictures and maps can be printed to screen in real time or from disk on IBM and compatibles with the MFJ-1284 Starter Pack.

You can transmit FAX pictures right off disk and have fun exchanging and collecting them.

## Slow Scan TV

The MFJ-1278 introduces you to the exciting world of slow scan TV.

You'll not only enjoy receiving pictures from thousands of SSTVers all-over-the-world but you can send your own pictures to them, too.

You can print slow scan TV pictures on any Epson graphics compatible printer. If you have an IBM PC or compatible you can print to screen in near real time or from disk with the MFJ-1284 Starter Pack.

You can transmit slow scan pictures right off disk -- there's no need to set up lights and a camera for a casual contact.

You can save slow scan pictures on disk from over-the-air QSOs if your terminal program lets you save ASCII files.

The MFJ-1278 transmits and receives 8.5, 12, 24, and 36 second black and white format SSTV pictures using two levels.

## Contest Memory Keyer

Nothing beats the quick response of a memory keyer during a heated contest.

You'll score valuable contest points by completing QSOs so fast you'll leave your competition behind. And you can snag rare DX by slipping in so quickly you'll catch everyone by surprise.

You get iambic operation with dot-dash memories, self-completing dots and dashes and jamproof spacing.

Message memories let you store contest RST, QTH, call, rig info -- everything you used to repeat over and over. You'll save precious time and work more QSOs.

You get automatic incrementing serial numbering. In a contest it can make the difference between winning and losing.

A weight control lets you penetrate QRM with a distinctive signal or lets your transmitter send perfect sounding CW.

## More Features

Turn on your MFJ-1278 and it sets itself to match your computer baud rate. Select your operating mode and the correct modem is automatically selected.

Plus . . . printing in all modes, threshold control for varying band conditions, tune-up command, lithium battery backup, RS-232 and TTL level serial ports, watch dog timer, FSK and AFSK outputs, output level control, speaker jack for both radio ports, test and calibration software, Z-80 at 4.9 MHz, 32K EPROM, and socketed ICs. FCC approved. 9x1 1/2x9 1/2 inches, 12VDC or 110VAC.

Get yours today and join the fun crowd!

**FOR YOUR NEAREST DEALER**

or to order call toll free

**800-647-1800**

**One Year Unconditional Guarantee**

**MFJ ENTERPRISES, INC.**

Box 494, Miss. State, MS 39762  
601-323-5869 Telex: 53-4590 MFJSTKV

**MFJ . . . making quality affordable**



## comments

### transmission beeper hits discordant notes

Dear HR:

Six pages for an end of transmission beeper? Not only are these things annoying, but I would question their legality for use on hf. They certainly do not qualify as A1, A3, A4, A5, F3, F4 or F5. They come closest to A2 (amplitude tone modulated CW) since they convey information via an a-m tone...no different than sending an amplitude modulated "K" for end of transmission.

We have enough noise on our bands without encouraging bleep-bloops. What's wrong with just saying, "over?"

**Richard A. Nelson, WB0IKN,  
Fort Collins, Colorado 80524**

Dear Rich:

I have a bone to pick with you, Rich. The January issue of *ham radio*, somehow conveys to me that your sense of priorities in the selection of articles to be printed in the magazine is all screwed up.

Over the past few weeks, I have been playing around with various CW programs for my C-64. I was never pleased with the results. Being a rank novice at programming, I struggled to get the dash/dot ratios and the word spacings to my satisfaction. When all of a sudden as I was paging through the recent issue of *ham radio*, I find an article that perhaps would give me what I sought — a solution to the rather "sloppy" sending of computer-

ized CW programs. You can imagine my disappointment when the program was not listed at the end of the article.

Now I can appreciate your problem about space in the magazine. With your organization no longer providing mailing covers on the magazine, and with the magazine arriving tattered, torn and dog-eared, I can really empathize with you. So I was ready to let sleeping dogs lie, until I continued on through the issue and found the most useless waste of print in years in an article entitled "Build a QSO 'Beeper'".

Now, really Rich, we need this sort of thing on the bands like we need another hole in the head. Can't you imagine what a crowded band like 20 meters or 75 meters would sound like? It would remind me of trying to go to sleep on a hot night when all the crickets are chirping away. Once again I could forgive you for a lapse in good judgment, but not for wasting six good pages on the beeper article when you couldn't spare seven pages for a decent computer CW program!

This sort of thing has put me on hold for a few weeks because I must now wait for a copy of the program from you or pay 8 bucks for a programmed disk.

You must realize by now, that your readership is of a high caliber and will not put up for long with articles of this type.

**Tony Sivo, W2FJ  
Plainsboro, New Jersey 08536**

### on the other hand...

Dear HR:

Congratulations on your January 1988 edition. Every article and item was crammed with information at just the right level for we non-engineers, non-appliance operator Amateurs, and hobbyists who still build, experiment, and improve our equipment. Hope you can keep it up.

**John Browning, Buena Park, CA  
90620**

## Are you radioACTIVE?



Dean LeMon, KR0V sure is! Dean got active in Amateur Radio when he was 16 years old and earned his Extra Class license in less than four years! "It's a fascinating hobby and a great way to meet all kinds of new people from all over the world."

Dean has cerebral palsy and got started in Amateur Radio with help from the Courage HANDI-HAM System. The HANDI-HAM System is an international organization of able-bodied and disabled hams who help people with physical disabilities expand their world through Amateur Radio. The System matches students with one to one helpers, provides instruction material and support, and loans radio equipment.

Isn't it time you got radioACTIVE with the Courage HANDI-HAM System?

Call or write the Courage HANDI-HAM System W0ZSW at Courage Center, 3915 Golden Valley Road, Golden Valley, Minnesota 55422, phone (612) 588-0811.

## Are you radioACTIVE?

# high dynamic range mixing with the Si8901

Extends intermod  
HF/VHF performance  
at lower drive

The dynamic range of a mixer is intimately related to how well its intermodulation products are suppressed, how well the mixer can handle high-level signals, and its overall noise figure. Whether a mixer offers conversion gain or loss is secondary to the benefits derived from a high dynamic range. In fact, conversion gain simply transfers the problems associated with dynamic range from the mixer to subsequent amplifier stages.

Until now, most mixers sporting a high dynamic range have required a correspondingly high local oscillator drive, as shown in the performance comparison in **fig. 1**. The popular diode-ring double-balanced mixer (DBM), shown in **fig. 2**, often requires the local oscillator power to exceed the signal compression level by at least 6 dB.

The Siliconix Si8901 DBM (**fig. 3**) is a monolithic quad-MOSFET ring demodulator especially suited for hf and low VHF operation where, operating as a commutation (switching) mixer, it is capable of two-tone, third-order input intercepts exceeding +37 dBm and a 2-dB signal overload compression and desensitization of +30 dBm — all at a local oscillator drive level

of only +17 dBm (50 mW)! An additional benefit of this low local oscillator drive results when, in combination with the traditionally high interport isolation afforded by DBM design, little re-radiated power exits the mixer through the signal port.

The Si8901 is available in the hermetic TO-99 package, suitable for full military applications, as well as in a surface-mount SO-14, which is useful for modern industrial and Amateur applications where high dynamic range is mandatory.

## theory of operation — conversion efficiency

Unlike the diode-ring mixer, the commutation mixer relies on the switching action of the quad-MOSFET elements to effect mixing action. Consequently, the Si8901 is, essentially, a pair of switches reversing the phase of the signal at a rate determined by the local oscillator frequency. Ideally, we would expect little noise. Since the MOSFET exhibits a finite on-resistance, the conversion efficiency is expressed as a loss. This loss results from two related factors: first, the  $r_{DS(on)}$  of the MOSFETs relative to both the signal and i-f impedances, and second, signal conversion to undesired frequencies.

The effect of  $r_{DS(on)}$  on both the signal and the i-f impedances ( $R_g$  and  $R_L$ , respectively) may be derived from analysis of an equivalent circuit (**fig. 4**), assuming the local oscillator drive is an idealized square wave. The term  $4/\pi^2$  is the power function of the Fourier series of an idealized square-wave excitation.

Conversion loss for an ideal mixer with the image and sum frequency (RF + LO) ports shorted may be expressed in terms of  $r_{ds(on)}$ ,  $R_g$ , and  $R_L$  as follows:

$$L_c = 10 \text{ Log } \frac{[(\pi^2/4)(R_g + r_{DS(on)}) + R_L + r_{DS(on)}]^2}{\pi^2 R_L R_g} \quad (1)$$

If we let  $r_{DS(on)} = 0$  and resistively-terminate the image and sum frequency ports the minimum attainable conversion loss reduces to

$$L_c = 10 \text{ Log } 4/\pi^2 \text{ dB} \quad (2)$$

which computes to  $L_c = -3.92$  dB. In a practical sense we need to add 3.92 dB to the results of **eqn. 1** or **fig. 5** to obtain the true conversion loss.

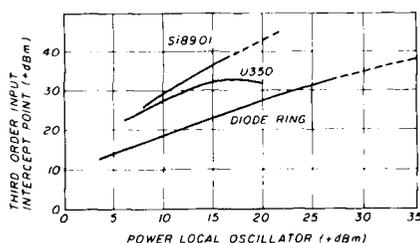


fig. 1. Performance comparison of double-balanced mixers.

By Ed Oxner, KB6QJ, Applications Engineer, Siliconix Inc., Santa Clara, California 95054

Equation 1 plotted for various ratios of  $R_g$ ,  $R_L$ , and  $r_{DS(on)}$  (fig. 5) illustrates how seriously the on-resistance of the MOSFETs affects the conversion loss.

### intermodulation distortion

Unbalanced, single-balanced, and double-balanced mixers are distinguished by their ability to reject spurious frequency components selectively, as defined in table 1. In the majority of mixer applications, the most

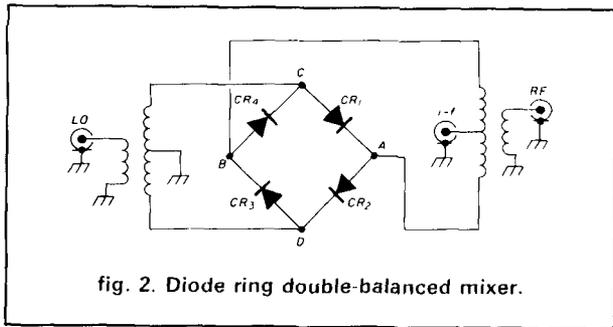


fig. 2. Diode ring double-balanced mixer.

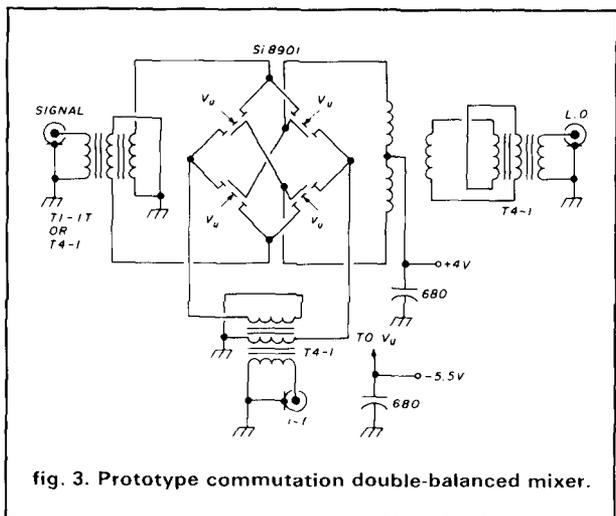


fig. 3. Prototype commutation double-balanced mixer.

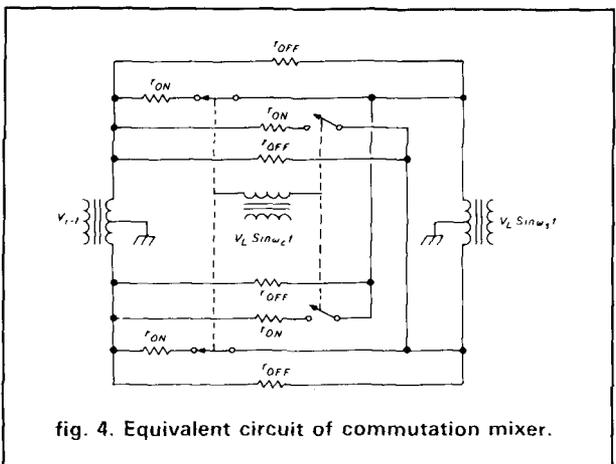


fig. 4. Equivalent circuit of commutation mixer.

Table 1. A comparison of modulation products in single- and double-balanced mixers to the sixth order.

single-balanced	double-balanced
$f_s$	
$3f_s$	
$5f_s$	
$f_1 + f_2$	$f_1 + f_2$
$f_1 + 3f_2$	$f_1 + 3f_2$
$f_1 + 5f_2$	$f_1 + 5f_2$
$2f_1 + f_2$	
$3f_1 + f_2$	$3f_1 + f_2$
$3f_1 + 3f_2$	$3f_1 + 3f_2$
$4f_1 + f_2$	
$5f_1 + f_2$	$5f_1 + f_2$

damaging intermodulation distortion products (IMD) are those attributed to odd order and, in particular, those identified as the third order (IMD3).

Although the DBM outperforms the single-balanced mixer, a more serious source of intermodulation products results when the local oscillator excitation departs from the idealized square wave. This phenomenon is easily recognized by a careful examination of fig. 6, which shows the effect of sinusoidal local oscillator voltage on varying transfer characteristics. Since optimum IMD performance demands that the switches of a commutation mixer operate in a 50-percent duty cycle (i.e., fully on and fully off for equal times), some offset voltage is necessary.

Walker<sup>1</sup> has derived an expression showing the predicted improvement in the relative level of two-tone, third-order IMD as a function of the rise and fall times of the local oscillator waveform.

$$IMD = 20 \text{ Log } \frac{t_r \omega_{LO} V_s / V_c J^2}{8} \text{ dB} \quad (3)$$

where  $V_c$  is the peak-to-peak local oscillator voltage

$V_s$  is the peak signal voltage

$t_r$  is the rise and fall time of  $V_c$

$\omega_{LO}$  is  $2\pi f_{LO}$  where  $f_{LO}$  is the local oscillator frequency

Equation 3 shows that by lowering  $R_g$  (which, in turn, decreases the magnitude of  $V_s$ ) IMD performance is improved. Likewise, increasing the local oscillator voltage,  $V_c$ , improves IMD performance. Finally, if we can provide idealized square-wave excitation, we achieve the perfect mixer! Additionally, we see that low-side injection is more efficient than high-side injection.

Further justification for square-wave local oscillator drive is an additional fault of sinusoidal excitation. Whenever the exciting wave approaches zero crossing at half-period intervals, the FETs, in effect, lose

**Table 2. Comparison of ac gate voltage vs. local-oscillator drive between a non-resonant/resonant tank with a loaded Q of 14 (150 MHz frequency).**

power in (mW)	non-resonant gate voltage (V)	resonant gate voltage (V)
10	0.20	5.4
20	0.29	7.7
30	0.33	9.4
60	0.44	13.3

their bias, and serious signal voltage overload results in severely degraded IMD performance. The effects of sinusoidal excitation on gate bias are easily seen in **fig. 7**.

### building the mixer

Based on the knowledge derived from **eqn. 3**, low source resistance,  $R_g$ , and high local oscillator excitation voltage,  $V_c$ , are ideal conditions for a mixer. The Si8901, operating as the mixer switch, offers a typical on-resistance of approximately 23 ohms when excited by a gate potential of 15 volts. Using the popular 4:1 i-f output transformer to a 50-ohm preamplifier, ( $R_L/r_{DS(on)} \sim 8$ ), **fig. 5** suggests optimum conversion efficiency with an  $R_g$  of 92 ohms. This is contradicted in **eqn. 3**, which shows that optimum IMD performance results with the lowest possible  $V_s$ . This result is achieved by lowering  $R_g$ . It now becomes clear that a performance tradeoff may be necessary. Either we seek low conversion loss, and with it a low noise figure, or aim for the highest IMD performance. Fortunately, as we seek high performance, the dynamic range will improve since a mismatched signal port has less effect upon the signal-to-noise performance than a matched signal port has upon IMD.

### establishing the gate drive

Using the conventional broadband, transmission-line transformer characteristic of the diode-ring DBM requires massive local oscillator drive to effect the required gate voltage needed to satisfy **eqn. 3**. Earlier MOSFET commutation mixers required watts of local oscillator drive to achieve high dynamic range!<sup>2</sup>

One obvious means of obtaining a high gate voltage is to use a resonant gate drive. The voltage appearing across the resonant tank, and thus on the gates, may be calculated as

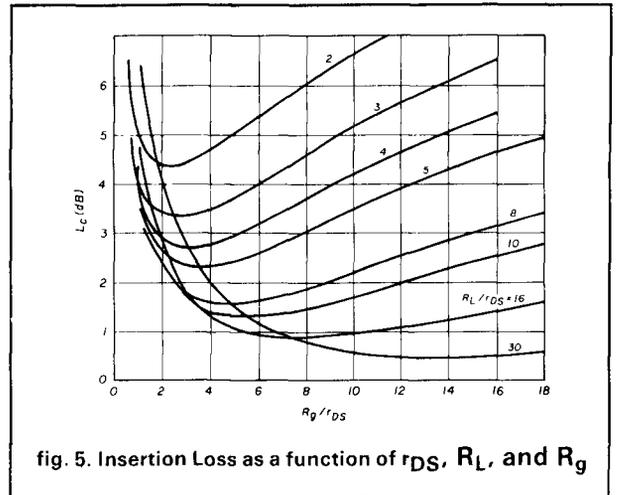
$$V = (PQX)^{1/2} \quad (4)$$

where P is the local oscillator power delivered to the resonant tank

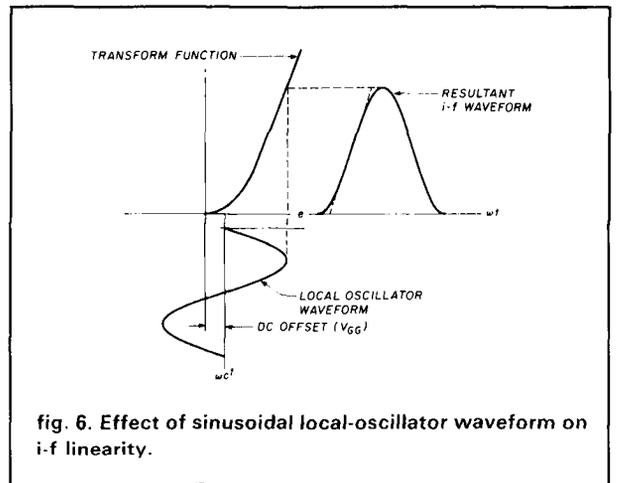
Q is the loaded Q of the resonant tank

X is the reactance of the gate

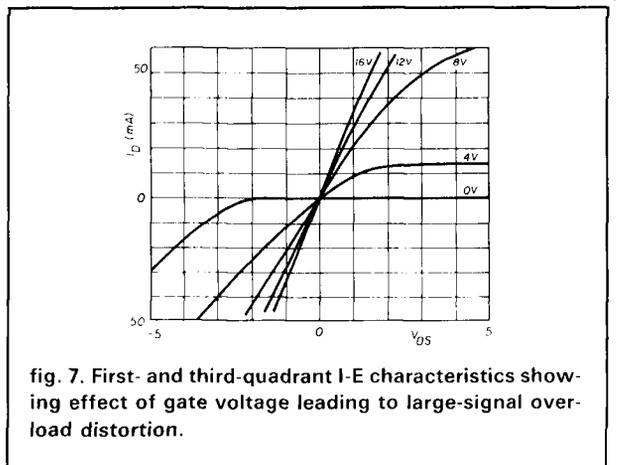
Since the gate capacitance of the MOSFETs is voltage dependent, the reactance becomes dependent upon the impressed excitation voltage. To allow this condition would severely degrade the IMD performance of the mixer. However, this reactive dependence on excitation voltage can be minimized using a com-



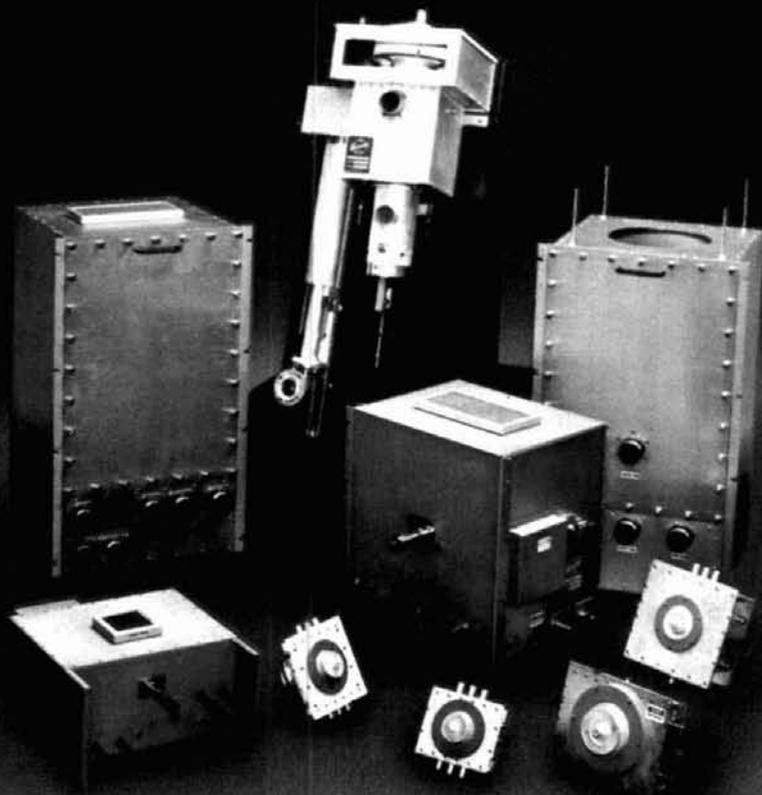
**fig. 5. Insertion Loss as a function of  $r_{DS}$ ,  $R_L$ , and  $R_g$**



**fig. 6. Effect of sinusoidal local-oscillator waveform on i-f linearity.**



**fig. 7. First- and third-quadrant I-E characteristics showing effect of gate voltage leading to large-signal overload distortion.**



# EIMAC cavities cover 54 to 970 MHz at power levels to 30 kW —our design or yours

Varian EIMAC has complete cavity design and production capability. We make sure that tube and cavity are compatible. If it isn't an off-the-shelf-item, we have the designers and engineers for any specific job.

EIMAC has expertise in all disciplines including pulse, CW, FM, and TV. We match tube, power,

bandwidth and operating mode to achieve optimum performance.

More information on EIMAC cavities and tubes is available in our Cavity Capability brochure from Varian EIMAC. Or for prompt consideration of your special design requirements, contact Product Manager, Var-

ian EIMAC, or the nearest Varian Electron Device Group sales office. Call or write today.

**Electron Device Group  
Varian EIMAC  
301 Industrial Way  
San Carlos, California 94070  
415-592-1221**

**Varian A.G.  
Steinhauserstrasse  
CH-6300 Zug, Switzerland  
Tel: (042) 23 25 75  
Telex: 78 841**

EIMAC Cavity	Matching EIMAC Tube	Tuning Range (MHz)	Power Output
CV-2200	4CX20,000A	86-108	30 kW
CV-2220	3CX1500A7	86-108	1.5 kW
CV-2225	4CX3500A	86-108	5 kW
CV-2240	3CX10,000U7	54-88	10 kW†
CV-2250	3CX10,000U7	170-227	10 kW†
CV-2400	8874	420-450	300/1250 W*
CV-2800	3CX400U7	850-970	225 W
CV-2810	3CX400U7	910-970	190 W

\*pulsed power

†peak sync, or 2.5 kW combined in translator service



**varian**

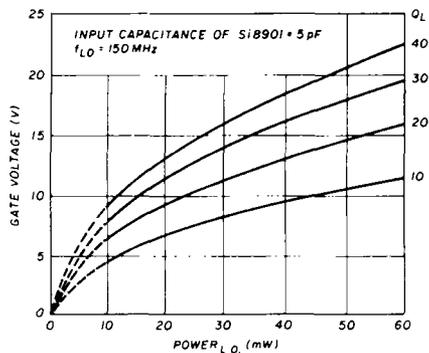


fig. 8. Influence of loaded Q on gate voltage vs. local-oscillator power.

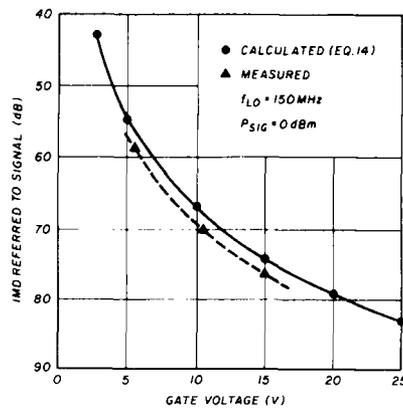


fig. 9. Effect of gate voltage on IMD performance.

combination of gate and substrate biasing. As we saw in fig. 6, the offset gate bias helps to achieve the required 50-percent duty cycle for optimum IMD performance.

Table 2 and fig. 8 offer an interesting comparison between a resonant-gate drive with a loaded Q of 14 and conventional drive using a 50 ohm to 200 ohm (100-0-100) 4:1 transformer. The full impact of a high-voltage gate drive can be seen in fig. 9, which shows close agreement between the calculated (eqn. 3) and the measured IMD.

### designing the mixer

Achieving the low signal input impedance can be easily accomplished using the Mini-Circuits T1-1T (1:1) broadband transformer. Likewise, for the i-f output, the Mini-Circuits T4-1 (4:1) does an excellent job.

The principal effort is the resonant gate drive, which necessitates an accurate knowledge of the Si8901's total capacitive loading. The data sheet offers typically 4.4 pF. To ensure good interport isolation, symmetry is critical. If this resonant tank is driven from an asymmetrical local oscillator source (coax), an unbalanced-to-balanced transformer ensures symmetry (see complete mixer schematic shown in fig. 3).

### performance of the Si8901 commutation mixer

The following tests were performed across the 2-to-30 MHz hf band.

- conversion efficiency (loss)
- two-tone, third-order intercept point
- compression level
- desensitization level
- noise figure

The conversion loss and input intercept point are plotted as a function of local oscillator drive power in fig. 10.

The 2-dB compression and desensitization levels appear to contradict what is normally expected based

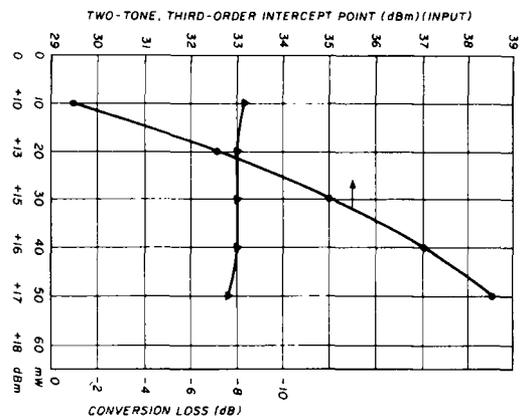


fig. 10 Intercept point and conversion loss.

on the +17-dBm local oscillator drive until we are reminded that the mixer's performance is based on gate voltage, not gate drive expressed as power. Both were measured at +30 dBm. The single-sideband noise figure was 7.95 dBm.

If the design engineer follows the concepts suggested in this note, the Siliconix Si8901 will provide the highest dynamic range of any comparable mixer currently available. Achieving a high gate voltage using a resonant drive does not label the mixer as a narrow-band device. Tank tuning may be accomplished in a number of ways, such as electronic tuning using varactors. It is conceivable that the tank may be the output of an electronically tuned balanced local oscillator circuit.

### references

1. H.P. Walker, "Sources of Intermodulation in Diode-Ring Mixers," *The Radio and Electronic Engineer*, Vol. 46, No. 5, May 1967, p. 247-255
2. R.P. Rafuse, "Symmetric MOSFET Mixers of High Dynamic Range," *Digest of Technical Papers*, 1968 International Solid-State Circuits Conference, p. 122-123.

ham radio

# Introducing the only mobiles that double as answering machines.

Now you can stay in touch—even when you're away from your radio.

With Yaesu's 2-meter FT-212RH and 70-cm FT-712RH, an optional, internal digital voice recorder serves as a convenient answering machine for you and your friends. And that's just the beginning!

## High performance mobiles.

The FT-212RH features wideband receive coverage of 138-174 MHz (144-148 MHz Tx), while the FT-712RH covers 430-450 MHz. An oversize amber display includes an innovative photo-sensor which increases the display brightness during the day. The function buttons are arranged in a chromatic musical scale—ideal for visually-impaired operators. You get 45 watts output on 2 meters, 35 watts on 70 cm.

An autodialer DTMF microphone with 10 memories, each ready to store telephone numbers up to 22 digits long.

And, like our FT-211RH Series mobiles, you'll enjoy surprisingly simple controls, yet highly sophisticated microprocessor-based flexibility. Including 18 memories that store frequency, offset, PL tone, and PL mode (CTCSS unit optional). Band or memory scanning. Offset tuning from any memory channel. Memory channel lockout for scanning. High-low power switch.

All in an amazingly small package, shown actual size below.

## Digital voice recorder option.

Only Yaesu brings you the advanced technology found in our digital voice recorder option.

You can store messages or your call sign—in your own voice, not a synthesized replica—or give your friends a private code for leaving messages on your radio. All they need is a DTMF microphone! Then you can play back your messages either in-person, or remotely by using another radio with a DTMF microphone. And you've always got security because you can command your radio to respond only to in-person playback requests.

## Visit your Yaesu dealer today.

And test drive Yaesu's FT-212RH and FT-712RH mobiles. The only radios with the power to keep you in touch. Always.

# YAESU



218

Yaesu USA 17210 Edwards Road, Cerritos, CA 90701 (213) 404-2700. Repair Service: (213) 404-4884. Parts: (213) 404-4847

Prices and specifications subject to change without notice. PL is a registered trademark of Motorola, Inc.



# Dynamite Discovery

Communications Specialists' latest excavation brings to light yet another dynamite discovery—our new dip switch programmable SD-1000. No need to tunnel your way through Two-Tone Sequential decoding anymore. We've mined this amazing unit! Now, for the first time, you can stock one unit that will decode all calls in a 1000-call paging system with  $\pm .2$ Hz crystal accuracy. The EEPROM on-board memory can even be programmed for custom tones, and every unit includes group call. Universal switched outputs control your call light, squelch gate and horn. The SD-1000 can

also generate CTCSS and decode Two-Tone Sequential. Its miniature size of 2.0" x 1.25" x .4" is no minor fact either, as it's a flawless companion for our PE-1000 Paging Encoder. We ensure one-day delivery and our one-year standard warranty. Tap the rich vein of Communications Specialists and unearth the SD-1000 or other fine gems.



**COMMUNICATIONS SPECIALISTS, INC.**  
 426 West Taft Avenue • Orange, CA 92665-4296  
 Local (714) 998-3021 • FAX (714) 974-3420  
 Entire U.S.A. 1-800-854-0547

provides new dimension  
in signal reception



## the IC-781

### ICOM's newest transceiver

By **J. Craig Clark, Jr.**,  
**N1ACH**, Assistant Publisher,  
*ham radio*.

Rumors have been flying for the past few months about a major new radio on the way from Japan. We've carefully watched the Japanese *CQ*

Ads first appeared in February issues of *American Ham* magazines. ICOM has also been showing the unit at various dealers around the country in conjunction with ICOM DAY promotions. When I found that the new ICOM IC-781 was going to be at Hamtronics in Trevose, PA, in early December, I

Hamtronics gang and Evelyn Garrison and Mike Vincent from ICOM, I got my first look at the radio.

Let me give you an overview of the radio's unique features. While the price is rather steep, (about \$7,000) one thing to remember is that an innovative radio like this has a trickle-down effect within the industry. If you look back about 20 years to the Signal One CX-7 (at the time a quantum leap in transceiver design) and compare it to today's state-of-the-art transceiver, you'll find plenty of parallels. The IC-781 will pave the way for many new features you'll want in your next radio.

The first thing you notice about the IC-781 is its 5-inch CRT display set smack dab in the middle of the radio's front panel. Other than that, it bears a striking physical resemblance to ICOM's IC-761 transceiver. The unique feature of the IC-781 is that it contains a spectrum analyzer which gives you a picture of band occupancy and relative signal strength in 100, 200, and 400-kHz windows centered on your operating frequency. As with a conventional spectrum analyzer, frequency is plotted on the horizontal axis and signal strength on the vertical.

DXers will find this to be a boon in finding pileups as they scan the bands. Big wide blips will indicate hotbeds of activity. Contesters will no longer have to search up and down the band for



*Ham Radio*, the largest ham radio magazine in the world, for a glimpse of this interesting new product. Little has slipped through — a whisper here, a hushed conversation there — snippets that when put together yield tantalizingly little about what it actually is.

By now, you know that ICOM has announced its new IC-781 transceiver.

decided to get a hands-on demonstration.

A few days later, I found myself standing in front of the store in Trevose. Though it was still pretty early, a fair crowd had already arrived and was hovering around the IC-781. After making my way through the throng and introducing myself to the

**FLASH**

# MIRAGE NEWS

**NEW  
PRODUCT  
NEWS**

Vol. MCMLXXXVIII

Fact Sheet

February 1988

## Morgan Hill, CA

### NEW IMPROVED HEAT SINKS FOR ALL MIRAGE AMPLIFIERS

One of the biggest problems with transistor amplifiers is thermal overload — during extensive key down operation the amplifier will shut down due to excessive transistor heat build up. MIRAGE'S new heat sink uses a special manufacturing process to imbed copper in the aluminum body. Copper is 2.5 times more conductive than aluminum and ensures more rapid and even heat dissipation throughout the heat sink. By reducing the amount of heat in the amplifier, transistor life has been significantly improved. The extra margin of safety means you don't have to worry about shut down during long winded FM conversations or RTTY operation.

## Morgan Hill, CA

### NEW 360 WATT 2 METER AMPLIFIER

Here's a new amplifier active 2 meter operators will want! Designed with the DX'er in mind, the new B3036 amplifier gives a full 360 watts output with just 30 watts of drive power. Also includes a low noise (.5dB) GaAs FET pre-amplifier with a helical resonator front end. Uses MIRAGE'S new copper/aluminum high dissipation heat sink with built-in fan for extra protection and heat transfer. The unit measures approximately 13" x 5 3/8" and is powered by 13.6 volts DC at 40 amps. Carries the MIRAGE five year warranty, one year on transistors.

## Morgan Hill, CA

### HEAVY DUTY BOOM FOR LARGE HF ANTENNAS

Designed to meet the challenge of the severest of weather conditions, KLM now offers a heavy duty boom for its line of HF antennas. The boom is a 3" diameter by .25" wall size piece of aluminum. Instead of swaged ends to join pieces, the heavy duty boom uses splice sections that insert into the boom. The splices are made from the same rugged aluminum as the boom and are designed to meet or exceed the most demanding Amateur requirements. Contact your KLM dealer for this special order item.

**MIRAGE/KLM**  
COMMUNICATIONS EQUIPMENT, INC.

P.O. BOX 1000 MORGAN HILL, CA 95037  
(408) 779-7363  
(800) 538-2140 (outside CA)

✓ 224

## Iron Powder and Ferrite TOROIDAL CORES

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

Small Orders Welcome  
Free 'Tech-Data' Flyer

**AMIDON** Associates Since 1963

12033 Otsego Street, North Hollywood, Calif. 91607



In Germany: Elektronikladen, Wilhelm — Mellies Str. 88, 4930 Detmold 18, West Germany  
In Japan: Toyomura Electronics Company, Ltd. / 7-9, 2-Chome Sota-Kanda, Chiyoda-Ku, Tokyo, Japan

✓ 223

## Multiband QRV 160-10 Emergency Pack

### Field Day Winner

The Emergency Pack contains QRV 160-10 All Band kink-proof weather sealed antenna, Quick Launch kit, 70' RG-8x feedline, 160 meter adapter, all band counterpoise, 200' rotproof line. Complete and QRV. One person installs in 15 minutes.

### Fastest Antenna in the West

**\$139.95**  
+ \$10 P.&H.  
incl 47 page Tech Manual  
Info: 56c s.a.s.e.

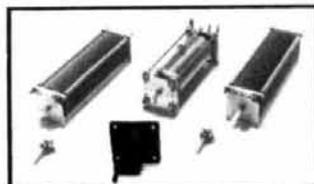
1971 N. Oak Lane 1300 E.  
Provo, UT 84604-2138

**Antennas West**  
(801) 374-1084

✓ 270

## 1500 + WATT TRANSMATCH KIT \$169.95

## OTHER KITS



### BASIC KIT: INDIVIDUAL ITEMS

- 1 - rotary inductor 28μh..... \$59.00
- 2 - 6:1 ball drives..... \$9.00 ea.
- 1 - 0-100 turns counter..... \$62.50
- 2 - variable capacitors
- 25-245 pf 4500 v..... \$44.00 ea.

### OPTIONS—

- enclosure (pictured in Sept. 86 CQ)..... \$64.00
- 4:1 balun kit..... \$22.50
- dials, terminals, chassis, ceramic standoffs, hardware,

- Article Reprints (refundable)..... \$1.50
- G3RUH, PSK Packet Modem, Sat./Terrestrial \$99.00
- PC Board for above only, delivered..... \$27.99
- Ten-Tec Designer Cabinet for above..... \$12.00
- K9CW Memory Contest Keyer..... \$109.00
- Yaesu FRG-9600, .1 to 60 MHz Converter..... \$94.95
- 20m CW, 15w Transceiver (H.R. 6/87)..... \$159.95
- 50W 75M SSB XCVR..... \$199.95

### Factory Wired

- Nel-Tech DVK-100A (New Model)..... \$269.00
- B & W PT-2500A Amp..... \$1,670.00
- B & W VS1500A Tuner..... \$388.00
- Amp Supply/Ameritron Linears..... CALL
- Shipping Extra Unless Noted ✓ 222
- Catalog \$1.00

### RADIOKIT • P.O. Box 973-H

Pelham, NH 03076 • (603) 635-2235  
toroids, amp components, B&W coil stock, etc.



**We've Got Books  
Plenty of Books**

Send SASE for free flyer

**Ham Radio's Bookstore**  
Greenville, N. H. 03048

clear frequencies to set up a new run. Also, by looking at relative strengths of signals and finding out what areas of the world are coming in the best, you can determine if it's better to look for new multipliers or try to run them.

The multi-function CRT displays VFO A and B frequencies, memory contents and, when connected to an external TU such as the Kantronics KAM, MFJ, or AEA PK-232, the demodulated output of CW, RTTY or other digital modes. This eliminates the need for a bulky external monitor.

But that's not all! In addition to the CRT display features, the IC-781 also has a number of other interesting capabilities.

For example, you can listen on both VFO frequencies simultaneously (while in the same band) and vary audio balance between each. Don't want to miss that rare DX station that's working call zones? Tune the DX station on VFO B, turn the audio balance up enough so you can hear and keep track of his operation, tune VFO A to an open spot and call CQ. When the DX station gets to your call area, switch VFOs and call. Or, when you are working a split frequency pileup, adjust the audio balance between VFOs so you can keep track of both your transmit and receive frequencies. Too many stations calling on your transmit frequency? Slide up 500 Hz without losing track of the DX station and call again. It's that easy.

Another innovation is the twin pass-band tuning capability. You can tune



the second and third IF separately for double passband tuning or together as an IF shift. Sometimes you want that extra ability to reduce an interfering signal. The double passband control will give you this.

Recognizing that in many cases 90 to 110 watts power output is not enough to fully drive many of the amplifiers now available, ICOM has increased the power output of the IC-781 to a generous 150 watt level. This should be more than enough to drive grounded grid amplifiers to full legal output or provide that extra bit of signal when running "barefoot".

The IC-781 also comes with: built-in switching power supply, automatic "one-button" antenna tuner, keyboard frequency entry control, dual noise blanker with monolithic crystal filter, 99 tunable memories, wide and narrow filters, and an internal iambic keyer at no additional cost.

As you can see by looking at the photos, the IC-781 is a pretty complete radio.

ham radio

# RF POWER TRANSISTORS

We stock a full line of Motorola & Toshiba parts for amateur, marine, and business radio servicing

SEE YOU AT THE ORLANDO CHARLOTTE & DAYTON HAMFESTS

## Partial Listing of Popular Transistors

2-30 MHz 12V. (* 28V)				
P/N	Rating	Net Ea.	Match Pr.	
MRF421	Q 100W	\$24.00	\$53.00	
MRF422	Q 150W	36.00	78.00	
MRF454, A	Q 80W	14.50	32.00	
MRF455, A	Q 60W	11.75	26.50	
MRF485	Q 15W	6.00	16.00	
MRF492	Q 90W	16.00	35.00	
SFR2072	Q 65W	12.75	28.50	
SFR3662	Q 110W	24.00	53.00	
SFR3775	Q 75W	13.00	29.00	
SFR3795	Q 90W	15.50	34.00	
SFR3800	Q 100W	17.50	38.00	
2SC2290	Q 80W	16.75	39.50	
2SC2879	Q 100W	22.00	48.00	

Q Selected High Gain Matched Quads Available

## VHF UHF TRANSISTORS 12V.

Rating	MHz	Net Ea.	Match Pr.
MRF245	80W 136-174	27.50	61.00
MRF247	75W 136-174	26.00	58.00
MRF248	80W 136-174	33.00	71.00
MRF641	15W 407-512	18.00	42.00
MRF644	25W 407-512	21.00	46.00
MRF646	40W 407-512	25.00	54.00
MRF648	60W 407-512	31.00	66.00
2N6080	4W 136-174	6.25	—
2N6081	15W 136-174	8.00	—
2N6082	25W 136-174	9.50	—
2N6083	30W 136-174	9.75	24.00
2N6084	40W 136-174	11.50	28.00

## PARTIAL LISTING OF MISC. TRANSISTORS

MRF134	\$16.00	MRF515	2.50
MRF136	21.00	MRF607	2.50
MRF137	24.00	MRF630	4.25
MRF138	35.00	MRF846	43.50
MRF174	80.00	MRF1946.A	14.00
MRF208	11.50	CD2545	16.00
MRF212	16.00	SD1278-1	17.75
MRF221	11.00	2N3553	2.29
MRF224	13.50	2N3866	1.25
MRF237	2.70	2N4427	1.25
MRF238	12.50	2N5589	7.25
MRF239	14.00	2N5590	10.00
MRF240	15.00	2N5591	13.50
MRF260	7.00	2N5641	9.50
MRF261	8.00	2N5642	13.75
MRF262	8.75	2N5643	15.00
MRF264	12.50	2N5945	10.00
MRF309	29.75	2N5946	12.00
MRF317	56.00	2SC1946.A	15.00
MRF406	12.00	2SC1947	9.75
MRF433	11.00	2SC2075	3.00
MRF449	12.50	2SC2097	28.00
MRF450	13.50	2SC2509	9.00
MRF453	15.00	2SC2640	15.00
MRF458	20.00	2SC2641	16.00
MRF475	3.00	OUTPUT MODULES	
MRF476	2.75	SAU4	55.00
MRF477	11.75	SAU17A	50.00
MRF479	10.00	SAV6	42.50
MRF492A	18.75	SAV7	42.50
MRF497	14.25	SAV15	48.00
40582	7.50	M57712, M57733	use
NE41137	2.50	M57737, SC1019	SAV7

Hi-Gain, Matched, and Selected Parts Available

We stock RF Power transistors for Atlas, KLM, Collins, Yaesu, Kenwood, Cubic, Mirage, Motorola, Heathkit, Regency, Johnson, Icom, Drake, TWC, Wilson, GE, etc. Cross-reference on CD, PT, SD, SRF, JO, and 2SC P Ns. Quantity Pricing Available Foreign Orders Accepted Shipping Handling \$5.00 COD VISA MC

Orders received by 1 PM PST shipped UPS same day. Next day UPS delivery available

ORDER DESK ONLY — NO TECHNICAL

(800) 854-1927

ORDER LINE and or TECH HELP

(619) 744-0728

FAX (619) 744-1943

## INTERFERENCE?

- ★ Interference Location
- ★ Stuck Microphones
- ★ Cable TV Leaks
- ★ Security Monitoring



- ★ VHF and UHF Coverage
- ★ Computer Interface
- ★ Speech Synthesizer
- ★ 12 VDC Operation

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

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



# RF PARTS

1320 Grand Avenue  
San Marcos, CA 92069

WE SHIP WORLDWIDE

# Barry Electronics Corp.

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

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

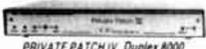
KITTY SAYS: WE ARE NOW OPEN 7 DAYS A WEEK.  
**Saturday & Sunday 10 to 5 P.M.**  
Monday-Friday 9 to 6:30 PM Thurs. to 8 PM  
Come to Barry's for the best buys in town.



ICOM  
IC-714 7.15M 143.28MHz 10A 485 MHz/214  
IC-7000 IC-741 IC-375A 2750W 3200A  
475AH 7.15 IC-900 IC-781



SMART PATCH  
G.E.S. Simple Antenna 510.5A W- Patch FM  
Patchwork to your Telephone. Great For  
Telephone Location Mobile To Base Simple  
To Use. \$105A/105AH



PRIVATE PATCH IV Duplex 8000



NYE MBV-A 3 Kilowatt Tuner



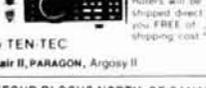
SANTEC  
ST-222/UP  
ST-201  
ST-442/UP  
HT-7



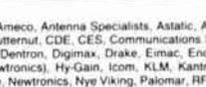
MFJ-989B



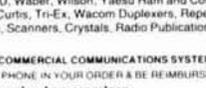
Ten-Tec  
Tuner 229B



SANGEAN Portable Shortwave Radios



HEIL EQUIPMENT  
IN STOCK



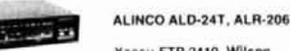
New TEN-TEC  
Corsair II, PARAGON, Argosy II



YAESU  
FT-767GX, FT-757GXII, FT-311 RM,  
FRG-8800, FT-736, FRG-9600,  
FT-211/711RH, FT-2700RH



AMERITRON AMPLIFIER AUTHORIZED DEALER



ALINCO ALD-24T, ALR-206T



Yaesu FTR-2410, Wilson  
ICOM IC-RP 3010 (440 MHz)  
ICOM IC-RP 1210 (1.2 GHz)  
ICOM IC-RP 2210 (220 MHz)



Complete Butternut Antenna  
Inventory in Stock!



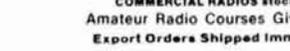
DIGITAL FREQUENCY COUNTERS  
Tromax Model TR-1000 0-500 MHz  
AMP SUPPLY STOCKED  
Long range Wireless  
Telephone for export in stock



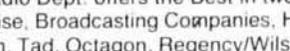
BENCHER PADDLES,  
BALUNS, LOW PASS FILTERS  
IN STOCK



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



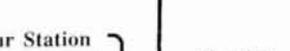
Commercial Equipment  
Stocked: ICOM, MACKON,  
Midland, Standard,  
Wilson. Yaesu. We serve  
municipalities, business-  
es, Civil Defense, etc.  
Portables, mobiles, bases,  
repeaters



Wanted: Full-time Technicians



COMMERCIAL RADIOS stocked & serviced on premises.



Amateur Radio Courses Given On Our Premises, Call



Export Orders Shipped Immediately. TELEX 12-7670

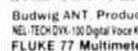


ALL SALES  
FINAL

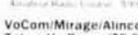
## KENWOOD



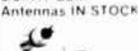
154405-AT, N5000, N2000, 15 940 5 AT  
1M-221A-421A, 1M-2570A-50A-30A TR 751A  
Newport Service Repair TR 213 3143 BT  
15 11001A 15 11001A 14000AT 14000A  
1W-4100A 1M-307A 15 14015-AB05



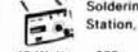
Budwig ANT Products  
NEL-TECH-DVX-100 Digital Voice Keyer  
FLUKE 77 Multimeter



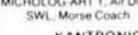
VoCom/Mirage/Alinco  
Tokyo Hy-Power/TE SYSTEMS  
Amplifiers &  
5/8 HT Gain  
Antennas IN STOCK



Soldering  
Station.



48 Watts, \$68



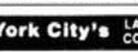
MICROLOG ART-1, Air Disk,  
SWL, Morse Coach



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



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



BIRD  
Wattmeters &  
Elements  
In Stock



AEA 144 MHz  
AEA 220 MHz  
AEA 440 MHz  
ANTENNAS

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

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

"Aqui Se Habla Espanol!"  
BARRY INTERNATIONAL TELEX 12 7670  
MERCHANDISE TAKEN ON CONSIGNMENT  
FOR TOP PRICES  
Monday-Friday 9 A.M. to 6 P.M. Thursday to 8 P.M.  
Saturday & Sunday 10 A.M. to 5 P.M. (Free Parking)  
AUTHORIZED DIST. MCKAY DYMER FOR  
SHORTWAVE ANTENNAS & RECEIVERS  
IRI/LEX - Spring St. Station  
Subways: BMT - "Prince St. Station"  
IND - "F" Train Bwy. Station  
Bus: Broadway #6 to Spring St.  
Path - 9th St. 6th Ave. Station

We Stock: AEA, ARRL, Alpha, Ameco, Antenna Specialists, Astatic, Astron, B & K, B & W, Bencher, Bird, Butternut, CDE, CES, Communications Spec., Connectors, Cushcraft, Daiwa, Dentrone, Digimax, Drake, Eimac, Encomm, HeilSound, Henry, Hustler (Newtronics), Hy-Gain, Icom, KLM, Kantronics, Larsen, MFJ, J.W. Miller, Mirage, Newtronics, Nye Viking, Palomar, RF Products, Radio Amateur Callbook, Saxton, Shure, Telex, Tempo, Ten-Tec, Tokyo H Power, Tronix TUBES, W2AU, Wabur, Wilson, Yaesu Ham and Commercial Radios, Vocom, Vibroplex, Curtis, Tri-Ex, Wacom Duplexers, Repeaters, Phelps Dodge, Fanon Intercoms, Scanners, Crystals, Radio Publications.

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

ALL SALES FINAL

## ENHANCE PERFORMANCE

The Ultimate Upgrades!

Drake R-4B/C, TR-7, R-7, TR-4/C, SPR-4, SW-4A  
First & Second IF Filters, P.C. Board Retrofits  
JRC NRD 515 Filters + Motherboard Modifications

Speech Processing + IF Filters: T-4XC, TR-7, CX-11A

Front-End Antenna Filters: 160, 80, 40, 20, & 15 M  
High-Performance SSH & Phase-Locked AM Detector  
Improved HF Mobile Antennas: 80-10 or 40-10 M

Receiver / Transmitter Modification Services  
Alignments, Receiver Testing, Filter Plots

DX Locator - MS-DOS. Call sign gives Location, Zones,  
Continent, Distance, and Beam heading in 1 second

## Sherwood Engineering Inc.

1268 South Ogden Street, Denver, CO 80210

(303) 722-2257 Monday-Friday 9 A.M. - 5 P.M.

Dealer: Design Electronics Ohio Full Installations  
(614) 836-5711 Days, (614) 836-3376 Evenings

## #1 NEED QUALITY In Mounts ACCESSORIES?



IIX Equipment Ltd.

SAY EYE-EYE-X

CALL OR WRITE  
FOR YOUR 1988 Y-6

20 PAGE CATALOG **FREE!**

Immediate Shipping On ALL Items

IIX EQUIPMENT LTD.

P.O. BOX 9

OAKLAWN, IL 60454

(312) 423-0605



225

## THE MULTIPLE RECEIVER SOLUTION



4 Channel Signal-to-Noise Voter

- Expandable to 32 Channel by Just Adding Cards
- Continuous Voting
- LED Indicators of COR and Voted Signals
- Built-in Calibrator
- Remote Voted Indicators Pinned Out
- 4 1/2 x 6 Double Sided Gold Plated 44 Pin Card
- Remote Disable Inputs
- MORE

Built, tested and calibrated with manual

**\$350.00**

Telephone interface now available  
For more information call or write:

HALL ELECTRONICS  
Voter Department  
815 E. Hudson Street  
Columbus, Ohio 43211  
(614) 261-8871

## QRV Solar Power for your Station



The \$289.95 Bullet-tested QVR Solar Power Supply keeps your  
repeater on the air round the clock or powers your 100-watt HF  
station 60 hrs a month. Control circuit speeds charge, protects gel  
cells & sealed batteries. Fully assembled, QVR, expandable, portable.

Add \$10 S & H. Info 56c s.a.s.c. Antennas West  
1971 N. Oak Ln., Provo, UT 84604 (801) 374-1084

270

## 5-900 MHz PREAMPLIFIERS

	NF	G	P(1dB)	\$
WLA21M	3dB	13dB	8dBm	54
WLA22N	4	11	12	58
WLA23M	4	22	12	83
WLA24M	3	20	18	109

## 430/50 MHz CONVERTER

RXC431 .15uV 20dB 99

## 1-900 MHz DIR-COUPLER

PC24-15 coupling -15dB 43

## WI-COMM ELECTRONICS INC.

P.O. Box 5174, MASSENA, N.Y. 13662

(315) 769-8334

227

# optimizing gain on Yagi antennas

## Examination of “short” boom Yagi reveals surprising results.

In the recent past, Yagi antenna construction was as much folklore, superstition, and magic as it was science and engineering. For example, the guidelines for constructing a Yagi antenna provided in the ARRL's 1980 *Antenna Handbook*<sup>1</sup> include a general table of ranges for “optimum” element spacing, but not a formula for determining optimum element lengths. Would an antenna built according to this data really be “optimum?”

Computer modeling of Yagi antennas provides a means of answering this question by allowing us to examine the effects of element length and spacing perturbation and by providing an efficient and reproducible means of calculating gain and pattern. Even with some major simplifying assumptions about element interactions and element self-impedance, the result of Yagi modeling predicts the results from the antenna test range.<sup>7</sup> Two previous papers examined the change in forward gain with different taper regimens — i.e., all directors the same length, all directors getting shorter towards the front, all directors longer towards the front.<sup>2,5</sup> Although a taper regimen may offer a slight advantage, the difference is almost vanishingly small. For example, maximum gain on a 3.44-wavelength boom Yagi with no director taper was 15.601 dBi, and the maximum gain with an “optimum” director taper was 15.618 dBi.<sup>2</sup> However, these previous studies imposed a fixed geometric relationship between the directors, although the only rationale for this is aesthetics. In his thesis work, Dr. Chen found that Yagi antennas maximized for forward gain smoothly converged to a single unique solution and, from his examples, director lengths had no apparent geometric relationship.<sup>3</sup> Thus, the question of maximizing gain by changing director size deserves a second look without the constraint of a fixed physical relationship between director lengths.

The purpose of this article is to examine Yagi gain performance under certain constraints:

- Maximum boom length will be limited to one wavelength, which is about the longest practical boom on 15, 20 or 40 meters.
- Antennas will be optimized for maximum gain. By concentrating on antenna gain, front-to-back ratio and bandwidth are not considered. While both are important, both generally take away from forward gain. Our primary focus is: what is the maximum Yagi gain for a given boom length, and how much better is the optimized gain from where we started?

