ICOM's IC-735 is the world's most popular HF transceiver. With the highest performance, smallest size, and best customer satisfaction of any HF transceiver, the IC-735 is the winner's choice for fixed, portable, or mobile operations.

- **Field Proven 100W Transmitter** with 100% duty cycle. Proudly backed with ICOM's full one-year warranty.
- **105dB Dynamic Range Receiver** includes passband tuning, IF notch, adjustable noise blanker, and semi or full CW QSK.
- **Conveniently Designed.** Measures only 3.7"H by 9.5"W by 9"D.

- **Optional AH-2 Automatic Tuning Mobile Antenna System** covers 3.5MHz-30MHz and tracks with the IC-735's tuned frequencies.
- **All HF Amateur Bands and Modes** plus general coverage reception from 100kHz-30MHz.
- **12 Tunable Memories** operate and reprogram like 12 separate VFOs. Supreme flexibility!

**Additional Options:** SM-10 graphic equalized mic, PS-55 AC power supply, AT-150 automatic antenna tuner for base operation.

ICOM's IC-735...a proven winner for reliable worldwide HF communications. See it today at your local ICOM dealer.

**ICOM First in Communications**

ICOM America, Inc.,
2380 116th Avenue N.E., Bellevue, WA 98004
Customer Service Hotline (206) 454-7619
3150 Premier Drive, Suite 125, Irving, TX 75063
1777 Phoenix Parkway, Suite 201, Atlanta, GA 30349
ICOM CANADA, A Division of ICOM America, Inc.,
3071 S Hilltop Drive, 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. 735188.
FOUR user selectable operating modes and a 90 number autodialer make Private Patch V the ONLY choice!

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

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

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

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

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

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

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

You may never need another patch again.

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

Call or write today for your FREE brochure.

CONNECT SYSTEMS INC.
23731 Madison St. Torrance, CA 90505
Phone: (213) 373-6803
Kenwood brings you the greatest hand-held transceiver ever! More than just "big rig performance," the new TH-215A for 2 m, TH-315A for 220 MHz, and TH-415A for 70 cm pack the most features and the best performance in a handy size. And our full line of accessories will let you go from ham shack to portable to mobile with the greatest of ease!

- Wide receiver frequency range. Receives from 41-163 MHz. Includes the weather channels!
- Transmit from 144-148 MHz. Modifiable to cover 141-151 MHz (MARS or CAP permit required).
- TH-315A covers 220-225 MHz, TH-415A covers 220-449 MHz.
- 5, 2.5, or 1.5 W output, depending on the power source. Supplied battery pack (PB-2) provides 2.5 W output. Optional NiCd packs for extended operation or higher RF output available.
- CTCSS encoder built-in, TSU-4 CTCSS decoder optional.
- 10 memory channels store any offset, in 100-kHz steps.
- Odd split, any frequency TX or RX in memory channel (0).
- Nine types of scanning! Including new "seek scan" and priority alert. Also memory channel lockout.
- Intelligent 2-way battery saver circuit extends battery life. Two battery-saver modes to choose, with power saver ratio selection.
- Easy memory recall. Simply press the channel number!
- 12 VDC input terminal for direct mobile or base station supply operation. When 12 volts applied, RF output is 5 W (Cable supplied!)
- New Twist-Lok Positive Connect locking battery case.
- Priority alert function.
- Monitor switch to defeat squelch. Used to check the frequency when CTCSS encode/decode is used or when squelch is on.

Optional Accessories:
- PB 1: 12 V, 800 mAH NiCd pack for 5 W output
- PB-2: 8.4 V, 500 mAH NiCd pack (2.5 W output)
- PB-3: 7.2 V, 800 mAH NiCd pack (1.5 W output)
- PB-4: 7.2 V, 1600 mAH NiCd pack (1.5 W output)
- BI-5 AA-cell manganese/alkaline battery case
- BC-7 rapid charger for PB 1, 2, 3, or 4
- BC-8 compact battery charger
- SMC-30 speaker microphone
- SC-12, 13 soft cases
- RA-3, 5 telescoping antennas
- RA-80 StubbyDuk antenna
- TSU-4 CTCSS decoder unit
- VB-2500: 2 m, 25 W amplifier (1.4 W input)
- LH-4: 4 leather cases
- MB-4 mobile bracket
- BH-5 swivel mount
- PG-2V extra DC cable
- PG-3D cigarette lighter cord with filter

Specifications and prices are subject to change without notice or obligation.
9 A Simple Direct Conversion Receiver
Rodney A. Kreuter, WA3ENK

19 The Weekender: Build This Simple L-C Checker
Jack Najork, W5FG

22 Ham Radio Techniques: New Zeland, Maui, and the Solar Cycle
Bill Orr, W6SAI

29 Structural Evaluation of Yagi Elements
Dick Weber, K51U

51 Formatted Display of Packets Using KISS
Michael Pechura, WABBXN

60 Decoding Data Signals
James A. Sanford, WB4GCS

75 A Homebrew Tuning Dial
John Pivnichny, N2DCH

83 Practically Speaking: Overview of Operational Amplifiers: Part 2
Joe Carr, K41PV

88 The Weekender: Get the Most from Your NiCd
W.C. Cloninger, Jr., K30F

117 Elmer’s Notebook: SSB Basics — Receiving the Signal
Tom McMullen, W1SL

Joe Reisert’s column returns next month.