### procedure

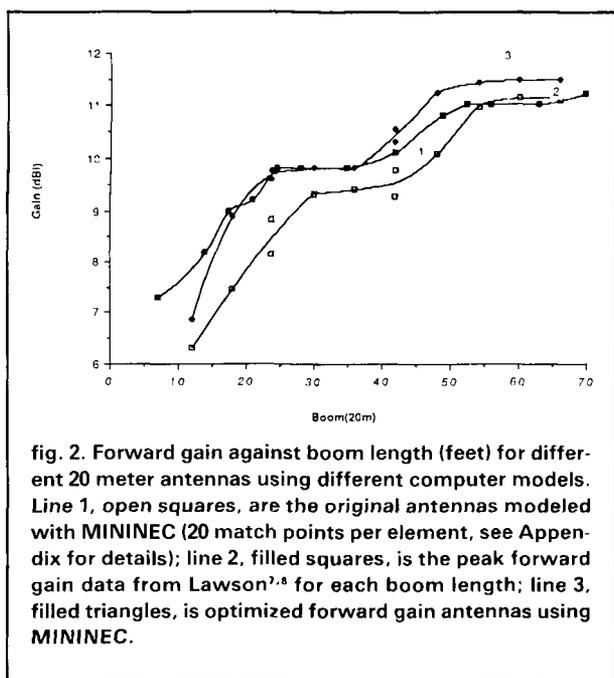
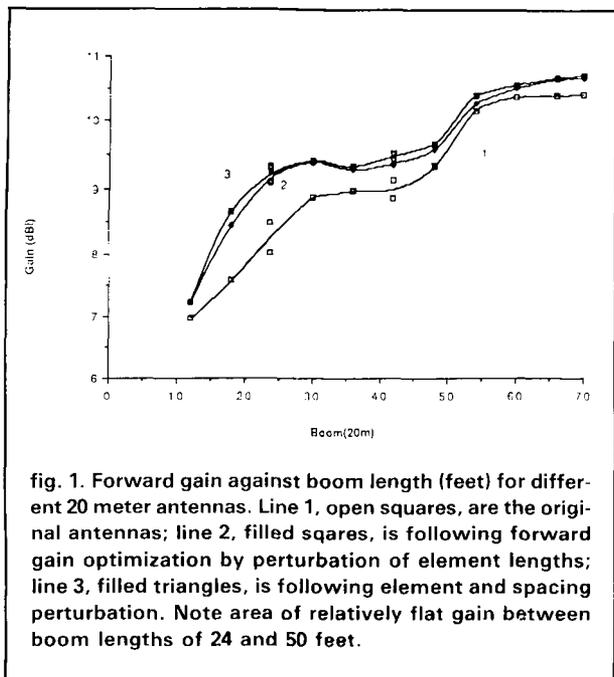
Antennas will be modeled in free space using the assumptions presented in the **appendix**. The basic antenna design is initially estimated using the general principles outlined in the ARRL's *Antenna Handbook*, with equal spacing between the elements. Initial parameters are:

- Element diameter: 0.001 wavelength (1 inch on 20 meters)
- Reflector length: 0.51 wavelength
- Director lengths: 0.45 wavelength

The reflector's length will be increased by 0.0025 wavelength; the gain will again be calculated. If the forward gain improves by more than 0.01 dB, then that element will be incremented again in the same direction. If forward gain does not improve, the element will be shortened until the gain starts falling off. Once the reflector is optimized for forward gain, the same procedure is applied to the directors in order, and then back to the reflector. This iteration is continued until no further gain improvement is noted for a complete cycle through all parasitic elements. Once the antenna is optimized for forward gain using element perturbation, this same procedure is applied for element spacings with the first and last element fixed at the ends of the boom. Table 1 presents the starting and final values after forward gain optimization for some representative examples. After optimizing an antenna with equal element spacing, the same procedure is done for some antennas with unequal spacing.

For a given boom length and element spacing, the element lengths were found to converge smoothly to the same final values and were *independent of starting lengths*. Element and boom lengths in the tables are presented in terms of wavelength, but for **figs.**

By Dave Donnelly, K2SS, 8 Alder Street, Lincoln Park, New Jersey 07035



1 and 2, the boom length is translated to a 20-meter antenna in order to provide a clearer sense of physical size.

## results

Two- and three-element antennas on a short boom (0.17 and 0.258 wavelength, 12 and 18 feet on 20 meters) showed 6.8- to 6.9-dBi gain in the initial con-

figuration that increased to 7.2 to 8.6 with optimization. A gain increase of 0.15 dB over equal spacing was found with close spacing of the driven-reflector in the three element configuration. On longer booms (.34, .43, .52, .60 and .68 wavelength, 24, 30, 36, 42 and 48 feet on 20 meters), configurations had between 8.0-9.1 dBi forward gain before and 9.1-9.6 dBi after optimization. A 4 element configuration on a .34 wavelength boom was about 0.2 dB better than a 3 element configuration.

Large antennas on booms of 0.77, 0.86, 0.95 and 1.0 wavelength (54, 60, 66 and 72 feet on 20 meters) had 10.1-10.5 dBi. Following optimization these antennas had 10.5-10.8 dBi.

Overall, the improvement in forward gain from the starting values was 0.7 (range: 0.3 to 1.53) dB, averaged over all the antennas, and usually came at the expense of front-to-back discrimination. In no case did the optimized antenna show any particular pattern in director taper — i.e., all elements getting shorter or longer.

Once an antenna is optimized for forward gain using element perturbation, changing the element spacing resulted in only minor forward gain improvement. The only exception was with wide spaced antennas (i.e. > 0.2 wavelengths) which work better with shorter element spacing between the reflector and driven elements.

In general, gain optimized antennas had reflectors which were rather short (about 0.49 wavelength or +j 30 ohms) and at least one director which was rather long (0.45-0.46 wavelength or -j 10 ohms). Since some parasitic elements are close to resonance, the optimized antennas would likely have a very limited bandwidth, and not adequately cover the CW and phone portions of the bands.

For a given boom length, the maximum gain figure was independent of the number of elements or spacing, with a slight edge to antennas with a short spacing from driven element to reflector (about 0.2 dB). Of particular interest is the relationship between maximum forward gain and boom length (fig. 1). The curve is not smooth, and shows a pronounced plateau after the 24-foot boom on 20 meters (0.35 wavelength) before again increasing with a 48-54-foot (0.76 wavelength) boom.

## discussion

These results suggest two conclusions:

- Yagi antenna gain is basically only a function of boom length. However, the increase in gain is not smooth for boom lengths between 24 and 70 feet on 20 meters. Increasing the boom length from 24 to 48 feet increases the maximum gain by only 0.5 dB, while

Table 1. Element length and spacing, forward gain and front-to-back ratio (at the end of the horizon) for two-eight elements with boom lengths between 0.172 to 1 wavelength (12 and 70 feet, respectively, on 20 meters). Row S shows the starting element length (wavelength) with a diameter of 0.0005 wavelength. The position of the element from the reflector end of the boom is given in parenthesis. R is the reflector, De is the driven element, D1 - D6 are the first through sixth directors.

	element length (boom position)		D1	D2	D3	gain (dB)	F/B (dB)
	R	De	D4	D5	D6		
S	0.510(0)	0.470(0.17)				6.87	9.9
O	0.490(0)	0.470(0.17)				7.23	7.2
S	0.500(0)	0.470(0.17)	0.450(0.35)			8.07	34.7
O	0.492(0)	0.479(0.15)	0.482(0.35)			9.11	4.6
S	0.500(0)	0.470(0.11)	0.450(0.22)	0.450(0.35)		8.43	16.9
O	0.495(0)	0.470(0.10)	0.442(0.25)	0.477(0.35)		9.32	5.5
S	0.500(0)	0.470(0.17)	0.450(0.34)	0.450(0.53)		8.96	10.0
O	0.490(0)	0.470(0.15)	0.447(0.36)	0.460(0.52)		9.35	6.3
S	0.500(0)	0.470(0.15)	0.450(0.30)	0.450(0.45)	0.450(0.60)	9.12	10.1
O	0.490(0)	0.470(0.15)	0.445(0.32)	0.472(0.44)	0.440(0.60)	9.42	8.5
S	0.500(0)	0.470(0.17)	0.450(0.35)	0.450(0.52)	0.450(0.69)		
			0.450(0.86)			10.31	11.2
O	0.492(0)	0.470(0.15)	0.427(0.34)	0.455(0.53)	0.445(0.69)		
			0.455(0.86)			10.5	9.8
S	0.500(0)	0.470(0.15)	0.450(0.30)	0.450(0.44)	0.450(0.59)		
			0.450(0.74)	0.450(0.88)	0.450(1.03)	10.67	10
O	0.517(0)	0.470(0.15)	0.467(0.30)	0.447(0.44)	0.428(0.59)		
			0.443(0.74)	0.435(0.88)	0.447(1.03)	10.97	13

increasing the boom length by another 12 feet (to 60 feet) offers a 1-dB improvement.

•If one starts with reasonable element lengths, the average improvement in gain that can be expected is about 0.7 dB.

In other papers, Yagi gain was generally considered to be a smooth function of boom length. Bill Myers fit the NBS test range results to a curve and found good agreement for the function: Gain (dB) = 3 ln (boom length) + 12 dBi.<sup>11</sup> However, this was fit with data from boom lengths of 0.4 to 4.2 wavelength, and only two points at one wavelength or less. An examination of the calculated gains from a previous article suggests a conclusion similar to the one drawn here (fig. 2, line 2). A datum point for this figure was the peak gain numbers from all of the frequency points and all the element configurations for a given boom length presented in references 8 and 9. Keep in mind that these were *not* gain optimized antennas. Here again, forward gain was not a smooth function of boom length, but also showed a plateau region above 0.3 wavelength (24-foot boom on 20 meters). Although the plateau points don't correspond exactly to the lengths found in this paper, the phenomenon of nearly doubling boom length for 0.5 dB or less increase in gain is visible.

If one accepts this staircase phenomenon in forward gain, one would conclude that the ideal place to sit is at the edge of the step. From the computer results

presented here, a good choice would be an optimally tuned four-element Yagi on a 24-foot boom for 20 meters. If you go to the effort of doubling the boom length to 48 feet, which probably requires a larger rotor, the forward gain may stay within 0.5 dB of the original antenna. Even if the boom length is expanded to 60 feet, the gain increase may only be 1.5 dB over the initial antenna. Is it worth the worry when the wind picks up?

The rather small average difference in forward gain between the initial and optimized antennas is surprising. The comments of Jim Lawson, W2PV, seem to be accurate and in order: "Yagi antennas 'want' to work."<sup>15</sup> The gain of non-optimized antennas is usually within 1 dB or so of the maximum possible gain. This frees the designer to optimize for other factors such as pattern nulls or average front-to-back without major worry that the forward gain will be compromised. Furthermore, *one should not expect great increases in forward gain through fine tuning of the antenna.* This may limit motivation for running up and down the tower, and performing hundreds of "This is antenna one, this is antenna two. . ." tests. Similarly, there is no magic about any particular antenna configuration. Thus, a 20 meter Yagi on a 24 foot boom should work the same (within a dB) whether it is homemade or from a commercial manufacturer.

In attempting to build actual antennas from data such as these, several factors must be kept in mind.

Although computer folks, myself included, tend to express gain to the hundredth<sup>7</sup> or thousandth dB,<sup>2</sup> the simplifying assumptions probably invalidate such accuracy. For instance, other investigators have assumed a real value for the self-impedance of 73 ohms,<sup>2,6</sup> while in reality, self-impedance varies between 50 and 100 ohms, depending on element length and diameter. Therefore, some of the terms in the impedance matrix are perhaps 20 percent in error. And an assumption that mutual impedance (coupling) between elements is independent of element length is probably only 90 percent accurate—shorter elements are less coupled. Nevertheless, despite these assumptions, the computer results show good correspondence to test range results,<sup>7</sup> and many fine working antennas have been based on computer designs.<sup>11</sup> A critical factor to keep in mind in implementing computer design data is constructing the same type element that was modeled; this is affected not only by element length, but also element diameter and physical taper. Two other papers provide an excellent discussion of this point.<sup>10,11</sup>

## conclusion

Short antennas (with a 0.35-wavelength boom) can work very well, and it may not be cost effective to increase the boom size unless one goes almost two and a half to three times longer. Changing element lengths or element positions may provide a gain increase of about 1 dB.

## appendix

This appendix provides the assumptions used for modeling the Yagi antennas, including how the mutual impedance matrix and gain were calculated. A more complete description of the general methodology is given elsewhere.<sup>6</sup>

The following assumptions and methodology were employed:

1. The mutual impedance between elements is assumed to be independent of element length and to be equal to published values for half-wave elements. This assumption was also used by others<sup>2,6</sup> and obviates the need to calculate mutual impedance for each antenna configuration, thereby greatly reducing computational time.

2. The self-impedance of an element is computed using Tai's formula, which estimates the real and imaginary self-impedance terms based on element length and element diameter:<sup>4</sup>

$$Z(\text{self}) = [122.65 - 204.1 (k\ell) + 110 (k\ell)^2] \\ -j 120 \left[ \ln \left( \frac{2\ell}{a} \right) - 1 \right] \cot(k\ell) - 162.5 + 140 (k\ell) - 40 (k\ell)^2]$$

where  $\ell$  is the element length,  $k\ell$  is  $2\pi/\text{wavelength}$ , and  $a$  is the diameter.

3. The impedance matrix is inverted and multiplied by the driving voltage matrix to give the element current distribution. The element currents are multiplied by the array factor for dipole elements to give the E field at a given value of theta and phi (spherical coordinates). The total radiated field is calculated by integrating theta and phi over a sphere and the gain in any direction is computed as the field ratio of the power in that direction divided by the average power flowing through the sphere. While this is theoretically equivalent to calculating the power in the forward direction and comparing to the input power at the driven element,<sup>2,6</sup> it is probably more accurate, since it is independent of uncertainties in driving impedance.

4. Because all calculations are done in free space, ground effects are neglected. The assumption is that the effect of the ground, which is to reinforce or cancel the radiated field, does not play a significant role in determining the current distribution.

Some reviewers of this manuscript were incredulous about the conclusion that forward gain did not increase smoothly with boom length and suggested that perhaps my underlying assumptions biased the results. Subsequently, I have performed the same optimization procedure using a version of MININEC with 20 match points per element. MININEC calculates all self and mutual impedances between element segments and thus does not use some of the assumptions I presented. Although the optimized element lengths were somewhat different than what I showed in **table 1**, the relationship of boom length to forward gain and the amount of improvement noted with gain optimization was identical. (See **fig. 2**, lines 1, 3.)

## references

1. *Antenna Handbook*, ARRL, Newington, Connecticut, 1980, page 153.
2. Stan Jaffin, WB3GTU, "Applied Yagi Antenna Design, Part 1: A 2-Meter Classic Revisited," *ham radio*, May 1984, pages 14-28.
3. C. Chen, "Perturbation Techniques for Directivity Optimization of Yagi-Uda Arrays," Ph.D. Thesis, Syracuse University, 1974.
4. R. S. Elliot, in: *Antenna Theory and Design*, edited by R. S. Elliot, Prentice-Hall, Englewood Cliffs, New Jersey, 1981, pages 301-303.
5. J. L. Lawson, W2PV, "Yagi Antenna Design: Optimizing Performance," *ham radio*, July 1980, pages 18-31.
6. J. L. Lawson, W2PV, "Yagi Antenna Design: Performance Calculations," *ham radio*, January 1980, pages 22-27.
7. J. L. Lawson, W2PV, "Yagi Antenna Design: Experiments Confirm Computer Analysis," *ham radio*, February 1980, pages 19-27.
8. J. L. Lawson, W2PV, "Yagi Antenna Design: Performance of Multi-element Simplistic Beams," *ham radio*, May 1980, pages 18-32.
9. J. L. Lawson, W2PV, "Yagi Antenna Design: More Data on the Performance of Multi-element Simplistic Beams," *ham radio*, June 1980, pages 33-40.
10. J. L. Lawson, W2PV, "Yagi Antenna Design: Practical Designs," *ham radio*, December 1980, pages 30-41.
11. Bill Myers, K1GQ, "The W2PV Four-element Yagi," *QST*, October, 1986, pages 15-19.

ham radio

# Radio Shack Parts Place™

PROJECT PARTS ARE AS CLOSE AS YOUR NEIGHBORHOOD SHACK®

## "Hotline" Service!



No Minimum Order  
No Service Charge

Your Radio Shack store manager can special-order many parts and accessories not in our catalog—tubes, semiconductors, crystals and more.

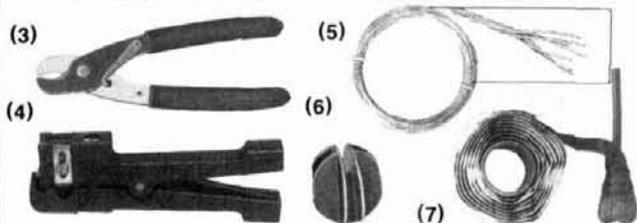
## Coax/Rotor Cable



In Demand by Hams!

- (1) **New High-Shield RG 8/U Coax.** 95% shielding. Velocity factor: 66%. Loss per 100 ft. at 100 MHz: 2.5 dB. Try it! #278-1323 . . . Per Ft. **36¢**  
(2) **5-Conductor Rotor Cable.** 100-Ft. roll. #15-1201 . . . **11.95**

## Antenna Coax Tools and Wire



- (3) **Coax Cutter.** Preserves impedance. 278-244 . . . **4.95**  
(4) **Coax Cable Stripper.** For most popular-size coax. #278-240. **11.95**  
(5) **Heavy-Duty SW Antenna Wire.** 65 feet. #278-1329 . . . **4.59**  
(6) **Insulators.** For antenna center and end, or for guy wires. #278-1333 . . . **Pkg. of 2/69¢**  
(7) **RF Connector-Sealant Tape.** Weatherproofs outdoor antenna connections. #278-1645 . . . **2.49**

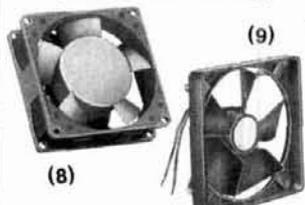
## Comfort 'Phones

Engineered  
For SWL and  
"Com" Use



Copy CW with total concentration! A featherweight headset, efficient ferrite magnets and high-compliance diaphragms let you burn the midnight oil in luxury. With 6-ft. cord, 1/8" plug, and 1/4" phone plug adapter. #20-210 . . . **9.95**

## Quiet Cooling



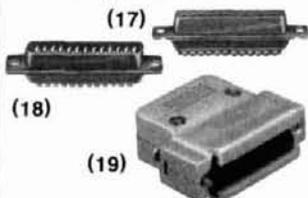
- (8) **3" Brushless DC Fan.** Great for mobile equipment and for cooling circuitry sensitive to AC fields. 7 to 13.8 VDC. #273-243 . . . **14.95**  
(9) **4" 120 VAC Fan.** 65 CFM. UL recognized. #273-241 . . . **16.95**

## Adapters & Plugs



- (10) **HT Ext. Speaker Adapter.** Shielded, monaural. #274-327. **1.29**  
(11) **Right-Angle 1/8" Jack to 1/4" Plug.** Stereo. #274-371 . . . **2.99**  
(12) **Phono Jack to 1/4" Plug.** For taping. #274-320 . . . **Pkg. of 2/2.59**  
(13) **Submini 3/32" Phone Plugs.** Black. #274-289 . . . **Pkg. of 2/1.39**  
(14) **Shielded Phono Plugs.** Easy to solder. #274-339. **Pkg. of 2/1.49**  
(15) **1/4" Plug.** #274-1545 . . . **1.79**  
(16) **8-Pin Mike Plug.** Fits most transceivers. #274-025 . . . **2.19**

## Computer Links



Solder-type "D" submini, 25 position connectors/hood.  
(17) **Male.** #276-1547 . . . **1.99**  
(18) **Female.** #276-1548 . . . **2.99**  
(19) **Shielded Hood.** Preserves EMI/RFI protection when used with shielded cable. #276-1536 . . . **1.99**

## Power Parts



- (20) **6-Ft. Grounded AC Cord.** CEE-type. #278-1257 . . . **3.99**  
(21) **100 µH RF Choke.** #273-102 . . . **99¢**  
(22) **Varistor.** #276-568 . . . **1.99**  
(23) **3-Wire, AC-Outlet Tester.** #22-101 . . . **5.95**

## Chargeable Light



Automatically lights when AC fails. Doubles as cordless lantern. With wall bracket and UL listed charger. #61-2740 . . . **19.95**

## 16-Piece Tool Set

Includes popular sizes in Phillips and flat-blade screwdrivers, hex keys, nut-drivers and a torque bar. #64-1961 . . . **8.95**

## Novice Exam Kit



No need to go whole-hog on the books to become a Ham! This course quickly and painlessly prepares you for the new Voice Class FCC exam. With two cassettes of Morse code plus practice exam questions and answers. #62-2402 . . . **19.95**

## Time/Weather Radio



Receive the time, to the nanosecond, from WWV National Bureau of Standards on 5, 10 or 15 MHz. Or get forecasts from your local weather station on 162.4, 162.475 or 162.55 MHz. Crystal controlled! #12-148 . . . **39.95**

## Scientific Calc



Handy Folding Support for Convenient Viewing

**27<sup>95</sup>**

Loaded with advanced features! This 68-function mathematician handles complex numbers and accepts 15 levels of parentheses. Makes ticket-upgrade math a snap. Auto-shutoff conserves batteries. #65-989

## Transistor Tester

Works In Or Out of Circuit

**14<sup>95</sup>**



Tests PNPs, NPNs, silicon and germanium types. Makes fast go/no-go tests of small-signal and power transistors, and matches similar transistors. Front-panel pin socket. Leads for in-circuit tests. #22-025

## Noise-Canceling Mike

With Preamp

**26<sup>95</sup>**



Picks up only the voice spoken into the microphone, cuts background noise. Assures 100% modulation to deliver maximum signal "punch." Battery extra. Without battery, operates as dynamic mike. #21-1175

Over 1000 items in stock! Binding Posts, Books, Breadboards, Buzzers, Capacitors, Chokes, Clips, Coax, Connectors, Fuses, Hardware, ICs, Jacks, Knobs, Lamps, Multitesters, PC Boards, Plugs, Rectifiers, Resistors, Switches, Tools, Transformers, Wire, Zeners, More!

Prices apply at participating Radio Shack stores and dealers

**Radio Shack**  
The Technology Store

A DIVISION OF TANDY CORPORATION

# homebrewing equipment from parts to metal work

## Helpful hints to get you started

**Why are so few hams** building electronic gear these days? To find out I conducted a survey among my ham friends. Three major reasons are:

- Lack of parts and difficulty in finding the necessary materials at reasonable prices.
- Choosing the wrong projects. Some pick projects of no use to their ham operations or that are too difficult for them to complete.
- The challenge of metal work can be overwhelming.

### the parts problem

Inexpensive parts are readily available from many sources. Here are some possibilities:

- Local radio clubs often hold sales and auctions. Large, heavy World War II equipment (often called boat anchors) usually sells at give-away prices. Strip down for usable parts and hardware. Keep all screws, nuts, spacers, and small parts such as capacitors and resistors. Your junk box will soon overflow with building material.
- Garage and silent-key sales often yield worthwhile items. Look for wire, solder, tools, coax fittings, connectors, etc. If you don't have an immediate need, buy parts and store them for future use.
- Hamfests. Watch for notices in ham publications. The flea market is usually the main attraction; the variety of material is unbelievable. Where else can you buy a Weston meter for a buck? Testing your bargaining skills is fun.
- Electronic surplus houses. These are scattered across the country, and frequently advertise in the yellow pages of the local phone book. Better companies often publish catalogs.
- Junk yards. Some of my best buys were made at junk yards where electronic material occasionally shows up as a byproduct and the seller doesn't know its value. I recently purchased some excellent coaxial cable at ten cents a foot.
- Ham friends. Some of your acquaintances may have a basement, garage, or an attic full of items collected in the heyday of World War II surplus sales.
- On-the-air swap meets can be an excellent source of cheap parts. I have contacted many hams on the air to buy hard-to-get items. You must be flexible in your

selection; sensible substitutions come from experience.

### selecting the right project

Keep your first project simple. It's easy to get discouraged if your initial attempt is too difficult. As you finish one project, look for something more complicated to test your abilities. I started building items such as field strength meters, moved on to antenna tuners, and finally to a linear amplifier. Build an item you will use in your ham operations. You'll give your confidence a boost if you build something and use it.

### preliminary design

The foundation of any electronic project is the panel, chassis and, cabinet. Do your homework on circuit design and determine its size before gathering materials.

When you have all the necessary parts, decide on their proper placement. Look at handbook illustrations and photos to see how the experts do it. Juggle the parts into a configuration that meets your project's requirements. For example, short rf leads are important. Keep the coils spaced from metal shields by a distance at least one half their (coil) diameter. The rf switches must be close to the coils to maintain short lead length. Allow plenty of space around high-voltage components to avoid flashovers.

Don't design in layers that will be hard to wire initially; it may be difficult to repair or replace components later.

### metal fabrication

Most hams dislike metal work either because they don't have the proper tools or don't know how to use them. This situation has an easy solution.

Cabinet and chassis dimensions are determined when your design and parts placement are frozen. Now start looking for sources of sheet aluminum. It's the only material easily worked and electrically excellent. I find aluminum at salvage yards, surplus houses, and flea markets. Prices average \$1.25 per pound. Buy 6061T-6 alloy for panels or pieces that don't need bending. Material 1/8 inch thick is needed; it's stiff and machines cleanly. Choose bendable material for the chassis and outer cabinet. Test for flexibility by bending a small corner with a pair of pliers. It should

**By Paul A. Johnson, W7KBE, 10817 Brookside Drive, Sun City, Arizona 85351**

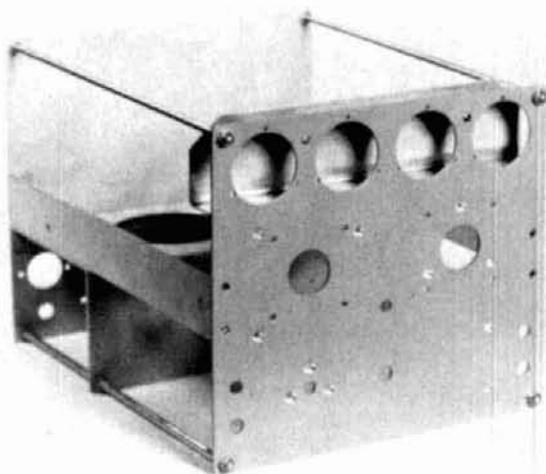


fig. 1. RF deck for KW linear amplifier. There's ample room in this compact 11" x 16" homebrew chassis for excellent parts placement and ease of wiring from all angles.

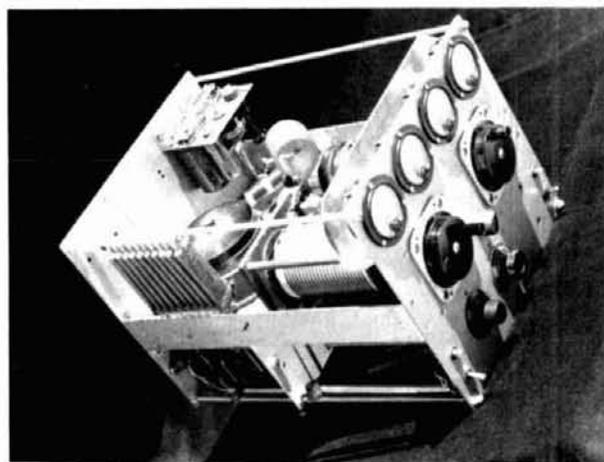


fig. 2. The wiring has been completed and tested on this amplifier that covers all the bands using two roller inductors and a variable vacuum capacitor in a Pi L network.

bend 90 degrees without breaking or springing back. Use 1/16 inch aluminum for these parts.

When looking for sheet aluminum, remember that salvage yards buy and sell *drops* (random sized pieces left from manufacturing processes). You can usually find material close to the correct size. One word of caution: stay away from aluminum that has been exposed to the weather — it's hard to clean.

### tools to use

You can cut aluminum easily with hack, sabre, circular, and hole saws or with a fly cutter. Cut meter holes with a hole saw or fly cutter (which must be used in a drill press at its lowest speed). Fly cutters can be dangerous; use cutting lubricants like kerosene or paraffin and smooth ragged edges with a file. Clamp the panel to the table, cut halfway through, then turn the

panel over to finish the job. Greenlee punches are useful for making holes ranging from 1/2 to 1-1/2 inches in diameter.

Aluminum angle, 1/4-inch threaded rod and nuts, 6-32 machine screws and nuts, and no. 6 drive screws are needed and can be found at well-stocked hardware stores.

### bending aluminum

You'll need to bend the aluminum for the chassis and cabinets, something that's difficult to do with regular home tools. Take the pieces that need bending to a local sheet metal shop. Let the metal worker figure the dimensions as he knows the allowances that have to be made for proper fitting. Sometimes you can avoid making bends by using angle aluminum.

### the finished product

Figure 1 shows the skeleton frame of an assembly designed to house a linear amplifier. Note the simple construction. The front and back panels are the same size, and held together with four 1/4-inch threaded rods. To assure perfect alignment between front and back panels, clamp them together and drill holes for the 1/4-inch threaded rod through both. The meter shield has only one 90 degree bend. The side rails, chassis, and outer shell covers all have two bends. With the outer shell in place, all the necessary shielding is complete.

The chassis is open for ease of assembly. When all parts are in place, wiring is easy. Nothing is buried. Coils, switches, and capacitors are placed for efficient operation at radio frequencies. Figure 2 shows that there is no layering of parts. This makes future repairs, changes, or parts replacement easy.

Figure 3 shows a completed 1-kW linear amplifier. The outer shell is held to the side rails with no. 6 sheet metal screws. The front of the cabinet extends beyond the front panel to give a shadow box effect similar to many commercial cabinets.

This open frame construction can be still be used if you find a commercial cabinet that fits your needs. Figure 4 shows an antenna tuner for 40, 80, and 160 meters designed for open wire line. The sliding switch<sup>1</sup> and the coils<sup>2</sup> are homemade. The assembly in fig. 4 was easy to wire and slides into a commercial cabinet.

### finishing the metal work

After drilling the holes, assemble the pieces to make sure everything fits. Now disassemble and clean each surface with sandpaper (100 grit). Remove all burrs and scrub down the metal with an abrasive cleanser; now you're ready to paint. I paint only the front panel and outer shell; try making the panel one color and the outer shell another as contrasting colors enhance

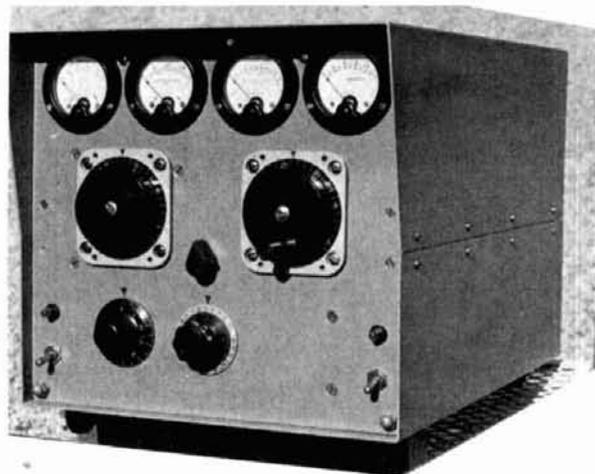


fig. 3. Here's the amplifier buttoned up and ready for action. Plenty of meters are available to monitor all circuitry. A symmetrical layout of the front panel adds to the appearance. Notice the use of surplus dial counters and meters.

the appearance. Epoxy metal spray paint does a good job.

### the final touch

Reassemble and wire all components. You need to maintain excellent contact between parts and sheet metal. Don't skimp on the number of screws; rf grounds are very important.

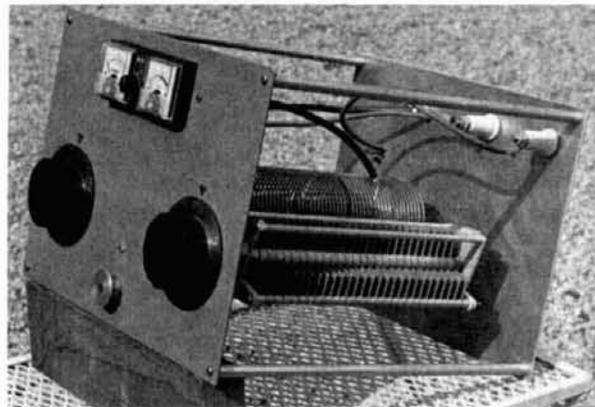


fig. 4. This tuner was housed in a commercial cabinet which had a hinged top cover to allow ready access to the tapped coil. The meters display POWER and VSWR.

I have built many of these cabinets for my friends and myself. The designs evolved over years of trying to simplify construction of homebrewed equipment. I think the finished product is very functional. Why not give it a try?

1. Johnson, Paul A., "Be Switched, Easily," *QST*, February 1983, page 18.
2. Johnson, Paul A., "Constructing Air-wound Coils," *ham radio*, August 1984, page 37.

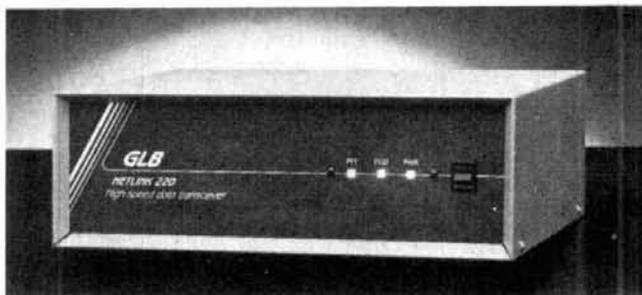
ham radio

## NEW FROM GLB

### GLB NETLINK 220 HIGH-SPEED DATA TRANSCEIVER

GLB Electronics is pleased to announce a fast digital-in, digital-out data radio, intended to further the development of the international amateur packet network.

Netlink radios are specifically intended for use in remote, unattended applications for long term service. Compatible with any digital format, they turn around (transmit to receive and receive to transmit) in less than a millisecond while holding keying transients within the channel. A digital sampling AFC tracks transmitted signals in frequency to maintain low error rates over long periods of time. In addition, they utilize crystal ovens and temperature-compensated circuitry for reliable operation at unheated sites.



#### FEATURES

- Conservative design
- Digital transparent operation
- Digital sampling AFC
- 1/2" mechanical resonator front end
- High speed squelch suppressor (DCS)
- Quasi-controlled operators
- PTT, DCD & PWR LEDs
- PIN diode antenna switching
- Transmitter time-out timer
- Compatible with TNC2 controllers
- Compatible with all applicable Sections of Part 15 FCC Rules

#### SPECIFICATIONS

- Data rate: 0 - 19,200 baud
- Data format: any format (RTTY, APRS and NRZ)
- Modulation: FSK
- Signal levels: TTL or RS232C
- Frequency: 220 to 225 MHz
- Rx bandwidth: 30 KHz
- Turnaround time: 1 ms TX
- Power output: 2 W min
- Input: 3 Amp

- Digital sensitivity: 5  $\mu$ V for 1 error in Squelch (minimum time: 1 ms)
- Spurious output: -60 dBc max
- Power: 12 VDC
- Operating temperature range: 30 to +60 degrees C
- Antenna connector: BNC
- RS232 connector: DB25S
- Dimensions: 12" x 10" x 4"
- Weight: 5 lbs 8 oz

See us at  
DAYTON  
Booth 318

Amateur net \$ 699.95  
List price \$ 799.95

MC & Visa welcome

GLB ELECTRONICS, INC.

151 Commerce Pkwy.,  
Buffalo, NY 14224  
716-675-6740 9 to 4



INTERNATIONAL MONTHLY MAGAZINE BY AND FOR ACTIVE RADIOAMATEURS

## Radiosporting

THIS IS IT! - FOR BIG GUNS & LITTLE PISTOLS

A magazine dedicated to quality and sportsmanship in amateur radio operating. Fresh, timely, practical and down to earth reading for little pistols and big guns. Written by the world's best in their fields: ON4UN, SM0AGD, LZ2CJ, VE3BMV, KH6BZF, DJ9ZB, ZS6BRZ, W1WY, N2AU, K7GCO, K4ZN, W4GF, VE3JTQ, WB4ZNH, WB9TBU, KQ2M, NS6X, W3FG, KA3B, K1PLR, N7CKD, VE3XN, AB0X, JE1CKA and others.

Includes DX News, QSL Info, 160m, 80m, 10m, 6m columns, DXpeditioning, Propagation, Awards, Contest rules and results, Traffic - Emergency, FCC News, New Products, Antennas, Technical news and articles, equipment reviews and modifications, computer programs, Radio Funnies, Club Life, RTTY, VHF/UHF, Mail Box, Classified Ads and much more in a magazine format with the speed of a bulletin.

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

"Your publication is superb! Keep it up!" Joe Reisert, W1JR

"Your W2PV articles are priceless. Your magazine is super!"

Rush Drake, W7RM

"Let me congratulate you on a very impressive magazine. Just what I've been looking for as a DXer and Contester!"

Dick Moen, N7RO

"RADIOSPORTING, once received, cannot be tossed aside until it is read from cover to cover. Then reviewed again and again."

Chas Browning, W4PKA

Subscription rates: 1 year USA \$18, Canada CD\$26, Overseas US\$23; 2 years \$33, \$48, \$42 respectively. Single issue \$2. USA First Class Mail add \$8/year, DX Air Mail add \$15/year.

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

RADIOSPORTING Magazine

PO Box 282, Pine Brook, NJ 07058, USA



# automatically switched half-octave filters: part 2

Modular approach  
facilitates construction,  
improves performance

In part one,\* we discussed the low-pass and band-pass requirements for multi-octave transmitters and receivers. They differ considerably from the ones needed for narrowband applications like those in Amateur equipment with 500-kHz band coverage. We found that the best way to use filters in a multi-octave transmitter application with stringent attenuation and ripple characteristics is to select contiguous half-octave networks that will attenuate second-order and higher harmonic products while maintaining flat bandpass characteristics (fig. 1).

We discussed the practical limitations of filter design and the tradeoffs in linear amplifier design necessary to reduce the complexity of the filters, presented an ideal filter model, and discussed how some practical filter approximations can satisfy stringent requirements better than others. Based on this knowledge, we selected the Cauer (elliptical) filter for our application, and designed bandpass and low-pass networks for a full coverage transceiver. In part 2, we will implement the low-pass filters from table 3 of part 1 in the transceiver environment. This requires additional design in the areas of rf switching and digital decoding that will have to work with the filter networks, the control system of the transceiver, and the mechanical design.

## system implementation

Because the low-pass networks must withstand high power (and high VSWR), they need to be implemented with relatively large inductors and capacitors, which will take up space in the compact transceiver.

\*Cornell Drentea, WB3JZO, and Lee R Watkins. "Automatically Switched Half Octave Filters: part 1," *ham radio*, February 1988, pages 10-32.

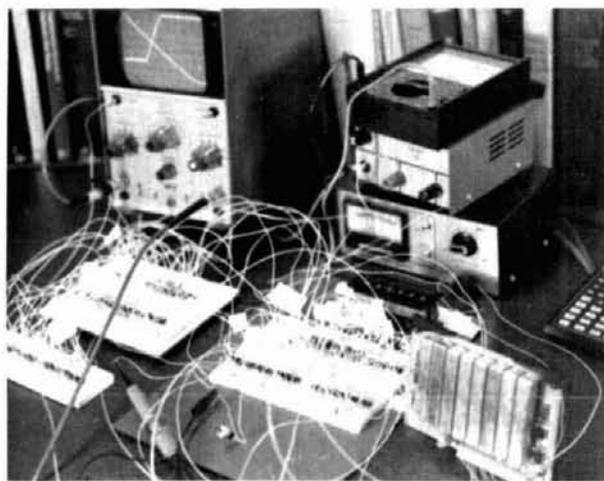


fig. 1. Breadboarding the automatic filters for the WB3JZO transceiver.

By contrast, the modular packaging of the transceiver dictates the use of small pc boards containing sensitive driving circuits and arrays of rf power relays for switching in the proper networks at the right time. This combination of rf and digital circuits could be cumbersome if not properly designed and implemented, even though we planned the networks with a minimum number of poles.

A special approach to packaging was adopted in the WB3JZO transceiver. To keep the digital circuits away from the rf, the filter networks are packaged in separate plug-in assemblies, each containing four filters (fig. 2A). The assemblies plug into pc boards containing all the digital circuitry and switching. Stainless steel containers were constructed with Teflon™ standoffs to give mechanical support to the inductors and capacitors. In addition, a set of precision-guided RCA connectors were built into the containers for quick connect/disconnect of all filters from the pc boards.

This construction proved effective in preventing the

By Cornell Drentea, WB3JZO 7140 Colorado Avenue North, Minneapolis, Minnesota 55429 and Lee R Watkins, 2256 East Jaeger Street, Mesa, Arizona 85213.

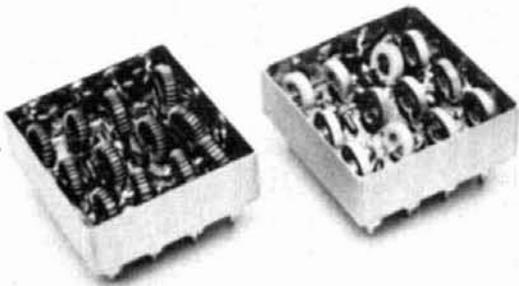


fig. 2A. Implementing the filter banks in the WB3JZO transceiver. Stainless steel containers with built-in Teflon™ stand-offs and precision guided RCA connectors allow off-board access to the filters for tuning. This packaging keeps rf out of the digital circuits.

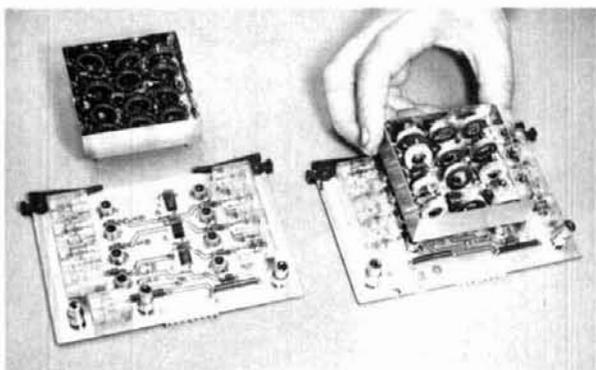


fig. 2B. Filter assemblies are easily inserted into the pc boards which in turn plug into the transceiver.

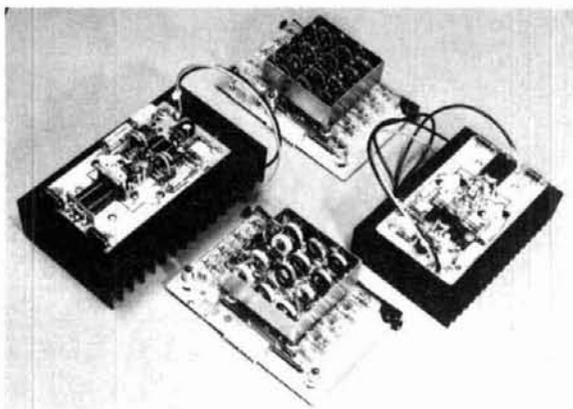


fig. 3. View of the amplifier assemblies and associated filter banks.

rf from getting into the sensitive digital circuitry on the pc boards under the filter assemblies. High-power rf switching relays, associated striplines, and rf connectors were built into the boards. The separate rf tuning and pc boards allow independent rf tuning and

digital testing of the networks and their switching. Each bank of filters can be plugged or unplugged from the pc boards (fig. 2B). Two board assemblies are required for the eight low-pass filters. Only one board is needed to accommodate the bandpass filter bank, since the size of the parts for these filters permits miniaturization.

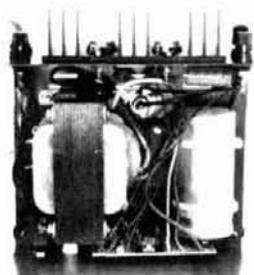
Many other design goals were considered. An opto-encoded digital count up/down circuit on the digital interface command board (DBIC) at the front of the transceiver provides decoding for all filter banks, and works in conjunction with two other interface boards. The frequency word logic board (FWLB) lets the operator dial up any frequency from the transceiver's front panel and the frequency mode display board (FMDB) serves as digital display feedback. The high-gain (39 dB) linear amplifier chain and the low-pass filter banks are shown in fig. 3.

The system is implemented modularly and connected via ribbon cables and motherboard layout to decode and communicate information to the proper automatically selected filters. The rf paths are joined by RG-174/U and RG-58/U coaxial cables, depending on rf power requirements. Digital information is transmitted to the synthesizer as corrected by the i-f value and CW shift. Several other functions were incorporated: power-up memory for the "mode" mechanism, ensuring that the transceiver always starts up in upper sideband; alpha-numeric display circuits with electronic band edge stops at 2 and 30 MHz, to prevent operation outside the range; various sequencing and delay circuits that work in conjunction with the synthesizer; and AGC command functions, thumb-wheel encoding circuits, and a multiple-tone alert system working in the receiver's audio section. Figure 4A shows all significant digital assemblies and the filter banks prior to final transceiver packaging; figs. 4B and 4C show their incorporation in the transceiver.

### building the filters

Next, we will see how the low-pass filters from table 3 of part 1 were constructed. First, precision inductors were devised for all values from the table. We used commercial Micrometals™ T-68 toroid cores — red mix No. 2 for the lower frequency banks and yellow mix No. 6 for the higher frequencies. The number of turns ( $N_2$ ) was calculated using the equations listed in table 1. The final inductance adjustments were made with the setup shown in fig. 5.

By placing a precision silver mica capacitor of known value across each of the inductors and using a grid dip meter and digital frequency counter to measure the resonance of the circuit, the value of L was calculated with the equations shown in table 2. The counter measured the frequency of the grid dip meter's oscillator at the precise resonance point. The



INSIDE VIEW — RS-12A

## ASTRON POWER SUPPLIES

• HEAVY DUTY • HIGH QUALITY • RUGGED • RELIABLE •

### SPECIAL FEATURES

- SOLID STATE ELECTRONICALLY REGULATED
- FOLD-BACK CURRENT LIMITING Protects Power Supply from excessive current & continuous shorted output
- CROWBAR OVER VOLTAGE PROTECTION on all Models except RS-3A, RS-4A, RS-5A.
- MAINTAIN REGULATION & LOW RIPPLE at low line input Voltage
- HEAVY DUTY HEAT SINK • CHASSIS MOUNT FUSE
- THREE CONDUCTOR POWER CORD
- ONE YEAR WARRANTY • MADE IN U.S.A.

### PERFORMANCE SPECIFICATIONS

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



MODEL RS-50A



MODEL RS-50M



MODEL VS-50M

### RM SERIES



MODEL RM-35M

### 19" x 5 1/4" RACK MOUNT POWER SUPPLIES

MODEL	Continuous Duty (Amps)	ICS* (Amps)	Size (IN) H x W x D	Shipping Wt. (lbs.)
RM-12A	9	12	5 1/4 x 19 x 8 1/4	16
RM-35A	25	35	5 1/4 x 19 x 12 1/2	38
RM-50A	37	50	5 1/4 x 19 x 12 1/2	50
• Separate Volt and Amp Meters				
RM-12M	9	12	5 1/4 x 19 x 8 1/4	16
RM-35M	25	35	5 1/4 x 19 x 12 1/2	38
RM-50M	37	50	5 1/4 x 19 x 12 1/2	50

### RS-A SERIES



MODEL RS-7A

MODEL	Continuous Duty (Amps)	ICS* (Amps)	Size (IN) H x W x D	Shipping Wt. (lbs.)
RS-3A	2.5	3	3 x 4 1/4 x 5 1/4	4
RS-4A	3	4	3 1/4 x 6 1/2 x 9	5
RS-5A	4	5	3 1/2 x 6 1/2 x 7 1/4	7
RS-7A	5	7	3 3/4 x 6 1/2 x 9	9
RS-7B	5	7	4 x 7 1/2 x 10 3/4	10
RS-10A	7.5	10	4 x 7 1/2 x 10 3/4	11
RS-12A	9	12	4 1/2 x 8 x 9	13
RS-12B	9	12	4 x 7 1/2 x 10 3/4	13
RS-20A	16	20	5 x 9 x 10 1/2	18
RS-35A	25	35	5 x 11 x 11	27
RS-50A	37	50	6 x 13 1/4 x 11	46

### RS-M SERIES



MODEL RS-35M

MODEL	Continuous Duty (Amps)	ICS* (Amps)	Size (IN) H x W x D	Shipping Wt. (lbs.)
RS-12M	9	12	4 1/2 x 8 x 9	13
RS-20M	16	20	5 x 9 x 10 1/2	18
RS-35M	25	35	5 x 11 x 11	27
RS-50M	37	50	6 x 13 1/4 x 11	46

### VS-M AND VRM-M SERIES



MODEL VS-35M

MODEL	Continuous Duty (Amps)			ICS* (Amps)	Size (IN) H x W x D	Shipping Wt. (lbs.)
	@13.8VDC	@10VDC	@5VDC	@13.8V		
VS-12M	9	5	2	12	4 1/2 x 8 x 9	13
VS-20M	16	9	4	20	5 x 9 x 10 1/2	20
VS-35M	25	15	7	35	5 x 11 x 11	29
VS-50M	37	22	10	50	6 x 13 1/4 x 11	46
• Variable rack mount power supplies						
VRM-35M	25	15	7	35	5 1/4 x 19 x 12 1/2	38
VRM-50M	37	22	10	50	5 1/4 x 19 x 12 1/2	50

### RS-S SERIES



MODEL RS-12S

MODEL	Continuous Duty (Amps)	ICS* (Amps)	Size (IN) H x W x D	Shipping Wt. (lbs.)
RS-7S	5	7	4 x 7 1/2 x 10 3/4	10
RS-10S	7.5	10	4 x 7 1/2 x 10 3/4	12
RS-12S	9	12	4 1/2 x 8 x 9	13
RS-20S	16	20	5 x 9 x 10 1/2	18

Send for a FREE copy of our NEW 52 page CATALOG

★QUALITY PARTS ★DISCOUNT PRICES ★FAST SHIPPING!

# ALL ELECTRONICS CORP.

## TRANSFORMERS

**5.6 VOLT - 750ma**  
CAT# TX-56 \$3.00

**12 V.C.T. - 1 amp**  
CAT# TX-121 \$4.00

**12 V.C.T. - 2 amp**  
CAT# TX-122 \$4.85

**12 V.C.T. - 4 amp**  
CAT# TX-124 \$7.00

**18 VOLT - 650 ma**  
CAT# TX-186 \$2.00  
10 for \$17.50

**24 V.C.T. - 1 amp**  
CAT# TX-241 \$4.85

**24 V.C.T. - 2 amp**  
CAT# TX-242 \$6.75

**24 V.C.T. - 3 amp**  
CAT# TX-243 \$9.50

**24 V.C.T. - 4 amp**  
CAT# TX-244 \$11.00

## LED'S

**STANDARD JUMBO**  
DIFFUSED  
T: 1-3/4 size

RED: 10 for \$1.50 • 100 for \$13.00  
CAT# LED-1 1000 for \$110.00

GREEN 10 for \$2.00  
CAT# LED-2 100 for \$17.00  
1000 for \$150.00

YELLOW 10 for \$2.00  
CAT# LED-3 100 for \$17.00  
1000 for \$150.00

## FLASHING LED

with built in flashing circuit operates on 5 volts.

RED \$1.00 each  
CAT# LED-4 10 for \$9.50

GREEN \$1.00 each  
CAT# LED-4G 10 for \$9.50

## LED HOLDER

Two piece holder:  
CAT# HLD-1 10 for \$5.00

**CLIP-LITE LED HOLDER**  
Makes a LED look like a fancy indicator. Fits T: 1-3/4 size LED.

CLEAR CAT# HLDCL-C  
RED CAT# HLDCL-R  
GREEN CAT# HLDCL-G  
YELLOW CAT# HLDCL-Y  
4 for \$1.00

## SWITCHES

**MINIATURE TOGGLE SWITCHES**  
all rated 5 Amps

**S.P.D.T. (on-on)**  
Non threaded bushing  
P.C. mount  
CAT# MTS-40PC 75c each  
10 for \$7.00

**D.P.D.T. (on-on)**  
Solder lug terminals  
CAT# MTS-8 \$2.00 each  
10 for \$19.00

**MINI PUSH BUTTON**  
S.P.S.T. momentary  
Push to make 1/4" threaded bushing  
Red button  
CAT# MPB-1 35c each • 10 for \$3.25

## 13.8 VDC REGULATED POWER SUPPLY

Solid state, fully regulated 13.8 Vdc power supplies. Both feature 100% solid state construction, fuse protection and LED power indicator. UL listed.

2 AMP CONSTANT, 4 AMP SURGE  
CAT# DVP-412 \$22.50 each

3 AMP CONSTANT, 5 AMP SURGE  
CAT# DVP-512 \$30.00 each

## COMPUTER GRADE CAPACITORS

1400 MFD 200 VDC  
7" dia X 3 7/8" high  
CAT# CG-1420 \$2.00

7500 MFD 200 VDC  
7" dia X 5 3/4" high  
CAT# CG-75 \$4.00

22000 MFD 25 VDC  
7" dia X 4 3/4" high  
CAT# CG-22 \$2.50

## SWITCHING POWER SUPPLY

Compact, well regulated switching power supply designed to power Texas Instruments computer equipment. INPUT: 114.25 Vdc @ 1 amp  
OUTPUT: -12 Vdc @ 350 ma • -5 Vdc @ 1/2 amp • 5 Vdc @ 200 ma  
SIZE: 4.34" square  
Includes 18 Vac @ 1 amp wall transformer designed for this power supply.  
CAT# PS-TX \$5.00 per set  
10 for \$45.00

## BATTERY AND CHARGER SET

Two rechargeable 6 Volt 9.5 Amp Hr gel cell batteries and a charger to charge both batteries at the same time. Batteries measure 2.34" X 5.12" high. Ideal as a 6 or 12 Volt D.C. back-up system.  
CAT# AH-695 \$35.00 per set

## A/B SWITCH

JVC# PUS3593-2  
High quality A/B switch. 75 OHMS IN/OUT. Measures: 3.34" X 1.716" X 1".  
CAT# ABS-2 \$3.50 each

## BLACKLIGHT ASSEMBLY

Complete, functioning assembly including ballast, on-off switch, power cord sockets and F4T5-BL blacklight. Mounted on a 7.18" X 3.18" metal plate. Use for special effects lighting or erasing EPROMS.  
CAT# BLTA \$10.00 each

## RELAYS

12 VDC 4PDT  
P.C. mount  
5 amp contacts  
150 ohm coil. Size: 1 1/4" X 1 3/4" X 7/8"  
CAT# 4PRLY-12PC \$3.50 each

10 AMP SOLID STATE RELAY  
Control: 3 3/2 Vdc, 2 1/2" X 3 1/4" X 7/8"  
CAT# SSRLY-10A \$9.50 ea. 10 for \$85.00  
\$1.50 ea. • 10 for \$12.50

## VIC 20 MOTHERBOARD

26 IC's including 85C20A and 6560. Not guaranteed but great for replacement parts or experimentation.  
CAT# VIC-20 \$15.00 each

## PUSHBUTTON PHONE

Spectra phone Model OP-1 1 piece telephone with rotary (pulse) output. Operates on most rotary or touch tone systems. Features last minute redial and mute button. Includes coil cord with standard modular plug IVORY.  
CAT# PHN-1 \$6.50 each  
2 for \$15.00

## 48 KEY ASSEMBLY

NEW T1 KEYBOARDS  
Originally used on computers, these keyboards contain 48 S.P.S.T. mechanical switches. Terminates to 15 pin connector. Frame size 4" X 9".  
CAT# KP-48 \$3.50 each

## POLARITY SWITCH

Designed to control an external coaxial relay on a satellite tv system. Ideal for parts. Contains a 5 Vdc relay and many other parts on a P.C. board.  
CAT# RPS \$1.75 each • 10 for \$15.00

## SOUND EFFECTS BOARD

P.C. board with 2 1/4" speaker, 2 LED's, IC battery snap, other components. 2.38" X 3". When switch is pulled board beeps and LED's light. Operates on a 9 volt battery (not included).  
CAT# ST-3 \$1.25 each

## NICKEL-CAD CHARGER/TESTER

Will charge most nickel-cad batteries even button & N size.  
CAT# UNCC-N \$15.00

## THIRD TAIL LIGHT

Deep, high tech lamp assembly. Could be used as a third auto tail light, emergency warning light, or special effects lamp. Red reflective lens is 2.34" X 5.12" mounted on a 4" high pedestal with up/down swivel adjustment. Includes 12 V replaceable bulb.  
CAT# TLB \$3.95 each

## WALL TRANSFORMER

11.5 Vdc 1.95 AMP  
Input: 120 Vac  
Size: 3.34" X 2.78" X 2.58"  
CAT# DCTX-11519 \$6.50 each

## LIGHT ACTIVATED MOTION SENSOR

This device contains a photo cell which senses sudden change in ambient light. Could be used as a door annunciator or modified to trigger other devices. 5.12" X 4" X 1". Operates on 6 Vdc. Requires 4 AA batteries (not included).  
CAT# LSMD \$5.75 per unit.

## TRANSISTORS

2N2222A 3 for \$1.00  
PN2222A 10 for \$1.50  
2N2904 3 for \$1.00  
2N2905 3 for \$1.00  
2N3055 \$1.00 each  
PN3569 10 for \$1.50  
2N4400 10 for \$1.50

## RECHARGEABLE NICKEL-CAD BATTERIES

AAA SIZE 1.25V 180mAh \$2.25  
AA SIZE 1.25V 500mAh \$2.00  
AA with solder tabs \$2.20  
C SIZE 1.2 V 1200mAh \$4.25  
SUB C with solder tabs \$4.25  
D SIZE 1.2V 1200mAh \$4.25

## XENON FLASH TUBE

3 1/4" X 1 1/8" dia  
CAT# FLT-1 2 for \$1.00

## SOUND & VIDEO MODULATOR

T# UM1381-1  
Designed for use with T1 computers. Can be used with video camera, games, or other audio/video sources. Built in A/B switch enables user to switch from T.V. antenna without disconnection. Operates on channel 3 or 4. Requires 12 Vdc. Hook up diagram included.  
CAT# AVMOD \$5.00 each

## 6-12 VDC MOTOR

Matsub# RS 5505  
Permanent magnet motor. 1 7/16" dia X 2 1/4" long. 2600 RPM @ 6 V. 5300 RPM @ 12 Vdc.  
CAT# DCM-7 \$3.00 each

## BRIDGE RECTIFIER

10 AMP 200 PIV  
5 8" square  
CAT# FB-1020 \$1.00 each • 10 for \$9.00

## STORES:

LOS ANGELES  
906 S. VERNON AVE.  
LOS ANGELES, CA 90006  
(213) 380-4000

VAN NUYS  
6228 SEPULVEDA BLVD  
VAN NUYS, CA 91411  
(818) 997-1806

## MAIL ORDERS TO:

ALL ELECTRONICS  
P.O. BOX 567  
VAN NUYS, CA  
91408

## TELEX \$10101613

(ALL ELECTRONIC) CUSTOMERS  
OUTSIDE OF THE U.S.  
SEND \$1.50 POSTAGE FOR CATALOG

## TOLL FREE

800-826-5432  
INFO (818) 904-0524  
FAX (818) 781-2653



## R-7000 Widespan Panadaptor

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

## GTI Electronics

RD 1 BOX 272  
Leighton, Pa. 18235  
717-386-4032

# SPECIALISTS IN FAST TURN P.C. BOARDS

## PROTO TYPE P.C. BOARDS AS LOW AS \$25.00

- SINGLE & DOUBLE SIDED
- PLATE THROUGH HOLES
- TEFLON AVAILABLE
- P.C. DESIGN SERVICES

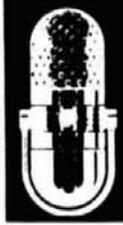
FOR MORE INFORMATION



34374 EAST FRONTAGE ROAD  
BOZEMAN, MT 59715 (406) 586-1190

# YOU . . Make It Happen

# ON THE AIR



## TRAIN TO BE A RADIO or T.V. ANNOUNCER

### AMAZING SECRETS REVEALED

On the job training at Local Stations in your area. Keep your present job, train around your own schedule. No experience required. Tuition free. Call THE RADIO CONNECTION for free brochure!!!  
Toll Free 1-800-541-0900

## A better way to design and analyze Long wires, Vee's, and Rhombics.



## LONG WIRE PRO

Easy to use, menu driven, select wire length, height, frequency, ground type, and get a color coded sinusoidal projection of your HF antenna. For the IBM PC and compatibles, DOS 2.0 or higher, 256K, color required.

Price \$35.00

EPSILON CO  
Box 715, Trumbull CT, 06611, (203) 261-7694

**Table 1. Equation used to calculate the number of turns ( $N_2$ ).**

$$\frac{L_1}{|N_1|^2} = \frac{L_2}{|N_2|^2} \quad \text{Eqn. 1}$$

$$L_1|N_2|^2 = L_2|N_1|^2 \quad \text{Eqn. 2}$$

$$|N_2|^2 = \frac{L_2|N_1|^2}{L_1} \quad \text{Eqn. 3}$$

$$N_2 = \sqrt{\frac{L_2|N_1|^2}{L_1}} \quad \text{Eqn. 4}$$

Where:

- $N_2$  = Required number of turns
- $L_1$  = Known inductance per 100 turns\*
- $L_2$  = Known required inductance
- $N_1$  = 100

\*Values of  $L_1$  from tables

- T68-2 = 55  $\mu\text{H}$
- T68-6 = 47  $\mu\text{H}$

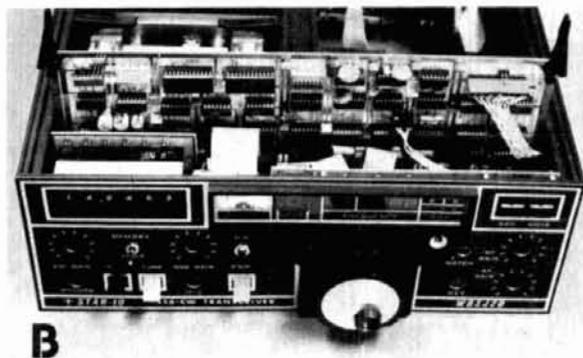
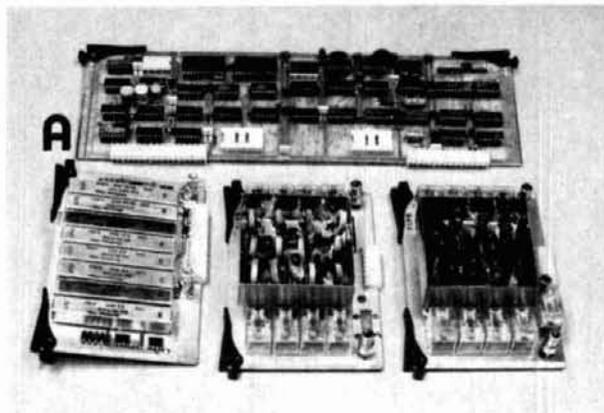
**Table 2. Equation used to calculate the value of L.**

$$L = \frac{25330}{(F^2 C)} \quad \text{Eqn. 5} \quad C = \frac{25330}{(F^2 L)} \quad \text{Eqn. 6}$$

Example: If  $C = 107.6$ ,  $L = 3.40 \mu\text{H}$   
 To resonate at 8.316 MHz  
 (from filter no. 1, Table 3 (from part 1)).

numbers were entered into a TI-59 calculator programmed to solve for L or C according to the equations. This semiautomated process allowed quick, consistent, error-free calculations, making measurements for all the inductors easy. The setup worked well for all cases. Adjustments were made to the coils by pushing or spreading the windings a bit. The same procedure was used to obtain practical combinations of capacitor values approaching the theoretical values prescribed in **table 3** of part 1. In this case, the equation was solved for C rather than L (**table 2**). The parts were then soldered into the containers, using RCA connectors and Teflon standoffs as mechanical supports. The filters were then tuned for theoretical peaks with a Collins R-392 receiver used as a spectrum analyzer. We later used an HP-8754 network analyzer to complete the job.

**Figure 6** shows the composite frequency response of the finished low-pass filters as plotted with the



**fig. 4. (A)** View of significant assemblies associated with the implementation of the filters. Shown are all filter banks and the digital interface command board (DBIC). **(B)** and **(C)** Views of all digital boards and filter assemblies as packaged in the transceiver. In addition to the boards and visible behind the front panel are the frequency word logic board (FWLB) and the frequency mode display board (FMDB). All boards are interconnected via continuous ribbon cables equipped with press-on connectors.



fig. 5. Setup used to speed up the inductance measurement process. The toroidal coil under test was paralleled by a known precision silver mica capacitor. The exact frequency of the circuit was read with a digital counter which measured the frequency of rf generated by the grid dip meter at resonance. All numbers were inputted to the TI-59 programmable calculator which resolved the equation for L or C.

analyzer. Little work was needed to bring the filters within the design specifications. We also performed spectrum analyzer tests (fig. 7).

### communication and decoding mechanism

The schematic diagram of the low-pass assemblies, and their switching mechanism, are shown in fig. 8A. Figure 8B shows the implementation of the bandpass banks with their corresponding switching. Some of the functions included here are filter switching with associated driving circuits, transmit/receive (T/R) switching, and the transmitter gain control (TGC) sensory circuit. Next, we will discuss the communication and decoding mechanism.

We decided early in the design that digital communications in the transceiver would be performed with parallel low-true TTL levels for good noise immunity in the presence of an rf field. This meant that the TTL lines would be terminated on the destination boards with 75451 line drivers, normally used in computer communications hardware. These devices deliver up to 400 milliamperes of current at 5 volts and can drive relays directly. They have been used throughout the system, in the control circuits, as relay drivers for all filter boards, and as power switches for muting the

receiver's i-f section. The 75451 is an integrated circuit containing two drivers and associated TTL logic. Two of these were used per filter board (fig. 8). Reverse-biased silicon diodes on the coils eliminated voltage transients that occur when current is interrupted.

The rf relays were standard parts chosen for their reliability and low cost (evidenced by their use in commercial maritime transceivers). Small Teledyne rf relays were used for the bandpass bank. The design lets only one filter be switched in at any given time, eliminating possible interaction between the selected filter and adjacent devices. During selection, all other filters are shorted to ground at the input and output; this is done by taking advantage of the natural resting position of

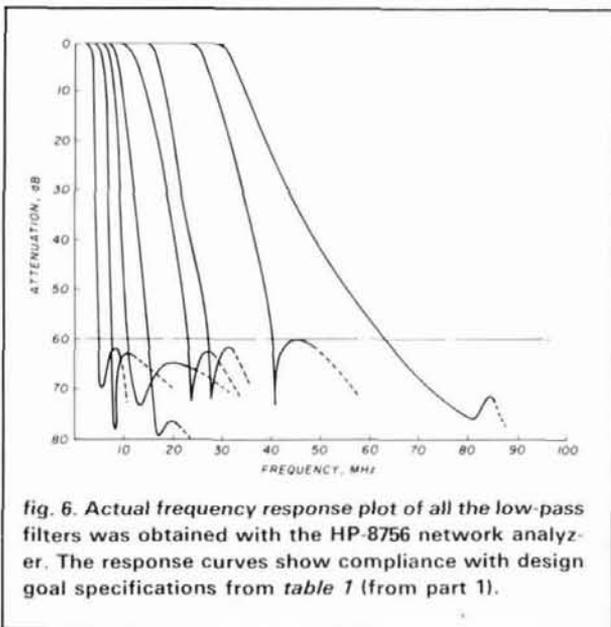


fig. 6. Actual frequency response plot of all the low-pass filters was obtained with the HP-8756 network analyzer. The response curves show compliance with design goal specifications from table 1 (from part 1).

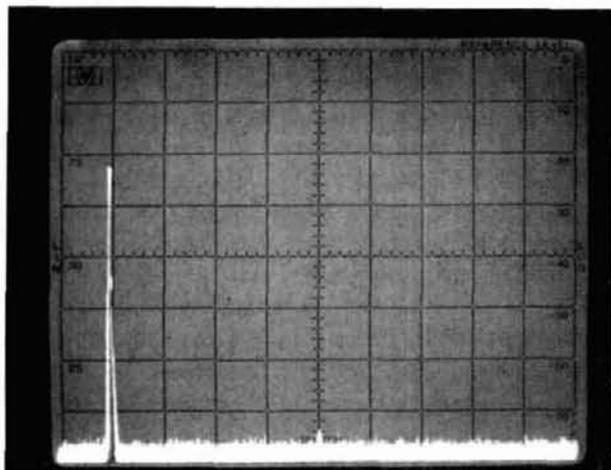


fig. 7. Typical worst-case spectrum analyzer test shows that harmonics are at least 50 dB below the carrier. Filter No. 4 was used in this example. Similar results are obtained with the other low-pass filters.



## THE FUTURE OF AMATEUR COMMUNICATIONS

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

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



**Unique Spectrum Scope.** Continuously indicates all signal activities and DX pileups with your operating frequency in the center. Selectable horizontal frequency spans of

$\pm 50$ ,  $\pm 100$ , and  $\pm 200$  kHz for each side of the frequency you're listening to. Vertical range indicates relative signal strengths. A contesteer's dream!



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

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

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

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

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

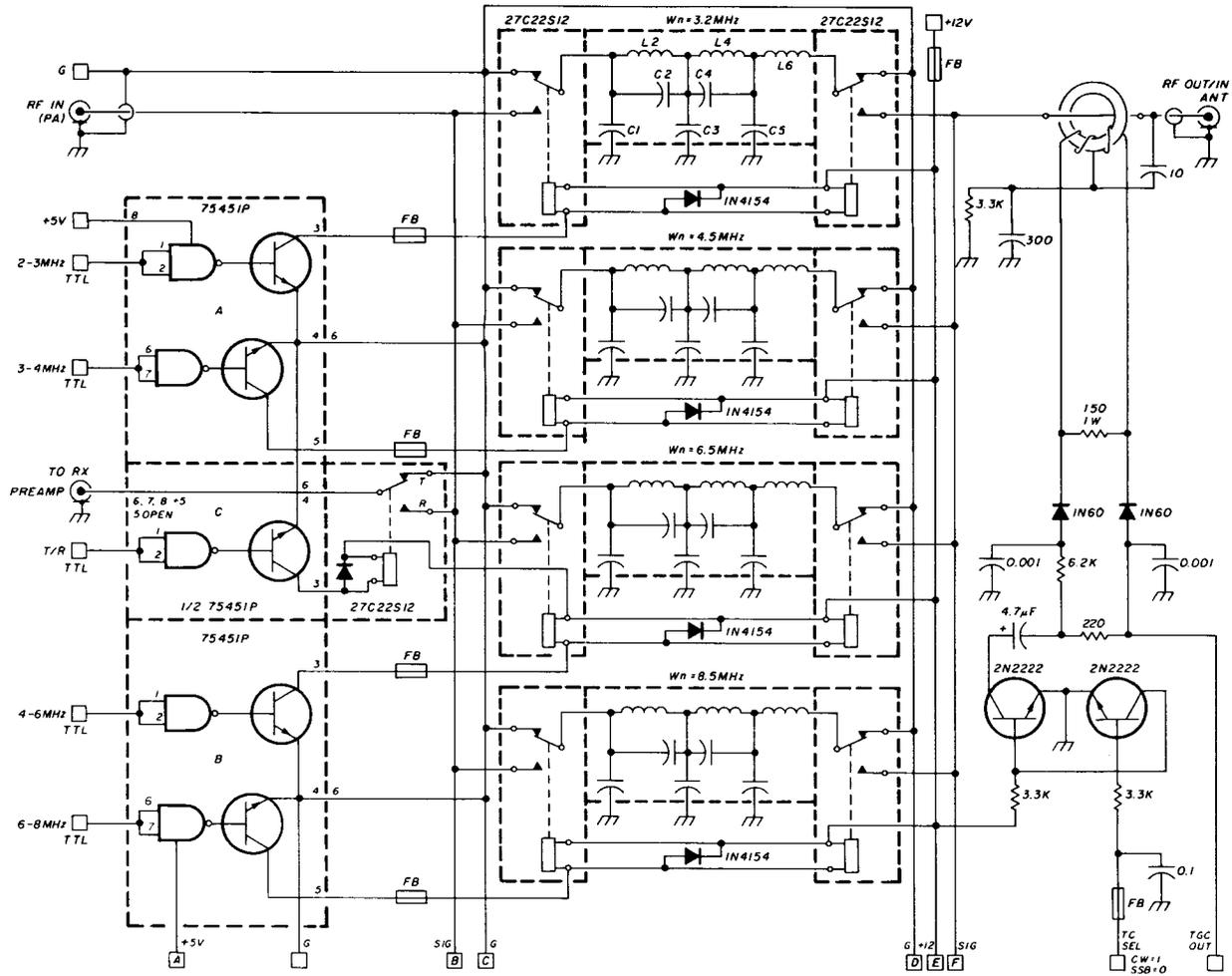
**A Total Communications System!** Includes built-in 100% duty AC supply, high speed automatic antenna tuner, iambic keyer, semi-automatic or full QSK CW break-in to 60 wpm, Audio Peaking Filter (APF), RF speech processor, multiscanning, 105dB dynamic range, all-band/all-mode receiver with general coverage,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

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

See the IC-781 at your local ICOM dealer.

# ICOM

Icom America, Inc.  
 2380 116th Avenue N.E., Bellevue, WA 98004  
**Customer Service Hotline (206) 454-7619**  
 3150 Premier Drive, Suite 126, Irving, TX 75063  
 1777 Phoenix Parkway, Suite 201, Atlanta, GA 30349  
 ICOM CANADA, A Division of ICOM America, Inc.,  
 3071 - #5 Road, Unit 9, Richmond, B.C. V6X 2T4  
 All stated specifications subject to change without notice or obligation. All ICOM radios significantly exceed FCC regulations limiting spurious emissions. 781187.



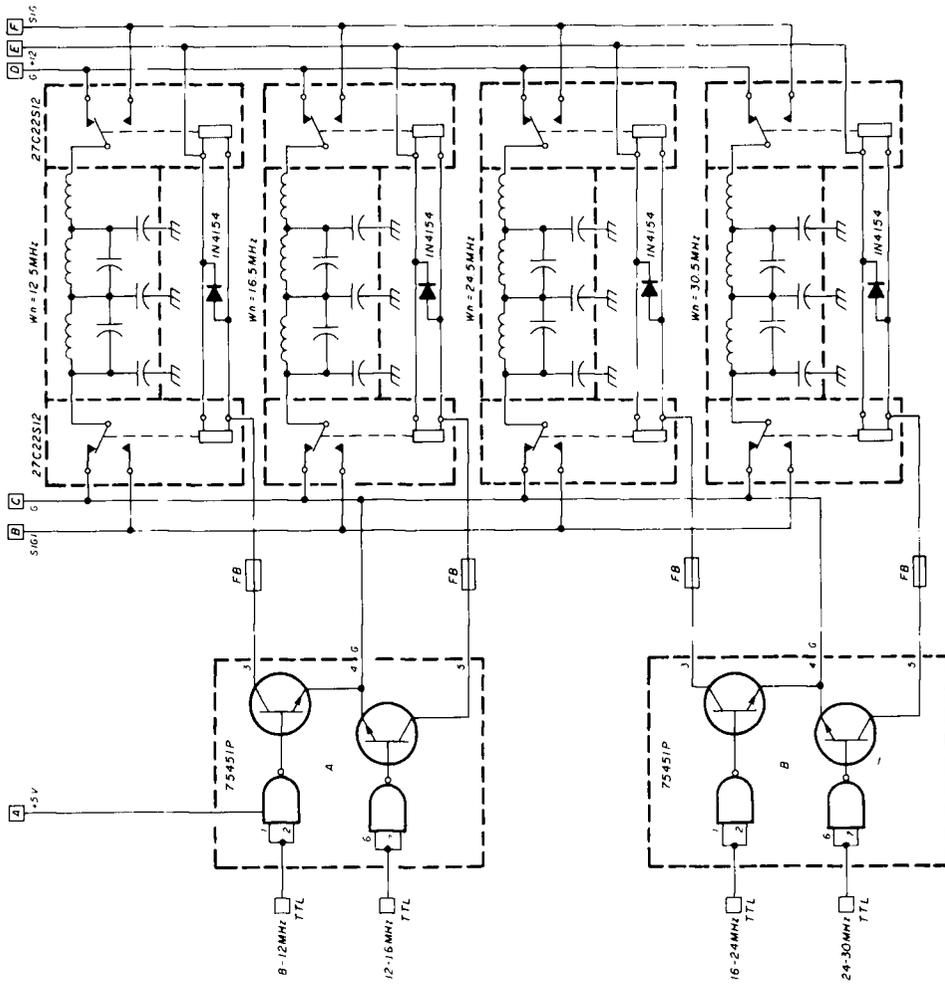


fig. 8A. Schematic diagram of the switching mechanism for the low-pass assemblies.

# AMATEUR TELEVISION



## KPA5 1 WATT 70 CM ATV TRANSMITTER BOARD

- APPLICATIONS:** Cordless portable TV camera for races & other public service events, remote VCR, etc. Remote control of R/C airplanes or robots. Show home video tapes, computer programs, repeat SSTV to local ATVs. DX depends on antennas and terrain typ. 1 to 40 miles.
- FULL COLOR VIDEO & SOUND** on one small 3.25x4" board.
- RUNS ON EXTERNAL 13.8 VDC** at 300 ma supply or battery.
- TUNED WITH ONE CRYSTAL** on 426.25, 434.0, or 439.25 mHz.
- 2 AUDIO INPUTS** for a low Z dynamic and line level audio input found in most portable color cameras, VCRs, or home computers.
- APPLICATION NOTES & schematic** supplied for typical external connections, packaging, and system operation.
- PRICE ONLY \$159** delivered via UPS surface in the USA. Technician class amateur license or higher required for purchase and operation.

238

**WHAT IS REQUIRED FOR A COMPLETE OPERATING SYSTEM?** A TV set with a TVC-2 or TVC-4 420-450 mHz to channel 3 downconverter, 70 cm antenna, and coax cable to receive. Package up the KPA5, add 12 to 14 vdc, antenna, and any TV camera, VCR, or computer with a composite video output. Simple, eh?

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

**TERMS:** Visa, Mastercard, or cash only UPS COD by telephone or mail. Telephone orders & postal MO usually shipped within 2 days, all other checks must clear before shipment. Transmitting equipment sold only to licensed amateurs verified in 1984 Callbook. Calif. include sales tax.

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

**P.C. ELECTRONICS**

Tom W6ORG Maryann WB6YSS

2522 Paxson Lane  
Arcadia CA 91006

### \*\*\* Super Comshack 64 \*\*\*

Programmable Repeater Controller/HF & VHF Remotes/Autopatch  
Rotor Control/Voice/CTCSS; 2 Tone Paging/User Logging/Unlimited Vocabulary

**REMOTE #1** CS645 \* HMI \* CART \* CS8 \* BASE TX/RX  
FT75/76/7980  
15440/940, IC735

**REMOTE #2**  
F172R/767, TS711/811

**REPEATER CONTROLLER**  
\* Change all variables remotely  
\* Synthesized voice adj pitch/speed  
\* Program mail box or select ID tail mess. with touchtones from HT  
\* Alarm clock & auto excite mode  
\* Macro commands/user logging  
\* Individual user access codes  
\* Code practice & voice readback  
\* Multifunction voice alarm clock

**H.F. REMOTE #1**  
\* 20 Macro mem./auto mode sel  
\* Scan up/down sel. rate or step  
\* Voice lock all control commands

**AUTOPATCH & REVERSE PATCH**  
\* 1000 (18 digit) tel. #'s stored  
\* 300 users/CTCSS & 2 tone paging  
\* 50 enable/disable tel. #'s  
\* Individual access privileges  
\* Directed/general & reverse page  
\* Full or Half duplex (level cont.)  
\* Security mode/TT readback on/off  
\* Store MCI/Sprint tel. #'s  
\* Reverse Patch active all modes  
\* Call waiting/quick dial & reset

**Y.H.F. REMOTE #2**  
\* Dual VFO's/Rev/Split/CDR detect  
\* Set Scan inc. & offset/ver. resume

**MINI (BEAR CAT) COMPUTER CONTROL FT-727R**  
Programs and Scans 100 ch. in Ham/General coverage. Converts HT into a power full 100 ch. scanner & programs all for field use!  
\* Digital "S" meter, stops scan from S(1-9), Auto resume  
\* Loads & programs all FT-727R parameters, in less than 15 secs.  
\* Includes hardware & disk for C64 or IBM PC. MODEL 727S \$39.95

**12v C64 SWITCHER**  
\* Draws 1.1A @ 12v  
\* 70kHz 75% efficient  
\* Outputs 5v @ 2 amps and 9 vac 60Hz  
\* Crystal time base  
\* Plugs into C64 power  
MODEL DCPS \$119.95

**Touchtone 4 Digit Decoder & on/off latch with all 16 Digits**  
\* Expandable Repeater on/off control  
\* Low power CMOS +5 to +12 Volts  
\* User programmable 50,000, 4 digit codes  
\* Send code once to turn on, again to turn off  
\* Momentary & Latch output drives relay  
\* Wrong digit reset, no falsing, 2 to 4 digits  
\* Mute speaker auto until call is received  
\* LED displays latch state, Optional 4 digit extra custom latch, (7225) IC's \$6.95 ea  
\* Model T50 \$59.95

**"Audio Blaster" IC02/04, 2A1, U16, FT209/727, 23/73R**  
Module installs inside the radio in 15 Min. Boost audio to 1 watt! Low standby drain/Corrects low audio/1000's of happy users. Miniature audio amplifier...  
Used by Police, fire, Emergency, when it needs to be HEARD!  
Wow! that's loud now!!! You can hear everything!  
NOW FOR FT727/23R ORDER MODEL AB1-S \$22.95  
MODEL AB1 \$19.95

**ENGINEERING CONSULTING 583 CANDLEWOOD ST. BREA, CA. 92621**  
MASTERCARD - VISA - CHECK - M.O. - CA. RES. ADD \$6. TEL: 714-671-2009



Hey LOOK!

Your Friends have been talking!

# The Secret's Out!



CTM is the ham radio and computer magazine with that "down home flavor", dedicated to the practical aspects of Amateur Communications. Just starting out? You'll find our well-illustrated tutorials friendly and open; we show you how. If your interest is in High Tech, you'll find reviews and user reports of the latest thing to come down the pike and they are written so you can understand them too! If your interest is in training, you'll find articles for ham radio, computers and emergency communications.



\$18. year U.S. - 6 Months \$10.  
Mexico & Canada \$32. year  
Other Countries (air) \$68. (Surface) \$43.

There is always time for some friendly fun that you don't need a license to enjoy — and appreciate... Are you into Packet Radio? Thinking about it? Then you definitely need CTM! During 1987 we had 65 packet and packet related articles and that doesn't even count the other HAM articles or the many Computer articles. The other four ham magazines\* only had 26 packet articles during 1987. There's something for everyone in CTM! Jump right in, you'll find the natives friendly — and helpful, too!

You'll find it ALL in CTM

VISA Add 5% for credit cards MasterCard

Name: \_\_\_\_\_  
Call Sign: \_\_\_\_\_  
Address: \_\_\_\_\_  
City: \_\_\_\_\_ ST \_\_\_\_\_ ZIP \_\_\_\_\_  
Phone No. (\_\_\_\_) \_\_\_\_\_

CTM Magazine  
Circulation Manager  
1704 Sam Drive  
Birmingham, AL 35235  
(205) 854-0271

\*CQ™ 5 articles; Ham Radio™ 10 articles; QST™ 5 articles and 73™ 6 articles = 26 articles for 1987 for the other ham magazines...

NOW which do you need to  
SUBSCRIBE?  
CTM of course!

237

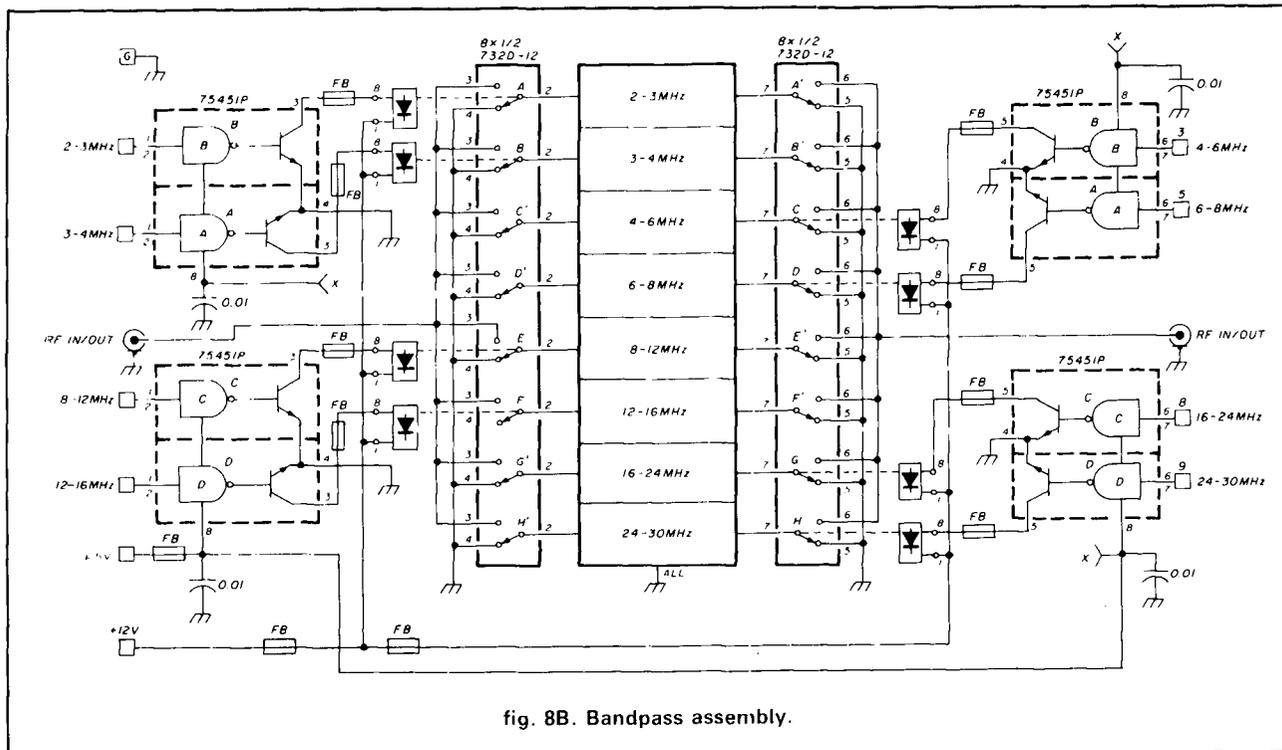


fig. 8B. Bandpass assembly.

the relay arms. We observed no stray effects between the active filter networks and adjacent coils, despite the compact packaging. Ferrite beads were used in all relay driving lines to prevent rf from getting into the dc switching circuits. Finally, all power lines were bypassed with decoupling capacitors and rf chokes and the finished product worked smoothly.

### digital intelligence

The decoding for selecting the appropriate filter networks was designed into the digital interface command board (fig. 9). When power is first applied, all logic circuits are reset via the built-in power-on strobe circuits as shown. This mutes the receiver and transmitter circuits until the synthesizer locks up on the frequency indicated by the thumbwheel switch and the dot-matrix LED display. Within a few milliseconds a short tone burst, audible through the audio amplifier of the transceiver, signals transceiver readiness. The entire transceiver then is set to the frequency indicated by the thumbwheel switch, which also controls the filter selection. The half-octave filters are automatically selected by the BCD-to-decimal decoder, which in turn activates one of the eight lines going to the filter banks (fig. 9). In addition, parallel digital data intended for the display is modified by the amount of *i-f* frequency before being sent to the synthesizer.

### final considerations

Some additional, but unrelated, circuits are shown

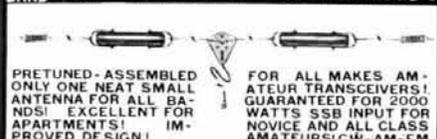
in fig. 9. In the WB3JZO transceiver, mode selection is made automatically at power-up and is initially in the upper sideband condition. It is controlled with a push-push sequencer button located in the front of the transceiver. Selection is indicated by a large LED display, visible through the front panel, programmed to show the letters U, L, or variations of the letter C for different CW bandwidths. Similar circuits control the AGC characteristics of the receiver, and several other functions. The frequency display shows the frequency of the thumbwheel switch (which acts as a 280,000-position band switch) as soon as power is applied. The operator can then take over the frequency control manually via the optical interrupter of the transceiver over a 10-kHz range. Split operation is activated by the memory switch (fig. 9).

When the operator sets the thumbwheel switch to the chosen frequency, the 7430 NAND gate IC detects any large frequency change and resets all circuits. This mutes the transceiver for a few milliseconds until there is lock-up and the MC-4024 generates a short sequence of tones indicating that the change has been made. Any out-of-band (i.e., outside the range of 2 to 30 MHz) condition disables transmitting and receiving circuits generating a set of aural and visual alarms (audio tones and all decimal points are lit on the alphanumeric display).

### conclusion

This paper details a procedure for defining and

## ALL BAND DIPOLE TRAP ANTENNAS!



PRE-TUNED-ASSEMBLED ONLY ONE NEAT SMALL ANTENNA FOR ALL BANDS! EXCELLENT FOR APARTMENTS! IMPROVED DESIGN!

FOR ALL MAKES AMATEUR TRANSCEIVERS! GUARANTEED FOR 2000 WATTS SSB INPUT FOR NOVICE AND ALL CLASS AMATEURS! CW-AM-FM

COMPLETE with 90 ft. RG58U-52 ohm feedline, and PL259 connector, insulators, 30 ft. 300 lb. test dacron end supports, center connector with built in lightning arrester and static discharge, sealed, weatherproof, traps - 1" X 5" - wt 3 oz. Low SWR over all bands - Tuners usually NOT NEEDED! Can be used as inverted V's - slopers - in attic, on building tops or narrow lots. WORKS ON NEW WARC BANDS! The ONLY ANTENNA YOU WILL EVER NEED FOR ALL BANDS! NO BALUNS NEEDED!

160-80-40-20-15-10 -- 4 trap - 169 ft. No. 1060E... \$134.95  
80-40-20-15-10 -- 2 trap - 104 ft. - No. 998E... \$99.95  
40-20-15-10 -- 2 trap -- 54 ft. - No. 1001E... \$98.95  
20-15-10 meter - 2 trap - 26 ft. - No. 1007E... \$97.95

SEND FULL PRICE FOR PP DEL. IN USA. (Canada is \$5.00 extra for postage etc.) order using VISA - MASTER CARD - AMER. EXPRESS. Ph 1-308-236-5333 week days. We ship in 2-3 days. (Per Ck's 14 days) All antennas guaranteed for 1 year. 10 day money back trial if returned in new condition Made in USA. FREE INFO, AVAILABLE ONLY FROM WESTERN ELECTRONICS

Dept. AH Kearney, Nebraska, 68847

✓ 241

### Factory-less, jumper-less, ROM-less programming.



With the new S-COM 5K Repeater Controller, you'll be able to configure your repeater remotely — using DTMF commands. Only the 5K offers this capability for just \$189, wired and tested.

**S-COM Industries**  
P.O. Box 8921  
Fort Collins, CO 80525  
(303) 493-8316

✓ 240

## QSO PRO

### A Easy-To-Use Logbook Program For Your MS-DOS® Compatible Computer

- ★ Complete Cursor Control
- ★ Room to store complete address information
- ★ A Real-Time Log
- ★ Total QSL's by State
- ★ 900 QSO's on floppy, hard disk limited by space available



**\$39.95\***

\*Ohio resident must add 5% sales tax.

Make Checks Payable To:  
**MORLAN SOFTWARE**  
P.O. Box 2400  
East Liverpool, Ohio 43920-2400

✓ 239



**LOW-BAND DX'ING**

NEW

### LOW BAND DX'ING COMPUTER PROGRAMS

by John Devoldere, ON4UN, for Apple IIe/c, MS-DOS, Commodore C-128 Apple Macintosh and Kaypro CPM Computers

Here's a collection of 30 super programs written by ON4UN. Just about every interest or need is covered—from antenna design and optimization to general operating programs. Antenna programs include: shunt and series input L network design, feedline transformer, shunt network design. SWR calculation, plus 11 more! General Ham programs include: sunrise/sunset, great circle distances, grayline, vertical antenna design program, sunrise calendar plus 9 more! Phew. When you sit down to use these programs you'll be amazed at what you have. The best value in computer software available today. © 1986.

- UN-Apple IIe/IIc \$39.95 ea.
- UN-MS (MS-DOS) \$39.95 ea.
- UN-CPM/Kaypro \$39.95 ea.
- UN-C-128 (COMMODORE) \$39.95 ea.
- UN-MAC (MACINTOSH) \$49.95

### LOW BAND DX'ING by John Devoldere ON4UN

Now Available! The new, 2nd edition of the definitive book on Low Band DX'ing. Based upon years of practical on-the-air experience, learn the secrets of how ON4UN has been so successful on the low bands. Extensive coverage is given to transmit and receive antennas with clear concise explanations and plenty of illustrations—dipoles, inverted V's, slopers, phased arrays and Beverages—they're all in this book. Also covered: propagation, transmitters, receivers, operating, software and an extensive Low Band bibliography. Going to be a best seller! Get yours today. © 1987 2nd Edition 200 pages

AR-UN Softbound \$9.95

### BUY'EM BOTH SPECIAL OFFER

- Book & Software Reg. \$49.90 (\$59.90 for Mac)  
Just \$44.90 (\$54.90 for Mac)
- UN-SO (specify computer) \$44.90
  - UN-MSO Macintosh Special \$54.90

**SAVE \$5**

Please enclose \$3.50 shipping & handling

ORDERS ONLY: (800) 341-1522  
**ham radio BOOKSTORE**

## Antenna Books

### ALL ABOUT CUBICAL QUAD ANTENNAS

by Bill Orr, W6SAI and Stu Cowan, W2LX

The cubical quad antenna is considered by many to be the best DX antenna because of its simple, lightweight design and high performance. You'll find quad designs for everything from the single element to the multi-element monster quad. There's a wealth of data on construction, feeding, tuning, and mounting quad antennas. 112 pages. ©1982, 3rd edition. Includes data for WARC bands

RP-CQ Softbound \$7.95

### THE AMATEUR RADIO VERTICAL HANDBOOK

by Cpt. Paul H. Lee, USN (Ret.), N6PL

Based upon the author's years of work with a number of different vertical antenna designs, you'll get plenty of theory and design information along with a number of practical construction ideas. Included are designs for simple 1/4 and 5/8-wave antennas as well as broadband and multi-element directional antennas. Paul Lee is an engineer and avid ham and is Amateur Radio's resident expert on the vertical antenna. ©1984, 2nd edition.

CQ-VAH Softbound \$9.95

### THE RADIO AMATEUR ANTENNA HANDBOOK

by Bill Orr, W6SAI and Stu Cowan, W2LX

Contains lots of well illustrated construction projects for vertical, long wire, and HF/VHF beam antennas. There is an honest judgment of antenna gain figures, information on the best and worst antenna locations and heights, a long look at the quad vs. the yagi antenna, information on baluns and how to use them, and new information on the popular Sloper and Delta Loop antennas. The text is based on proven data plus practical, on-the-air experience. 190 pages. ©1978, 1st edition.

RP-AH Softbound \$9.95

### HF ANTENNAS — The Easy Way

by John Haerle, WBSIR

This tutorial is an excellent source book on antenna theory and applications. Examples of areas covered are: Fundamentals, antenna and feedline terminology, baluns, ground systems, lightning protection, *The Basic Antenna*, the dipole, the zep, G5RV, Windom, *Special Antennas*, the sloper, DORR, Beverage, folded dipole, *Beams*, W8JK, Yagi, two element quad, and the *160 meter band story*. John's writing is in an easy-to-understand conversational style and is full of examples and handy tips and hints. There are no drawings or illustrations but John's prose paints pictures for clear and complete understanding of the information being presented. ©1984 1st Edition.

JH-AT Softbound \$11.95

### BEAM ANTENNA HANDBOOK by W6SAI and W2LX

Completely revised and updated the *Beam Antenna Handbook* includes the very latest state-of-the-art antenna design. Computer generated beam dimensions for the 40, 30, 20, 17, 15, 12, 10 and VHF bands are included eliminating the need for time consuming math calculations. Also covered are: Beam height and optimum apex of radiation, how element types and hardware effect performance, effect of nearby objects on radiation patterns, feedlines, baluns and matching systems and much more. Ham Radio VHF columnist W1JR, and noted European VHF'er DL6WO's VHF antenna designs are covered extensively as well as NBS VHF long Yagis. 268 clearly written pages — 204 easy-to-understand illustrations, make this the book to buy for beam construction. ©1985, 1st edition.

RP-BA Softbound \$9.95

### SIMPLE LOW-COST WIRE ANTENNAS

by Bill Orr, W6SAI and Stu Cowan, W2LX

Learn how to build simple, economical wire antennas. Apartment dwellers take note! Fool your landlord and your neighbors with some of the "invisible" antennas found here. Well diagrammed 192 pages. ©1972.

RP-WA Softbound \$9.95

### ARRL ANTENNA BOOK

14th Edition

The Amateur Antenna bible. Includes just about every bit of information you'd ever want to know about antenna design, construction and theory. Starts with wave propagation, antenna fundamentals and transmission line theory, progresses through coupling the transmitter and antenna to the feedline to 9 big, inclusive chapters on how to build different antennas. ©1982, 14th edition, 200 pages.

AR-AM Softbound \$8.00

FOR INFORMATION: (603) 878-1441

GREENVILLE, NH 03048 603-878-1441

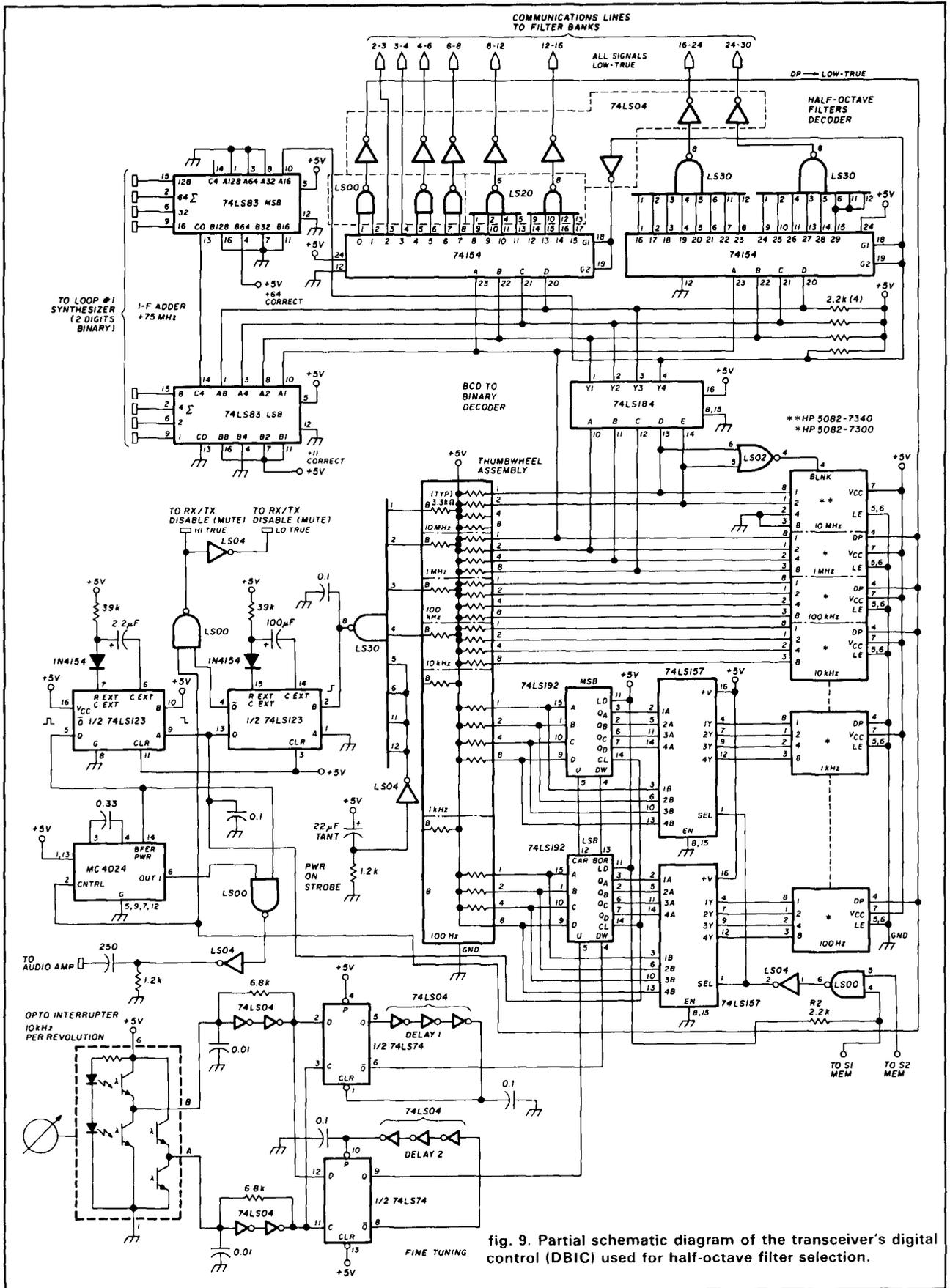


fig. 9. Partial schematic diagram of the transceiver's digital control (DBIC) used for half-octave filter selection.

# Join the Packet Racket!

Annual New Hampshire Store Sale March 5 & 6

Door prizes • Manufacturers' Reps • It's Better Than a Hamfest



**ege inc™**

## DISCOUNTS FOR AMATEURS

### EGE VIRGINIA

14803 Build America Drive, Bldg. B  
Woodbridge, Virginia 22191  
Information: (703) 643-1063  
Service Dept. (703) 494-8750  
Fax: (703) 494-3679

Store Hours: M-F 10-6  
Sat 10-4

Order Hours: M-F 9-7  
Sat 10-4

### EGE NEW ENGLAND

8 Shiles Road  
Salem, New Hampshire 03079  
New England (NH Included)  
Toll Free: 800-444-0047  
Info & Service: (603) 898-3750

Store Hours: MTuWf 10-5  
Th 12-8; Sat 10-4



Our associate store  
Davis & Jackson Road, P.O. Box 293  
Lacombe, Louisiana 70445  
Info & Service: (504) 882-5355



**Terms:** No personal checks accepted.  
Prices do not include shipping. UPS  
COD fee: \$2.35 per package. Prices are  
subject to change without notice or  
obligation. Products are not sold for  
evaluation. Authorized returns are sub-  
ject to a 15% restocking and handling  
fee and credit will be issued for use on  
your next purchase. EGE supports the  
manufacturers' warranties. To get a  
copy of a warranty prior to purchase,  
call customer service at 703-643-1063  
and it will be furnished at no cost.

**ege inc™**

Winter Buyer's  
Guide/Catalog  
Available - Send \$1.

## Antennas

### Amateur HF Bands

Cushcraft, Batternut, KLM,  
Mosley, Hy-Gain, B&W, Van  
Gorden, Hustler, Larsen,  
Antenna Specialists,  
Centurion, Smiley

### Antennas in Stock for Mobiles, Base Stations, and Handhelds

Everything from mini rubber  
duckies to huge monobanders

ASK FOR PACKAGE  
DEALS ON ANTENNAS  
AND ACCESSORIES

Also...

Antennas for Scanners, CBs,  
Marine, Commercial, and  
Short Wave Listening

**YAESU**



**FT 23/33/73**  
Mini HTs for 2m,  
220/440 MHz



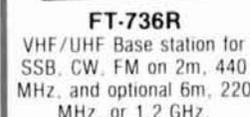
**FT 727R**  
2m/440 MHz Dual Band HT



**FT-767GX**  
All Mode Transceiver  
with CAT System



**FT-747GX**  
Good low-priced basic HF  
amateur rig.



**FT-736R**  
VHF/UHF Base station for  
SSB, CW, FM on 2m, 440  
MHz, and optional 6m, 220  
MHz, or 1.2 GHz.



**FT-757GX Mark II**  
HF Transceiver with  
General Coverage Receiver

## Towers

### UNARCO-ROHN

#### TRI-EX HY-GAIN

Ask for package quotes on  
complete tower assemblies  
including Phillystran, guy  
wire, antennas, rotators, etc.

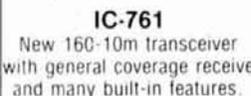
#### ROTATORS

Kenpro, Alliance, Daiwa,  
Telex Hy-Gain

**ICOM**



**IC-781**  
Ultimate ham HF radio. CRT  
display & spectrum analyzer.



**IC-761**  
New 160-10m transceiver  
with general coverage receive  
and many built-in features.



**IC-28H**  
Tiny 2m with 45 W output



**IC-275A**  
All-mode Transceiver



**R-7000**  
General Coverage Receiver



**Micro 2AT/4AT**  
Mini Handhelds  
for 2m or 440 MHz



**IC-02AT/03AT/04AT**  
Handhelds for 2m/220/440

## Computer Stuff

### Packet Controllers

Kantronics and MFJ

### Amateur Software

Ham Data Software for  
Commodore Computers  
Ask for Descriptions

### RTTY/Morse/Amtor

Hardware and Software and  
packages by Kantronics,  
Microlog, HAL, MFJ, & more

**KENWOOD**



**TS-140S**  
HF Transceiver with  
General Coverage Receiver



**TS-940S**  
HF Transceiver with  
General Coverage Receiver



**TM-221A/321A/421A**  
2m/220/440 MHz Mobiles



**New Improved  
TH 215AT**  
2m Handheld



**TH-25AT/45AT**  
Tiny HTs for 2m/440 MHz



**R-5000**  
General Coverage Receiver

## Accessories

### AMPLIFIERS

Vocom, Daiwa, TE Systems,  
Amp Supply, Mirage, Alinco,  
Ameritron, Tokyo Hy-Power,  
RF Concepts

### ANTENNA TUNERS

Amp Supply, Ameritron, MFJ

Switches, Couplers, Filters,  
Connectors, Mikes, Keyers,  
Paddles, Headsets, Clocks,  
Books, Power Supplies

## Kantronics Packet Units Now with WeatherFAX

Ask about KPC-2/4  
& KAM All-Mode

Now Available  
**Heathkit®**  
Amateur Products  
Call for details



**Paragon**  
Amateur Transceiver with  
General Coverage Receiver

**Corsair II**  
Model 561 HF Transceiver



**ALR-22T**  
Compact 2m Mobile



**ALD-24T**  
Compact Dual-band Mobile  
for 2m & 440 MHz

## More Radios

**SONY**  
Receivers

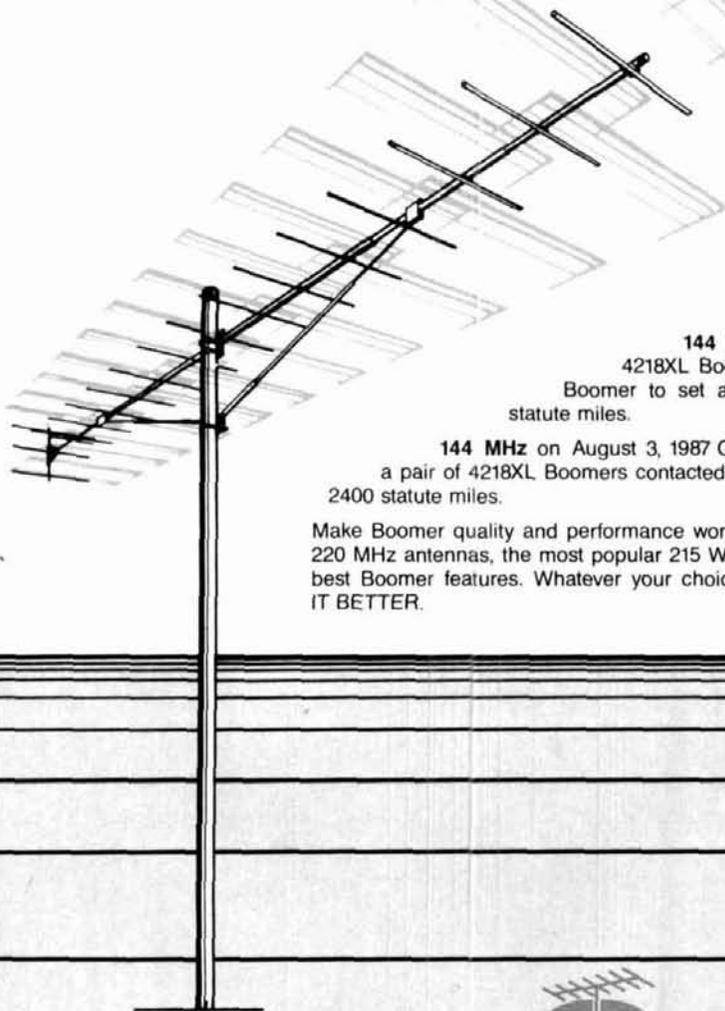
**REGENCY  
BEARCAT**  
Scanners

**CB RADIOS**  
Midland, Cobra, Uniden

To Order Call Toll Free: 800-444-4799

**ege inc™**

# NEW BOOMER DISTANCE RECORDS



**220 MHz** on June 14, 1987 Bill Duval, K5UGM of Irving, Texas made the first ever 220 MHz sporadic E contact with John Moore W5HUQ/4 of Orange Park, Florida. Both operators were using 220B Boomers.

**144 MHz** on June 14, 1987 Jim Frye, NW70 using the 4218XL Boomer contacted Jim Poore, KD4WF using a 215WB Boomer to set a new 144 MHz overland distance record of 1980 statute miles.

**144 MHz** on August 3, 1987 Gordon West WB6N0A, using a 1/2 watt handheld into a pair of 4218XL Boomers contacted KH6HME in Hawaii a distance record of more than 2400 statute miles.

Make Boomer quality and performance work for you. Whether you choose one of our two new 220 MHz antennas, the most popular 215 WB or the world class 4218XL, you will have all of the best Boomer features. Whatever your choice of operating mode or distance BOOMER DOES IT BETTER.

✓ 242

AVAILABLE THROUGH  
DEALERS WORLDWIDE



THE ANTENNA COMPANY

48 PERIMETER ROAD, MANCHESTER, NH 03108 USA  
603-627-7877 • TELEX 4949472 • FAX 603-627-1764

implementing automatic switched half-octave filters. The key to this method is to design the electrical filters with a minimum number of elements, while maintaining stringent electrical and mechanical requirements over a wide frequency range.

The resulting architecture is modular in that it preserves the plug-in board approach in a high-power rf environment and allows for proper digital interfacing to automate the system.

Although this project is dedicated to hf communications and particularly to linear amplifier harmonic suppression, there are many opportunities for using similar systems in other signal processing tasks. The authors would like to hear from anyone who has found new or novel applications for this concept.

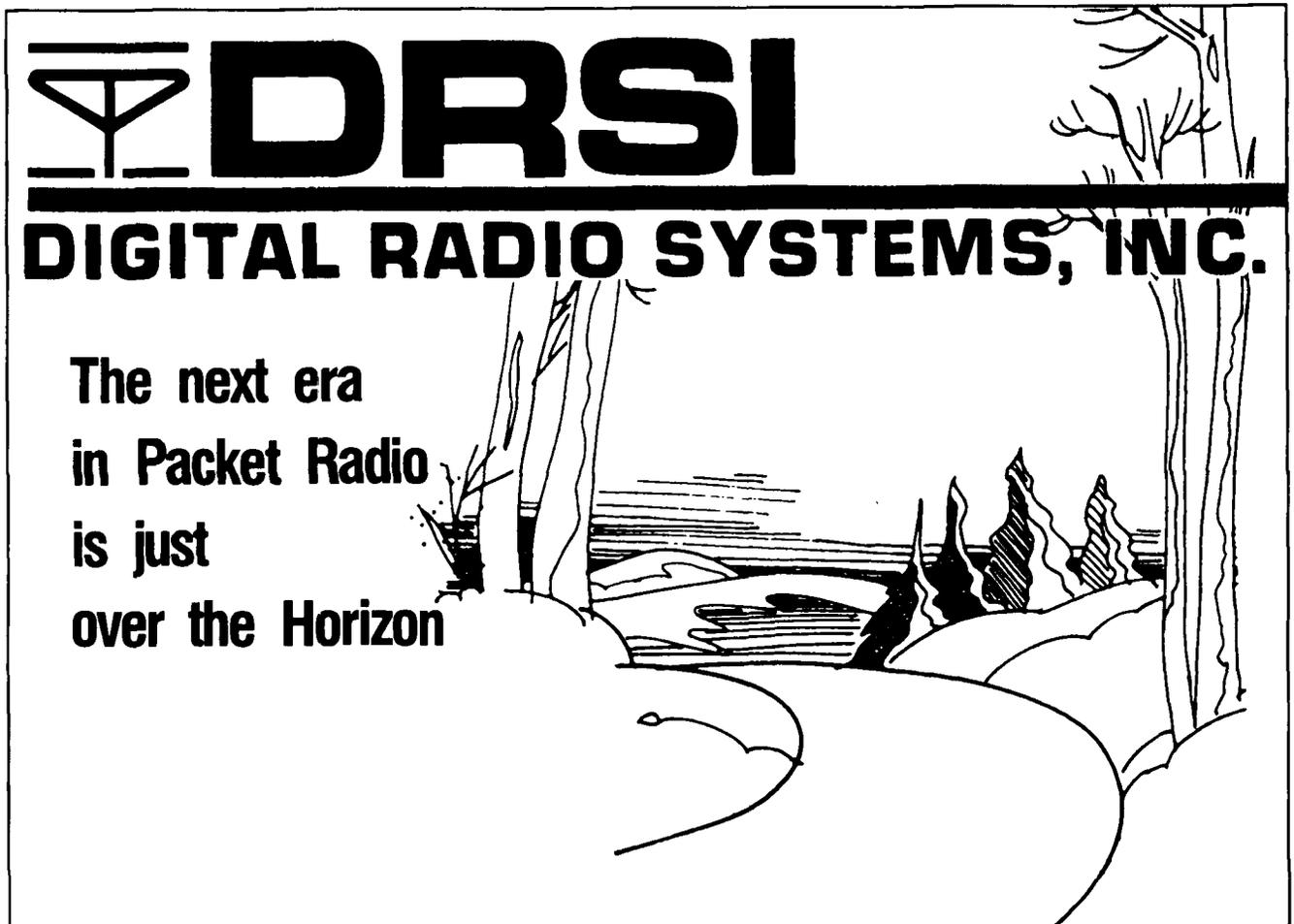
### acknowledgments

We would like to acknowledge Gary Dublin, N0BAB, for his help in performing the network and spectrum analyzer tests needed for the development of the WB3JZO transceiver; and Mike Stapp, KA0TQY, and Marc Denis, KD0QO, for carefully reviewing the material.

### bibliography

1. Anatol I. Zverev, *Handbook of Filter Synthesis*, Wiley, New York, 1967.
2. Herman J. Blinchikoff and Anatol I. Zverev, *Filtering in the Time and Frequency Domains*, Wiley, New York, 1976.
3. Lee R Watkins, "Designing Narrowband Butterworth or Chebyshev Filters in Less Than Two Minutes Using the TI-59 Calculator/Printer," *rf design*, November-December, 1980, pages 22-31.
4. Deverl S. Humphreys, *The Analysis, Design, and Synthesis of Electrical Filters*, Prentice-Hall, Englewood Cliffs, New Jersey, 1970.
5. Arthur C. Williams, *Electronic Filter Design Handbook*, McGraw-Hill, 1981.
6. Von R. Saal, *Der Entwurf von Filtern mit Hilfe des Kataloges Normierter Tiefpässe*, AEG-Telefunken, 715 Backnang, West Germany, 1968.
7. Von R. Saal and E. Ulbrich, "On the Design of Filters by Synthesis," *IRE Transactions on Circuit Theory*, December 1958.
8. Phillip R. Geffe, *Simplified Modern Filter Design*, John F. Rider Publishing, Inc., New York, 1963.
9. Lee R Watkins, "Wideband Filter Design Method Uses a Least-squares Approximation to Constant Group Delay," *Microwave Systems News*, October 1984, pages 141-144.
10. Donald D. Weiner and John E. Spina, *Sinusoidal Analysis and Modeling of Weakly Nonlinear Circuits with Applications to Nonlinear Interference Effects*, Van Nostrand Reinhold, New York, 1980.
11. Cornell Drentea, *Radio Communications Receivers*, TAB Books, 1982.
12. Clare D. McGillem and George R. Cooper, *Continuous and Discrete Signal and System Analysis*, Purdue University Press, 1974.
13. *RF Data Manual*, Motorola, Inc., 1982.
14. *ARRL Electronics Data Book*, The American Radio Relay League, Newington, Connecticut 06111, 1976.

ham radio



**DRSI**  
**DIGITAL RADIO SYSTEMS, INC.**

The next era  
in Packet Radio  
is just  
over the Horizon

# frequency calibration using 60 kHz WWVB

phase comparison method  
using NBS station  
yields higher accuracy

As the techniques used by the average Amateur Radio operator become more sophisticated, the need for precise frequency control becomes more important. Satellite communications, digital data links, coherent CW operation, and even the everyday business of saying "QSY to 14259.0" all place increasing demands on our ability to accurately measure frequency.

WWV and WWVH have been used for years to calibrate equipment by audibly comparing transmitted signals against the receiver's internal reference oscillator for zero beat. This is still the most convenient method. However, for greater calibration accuracy, use station WWVB which transmits on 60kHz.

WWVB broadcasts a highly stable reference signal in the Very Low Frequency (VLF) band and, despite its relatively low power, is receivable nationwide. Its signal is a continuous carrier modulated by decreasing output power 10 dB on the second for varying pulse widths. In this way, time, date, and error information are sent in binary format without disturbing the phase coherence of the reference signal. None of this information is decodable using standard audio detection techniques.

In recent years there have been a number of articles dealing with reception at VLF. Most employ conversion circuits which work fine for a-m, CW, and RTTY but are useless for reference work. The following circuit overcomes this limitation by using a synchronous detection scheme, which when used in conjunction with an oscilloscope, gives a convenient visual readout of frequency error.

The rf signal from the antenna is amplified without conversion using moderate selectivity and after conditioning is fed to the vertical channel of an oscilloscope. If the horizontal sweep time is then set to display about two cycles at 60 kHz (5 microseconds per cm on my scope), and the sweep is triggered by an oscil-

lator at 60 kHz or any submultiple frequency (i.e. 60 kHz/n; where n = 1, 2, 3, etc.) the rf signal can be directly viewed. The modulation appears as amplitude level shifts on the screen, and the frequency error of the oscillator is displayed as a phase drift. Rightward drift means the frequency is high and leftward drift means it is low. The rate of error can be exactly calculated from the following formula:

$$\text{error in parts per million} = \frac{16.7}{T}$$

where T is the time in seconds for one full sine wave to drift past a reference point on the screen. (See fig. 1.)

This creates a visual converter of very high Q. The screen's phosphorus persistence provides selectivity and the difference signal is detected as drift, easily measured in both direction and level. The result is an accurate method of frequency standard calibration at minimal cost.

## using an existing oscillator

In most situations, one oscillator is established as the reference source. It can be used as a 100-kHz band marker, the master oscillator of a phase-locked loop scheme, or as the standard oscillator in a frequency counter. This reference oscillator should be calibrated by phase comparison to WWVB.

To properly use this circuit for calibration, it is necessary that the oscillator signal be brought out of your existing equipment and be processed so that a suitable submultiple frequency is available. Do some individual planning before beginning construction.

Digital division is usually necessary as the oscillator frequency will be higher than 60 kHz. Most equipment has internal dividers so the subfrequency you need may already be available. Make sure that this source is not so heavily loaded by the interface circuit that stability is affected.

Suitable frequencies meet the following requirement:

$$\text{frequency (Hz)} = \frac{60000}{n} \text{ where } n = 1, 2, 3, \dots \text{etc.}$$

By John A. Cowan, W4ZPS, 303 Kingston Highway 293 NW, Cartersville, Georgia 30120

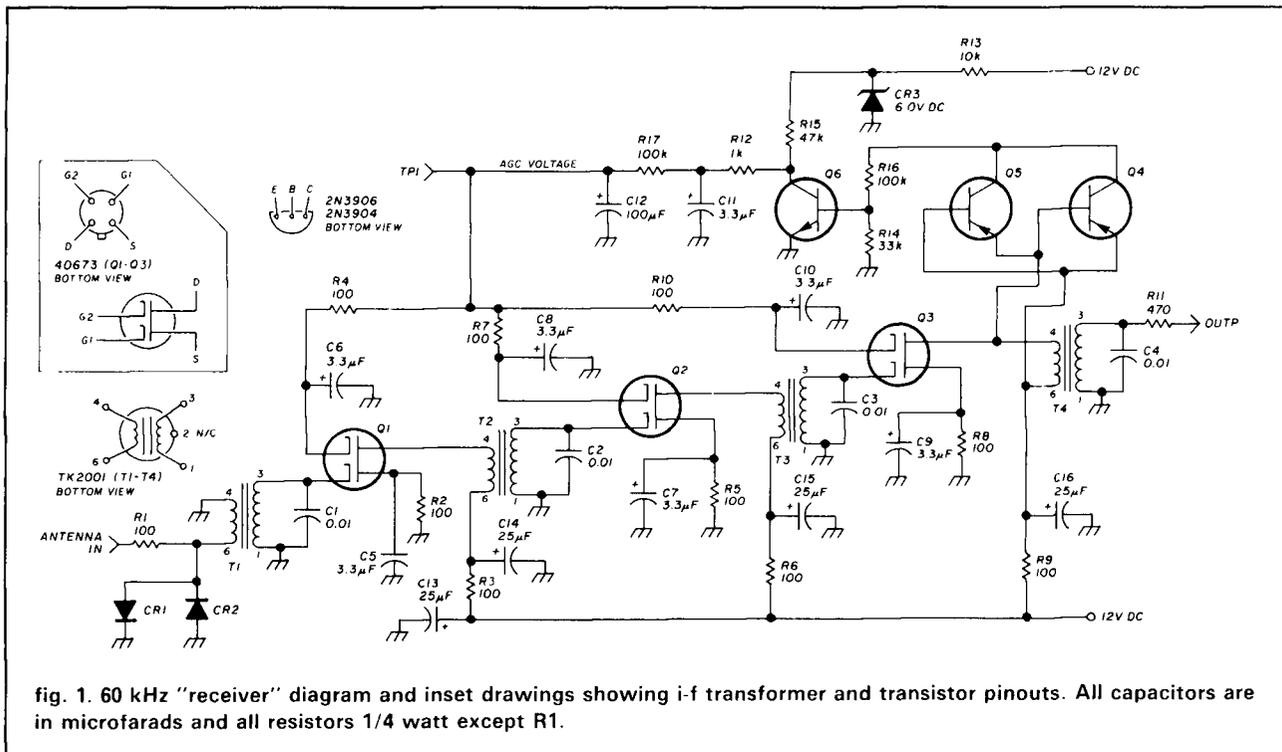


fig. 1. 60 kHz "receiver" diagram and inset drawings showing i-f transformer and transistor pinouts. All capacitors are in microfarads and all resistors 1/4 watt except R1.

#### parts list

CR1, CR2	1-amp general purpose power diodes
CR3	6.0-volt Zener diode, 1 watt
C1-C4	0.01µF 100-volt mylar capacitors (Jameco No. MY.01/100)
C5-C11	3.3µF 35-volt dipped tantalum (Jameco No. TM3.3/35)
C12	100µF 6-volt dipped tantalum (Jameco No. TM100/6)
C13-C16	25 µF 25-volt electrolytic capacitors
R1	100-ohm 1/2-watt resistor
R2-R10	100-ohm 1/4-watt resistors
R11	470-ohm 1/4-watt resistor
R12	1-k 1/4-watt resistor
R13	10-k 1/4-watt resistor
R14	33-k 1/4-watt resistor
R15	47-k 1/4-watt resistor
R16, R17	100-k 1/4-watt resistors
T1-T4	1-mH i-f transformers (Digi-Key No. TK 2001)
Q1-Q3	40673 MOSFETs (Jameco No. 40673)
Q4, Q5	2N3906 PNP transistors
Q6	2N3904 NPN transistor

A 100-kHz oscillator need only be divided by 10 since the resulting 10 kHz is a suitable submultiple ( $n = 6$ ). A 1, 2, 3, or 6-MHz signal could be divided by 100 as 10, 20, 30, and 60 kHz also work ( $n = 6, 3, 2, 1$ ). Oscillators at 4, 5, and 10 MHz must be divided by 1000. Division by 1000 works for all the above frequencies because further division of a suitable frequency always gives another. The only drawback in using higher than minimum division ratios is that fewer sweeps per second mean a dimmer display. Some frequencies are selected for use in binary schemes and will need division by binary counters. Rarely does a frequency require complex divide-by- $n$  circuitry.

### crystal oscillators aren't perfect

There's no such thing as long term stability in crys-

tal oscillators. Even the best commercial circuits drift as the crystals age. The best that can be hoped for is to minimize short term drift from voltage changes, loading, and ambient temperature variations. Once tuned to frequency, these oscillators drift slowly and at a constant rate. Eventually, however, the cumulative effect of crystal aging will leave the frequency far from its mark. These are the times when this circuit and WWVB come to the rescue.

### antenna considerations

Many antenna designs are suitable for use at 60 kHz. Loops, top-loaded verticals, and elaborate long-wire arrays all work well. However, when only reception is important, and cost the major factor, a *short* long wire and good earth ground are hard to beat.

One good technique uses a run of RG-59/U coax to exit the building and then attach the braid to a good earth ground. From this point, attach a length of wire to the center conductor and run it as far as possible. On small lots, running around the perimeter of the property gives good results. One leg of a dipole antenna may work well, but make certain that baluns and matching networks don't attenuate at 60 kHz. Power lines and color television sets generate significant interference at VLF, so locate the antenna as far away from these sources as possible.

Neither height nor great length is absolutely necessary. Even at my rather fringe location, I have received usable signals on a 30-foot wire running across the basement floor. My primary antenna is somewhat

# TINY-2 PACKET CONTROLLER

## \$119.95

READY TO USE - NOT A KIT

- \* USES TNC-2 EPROMS INCLUDING NET/ROM. FIRMWARE VERSION 1.1.5 PROVIDED
- \* 32K RAM AND 32K EPROM STANDARD
- \* SUPPORTS BOTH RS-232 AND TTL COMPUTERS, 300-19,200 BAUDS
- \* EXTRUDED ALUMINUM CABINET WITH OVEN-BAKED WRINKLE FINISH. ONLY 5" x 7"
- \* WATCHDOG TIMER, MODEM DISCONNECT HEADER, 12V DC OPERATION.

SALE

THE BEST VALUE IN A VHF/HF TNC  
**PAC-COMM TNC-220 \$149.95**

WITH TUNING INDICATOR \$179.95

- NOW WITH 32K RAM STANDARD, FIRMWARE VERSION 1.1.5
- SELECT EITHER HF OR VHF RADIOS FROM THE KEYBOARD.
- SUPPORTS RS-232 AND TTL COMPUTERS
- IN KIT FORM -- \$129.95
- INTERNAL TUNING INDICATOR -- \$44.95

✓ 245

### PACKET TERMINAL PROGRAMS

PAC-PRO (PC)	\$29.95
DIGIPACK II (PC)	\$49.95
MACPACKET (MAC)	\$49.95
MACKET (MAC)	\$39.95
COMMODORE 64	\$19.95

TNC-200, TNC-220 VERSION 1.1.5 EPROMS  
 \$10.00

### ACCESSORIES:

12v WALL MOUNT POWER SUPPLY \$9.95  
 RS-232 CABLE \$9.95, C-64 CABLE \$12.95

WRITE OR CALL FOR OUR NEW CATALOG OF PACKET EQUIPMENT, SOFTWARE AND ACCESSORIES.

TOLL FREE  
 (ORDERS ONLY)  
**800-223-3511**  
 EXCEPT FLORIDA



**PAC-COMM, 3652 West Cypress St., Tampa, FL 33607**

FLORIDA ADDRESSES ADD 5%. \$3.00 SHIPPING/HANDLING PER ORDER.

TECHNICAL INFORMATION

7:30 AM - 11 PM EASTERN

(813) 874-2980

TELEX: 650-288-1526 MCI

FAX: (813) 872-8696

## W6SAI BOOKS

published by Bill Orr, W6SAI and Stu Cowan, W2LX

### BEAM ANTENNA HANDBOOK

Completely revised and updated with the latest computer generated information on BEAM Antenna design. Covers HF and VHF Yagis and 10, 18 and 24 MHz WARC bands. Everything you need to know. 204 illustrations. 268 pages. © 1985. Revised 1st edition.

RP-BA

Softbound \$9.95

### SIMPLE LOW-COST WIRE ANTENNAS

Primer on how-to-build simple low cost wire antennas. Includes invisible designs for apartment dwellers. Full of diagrams and schematics. 192 pages. © 1972 2nd edition

RP-WA

Softbound \$9.95

### ALL ABOUT CUBICAL QUAD ANTENNAS

Simple to build, lightweight, and high performance make the Quad at DX'ers delight. Everything from the single element to a multi-element monster. A wealth of information on construction, feeding, tuning and installing the quad antenna. 112 pages. © 1982. 3rd edition.

RP-CQ

Softbound \$7.95

### THE RADIO AMATEUR ANTENNA HANDBOOK

A wealth of projects that covers verticals, long wires, beams as well as plenty of other interesting designs. It includes an honest judgement of gain figures, how to site your antenna for the best performance, a look at the Yagi-Quad controversy, baluns, slopers, and delta loops. Practical antenna projects that work! 190 pages. © 1978. 1st edition.

RP-AH

Softbound \$9.95

Please enclose \$3.50 for shipping and handling.



**ham radio** magazine **BOOKSTORE**

GREENVILLE, NH 03048

(603) 878-1441

## K.V.G. CRYSTAL PRODUCTS



### 9 MHz CRYSTAL FILTERS

MODEL	Application	Bandwidth	Poles	Price
XF-9A	SSB	2.4 kHz	5	\$61.00
XF-9B	SSB	2.4 kHz	8	89.00
XF-9B-01	LSB	2.4 kHz	8	125.00
XF-9B-02	USB	2.4 kHz	8	125.00
XF-9B-10	SSB	2.4 kHz	10	165.00
XF-9C	AM	3.75 kHz	8	89.00
XF-9D	AM	5.0 kHz	8	89.00
XF-9E	FM	12.0 kHz	8	62.00
XF-9M	CW	500 Hz	4	145.00
XF-9NB	CW	500 Hz	8	175.00
XF-9P	CW	250 Hz	8	21.00
XF-910	IF noise	15 kHz	2	21.00

### 10.7 MHz CRYSTAL FILTERS

WRITE FOR FULL DETAILS OF CRYSTALS AND FILTERS  
 Export inquiries Invited.

Shipping \$3.75

### ANTENNAS

2M			
10XY-2M	\$93.00	LOOP YAGIS	
70cm		1268-LY	\$60.00
70/MBM2B	65.00	1296-LY	60.00
70/MBM4B	90.00	1691-LY	70.00
70/MBM8B	135.00	order loop yagi connector extra	
DY20-900 MHz	99.00		

Send 66¢ (3 stamps) for full details of all our VHF & UHF equipments and KVG crystal products.

Shipping: FOB Concord, Mass.

Prices subject to change without notice.



# si

(617) 263-2145

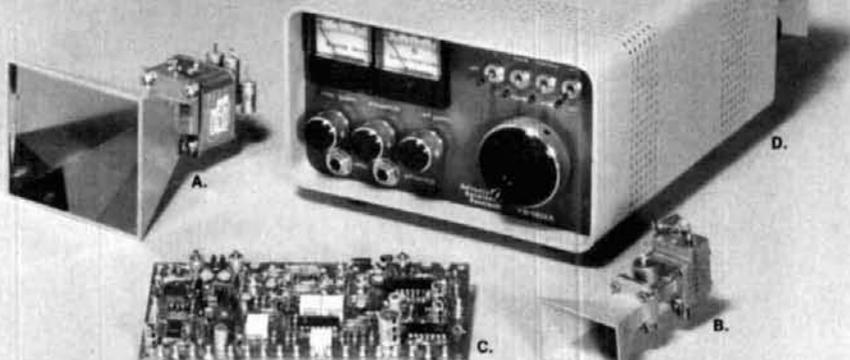
**SPECTRUM INTERNATIONAL, INC.**

Post Office Box 1084

Concord, MA 01742, U.S.A.

✓ 244

# Gunnplexers & accessories 10 & 24 GHz



A. Microwave Associates 10 GHz Gunnplexer. Two of these transceivers can form the heart of a 10 GHz communication system for voice, mcw, video or data transmission, not to mention mountaintop DXing! MA87141-1 (pair of 10 mW transceivers) \$251.95. Higher power units (up to 200 mW) available. B. Microwave Associates 24 GHz Gunnplexer. Similar characteristics to 10 GHz unit. MA87820-4 (pair of 20 mW transceivers) \$739.20. C. This support module is designed for use with the MA87141 and MA87820 and provides all of the circuitry for a full duplex audio transceiver system. This board contains a low-noise, 30-MHz fm receiver, modulators for voice and mcw operation, Gunn diode regulator and varactor supply. Meter outputs are provided for monitoring received signal levels, discriminator output and varactor tuning voltage. RXMR30VD assembled and tested \$119.95. D. Complete, ready to use communication system for voice or mcw operation. Ideal for repeater linking. A power supply capable of delivering 13 volts dc at 250 mA (for a 10 mW version), microphone, and headphone and/or loudspeaker are the only additional items needed for operation. The Gunnplexer can be removed for remote mounting to a tower or 2 or 4 foot parabolic antenna. TR10GA (10 GHz, 10 mW) \$399.95. Higher power units available. TR24GA (24 GHz, 20 mW) \$639.95. Also available: horn, 2 and 4 foot parabolic antennas, Gunn, varactor and detector diodes, search and lock systems, oscillator modules, waveguide, flanges, etc. Call or write for additional information. Let ARR take you higher with quality 10 and 24 GHz equipment!

## Advanced Receiver Research

Box 1242 • Burlington CT 06013 • 203 582-9409



**THE 4SOTRON**  
ANTENNAS FROM 160-10 METERS

NO TUNERS!  
NO RADIALS!  
NO RESISTORS!  
NO COMPROMISE!

THREE EXCELLENT REVIEWS JUST DON'T HAPPEN BY CHANCE.  
CALL US FOR A FREE CATALOGUE.

\*See review in Oct 7, 1984  
\*Sept 7, 1985 \*March 7, 1986

**NEW LOCATION!**  
**BILAL COMPANY**  
137 Manchester Dr.  
Florissant, Colo. 80816  
(719) 687-0650

**Wideband Preamp 10-1000 Mhz**

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

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

## NEMAL ELECTRONICS

- \*Complete Cable Assembly facilities MIL-STD-45208
- \*Commercial Accounts welcome- Quantity pricing \* Same day shipping most orders
- \*Factory authorized distributor for Alpha, Amphenol, Belden, Kings, Times Fiber

Call NEMAL for computer cable, CATV cable, Flat cable, semi-rigid cable, telephone cable, crimping tools, D-sub connectors, heat shrink, cable ties, high voltage connectors.

**HARDLINE 50 OHM**

FXA12 1/2" Aluminum Black Jacket.....	.89/ft
FLC12 1/2" Cablewave corr. copper blk jkt .....	1.59/ft
FLC7B 7/8" Cablewave corr.copper blk jkt .....	3.92/ft
NM12CC N conn 1/2" corr copper m/1 .....	23.00
NM78CC N conn 7/8" corr copper m/1 .....	54.00

**COAXIAL CABLES (per ft)**

1180 BELDEN 9913 very low loss .....	C
1102 RG8/U 95% shield low loss foam 11gs.....	C
1110 RG8X 95% shield (mini B) .....	A
1130 RG213/U 95% shield mil spec MCV jkt.....	A
1140 RG214/U dbl silver shield mil spec.....	L
1705 RG142B/U dbl silver shield, teflon ins .....	L
1310 RG217/U 50 ohm 5000 watt dbl shield .....	L
1450 RG174/U 50 ohm .100" od mil spec .....	L

**ROTOR CABLE-8 CONDUCTOR**

8C1822 2-18ga and 6-22ga .....	CALL
8C1820 2-18ga and 6-20ga .....	CALL

**CONNECTORS-MADE IN USA**

NE720 Type N plug for Belden 9913 .....	\$3.95
NE723 Type N jack for Belden 9913.....	4.95
PL259 standard UHF plug for RG8,213.....	.65
PL259AM Amphenol PL259 .....	.89
PL259TS PL259 teflon ins/silver plated.....	1.59
PL258AM Amphenol female-female (barrel).....	1.45
UG175/UG176 reducer for RG58/59 (specify).....	.22
UG21DS N plug for RG8,213,214 Silver.....	3.35
UG83B N jack to PL259 adapter, teflon .....	6.50
UG146A SO239 to N plug adapter, teflon .....	6.50
UG255 SO239 to BNC plug adapter, Amphenol.....	3.29
SO239AM UHF chassis mt receptacle,Amphenol.....	.89

**GROUND STRAP-GROUND WIRE**

GS38 3/8" tinned copper braid .....	C
GS12 1/2" tinned copper braid .....	A
GS200 1-1/2" heavy tinned copper braid .....	L
HW06 6ga insulated stranded wire .....	L
AW14 14ga stranded Antenna wire CCS .....	L

\*Shipping: Cable \$3/100, Connectors \$3.00, Visa/Mastercard \$30 min, COD add \$2.00  
Call or write for complete price list. NEMAL's new 36 page CABLE AND CONNECTOR SELECTION GUIDE is available at no charge with orders of \$50 or more, or at a cost of \$4 with credit against next qualifying order.

NEMAL ELECTRONICS, INC. 12240 NE 14th Ave. N. Miami, FL 33161  
(305) 893-3924 Telex 6975377 24hr FAX (305)895-8178

*America's Best kept Secret!*

**TEN-TEC**

For the serious radio operator!

**PARAGON HF TRANSCEIVER, MODEL 585**

MEET AMERICA'S NEWEST FULL FEATURED, SYNTHESIZED TRANSCEIVER. GENERAL COVERAGE ALL MODE RECEIVER TUNING FROM 100 KHZ TO 29,999,999 MHZ. TRANSMIT AT 100 WATTS OUTPUT ON ALL AUTHORIZED FREQUENCIES FROM 1.8 TO 29,999,999 MHZ. SSB, CW, FSK AND OPTIONAL FM. VOICE BLENDER AND SPEECH PROCESSOR ARE STANDARD EQUIPMENT. DUAL SPLIT, RX OFFSET.

LIST PRICE \$2245.00  
SALE PRICE \$1995.00 !!!  
(LIMITED TIME ONLY)

MISSION COMMUNICATIONS  
1903 Alzet (Coburn) Suite 500  
HOUSTON, TEXAS 77082  
(713) 879-7764  
Telex 166872 MCON UT

**MADE IN USA**

longer and made of well-insulated wire *buried* 3 feet underground!

*In every case, a good (but not necessarily elaborate) earth ground is essential.*

## propagation

For about an hour, around sunrise and sunset along the main propagation path, signal strength and phase coherence are unreliable. During daylight hours (high sun angles) signals arrive entirely by ground wave and measurements performed then are theoretically most accurate. However, daytime weather along the route and noise spikes from power lines may be problems at times.

At night, particularly at some distance, sky wave propagation is a factor. Initially, ground and sky wave may be of near equal strength, alternately canceling and reinforcing one another, giving rapid phase shifts, and affecting reliability. Later, sky wave can dominate, providing significantly higher signal strengths while weather noise decreases. This improved signal-to-noise ratio makes the binary information easier to decode, although the varying path length will affect accuracy.

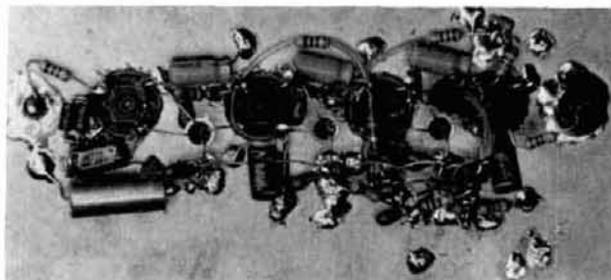
## circuit description

The actual circuit design (see **fig. 2**) is straightforward with only a few necessary subtleties. Q1, Q2, and Q3 are used as variable gain amplifiers, which along with T1, T2, T3, and T4 form an RF amplifier having moderate selectivity. Q4 and Q5 have emitter-base junctions wired back-to-back, which clip the peak output voltage and along with Q6 derive an AGC voltage that is fed back to gate 2 of the MOSFETs. The AGC time constant is selected to prevent noise spikes from desensitizing the amplifier while being slow enough *not* to demodulate the a-m signal. A 100-ohm 1/2-watt resistor with back-to-back diodes is included at the input for lightning protection. The AGC voltage is available at TP1.

## construction

At VLF layout is not critical and any reasonable materials, including perfboard, may be used. I prefer to build on one side of a copper-clad board and tack solder all components to this surface. Major components are glued or soldered to the surface and smaller pieces suspended in between. With care and practice, circuits can be quickly assembled, easily modified, and result in a finished product of surprising mechanical stability.

To begin construction, drill four holes in a row about 1 inch (25 mm) apart and ream them out to snug fit coils T1 to T4. Make their bases level with the working surface. Bend those terminals that need to be grounded 90 degrees and solder directly. Capacitors



**fig. 2.** Single-sided solder tack construction technique is fast and mechanically/electrical sound. A few circuit improvements have been made so schematic differs slightly.

and diodes can be soldered from the proper lugs to ground with short leads. Suspend the 40673 MOSFETs upside down by the coil lugs for the gate 1 and drain, the 100-ohm source resistor and bypass for the source, and the bypass capacitor for gate 2. Take care that the case doesn't actually contact ground. The other components are suspended between the MOSFETs and the circuit board. The board can be used for support wherever a bypass capacitor is needed. Connect power and the test point (TP1) by feedthrough capacitors and the input and output signals by coax connectors or phono jacks.

## alignment

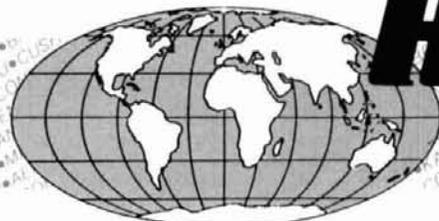
Verify the wiring. Now connect a jumper between TP1 and ground to reduce the receiver gain to a minimum. Apply 12 to 15 VDC and check the current (should be 10 to 15 mA). Check the voltage from source to ground at each transistor. This should read between 0.2 and 0.4 VDC.

Connect a 60-kHz frequency source to the input and connect an oscilloscope to the output. An audio oscillator can be used, but be careful that the frequency is within 100 Hz. Peak the coils starting with T4 and work backward, reducing the input when necessary to keep all stages in a linear range.

If there is a problem, connect the oscilloscope to gate 1 of Q2 and peak T1 and T2. Then move the probe to Q3 and peak T3. At this point reconnect to the output and retune T4 through T1. When properly tuned, selectivity is sharp and there will be a rapid drop-off as the test oscillator is tuned off frequency.

At this point the receiver is ready for operation. Make certain you have a reference signal that can trigger the scope and is at a suitable submultiple frequency. To check this, connect the audio oscillator to the vertical input and with the sweep time at about 5 microseconds/cm, see if the sine wave can be frozen (synchronized) as the frequency is edged through 60 kHz.

Now connect the antenna to the receiver's input and the output to the vertical channel of the oscilloscope



# HAM RADIO OUTLET

LARGEST HAM OUTLET IN THE WORLD

**GUARANTEED  
QUALITY  
AT LOW OUTLET PRICES**

## 7 STORE BUYING POWER



30w in, 160w out,  
with low-noise  
preamp!  
MODEL  
2M30-160P  
for 2 meters  
**SALE!**  
**\$219.95**



From the Originator of the  
**QUALITY VHF AMP/PREAMP COMBO!**

### Gordon West's 21 DAY NOVICE

**\$19.95**



CODE TAPES • 112 PAGE BOOK • BANDS CHART  
ALL FCC FORMS • SAMPLE TESTS • PLUS MORE!

- \$70 in equipment certificates from ICOM, KENWOOD, & YAESU.
  - Ham radio equipment "Wish Books".
  - ARRL membership forms.
  - Hotline for student questions.
  - Course completion certificate.
- PLUS  
ADDITIONAL  
ITEMS



Contemporary design,  
quality and a 5 year warranty  
on parts and labor.  
6 months on the RF Final transistors.  
All amplifiers have GaAsFET receive  
pre-amps and high SWR shutdown protection.



**MA-40**  
40' TUBULAR TOWER  
~~\$745~~ **SALE! \$549**

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

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

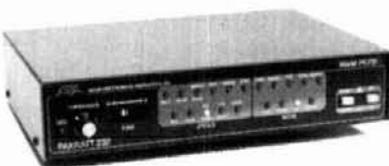
Shown with optional  
MARRD motor base

IN STOCK FOR QUICK DELIVERY  
OTHER MODELS AT GREAT PRICES



Advanced  
Electronic  
Applications

### PK-232 Multi-mode Data Controller



- NEW IBM Fax Screen Display Program Available
- Transmit/Receive on Six Modes
- CW/RTTY/ASCII/AMTOR/Packet/FAX
- IBM and Commodore terminal programs available
- Radio Ports for HF and VHF

**In Stock for Quick Delivery**

Free Shipment

### Alpha Delta Model DELTA-4

Lightning Surge Protected  
4-Position RF Coax Switch

- Exclusive center "off" (ground) position.
- Uses ceramic Arc-Plug® protector.
- Micro-strip circuitry—no wafer switch.



**Model DELTA-4**  
(UHF Connectors) \$69.95

**Model DELTA-4/N**  
(N-type Connectors) \$89.95

FREE SHIPMENT  
MOST ITEMS UPS SURFACE

**A3** DX THAT  
STANDS OUT  
FROM THE CROWD  
**10, 15, 20  
Meters**

Whether busting pileups,  
rag chewing or hunting  
rare DX, the A3 stands  
out from the crowd with  
the perfect combination  
of easy assembly, the  
right size, rugged durabil-  
ity and great  
performance.

- Boom Length 14 ft.,  
Weight 27 lbs.
- Wind Surface Area  
4.36 ft.

REG.  
**319.95**

SALE  
**219.95**

Plus Shipping

Mast  
not  
included

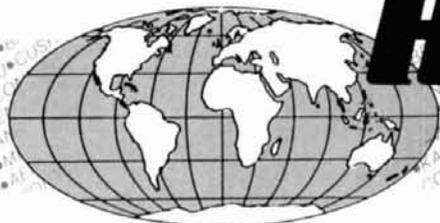
**All Major Brands in Stock Now!**

**CALL TOLL FREE (800) 854-6046**



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





# HAM RADIO OUTLET

LARGEST HAM OUTLET IN THE WORLD

**FREE SHIPMENT**  
MOST ITEMS UPS SURFACE

## 7 STORE BUYING POWER

**ICOM IC-761**



**HF SUPERIOR GRADE  
TRANSCEIVER**

**SALE! CALL FOR PRICE**

**ICOM** A Models 25W, H Models 100 W

**IC-275A/275H, 138-174 MHz**  
**IC-375A, 220 MHz**  
**IC-475A/475H, 430-450 MHz**



**GREAT PRICE!**

**ICOM IC-900**  
**MULTI-BAND  
MOBILE**



**YOU CAN OPERATE SIX BANDS  
WITH ONE CONTROLLER!**  
2 MTR 25/45W, 440 MHz 10 MTR, 6 MTR,  
220 MHz & 1.2 GHz 10 MEMORIES  
**ARE YOU READY FOR  
1.2 GHz OPERATION?**

**ICOM**  
**IC-28A/28H**



**2-METER MOBILES**  
IC-28A (25w) IC-28H (45w)

**LOW PRICE!**

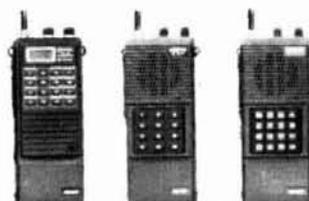
**NOW!  
IC-38A  
220 MHz**

**NOW! RAPID DELIVERIES**



**FROM STORE NEAREST YOU**

**ICOM** HAND-HELD  
VHF/UHF



IC-02AT IC-2AT 2MTR  
IC-03AT IC-3AT 220 MHz  
IC-04AT IC-4AT 440 MHz

**ICOM IC-735**



The Latest in ICOM's Long  
Line of HF Transceivers

**CALL FOR LOW, LOW PRICE**

**ICOM IC-R7000**



25 MHz-1300 MHz

**IN STOCK FOR  
IMMEDIATE DELIVERY**

**ICOM**  
**IC-u4AT/u2AT**  
440 MHz, 2MTR

Mini  
Hand-Held  
AT Model  
w/ TT Pad

**GREAT  
PRICE!**



## All Major Brands in Stock Now!



**Bob Ferrero W6RJ**  
President  
**Jim Rafferty N6RJ**  
VP So. Calif Div.  
Anaheim Mgr.

**ANAHEIM, CA 92801**  
2620 W. La Palma  
(714) 761-3033. (213) 860-2040  
Between Disneyland &  
Knott's Berry Farm  
**ATLANTA, GA 30340**  
6071 Buford Hwy.  
(404) 263-0700  
Neil Mgr. KC4MJ  
Doraville. 1 mi. north of I-285

**BURLINGAME, CA 94010**  
999 Howard Ave.  
(415) 342-5757  
George Mgr. WB6DSV  
5 miles south on 101 from SFO  
**OAKLAND, CA 94606**  
2210 Livingston St  
(415) 534-5757  
Al Mgr. WA6SYK  
17N-5th Ave /17S-16th Ave.

**PHOENIX, AZ 85015**  
1702 W. Camelback Rd  
(602) 242-3515  
Bob Mgr. K7RDH  
East of Hwy 17  
**SAN DIEGO, CA 92123**  
5375 Kearny Villa Rd.  
(619) 560-4900  
Tom Mgr. KM6K  
Hwy 163 & Claremont Mesa Blvd

**VAN NUYS, CA 91411**  
6265 Sepulveda Blvd  
(818) 988-2212  
Al Mgr. K6YRA  
San Diego Fwy  
at Victory Blvd  
**STORE HOURS**  
10 AM-5:30 PM  
**CLOSED SUNDAYS**



**CALL TOLL FREE (800) 854-6046**

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



# Join AMSAT...Today

*Amateur Radio Satellite OSCAR 10 provides:*

- **A New Worldwide DX Ham Band** open 10 hours a day.
- **Rag Chew With Rare DX Stations** in an uncrowded, gentlemanly fashion.
- **Popular Modes In Use:** SSB, CW, RTTY, SSTV, Packet
- **Full Operating Privileges** open to Technician Class licensee or higher.

## *Other AMSAT Membership Benefits:*

### **Newsletter Subscription:**

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

### **Satellite Tracking Software**

Available for most popular PCs.

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

**Construction of Future Satellites For Your Enjoyment!**

AMSAT Membership is \$24 a year, \$26 outside North America. VISA and MC accepted.

**AMSAT**  
**P.O. Box 27**  
**Washington, DC 20044**

**301 589-6062**

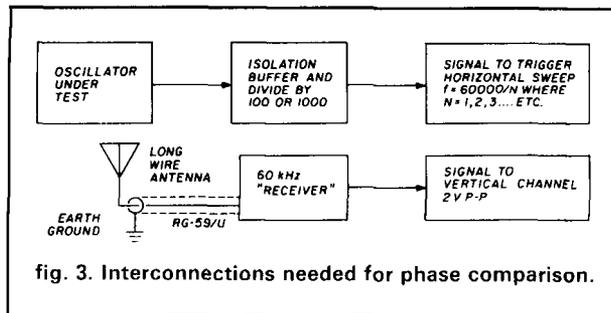


fig. 3. Interconnections needed for phase comparison.

(see fig. 3). WWVB should appear after the AGC level adjusts.

## **WWVB locking problems**

There are many factors that frustrate attempts to directly phase lock an oscillator to WWVB. The most obvious is that the signal is erratic during certain times of the day and a tight locking scheme could go awry. Secondly, for identification purposes, the signal phase is advanced 45 degrees at 10 minutes past each hour and returned at 15 past. There will be instability unless offset circuitry is included. To avoid instability and other problems, you must start with a standard that is capable of maintaining short term stability of 0.0001 ppm (parts per million) per day or better. Compare the phase daily when ground wave is dominant and compute the aging rates. Error correction information can then be fed back digitally to the oscillator control whenever necessary, irrespective of signal conditions.

A more practical solution is to build or access the most stable oscillator possible and use this circuit to verify accuracy and, if necessary, make periodic adjustments using WWVB.

## **conclusion**

WWVB can be received at most locations in the United States using minimum circuitry and reasonable antenna systems. With an oscilloscope and a few divider ICs almost any oscillator can be calibrated to 0.01 ppm or better. Calibration and temperature compensation of oscillators are facilitated because both the amount and the direction of frequency error are conveniently displayed.

## **sources of parts**

Digi-Key Corp., POB 677, Thief River Falls, Minnesota 56701

Jameco Electronics, 1355 Shoreway Road, Belmont, California 94002

## **bibliography**

*NBS Special Publication 432, U.S. Department of Commerce, National Bureau of Standards, Washington, DC 20234*

# ham radio TECHNIQUES

Bill Orr  
W6SAI

## the "radio ground" on 160 meters

My good friend Stew Perry, W1BB, is an avid 160-meter operator. He once told me that a fine "top-band" compromise antenna for hams with little space was an extended Marconi working against a good ground system. Taking his advice, I put up a 165-foot, series-tuned long wire (resonant at 1500 kHz) working against ground (fig. 1).

The ground consisted of the cold water copper pipes in the house, plus two ground rods — one at each end of the house — and a single quarter-wave radial wire running through the bushes about 2 feet above the ground.

This antenna worked quite well. However, when I went on 160 the ceiling light in the family room lit up! Obviously, the rf was getting into the house wiring somehow.

Using an MFJ-206 Antenna Current Probe, tuned to 160 meters, I started "sniffing" the house wiring for rf energy. Aha! I could put the transmitter on low power, lock the key, walk through the house with the probe, and actually trace the electric wires hidden in the walls. The house's whole electrical system was "hot" with rf.

My first thought was that the wiring was picking up induced rf energy merely by being in the near field of the antenna. But the amount of rf measured seemed too high, considering the physical separation of the Marconi antenna from the house. If this was not the path, what was?

The probe indicated that the power cable to the transceiver was full of rf

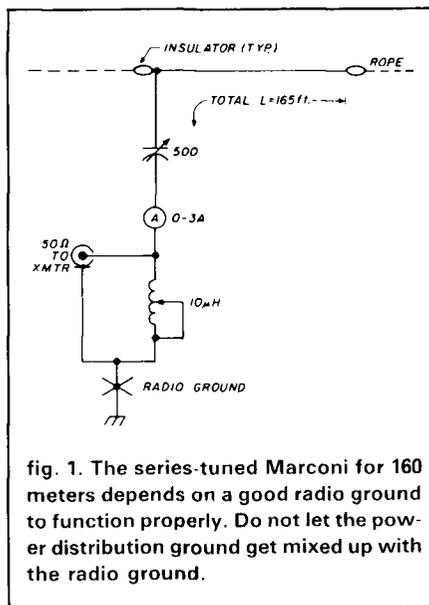


fig. 1. The series-tuned Marconi for 160 meters depends on a good radio ground to function properly. Do not let the power distribution ground get mixed up with the radio ground.

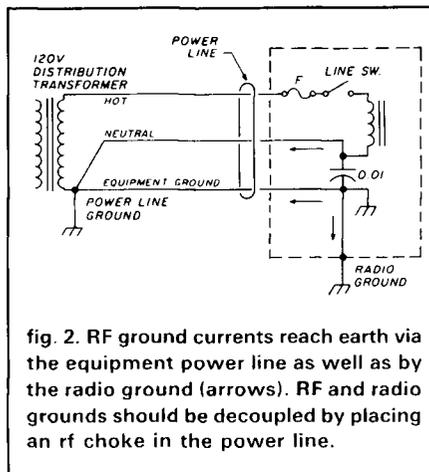


fig. 2. RF ground currents reach earth via the equipment power line as well as by the radio ground (arrows). RF and radio grounds should be decoupled by placing an rf choke in the power line.

energy. Most confusing. The rig actually had two grounds on it, didn't it? They were the radio ground system I installed, plus the neutral and ground conductors of the power line (fig. 2). A little thought revealed the problem.

## separating the radio and electrical grounds

Figure 2 shows that two ground points exist: the intentional radio ground at the equipment, and the electrical ground at the power distribution transformer. The latter serves as a radio ground, as rf ground currents in the antenna circuit return via both paths. The unwanted path through the power cable is closely coupled to the other power conductors and feeds rf energy into them. And, if the power wiring has appreciable impedance at 160 meters, any rf fed into the power line can wander into some very unlikely places.

My solution was to wind the line cord of the transceiver around a ferrite rod (Amidon R-33-050-750), 7-1/2 inches long, and 1/2 inch in diameter. This was held in place by two plastic cable wraps. The rf antenna current immediately increased 30 percent (!) after the line choke was installed. Encouraged by this success, I took an 8-foot extension cord, wrapped it around a second ferrite rod, and placed it in series with the first line choke. This increased the antenna current an additional 5 percent and the family room light did not go on when I hit the key.

I "sniffed" the house wiring with the probe again. There was still a little rf present, but it was greatly reduced. It looked as if the problem was solved.

## problems with a linear amplifier

Now that everything had cooled off, I decided to put my 160-meter, home-made linear amplifier on the air. It uses a single 3-500Z and runs about 1-kW PEP input.

As I fired it up, a loud cry came from the other end of the house. The family room lights magically turned themselves on, along with the light in the entry hall!

Since I had used up all my ferrite rods, I found a fine industrial rf filter for the 240-volt line in the junk box. It was a well-known brand built in a nice plastic box with heavy conductors on each end (fig. 3). Unfortunately, placing it in the power line to the amplifier made no difference in the amount of rf in the power line.

It seemed that the impedance of the power line neutral wire was sufficiently high at 160 meters to allow the neutral to rise above rf ground at the filter. If this guess was correct, the capacitors in the filter served merely to bypass the rf around the line chokes.

Grounding the common point of the capacitors to the radio ground at the amplifier helped but did not solve the problem. Now the amplifier had a radio ground point, plus two power line ground points: one at the distribution transformer and a second at the transmitter radio ground. This complex grounding situation left me uneasy, so I tossed out the 240-volt line filter and wrapped the power cord to the amplifier around two ferrite rods held together with plastic tape. (I used two rods because the amplifier power cable was heavy and difficult to wrap around a single rod.)

I was happy to note that the lights no longer blinked as I keyed the amplifier. All was as it should be. Thus I learned that when a Marconi antenna is used, the ground system may be more complex than it looks. It is important to decouple the power line

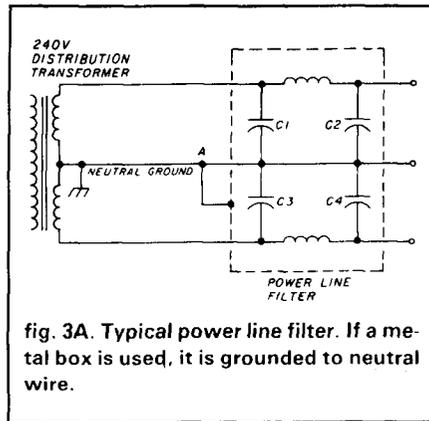


fig. 3A. Typical power line filter. If a metal box is used, it is grounded to neutral wire.

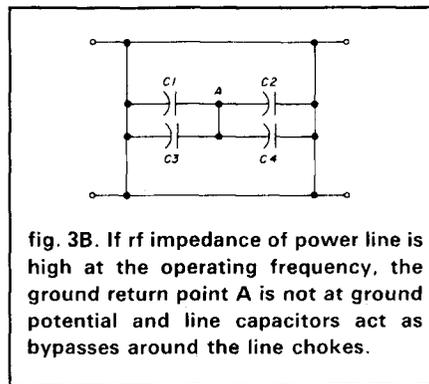


fig. 3B. If rf impedance of power line is high at the operating frequency, the ground return point A is not at ground potential and line capacitors act as bypasses around the line chokes.

from the rf ground system, and the easiest way to do this is to wrap the power cable around a ferrite rod. The old-style line filter made up of inductors and capacitors just doesn't do the job if the neutral line is used as the filter return ground point.

## a two-band dipole antenna

Much is written about two-band antenna designs using tuned traps in the radiating element. A different approach is shown (fig. 4) in a design by Ron May, VK1PM.

This dipole covers the 80 and 40-meter bands. On 40 meters, the center section of the antenna acts as a folded dipole with a feedpoint impedance of about 300 ohms. The end sections, each a quarter wavelength long, are decoupled from the antenna and act as linear traps. On 80 meters, the full length of the antenna forms a half-wave element, fed with a T-match to the 300-ohm feedpoint. A 300-ohm TV-type feedline, with a 6:1 balun at the end, is used to match a nominal

50-ohm feedpoint (Palomar PB-6 balun). A coax line runs from the balun to the station. Overseas Amateurs using 75-ohm coax can use a 4:1 balun.

The idea can be applied to any two harmonically related bands, such as 40/20, or 20/10 meters.

## HB9ADQ delta loop for 7/14/21/28 MHz

The delta loop shown in fig. 5 can operate on four bands. Maximum current is in the horizontal wire for best low angle radiation. The loop can be slung between two trees for ease of installation. Maximum radiation is at right angles to the plane of the loop (into and out of the page).

The loop is fed with a two-wire transmission line. The original design called for a 600-ohm line, which could be made up easily by any old-timer who has had experience building a Zepp antenna. Modern substitutes are the Saxton Products Corp. 1562 insulated open wire line (using a polyethylene web) or the 2500 open-air line. The length of the line is adjusted for minimum SWR on the coax feedline. When the 600-ohm line is used, a 20-pF capacitor is connected across the feedpoint.

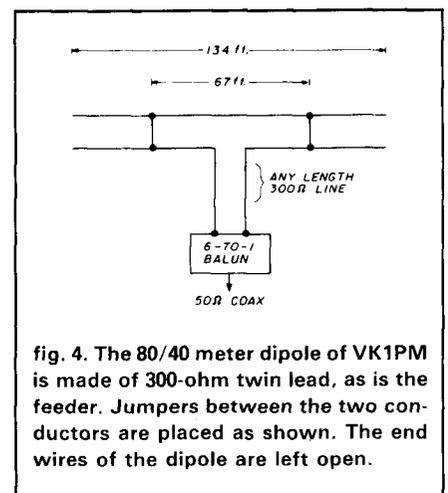


fig. 4. The 80/40 meter dipole of VK1PM is made of 300-ohm twin lead, as is the feeder. Jumpers between the two conductors are placed as shown. The end wires of the dipole are left open.

The open wire line can be extended to reach the station where it is fed with an antenna tuner that provides balanced output in the range of 100 to 600 ohms.

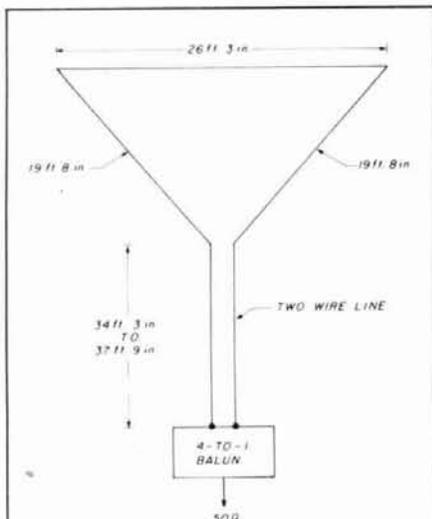


fig. 5. Four-band loop for 7/14/21/28 MHz. Balanced feedline and balun provide match to 50-ohm coax. Adjust length of two-wire line for lowest SWR on coax.

The loop need not be in the vertical plane. It can be laid on the side or at a 45 degree angle and still do the job.

ham radio

## SPECIALIZED COMMUNICATIONS FOR TODAY'S RADIO AMATEUR!



Our 20th Year!

Since 1967, covering all modes of Amateur Radio "specialty" communications; Fast Scan TV, SSTV, FAX, Packet Radio, Computers, RTTY, AMTOR, Satellites, TVRO, Microwave, Lasers and more! 10 issues per year. Back issues available, SASE brings TRS80C, C64, IBM software catalog. U.S. subscribers \$20/year. Foreign slightly higher. Add \$2.00 for Index Issue.

**SPEC-COM Communications & Publishing Group**  
P.O. Box H  
Lowden, Iowa  
52255-0408



5% Added

# 1988 CALLBOOKS



## The "Flying Horse" sets the standards

Continuing a 67 year tradition, we bring you three new Callbooks for 1988.

The North American Callbook lists the calls, names, and address information for 478,000 licensed radio amateurs in all countries of North America, from Canada to Panama including Greenland, Bermuda, and the Caribbean islands plus Hawaii and the U.S. possessions.

The International Callbook lists 481,000 licensed radio amateurs in countries outside North America. Its coverage includes South America, Europe, Africa, Asia, and the Pacific area (exclusive of Hawaii and the U.S. possessions).

The 1988 Callbook Supplement is a new idea in Callbook updates, listing the activity in both the North American and International Callbooks. Published June 1, 1988, this Supplement will include thousands of new licenses, address changes, and call sign changes for the preceding 6 months.

The 1988 Callbooks will be published December 1, 1987. See your dealer or order now directly from the publisher.

- North American Callbook  
incl. shipping within USA \$28.00  
incl. shipping to foreign countries 30.00
- International Callbook  
incl. shipping within USA \$30.00  
incl. shipping to foreign countries 32.00
- Callbook Supplement, published June 1st  
incl. shipping within USA \$13.00  
incl. shipping to foreign countries 14.00

### SPECIAL OFFER

- Both N.A. & International Callbooks  
incl. shipping within USA \$55.00  
incl. shipping to foreign countries 60.00

Illinois residents please add 6 1/2% tax.  
All payments must be in U.S. funds.

RADIO AMATEUR **callbook** INC.



Dept. F  
925 Sherwood Dr., Box 247  
Lake Bluff, IL 60044, USA

Tel: (312) 234-6600



## Above and Beyond AR2002

PROFESSIONAL MONITOR RECEIVER

25 - 550 MHz  
800 - 1300 MHz



### Specifications:

Receiving mode - Narrow band FM, Wide band FM & AM

Receiver circuit - Microprocessor controlled PLL  
Frequency synthesized superheterodyne type  
with high-level doubled balanced mixer

Receiver IF - 750MHz, 45.03MHz, 5.5 MHz (WFM)  
and 455kHz (NFM & AM)

Sensitivity - NFM - 0.35  $\mu$ V (12dB SINAD)  
WFM - 1.00  $\mu$ V (12dB SINAD)  
AM - 1.00  $\mu$ V (10dB S/N)

Selectivity - NFM -  $\pm$  7.5kHz @ 6dB  
 $\pm$  20kHz @ 70dB  
WFM -  $\pm$  50kHz @ 6dB  
 $\pm$  250kHz @ 60dB  
AM -  $\pm$  5.0kHz @ 6dB  
 $\pm$  10kHz @ 70dB

Number of memory channel - 20 channels

Scan rate - 5 channels per second

Search rate - 6 seconds per MHz

Antenna connector - Standard BNC type, 50-ohm

Audio output power - 1 watt at less than 10% THD.

Power requirement - 12 to 14Vdc at 300 to 500mA

Size and weight - 5.4"W x 3.15"H x 7.88"D, 2.6 lbs.

### Options:

Cradled mobile mounting bracket

Trunk lid mobile antenna with 12 ft cable

Discone base antenna with 30 ft cable

RS-232C Interface unit

**Please: No Dealer Inquiries**

**AR2002**

Professional Monitor Receiver

**\$455.00**

(California res. add \$27.30 tax)

Visa and MasterCard accepted

Prices includes shipping & handling

C.O.D. slightly higher

22511 Aspan Street, Lake Forest, CA 92630-6321

Calif/Alaska (714) 581-4900

Facsimile (714) 768-4410 (not a phone)

**TOLL FREE 1-800-523-6366**

**ACE communications, inc.**

# amateur packet radio networking and protocols: part 2

## OSI/RM levels and the AX.25 packet radio protocol

**This is the second article** in a three part series on networking and protocols in amateur packet radio. Last month I introduced the subject of networks and protocols with examples of various systems.

Part 2 gives more detailed information on the initial layers of the OSI/RM introduced in Part 1 and their relation to amateur packet radio. Also examined is the AX.25 packet radio protocol. Portions of this series are excerpted from my book, *The Packet Radio Handbook*.\*

### OSI/RM and amateur packet radio

There are three levels of OSI/RM (Open Systems Interconnection Reference Model) currently implemented in amateur packet radio in the United States: the physical, data link, and rough forms of the network layer. We will discuss the first two. Levels and protocols now under development will be covered in Part 3.

#### physical layer

The physical layer is well prescribed and the Bell 202 and 103 are its most widely used modulation standards. The RS-232C asynchronous serial interface is another physical layer standard and more should emerge when high speed modems and new modulation schemes are developed.

Encoding technique is an area of the physical layer involved in transmission of data which defines the format of the modulated signal. In RTTY and Amateur packet radio, a bipolar format is used. In bipolar key-

ing, two different levels are used to represent a 1 and a 0. This is an improvement over unipolar keying where a single tone indicates a 1 and the absence of a tone a 0. (See **fig. 1**.)

Bipolar keying takes several forms. NRZ (NonReturn to Zero) or NRZ-L (NRZ-Level) is used by regular Baudot RTTY and AMTOR. In NRZ, a 1 is represented by a particular level or tone, and a 0 by another. See **fig. 2**.

NRZ-I (NRZ Inverted) or NRZ-S (NRZ Space) is the bipolar method employed by most packet radio stations and supported by all manufactured TNCs. In NRZI, a binary 0 causes a switch (or transition) between signal levels while a binary 1 remains at the current level. The two signal levels can also be referred to as "mark" and "space" levels.

Other forms of bipolar keying encoding techniques are: NRZ-M (NRZ-Mark; the opposite of NRZ-S), PPM (Pulse Position Modulation), PDM (Pulse Duration Modulation), and Manchester I and II. These and other encoding techniques are discussed on pages 19-39 of the 1986 ARRL Handbook.

#### data link layer

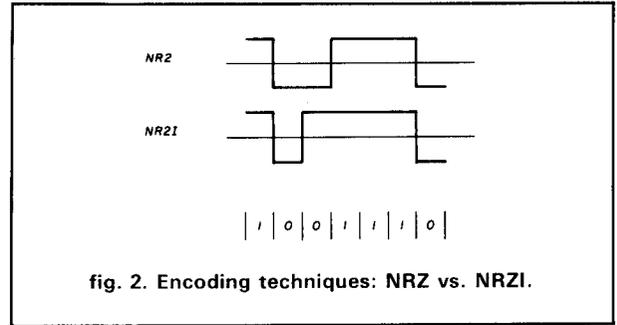
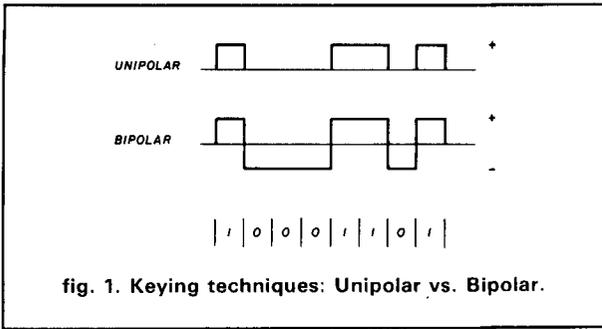
The data link layer in amateur packet radio is also well prescribed. The AX.25 protocol is the most common and is supported by the majority of commercial TNCs. The V-1 (VADCG—Vancouver Amateur Digital Communications Group), and V-2 protocols are other data link layer protocols. These differ from AX.25 in many respects, however, all three protocols are based on the HDLC ISO standard.

#### HDLC

High-level Data Link Control (HDLC) is the data link layer (level 2) of X.25 and is defined in the following ISO standards: ISO 3309, ISO/DIS 4335, ISO/DIS 6156, and ISO/DIS 6259. HDLC is responsible for

\*Available from the *ham radio* Bookstore for \$14.95 plus \$3.50 shipping and handling.

**By Jonathan L. Mayo, KR3T, 1817 Saratoga Court, Allentown, Pennsylvania 18104**



delivering error free data throughout the network. It also isolates the upper levels from the physical layer. Data is broken up into blocks (frames) for transmission. The user data (actual data sent through the network by the users) is called data or information.

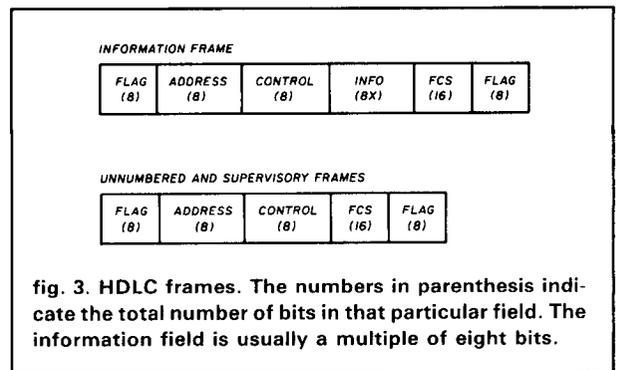
HDLC consists of three sublayers: 1) transparency of the bit stream, 2) frame format, and 3) cooperation between stations. Before continuing this discussion of HDLC, an explanation of the differences between COPs and BOPs is necessary.

COP stands for Character Oriented Protocol. Two examples are ANSI X3.28 and IBM Binary Synchronous Communication. In a COP, the data being sent must be represented as characters of specified length — usually seven or eight bits (one byte) — so there is a limit to the type of information that can be transmitted. All transmission lengths must be a multiple of the specified character length. COPs are helpful if just text is being transmitted, but less useful in packet radio which is designed to send any type of digital data including characters of different lengths, graphics, and special formats. In packet radio, transmission size must also be condensed as much as possible. BOPs (Bit Oriented Protocols) come in handy here.

BOPs permit the transmission of any format of digital data. A good example of a BOP is HDLC along with the amateur packet radio data link layer protocols. If control information is only 3 or 4 bits long, BOPs will only consume 3 or 4 bits, not a full 7 or 8 as COPs do.

In the first sub-layer of HDLC, transparency of the bit stream, all data being transmitted must be packaged the same. HDLC must be independent of the data sent and simply delimit (mark the beginning and end) frames. No special length bits or signaling elements can be used and all data should pass through the physical layer without alteration or processing. A flag — a special binary sequence found only at the beginning and end of a frame — is used to do this. The flag used in HDLC is 01111110 and must not appear anywhere else in the frame.

To keep flags out of the user data, the information is examined, and a 0 is inserted after every five consecutive 1 bits. This is called *bit stuffing*. The receiv-



ing station corrects for this by removing the stuffed bit after a sequence of five 1s if it is a 0; if the bit is a 1, it will not be removed as the sequence of ones is part of a flag.

In the second sub-layer, the frame format, all data is segmented and sent in frames delimited by flags. The components of the frame between the two flags are: addresses, control information, data, and the FCS (Frame Check Sequence). **Figure 3** shows the HDLC frames. Frame components are described below.

The first frame component following the initial flag is the address. In HDLC this includes the address of the originating and destination station. The addresses are usually numerics, but AX.25 uses callsigns instead of numbers and includes digipeaters in this section.

The next section (or field) in the HDLC frame is control information. Depending on the type of frame, control information can consist of several things. The three types of frames defined under HDLC are: information, supervisory, and unnumbered. The control field is made up of 8 bits.

Information frames are used for data transfer (to carry user information). Bit 1 of the control field of an information frame is a 0, bits 2 through 4 represent the transmitting station sequence number (often called transmit count), bit 5 is the poll/final bit, and bits 6 to 8 represent the receiving station sequence number (receive count).

Supervisory frames are used to control data flow.

## CONFERENCE PROCEEDINGS

NEW

### AMSAT-NA FIFTH Space Symposium

This conference was held in conjunction with the 1987 Amsat Annual Meeting in Southfield, MI, Nov. 6-8, 1987. 11 papers are presented with topics on: trends in spacecraft technology, and space science education, FO-12 mailbox, QRP EME, Phase III-C and Phase IV developments in orbital determination and attitude control. Over 100 pages \$12.

**21st Central States VHF Society Conference** held in Arlington, Texas, July 23-26, 1987. 28 papers covering everything from use of TVRO dishes for moonbounce to a solid state amplifier for 5.7 GHz. 166 pages. \$10.

**6th ARRL Computer Networking Conference** held in Redondo Beach, California, August 29, 1987. The latest concepts on networking, high speed modems and other packet-radio technology are discussed in 30 papers that were prepared for the conference. 174 pages. \$10.

### OTHER CONFERENCES

**Mid-Atlantic VHF Conference.** This conference was sponsored by the Mt. Airy VHF Radio Club, Oct. 10-11, 1987. 11 papers cover everything from mountain topping to transceivers for the 3400 and 5600 MHz bands. 120 pages. \$10.

**MICROWAVE UPDATE 1987** held in Estes Park, Colorado, September 10-13, 1987. 17 papers on equipment, antennas and techniques for 902 MHz through 10 GHz. Much information on construction of 2.3, 3.4 and 5.7 GHz gear. 136 pages. \$10.

Please include \$2.50 (\$3.50 UPS) for shipping and handling.

**PUBLISHED BY:**

THE AMERICAN RADIO RELAY LEAGUE  
225 MAIN STREET  
NEWINGTON, CT 06111

✓ 252



**SPECIAL PURCHASE FROM THE PUBLISHER ALLOWS US TO SLASH THE PRICES ON THESE BOOKS**

### PROGRAMMING FOR THE TI-59 AND HP-41 CALCULATORS

by Paul Garrison

To take full advantage of your hand-held calculator's power, you need to learn how to program it. Clear easy-to-understand instructions make programming a snap! Over half the book has practical programming applications that will solve some very complex problems. 1982. 294 pages.

T-1442 Was \$12.95 SAVE \$8 Softbound \$4.95

### MICROCOMPUTERS IN AMATEUR RADIO

by Joe Kasser, G3ZCZ

Computers can be used in a number of different ways in your Ham shack. They can be used to control your rig, predict propagation, control antennas and hundreds of other applications. Kasser explores the possibilities in this book. Includes interface I/O devices, system categories, programming the micro-computer and much more. Great reading. 1981. 307 pages.

T-1305 Was \$15.95 SAVE \$4.95 Softbound \$4.95

### SOFTWARE FOR AMATEUR RADIO

by Joe Kasser, G3ZCZ

Packed with practical computer applications and tested and debugged programs that can be simply adapted to almost any microcomputer. Includes BASIC programming concepts as well as how to interface your computer to your radio, digital communications and more. 1984. 284 pages.

T-1560 Was \$15.95 SAVE \$11.00 Softbound \$4.95

### BUY ALL 3 SPECIAL

\$44.85 VALUE at retail

T-SPB \$10.95  
SAVE \$33.90 WOW What a Deal!!!

Please enclose \$3.50 shipping and handling

**ham radio BOOKSTORE**

GREENVILLE, NH 03048

603-878-1441

## THROW AWAY YOUR FALCON CATALOGS

Falcon Communications, THE source for quality, American made, MOS-FET and bipolar repeater, base station and mobile power amplifiers announces a major re-design of our line.

Send for information on our models 8151, 8152, 8153, 8162, 8163, 8171, 8172, 8181, 8182, 8183, 8184, 8251, 8252, 8253, 8261, 8262, 8271, 8272 and 8282.



**FALCON COMMUNICATIONS**

P.O. Box 8979 • Newport Beach, CA 92658  
(714) 760-3622

Please send all reader inquiries directly.

### CORDLESS PHONE - LINK??

FEELING TIED DOWN TO YOUR MICROPHONE??

American Lightwave introduces a fantastic kit that converts your cordless phone into a remote link!!

#### PHONE LINK

- \* Use your rig from the kitchen, garden, garage
- \* Easy to build - one evening assembly time
- \* Easily connects to your rigs mic and speaker jacks
- \* No mods to radio or telephone system - just plug in
- \* VOX operation
- \* MADE IN THE USA

KIT PL-A High quality glass epoxy board with doc. \$10

KIT PL-B Complete kit - board, parts, doc (less cabinet) \$30

FREE SHIPPING IN THE CONTINENTAL USA

Check, Money Order, C.O.D. **AMERICAN-LIGHTWAVE**

Or call 313-548-4440

P.O. BOX 71684

C.O.D. only add \$3

Madison Heights, MI 48071-0684

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

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



## ST-8000 HF Modem

**Real HF radio teleprinter signals exhibit heavy fading and distortion, requirements that cannot be measured by standard constant amplitude BER and distortion test procedures.** In designing the ST-8000, HAL has gone the extra step beyond traditional test and design. Our noise floor is at -65 dBm, not at -30 dBm as on other units, an extra 35 dB gain margin to handle fading. Filters in the ST-8000 are all of linear-phase design to give minimum pulse

distortion, not sharp-skirted filters with high phase distortion. All signal processing is done at the input tone frequency; heterodyning is NOT used. This avoids distortion due to frequency conversion or introduced by abnormally high or low filter Q's. Bandwidths of the input, Mark/Space channels, and post-detection filters are all computed and set for the baud rate you select, from 10 to 1200 baud. Other standard features of the ST-8000 include:

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

**Write or call for complete ST-8000 specifications.**



### HAL Communications Corp.

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

Bit 1 of a supervisory frame's control field is a 1, bit 2 is a 0, and bits 3 and 4 represent the supervisory frame type indicator. Bit 5 is the poll/final bit, and bits 6 to 8 show the receive count.

Unnumbered frames control the link. Bits 1 and 2 of the control field of an unnumbered frame consist of ones, bits 3 and 4 are modifier bits, bit 5 is the poll/final bit, and bits 6 to 8 are modifier bits.

Each station involved in a link maintains counters for the number of information frames sent and received. These counters are the "sequence number" or "count". They are sent in the control field of each information frame, and used to check the sequence of received frames and acknowledge their reception.

The HDLC frame component next to the final flag is the FCS. The FCS is a cyclic redundancy check (CRC) performed on a frame — an error detection scheme in which a check character is generated by dividing the entire numeric binary value of a block of data by a generator polynomial. The FCS value is sent along with the data, and at the destination station, is recomputed from the received data. If the received FCS matches the one generated from the received data, the data is considered error free.

Computation of the FCS starts with the first bit after the opening flag and ends with the last bit preceding the FCS. For details on FCS methods, see ISO standard 3309.

Cooperation between stations, the last sub-layer, is handled by special frames recognized by HDLC as commands and responses. Three tasks of command and response frames are to establish connections, acknowledge receipt of frames, and handle disconnects. Specifics of the different commands and responses used by HDLC to manage the link layer in Amateur packet radio are discussed under the appropriate protocols.

## AX.25

AX.25 has become the standard level 2 protocol in Amateur packet radio. It is very similar to the level 2 protocol of the X.25 standard; thus the name 'AX.25' ('A' is for Amateur). The original version of AX.25 has been around for a while and minor incompatibilities existed between various implementations until the ARRL Ad Hoc Committee on Amateur Digital Communications finished a revised version of the AX.25 standard in 1984.

The ARRL version of AX.25 is called *AX.25 Version 2* and the earlier AX.25 protocol is now *AX.25 Version 1*. The more popular AX.25 Version 1 protocol was developed by Tucson Amateur Packet Radio (TAPR). There are both similarities and incompatibilities between these versions of AX.25.

AX.25 follows the same frame format as HDLC. The main differences are that 1) the address field has been

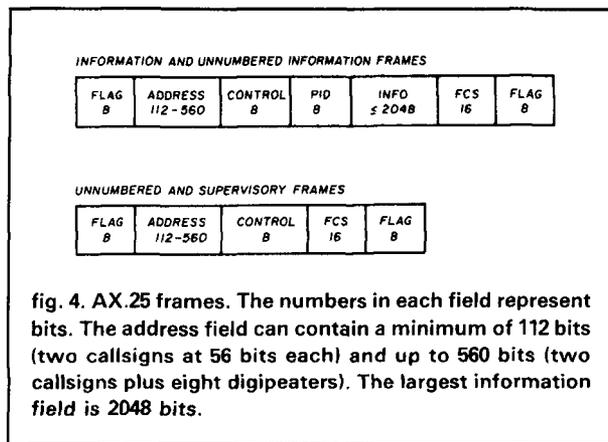


fig. 4. AX.25 frames. The numbers in each field represent bits. The address field can contain a minimum of 112 bits (two callsigns at 56 bits each) and up to 560 bits (two callsigns plus eight digipeaters). The largest information field is 2048 bits.

extended to permit amateur radio callsigns as addresses and 2) unnumbered information frames may be transmitted.

A description of the various components of an AX.25 frame (see fig. 4) follows.

The flag is identical in function and design to that used in HDLC.

The address field is made up of a minimum of one amateur radio callsign belonging to the sending station in a unnumbered information frame (the destination is set to a dummy address). In most cases, the destination station's callsign is included. Up to eight digipeater callsigns may also be added. There is a maximum number of ten callsign addresses in the AX.25 address field.

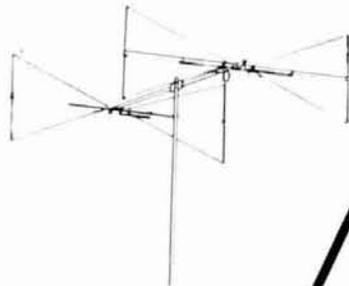
Each callsign requires seven groups of eight bits (eight bits = one byte = one character or an 'octet'). Callsigns consist of uppercase ASCII characters and numbers. The first six characters are allotted for the actual callsign; if the callsign is less than six characters in length, spaces are added to the end. The seventh character is the SSID (Sub-Station Identifier or Secondary Station Identifier) and ranges from 0 to 15. Only four bits of the eight available for the SSID are used. The first and last bits are set to 0 and the remaining two are reserved for future use.

The SSID of a digipeater carries additional information. To avoid a digipeater repeating a frame twice, the last bit of the SSID is set to 1 once the frame has been digipeated by that station.

The control field is made up of one eight bit group (an octet) and is used to identify the type of frame: information, unnumbered, unnumbered information, and supervisory. It also contains the frame count numbers used for acknowledgements and special signals for establishing and maintaining connections (commands and responses).

A Protocol Identifier Field (PID) is included with information frames. It identifies what kind of network layer protocol, if any, is being used.

The HF4B "Butterfly"™  
A Compact Beam  
for 20-15-12-10 Meters



- Unique design reduces size but **not** performance
- No lossy traps; full element radiates on all bands
- Retrofit kit for 17 meters coming soon.
- Turns with TV rotor
- Only 17 lbs.

HF ANTENNAS FROM BUTTERNUT

**Butternut Verticals**

Butternut's HF verticals use highest-Q tuning circuits (not lossy traps) to outperform all multiband designs of comparable size!

**Model HF6V**

- 80, 40, 30, 20, 15 and 10 meters automatic bandswitching
- Add-on kit for 17 and 12 meters available now
- 26 ft. tall

**Model HF2V**

- Designed for the low band DXer
- Automatic bandswitching on 80 and 40 meters
- Add-on units for 160 and 30 or 20 meters
- 32 feet tall - may be top loaded for additional bandwidth

For more information see your dealer or write for a free brochure



**BUTTERNUT ELECTRONICS CO**  
405 East Market Lockhart, Texas 78644



**MUST SELL  
AT BIG SAVINGS TO YOU!**



**Magnetic Roof Antenna Included.**

**MOBILE CB RADIO**

Looks Like a Phone, but it's really a CB Radio from Fox. Equip your vehicle with this Model CB800 for on-the-road help, information, or friendly conversation. Take advantage of our special arrangements with the manufacturer. Order yours today at **Tremendous savings!**

- 40 Channel CB Radio Resembles a Mobile Car Phone. Ivory Colored, Compact.
- Digital LED Type Channel Display.
- Up/Down Channel Tuning/Volume Control.
- Automatic, Built-In Noise Eliminator.
- Squelch Control Cuts Background Noise.
- Easy Transmit Button (Push to Talk).
- Built-In Dynamic Microphone.
- Fast Channel 9 Emergency Switching.
- PA Capability. Built-In Speaker Jack.
- Magnetic Mount Black Antenna (Included).
- CB Plugs Into 12V Car Cigarette Lighter Socket. Mounting Hardware and Complete Instructions Provided. 8 1/2" H x 4 1/4" W x 2" D.

**One-Year Limited Factory Warranty.**

List: ~~\$162.90~~ **\$99**

Liquidation Price . . .  
Item H-3163-7237-969 S/H: \$6.50 ea.

Credit card customers can order by phone, 24 hours a day, 7 days a week.

**Toll-Free: 1-800-328-0609**

**SEND TO:**

**COMB** Authorized Liquidator

1405 Xenium Lane N/Minneapolis, MN 55441-4494

Send      Fox CB Radio(s) Item H-3163-7237-969 at \$99 each, plus \$6.50 each for insured shipping, handling (Minnesota residents add 6% sales tax. Sorry, no C.O.D. orders.)

My check or money order is enclosed. (No delays in processing orders paid by check.)

PLEASE CHECK  VISA  MasterCard  Discover  American Express

Acct No \_\_\_\_\_ Exp. / \_\_\_\_\_  
PLEASE PRINT CLEARLY

Name \_\_\_\_\_

Address \_\_\_\_\_ Apt. # \_\_\_\_\_

City \_\_\_\_\_

State \_\_\_\_\_ ZIP \_\_\_\_\_

Phone (\_\_\_\_) \_\_\_\_\_

Sign Here \_\_\_\_\_

**THE 1988  
ARRL  
HANDBOOK**

FOR THE RADIO AMATEUR



**NEW  
EDITION**

The 1988 ARRL Handbook For The Radio Amateur carries on the tradition of the previous editions by presenting 1200 pages of comprehensive information for the radio amateur, engineer, technician and student. Clothbound only. **\$21** in the U.S., **\$23** in Canada and elsewhere.

THE AMERICAN RADIO RELAY LEAGUE  
225 MAIN STREET  
NEWINGTON, CT 06111

**MADISON**

Electronics Supply, Inc.  
3621 Fannin St. • Houston, Texas 77004



**BELDEN**

✓ 253

**BELDEN**

9913 low loss, solid center conductor, foil & braid shield - excellent product	45¢/ft
8214 RG8 foam	43¢/ft
8237 RG8	40¢/ft
8267 RG213	52¢/ft
8262 RG-58 c/u milspec	16¢/ft
8000 14ga stranded copper ant. wire	13¢/ft
8448 8 conductor rotor cable	31¢/ft
9405 as above but HD--2 16ga, 6 18ga	52¢/ft
8403 Mic cable 3 conductr & shield	80¢/ft
100 feet 8214 wends installed	45.00
9258 RG-8X	19¢/ft
9914	54¢/ft

**POLICIES--MASTERCARDS, VISA or C.O.D.**

All prices FOB Houston, Texas, except as noted. Prices subject to change without notice, subject to prior sale. Used gear sale price refunded if not satisfied. Call anytime to check status of your order. Texas residents add sales tax.

**FOR MORE INFORMATION CALL**

outside Texas

**1-800-231-3057**

Texas and outside U.S.

**1-713-520-7300**

**TOWERS** by ALUMA HR-2

HIGHEST QUALITY ALUMINUM

- TELESCOPING (CRANK-UP)
- GUYED (STACK-UP)
- TILT-OVER MODELS

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

EXCELLENT FOR AMATEUR COMMUNICATIONS

Over 36 types aluminum towers made — specials designed and made — Write for details.

T-140 40' Crank-Up Tower

T-40H 40' Heavy Duty Ham Tower Crank-Up

Mobile Trailer Type

Mobile Truck Type

SPECIAL Four Section 50 FL Van Mounted Crank-up Aluma Tower

Fixed Base

**ALUMA TOWER CO.**  
 BOX 2806HR  
 VERO BEACH, FL 32961-2806  
 (305) 567-3423 803405 MAIN-VERO

THE BEVERAGE ANTENNA HANDBOOK

BRAND NEW

FULLY REVISED

BEVERAGE ANTENNA HANDBOOK

by Vic Misk, W1WCR New Edition

W1WCR has spent countless hours developing new antenna ideas and optimizing the SWA (Steerable wave antenna.) Misk delves deep into the secrets of the single wire Beverage with helpful hints and tips on how to maximize performance based upon wire size, height above ground, overall length and impedance matching. Also includes information on center fed Beverages constructed out of several wire types. **SMALL LOT OWNERS** — Beverage for you too! Called the Micro-SWA, it is just 60 ft long. You get excellent directivity and null steering capabilities. Transformer design information for both termination and feedline matching is completely revised. © 1987 80 pages

VM-BAH   Softbound \$14.95

Please enclose \$3.50 shipping & handling

**ham radio BOOKSTORE**  
 GREENVILLE, NH 03048 603-878-1441

**CADDELL COIL CORP.**

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

**BALUNS**

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

100 Watt (4:1, 6:1, 9:1, or 1:1 Impedance—select one)	\$10.50
Universal Transmatch 1 KW (4:1 Impedance)	14.50
Universal Transmatch 2 KW (4:1 Impedance)	17.00
Universal Transmatch 1 KW (6:1, 9:1, or 1:1—select one)	16.00
Universal Transmatch 2 KW (6:1, 9:1, or 1:1—select one)	18.50

Please send large SASE for info.

**FIELD DAY!**



**3 in 1 Portable Antenna Kit** perfect for "field days!" Designed for 2-12 MHz operation; includes At-101-102 long-wire (#15 stranded-copper) with insulators & clips for adjusting frequency, 5-section whip with IN-127 base, plus CP-12-13 counterpoise for 15' radial groundplane. Also guys, 4-stakes, and canvas carrying bag. NATO-surplus; used-good. 22 lbs.

#FD-GRC-9, ..... \$49.50

Prices F.O.B. Lima, O. - VISA, MASTERCARD Accepted.  
 Allow for Shipping • Write for 1988 CATALOG  
 Address Dept. HR • Phone 419/227-6573

**FAIR RADIO SALES**  
 1016 E. EUREKA • Box 1105 • LIMA, OHIO • 45802

CALL LONG DISTANCE ON YOUR HANDHELD

35 WATT and 75 WATT 2-METER AMPLIFIERS

The **MODEL 335A** will deliver 35 watts of power using the latest state-of-the-art circuitry. The amplifier will operate SSB or FM and is compatible with most handheld transceivers, including the TR2400, TR2500, TR2600, IC-2AT, Yaesu, Santec, and TenTec. Only 300 mw input will deliver 5 watts out; 3 watts in will deliver 35 watts out. Maximum input level is 5 watts.



We specialize in carrying a complete parts list for the 140 and 300 watt HF amplifiers as described in the **MOTOROLA** Bulletins EB-27A, AN-758, EB-63, AN-762 and as described in the **ARRL** Handbook. We also carry a line of **ATV** equipment for 70 and 33 CM. For detailed information and prices, call or write for our free catalog.

MODEL 335A (35watt) Kit \$ 79.95  
 MODEL 875A (75watt) Kit \$119.95  
 (add \$2.00 Shipping and Handling)

**CCI Communication Concepts Inc.**

121 Brown Street • Dayton, Ohio 45402 • (513) 220-9677

VISA 

VISA  **ICOM** 

**VHF COMMUNICATIONS**

INTRODUCING W2DRZ VHF/UHF MODULES. NOW AVAILABLE.

ICOM, AEA, LARSEN, VAN GORDEN, VIBROPLEX, NYE-VIKING, FALCON COMM, LEADING EDGE, ARRL PUBLICATIONS, KAGLO, HAMTRONICS, PROWRITER, ELEPHANT DISKS, DEBCO, TRIONYX

915 North Main Street  
 Jamestown, New York 14701

PH. (716) 664-6345

Western New York's finest... amateur radio dealer!

**SECURITY SYSTEMS**

ALARM & CLOSED CIRCUIT TV

DISCOUNT PRICING

- Panasonic CCTV
- Wireless & Hardwired Alarm Systems
- Experienced
- State Licensed

For More Information

7:30 AM-6 PM CST M-F

**DETECTION DYNAMICS**

4700 LOYOLA LANE, #119  
 AUSTIN, TX 78723 (512) 345-8401

The information field contains the user data being transmitted and is most often divided into a multiple of octets; the maximum is 256.

The FCS is the same as that used in HDLC.

Each transmission is usually preceded by a series of sixteen alternating bits giving the receiving station time to synchronize to the signal.

AX.25 is actually a subset of the HDLC standard as it does not implement the full range of features defined in HDLC. It is based on the LAPB (Link Access Procedure Balanced) subset of HDLC.

In a "normal" HDLC network, there are frequently several slave stations (user terminals) linked to a central controller or host system (also called a primary or master station). The master station is usually more "intelligent" than the slave stations and better able to manage the link. This configuration, with one intelligent master station linked to a less intelligent slave station, is *unbalanced* because the stations possess unequal capabilities.

In amateur packet radio, the goal is for each station to have equal capability in a balanced configuration eliminating the need for a master or host station. This type of station arrangement is supported by LAPB under HDLC.

A discussion of the frames used by AX.25 to establish connections, acknowledge frames, and disconnect follows.

Unnumbered frame control fields are either commands or responses. Unnumbered frames handle all communications between stations when no connection has been established. There are six different unnumbered frames defined in AX.25.

**SABM** (Set Asynchronous Balanced Mode) is a command which sends a connect request to another station. The control field in this frame contains a special sequence of bits identifying it as a SABM frame. The SABM command places two stations in *asynchronous balanced mode* (meaning they are connected).

**DISC**, the next unnumbered frame and another command, is used to send a DISConnect request terminating a connection with another station.

**DM** (Disconnect Mode), is a response sent whenever a station receives any frame other than a SABM while disconnected. It can also be sent in response to a SABM frame to indicate the station is not available.

The **UA** (Unnumbered Acknowledge) response is sent as an acknowledgment for unnumbered frame commands. A received command is not executed until a UA frame has been sent.

**FRMR** (FRaMe Reject) is also a response. It is sent when a station receives a frame that cannot be processed. This response is usually sent when a frame clears the FCS check but is not recognized by the sta-

tion's protocol. Two situations when this might occur are the reception of a command or response not defined in the protocol, or an information frame whose information field exceeds the maximum allowable length.

**UI** (Unnumbered Information) is an addition to the X.25 protocol included in AX.25. The UI frame lets an information field be transmitted without first establishing a connection. These frames are not acknowledged.

Once a connection is established using the above commands and responses, AX.25's function is to transfer error free data between the two stations. It does this by using one of three of supervisory frames.

The **RR** (Receive Ready) response indicates that the sending station is able to receive information frames, acknowledge the reception of information frames, and clear an RNR response previously set by the station. The RR frame acknowledges the reception of information frames by including the receiver count indicating which frames have been correctly received. The other station can examine the count and update the next packet to be sent according to what frames can now be "forgotten".

To indicate that the sending station is temporarily busy and unable to accept more information frames, a **RNR** (Receive Not Ready) response is sent. This might occur when the receive station's buffer is full and it sends an RNR to the other station telling it to hold further information frames until the buffer can receive them. The RNR condition can be cleared by sending a UA, RR, REJ, or SABM frame.

The **REJ** (REject) response requests the retransmission of information frames received out of sequence. The frame(s) to be retransmitted are indicated by the receive count in the frame's control field. The REJ condition is cleared when the frames are properly received.

AX.25 follows certain steps when connecting and disconnecting from another station.

When a user types a "C KR3T" at the command prompt and presses the RETURN key, the TNC prepares a SABM frame containing the user's call and KR3T in the address field. The TNC then checks to see if the channel is available (CSMA) and transmits the SABM frame if it is.

KR3T receives the frame and finds its call in the destination address. If connect-ok (CONOK) is on and the TNC is free to establish a connection, KR3T sends a UA frame to the originating station and is connected. If CONOK is off, KR3T sends a DM frame to the originating station.

Assuming KR3T is available and the originating station has received the UA frame from KR3T, it too becomes connected and information frames are used to transfer data between them. Both stations keep receive and transmit counters current.

# OnSat

"America's Weekly Guide to Satellite TV"



The best in satellite programming! Featuring: ★ Over 120 Channels listed ★ Weekly, Updated Listings ★ Magazine Format ★ Complete Alphabetical Movie Listings ★ Sports Specials ★ Prime Time Grids ★ Specials ★ Programming Updates!

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

\*NC Residents must add 5% Sales Tax

**Subscribe Today!**

call toll free 1-800-234-0021  
Visa® and MasterCard® accepted

OnSat PO Box 2347 Shelby, NC 28151-2347



# STV GUIDE

The new **STV Guide** contains valuable information on zoning regulations, scrambling, plus technical tips for installing or updating a satellite system—and now a precise monthly guide to satellite TV with the latest program listings for over **90 channels!**



All this in each complete issue of **STV Guide!**

- Only \$48.00 per year (12 monthly issues)
- \$2.00 for a sample copy

\*NC Residents must add 5% sales tax

**Subscribe Today!**

Call toll free 1-800-234-0021  
Visa® and MasterCard® accepted

STV Guide PO Box 2384 Shelby, NC 28151-2384



The RR frame is used to acknowledge the receipt of information frames. If a frame is received out of sequence by one of the stations, it sends a REJ to the other and the frame is retransmitted.

When one of the stations wants to end the connection, he returns to command mode and enters "D" at the prompt. His TNC then sends a DISC frame to the other station which, in turn, sends him a UA frame acknowledging the disconnect request and breaking the connection. When the first station receives the UA frame, it also disconnects.

A few points in the previous section on the AX.25 link layer protocol may not seem to fit the description of the data link layer given in Part 1 of this series. These discrepancies include the addition of digipeaters and the use of end to end acknowledgements.

Digipeaters seem to fall under the control of the network layer protocol, not the data link layer, and in many respects this is true. However digipeaters are not, by any means, full fledged level 3 network nodes but rather a simple arrangement added to allow for rudimentary networking. The user must select the digipeaters used; the TNC does not contain automatic routing tables or other means of independently selecting digipeater routes. Digipeaters will most likely disappear as more advanced network nodes and level 3 protocols emerge.

In the OSI/RM the end to end acknowledgements would seem to be the responsibility of the transport layer (level 4). This layer is responsible for the proper reception of frames from station to station through the network. In AX.25 there is no network layer protocol implemented yet, so point to point acknowledgements of the data link layer are simply extended over the digipeater path. If the digipeaters are eliminated from the path, the acknowledgment returns to a point to point acknowledgment as used by the data link layer. Once network nodes are implemented, they will use point to point acknowledgments between nodes and a transport layer acknowledgment between the two end stations.

## summary

This article detailed the first two levels of the OSI/RM as they relate to Amateur packet radio. Also included were a discussion of HDLC (upon which most current Amateur packet radio level 2 protocols are based), and an examination of the AX.25 data link protocol. Part 3, the final article in this series will cover other level 2 packet radio protocols and discuss the remaining layers of the OSI/RM.

If you have any questions or comments, you can write to me at the address listed or leave a message on CompuServe; my User ID is 72276,2276.

ham radio

## parametric amplifiers

**Parametric amplifiers** can operate with very low noise in the UHF and microwave regions of the electromagnetic spectrum. Noise temperatures from 100 to 270 degrees Kelvin (1.4 to 2 dB noise figure) were reported in uncooled parametric amplifiers as early as 1970, and more recent devices offer even better performance.<sup>1</sup> As a result, parametric amplifiers are sometimes used as low noise amplifiers (LNA) in the input stages of VHF/UHF and microwave communications receivers.

The name *parametric amplifier* was chosen because amplification occurs through the excitation of a circuit parameter. This is actually a misnomer because it is the reactance parameters ( $X_C$  and  $X_L$ ) that are excited. A better name might be *reactance amplifier*.<sup>2</sup> The parametric amplifier is fundamentally different from other LNAs because it uses a passive device for amplification. In this type of amplifier circuit a reactance is used as the amplifying element. A perfect reactor stores and discharges energy, but does not dissipate power. Capacitive reactors store energy in an electrostatic field, while inductive reactors store energy in a magnetic field. Parametric amplifiers store energy from an rf "pump" signal in the reactance, and then switch it to the load under the influence of the input signal. Addition of stored energy to the signal at the output of the amplifier causes power amplification.<sup>3</sup>

The parametric amplifier has low noise because reactances dissipate no

power and ideally produce no Johnson (thermal agitation) noise. In practical circuits, resistive losses do occur and Johnson noise is present. By varying the reactance at a rapid rate, energy is stored and discharged by the reactance and is used to amplify the signal. Although either capacitors or inductors can be used in parametric amplifiers, the capacitive reactance is used in practical circuits because suitable voltage variable capacitance diodes ("varactors") are available. However, other processes inside a diode generate noise and while parametric amplifiers exhibit low noise factors, the level is *not* zero.

The capacitance of a varactor is a function of the reverse-bias potential applied across the PN junction of the diode. A typical varactor useful in parametric amplifiers has a breakdown voltage of  $-4$  to  $-12$  volts, and a zero-bias junction capacitance of 0.2 to 5 picofarads. The cutoff frequency should be 20 GHz or higher. Generally, noise figure improves with higher diode cutoff frequencies.<sup>4</sup>

Parametric amplifiers can be operated in either of three modes: *degenerative*, *nondegenerative*, and *regenerative*. We will consider these modes, and provide a tool for evaluating parametric amplifier circuits.

### degenerative parametric amplifiers

**Figure 1A** shows a basic parametric amplifier. A varactor diode switches the signal on and off to the load as an external pump signal is applied. Although shown as a series connected

switch, both series and parallel connected diodes can be used. The signal and pump waveform (see **fig. 1B**) are phased so that the diode capacitance is fully charged when the pump signal peak occurs. Because the charge is constant, the voltage increases by the relationship  $V = Q/C$  in step with a pump voltage reduction of diode capacitance.

Parametric amplification occurs when the peak of the pump signal coincides with the positive and negative peaks of the signal waveform. As the pump voltage peaks the diode capacitance decreases to a minimum, and the capacitor's charge is dumped to the load. Phasing must be precise to achieve degenerative parametric amplification. This occurs when the pump frequency is twice the signal frequency. However, this precise phasing requirement means that drift in either signal can reduce the gain or prevent the circuit from operating. Using nondegenerative or regenerative parametric amplifier circuits is a broader bandwidth approach.

### nondegenerative and regenerative parametric amplifiers

In a nondegenerative parametric amplifier a third frequency, known as an idler,  $f_i$ , is used in addition to the signal and pump frequencies,  $f_s$  and  $f_p$ . In **fig. 2** a third resonant tank circuit ( $L_3C_3$ ) tuned to  $f_i$  is indicated. The idler is the output frequency of the circuit which also operates as a frequency translator or converter.

There are two general cases of non-

# Handheld DX with the DX Handy™

The idea of handheld DX seems far-fetched, but it's actually very simple. The DX Handy is a battery powered (six penlight AA drycells included) SSB/CW transceiver with two watts output. DX Handy can also use nicad rechargeable batteries, or be powered with 9 VDC.

Two variable crystal oscillators (VXOs), each with 50 KHz range, can be selected with a top panel switch. Crystals for 28.250 to 28.300 and 28.300 to 28.350 Mhz are included, and other crystal ranges for the 10 meter band are also available at a nominal cost.

CW operation can be by either the built-in push button or with an external key or keyer. External speaker and microphone jacks are also provided, and the telescoping antenna is included. The DX Handy also has a top panel S-meter/ output power meter and an effective noise blanker circuit. DX Handy is housed in an attractive gray metal case comparing in size to popular VHF FM handhelds.

Ten meters is coming back strong. With DX Handy all amateurs, novice to extra class, can enjoy the thrill of working handheld DX.

**AEA**  
Advanced Electronic Applications  
P.O. Box C2160  
Lynnwood, WA 98036-0918  
(206) 775-7373

AEA Retail \$379.95

Amateur Net \$319.95

## Specifications

### General

- Frequency Coverage: Any two 50 KHz segments in the 28.0–29.0 MHz Amateur Band (28.25–28.30 and 28.30–28.35 MHz supplied)
- Frequency Control: VXO provides 50 KHz of continuous tuning with a single crystal
- Frequency Stability: Within  $\pm 500$  Hz from a cold start
- Antenna: 50 Ohms Unbalanced, BNC connector
- Power Requirement: 8.4–9.0 VDC  
(Included): 6-AA Dry Cells (1.5 volt/cell) = 9.0 VDC  
(Optional): 7-AA NiCads (1.2 Volt/cell) = 8.4 VDC
- Current Drain: Receiving - Approx. 70 mA  
Transmitting - Approx. 620 mA
- Dimensions: (W) 66mm  $\times$  (H) 39mm  $\times$  (D) 142mm
- Weight: 710 Grams (1 lb. 9 oz.) with batteries and antenna

### Transmitter

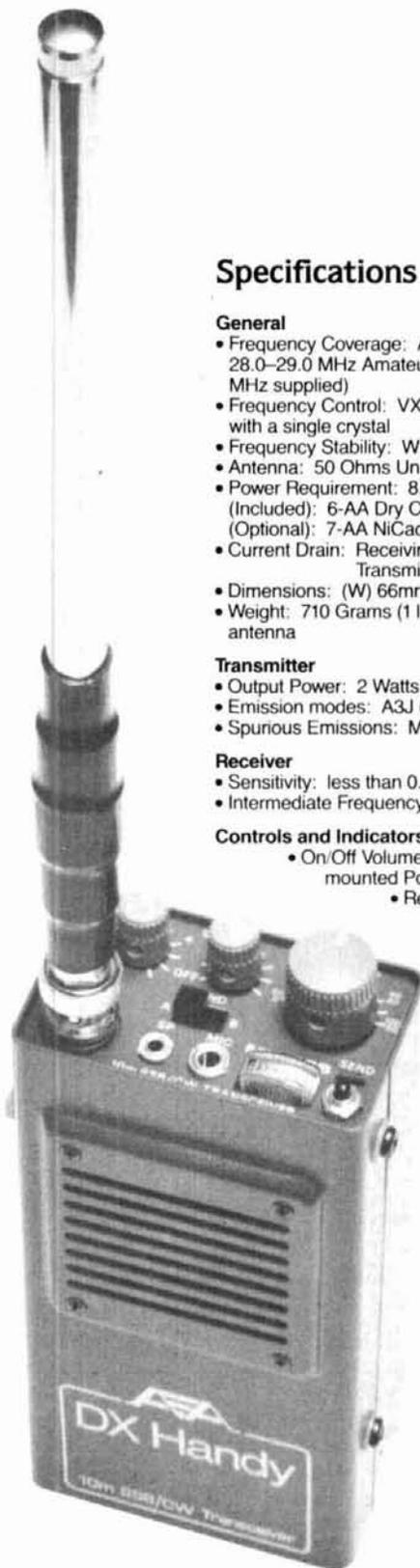
- Output Power: 2 Watts at 9.0 VDC
- Emission modes: A3J (USB) and A1 (CW)
- Spurious Emissions: More than 40 dB down

### Receiver

- Sensitivity: less than 0.5  $\mu$ V for 15 dB S/N
- Intermediate Frequency: 11.2735 MHz

### Controls and Indicators

- On/Off Volume control Top mounted Potentiometer
- Receiver Incremental Tuning (RIT): Top mounted Potentiometer with center off detent position
- Frequency: Top mounted 50 KHz VXO
- Frequency Range: Top mounted 2-position switch
- Noise Blanking: Top mounted On/Off switch
- S/R/F meter: Top mounted S/R/F meter
- Built in CW key: Top mounted momentary switch
- External Speaker output: Top mounted  $\frac{1}{8}$ " phone jack
- External Microphone input: Top mounted  $\frac{1}{8}$ " phone jack
- Antenna Connector: Top mounted Female BNC
- Transmit Indicator: Top mounted Transmit LED
- Push-To-Talk: Side mounted momentary switch
- External Power: Bottom mounted 2.1 mm coaxial
- External key input: Bottom mounted  $\frac{1}{8}$ " phone jack
- Mode Selector Switch: Bottom mounted 2-position switch
- Charge/External Power: Bottom mounted 2-position switch selecting 12 VDC external power function



Specifications and prices subject to change without notice or obligation.

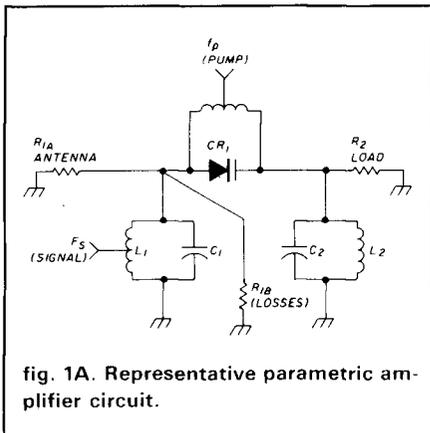


fig. 1A. Representative parametric amplifier circuit.

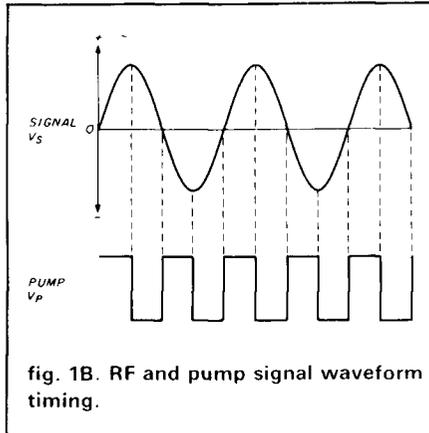


fig. 1B. RF and pump signal waveform timing.

degenerative parametric amplifiers: up-converters and downconverters. In the upconverter the idler frequency is the sum of the pump and signal frequencies:

$$f_i = f_s + f_p$$

In the downconverter, the idler frequency is the difference between pump and signal frequencies:

$$f_i = f_s - f_p$$

Power gain is defined as the ratio of the output to input power. In the case of a lossless circuit the gain of the up-converter ( $f_i$  greater than  $f_s$ ) is:

$$G = f_i/f_s$$

The downconverter actually shows a loss (attenuation), rather than a power gain.

The third category of parametric amplifiers is the regenerative circuit, and is actually a special case of the nondegenerative amplifier. In the regenerative amplifier the pump frequency is the sum of the signal and idler frequencies. The power transfer direction is reversed, implying a negative resistance characteristic and the resulting circuit is regenerative. If prevented from oscillating, low noise and very high gain are achieved.

### noise in parametric amplifiers

The low noise capability of the parametric amplifier results from the use of a reactance instead of a resistance for the amplifier element. In an ideal parametric amplifier the noise figure is zero.

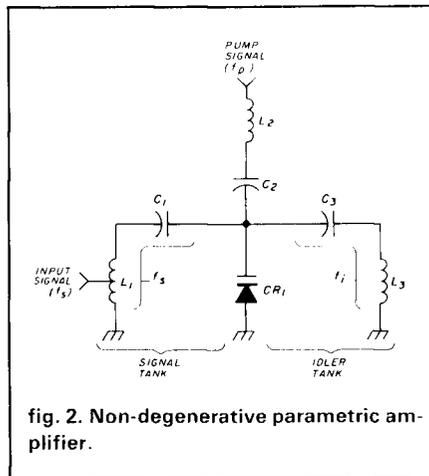


fig. 2. Non-degenerative parametric amplifier.

There are two noise contributions in practical circuits — circuit losses and frequency conversion noise. These sources combine to create a non-zero noise factor of the order:

$$F_{noise} = \frac{R_a}{R_l} + \frac{f_s}{f_i} \quad (4)$$

Where:

$F_{noise}$  is the noise factor

$R_a$  is the antenna impedance resistive component

$R_l$  is the sum of circuit resistance losses

$f_i$  is the idler frequency

$f_s$  is the signal frequency

As a rule of thumb, a pump frequency seven to ten times the signal frequency for lowest noise operation is chosen.

### microwave configurations for parametric amplifiers

The circuit examples given show the

use of discrete inductor-capacitor (LC) resonant tank circuits. These circuits work well up into the UHF and lower microwave region. At higher microwave frequencies, the LC tank circuit is impractical. At these frequencies parametric amplifiers use resonant cavities (fig. 3) in place of resonant tank circuits. Use a tuning disk to adjust the cavities to resonance.

### Manley-Rowe relationships

In 1957 Manley and Rowe developed a way to evaluate parametric amplifier circuits.\* Consider the equivalent circuit in fig. 4. We have a variable capacitance as the element and two signal sources: the signal frequency ( $f_s$ ) and the pump frequency ( $f_p$ ), both shown as generators. Filters in series with both generators pass the generator frequency and reject all others. There is also a series of loads, each isolated from the others by the same kind of ideal narrowband filter. The frequencies of these filters are: ( $f_p + f_s$ ), ( $f_p - f_s$ ), up to ( $mf_p \pm nf_s$ ) (where  $m$  and  $n$  are integers). The Manley-Rowe relationships are:

$$I. \quad \sum_{m,n} \frac{m P_{m,n}}{mf_p + nf_s} = 0 \quad (5)$$

$$II. \quad \sum_{m,n} \frac{n P_{m,n}}{mf_p - nf_s} = 0 \quad (6)$$

In working with Manley-Rowe equations, the following algebraic sign conventions regarding power are used:

- +P is assigned to power flowing either into the capacitor, or from the pump and input signal "generators," and
- -P is assigned to power flowing out of the capacitor or into a load resistance.

The parametric amplifier's stability is determined by the sign of the power flowing with respect to the capacitor. If the power from the signal flows into the capacitor, the stage is stable. Because we deal with integers from 0

\*See Liao and Coleman for discussions of Manley-Rowe relationships. The Liao book derives the equations, while Coleman works out several examples.

through the *i*th, we can check not only the fundamental frequencies (*m* and *n* = 1), but also their respective harmonics (*m, n* > 1). Some of these combinations are stable; others are not. There are several cases where the Manley-Rowe equations apply. Let's consider only one to see how such problems are solved.

### example

Consider a parametric amplifier in which an output frequency (*f*) is the sum of the pump signal (*f<sub>p</sub>*) and the input signal (*f*) frequencies: *f* = *f<sub>p</sub>* + *f<sub>s</sub>*. Solve the Manley-Rowe equations to determine network stability.

### solutions

First construct a table showing the signals and permissible values of *m* and *n* (we will consider only the fundamentals).

SIGNAL	<i>m</i>	<i>n</i>	<i>m</i> <i>f<sub>p</sub></i> + <i>n</i> <i>f<sub>s</sub></i> = ?	<i>P<sub>m,n</sub></i>
Input Signal	1	0	<i>f<sub>s</sub></i>	<i>P<sub>10</sub></i>
Pump	0	1	<i>f<sub>p</sub></i>	<i>P<sub>01</sub></i>
Idler	1	1	<i>f<sub>p</sub></i> + <i>f<sub>s</sub></i>	<i>P<sub>11</sub></i>

The first case (Manley-Rowe I) can be rewritten in the form:

$$\frac{P_{10}}{f_p} = \frac{-P_{11}}{f_p + f_s} \quad (7)$$

*P<sub>11</sub>* is negative because *P<sub>10</sub>* is positive by definition (it is the pump signal). We also know that (*f<sub>p</sub>* + *f<sub>s</sub>*) is always positive, so the negative sign is associated with *P<sub>11</sub>*.

For the second case (Manley-Rowe II):

$$\frac{P_{01}}{f_s} = \frac{-P_{11}}{f_p + f_s} \quad (8)$$

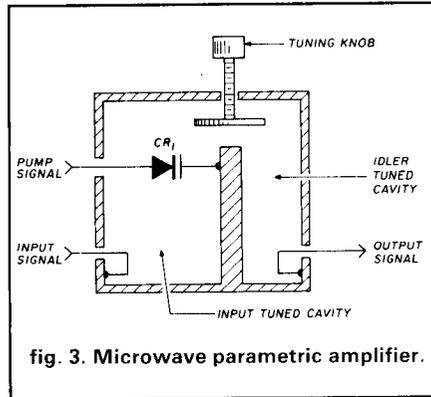


fig. 3. Microwave parametric amplifier.

Since *P<sub>11</sub>* was defined as negative, by the same reasoning *P<sub>01</sub>* is positive. Because *P<sub>01</sub>* is positive, *signal power flows into the reactance*, and the circuit is stable. (A negative power term for the signal would denote instability.)

Either inductors or capacitors can be used as reactive elements in a parametric amplifier. In 1957 Suhl<sup>5</sup> and Weiss<sup>6</sup> proposed the use of ferromagnetic inductors in microwave amplifiers. Practical considerations favor the voltage variable capacitance diode ("varicap") as the reactance in parametric amplifiers. These devices work to frequencies above 20 GHz, and because they are voltage variable capacitors, make actual circuit implementation relatively easy. Varicaps operate in the reverse-bias zone of the I versus V curve, and tend to have low avalanche potentials. This ease of circuit implementation is gained at the

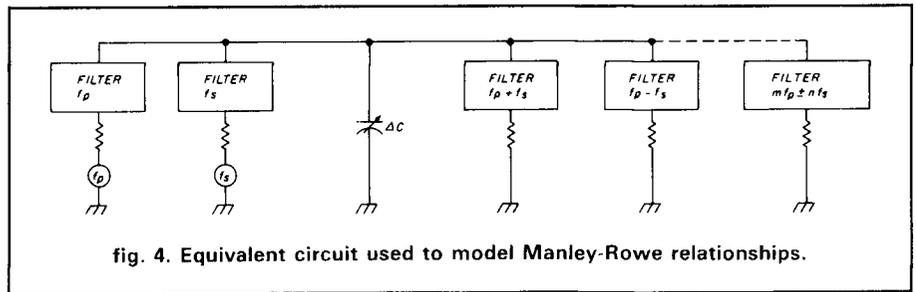


fig. 4. Equivalent circuit used to model Manley-Rowe relationships.

Solve the Manley-Rowe equations for this case:

$$I. \sum_{m,n} \frac{m P_{m,n}}{m f_p + n f_s} =$$

$$\frac{(1) (P_{10})}{(1) (f_p) + (0) (f_s)} + \frac{(0) (P_{01})}{(0) (f_p) + (1) (f_s)} +$$

$$\frac{(1) (P_{11})}{(1) (f_p) + (1) (f_s)} =$$

$$\frac{P_{10}}{f_p} + 0 + \frac{P_{11}}{f_p + f_s} = 0$$

$$\frac{P_{10}}{f_p} + \frac{P_{11}}{f_p + f_s} = 0$$

$$II. \sum_{m,n} \frac{n P_{m,n}}{m f_p + n f_s} =$$

$$\frac{(0) (P_{10})}{(1) (f_p) + (0) (f_s)} + \frac{(1) (P_{01})}{(0) (f_p) + (1) (f_s)} +$$

$$\frac{(1) (P_{11})}{(1) (f_p) + (1) (f_s)} =$$

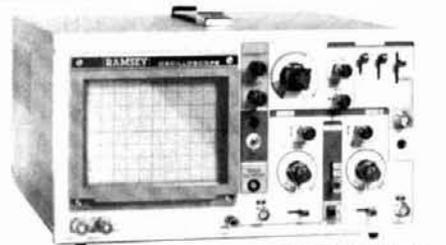
$$0 + \frac{P_{01}}{f_s} + \frac{P_{11}}{f_p + f_s} = 0$$

$$\frac{P_{01}}{f_s} + \frac{P_{11}}{f_p + f_s} = 0$$

# RAMSEY

## RAMSEY ELECTRONICS

# QUALITY TEST GEAR YOU CAN COUNT ON



**\$369.95\***  
**20 MHz DUAL TRACE**  
 Features component testing circuit for resistors, capacitors, digital circuits and diodes—TV sync filter—high sensitivity—Z axis—XY mode—built-in calibrator—5X horizontal magnifier



**\$469.95\***  
**35 MHz DUAL TRACE**  
 wide frequency bandwidth—optimal sensitivity—delayed triggering sweep—hold off—ALT trigger—single sweep TV sync 5X magnification—XY or XYZ operation—HF/LF noise reduction



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

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

### UNSURPASSED QUALITY • SUITABLE FOR HOBBY, SERVICE & PRODUCTION

MODEL	BAND WIDTH	# TRACES	CRT SIZE	VERTICAL SENSITIVITY	MAXIMUM TRIG FREQ	USEABLE MAXIMUM BANDWIDTH
2200	20 MHz	(2)	8x10CM	5 mV per div	35 MHz	30 MHz
3500	35 MHz	(2)	8x10CM	1 mV per div	50 MHz	60 MHz

All include high quality 1:1, 10:1 hook on probes, instruction/service manual with schematic and component layout, 1 year warranty

\*Add an additional \$10.00 for each unit for shipping.

### MINI-100 COUNTER



**\$119.95** CHARGER, NICAD BATTERIES, AC ADAPTER INCLUDED

### CT-70 7 DIGIT 525 MHz



**\$139.95** WIRED, INCLUDES AC ADAPTER

### CT-90 9 DIGIT 600 MHz



**\$169.95** WIRED INCLUDES AC ADAPTER

### CT-50 8 DIGIT 600 MHz



**\$189.95** WIRED INCLUDES AC ADAPTER

### CT-125 9 DIGIT 1.2 GHz



**\$189.95** WIRED INCLUDES AC ADAPTER

MODEL	FREQ RANGE	SENSITIVITY	ACCURACY	DIGITS	RESOLUTION	PRICE
MINI-100	1-500 MHz	Less than 250mv	1 PPM	7	100 Hz, 1 KHz	119.95
CT-70	20 Hz-550 MHz	< 50mv to 150 MHz	1 PPM	7	1 Hz, 10 Hz, 100 Hz	139.95
CT-90	10 Hz-600 MHz	< 10mv to 150 MHz < 150mv to 600 MHz	1 PPM	9	0.1 Hz, 1 Hz, 10 Hz	169.95
CT-50	5 Hz-600 MHz	< LESS THAN 25 mv	1 PPM	8	1 Hz, 10 Hz	189.95
CT-125	10 Hz-1.25 GHz	< 25mv to 50 MHz < 15mv to 500 MHz < 100 mv to 800 MHz	1 PPM	9	0.1 Hz, 1 Hz, 10 Hz	189.95
CT-90 WITH DV-1 OPTION	10 Hz-600 MHz	< 10mv to 150 MHz < 150mv to 600 MHz	0.1 PPM	9	0.1 Hz, 1 Hz, 10 Hz	229.90

## RAMSEY FREQUENCY COUNTERS

Ramsey Electronics has been manufacturing electronic test gear for over 10 years and is recognized for lab quality products at breakthrough prices. Our frequency counters have features and capabilities of counters costing twice as much.



**RAMSEY D-4100 COMPACT DIGITAL MULTITESTER**  
**\$249.95**  
 test leads and battery included

Compact sized reliability and accuracy. This LCD digital multimeter easily fits in your pocket, you can take it anywhere. It features full overload protection • 3 1/2 digit LCD readout • recessed input jacks • safety probes • diode check function • 2000 hours battery life

**PRICE CUT**



**RAMSEY D-5100 HANDHELD DIGITAL AUTORANGING METER**  
**\$44.95**  
 Includes Probes 1 Year Warranty

Provides distinctive audible chirp after contact has been made and meter reading has stabilized. Has TOUCH-HOLD feature to allow readings to be logged or referred to before making the next reading. Up to 10 AMP current capability and a continuity function which beeps on zero Ohms



**\$499.95** wired includes AC adapter  
 PR-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 sniffing RF • ideal receiver/TV preamp



**\$699.95** wired  
 PS-2 kit **\$49.95**

### 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



**\$899.95** wired includes AC adapter

### PS-10B 1 GHz PRESCALER

Extends the range of your present counter to 1 GHz • 2 stage preamp • divide by 1000 circuitry • super sensitive (50 mV typical) • BNC connectors • 1 GHz in, 1 MHz out • drives any counter

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

<b>tone decoder</b> A complete tone decoder on a single PCB board. Features 400-5000 Hz adjustable range via 20 turn pot, voltage regulation, 567 IC. Useful for touch-tone burst detection, FSK, etc. Can also be used as a stable tone encoder. Runs on 9V battery. Complete kit: <b>\$5.95</b>	<b>COLOR ORGAN</b> See music come alive! 3 different lights flicker with music. One light each for high, mid-range and low. Each individually adjustable and drives up to 300 W. runs on 110VAC. ML-1 kit <b>\$8.95</b>	<b>VIDEO MODULATOR</b> Converts any TV to video monitor! Super-stable, tunable over ch 4-6. Runs on 5-15V, accepts STD video signal. Best unit on the market! Complete kit: <b>\$7.95</b>	<b>FM WIRELESS MIKE</b> Transmits up to 300 ft to any FM broadcast radio uses any type of FM. Type FM-2 has added sensitive microphone preamp stage. FM-1 kit <b>\$3.95</b> FM-2 kit <b>\$4.95</b>	<b>SUPER SLEUTH</b> A super sensitive amplifier which will pick up a pin drop at 15 feet! Great for monitoring baby's room or as general purpose amplifier. Full SW rms output, runs on 6 to 75 volts, uses 8-45 ohm speaker. SN-9 kit <b>\$5.95</b>	<b>NEW TELEPHONE TRANSMITTER</b> Low cost with professional performance. Features include: self phone line powered, tunable from 76 to 100 MHz, polarity insensitive (compact size) • 1 1/2" x 1 1/2" easily installs anywhere on the phone line or inside the instrument itself. PB-1 kit <b>\$14.95</b>	<b>NEW FM RECEIVER</b> For built-in applications or hobby experiments. Full featured super-heterodyne receiver, microwatt sensitivity, 10.7 MHz IF. Integrated circuit detector, 50 ma audio amplifier, 9V external power source super above on standard FM broadcast band as well as large portions on each side, compact 1 1/2" square, for bug detection or reception. FR-1 kit <b>\$14.95</b>	<b>FM MINI MIKE</b> A super high performance FM wireless mike kit. Transmits a stable signal up to 300 yards with exceptional audio quality by means of its built in electric mike. Kit includes case, mike, on-off switch, antenna, battery and super instructions. This is the finest unit available. FM-3 kit <b>\$14.95</b> FM-3 Wired and tested <b>19.95</b>
<b>40 WATT 2 mtr PWR AMP</b> Simple Class C power amp features 8 times power gain 1 W in for 8 out, 2 W in for 15 out, 5 W in for 40 W out. Max output of 50 W, incredible value, complete with all parts, less case and T-R relay. PA-1 40 W pwr amp kit <b>\$22.95</b> TR-1 RF sensed T-R relay kit <b>6.95</b>	<b>VOICE ACTIVATED SWITCH</b> Voice activated switch kit provides switched output with current capability up to 300 mA. Can drive relays, lights, LED or even a tape recorder motor. Runs on 9 VDC. VS-1 kit <b>\$6.95</b>	<b>UNIVERSAL TIMER</b> Provides the basic parts and PCB board required to provide a source of precision timing and pulse generation. Uses 555 timer IC and includes a range of parts for most timing needs. UT-5 kit <b>\$5.95</b>	<b>MAD BLASTER</b> Produces LOUD ear shattering and attention getting siren like sound. Can supply up to 15 watts of obnoxious audio. Runs on 6-15 VDC. MB-1 kit <b>\$4.95</b>	<b>60 Hz TIME BASE</b> Low current (25ma) 1 min/month accuracy. TB-6 kit <b>\$5.50</b> TB-6 Ass'y <b>\$9.95</b>	<b>WHISPER LIGHT</b> An interesting kit, small mike picks up sounds and converts them to light. The louder the sound, the brighter the light. Includes mike, controls up to 300 W, runs on 110 VAC. WL-1 kit <b>\$6.95</b>	<b>SIREN</b> Produces upward and downward wail. 5 W peak audio output, runs on 3-15 volts, uses 3-45 ohm speaker. Complete kit: SM-3 <b>\$2.95</b>	

### 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

**PHONE ORDERS CALL**  
**716-586-3950**  
 TELEX 466735 RAMSEY CI  
 FAX 716-586-4754



**TERMS** • satisfaction guaranteed • examine for 10 days, if not pleased, return in original form for refund • add 0% for shipping and insurance to a maximum of \$10.00 • foreign add 15% for surface mail • COD add \$2.50 (COD in USA only) • orders under \$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 ELECTRONICS, INC.**  
 2575 Baird Rd.  
 Penfield, N.Y. 14526

expense of Johnson and other diode noise terms.

## inductor-based superconductive parametric amplifiers

New superconductivity technology based on metallic ceramic materials has been reported. Researchers have achieved superconductivity states at relatively high temperatures (about 95 degrees K, with some promise of 225 degrees K).<sup>7</sup> The use of inductive reactances in parametric amplifiers is under reconsideration based on recent research. Several points are worth noting:

- Lower loss resonant circuits for signal, pump, and idler frequencies in conventional varicap-based parametric amplifiers (and perhaps lower achievable noise figures).
- Improved switchable inductors that operate at microwave frequencies, and make possible inductor-based parametric amplifiers.
- New forms of switchable energy

storage devices that could replace present reactances in parametric amplifiers. Although one tends to think in traditional terms about inductive and capacitive reactances, perhaps a new type of reactance is possible. The strange behavior of superconductors with respect to magnetic fields may prove promising.<sup>8</sup>

A phenomenon noted as early as 1947 may be of interest in the latter case. Kinetic inductance produces inductance-like effects caused by the mass inertia of charge carriers in the material. In non-superconducting materials, ordinary magnetic inductance swamps the effects of kinetic inductance. In superconducting materials, however, magnetic inductance collapses leaving the kinetic variety.<sup>9</sup>

The conventional (varicap-based) parametric amplifiers are limited by their small dynamic range, due to the characteristics of the varicap diode used for the reactance. It may turn out that inductor-based devices will exhibit improved dynamic range.

One reason parametric amplifiers do not use superconductive technology is because the equipment needed to achieve the required near Absolute Zero temperature is expensive and large. This situation may change as progress is made in high temperature superconductivity.

## references

1. M. Skolnik, *Radar Handbook*, McGraw-Hill, New York, 1970, pages 5-10 and M. Skolnik, *Introduction to Radar Systems*, McGraw-Hill, New York, 1980, figure 9.4, page 351.
2. S. Y. Liao, *Microwave Devices and Circuits Second Edition*, Prentice-Hall, Englewood Cliffs, New Jersey, 1985.
3. Ibid. See also Dr. James T. Coleman, *Microwave Devices*, Reston Publishing Company (Division of Prentice-Hall), Englewood Cliffs, New Jersey, 1982.
4. *ARRL VHF Manual*.
5. H. Suhl, "Proposal for a Ferromagnetic Amplifier in the Microwave Region," *Physics Review* 106, April 15, 1957, pages 384-385.
6. M.T. Weiss, "A Solid State Microwave Amplifier and Oscillator Using Ferrites," *Physics Review* 107, July 1957, page 317.
7. G. Maranto, "Superconductivity: Hope vs. Reality," *Discover* August 1987, pages 22-32.
8. Ibid.
9. *IEEE Transactions on Magnetics*, March 1987. Entire issue is devoted to superconductivity.

ham radio

**SAY YOU SAW IT IN** *ham radio* magazine

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

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

**JENSEN TOOLS INC.** Dept. HR  
7815 S. 46th Street  
Phoenix, AZ 85044  
(602) 968-6231

263

**VHF-UHF POWER DIVIDERS**

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

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

MODEL	CONFIG.	PRICE
144-2P	(2) ports	\$51.00
144-4P	(4) ports	\$58.00
220-2P	(2) ports	\$50.00
220-4P	(4) ports	\$57.00
430-2P	(2) ports	\$48.00
430-4P	(4) ports	\$56.00
902-2P	(2) ports	\$48.00
902-4P	(4) ports	\$56.00
1296-2P	(2) ports	\$49.00
1296-4P	(4) ports	\$57.00

SHIPPING NOT INCLUDED

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

262

**Texas Radio**  
**BUGCATCHER**  
MOBILE HF ANTENNA

NEW IMPROVED MODELS!

**8-BAND COVERAGE** - All Amateur, MARS, and CAP frequencies from 10 to 80 meters!

**BANDSWITCHING** - Switches instantly to pre-tuned frequencies on any band!

**HIGH-Q RESONATOR** - High-Q air inductor provides maximum efficiency on all bands!

**FUNCTIONAL DESIGN** - Provides low wind loading, easier tuning, and more pleasing appearance! Rugged construction for long life and reliability! New fold-over feature!

**500 WATT CAPACITY** - Conservative rating!

COMPLETE ANTENNA - READY TO MOUNT

**PRICE \$74.95**

1000 WATT MODEL AVAILABLE - \$84.95  
Add 5% for shipping in lower 48.

SASE for Product info  
**TEXAS RADIO PRODUCTS**  
5 East Upshaw Temple, Texas 76501  
(817) 771-1188

261

## microwave components and terminology: part 1

From time to time I've featured microwave topics in this column. Most dealt with the present state of the art (SOA) but some gave a glimpse at older microwave components or terminologies.

The SOA changes so rapidly that many of the components once necessary for microwave systems have become extinct, been replaced, or moved upward in frequency. In light of this, I thought it would be a good time to discuss the basic microwave components of the past and present. This will make future developments easier to understand.

The subject of microwave components is extensive. Entire books have been written on single components such as waveguides. In this month's column, I will concentrate on microwave transmission lines and related components and build upon this information next month, in addition to describing some other common microwave features.

### microwave transmission lines

A transmission line is a system of material boundaries forming a continuous path from one location to another. In radio communications from low frequencies through UHF this usually refers to a balanced line, coax-

ial cable, stripline, or microstrip transmission line. From UHF up through the microwave and millimeter wavelengths a waveguide or G-line is often used.

Transmission lines have many different properties. The most important for Amateurs are the impedance, insertion loss, power handling capacity, and velocity of propagation. These terms are described in detail in reference 1.

Balanced lines, often referred to as open wire, twin lead, or ladder lines, were the first type of transmission lines. They became popular when commercial television was introduced but have largely been replaced by coaxial cable.

### coaxial transmission lines

Coaxial cable was invented in 1921 by Lloyd Espenschied and Herman A. Affel at the AT&T Engineering Labs in New York City. Nowadays it is by far the most common transmission line because it is easy to use, low cost, and operates over a wide frequency range. But, as frequency increases, so does the insertion loss. In general, the larger the diameter and the lower the dielectric loss (air is the lowest), the lower the insertion loss. Reference 1 gives information on typical insertion loss versus frequency.

Coaxial transmission lines normally consist of two conductors, often described as operating in the TEM (transverse electromagnetic mode or field pattern). This means that both the electric and magnetic fields are transverse or perpendicular to the axis of the line as shown in **fig. 1A**.

When spacing between the two elements in a coaxial transmission line exceeds one-half the operating wavelength or the circumference of the inside of the outer conductor exceeds one wavelength, energy can propagate down the transmission line in other than the desired mode. This is usually referred to as a higher order mode. The following formula quickly determines the maximum usable frequency below which higher order modes will *not* occur:

$$f_{co} = \frac{7.5}{\sqrt{\epsilon_r} (D+d)} \quad (1)$$

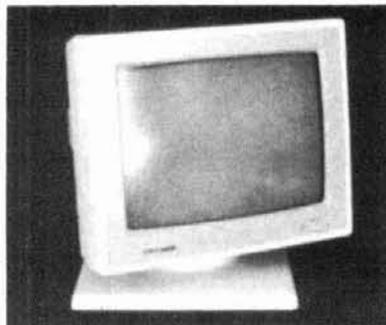
Where  $f_{co}$  is in GHz,  $\epsilon_r$  is the dielectric constant (air = 1.0),  $D$  is the inside diameter of the outer conductor, and  $d$  is the outside diameter of the inner conductor — both in inches. For example, a 50-ohm Teflon™ coax line,  $\epsilon_r = 2.1$ , with  $D$  of 0.120 inches and  $d$  of 0.036 inches would be usable to at least 13.1 GHz.

In the last two decades, there has been much research and development in the field of coaxial transmission lines. Improved coaxial cables are smaller, more precise in impedance characteristics, and have lower loss. There are now commercial coax transmission lines that operate beyond 20 GHz.

Two of the most common microwave coax types used by Amateurs are the semi-rigid 0.141 and 0.085 inch outside diameter Teflon dielectric

# John J. Meshna Jr., Inc.

## SURPLUS ELECTRONICS

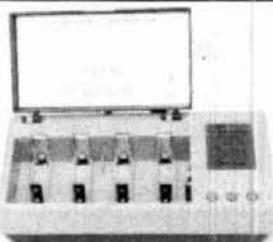


### IBM® Compatible Flat Screen Monitor

We just bought a bunch of classy looking IBM® compatible TTL monitors. They were made by Samsung (Sm12SFA7). The monitors utilize a flat, 12" amber high contrast, non-glare CRT. Some of the nice features of this item are: high resolution 80 x 25 character display, they are fully enclosed and come with a tilt & swivel base. The TTL level signals are input thru a sub-D type connector. The monitors run on standard US house current. 95% of them are in their original factory cartons. They are tagged as having minor defects. We have looked over a few of them and have found them to be completely intact. We guarantee the CRT's are unbroken and will not have burn marks on them. The original selling price of this very handsome unit was over \$125.00 each including the tilt/swivel base. We offer it for only \$50.00 with the CRT guaranteed OK, as mentioned above. We will also provide a schematic. "AS IS" with Schematic.  
Shpg. Wt. 20 lbs...MOT-17...\$50.00

### Universal Battery Charger

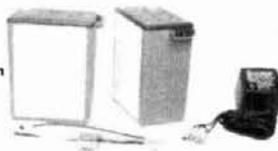
Rechargeable nickel cadmium batteries are becoming more popular everyday. This has created a need for an inexpensive, reliable charger for them. The charger we offer is very universal because it will charge AAA, AA, C, D & 9V batteries. There are 2 charging sections with corresponding LED indicators. Any pair or same size batteries may be charged in a single section. 2 or 4 batteries can be charged at the same time. Each charger comes new in the box with instructions.  
Shpg. wt. 3 lbs...SPL-39A-49...\$10.00



### 6V, 9A BATTERIES

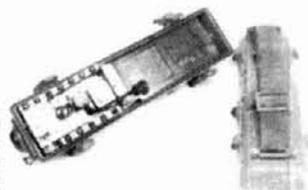
As originally used, 2 of these 6V, 9A sealed lead acid batteries were put in series which gave them 12V to power a child's ride around car or jeep. The batteries we offer are from a discontinued model and are all unused. We have also found batteries of this type used in many fire alarms. Since they are sealed, they can be operated in any position without fear of spillage. We also have some of the dual 25A, fused wiring harnesses with the special connector available that they used for connecting the batteries in series. In addition, we have in stock the 12VDC, 800MA charge module with the mating connector for the wiring harness. All of these goodies are unused and are guaranteed OK. Current list price on these batteries is approximately \$22.00.

UNUSED BATTERY  
Shpg. Wt. 6 Lbs...SP-170-48...\$13.00 each  
WIRING HARNESS  
Shpg. wt. 4 oz...SP-171-48...\$2.00 each  
CHARGER MODULE  
Shpg. wt. 2 Lbs...SP-172-48...\$5.00 each



### PRC-6

US Military hand held walkie talkie chassis which covers the range of 47-55.4 MHz. Covers distance of approximately 1 mile. Amateur license required to operate this set. Requires batteries 1.5V & 45 (we don't have). We have a bunch of these now available that we are selling as parts value. Some of the parts that can be salvaged are the following peanut tubes (3) Jan 5676, (6) Jan 5678, (1) Jan 2G21, 1 3B4, output x. former, components, connectors, springs, hardware. The kind of stuff found in older transceivers. Some are complete and some are not. Maybe you can make 1 from 2 units, we don't know. We offer them as a parts value or a collectors item. No more once these are gone. Sold "AS IS".  
Shpg. wt. 6 Lbs...PRC-6...\$7.00



### Rechargeable sub "D" Cell BATTERY PACK

We were fortunate to have purchased a Ltd. Qty. of these very high quality nicad sub. "D" cells, but only 1-3/8" H. Great for radio controlled devices, battery back-up systems & many other uses. 6" color coded leads. This pack probably sold for over \$60.00 each. NEW.  
Shpg. wt. 2 Lbs...SP-84-47...\$25.00  
Battery Charger module for above:  
Shpg. wt. 1/2 Lb...SPL-128-38...\$3.00



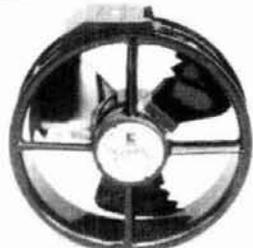
### QUAD SUPPLY BARGAIN

Because our customers are always looking for inexpensive power supply parts, we look extra hard for the same thing and these should fulfill many a customer's wish. This power supply is made by ASTEC (No. AA12690) for Wang Labs. The outputs are as follows: \*5VDC, 10A(reg.); \*12VDC 2.5A(reg.); \*12VDC, 5A(unreg.); -12VDC, .25A(reg). We bought them cheap in "AS IS" condition and offer them the same way. The supplies are whole and intact. They are not cannibalize or trashed. The input is fused and switched. Turning on the supply automatically turns on the enclosed spiral type fan. There are many salvageable parts should you wish to stock your parts bin. The fan, when new, sells for over \$20.00. We are trying to obtain a schematic for it and should we get one, we will provide it for free. The input is switchable for 110/220 Volts. A great deal whether you want to repair them or strip it for the many valuable parts.  
Shpg. wt. 8 Lbs...SP-31A-49...\$12.00" as is"  
Line Cord  
With appropriate connectors for above...cord 6 ...\$1.75 each



### Rotron® Feather Fans

We just uncovered a small batch of these very popular high performance fans. They are rated to deliver 245CFM very quietly via Rotron's patented feathered edged blades. They measure 7" in diameter x 2.47" deep. We had these before and sold out very quickly. The current price on these babies is \$62.00 each! We have seen these fans used in many different applications including cooling down computer racks. They are very reliable. Unused surplus.  
Shpg. wt. 3 Lbs...SPL-17A-49...\$18.00 each



## John J. Meshna Jr., Inc. SURPLUS ELECTRONICS

19 Allerton Street P.O. Box 8062 E. Lynn, MA 01904 Tel:(617)595-2275  
Phone Orders accepted on MC, VISA or American Express. \$20.00 minimum order.  
Spring Catalog now available 64 Pages of good stuff!

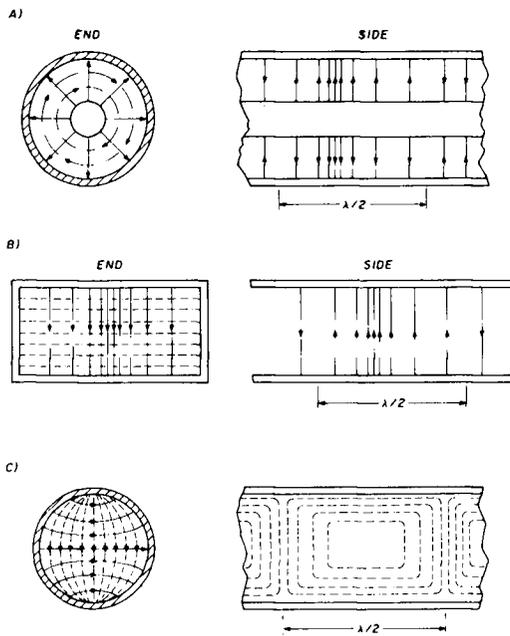


fig. 1. Typical field patterns present in (A) a coaxial transmission line operating in the TEM mode, (B) a rectangular waveguide operating in the TE<sub>10</sub> mode, and (C) circular waveguide operating in the TE<sub>11</sub> mode. The solid lines are the electric fields and the dashed lines are the magnetic lines.

50-ohm coax that manufacturers claim can operate to 30 and 55 GHz, respectively. Attenuation at 20 GHz is typically 60 and 100 dB per 100 feet for the two cables, respectively.

### microwave strip transmission lines

The concept of strip-type transmission lines was discovered during World War II, and in the mid-1950s the first practical designs were introduced as "Tri-Plate".<sup>2</sup> These first strip transmission lines were a balanced structure with a "sandwich" construction and operated in the TEM mode similar to coaxial transmission line.<sup>1</sup>

Microstrip, a sort of open-faced sandwich version of stripline<sup>1</sup>, followed and is widely used well into the microwave region. Glass PCB, G-10, can be used but is lossy at microwave frequencies. Lower loss dielectrics like Teflon-impregnated glass laminates and low-loss ceramics are available as are new types of structures — fin-line and suspended substrate, to name two.

### waveguides

When you think of microwaves, what probably comes to mind are those bulky waveguides and waveguide components. In the "good old days", microwave engineers were often referred to as "plumbers" because they worked mainly with waveguides and other materials that resembled pipes and plumbing.

The practical uses of waveguides as transmission lines were discovered independently and almost simultaneously by W.L. Barrow and G.C. Southworth in 1936.<sup>3,4</sup> The breakthrough was one of many making radar and microwaves possible. Waveguide transmission lines have been used at frequencies below 200 MHz to well above 150 GHz!

There are four basic waveguide cross-sectional geometries: rectangular, square, elliptical, and circular. Each type has specific electrical properties and preferred usage.

Rectangular waveguide is probably the most common since it has the widest operating bandwidth. Its width

is usually twice its height (see fig. 2A).

Square waveguide shown in fig. 2B is sometimes used in applications like dual polarized feeds and horns. However, since its height and width are the same and there is mode isolation, it is difficult to use.

Elliptical waveguide (fig. 2C) is often used where flexible runs are required — especially if it is corrugated and the run to be used is between 1.9 and 15 GHz. It is usually easier to install than rectangular waveguide but does have somewhat higher attenuation.

Circular waveguide (fig. 2D) has very low attenuation — sometimes only half that of rectangular waveguide — so it is often used on long, straight vertical or horizontal runs. Its circular nature allows two orthogonal modes to be propagated simultaneously, but this same circular symmetry can cause the polarization to rotate as the wave travels down the guide.

### waveguide modes

A waveguide is a transmission line

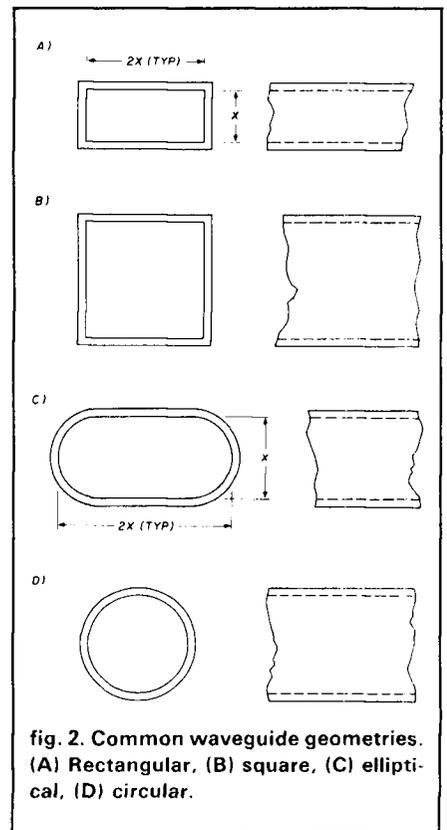


fig. 2. Common waveguide geometries. (A) Rectangular, (B) square, (C) elliptical, (D) circular.

where the wave propagation is not in TEM mode form. Waveguides appear to be simply a hollow tube with walls acting as a single conductor. Therefore, their operation is quite different from coaxial lines. Waveguides are mostly used as transmission lines but have other uses; these will be discussed in next month's column.

Waveguide transmission lines usually operate in a TE (transverse electric) mode in which the electric field is always transverse to the direction of propagation and transverse to the axis of the waveguide at all locations. Waveguides sometimes operate in the TM (transverse magnetic) mode in which the magnetic fields are everywhere transverse to the axis of the waveguide.

Unlike coaxial transmission lines which are not sensitive and can usually be operated from dc up to their cutoff frequency, waveguides are very frequency sensitive. Each geometry has a different cutoff wavelength or minimum frequency that can be propagated and below which the insertion loss is very high.

If the operating frequency is higher than some critical value determined by the dimensions and the geometry of the guide, the wave will propagate down it with low attenuation. If the wavelength is greater than this cutoff value, the waves in the waveguide die out rapidly in amplitude even if the material in the walls of the guide has infinite conductivity.

The mode for which the cutoff wavelength is greatest is the dominant mode (desired mode for transmission lines), since it has the least insertion loss. In a rectangular waveguide, it is often referred to as the TE<sub>10</sub> mode.

The subscript "1" means that the field distribution in the direction of the long (cross-sectional) side of the waveguide contains one-half cycle of variation. The subscript "0" indicates that there is no variation in either the electric or magnetic field strength in the direction of the short side of the guide. The TE<sub>10</sub> field pattern in a rectangular waveguide is shown in **fig. 1B**.

The width of a rectangular wave-

**Table 1. Resistivity and relative attenuation of some common metals or platings used in transmission lines at RF frequencies.**

Metal	Resistivity (ohms - cm × 10 <sup>-6</sup> )	Attenuation (relative to copper)
Aluminum	2.62	1.23
Brass (66 Cu 34 Zn)	3.9	1.5
Copper (commercial annealed)	1.7241	1
Gold	2.44	1.19
Silver	1.62	0.97
Steel (stainless)	90	7.23

**Table 2. Rectangular waveguide characteristics.**

EIA Waveguide designation	Outside width (inches)	Outside height (inches)	Wall thickness (inches)	Frequency range (GHz)
WR-229	2.418	1.273	0.064	3.3-4.90
WR-187	2.000	1.000	0.064	3.95-5.85
WR-159	1.718	0.923	0.064	4.9-7.05
WR-90	1.000	0.500	0.050	8.2-12.4
WR-75	0.850	0.475	0.050	10.0-15.0
WR-42	0.500	0.250	0.040	18-26.5

guide at the cutoff frequency is approximately half that of the free space wavelength. For example, the free space wavelength at 2.3 GHz is approximately 5.123 inches. Therefore, the width of a rectangular waveguide at this frequency must be at least 2.561 inches.

For minimum loss it is best to operate in the dominant mode, which is about 25 percent higher in frequency. Here the optimum width of a rectangular waveguide at 2.3 GHz would be 25 percent wider, or about 3.2 inches.

The dominant mode in a circular waveguide is the TE<sub>11</sub> mode. **Figure 1C** shows its field pattern. Cutoff frequencies are different for circular and rectangular waveguides. The circular waveguides also have modes that are closer in frequency than those of rectangular waveguides so they have narrower mode-free bandwidth.

In general, the diameter of a circular waveguide needs to be slightly larger than the width of an equivalent rectangular waveguide to work at the same frequency. See reference 5 for additional design information for circular waveguides.

The impedance of a coaxial line is constant. In waveguides, impedance

changes with size, mode, and frequency and is not easy to determine. If operating in the dominant mode in rectangular waveguide, the impedance is generally in the 350-to-600 ohm region.

Because waveguides are specifically intended for high frequency operation, the conductivity of the walls is very important and plating is usually used. The plating need not be thick since the skin depth is shallow — often less than 0.001 inches above 1.0 GHz.

**Table 1** shows the resistivity and relative conductivity of some commonly used waveguide materials and plating. Copper and silver-plated copper are preferred.

Waveguides have standards and a part numbering system just like coaxial cables. See **table 2** for some of the standard rectangular waveguide types and their important physical and frequency characteristics.

Amateurs often use waveguides on the microwave bands. They cost little on the surplus market and have low loss, especially when used for antenna feed systems. Compared to coax, the loss of WR-90 waveguide is 4.5 to 6.5 dB per 100 feet over its operational frequency range of 8.2 to 12.4 GHz. A more complete list of the stan-

# 1988 CHARLOTTE HAMFEST AND COMPUTERFAIR

ARRL SANCTIONED HAMFEST

SAT. MARCH 19, 9:00 AM to 5:00 PM -- SUN. MARCH 20, 9:00 AM to 3:00 PM  
CHARLOTTE CONVENTION CENTER, 4th & COLLEGE STREETS, CHARLOTTE, NC

87,000 SQUARE FEET INDOORS. 500 FLEA MARKET TABLES. 160 EXHIBIT BOOTHS

AWARDS \* EXAMS \* FORUMS \* LADIES ACTIVITIES

LICENSE EXAMS BY CHARLOTTE VEC \* EXAMS ON SUNDAY ONLY

Completed Form 610 + \$4.50 + Photo Copy of License & Certificates

Required by March 12, 1988 - NO WALK-INS

Mail to: CHARLOTTE VEC, 227 Bennett Lane, Charlotte, NC 28213

**SPECIAL FLEA MARKET AREA WITH ELECTRICITY**  
5 TABLE MINIMUM - By advanced reservation only - NC Sales Tax Collected  
Special Area reservations must be in by March 1, 1988

**ADMISSION STILL AT 1983 PRICES!**

PRE-REGISTRATION TICKETS: \$5.00 AT-THE-DOOR TICKETS: \$6.00

Flea Market Tables (6 ft.) - Pre-registration \$10.00 - At the door \$12.00

Tickets and Flea Market Tables valid for both days!

PRE-REG DEADLINE March 11, 1988 - MAIL REQUESTS + S.A.S.E. and CHECK TO:  
CHARLOTTE HAMFEST, P. O. BOX 221136, CHARLOTTE, NC 28222-1136

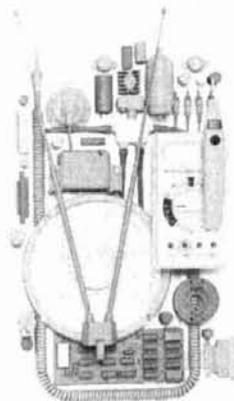
**TALK-IN FREQUENCY - 145.29 MHz - W4BFB**

EXHIBIT BOOTH: Robert Starling, N4GVF, 7921 Holly Hill Rd., Charlotte, NC 28212, (704) 568-7611

FLEA MARKET CHMN: Jeff Blythe, KA4WYC, 634 Northway Drive, Charlotte, NC 28208, (704) 393-7140

PRE-REGISTRATION: Andy Hawkins, G4GKY, 426 Greystone Road, Charlotte, NC 28209, (704) 523-4463

**CONSOLIDATED**  
ELECTRONICS



© 1988 CONSOLIDATED ELECTRONICS CATALOG • 17TH EDITION  
1318

## THE ULTIMATE ELECTRONICS CATALOG.

Order your 260 page catalogue packed with over 10,000 money saving electronic parts and equipment. Send \$3.00 check or money order - or call 1-800-543-3568 today and use your Mastercard or Visa.  
Consolidated Electronics, Incorporated  
705 Watervliet Ave., Dayton, Ohio 45420-2599

NAME

ADDRESS

CITY

STATE

ZIP

✓ 267

## EQUIP-tips



By Bob Grove  
WA4PYQ

*Tips from the expert on  
boosting the performance  
of your radio equipment.*

### Boost the Range of Hand-Helds

Today's hand-held VHF/UHF scanners and handie-talkies from Bearcat, Regency, Cobra, and Radio Shack, ICOM, Yaesu, and Kenwood have excellent sensitivity and talk power, but their range is reduced by their short flex antennas.

**Tip:** To increase the range of your hand-held scanner or transceiver, connect a Grove ANT-8 extendable whip antenna, equipped with standard BNC base.

The Grove ANT-8 is a fully-adjustable, professional whip antenna made of chrome-plated brass and equipped with a standard BNC base to fit most hand-held radios. Length is extendable from 7 to 46 inches. Replace that inefficient "rubber duckie" with the ANT-8 and **STAND BACK!**

Only \$12<sup>95</sup> plus \$1.50 UPS Shipping (US)

**Grove Enterprises**

140 Dog Branch Road Brasstown, N.C. 28902  
(704) 837-9200 or (MC, Visa & COD only) 1-800-438-8155

✓ 268

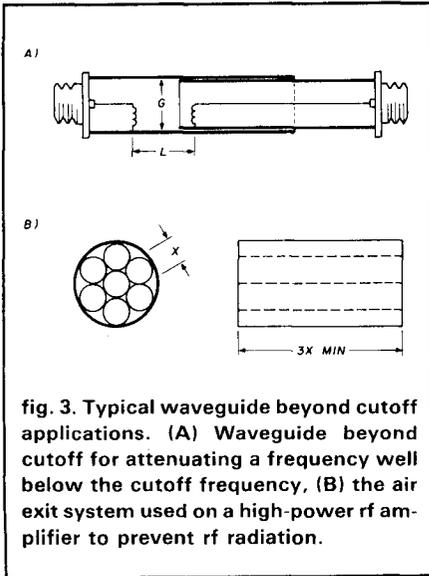


fig. 3. Typical waveguide beyond cutoff applications. (A) Waveguide beyond cutoff for attenuating a frequency well below the cutoff frequency. (B) The air exit system used on a high-power rf amplifier to prevent rf radiation.

standard waveguide types is found in reference 6.

## G-lines

The G-line, invented in 1950 by the late Georg Goubau, is a single conductor surface-wave transmission line that suits the microwave frequencies, but until recently it hasn't been popular. Basically, the G-line is a single wire feedline with cone-like "launchers" at each end. Warren Weldon, W5DFU, has done a lot of work on this type of transmission line and has several operational low-loss lines in use on the microwave frequencies.<sup>1</sup> Perhaps more Amateurs will try his techniques and add G-line to their arsenal.

## waveguides beyond cutoff

Although waveguides are most often used as transmission lines in the dominant mode, they can be used in the cutoff mode as RF attenuators at lower frequencies (see fig. 3A). Calculate the attenuation below the cutoff region in a rectangular waveguide using eqn. 2:

$$A = 27 (L/G)$$

where  $A$  is the attenuation in dB,  $L$  is the length of the guide, and  $G$  is the width, in the same units. For circular waveguide, use eqn. 3:

$$A = 32 (L/G)$$

where  $L$  is the length and  $G$  is the diameter of the guide in the same units.

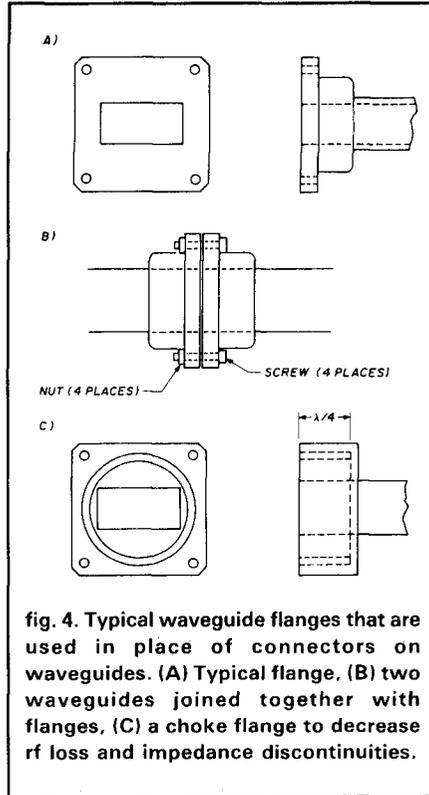


fig. 4. Typical waveguide flanges that are used in place of connectors on waveguides. (A) Typical flange. (B) two waveguides joined together with flanges. (C) a choke flange to decrease rf loss and impedance discontinuities.

Attenuation is a linear function and not frequency sensitive if operated sufficiently below the cutoff frequency. For example, a circular waveguide 0.5 inches in diameter and 0.5 inches long will have an attenuation of approximately 32 dB and 96 dB at 1.5 inches. A simple and accurate mechanical attenuator can be designed. One example is the output attenuator on signal generators like the Hewlett-Packard 608 (10-450 MHz).

Amateurs can also use waveguides beyond cutoff in high-power amplifiers at the entrance or exit for the air delivery system, where rf could leak and any restrictions will cause the tube to overheat.<sup>7</sup> Often a group of five to ten smaller tubes (e.g., 0.5 inch diameter) are grouped together to reduce the required length of a single large diameter tube, as shown in fig. 3B.

Today waveguides and microwaves are not always seen as synonymous and the SOA is changing so rapidly that coaxial components are starting to dominate the microwave field (at least up through 10 to 20 GHz). Refer-

ences 5 and 6 discuss microwave transmission lines and waveguide use in detail.

## microwave connectors

Whether you use coaxial or waveguide transmission lines, you will probably need connectors. Special coax connectors have been developed for use as high as 34 GHz.<sup>8</sup>

Waveguides have connectors called "flanges" (fig. 4A). They are butting joints similar to plumbing unions and can be held together with ordinary machine screws as shown in fig. 4B. Sometimes these flanges do not join perfectly, causing rf leaks or impedance discontinuities. To prevent this, "choke" flanges with quarter-wavelength slots like those in fig. 4C have been developed.

## transitions and junctions

Sometimes it's necessary to connect one waveguide size to another, just as you may interconnect an RG-8/U with an RG-17/U coax cable through a coax adapter. You might also want to change from a rectangular to a circular waveguide, or from a waveguide to a coaxial line. You can accomplish this with a "transition" device.

When connecting waveguides of different sizes, remember they will each have different impedances. If you were to operate at only one frequency you could design a quarter-wavelength waveguide transformer; but this would require tight mechanical tolerances that are difficult to maintain at these frequencies.

For this reason, waveguides of different sizes with common frequency ranges are often joined through a tapered section or transition. It is also desirable to have a transition to interconnect a circular and rectangular waveguide. Typical transition is shown in fig. 5A.

For a smooth change with minimum impedance discontinuities, transitions should occur over at least a wavelength. Typical losses in commercial circular to rectangular waveguide transitions are 0.1 to 0.3 dB.

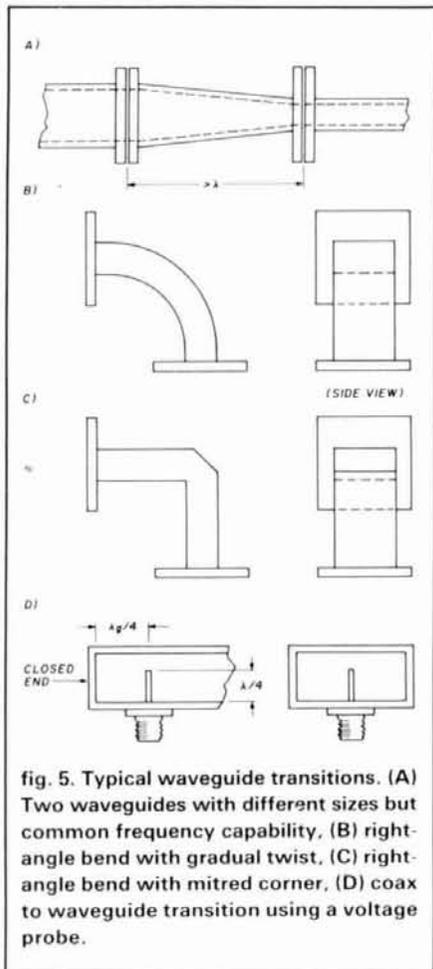


fig. 5. Typical waveguide transitions. (A) Two waveguides with different sizes but common frequency capability, (B) right-angle bend with gradual twist, (C) right-angle bend with mitred corner, (D) coax to waveguide transition using a voltage probe.

A right-angle bend is another common waveguide transition. An abrupt bend can be lossy, so smoothly bent waveguides (fig. 5B) or an abrupt bend with a mitred corner (fig. 5C) are used.

Sometimes it is desirable to connect a coaxial device to a waveguide section and vice versa. It is referred to as a waveguide-to-coax adapter and the impedance within the waveguide may be difficult to determine.

A coax-to-waveguide transition can be done with a voltage or a current probe inserted near the end of a shorted waveguide. The most common technique is the voltage probe which puts a quarter-wavelength "probe" into the closed end of a waveguide as shown in fig. 5D. This type of transition is often found at flea markets.

### summary

This month's topic was microwave

transmission lines and waveguides. The discussion concludes in next month's column, which will concentrate on other microwave components and terminology.

### new VHF records

For some time now EME activity on 6 meters has been limited to a few energetic Amateurs who "think big". That is rapidly changing. I just heard that there is a new 6-meter EME DX record. On November 15, 1987 Ray Rector, WA4NJP, (EM84) worked Jim Treybig, W6JKV, (CM87) for an approximate distance of 2145 miles (3451 km). I hope to have more details in next month's column. Congratulations, Ray and Jim.

### important VHF/UHF events:

March 16	EME perigee
March 18	New moon (eclipse of the sun)
March 21	$\pm 2$ weeks. Optimum time for TE propagation
April 11	ARRL 144-MHz Spring Sprint Contest (Monday evening local)
April 13	EME perigee
April 16	New moon
April 19	ARRL 220-MHz Spring Sprint Contest (Tuesday evening local)
April 21	Predicted peak of the Lyrids meteor shower at 1730 UTC
April 27	ARRL 432-MHz Spring Sprint Contest (Wednesday evening local)
April 29-30	Dayton Hamvention
May 1	

### references

1. Joe Reisert, W1JR, "Transmission Lines," *ham radio*, October 1985, page 83.
2. Richard W. Peters et al, "Handbook of TRI-PLATE Microwave Components," Copyright 1956 by Sanders Associates, Inc., Nashua, New Hampshire
3. W.L. Barrow, "Transmission of Electromagnetic Waves in Hollow Tubes of Metal," *Proceedings IRE*, Volume 24, October 1936, page 1298.
4. G.C. Southworth, "Hyper-frequency Wave Guides-General Considerations and Experimental Results," *Bell System Technical Journal*, Volume 15, October 1936, page 284.
5. Theodore Moreno, "Microwave Transmission Design Data," Dover Publishing, 1958.
6. "Reference Data for Radio Engineers," sixth edition, Howard Sams.
7. Joe Reisert, W1JR, "High Power Amplifiers: part 2," *ham radio*, February 1985, page 38.
8. Joe Reisert, W1JR, "RF Connectors: part I," *ham radio*, September 1986, page 77.
9. Joe Reisert, W1JR, "RF Connectors: part II," *ham radio*, October 1986, page 59.

ham radio

# 10 METER DX IS HOT!

AND YOU CAN WORK IT WITH THE NEW RANGER AR 3500



- Convenient, easy-to-use front panel controls
- All Mode operation
- Switchable noise blanker—highly effective on ignition noises
- 100 Hz per step
- Programmable band scanning
- Five selectable memory channels
- Split frequency operation
- Easy-to-read LED frequency display
- Available in outputs of 30 & 100 watts
- Microphone and power cord supplied

### RECEIVER

Frequency Range: 28.0000-29.9999 MHz  
 Circuit Type: Superhet, dual conversion  
 Clarifier Range:  $\pm 500$  Hz  
 Sensitivity: SSB & CW better than  $0.3 \mu V$  for 10 dB S+N N FM better than  $0.5 \mu V$   
 Selectivity: -6dB -60dB  
 SSB, CW 2.6 KHz 4.7 KHz  
 AM, FM 6.0 KHz 18 KHz

### TRANSMITTER

Frequency Range: 28.0000-29.9999 MHz  
 Power Output: 30 watt Model: SSB—25 Watts, AM FM—8 watts, CW—30 Watts  
 Input 12.5 VDC, 6A Max  
 Power Output: 100 watt Model: SSB—100 Watts, AM FM—30 Watts, CW—150 Watts  
 Input 12.5 VDC, 25A Max

### WARRANTY

Limited one year warranty by Clear Channel Corporation of Issaquah, WA.  
 AR35000-30W (Reg. 359) ..... Call Us  
 AR3500-100W (Reg. 449) ..... Call Us  
 Scan, Mic & Mod installed ..... \$45.00  
 SP-1 Speech Processor ..... 33.00  
 CW Bd. Auto break-in ..... 39.95  
 3 Element Beam 26-30 MHz ..... 89.50  
 Penetrator Mobile Ant. .... 44.95  
 RS-7A Pwr Sup for 30W ..... 49.95  
 RS-35A Pwr Sup for 100W ..... 134.95

SEE YOU AT THE ORLANDO, CHARLOTTE & DAYTON HAMFESTS

Quantity Pricing Available Foreign Orders Accepted  
 Orders received by 1 PM PST shipped UPS same day.  
 COD VISA / MC Next day UPS delivery available  
 ORDER DESK ONLY — NO TECHNICAL  
 (800) 854-1927  
 ORDER LINE and/or TECH HELP  
 (619) 744-0728  
 FAX (619) 744-1943



**RF PARTS COMPANY**  
 1320 Grand San Marcos California 92069

800-882-1343



IC-735

	List	Juns
IC-761 New Top of Line	2499.00	Call \$
IC-735 Gen. Cvg. Xcvr	\$999.00	Call \$
IC-751A Gen. Cvg. Xcvr	1649.00	Call \$
R7000 Gen. Cvg. Rcvr.	1099.00	Call \$
R71A Gen. Cvg. Rcvr.	949.00	Call \$
IC-28A/H FM Mobile 25w/45w	429/459	Call \$
IC-37A FM Mobile 25w	499.00	Call \$
IC-900 Super Multi-Band Mobile	589.00	Call \$
IC-04AT UHF HT	449.00	Call \$
IC-48A UHF 45w	459.00	Call \$
IC-38A FM Mobile 25w	459.00	Call \$
IC-02AT FM HT	399.00	Call \$
IC-μ2AT Micro HT	329.00	Call \$



TS-440S/AT

TS-940SAT Gen. Cvg. Xcvr.	\$2249.95	Call \$
TS-430S Gen. Cvg. Xcvr.	819.95	Call \$
TS-711A All Mode Base 25w	899.95	Call \$
TR-751A All Mode Mobile 25w	599.95	Call \$
TS-440S/AT Gen. Cvg. Xcvr	1199.95	Call \$
TM-2530A FM Mobile 25w	429.95	Call \$
TM-2550A FM Mobile 45w	469.95	Call \$
TM-2570A FM Mobile 70w	559.95	Call \$
TH-205 AT, NEW 2m HT	259.95	Call \$
TH-215A, 2m HT Has It All	349.95	Call \$
TH21BT 2M HT	259.95	Call \$
TH31BT 220 HT	269.95	Call \$
TM-3530A FM 220 MHz 25w	449.95	Call \$

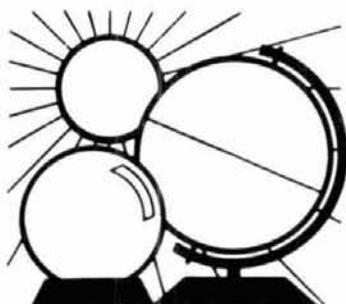


FT-757GX

FT-757 GX Gen. Cvg. Xcvr.	\$995.00	Call \$
FT-767 4 Band New	1895.00	Call \$
FT-211 RH	459.95	Call \$
FT-290R All Mode Portable	579.95	Call \$
FT-23 R/TT Mini HT	299.95	Call \$
FT-209RH RM Handheld 5w	359.95	Call \$
FT-726R All Mode Xcvr.	1095.95	Call \$
FT-727R 2M/70CM HT	479.95	Call \$
FT-2700RH 2M/70CM 25w	599.95	Call \$



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



## DX FORECASTER

Garth Stonehocker, KØRYW

### the ultimate antipode DX

In our eternal search for the optimum propagation path and mode, one in particular — antipodal DX — has probably escaped our attention. The antipode is the farthest location on the earth from you. You can visualize this point by drawing a line from your location through the center of the earth to the opposite side of the world, or calculate it by taking the opposite latitude (40°S from 40°N) and subtract your longitude from 180° and switch west to east or vice versa. Now the question is: are any Radio Amateurs there?

### what's special about your antipode?

All directions point to it, every great circle path from your location goes through it, and, at the antipode there are energy focusing effects enhancing signal strengths. Experiments have determined that the antipode reception area has a 300-mile radius before the signal diminishes by 12 dB. At greater distances, signal levels *rebuild* by 6 dB. This 6-dB range is equivalent to the cyclical signal variations that occur in sync with propagation mode changes.

The 6-dB circle perimeter is not fixed and its size can vary on a short (diurnal) and long term (yearly) basis much like any other geophysical parameter. Propagation experiments also show that reception occurs up to 50 percent more often at the antipode than at a location only 900 miles away. The operating frequency used must not exceed the MUF for the particular azimuth you choose. Avoid paths requir-

ing the signal to cross the polar regions because of accompanying low MUFs, geomagnetic, and auroral signal absorption problems. Also avoid equatorial paths where the MUF is considerably higher than the operating frequency because the greatest daytime signal absorption is found in those directions. Just remember — many directions still point toward your antipode and one will be best for you.

### last-minute forecast

The higher hf bands should peak (higher MUF) during the third and fourth weeks of March with increased solar flux levels and flare activity. These flares may cause geomagnetic field-ionospheric disturbances around the 17th and 26th. The solar wind particle count is expected to increase around the 6th as a result of thinner solar coronal. Excellent transequatorial openings should accompany these disturbances. Lower solar flux values expected during the first two weeks of the month with lower signal absorption will enhance daytime lower band DX (though not as good as a year ago). Evening/nighttime DX should be good except when local thunderstorm noise increases. Spring equinox occurs on March 20th at 0939 UTC. A full moon appears on the 3rd and will be at perigee on the 16th.

### band-by-band summary

Ten, fifteen, and twenty meters will be open from morning to early evening almost daily in most areas of the world. Expect higher band openings to be shorter and closer to local noon. Transequatorial propagation on these

GMT	WESTERN USA										MID USA										EASTERN USA									
	PST	N	NE	E	SE	S	SW	W	NW	MST	N	NE	E	SE	S	SW	W	NW	CST	EST	N	NE	E	SE	S	SW	W	NW		
0000	4:00	20	40	20	10	15	12*	10	15	5:00	20	40	20	12*	15	10	10	15	6:00	7:00	20	40	20	12	15	15	10	10	20	
0100	5:00	20	40	20	12	15	10	10	15	6:00	20	40	20	12	15	10	10	20	7:00	8:00	30	40	20	12	15	15	12	12	20	
0200	6:00	20	40	20	12	15	10	10	15	7:00	20	40	20	15	15	12*	10	20	8:00	9:00	30	40	20	15	15	12	12	30	30	
0300	7:00	20	40	20	15	15	10	10	20	8:00	30	40	20	15	15	15	12	30	9:00	10:00	40	40	20	15	15	15	15	30	40	
0400	8:00	20	40	20	15	15	12	12	20	9:00	40	40	20	15	15	12	30	30	10:00	11:00	40	40	20	20	20	20	15	15	30	
0500	9:00	30	40	20	20	15	12	12	30	10:00	40	40	20	20	20	15	15	30	11:00	12:00	40	40	20	20	20	20	20	20	40	
0600	10:00	30	40	20	20	20	15	15	30	11:00	40	40	20	20	30	20	20	40	12:00	1:00	40	40	20	20	30	20	20	20	40	
0700	11:00	40	40	20	20	30	15	15	30	12:00	40	40	20	20	30	20	20	40	1:00	2:00	40	40	20	20	30	20	20	20	40	
0800	12:00	40	40	20	20	30	15	20	30	1:00	40	40	20	20	30	20	20	40	2:00	3:00	40	40	20	20	30	20	20	20	40	
0900	1:00	40	40	30	20	20	20	20	40	2:00	40	40	30	20	30	20	20	40	3:00	4:00	40	20	20	15	30	20	20	20	40	
1000	2:00	40	40	30	20	20	20	20	40	3:00	40	40	20	20	30	20	20	40	4:00	5:00	20	20	15	20	30	20	20	20	40	
1100	3:00	40	40	30	20	20	20	20	40	4:00	30	30	15	20	30	20	20	40	5:00	6:00	20	20	15	20	30	20	20	30	30	
1200	4:00	40	30	15	20	30	20	20	40	5:00	20	20	15	20	30	20	20	40	6:00	7:00	20	20	10	15	20	20	20	20	40	
1300	5:00	40	20	15	20	30	20	20	40	6:00	20	20	12	20	30	20	20	40	7:00	8:00	20	20	10	15	20	20	20	20	40	
1400	6:00	30	20	12	15	30	20	20	40	7:00	20	20	12	15	20	20	20	40	8:00	9:00	30	20	10	15	20	20	20	20	40	
1500	7:00	30	20	12*	15	20	20	20	40	8:00	30	20	10	15	20	20	20	40	9:00	10:00	30	20	10	12	15	20	20	20	40	
1600	8:00	40	20	10	12	20	30	20	40	9:00	30	20	10	12	15	30	20	40	10:00	11:00	30	20	10	12	15	15	30	20	40	
1700	9:00	40	20	10	12	15	20	20	40	10:00	30	20	10	12	15	20	20	40	11:00	12:00	30	20	10	12	15	15	20	20	40	
1800	10:00	40	20	10	12*	15	20	30	40	11:00	40	20	10	12*	15	20	20	40	12:00	1:00	40	20	12*	12	15	20	20	20	40	
1900	11:00	40	20	12	10	15	15	15	30	12:00	40	20	12*	10	15	15	15	30	1:00	2:00	40	20	12	10	15	15	15	20	30	
2000	12:00	40	20	12	10	15	15	15	30	1:00	40	30	12	10	15	15	15	30	2:00	3:00	40	20	12	10	15	15	15	20	30	
2100	1:00	40	30	15	10	15	12	15	20	2:00	40	30	15	10	15	12	15	20	3:00	4:00	40	30	15	10	15	12	15	20	30	
2200	2:00	40	30	15	10	15	12	12	20	3:00	40	30	15	10	15	12	12	20	4:00	5:00	40	30	15	10	15	12	12	20	30	
2300	3:00	20	30	15	10	15	12	12	15	4:00	40	30	15	10	15	12*	12	20	5:00	6:00	40	40	15	10	15	12*	12	20	30	

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

\*Look at next higher band for possible openings.

# MADISON SHOPPER

**CALL FOR ORDERS**  
**1 (800) 231-3057**  
**1-713-520-7300 OR 1-713-520-0550**  
**TEXAS ORDERS CALL COLLECT**  
**ALL ITEMS ARE GUARANTEED OR**  
**SALES PRICE REFUNDED**

New Icom IC 7B1 Trades wanted  
 Kenwood TH215A, TH25AT Trade in your old HT



Kenwood TS140S — Call

Kenwood TS 140S Call for trade  
 New Kenwood TM-221A, 45W mobile Call  
 ICOM 28H/TTM Call



Icom 761 Call

Shure 444D	54.95
Astatic MC321 Cartridge D104	12.00
Astatic D104C/TUP-9	72.00
Isopole 144 MHz	44.95
Cushcraft 124-WB (146 MHz)	33.00
Butternut HF6V, 80-10 vertical	125.00
Hustler G7-144	119.95
KLM HF World Class Series Antennas	Call Don
KLM KT-34A	399.00
NEW KLM 1/2-44LBX	129.00
G5 RV	44.00
Larsen 2-meter on glass	49.95
New Larsen CM 490 CO	5.00
Anteco 2M 5/8 Mag Mount Comp	25.00
Thousands of panel meters	3.95 up CALL
8560A	95.00
Aerovox 1000 pf/500 V feedthrough caps	1.95
Transformer 120 V Pri, 1050 V/1A (Sec #18 Wire)	50.00
100 mfd/450V Axial Cap	2.00
831SP-PL259 Silverplate	1.25
82-61 N Male	3.00
GE 6146B	13.95
3-500Z	140.00
GE 12BY7A	7.00
6MJ6	12.95
6KD6	12.95
AEA PK-232 with new WX FAX	299.00
Kantronics KPC II	149.00
AEA Packet Terminal	Call

## USED EQUIPMENT

All equipment used, clean, with 90 day warranty and 30 day trial. Six months full trade against new equipment. Sale price refunded if not satisfied.

Call for latest used gear  
 (800) 231-3057

TS-430S TS-830S TS-520S FT-101E and Collins

Porcelain 502 Guy Insulators (1/4) 3.39

## POLICIES

Minimum order \$10.00. Mastercard, VISA, or C.O.D. All prices FOB Houston, except as noted. Prices subject to change without notice. Items subject to prior sale. Call any time to check the status of your order. Texas residents add sales tax. All items full factory warranty plus Madison warranty.

Bird and Belden products in stock. Call today. ✓ 273

# MADISON Electronics Supply

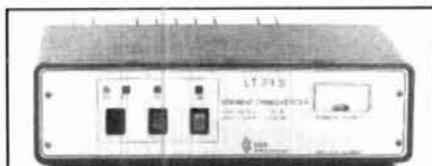
3621 FANNIN  
 HOUSTON, TEXAS 77004



## UNADILLA

**CONTACT YOUR DEALER FOR MORE INFORMATION**  
**Amateur Radio Baluns- Traps-Remote Coaxial Switches**  
 Or Write To:  
**UNADILLA DIV. of ANTENNA'S ETC.**  
 P.O. Box 215 BV ANDOVER, MA. 01810  
 617-475-7831

✓ 272



### SSB ELECTRONIC TRANSVERTERS & PREAMPLIFIERS

LT33S	902/144 Xvtr 20W GaAsFet	\$599
LT23S	1296/144 Xvtr 10W GaAsFet	\$599
MICRO-13	2304/144 Xvtr 0.5W GaAsFet	\$419
MICRO-X	10.368/144 Xvtr 200mw GaAsFet	\$649
new products:		
SP-2	144-148 Mhz RF switched preamp	\$209
SP-70	430-440 Mhz RF switched preamp	\$209
LT13S	2304/144 Xvtr 5W GaAsFet	\$599
other items:		
T144/28	144 Mhz transverter 25W, 28 or 50 IF	\$229
T220/28	220 Mhz transverter 15W, 28 or 50 IF	\$249
PA 33200	902 Mhz 200 Watt PA	\$549
PA 23150	1296 Mhz 150 Watt PA	\$469
PA 23200	1296 Mhz 200 Watt water cooled PA	\$299
PA 1325	2304 Mhz 25 Watt PA	\$439
HF 400	High Power Relay 2 KW at 144 Mhz	\$139
HF 2000/6	Relay 2 KW at 100 Mhz, 400 W at 6 Ghz	\$219

Factory Authorized Dealer for SSB Electronics for North America

<b>TRANSVERTERS UNLIMITED</b>	<b>TRANSVERTERS UNLIMITED</b>
BOX 6286 STATION A	(US)
TORONTO, ONTARIO	P.O. BOX 178
CANADA M5W 1P3	NEW BOSTON, NH 03070
(416) 759-5562	(603) 547-2213

✓ 271

### Half-Square QRV-DX Monobanders

Work DX with No Tower and No Amplifier.  
 Cut noise, cut near sigs, build DX sigs, kill QRM.

10 Meters	15 Meters	20 Meters	30 Meters
\$29.95	\$39.95	\$49.95	\$59.95

Broadside Pattern, Low Profile, Coax Feed, Ready to Use  
 Highest DX Gain per Dollar

To order add \$5 Postage & Handling and call or write:  
 1971 North Oak Lane Antennas West  
 Provo, UT 84604-2138 (801) 374-1084

✓ 270

bands is likely to be toward evening during times of high solar flux and disturbed geomagnetic field conditions.

Thirty and forty meters will be useful almost 24 hours a day. Daytime conditions will resemble those on 20 meters, but skip and signal strength may decrease during midday on days with high solar flux values. Look for good nighttime use — except after days of very high MUF (solar flux) conditions. Usable distances on these bands should be somewhat greater than that achieved on 80 at night.

Eighty and one-sixty meters, the nighttime DXer's bands, will open just before sunset and last until sunrise on the path of interest. Except for daytime short-skip signal strengths, high solar flux values have little effect. Geomagnetic disturbances, more evident at the equinoctial periods, cause signal attenuation and fading on polar paths. Noise increases noticeably on these lower frequency bands now and in the coming months. Please remember the DX windows of 3790 to 3800, 1825 to 1830, and 1850 to 1855 kHz.

ham radio

This publication is available in microform from University Microfilms International.



Please send information about these titles:

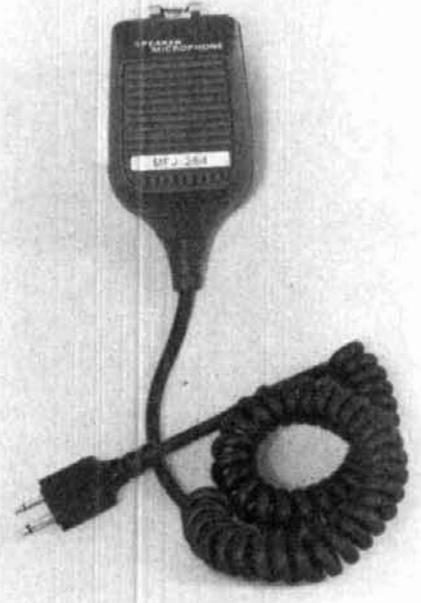
Name \_\_\_\_\_  
 Company/Institution \_\_\_\_\_  
 Address \_\_\_\_\_  
 City \_\_\_\_\_  
 State \_\_\_\_\_ Zip \_\_\_\_\_  
 Phone (\_\_\_\_) \_\_\_\_\_

Call toll-free 800-521-3044. In Michigan, Alaska and Hawaii call collect 313-761-4700. Or mail inquiry to: University Microfilms International, 300 North Zeeb Road, Ann Arbor, MI 48106.



## MFJ speaker/mic for handhelds

The new MFJ speaker/mic with its lapel/pocket clip, lets you carry your handheld easily. It has a lightweight retractable cord and a con-



ductor that fits ICOM and Yaesu handhelds. It features clean audio on both transmit and receive.

Available from MFJ dealers or direct from the company, the MFJ-284 retails for \$24.95 and has a one-year unconditional warranty.

For more information contact MFJ Enterprises, Inc., P.O. Box 494, Mississippi State, Mississippi 39762.

Circle #303 on Reader Service Card.

## novice welcome

Gordon West Radio School has a Novice welcome package containing literature sheets, rebate coupons, and in-store discount offers from 30 Amateur Radio equipment manufacturers and accessory suppliers, and five dealers.



Included are ICOM, Kenwood, and Yaesu gift certificates worth up to \$25 each towards the purchase of new radio gear and free magazine

issue certificates with subscription discounts. There are catalogs from Amateur Radio accessory manufacturers and "tip sheets" from manufacturers on how to set up a beginner Novice voice-class station sent with each beginner course.

The 21-day Novice course includes two stereo code-learning cassettes and West's 112-page Novice book. Priced at \$19.95 (plus \$2.50 postage and handling), the course materials include: FCC Form 610, a frequency reference chart, laminated world map, and a sample Novice exam package.

Students who pass any upgrade examination or Novice entry-level exam receive equipment discount coupons from ICOM, Yaesu, and Kenwood. Anyone who passes the exams within 120 days, using our materials, may write and receive radio rebate rewards, an FCC license holder, certificate of course completion, certificate for a free Amateur Radio magazine, and other coupons.

For more information, write to Gordon West Radio School, 2414 College Drive, Costa Mesa, California 92626.

Circle #304 on Reader Service Card.



## magnetic mount antennas

Hustler, Inc. announces two new magnetic mount antennas. Rated at 100 watts, the RX series consists of a 5/8 wave, 3.4-dB antenna on a magnet mount that withstands speeds up to 75 mph. The RX-2 (2 meter) and the RX-220 (220 MHz) are chrome with a black mount and coil cover. The suggested list price for both models is \$19.95. The RX series is available in all-black versions (models RX-2B and RX-220B), each with a list price of \$24.95.

The FX series, rated at 200 watts, is a 5/8 wave, 3.4-dB antenna on a heavy duty magnet mount which holds at speeds in excess of 100 mph. The FX-2 (2 meter) and the FX-220 (220 MHz) list for \$24.96 each. All-black versions of the FX series are available as models FX-2B and FX220B priced at \$29.95 each.

For information contact Hustler, Inc., One New-Tronics Place, Mineral Wells, Texas 76067.

Circle #301 on Reader Service Card.

## high-power linear amplifier

The HL-180V is a high-power linear amplifier designed for 144-MHz band and all-mode operation. It provides a maximum output power of 170 watts. You can operate the amplifier with 3/10/25 watt output transceivers, as it will automatically select the incoming drive level. The LED power level indicator enables you to monitor the output power level at all times. Over-voltage protection circuit prevents the rf power transistors from being damaged. Remote control lead wires are incorporated to enable a smooth and instant changeover especially on SSB.

The THL model HL-180V is now available at your local ENCOMM dealer. Suggested list price is \$359.95. For further information contact ENCOMM, Inc., 1506 Capital Avenue, Plano, Texas 75074.

Circle #302 on Reader Service Card.

## Heathkit catalog

The Heathkit H-386 Desktop Computer, an 80386-based computer that operates two to three times faster than a PC/AT, appears in the latest Heathkit Catalog. Also featured is the Zenith Data Systems Flat Tension Mask Color Monitor with a flat screen and VGA compatibility.



The most powerful kit computer offered today, the H-386 provides graphics capabilities using a 31-kHz video card that automatically emulates EGA, CGA, MDA, and Hercules graphics, depending on what video-mode software requires. The standard 1 megabyte of RAM can be expanded up to 16 megabytes. The kit is easy to build and includes the H-386 with 1 megabyte of RAM, the VGA video card, and one 1.2 megabyte 5-1/4 inch disk drive for \$3349.95.

# 2x4Z BASE REPEATER ANTENNA

THE HIGHEST GAIN DUAL BAND BASE/REPEATER ANTENNA

HIGH POWER 200 WATTS

CENTER FREQUENCY

146.500 MHz

446.500 MHz

GAIN:

VHF - 8.2dB

UHF - 11.5dB

VSWR - 1.-1.2 or less

CONNECTOR:

N TYPE FEMALE

LIGHTNING PROTECTION GROUNDED DIRECT

LENGTH: 16 FT.

WEIGHT: 5 LBS. 3 OZ.

WIND LOAD: 90 MPH

MOUNTING: UP TO 2 IN.

MAST

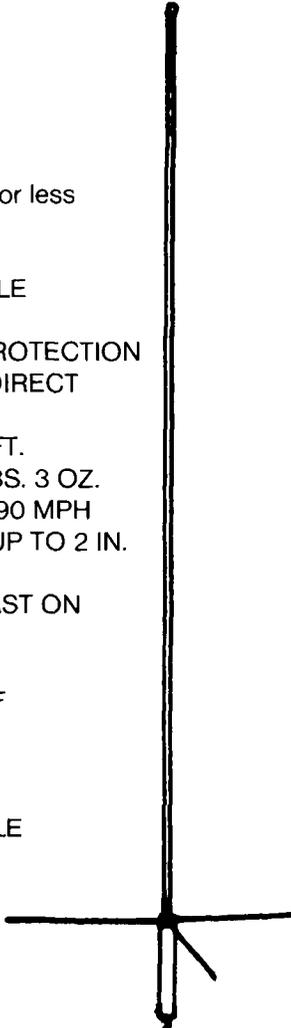
CAN SIMULCAST ON BOTH BANDS

WATERPROOF

CONNECTING

JOINTS

UPS SHIPPABLE



## AMATEUR SPECIAL



1275 NORTH GROVE ST.  
ANAHEIM, CALIF. 92806  
(714) 630-4541

CABLE: NATCOLGLZ ✓ 277  
FAX (714) 630-7024

## BLACK DACRON® POLYESTER ANTENNA ROPE

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

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

Dealer Inquiries Invited



MANUFACTURED BY  
**synthetic  
textiles, inc.**

2472 EASTMAN AVE., BUILDING 21  
VENTURA, CALIFORNIA 93003  
(805) 658-7903

✓ 276

## THE RF CONNECTION

"SPECIALIST IN RF CONNECTORS AND COAX"

Part No.	Description	Price
321-11064-3	BNC 2 PST 28 volt coaxial relay, Amphenol Insertion loss: 0 to 0.75GHz, 0.10dB Power rating: 0 to 0.5GHz, 100 watts CW, 2 kw peak Isolation: 0.1 GHz/45db, 0.2 GHz/40db, 0.4 GHz/35db	\$25 used tested
83-822	PL-259 Teflon, Amphenol	1 50
PL-259/ST	UHF Male Silver Teflon, USA	1 50
UG-21D/U	N Male RG-8, 213, 214, Amphenol	2 95
UG-21B/U	N Male RG-8, 213, 214, Kings	4 00
9913/PIN	N Male Pin for 9913, 9086, 8214 fits UG-21D/U & UG-21B/U N's	1 50
UG-21D/9913	N Male for RG-8 with 9913 Pin	3 95
UG-21B/9913	N Male for RG-8 with 9913 Pin	4 75
UG-146/U	N Male to SO-239, Teflon USA	5 00
UG-83/U	Female to SO-239, Teflon USA	5 00

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

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

(301) 840-5477

VISA/MASTERCARD: Add 4%  
Prices Do Not Include Shipping

✓ 275

## 1988 CALL DIRECTORY

(on microfiche)

Call Directory \$8  
Name Index \$8  
Geographic Index \$8  
All three — \$20 Shipping per order \$3

**BUCKMASTER PUBLISHING**  
Mineral, Virginia 23117  
703-894-5777

✓ 274



The ZCM-1490 Flat Tension Mask (14 inch diagonal) Monitor has true color at higher intensities with more contrast, brighter colors, and less glare than conventional round monitor cathode ray tubes.

The Robot Arm Trainer, a flexible, multijoint robotic arm, is also new. Controlled by an 8-bit microprocessor, the ETS-19-32 Trainer can be programmed through its attached teaching pendant, and connected to a computer through an RS-232 serial port. It features five axes of motion, and a patented sense-of-touch gripper programable for specific amounts of force. Six closed-loop DC servo motors provide smooth, accurate movement, and menu-driven software allows command option selections.

For a free catalog, write Heath Company, Department 350-030, Benton Harbor, Michigan 49022. In Canada, write Heath Company, Dept. 3100, 1020 Islington Ave., Toronto, Ontario M8Z 5Z3.

Circle #305 on Reader Service Card.

## YA-1 low pass filter

Bencher's Low Pass Filter can help Amateurs active on high frequency bands resolve television interference problems. The YA-1 filter has a minimum attenuation of 80 dB or better in independent lab tests for harmonic radiation in channel 2 and higher.

For details write Bencher, Inc., 333 West Lake Street, Chicago, Illinois 60606.

Circle #306 on Reader Service Card.

## "DCPS" switcher power supply for the C-64

Engineering Consulting announces a new power supply for Commodore 64 computers allowing operation directly from 12 volts dc or batteries. The power supply provides emergency backup and solar power operation.

The "DCPS" delivers 9 volts ac at exactly 60 Hz and 5 volts at up to 2 amps. A crystal-controlled time base is used to divide a 3.58-MHz crystal to 60 Hz so an accurate clock is generated for the computer's internal timers. The 5 volts dc is provided by a state-of-the-art switcher at 75 percent efficiency.

The power supply is cable ready and plugs right into the C-64. For additional current reduction a jumper can be installed bypassing the internal 5-volt regulator, and the "DCPS" will provide the entire 5-volt requirement. This modification lets the C-64 operate with a current drain of 1 amp from the 12-volt battery.

The "DCPS" is available from Engineering Consulting, 583 Candlewood Street, Brea, California 92621 for \$119.95 plus \$4.00 shipping.

# 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.

**TEST EQUIPMENT WANTED.** Don't wait—we'll pay cash for LATE MODEL HP, Tek, etc. Call Glenn, N/LPK, at Skagtronics Co. (800) 356 TRON.

**HAMLOG COMPUTER PROGRAMS.** 17 modules auto logs, sorts 7 band WAS DXCC. Full features. Apple \$19.95, IBM or CP/M \$24.95. KA1AWH, POB 2675, Prudboy, MA 01966.

**WANTED ATLAS 350-XL.** N5NM, Box 2169, Santa Fe, NM 87504 (505) 988 2305.

**GaAs FET Inexpensive.** NE72083 \$8.00 each or \$65.00 for 10 pcs. 1 Dec. 1981 thru Volume 72, Feb. 1988. Shipped UPS pre paid USA 48, \$75.00. Certified check or MO. (216) 494 9666. W8FRB, 4434 Fairhaven NW, Canton, OH 44709.

**HAVE \$60.** Want SB610 Scope in working condition, W8OX, Box 452, Birmingham, MI 48012 (313) 644 5042.

**QEX-QEX-QEX.** ARRL Experimenters Exchange Complete. Volume 1, Dec. 1981 thru Volume 72, Feb. 1988. Shipped UPS pre paid USA 48, \$75.00. Certified check or MO. (216) 494 9666. W8FRB, 4434 Fairhaven NW, Canton, OH 44709.

**CALL SIGN BADGES:** Custom license plate holders. Personal, distinctive. Club discounts. SASE. WB3GND, Box 750, Clinton, MD 20735 (301) 248 7302.

**R-390A Receiver:** \$115, electronically complete, repairable (government removed meters, operation unaffected). R 390A parts, info. SASE. Professional quality TS 352 Voltohm Multimeter AC DC, with leads, manual \$12.50. Mini military spec pull out 12A7, 6BA6, 6AG5, 6AL5 \$10.50. CPCR 26 in fantry Marpa E Radio, 6 meter FM receiver transmitter sections, cabinet, antenna, crystal, handset \$22.50, \$42.50 pair. H 251 Military Communications Headphones, \$7.50. Add \$4.50 price shipping (\$9 minimum), except R 390A shipped collect. Baytronics, Box 591, Sandusky, OH 44870.

**SB220 OWNERS:** Add 160 meters, OSK, + 3 additional on hand components. 30 page step by step manual includes parts sources, and 3 5000 ft manual. SASE for details. \$10 plus \$14 postage. WA2500, 69 Memorial Place, Elmwood Park, NJ 07407.

**SOLDERING STATION AND TOOLS.** European and American. For details, Robert Mox, expert. Expert, Box 643/R, Fair Haven, N.J. 07410 (201) 758 8885.

**WANTED TEN-TEC ARGONAUT.** N5NM, Box 2169, Santa Fe, NM 87504 (505) 988 2305.

**ANALOG AND RF CONSULTING** for the San Francisco Bay Area. Commercial and military circuits and systems. James Long, Ph.D. N6YB #1081/733 8329.

**GAIL'S QSL's** \$6.00 best 100, \$4.00 thereafter. Stamp for samples. KA0Y7, 1150H Murray, Wright City, MO 63390.

**AMP SUPPLY** LK 800 A Linear external power supply, 5 amp diodes, four 3CX 800A tubes. Bob, N2FBB, Rt 5, Box 860, Hecker, NY 13350. (315) 866-6527.

**WANTED:** Klystron tubes especially 2911. Magnatrons; also 304TL, 6012, 810 and 5CX1500A. All types of sockets for transmitting tubes. Harold Bramstedt, 6104 Egg Lk Rd, Hugo, MN 55038. (612) 429-9397.

**MACINTOSH SATELLITE** and Propagation Software. MacTrak™ displays graphic maps (rectangular, polar, great circle), views from space, schedules, windows. Also tracks Sun and Moon. Compatible with KLM MIRAGE rotor interface. Shows gray line, sunrise, sunset, bearing, distance, MUF vs time, areas of world "open". SASE for info or \$49.95 from R. Stogemeyer, PO Box 1590, Port Orchard, WA 98366.

**UNLOCK THE POWER** of your Heath Counter. IM-2400 owners, easy one evening kit yields two decades greater resolution. Measure things you thought you'd have to buy another counter for. You won't believe the difference: \$12.95 for kit #110 to L & R Distributing, PO Box 4643, Northbrook, IL 60062.

**1988 PRODUCT AND PRICE LIST** of our Kits and Assemblies is now available. Send SASE to: A & A Engineering, 2521 W. La Palma, Unit K, Anaheim, CA 92801.

**SUPERFAST MORSE CODE SUPREASY.** Subminimal cassette. 10. Learning Morse Code in 1 hour. Amazing new supersonic technique. \$10, Both \$17. Moneyback guarantee. Free catalog. SASE. Bahr, 2549 H1 Temple, Palm Bay, FL 32905.

**UHF PARTS.** GaAs fets, mimes, chip caps, trimmer caps, and other builder parts. MG #1402 @ \$14.00 MFG 1302 @ \$9.00 8 10yd. Tomronics trimmer @ \$3.75. Potencan chip caps @ \$1.75. Orders add \$1.00 p/h. SASE for complete list. MICRO WAVE COMPONENTS, 11216 Cape Cod, Taylor, MI 48180.

**WA9GFR COMMUNICATIONS SOFTWARE.** \$15.00 disk contains HF VHF UHF/L-Band propagation programs to predict range in miles based on transmitter power, receiver sensitivity, and antenna height & gain. A "must" for designing repeater installations. Also includes Smith Chart impedance matching programs. Commodore 64 or IBM. Lynn Gerig, RR1, Monroeville, IN 46773.

**IBM-PC RTTY/CW.** New CompRty II is the complete RTTY/CW program for IBM PCs and compatibles. Now with larger buffers, better support for packet units, pictures, much more. Virtually any speed ASCII, BAUDOT, CW. Text entry via built in screen editor! Adjustable split screen display. Instant mode speed change. Hardcopy, diskcopy, break in buffer, select calling, text file transfer, customizable full screen logging, 24 programmable 1000 character messages. Ideal for MARS and traffic handling. Requires 256k PC or AT compatible, serial port, RS 232C TU. \$65. Send call letters (including MARS) with order. David A. Rice, KC2HO, 25 Village View Bluff, Ballston Lake, NY 12019.

**CHASSIS, CABINET KITS.** SASE. K31WK, 5120 Hammeny Grove, Road, Dover, PA 17315.

**TELEVISION SETS** made before 1946, early TV parts, literature wanted for substantial cash. Especially interested in "mirror in the lid" and spinning disc tv's. Finder's fee paid for leads. Arnold Chase, 9 Rushleigh Road, West Hartford, Conn. 06117. (203) 521 5280.

**ENGINEERS** request free catalog of Electronics Software. Circuit analysis, filter design, graphics, etc. BV Engineering, 2200 Business Way, Suite 207, Riverside, CA 92501 (714) 781 0252.

**CODE PROGRAMS.** Apple. C 64 128 37 modes/graphics. Les sons. LARESCO, P.O.B. 2018 HR. Calumet City, IL 60409 (312) 891 3279.

**RTTY JOURNAL**—Now in our 36th year. Join the circle of RTTY friends from all over the world. Your's subscription to RTTY JOURNAL, \$10.00, foreign \$15.00. Send to: RTTY JOURNAL, 9085 La Casita Ave., Fountain Valley, CA 92708.

**IMRA** International Mission Radio Association helps missionaries. Equipment loaned. Weekday net. 14 280 MHz, 1.3 PM Eastern. Nine hundred Amateurs in 40 countries. Rev. Thomas Sable, S.J. University of Scranton, Scranton, PA 18510.

**MARCO:** Medical Amateur Radio Company, Ltd. operates daily and Sunday nets. Medically oriented Amateurs (physicians, dentists, veterinarians, nurses, physiotherapists, lab technicians, etc.) invited to join. Presently over 550 members. For information write MARCO, Box 73's, Acme, PA 15618.

**COMMODORE REPAIR/CHIPS.** We are the oldest largest Authorized Service Center in the country. Low prices, exp. C 64 repair \$39.95 including parts labor. Commodore Chips at low prices. #6510 \$8.95, #6526 \$8.95, #6567 \$14.45, #6581 \$10.95, #25100 P1A \$12.85, 325672 \$9.95, 325302 \$10.95, #8721 \$11.50, #8722 \$12.95, 901 ROM Series \$9.95. NLW Amnopa Chips, call for price, and many others. THE COMMODORE AGNOSTICIAN™. A complete diagnostic reference chart for fixed Commodore computers, etc. An absolute must for those who want to fix their own computers and save money and down time. \$6.95 plus postage. HD Power Supply for C 64. \$27.95 + pp. Send for complete chips parts catalog. We ship worldwide. VISA/MC, Kasara, Inc., 36 Murray Hill Drive, Spring Valley, NY 10977. 1 800 248 2983 (Nationwide) or 914 356 3131.

**YAESU FT-727-R COMPUTER INTERFACE.** For info write Gerald Hooper Consulting, 1581 Woodland, Palo Alto, CA 94303.

**RUBBER STAMPS:** 3 lines \$5.00 PPD. Send check or MO to G. L. Pierce, 5521 Birkdale Way, San Diego, CA 92117. SASE brings information.

**ELECTRON TUBES:** Receiving, transmitting, microwave. All types available. Large stock. Next day delivery, most cases. DAILY ELECTRONICS, PO Box 5029, Compton, CA 90224. (713) 774 1255.

**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.

**PACKET RADIO AMATEUR.** Announcing a new heavy duty C 64 Commodore replacement power supply especially for the Packet Radio Amateur. The new higher amperage output will now allow for 24 hour continuous "Packet" operation without voltage change or failure while the existing unit can succumb to. This P.S. is an exact physical replacement and will not run hot. \$27.95 + pp. VISA/MC, Kasara Inc., 36 Murray Hill Drive, Spring Valley, NY 10977. 1 800 248 2983 (Nationwide) or 914 356 3131.

**RECONDITIONED TEST EQUIPMENT** \$1.25 for catalog. Walter, 2697 Nickel, San Pablo, CA 94806.

## COMING EVENTS Activities — "Places to go . . ."

**SPECIAL REQUEST TO ALL AMATEUR RADIO PUBLICITY COORDINATORS:** PLEASE INDICATE IN YOUR ANNOUNCEMENTS WHETHER OR NOT YOUR HAMFEST LOCATION, CLASSES, EXAMS, MEETINGS, FLEA MARKETS, ETC. ARE WHEELCHAIR ACCESSIBLE. THIS INFORMATION WOULD BE GREATLY APPRECIATED BY OUR BROTHER/SISTER HAMS WITH LIMITED PHYSICAL ABILITY.

**OHIO:** March 6, The Conneaut Amateur Radio Club's Hamfest, Conneaut Human Resource Center, 327 Mill St, Conneaut Wheelchair acc. Paved parking. Admission \$3.00. 8 table \$5.00. Vendors 7 AM. Public 9 AM-3 PM. Jack Martila, KA8TUJ, 69/ Broad Street, Conneaut, OH 44030.

**MASSACHUSETTS:** March 6, The Mount Tom Amateur Repeater Association's annual Flea Market, Knights of Columbus, Council 69, Granby Road, Chicopee. Admission \$2. Your non ham spouse and kids admitted free. Tables \$8/advance, \$10/door. Free parking. Reserved Handicap parking. Vendors 7 AM. Public 9 AM. Computer, electronics and Amateur vendors. Food and refreshments available. Talk in on 146.94 and 223.82 repeaters, 146.52 simplex. For reservations write Marvin Yale, N1CDCR, 6 Laurel Terrace, Westfield, MA 01085 (413) 562 1027 evenings. (413) 532 6411, 532 4891 days.

**PENNSYLVANIA:** March 6, The first annual York Winterfest (Ham & Computer) Dover Firehall, Indoor tables \$10. Free tailgating, Food, refreshments and more. Registration \$4. Spouse and kids under 12 free. Admission 8 AM. Talk in on 146.3/ 97 and 147.93/33. For information and registration York Winterfest, 5112 Roller Rd, Millers, MD 21107.

**NEW JERSEY:** March 12, The Shore Points ARC invites you to Springfest '88 Hamfest, Atlantic County 4 H Center, Rt 50, Egg Harbor City. Sellers admitted 7 AM. Buyers 9 AM. Indoor selling space \$5. Buyers \$3. Talk in on 146.385/985 and 146.52. For information SPARC, POB 142, Absecon, NJ 08201.

**INDIANA:** March 12, The Morgan County Repeater Association is sponsoring Indiana Hamfest, Indiana State Fairgrounds Pavilion Building, Indianapolis. Open 8 AM. Admission \$5/door, 8' flea market table space \$8. No space without table. Talk in on 145.25. For information and table reservations SASE before 2:26 PM to Aileen Scales, KC9YA, 3142 Market Place, Bloomington, IN 47401 (812) 339 4446.

**MICHIGAN:** March 19, 27th annual Michigan Crossroads Hamfest, Marshall High School, Marshall. 8 AM to 3 PM. Tables \$3/door or \$2/advance (SASE). Talk in on 146.66 or 146.52. For information write SMARS, POB 934, Battle Creek, MI 49016.

**NEW HAMPSHIRE:** March 19, The Interstate Repeater Society of Derry will hold its annual Flea Market, Lion's Club Hall, Hudson, NH. 8 AM to 4 PM. Admission \$2. Tables \$10 for tables 2 admissions. Ham equipment, computers and more. For table reservations write IRS, POB 693, Derry, NH 03038 (603) 434 4435.

**TEXAS:** March 19 20, The Midland ARC will hold its annual St. Patrick's Day Swapfest, Midland County Exhibit Building, east of Midland, northside of Hwy 80. Saturday 10-5, Sunday 9-2:30. Pre registration \$5. \$6 at door. Tables \$6 each. Refreshments and food available. VE tests all categories. For information and reservations contact Midland ARC, POB 4401, Midland TX 79704.

**FLORIDA:** March 19 20, The Playground ARC will hold its 18th annual North Florida HAM SWAPFEST, Shrine Fairgrounds, north Ft. Walton Beach. Doors open 8 AM both days. FCC exams Saturday only. Banquet Saturday night. RV parking. Talk in on 146.19/.79 and 52. For more information write PARC, POB 873, Ft. Walton Beach, FL 32548.

**NORTH CAROLINA:** March 19 and 20, The Mecklenburg ARS is sponsoring the Charlotte Hamfest and Computer Fair. Charlotte Convention Center, 4th and College Streets, uptown. Char

# flea market

lotte. Saturday 9-5, Sunday 9-3. Tickets \$5 advance, \$6 door. Tables \$10 advance, \$12 door. Tickets and tables good for both days. Children under 12 free. Large flea market, programs, to rums, nearby restaurants and inside food concessions. Talk in on W4BFB R on 145 29. For information and reservations write Charlotte Hamfest, POB 221136, Charlotte, NC 28222 1136.

**PENNSYLVANIA:** March 20. The Beaver Valley ARA will sponsor the 4th annual Beaver Valley Hamfest, "Golden Dome" of the Community College of Beaver County, Monaca, 8 AM to 4 PM. Vendor spaces \$2 each. Free admission to each vendor 8' tables \$6. Forums, license testing and good food. For reserved space: tables write Don Washburne, WB3HWB, 207 Hall Road, Aliquippa, PA 15001. (412) 774 7079.

**KENTUCKY:** March 26. ARRL State Convention sponsored by the Lincoln Trail ARC, Pritchard Community Center, Elizabeth town. Many activities. Flea market, VE testing, forums. Admission \$4 advance, \$5 door. Vendor space \$5. Talk in on 146 52, 146 38 98. For information, tickets, reservations contact Chuck Strain, AA4ZD, POB 342, Vine Grove, KY 40175.

**MARYLAND:** March 26 and 27. Baltimore ARC's 1988 Greater Baltimore Hamfest and Computerfest, Maryland State Fair grounds Exhibition Complex at Timonium. Indoor flea market, large dealer area. Large outdoor flea market with lots of electronic bargains. Cafeteria service, plenty of free parking. Gates open 8 AM each day. Admission \$4 one day or \$6 both days. Children under 12 free. For more information contact GBHQC, POB 95, Timonium, MD 21093 0095 or call (310)HAM FEST.

**WISCONSIN:** March 27. The Tri County ARC, W9MOB, will hold its annual Hamfest, 8 AM to 3 PM, Jefferson County Fair grounds, Jefferson. Tickets \$2 \$0 advance, \$3 door. Tables \$3 advance, \$4 door. Doors open 7 AM sellers only. Plenty of free parking. Amateur exams. Talk in on 144 89 145 49 or 146 52. For information, tickets or tables SASE to TCARC, POB 321, Milton, WI 53563.

**OHIO:** March 27. The 10th annual Lake County Hamfest, Madison High School, Burns Road and Middle Ridge Road, Madison, Ohio. 8 AM to 3 PM. Sponsored by the Lake County ARA. Flea market, FCC exams, forums, computer topics. Admission \$4 door, \$3 prior to March 1 with SASE. Talk in 147 21 81 LCARA repeater. For information LCARA Hamfest, 7803 Skyline Drive, Mentor, OH 44060. (216) 953 9784 until 9 PM.

**ILLINOIS:** March 27. LAMARSFEST 1988 sponsored by the Libertyville and Mundelein ARS, Lake County Fairgrounds, Grayslake. Doors open 8 AM. Setup from 6 AM by reservation only. Donations \$3 at gate; \$2 advance. Commercial exhibitors call Mark Abramson, KC9VW (312) 255 0642 8 10 PM.

**NEW JERSEY:** March 27. Trenton. The Delaware Valley Radio Association will sponsor HAMCOMP '88, their 16th annual Flea Market, New Jersey National Guard 112th Field Artillery Armory, Eggers Crossing Road, Lawrence Township. Admission \$3 advance, \$4 door. Indoor selling spaces \$7 and \$10. Outdoors \$6. Sellers bring own tables. Doors open 6 AM for setup, 8 AM for public. Free parking. Refreshments available. Talk in on 146 07 67. For information and space reservations SASE to HAMCOMP '88 c/o KB2ZY, Box 441B, RD 1, Stockton, NJ 08559. Handicap parking and wheelchair accessible.

**MASSACHUSETTS:** April 10. The Framingham ARA will hold its annual spring Flea Market and exams, Framingham Civic League Bldg, 214 Concord St., downtown Framingham. Early Birds 9 AM admission \$5, 10 AM admission \$2. Reserved tables \$12 includes one free admission. Table setup 8:30 AM. Talk in on 147 15 repeater. Reserved tables Jan Weiner, K1VVC, 52 Overlook Drive, Framingham, MA 01701. (617) 877 7166. License exams registration FARA, PO Box 3005, Framingham, MA 01701.

**SOUTH CAROLINA:** April 10. The Charleston Amateur Radio Society's annual Hamfest, Elks Recreation Site, Hwy 7, off I 26, 8 AM to 5 PM. Admission \$5.00 at gate. Hospitality room Saturday night 7:30 PM at North Charleston Exchange Club, Helm Avenue. Flea Market, exams, dealers, free parking. Talk in on 146 16 76. Contact Jenny Myers, PO Box 70341, Charleston, NC 29405 747 2324.

**WISCONSIN:** April 10. The Madison area Repeater Association, Inc (MARA) announces its 16th annual Swapfest, Dane County Exposition Center Forum Building, Madison. Doors open 7:30 AM for flea market sellers; 8 AM for public. Admission \$2.75 advance; \$3 door. Children 12 and under free. Flea market tables \$7 advance; \$8 door plus admission. Deadline for tickets, table reservations is 4/3/88. Write MARA, POB 3403, Madison, WI 53704 or call (608) 274 5153.

## OPERATING EVENTS

"Things to do . . ."

**Augusta, Maine:** March 12. The August Emergency Amateur Radio Unit will operate from the state capital using the special Bicentennial call sign, W200TLC. 0001Z March 12 to 2359Z March 18. All bands/modes 160m/70cm. For a special QSL card, send QSL and SASE to W1TLC, August Emergency ARU, c/o K1NIT, William Crowley, Box 1589, Hallowell, ME 04347.

**HAM EXAMS:** The MIT UHF Repeater Association and the MIT Radio Society offer monthly Ham Exams. All classes Novice to Extra. Wednesday MARCH 23, 7 PM, MIT Room 1 150, 77 Mass Ave., Cambridge, MA. Reservations requested 2 days in advance. Contact Ron Hoffmann at (617) 646 1641. Exam fee \$4.25. Bring a copy of your current license (if any), two forms of picture ID, and a completed form 610 available from the FCC in Quincy, MA (617) 770 4023.

## CHARGE YOUR CLASSIFIED ADS

to your  
MC or VISA  
write or call

HAM RADIO MAGAZINE  
Greenville, NH 03048  
(603) 878-1441

## 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 \_\_\_\_\_  
Address \_\_\_\_\_  
City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

AFFIX  
LABEL  
HERE

SAY YOU SAW IT  
IN  
HAM RADIO

## MAKE CIRCUIT BOARDS THE NEW, EASY WAY



### WITH TEC-200 FILM

#### JUST 3 EASY STEPS:

- Copy circuit on TEC-200 film using any plain paper copier
- Iron film on to copper clad board
- Peel off film and etch

SATISFACTION GUARANTEED  
convenient 8 1/2 x 11 size

5-Sheets for \$3.95  
10 sheets only \$5.95

add \$1.00 postage — NY res. add sales tax

## The MEADOWLAKE Corp.

DEPT. I, P.O. Box 497  
Northport, New York 11768

279

## Electronic Repair Center Servicing

Amateur Commercial Radio

The most complete repair facility on the East Coast.

Large parts inventory and factory authorized warranty service for Kenwood, Icom and Yaesu.

### SEND US YOUR PROBLEMS

Servicing "Hams" for 30 years, no rig too old or new for us.

## HAMTRONICS, INC.

4033 Brownsville Road

Treose, Pa. 19047

215-357-1400

## INDUSTRIAL QUALITY REPLACEMENT BATTERIES FOR COMMUNICATIONS

Nickel-Cadmium, Alkaline, Lithium, etc.

Repair Packs For  
ICOM\*, KENWOOD, YAESU,  
SANTEC, AZDEN, TEMPO,  
CORDLESS PHONES...AND MORE!

NEW! I.C.E. PACK \$49<sup>95</sup>



E.H. YOST & CO.  
EVERETT H. YOST KB9XI  
7344 TETIVA RD  
SAUK CITY, WI 53583  
ASK FOR OUR CATALOG  
(608) 643-3194

278

**ORDER DESK HOURS (Eastern):**  
**MONDAY-FRIDAY 10 A.M. to 5 P.M.**  
**SATURDAY 10 A.M. to 4 P.M.**  
 Technical and VA orders call (703) 938-3350

**Electronic Equipment Bank**  
 516 Mill Street N.E., Vienna, VA 22180  
 Telephone (703) 938-3350

**STORE HOURS (Eastern):**  
 Same as Order Desk Hours  
 Closed Mondays  
 Thursday 10 A.M. to 9 P.M.

**Electronic Equipment Bank—Order Toll Free 800-368-3270**

## NOVEX 701 HANDSET



**NEW!**

- Handset w/PPT switch.
  - Bracket w/DTMF, speaker & volume controls.
  - Upgrade your 'mobile' image!
- Specify YAESU, ICOM or KENWOOD.  
**HSC701Y, I or K...\$79.95 + \$4. UPS**

## DATONG AUTOMATIC NOTCH FILTER

- Automatically notch out heterodynes, whistles.
- Get rid of 'tuner-uppers' on NET frequencies.
- 1 second is typical lock time/covers 270 Hz to 3.5 KHz.
- Auto/Manual operation in Notch or Peak modes.



**NEW!**

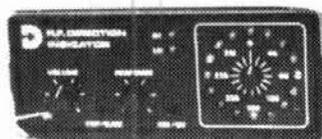
**ANF...\$119.95 + \$4. UPS**

## DATONG MULTIMODE AUDIO FILTER



- SSB, SSB & PEAK, SSB & NOTCH, CW & RTTY!
  - If you need an audio filter this is it!
  - The ultimate audio filter; same as FL2 but with AUTO NOTCH!
- FL2...\$159.95 + \$4. UPS**  
**FL3...\$229.95 + \$4. UPS**

## DATONG DIRECTION FINDER



- Doppler DF system for FM receivers.
  - User attaches his own coax, antennas & speaker.
  - Normal transceiver operation even while DFing!
  - 20 - 200 MHz, dependant on users equipment.
- DF...\$329.95 + S&H.**

## COMPUTER INTERFACE AEA PK 232



- Attach to any RS232 compatible computer for CW, RTTY, ASCII, AMTOR, PACKET and WEATHER FAX (Epson MS-80/RX-80 for Facsimile).
  - The PK 232 is THE UNIT to buy!
- EEB includes the AC Adapter #571512 with purchase!  
**PK232...\$299.95 + \$6. UPS**

## FREE 1988 CATALOG

## SHORTWAVE!

**CALL OR WRITE TODAY!**

36 Pages over 300 items for the SWLer!

## HANDHELD SCANNER

**NEW!**

### 220 MHz!

- Covers NOVICE 220 MHz band!
- 16 Memories/Scanning.
- Delay/Lockout/Priority.
- 26-30, 60-80, 115-178, 210-260, 410-520 MHz. NICAD power.

**BJ200...\$229.95 + \$4. UPS.**



## ADONIS LAPEL MIC!

**ADONIS**



**HW-10**

- Clip-on lapel Mic/Earphone.
  - PTT switch/battery powered, (battery not included).
- Specify ICOM, YAESU, KENWOOD.  
 Order: HW10I, Y or K **\$4. UPS**  
**INTRODUCTORY SPECIAL...\$39.95**

## DOCKING BOOSTERS



- GaAs FET preamp.
- Compact solid state POWER Amplifier in 30 or 50 watt models
- ICOM, KENWOOD or YAESU from: **\$169.95** and up!
- CALL FOR DETAILS. MICROS & Standard
- Turn your HANDHELD into a Mobile Giant!

**WP230 or WP250, Y, I, K + \$4. UPS**

## NOVEX 537 SPK MIC

**NEW!**



- Finally a speaker/mike we can all afford!
- Specify YAESU, ICOM or KENWOOD.

**DMC537Y, I or K...\$19.95 + \$4. UPS**

## DIPMETER

- 1.5 to 250 MHz.
- 6 plug-in coils.
- Use as OSC for receiver alignment.
- See the review in '73' Magazine (nov, 87).



**DM-4061...\$79.95 + \$4. UPS**

## RF SIGNAL GENERATOR

- 100 KHz - 150 MHz;
- 450 MHz on harmonics.
- RF output: 100 mV's.

**SG-4160...\$149.95 + \$4.**

## SWR/RF ANTENNA METER



- Read SWR, RF power and field strength
- 10 or 100 watt range.
- 1.7 to 150 MHz.

**SWR3P...\$19.95 + \$4. UPS**

**EEB**

- We ship world-wide
- Shipping charges not included
- Prices & specifications subject to change without notice

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

**ELECTRONIC EQUIPMENT BANK**  
 516 Mill Street, N.E.  
 Vienna, VA 22180

Order Toll Free: 800-368-3270  
 Technical and VA Orders (703) 938-3350



**"I convinced my club to buy a repeater controller from ACC and I'm glad I did."**

Our group decided to upgrade our repeater system and I was the one asked to investigate.

We've always tried to have the best system around so it was time to make some changes. We needed a control system that was reliable, easy to hook up, cost-effective, and something that would free the technical guys for more interesting projects than just keeping the equipment running.

Everyone in the club put a few bucks into the pot and it was ours!

We've found the voice messages and telemetry make using the repeater more fun. The convenience of remote programming and automatic scheduled

operation is remarkable. Not to mention the most sophisticated autopatch ever designed for amateur use. Later we added the Digital Voice Recorder for personalized IDs, bulletin boards, and voice mail.

ACC's products are state-of-the-art commercial quality and built to last. Workmanship so solid even the military uses them.

What impresses me even more, though, is the support we get from the staff at ACC - both before and after the sale. And they protect our investment through simple plug-in software and hardware upgrades... new features and capabilities that keep our club on top.

I feel good about recommending Advanced Computer Controls' repeater controllers. After all, it's my club's money that was spent and my reputation that was on the line.

2356 Walsh Avenue • Santa Clara, California (408) 727-3330

285

**ACC** advanced computer controls, inc.

**DOWN EAST MICROWAVE**

**MICROWAVE ANTENNAS AND EQUIPMENT**

- Loop Yagis • Power Dividers • Linear Amplifiers • Complete Arrays • Microwave Transverters • GaAsFET Preamps
- TROPO • EME • Weak Signal • OSCAR • 902 • 1269 • 1296 • 2304 • 2400 • 3456 MHz

2345 LY	45el loop Yagi	1296 MHz	20dB	\$93
1345 LY	45el loop Yagi	2304 MHz	20dB	\$80
3333 LY	33el loop Yagi	902 MHz	18.5dB	\$93

Above antennas assembled and tested. Kits available. All Aluminum and Stainless Construction. Add \$8 UPS S/H, \$11 West of the Mississippi.

2316 PA Linear Amp 1W in 18W out 1296 MHz 13.5V. \$245 ppd.  
2335 PA Linear Amp 10W in 35W out 1296 MHz 12.5V. \$295 ppd.

**NEW! MICROWAVE TRANSVERTERS BY LMW ELECTRONICS**

1296TRV6D 6W, GaAsFET, T/R Sequencer, Output Meter \$569  
2304TRV2D 2W, GaAsFET, T/R Sequencer, Output Meter \$649

Add \$6 for shipping UPS/48  
Stripped down version, kits also available  
Write For FREE Catalog

**DOWN EAST MICROWAVE**  
Bill Olson, W3HQT  
Box 2310, RR 1, Troy, ME 04987  
(207) 948-3741

283

**SYNTHESIZED SIGNAL GENERATOR**

MADE IN USA

MODEL SG-100F \$429.95 delivered

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

**VANGUARD LABS**  
196-23 Jamaica Ave., Hollis, NY 11423  
Phone: (718) 468-2720 Mon. thru Thu.

282

**AMATEUR RADIO MAIL LISTS**  
Self-stick 1x3 labels

- \*\*\* NEWLY LICENCED HAMS \*\*\*
- \*\*\* ALL NEW UPGRADES \*\*\*
- \*\*\* UPDATED EACH WEEK \*\*\*

Total List = 462,728 (ZIP sorted)  
Price is 2.5 cents each (4-up Cheshire)

**BUCKMASTER PUBLISHING**  
Mineral, Virginia 23117  
703:894-5777

281

From All 50 States

**Call EGE's NEW Toll-Free Number for Orders and Quotes:**  
**800-444-4799**

**ege inc** VIRGINIA

14803 Build America Dr., Bldg. B  
Woodbridge, Virginia 22191  
Customer Service: (703) 643-1063  
Service Department: (703) 494-8750

**ege inc** NEW HAMPSHIRE

8 Stiles Road  
Salem, New Hampshire 03079  
Customer Service: (603) 898-3750  
New England Toll Free: 800-444-0047

**DISCOUNTS FOR AMATEURS**

# Magnetic Attraction

Tired of paying higher and higher prices for V.H.F. magnetic mount antennas? Hustler has the solution. Two new series of antennas at suprisingly affordable prices. Built with the same quality and performance you expect from a Hustler product. Designed to offer you years of trouble-free operation. Priced to **save you money.**

## FX SERIES (pictured mounted)

- 3.4 db gain | 5/8 wave
- 200 watt rating
- 15 foot coax
- PL-259 connector installed
- Magnetic mount holds to 100 mph

**Model FX-2** — 2 Meter, black & chrome

**Model FX-220** — 220 MHz, black and chrome

**24.95** ea.

**Also Available in Black**

Model FX-2B, 2 Meter

Model FX-220B, 220 MHz ..... **29.95** ea.

## RX SERIES (pictured lying down)

- 3.4 db gain | 5/8 wave
- 100 watt rating
- 15 foot coax
- PL-259 connector installed
- Magnetic mount holds to 75 mph

**Model RX-2**, 2 meter black and chrome

**Model RX-220**, 220 MHz, black & chrome

**19.95** ea.

**Also Available in Black**

Model RX-2B, 2 meter

Model RX-220B, 220 MHz ..... **24.95** ea.



Model FX-2  
(Also Available in Black)



Model RX-2  
(Also Available in Black)





Ham Radio's guide to help you find your local

## California

### A-TECH ELECTRONICS

1033 HOLLYWOOD WAY  
BURBANK, CA 91505  
(818) 845-9203

New Ham Store and Ready to Make a Deal!

### JUN'S ELECTRONICS

3919 SEPULVEDA BLVD.  
CULVER CITY, CA 90230  
213-390-8003

800-882-1343 Trades  
Habla Espanol

## Colorado

### COLORADO COMM CENTER

525 EAST 70th AVE.  
SUITE ONE WEST  
DENVER, CO 80229

(303) 288-7373  
(800) 227-7373

Stocking all major lines  
Kenwood Yaesu, Encomm, ICOM

## Connecticut

### HATRY ELECTRONICS

500 LEDYARD ST. (SOUTH)  
HARTFORD, CT 06114  
203-527-1881

Call today. Friendly one-stop shopping  
at prices you can afford.

## Delaware

### AMATEUR & ADVANCED COMMUNICATIONS

3208 CONCORD PIKE  
WILMINGTON, DE 19803  
(302) 478-2757

Delaware's Friendliest Ham Store.

### DELAWARE AMATEUR SUPPLY

71 MEADOW ROAD  
NEW CASTLE, DE 19720  
302-328-7728  
800-441-7008

Icom, Ten-Tec, Microlog, Yaesu,  
Kenwood, Santec, KDK, and more.  
One mile off I-95, no sales tax.

## Florida

### AMATEUR ELECTRONIC SUPPLY

1898 DREW STREET  
CLEARWATER, FL 33575  
813-461-4267

Clearwater Branch

West Coast's only full service  
Amateur Radio Store.

Hours 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

## Georgia

### DOC'S COMMUNICATIONS

702 CHICKAMAUGA AVENUE  
ROSSVILLE, GA 30741  
(404) 866-2302 / 861-5610  
ICOM, Yaesu, Kenwood, Bird...  
9AM-5:30PM

We service what we sell.

## Hawaii

### HONOLULU ELECTRONICS

819 KEEAUMOKU STREET  
HONOLULU, HI 96814  
(808) 949-5564  
Kenwood, ICOM, Yaesu, Hy-Gain,  
Cushcraft, AEA, KLM, Tri-Ex Towers,  
Fluke, Belden, Astron, etc.

## Idaho

### ROSS DISTRIBUTING COMPANY

78 SOUTH STATE STREET  
PRESTON, ID 83263  
(208) 852-0830  
M 9-2; T-F 9-6; S 9-2  
Stock All Major Brands  
Over 7000 Ham Related Items on  
Hand

## 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 STATION

220 N. FULTON AVE.  
EVANSVILLE, IN 47710  
(800) 523-7731  
(812) 422-0231  
ICOM, Yaesu, Ten-Tec, Cushcraft, Hy-  
Gain, AEA & others.

## Maryland

### MARYLAND RADIO CENTER

8576 LAURELDALE DRIVE  
LAUREL, MD 20707  
301-725-1212  
Kenwood, Ten-Tec, Alinco, Azden. Full  
service dealer.  
M-F 10-7 SAT 9-5

## 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

### ATLANTIC SOLAR POWER/ENCON

(SINCE 1979)  
37279 W. SIX MILE RD.  
LIVONIA, MI 48152  
(313) 591-7745  
Solar Electric Power for Repeaters,  
Ham Shacks, Packet Radio.  
Call Paul, WD8AHO

## Missouri

### MISSOURI RADIO CENTER

102 NW BUSINESS PARK LANE  
KANSAS CITY, MO 64150  
(800) 821-7323  
Missouri: (816) 741-8118  
ICOM, Kenwood, Yaesu  
Same day service, low prices.

## Nevada

### AMATEUR ELECTRONIC SUPPLY

1072 N. RANCHO DRIVE  
LAS VEGAS, NV 89106  
702-647-3114  
Dale Porray "Squeak," AD7K  
Outside Nev: 1 (800) 634-6227  
Hours M-F 9-5:30, Sat. 9-3

## New Hampshire

### RIVENDELL ELECTRONICS

8 LONDONDERRY ROAD  
DERRY, N. H. 03038  
603-434-5371  
Hours M-S 10-5; THURS 10-7  
Closed Sun/Holidays

**Dealers:** YOU SHOULD BE HERE TOO!  
Contact Ham Radio now for complete details.

# Amateur Radio Dealer

## New Jersey

### ABARIS SYSTEMS

276 ORIENTAL PLACE  
LYNDHURST, NJ 07071  
201-939-0015  
Don WB2GPU  
Astatic, Azden, B&W, Butternut, Larsen,  
Mirage/KLM, Kenpro, Nye, Santec,  
THL, and many others.  
M-F 10 am-9 pm  
SAT 9 am-7 pm  
VISA/MC

### KJI ELECTRONICS

66 SKYTOP ROAD  
CEDAR GROVE, NJ 07009  
(201) 239-4389  
Gene K2KJL  
Maryann K2RVH  
Distributor of: KLM, Mirage, ICOM, Lar-  
sen, Lunar, Astron. Wholesale - retail.

## New York

### BARRY ELECTRONICS

512 BROADWAY  
NEW YORK, NY 10012  
212-925-7000  
New York City's Largest Full Service  
Ham and Commercial Radio Store.

### VHF COMMUNICATIONS

915 NORTH MAIN STREET  
JAMESTOWN, NY 14701  
716-664-6345  
Call after 7 PM and save! Supplying all  
of your Amateur needs. Featuring ICOM  
"The World System." Western New  
York's finest Amateur dealer.

## Ohio

### AMATEUR ELECTRONIC SUPPLY

28940 EUCLID AVE.  
WICKLIFFE, OH 44092 (Cleveland Area)  
216-585-7388  
Ohio Wats: 1 (800) 362-0290  
Outside Ohio: 1 (800) 321-3594  
Hours M-F 9-5:30, Sat. 9-3

### DEBCO ELECTRONICS, INC.

3931 EDWARDS RD.  
CINCINNATI, OHIO 45209  
(513) 531-4499  
Mon-Sat 10AM-9PM  
Sun 12-6PM  
We buy and sell all types of electronic  
parts.

UNIVERSAL AMATEUR RADIO, INC.  
1280 AIDA DRIVE  
REYNOLDSBURG (COLUMBUS), OH  
43068

614-866-4267  
Featuring Kenwood, Yaesu, Icom,  
and other fine gear. Factory author-  
ized sales and service. Shortwave  
specialists. Near I-270 and airport.

## Pennsylvania

HAMTRONICS,  
DIV. OF TREVOSE ELECTRONICS  
4033 BROWNSVILLE ROAD  
TREVOSE, PA 19047  
215-357-1400  
Same Location for over 30 Years

## Tennessee

MEMPHIS AMATEUR ELECTRONICS  
1465 WELLS STATION ROAD  
MEMPHIS, TN 38108  
Call Toll Free: 1-800-238-6168  
M-F 9-5; Sat 9-12  
Kenwood, ICOM, Ten-Tec, Cushcraft,  
Hy-Gain, Hustler, Larsen, AEA,  
Mirage, Ameritron, etc.

## Texas

MADISON ELECTRONICS SUPPLY  
3621 FANNIN  
HOUSTON, TX 77004  
713-520-7300  
Christmas?? Now??

KENNEDY ASSOCIATES  
AMATEUR RADIO DIVISION  
5707A MOBUD  
SAN ANTONIO, TX 78238  
512-680-6110

Stocking all major lines. San Antonio's  
Ham Store. Great Prices — Great  
Service. Factory authorized sales and  
service.  
Hours: M-F 10-6; SAT 9-3

### MISSION COMMUNICATIONS

11903 ALEIF CLODINE  
SUITE 500 (CORNER HARWIN &  
KIRKWOOD)  
HOUSTON, TEXAS 77082  
(713) 879-7764  
Now in Southwest Houston—full line  
of equipment. All the essentials and  
extras for the "ham."

## Wisconsin

### AMATEUR ELECTRONIC SUPPLY

4828 W. FOND DU LAC 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

### Foreign Subscription Agents for Ham Radio Magazine

Ham Radio Austria Karin Ueber Postfach 2454 D-7850 Loerrach West Germany	Canada Send orders to: Ham Radio Magazine Greenville, NH 03048 USA Prices in Canadian funds 1 yr \$41.85, 2 yrs \$74.25 3 yrs \$99.90
Ham Radio Belgium Sierothouse Brusselssteenweg 416 B-9218 Gent Belgium	Ham Radio Italy Via Manago 15 I-20134 Milano Italy
Ham Radio Holland Postbus 413 NL-7800 Ar Emmen Holland	Ham Radio Switzerland Karin Ueber Postfach 2454 D-7850 Loerrach West Germany
Ham Radio Europe Box 2084 S-194 02 Upplands Vasby Sweden	Ham Radio England c/o P.S.G.B. Lambda House Cranborne Road Pottery Bar Hants RG6 3JW England
Ham Radio France SM Electronik 20 Bis, Ave des Clairons F-89000 Auxerre France	
Ham Radio Germany Karin Ueber Postfach 2454 D-7850 Loerrach West Germany	

## Discover

At the  
RADIO WORKS,  
Ham radio is a  
CONTACT sport!

• SUPERLOAD •  
80 & 40 M loop  
Great performance  
All bands with  
transmatch.

Your  
Passport  
To a world  
Of new ideas  
And exceptional  
HF wire antennas

Rugged new baluns  
Full range of wire  
Coax, cable and parts  
Wide range of accessories  
—•—  
SEE WHAT WE'RE DOING NOW!  
—•—

Contact Jim, WATHJ for free catalog  
(send \$1 for 1st Class postage)  
Box 6159, Portsmouth, VA 23703  
(Dealer inquiries welcome)

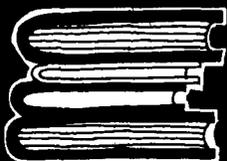
**804-484-0140**

Something New!

\*\*\* CAROLINA WINDOW \*\*\*

The best 75 M antenna around? Probably! When  
you hear one, you'll want one. You can use it on  
all bands with a transmatch. Feed it with coax.

ALL RADIO WORKS PRODUCTS ARE MADE WITH PRIDE ON  
THE AMERICAN SIDE. IN VA/USA.



# ELMER'S NOTEBOOK

Tom McMullen, W1SL

## transmission lines

**Transmission lines** are a vital part of any Amateur station, but often the most mysterious component (and most misunderstood as well) used in setting up a station. This month's notebook looks at how transmission lines are put together and what they do. Perhaps you'll feel a bit more at ease in a discussion of lines and their advantages and faults after reading it.

### why a transmission line?

There was a time when transmission lines were not widely used by Amateurs — when TV didn't exist, houses (and neighbors) were not packed together on postage stamp sized lots, and those who happened to hear an Amateur on their Broadcast-Band sets were more interested in eavesdropping than complaining.

In the interest of simplicity and economy, the end of a length of wire was simply run into the ham shack and tapped onto the power amplifier plate-tuning circuit through a suitable capacitor. The tap was moved along the turns of the coil until the proper plate current at resonance was obtained, indicating that the amplifier was properly loaded and providing power to the antenna.

This worked well -- the antenna radiated (and the radiation included several harmonics as well as the fundamental signal), QSOs were made, and everyone was happy. The fact that all of the wire radiated -- even the portion that was inside the ham shack -- didn't particularly bother anyone. An

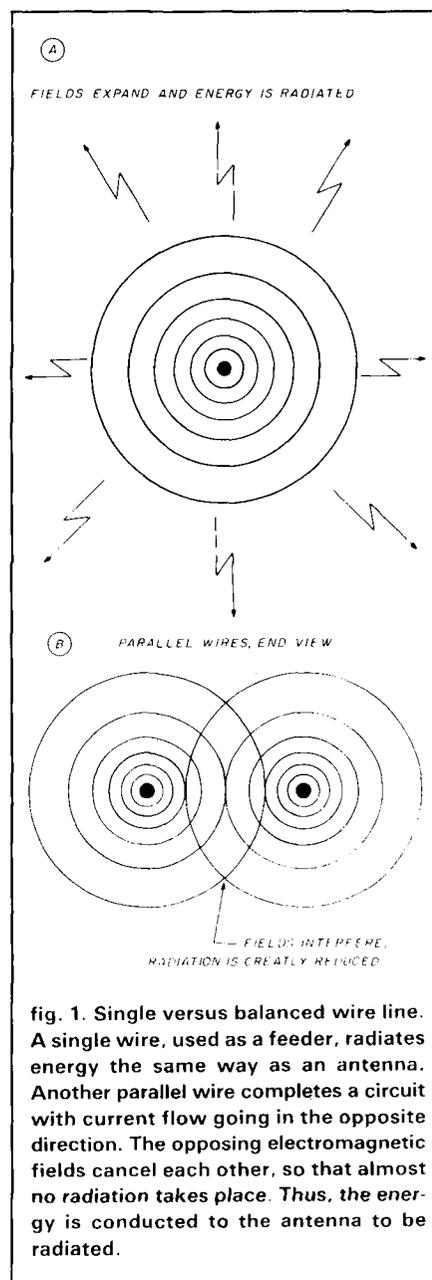
occasional "hot" key or microphone gave a slight tingle or warm sensation to the operator, and sometimes the lights flickered a bit from induced rf in the power lines, but that was part of the mystique of being an Amateur.

Those who were more interested in doing things right knew they would get better results by placing the antenna high, away from power lines, telephone lines, and other metal objects that could intercept the energy being sent toward the horizon for a distant station to hear. What was needed was a means of getting the energy across that gap between the output of the transmitter in the shack and the feed-point of the antenna many feet in the air. The answer was a transmission line.

Early transmission lines were hand-made, open-wire lines with fairly wide spacing (often 6 or 8 inches between wires). The ingenuity of hams in adapting materials for use as insulating spacers was just as great then as it is now: glass rods, porcelain insulators, and wood dowels that had been boiled in paraffin (wax) were common materials. Today, almost any type of transmission line you need can be found at electronics parts stores or Amateur conventions and flea markets. Still, there are those who take pride in constructing an open-wire line of parallel No. 14 wire supported by plastic hair curlers or 35-mm film can lids.

### open-wire lines

**Figure 1A** shows the evolution of a single-wire antenna (or feeder for an



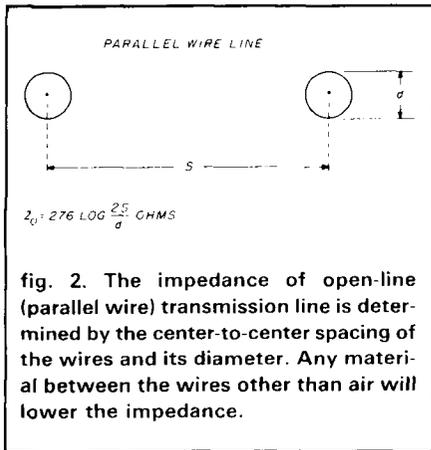


fig. 2. The impedance of open-line (parallel wire) transmission line is determined by the center-to-center spacing of the wires and its diameter. Any material between the wires other than air will lower the impedance.

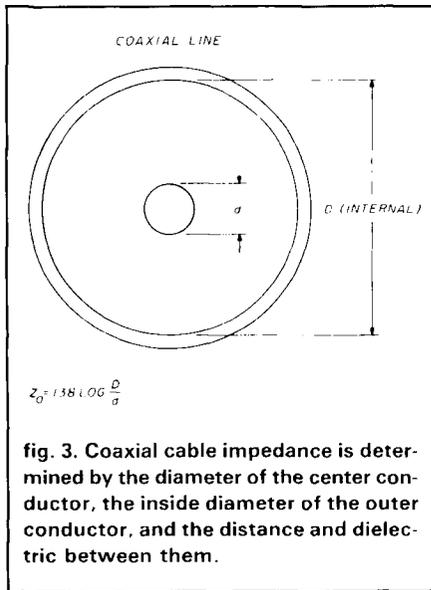


fig. 3. Coaxial cable impedance is determined by the diameter of the center conductor, the inside diameter of the outer conductor, and the distance and dielectric between them.

end-fed long wire) into a parallel-wire transmission line (fig. 1B). The line works because the fields from instantaneous current flow cancel each other. This means that the line does not radiate any significant amount of energy from your transmitter; it is being passed along to the antenna where it's radiated into space well above wires, TV sets, and telephones.

All transmission lines have a characteristic impedance, referred to as "Z", or "Z<sub>0</sub>". This is important because all parts of the system must be matched, as discussed in last month's notebook. The impedance of a line is determined by the diameter of the wires and the space between them, as shown in fig. 2. The formula given is accurate for wires that have mostly air between

them — a few supporting spacers will not change the impedance enough to worry about. The air between the wires is called the "dielectric", just as it is when referring to air between the plates of a capacitor.

Any insulating material other than air, if present in large amounts, will significantly change the impedance of the line — usually to a lower value. If you measure the wire diameter and spacing of common 300-ohm TV twin lead, and use the impedance formula in fig. 2, you'll get the wrong answer. The manufacturer knows what the effect of his dielectric is, and adjusts the spacing of the wires accordingly.

Two types of open-wire lines are 450- and 300-ohm "ladder line", once widely used for low-loss TV reception. This is the lowest loss transmission line you can get for an Amateur hf band installation and requires some care when putting it to use. Sharp bends are a no-no, and it should not be closer than 6 or 8 inches to any metal: gutter pipes, eaves, aluminum siding, window frames, or other wires. It should

be stretched tight and supported on insulators so it will not swing in the wind or twist and short-circuit.

Open-wire lines need a matching device or transformer of some sort between the line and the transmitter (and sometimes between the line and the antenna). For transforming from coaxial cable to open-wire line, a balun is often used. This device gets its name from the operation it performs — adapting a **balanced** line to an **unbalanced** one. The function of a balun is merely this — it does not match impedances.

There are different types of baluns: 50-to-300 ohm, 50-to-50 ohm, and 75-to-300 ohm are the most common. A typical installation might require a 50- or 75-ohm transmitter output to be adapted to 300-ohm open-wire line; a 75-to-300 ohm balun will do the job. Another typical use is at the center of a half-wave dipole for 80 meters — a 50-to-50 ohm balun is sold for this purpose, enclosed in a weather-tight case, ready to connect between the coaxial cable and the antenna wire.

Table 1. Characteristics of commonly used transmission lines.

Line	Z <sub>0</sub> ohms	Velocity factor	Outside diameter	Maximum working voltage (rms)
RG-8X	52.0	75	0.242	-
RG-8/U	52.0	66	0.405	4000
RG-8/U foam	50.0	80	0.405	1500
RG-8A/U	52.0	66	0.405	5000
RG-9A/U	51.0	66	0.420	4000
RG-9B/U	50.0	66	0.420	5000
RG-11/U	75.0	66	0.405	4000
RG-11/U foam	75.0	80	0.405	1600
RG-17A/U	52.0	66	0.870	11,000
RG-58/U foam	53.5	79	0.195	600
RG-58A/U	53.5	66	0.195	1900
RG-59/U foam	75.0	79	0.242	800
RG-59A/U	73.0	66	0.242	2300
Aluminum Jacket, foam (hardline)				
1/2 inch	50.0	81	0.5	2500
7/8 inch	50.0	81	0.875	4500
1/2 inch	75.0	81	0.5	2500
7/8 inch	75.0	81	0.875	4000
open wire				
TV 1/2 inch	300	95	-	-
1 inch	450	95	-	-
300-ohm twin lead	300	80	-	-

You can perform impedance matching with open-wire lines by using a matching network, like the Trans-match or similar circuit that accepts the line impedance at one input and the transmitter impedance at the other. At the antenna, matching methods include a quarter-wave transformer (that is the mean impedance between the antenna and the line), matching stubs, hairpin loops, or a specially designed balun.

## coaxial lines

The principles that apply to open- or parallel-wire transmission lines also apply, with some modifications, to coaxial lines. **Figure 3** shows how the impedance of an air-dielectric coaxial line is determined. Keep the conductors from touching each other (and maintain constant spacing), and remember that the insulating material used for support affects the impedance. One thing that is critical with coaxial cable is the power level it can handle. The center conductor is surrounded by insulation, and any heat generated by current flow in the copper is trapped inside the cable. If the heat is great enough the insulation can melt or break down and create a short-circuit. This is usually not a problem at legal Novice power levels, but at higher levels and high SWR, RG-58 and RG-8 cables have been known to burst into flame. **Table 1** shows some important characteristics of a few common transmission lines, including the rms voltage they can withstand.

Be wary of "bargain" transmission lines found at flea markets and surplus

houses. These coaxial cables can differ in several ways from what you might buy from a dealer. Only two are serious enough to create problems: the amount of shielding provided by the outer conductor, and possible contamination of the dielectric.

Most coaxial cables used today are flexible; that is, they are constructed with a woven braid as the outer conductor which allows the cable to bend in a reasonable curve without damage. While it is impossible to obtain 100 percent coverage with a braid, some cables come very close (better than 90 percent). It takes only a moment to remove a small piece of outer jacket from coax and look at the amount of visible braid. If the weave is loose, and you can see a lot of dielectric peeking through, the cable is no bargain at any price. Poor coverage lets rf "leak" out and noise leak in. The impedance is not likely to be constant, and losses will be greater than with good cable. Cables with double braid covering can sometimes be found, and these are excellent, although you may have trouble getting both braids to fit into a connector.

Another "gotcha" is contamination of the dielectric. Moisture and gases can be absorbed by almost any plastic, and the dielectric material itself can change chemically because of sunlight and heat. This changes the characteristic impedance of the line, increases loss, and may lead to heating and breakdown of the line at higher power levels. Some cables resist contamination, and are worth looking for if you live in a particularly hot, damp, or smoggy area. Some can even be left lying on the ground or buried without danger of contamination, but should be tested for losses every year or so. Decibel Products VB-8 and Times Wire and Cable Company Impervion are two.

## other impedance

The cable television industry uses 75 ohms as its standard for cable and amplifier termination. Surplus cable, often

hundreds of feet in length, appears at flea markets and surplus houses at tempting prices. Can you use it? Absolutely. Your transmitter (and receiver) will probably not know the difference. Antennas have to be coupled to the transmission line anyway, so just match it to 75 ohms instead of 50.

The rub is that since most power/SWR meters are made for 50-ohm cable, their indications will not be strictly accurate. They're useful, but you can't be sure that what you see is what's really happening. If the price is right, use the cable and take the indicated SWR and power readings with some skepticism. I'll discuss ways of dealing with this in a future column.

## repeater follow-up

I received a letter from Tom O'Hara, W6ORG, with information about 1200-MHz repeaters and equipment. He notes that there are six ATV (Amateur TV) repeaters in Southern California, with 70-cm inputs and 23-cm outputs. The ATV simplex frequency is 1289.25 MHz. PC Electronics,\* operated by Tom and Maryann, expects to have a 23-cm ATV transmitter board ready for the Dayton Hamvention this spring. Tom enclosed a list of 23-cm fm repeaters for that part of the country; it shows over 35 repeaters, starting at 1270.1 (input) with the output 12 MHz higher at 1282.1.

According to a technical note Tom included, the Icom RP1210 23-cm repeater can be ordered from dealers on the common 12-MHz input/output pairs, or converted to that spacing by a crystal change. He also suggests using Belden 9913 coaxial cable for 23-cm feedline. Thanks for the suggestions Tom!

## questions and answers?

I've had some queries about devoting a portion of each notebook to questions and answers. Are there some particularly nagging mysteries that this column could clear up? What do you think, Novices and Elmers? I'll be glad to hear from you.

ham radio

### Invitation to Authors

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

\*2252 Paxson Lane, Arcadia, California 91006-8537.

AEA  
PK-232  
PAKRATT  
\$309  
CASH PRICE



# TEL-COM

*Electronic Communications*

NEW ENGLAND'S FACTORY-AUTHORIZED SALES & SERVICE

FOR

**KENWOOD**  **ICOM**

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

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

✓ 290

**KENWOOD**  
SEE THE NEW  
POCKET PORTABLE  
**TH-25AT**  
FOR THE HAM  
WHO WANTS A  
COMPACT  
HANDHELD

OPEN SIX DAYS A WEEK

**Telephone 617/486-3400, 3040**  
675 Great Rd., (Rte. 119) Littleton, MA 01460  
1 1/4 miles from Rte. 495 (Exit 31) toward Groton, Mass.

The World's Most Advanced  
Antenna System.  
**DJ2UT Trapless Beams**



H.J. Theiler Corp.  
P.O. Box 5369  
Spartanburg, SC 29304  
(803) 576-5566

✓ 266

**1988 RADIO AMATEUR CALLBOOKS**  
**NORTH AMERICAN EDITION \$24.95**  
**INTERNATIONAL EDITION \$26.95.**  
(Please add \$3.50 for shipping)  
Buy Both **SPECIAL JUST 46.90**  
SAVE \$5  
HAM RADIO'S BOOKSTORE GREENVILLE, NH 03048  
(603) 878-1441

## Measure Up With Coaxial Dynamics Model 83500 Digital Wattmeter

The "Generation Gap" is filled with the "new" EXPEDITOR, the microprocessor based R.F. AnaDigit System.

The EXPEDITOR power computer. . . you make the demands, it fills the requirements.

- Programmable forward AND reflected power ranges.
- Can be used with the elements you now have.
- Compatible with all Coaxial Dynamics line sizes and power ranges.
- 18 scales from 100 mW to 50 kW.

Contact us for your nearest authorized Coaxial Dynamics representative or distributor in our world-wide sales network.



**COAXIAL DYNAMICS, INC.**

15210 Industrial Parkway  
Cleveland, Ohio 44135  
216-267-2233 1-800-COAXIAL  
Telex: 98-0630

*Service and Dependability...A Part of Every Product*



✓ 289

here is the next generation Repeater  
2 meters - 220 - 440

# MARK 4CR

The **only** repeaters and controllers  
with REAL SPEECH!

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

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



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

See us at DAYTON  
Booths 106, 107, 108



## MICRO CONTROL SPECIALTIES

Division of Kendecom Inc.  
23 Elm Park, Groveland, MA 01834 (617) 372-3442

TELEX 4932256 Kendecom

FAX 617-373-7304

# NUTS & VOLTS MAGAZINE

P.O. Box 1111-H  
PLACENTIA, CA 92670  
714-632-7721



- Ham Radio
- Computer Hardware
- Computer Software
- Plans-Kits
- Schematics
- Test Equipment
- CB Gear
- Satellite TV
- Video
- Components
- Antique Electronics
- Cable TV
- Publications
- Repairs-Services
- New Products
- Events Calendar

**IF YOU ARE INTO ELECTRONICS AND SAVING MONEY IS IMPORTANT TO YOU, THEN YOU OWE IT TO YOURSELF TO TRY NUTS & VOLTS MAGAZINE. DISCOVER WHY THOUSANDS OF SMART PEOPLE NATIONWIDE TURN TO NUTS & VOLTS EACH MONTH TO MEET THEIR ELECTRONIC NEEDS. WHETHER YOU'RE BUYING, SELLING, OR JUST TRYING TO LOCATE THOSE UNIQUE OR HARD-TO-FIND ITEMS, FIND OUT HOW NUTS & VOLTS CAN HELP!**

**SUBSCRIBE TODAY!**

CHECK    MONEY ORDER    VISA    MC

Name \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_

State \_\_\_\_\_ Zip \_\_\_\_\_

Card No. \_\_\_\_\_ Exp. Date \_\_\_\_\_

Subscription Rates	
U.S. FUNDS REQUIRED	
<b>3rd Class Mail - USA</b>	
One Year	\$10.00
Two Years	\$18.00
Lifetime	\$50.00
<b>1st Class Mail</b>	
One Year - USA	\$18.00
Canada & Mexico	\$20.00
<b>Air Mail</b>	
Foreign - 1 Year	\$50.00
Includes one FREE 40-word Classified Ad	

CALL FOR ADVERTISING INFORMATION  
DISTRIBUTOR INQUIRIES INVITED

*A National Publication For The Buying And Selling Of Electronic Equipment*

## THE MOST AFFORDABLE REPEATER

ALSO HAS THE MOST IMPRESSIVE PERFORMANCE FEATURES  
(AND GIVES THEM TO YOU AS STANDARD EQUIPMENT!)

**KIT, ONLY \$675**  
**WIRED \$975**  
**VHF OR UHF**



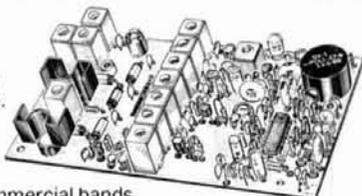
### FEATURES:

- **SENSITIVITY SECOND TO NONE!** GaAsFET front end on vhf models gives 12dB SINAD of 0.12uV (vhf), 0.15uV (220). UHF model 0.25uV std, 0.1uV with optional helical resonator preamp.
- **SELECTIVITY THAT CAN'T BE BEAT!** Both 8-pole xtal filter & ceramic filter for > 100dB at only ± 12kHz. Helical resonator front end to combat desense & intermod.
- **CLEAN, STABLE TRANSMITTER,** up to 18W output standard; 50W with accessory power amplifier.
- **FCC TYPE ACCEPTED** for commercial high band and uhf.
- **Courtesy beep,** field-programmable CWID, flutter-proof squelch, automatic frequency control to compensate for off-frequency transmitters (all standard features).
- **Full range of options** available, such as autopatch, phone line or radio remote control, sub-audible tones, duplexers.

## HIGH PERFORMANCE TRANSMITTERS & RECEIVERS FOR REPEATERS AUDIO & DIGITAL LINKS, TELEMETRY, ETC.

### FM EXCITERS:

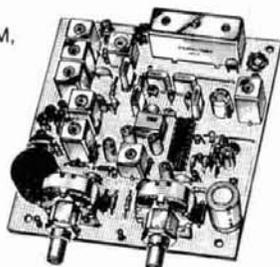
- Kits \$99, w/t \$179. 2W continuous duty. TCXO & xtal oven options available.
- **TA51 for 10M, 6M, 2M, 150-174, 220 MHz.**
- **TA451 for uhf.**



- FCC type accepted for commercial bands.
- Call for latest information on 900 MHz transmitters.
- **VHF & UHF AMPLIFIERS.** For FM, SSB, ATV. Output from 10 to 50 Watts. Several models, kits starting at \$79.

### R144/R220 FM RECEIVERS for 2M, 150-174, or 220 MHz. GaAs FET

- Both crystal & ceramic filters plus helical resonator front end for exceptional selectivity: > 100dB at ± 12kHz (best available anywhere)! Flutter-proof squelch. AFC tracks drifting transmitters.
- Kit \$149, w/t \$229.



- **R451 UHF FM RCVR.** Similar to above. Tuned line front end, 0.25uV sens. (0.1uV with optional hel. res. preamp). Kit \$149, w/t \$229.
- **R901 FM RCVR FOR 900 MHZ.** Triple-conversion, GaAs FET front end, 0.2uV sens. Kit \$169, w/t \$259.
- **R76 ECONOMY VHF FM RCVR** for 10M, 6M, 2M, 220. Without hel res or afc. Kits only \$129.
- **Weather satellite & AM Aircraft receivers also avail.**

FCC TYPE-ACCEPTED TRANSMITTERS & RECEIVERS AVAILABLE FOR HIGH-BAND AND UHF. CALL FOR DETAILS.

- Send \$1 for 36 page catalog by return mail. (Send \$2.00 or 4 IRC's for overseas mailing)
- Order by phone or mail • Min \$3 S & H per order
- Use Visa, Mastercard, Check, or UPS COD.

## GaAs FET PREAMPS at a fraction of the cost of comparable units!

NEW

## HIGH-SPEED DIGITAL RF LINKS

### LNG -(\*)

#### GaAs FET PREAMP

ONLY \$59!  
Wired/tested



### FEATURES:

- **Very Low Noise:** 0.7dB VHF, 0.8dB UHF
- **High Gain:** 13-20dB, depending on frequency
- **Wide Dynamic Range:** to resist overload
- **Stable:** new-type dual-gate GaAs FET

\* Specify tuning range desired: 26-30, 46-56, 137-150, 150-172, 210-230, 400-470, or 800-960 MHz.

### LNW -(\*)

#### MINIATURE GaAs FET PREAMP



ONLY \$24/kit,  
\$39 Wired/tested

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

\* Specify tuning range desired: 25-35, 35-55, 55-90, 90-120, 120-150, 150-200, 200-270, or 400-500 MHz.

### LNS-(\*)

#### IN-LINE PREAMP

ONLY \$79/kit,  
\$99 Wired/tested



GaAs FET Preamp with features similar to LNG series, except **automatically switches out of line during transmit.** Use with base or mobile transceivers up to 25W.

\* Specify tuning range desired: 120-175, 200-240, or 400-500 MHz.

## HELICAL RESONATOR PREAMPS

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

**MODEL HRA-(\*)**, \$49 vhf, \$84 uhf.

\* Specify tuning range desired: 143-150, 150-158, 158-162, 162-174, 213-233, 420-450, 450-465, or 465-475 MHz.

You've waited a long time for a simple, reliable, **low-cost 9600 baud PACKET NETWORKING** system. Now you've got it! Our new MO-96 MODEM and direct FSK Transmitters and Receivers for 220 or 440 MHz interface directly with most TNC's. Fast diode switched PA's output 15 or 50W. **Call for complete info on the right system for your application.**

## ACCESSORIES



- **COR-3 Kit.** Control ckts and audio mixers needed to make a repeater. Tail & time-out timers, local spkr ampl, courtesy beep ..... \$49
- **CWID Kit.** Field programmable, timers, the works ..... \$59
- **TD-2 DTMF DECODER/CONTROLLER Kit.** Full 16 digits, switches 5 functions, toll call restrictor, programmable, much more. Great for selective calling too! ..... \$79
- **AP-3 AUTOPATCH Kit.** Use with above for repeater autopatch. Reverse patch and phone line remote control std. .... \$79
- **AP-2 SIMPLEX AUTOPATCH TIMING BOARD Kit.** Use with above for simplex autopatch \$39
- **MO-202 FSK DATA MODULATOR Kit.** Run up to 1200 baud digital signals through any fm transmitter with full handshakes. Radio link computers, telemetry gear, etc. .... \$39
- **DE-202 FSK DATA DEMODULATOR Kit** for rcvr end of link ..... \$39

## RECEIVING CONVERTERS



	Antenna Input Range	Receiver Output
	28-32	144-148
	50-52	28-30
	90-94	144-148
	136-138	28-30
VHF MODELS	144-146	28-30
	145-147	28-30
Kit with Case	\$59	220-222 28-30
Kit less Case	\$39	220-222 28-30
Wired w/case	\$89	220-224 90-94
		222-224 28-30
UHF MODELS	432-434	28-30
Kit with Case	\$69	432-436 144-148
Kit less Case	\$49	432-436 50-54
		439-25 61-25
Wired w/case	\$99	902-928 422-448
		902-922 430-450

See catalog for full line of 2w transmitting converters for vhf & uhf. Kits only \$79. Linear Amplifiers avail. up to 50w.

Our 25th Anniversary  
**hamtronics, inc.**  
65-H MOUL ROAD • HILTON NY 14468-9535  
Phone: 716-392-9430 Hamtronics® is a registered trademark

DAYTON

# Hamvention

April 29, 30, May 1, 1988

## Early Reservation Information

- Giant 3 day flea market • Exhibits
- License exams • Free bus service
- CW proficiency test • Door prizes

Flea market tickets and grand banquet tickets are limited. Place your reservations early, please.

### Flea Market Tickets

A maximum of 3 spaces per person (non-transferable). Tickets (valid all 3 days) will be sold IN ADVANCE ONLY. No spaces sold at gate. Vendors MUST order registration ticket when ordering flea market spaces.

### Special Awards

Nominations are requested for 'Radio Amateur of the Year', 'Special Achievement' and 'Technical Achievement' awards. Contact; Hamvention Awards Chairman, Box 964, Dayton, OH 45401.

### License Exams

Novice thru Extra exams scheduled Saturday and Sunday by appointment only. Send FCC form 610 (Aug. 1985 or later) - with requested elements indicated at top of form, copy of present license and check for \$4.35 (payable to ARRL/VEC) to: Exam Registration, 8830 Windbluff Point, Dayton, OH 45458

### Hamvention Video

VHS video presentation about the HAMVENTION is available for loan. Contact Dick Miller, 2853 La Cresta, Beavercreek, OH 45324

### 1988 Deadlines

Award Nominations: March 15

Lodging: April 2

License Exams: March 26

Advance Registration and banquet:

USA - April 4 Canada - March 31

Flea Market Space:

Orders will not be processed **before** January 1

### Information

General Information: (513) 433-7720  
or, Box 2205, Dayton, OH 45401

Flea Market Information: (513) 898-8871

Lodging Information: (513) 223-2612

(No Reservations By Phone)

### Lodging

Reservations received after Housing Bureau room blocks are filled will be returned along with a list of hotel/motels located in the surrounding areas of Dayton. The reservation will then become the responsibility of the individual.

HAMVENTION is sponsored by the Dayton Amateur Radio Association Inc.

### Lodging Reservation Form

Dayton Hamvention - April 29, 30, May 1, 1988  
Reservation Deadline - April 2, 1988

Name \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

Phone \_\_\_\_\_

Arrival Date \_\_\_\_\_

Before 6 pm  After 6 pm

Departure Date \_\_\_\_\_

Rooms:  Single  Double (1 bed, 2 persons)

Double Double (2 beds, 2 persons)

Deposit required - Room deposit must be paid directly to the hotel or motel by date shown on the confirmation form sent to you. Use canceled check for confirmation.

Mail to - Lodging, Dayton Hamvention, 1880 Kettering Tower, Dayton, OH 45423-1880

(PLEASE SEPARATE)

### Advance Registration Form

Dayton Hamvention 1988

Reservation Deadline - USA-April 4, Canada-March 31

Name \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

#### How Many

Admission \_\_\_\_\_ @ \$8.00\* \$ \_\_\_\_\_

(valid all 3 days)

Grand Banquet \_\_\_\_\_ @ \$16.00\*\* \$ \_\_\_\_\_

Women's Luncheon

(Saturday) \_\_\_\_\_ @ \$6.75 \$ \_\_\_\_\_

(Sunday) \_\_\_\_\_ @ \$6.75 \$ \_\_\_\_\_

Flea Market \_\_\_\_\_ \$23/1 space

(Max. 3 spaces) \$50/2 adjacent

Admission ticket must \$150/3 adjacent \$ \_\_\_\_\_

be ordered with flea market tickets **Total** \$ \_\_\_\_\_

\* \$10.00 at door

\*\* \$18.00 at door, if available

Make checks payable and mail S.A.S.E. to -  
Dayton Hamvention, Box 2205, Dayton, OH 45401

## KENNEDY ASSOCIATES

Stocking all major lines. San Antonio's  
Ham Store. Great Prices—Great Service.  
Factory authorized sales and service.  
Hours: M-F 10-6; SAT 9-3

# KENWOOD

# YAESU

# ICOM

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



295

## Six Function DTMF Controller



Auto-Kall  
AK-4

- Outputs: 2 or 3 latched, 1 or 2 momentary, 1 timed and 1 manually reset group-call latched for remote alarm
- Different codes for turning outputs on/off **NOT** toggle on/off like most others! • Wrong number reset
- 4-digit access code - can use \* up # down
- Multiple group-call response • On-board 1-amp relay



MoTron Electronics  
AK-4K (board/kit) . . . . . \$69.95  
AK-4W (wired/tested board) . . . \$89.95

AK-4C (Complete unit in metal enclosure with in/out jacks, built-in speaker etc.) . . . . . \$139.95  
Plus \$3.00 shipping & handling

Call Toll Free 1-800-338-9058 or (503) 687-2118

294

## HI-PERFORMANCE DIPOLES

MODEL	DESCRIPTION	PRICE
MPD-1	80-40-20-15-10M MAX-PERFORMANCE DIPOLE 87' LONG	\$179.95
MPD-2	80-40-20-15-10M MAX-PERFORMANCE DIPOLE 85' LONG	\$179.95
MPD-3	140-80-40M HI-PERFORMANCE DIPOLE 113' LONG	\$179.95
SDI-1	140-80-40-20-15-10M SPACE-SAVING DIPOLE 71' LONG	\$179.95
SDI-2	80-40-20-15-10M SPACE-SAVING DIPOLE SPECIFY L, 42' & 93', 60' & 99'	\$199.95
SDI-3	80-40-20-15M SPACE-SAVING DIPOLE SPECIFY L, 46' & 93', 60' & 99'	\$199.95

BASE FOR CATALOGUE OF 30 DIPOLES, SLOPERS, & SPACE-SAVING, UNIQUE ANTENNAS  
W9INN ANTENNAS 312-394-3414  
BOX 393 MT. PROSPECT, IL 60056

293

# SUBSCRIBE

—AND RENEW—

## TOLL-FREE



# ham radio

magazine

1 YR - \$22.95 2YRS - \$38.95

3 YRS - \$49.95

Prices U.S. only



MASTERCARD  
 VISA  BILL ME

Please have your charge card ready.

DATATEL 800™

# 800-341-1522

Weekdays 8 AM - 9 PM EST • Saturdays 9 AM - 5 PM EST  
IN MAINE CALL COLLECT (207) 236-2896

OUR 800 NUMBER IS FOR SUBSCRIPTION ORDERS ONLY!

For Errors or Change of Address CALL ham radio  
direct at (603) 878-1441 8-5 EST

# ADVERTISER'S INDEX AND READER SERVICE NUMBERS

Listed below are the page and reader service number for each advertiser in this issue. For more information on their products, select the appropriate reader service number make a check mark in the space provided. Mail this form to ham radio Reader Service, I.C.A., P.O. Box 2558, Woburn, MA 01801.

Name \_\_\_\_\_ Call \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

\*Please contact this advertiser directly.

Please use before April 30, 1988.

READER SERVICE #	PAGE #
248 - Ace Communications, Inc	55
285 - Advanced Computer Controls, Inc	86
213 - Advanced Receiver Research	48
259 - AEA	66
235 - All Electronics Corp	32
257 - Aluma Tower Co	62
251 - American Lightwave	58
223 - Amidon Associates	18
247 - AMSAT	52
270 - Antennas West	18, 20, 80
252 - ARRL	58
254 - ARRL	61
231 - Astron Corp	31
* Barker & Williamson	98
* Barry Electronics	20
211 - Bilal Company	48
274 - Buckmaster Publishing	82
281 - Buckmaster Publishing	86
* Butternut Electronics	61
* Caddell Coil Corp	62
* Charlotte Hamfest and Computefair	75
289 - Coaxial Dynamics, Inc	93
* C.O.M.B.	61
256 - Communication Concepts, Inc	62
219 - Communications Specialists	16
215 - Connect Systems Inc	1
267 - Consolidated Electronics	75
* Courage Handi-Ham System	9
237 - CTM	38
242 - Cushcraft Corp	43
* Dayton Hamvention	96
264 - Detection Dynamics	62
220 - Doppler Systems	19
283 - Down East Microwave	86
* DRSI	44
286 - EEB	85
243 - EGE, Inc	42
* EGE, Inc	86
* Engineering Consulting	38
232 - Epsilon Co	32
265 - Fair Radio Sales	62
* Falcon Communications	58
230 - GLB Electronics	28
268 - Grove Enterprises	75
234 - GTI	32
210 - GTI	48
250 - HAL Communications Corp	59
226 - Hall Electronics	20
246 - Ham Radio Outlet	50, 51
* Ham Radio's Bookstore	40, 47, 58, 62, 72
* Hamtronics, NY	95
* Hamtronics, PA	84
280 - Hustler, Inc	87
214 - ICOM America, Inc	CII
236 - ICOM America, Inc	35
225 - IIX Equipment Ltd	20
263 - Jensen Tools, Inc	70
269 - Jun's Electronics	78
295 - Kennedy Associates	97
* Kenwood U.S.A. Corp	2, 5, 7, CIV

READER SERVICE #	PAGE #
253 - Madison Electronics Supply	61
273 - Madison Electronics Supply	80
279 - The Meadowlake Corp	84
288 - John J. Meshna Jr, Inc	72
216 - MFJ Enterprises	8
292 - Micro Control Specialties	94
233 - Midland Technologies	32
224 - Mirage Communications	18
287 - Mission Communications	48
296 - Missouri Radio Center	99
239 - Morlan Software	40
294 - Motron Electronics	97
277 - NCG	82
212 - Nema Electronics	48
291 - Nuts & Volts	94
298 - OPToelectronics	100
238 - P.C. Electronics	38
245 - Pac-Comm Packet Radio Systems, Inc	47
249 - Radio Amateur Callbook	55
221 - The Radio Connection	32
222 - Radiokit	18
228 - Radio Shack	25
229 - Radiosporting	28
284 - The Radio Works	86
260 - Ramsey Electronics, Inc	69
275 - The RF Connection	82
* RF Parts	19, 77
240 - S-Com Industries	40
* Sherwood Engineering, Inc	20
266 - Sommer	93
* Spec-Com	55
244 - Spectrum International	47
262 - Stridsburg Engineering Co	70
258 - STV/OnSat	64
276 - Synthetic Textiles, Inc	82
290 - Tel-Com	93
261 - Texas Radio Products	70
271 - Transverters Unlimited	80
272 - Unadilla/Antennas Etc	80
* University Microfilm Int	80
282 - Vanguard Labs	86
217 - Varian EIMAC	13
255 - VHF Communications	62
293 - W9INN Antennas	97
241 - Western Electronics	40
227 - Wi Comm Electronics Inc	20
218 - Yaesu USA	15
297 - Yaesu USA	CIII
278 - E.H. Yost Co	84

### PRODUCT REVIEW/NEW PRODUCTS

306 - Bencher, Inc	82
302 - Encomm, Inc	81
* Engineering Consulting	82
304 - Gordon West Radio School	81
305 - Heath Company	81
301 - Hustler, Inc	81
303 - MFJ Enterprises	81

## B & W PRESENTS A WINNING COMBINATION



1500W

### MODEL PT2500A LINEAR AMPLIFIER

The Barker & Williamson PT2500A Linear Amplifier is a completely self-contained table-top unit designed for continuous SSB, CW, RTTY, AM or ATV operation. Intended for coverage of all amateur bands between 1.8 MHz and 21 MHz, it can be readily modified for frequencies outside the amateur bands for commercial or military application. Two type 3-500z glass envelope triodes provide reliability and rapid turn-on time.

#### FEATURES INCLUDE:

- Full 1500 watt output
- Pi-network input for maximum drive
- Pressurized plenum cooling system
- DC antenna relay for hum-free operation
- Illuminated SWR and power meters
- Vernier tuning for accurate settings
- Pi-L output for greater harmonic attenuation

Ruggedly constructed of proven design, this amplifier reflects the manufacturer's critical attention to details - such as the silver-plated tank coil for maximum efficiency. Cathode zener fuse and internal/external cooling are among the protective and safety devices employed. Input and output impedances are 50 ohms.

Dimensions: 17" wide x 19" deep x 8 1/2" high  
Weight: 80 lbs. (shipped in 3 cartons to meet UPS requirements)

Price: \$2175.00 FOB factory. Price includes one year limited warranty.

Call or write factory for complete specifications.



1500W

### MODEL VS1500A ANTENNA COUPLER

The Barker & Williamson VS1500A antenna coupler is designed to match virtually any receiver, transmitter or transceiver in the 160 to 10 meter range (1.8 to 30 MHz) with up to 1500 watts RF power to almost any antenna, including dipoles, inverted vees, verticals, mobile whips, beams, random wire and others, fed by coax cable, balanced lines or a single wire. A 1:4 balun is built in for connection to balanced lines.

#### FEATURES INCLUDE:

- Series parallel capacitor connection for greater harmonic attenuation.
- In-circuit wattmeter for continuous monitoring.
- Vernier tuning for easy adjustment.

Front panel switching allows rapid selection of antennas, or to an external dummy load, or permits bypassing the tuner.

Dimension (Approx.): 11" wide x 13" deep x 6" high

Weight: 6 1/2 lbs

Price: \$499.00 FOB Factory Fully warranted for one year.

ALL OUR PRODUCTS MADE IN USA  
**BARKER & WILLIAMSON**  
Quality Communication Products Since 1932  
At your Distributor Write or Call  
10 Canal Street, Bristol, PA 19007  
(215) 788-5581

# MISSOURI RADIO CENTER

# 1-800-821-7323

102 N.W. Business Park Lane, Kansas City, MO 64116 816-741-8118

TRADE INS ACCEPTED

MasterCard — VISA — Discover

## Dependable Service At The Right Price ... Everytime

### KENWOOD



**TS440S "DX-CITING"**

- 100% Duty Cycle
- 100 Memories
- Direct Keyboard Entry
- Optional Built-in AT

On Sale Now, Call for Price!

### YAESU



**FT-767GX** HF/VHF/UHF BASE STATION

- Add Optional 6m, 2m & 70cm Modules
- Dual VFO's
- Full CW Break-in
- Lots More Features

### ICOM



**IC-761** NEWEST HF SUPER RIG

- 160-10M/General Coverage Receiver
- Built-in Power Supply and Automatic Antenna Tuner
- SSB, CW, FM, AM, RTTY
- QSK to 60 WPM

### ALINCO



**ALD-24T** DUAL BAND MOBILE

- 140-149.995 MHz/ 440-450 MHz
- 25 Watts on Both Bands
- Crossband Full Duplex
- 21 Memory Channels
- CTCSS Encoder/Decoder, Standard

### KENWOOD



**TS-140S** AFFORDABLE DX-ing!

- HF Transceiver With General Coverage Receiver
- All HF Amateur Bands
- 100 W Output
- Compact, Lots of Features

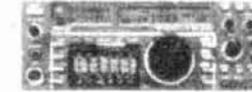
### YAESU



**FT-736R** VHF-UHF BASE STATION

- SSB, CW, FM on 2 Meters and 70 cm
- Optional 50 MHz, 220 MHz or 1.2 GHz
- 25 Watts Output on 2 Meters, 220 and 70 cm
- 10 Watts Output on 6 Meters and 1.2 GHz
- 100 Memories

### ICOM



**IC-735** COMPACT HF TRANSCEIVER

- All HF Band/General Coverage Receiver
- 12 Memories/Frequency and Mode
- USB, LSB, AM, FM, CW
- 100 Watts Output
- Includes HM-12 Scanning Mic

### riconcepts

2m and 220 MHz Amplifiers  
GaAsFET Receive Pre-Amps  
and High SWR Shutdown Protection

MODEL	144 MHz	220 MHz	SALE PRICE
2-23	2 in/30 out		
2-217	2 in/170 out		
2-117	10 in/170 out		
		220 MHz	
3-22	2 in/20 out		
2-211	2 in/110 out		
3-312	30 in/120 out		
		CALL	

### KENWOOD



**TM-221A**

- 2m FM Mobile Transceiver
- 45W Output w/HiLo Switch
- 14 Multi-Function Memories
- TM-221A Available For 440 MHz

### YAESU



**FT-212RH** THE "ANSWERING MACHINE" MOBILE

- Rx: 138-174 MHz
- Tx: 144-148 MHz
- 45W Output
- Digital Voice Recorder
- FT-712 RH for 70cm

### ICOM



**IC-900** SIX BANDS IN ONE MOBILE

- Remote Controller, Interface A Unit, Interface B Unit, Speaker, Mic and Cables
- Six Band Units to Choose
- 10 Memories Per Band
- Programmable Band Scan
- Fiber Optic Technology

### ASTRON CORPORATION



**Power Supply**

- RS7A ... \$48
- RS12A ... \$68
- RS20A ... \$88
- RS20M ... \$105
- VS20M ... \$125
- RS35A ... \$133
- RS35M ... \$149
- VS35M ... \$165
- RS50A ... \$189
- RS50M ... \$215
- RM50A ... \$219
- VS50M ... \$229

### KENWOOD



**TH-25AT** POCKET-SIZED AND POWERFUL

- Frequency Coverage: 141-163 MHz (Rx), 144-148 MHz (Tx)
- Front Panel DTMF Pad
- 5 Watts Output
- 14 Memories
- TH-45AT Available for 440 MHz

### YAESU



**FT23/73R**

- Super "Mini" HT's
- Zinc-Aluminum Alloy Case
- 10 Memories
- 140-164 MHz, 440-450 MHz
- 2W Battery Pack or Optional 5W Pack

### ICOM



**IC-μ2AT**  
**IC-μ4AT**

MICRO HT'S FOR 2M, 440

- Pocket Size HT Fun
- Ten Memories
- LCD Readout
- Wideband Coverage
- Up to 3 Watts Output
- 32 Built-in Subaudible Tones

### ASA



**PK-64/HFM**

- Morse, Baudot, ASCII, AMTOR and Packet
- Operates VHF and HF
- You Need Only Your Transceiver and a Commodore 64 or 128

**SPECIAL! FINAL CLEARANCE**  
**\$149.95** Limited Supply

• MOST ORDERS SHIPPED SAME DAY •

YAESU  
WELZ  
VIKING  
VANGORDON  
TEN-TEC  
SANTEC  
RFCONCEPTS  
QUATRON  
NVE  
MIRAGEIKLM  
MFJ  
LARSEN

OPTOelectronics inc

**NEW**

**POCKET SIZE**

**SIZE: 4" H x 3.5" W x 1" D  
MADE IN USA**

# FREQUENCY COUNTERS TO 1.3 GHz

\$99<sup>95</sup> - \$150<sup>00</sup>

**8 LED DIGITS · 2 GATE TIMES  
ANODIZED ALUMINUM CABINET  
INTERNAL NI-CAD BATTERIES INCLUDED  
AC ADAPTER/CHARGER INCLUDED**



**EXCELLENT SENSITIVITY  
& ACCURACY**

**AC-DC · PORTABLE  
OPERATION**



**#AC-1200  
AC ADAPTER  
CHARGER**

**#1200H 1.2 GHz**

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

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

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

**STOCK NO:**

- #1200HKC Model 1200H in kit form, 1-1200 MHz counter complete including all parts, cabinet, Ni-Cad batteries, AC adapter-battery charger and instructions ..... \$ 99.95
- #1200HC Model 1200H factory assembled 1-1200 MHz counter, tested and calibrated, complete including Ni-Cad batteries and AC adapter/battery charger ..... \$137.50
- #1300HC Model 1300H factory assembled 1-1300 MHz counter, tested and calibrated, complete including Ni-Cad batteries and AC adapter/battery charger ..... \$150.00

**ACCESSORIES:**

- #TA-1005 Telescoping RF pick-up antenna with BNC connector ..... \$12.00
- #P-100 Probe, direct connection 50 ohm, BNC connector ..... \$18.00
- #CC-70 Carrying case, black vinyl with zipper opening. Will hold a counter and accessories ..... \$10.00

✓ 298

FLA (305) 771-2050

ORDER FACTORY DIRECT

**1-800-327-5912**

**1.3 GHz**

**#1300H**



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



**AVAILABLE NOW!**

Orders to US and Canada add 5% of total (\$2 min., \$10 max)  
Florida residents add 5% sales tax. COD fee \$2.

"They said I couldn't work DX with just 100 watts. Especially with a radio that has less than 1000 switches on the front panel.

But the truth is, I'm working lots of DX, more than some of these blockbuster types, thanks to my Yaesu FT-747GX.

You see, my no-nonsense FT-747GX was designed with me in mind, so I can hop around the band fast to nail those DX stations. While the other guys are warming up their amplifiers, I'm working the new country!

My FT-747GX has a super receiver, with a directly-driven mixer for great overload protection. And, Yaesu included the CW filter in the purchase price

(I used the money I saved on postage for the QSL cards!).

And my FT-747GX is loaded with other features. The receiver works from 100 kHz straight through to 30 MHz, and it's a fantastic shortwave broadcast receiver. I can use all twenty memories for that alone! Plus it's got dual VFOs. A noise blanker. Split frequency operation for the pile-ups. And scanning up the band helps me check out openings as they happen.

I just put in the optional crystal oven, and next month I'm going to pick up the FM board. I can't wait to tell my buddies I worked England on a repeater!

And with the money I saved when I bought my FT-747GX, I got

a second ten-meter antenna for satellite work on the high end of the band. I use my personal computer to tell me what satellites are going by, and the computer even sets the frequencies on the radio for me.

Now my friends are getting FT-747GX rigs, too. I knew they'd figure out my secret weapon sooner or later. But now I'm setting the pace!

Thanks, Yaesu. You've made a rig that makes sense."

Yaesu USA 17210 Edwards Road, Cerritos, CA 90701  
(213) 404-2700. Repair Service: (213) 404-4884.  
Parts: (213) 404-4847. Prices and specifications subject to change without notice.

# YAESU

✓ 297

## "They laughed when they saw my radio. Then they saw my logbook."



# KENWOOD

...pacesetter in Amateur Radio

DX-celence!

## #1 Rated HF!



### TS-940S Competition class HF transceiver

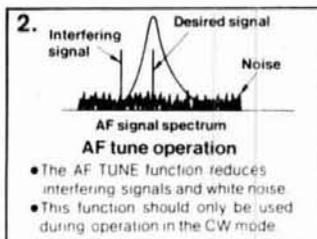
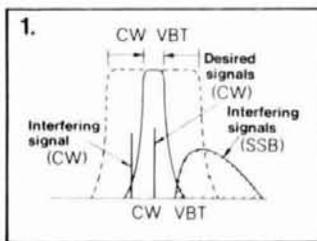
TS-940S—the standard of performance by which all other transceivers are judged. Pushing the state-of-the-art in HF transceiver design and construction, no one has been able to match the TS-940S in performance, value and reliability. The product reviews glow with superlatives, and the field-proven performance shows that the TS-940S is "The Number One Rated HF Transceiver!"

- 100% duty cycle transmitter. Kenwood specifies transmit duty cycle **time**. The TS-940S is guaranteed to operate at full power output for periods **exceeding one hour**. (14.250 MHz, CW, 110 watts.) Perfect for RTTY, SSTV, and other long-duration modes.
- First with a full one-year limited warranty.
- Extremely stable phase locked loop (PLL) VFO. Reference frequency accuracy is measured in **parts per million!**

#### Optional accessories:

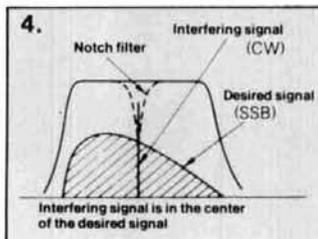
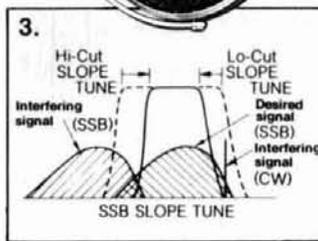
- AT-940 full range (160-10m) automatic antenna tuner • SP-940 external speaker with audio filtering • YG-455C-1 (500 Hz), YG-455CN-1 (250 Hz), YK-88C-1 (500 Hz) CW filters; YK-88A-1 (6 kHz) AM filter • VS-1 voice synthesizer • SO-1 temperature compensated

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



1) CW Variable Bandwidth Tuning. Vary the passband width continuously in the CW, FSK, and AM modes, without affecting the center frequency. This effectively minimizes DRM from nearby SSB and CW signals.

2) AF Tune. Enabled with the push of a button, this CW interference fighter inserts a tunable, three-pole active filter between the SSB/CW demodulator and the audio amplifier. During CW QSOs, this control can be used to reduce interfering signals and noise, and peaks audio frequency response for optimum CW performance.



3) SSB Slope Tuning. Operating in the LSB and USB modes, this front panel control allows independent, continuously variable adjustment of the high or low frequency slopes of the IF passband. The LCD sub display illustrates the filtering position.

4) IF Notch Filter. The tunable notch filter sharply attenuates interfering signals by as much as 40 dB. As shown here, the interfering signal is reduced, while the desired signal remains unaffected. The notch filter works in all modes except FM.

- Complete all band, all mode transceiver with general coverage receiver. Receiver covers 150 kHz-30 MHz. All modes built-in: AM, FM, CW, FSK, LSB, USB.
- Superb, human engineered front panel layout for the DX-minded or contesting ham. Large fluorescent tube main display with dimmer; direct keyboard input of frequency; flywheel type main tuning knob with optical encoder mechanism all combine to make the TS-940S a joy to operate.
- One-touch frequency check (T-F SET) during split operations.
- Unique LCD sub display indicates VFO, graphic indication of VBT and SSB Slope tuning, and time.
- Simple one step mode changing with CW announcement.
- Other vital operating functions. Selectable semi or full break-in CW (QSK), RIT/XIT, all mode squelch, RF attenuator, filter select switch, selectable AGC, CW variable pitch control, speech processor, and RF power output control, programmable band scan or 40 channel memory scan.

- crystal oscillator • MC-43S UP/DOWN hand mic. • MC-60A, MC-80, MC-85 deluxe base station mics. • PC-1A phone patch • TL-922A linear amplifier • SM-220 station monitor • BS-8 pan display • SW-200A and SW-2000 SWR and power meters • IF-232C/IF-10B computer interface.

# KENWOOD

KENWOOD U.S.A. CORPORATION  
2201E, Dominguez St., Long Beach, CA 90810  
P.O. Box 22745, Long Beach, CA 90801-5745