Backscatter 4 Short Circuits 107
Comments 6 DX Forecaster 110
Ham Notebook 26 Flea Market 118
New Products 59, 70, Advertiser’s Index 126
Ham Mart 104, 125 Reader Service 126

Special thanks to Hans Evers, PA1CY, for all his great covers this year.
A year of change at HAM RADIO.

What fosters a good relationship between a magazine and its readers? When I arrived here a little over a year ago, I asked myself that question. I decided that, first, I had to get to know you. I needed to find out what Amateur Radio, in general, and HAM RADIO Magazine, in particular, meant to you. I began reading letters, manuscripts, notes on renewal notices, old surveys — anything I could get my hands on. I met you at shows in Dayton and Boxborough. What I found was an incredibly diverse group of people — teachers, accountants, machinists, doctors, engineers, pilots, bank tellers, journalists, students, homemakers, retired persons (the list goes on and on) — all bound together by a love for Amateur Radio.

And even within the hobby itself, there is something for everyone. Whether you build, contest, do public service work, or just like to get on the radio and talk, you can find a niche in this great hobby. I suddenly noticed antennas I’d never seen before in my neighbors’ backyards, a ham radio communications post at a local road race I ran in, callsigns on license plates — Amateur Radio is everywhere and a very important part of lots of lives!

How does HAM RADIO Magazine fit into your lives? There was a common theme in all your correspondence to us. You liked the technical flair of the magazine, but found many of the articles were dry, complicated, or just plain too long. You wanted more construction projects, weekenders, and shorter technical pieces that explained the theory behind the idea in a more concise fashion. But, you didn’t want HAM RADIO to become "just another contest magazine." You liked what we were; you simply wanted some refinements.

After the Dayton Hamvention, the editorial staff got together to decide how to best meet your requests. In September we launched our first “new” HAM RADIO issue. We filled it with the kinds of articles you wanted to see (Weekenders, ham notes, projects, technical pieces), gave it a different look, and included evaluation cards for your comments. Your response to each new issue has been tremendous; it has given us a yardstick by which we can judge our performance. Without you, we could not have effected this change. With you, and your continued support, we will continue to grow.

Because our changes have been so well received, we’ll carry them into the future. In the months to come you can look forward to pieces on ATV, digital voice, and new antenna designs. And, for you homebrew buffs, January brings our first construction issue.

Of course, our ability to deliver the kind of magazine you want to read depends not only on your constructive criticisms, but on the fine manuscripts you submit. You are our writers as well as our readers, and we’d love to help you share what you’ve built or learned with your fellow Amateurs. If you don’t know how to get started, write for our author’s guide; it’s got lots of helpful hints. C’mon, what are you waiting for?

It’s been a long year. A year of change — but positive change. You’ve been with us through it all. We thank you and look forward to a long happy relationship with you — our readers and friends.

Terry Northup
Managing Editor

P.S. Thought you’d like to know that I too have succumbed to the lure of Amateur Radio. I passed my Novice test and am waiting for my license to come. Hope to see you soon on the Novice bands!

KA1???

Correction: In our November editorial, “A potential danger,” the National Career Institute was listed as a group concerned about the effects of electromagnetic radiation. The reference should have read National Cancer Institute. Ed.

Happy Holidays from all of us at HamRadio
Matching Pair

TS-711A/811A VHF/UHF all-mode base stations

The TS-711A 2 meter and the TS-811A 70 centimeter all mode transceivers are the perfect rigs for your VHF and UHF operations. Both rigs feature Kenwood's new Digital Code Squelch (DCS) signaling system. Together, they form the perfect "matching pair" for satellite operation.

- Highly stable dual digital VFOs. The 10 Hz step, dual digital VFOs offer excellent stability through the use of a TCXO (Temperature Compensated Crystal Oscillator).
- Large fluorescent multi-function display. Shows frequency, RIT shift, VFO A/B, SPLIT, ALERT, repeater offset, digital code, and memory channel.
- 40 multi-function memories. Stores frequency, mode, repeater offset, and CTCSS tone. Memories are backed up with a built-in lithium battery.
- Automatic mode selection. You may select the mode manually using the front panel mode keys. Manual mode selection is verified in International Morse Code.
- All-mode squelch.
- High performance noise blanker.
- Speech processor. For maximum efficiency on SSB and FM.
- IF shift.
- "Quick-Step" tuning. Vary the tuning characteristics from "conventional VFO feel" to a stepping action.
- Built-in AC power supply. Operation on 12 volts DC is also possible.
- Semi break-in CW, with side tone.
- VS-1 voice synthesizer (optional) More TS-711A/811A information is available from authorized Kenwood dealers.

Optional accessories.
- IF-10A computer interface
- IF-232C level translator
- CD-10 call sign display
- SP-430 external speaker
- VS-1 voice synthesizer
- TU-5 CTCSS tone unit
- MB-430 mobile mount
- MC-60A, MC-80, MC-85 deluxe desk top microphones
- MC-48B 16-key DTMF, MC-43S UP/DOWN mobile hand microphones
- SW-200A/B SWR/power meters:
  - SW-200A 1.8-150 MHz
  - SW-200B 140-450 MHz
- SWT-1 2-m antenna tuner
- SWT-2 70-cm antenna tuner
- PG-2U DC power cable

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

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

Good news and bad news

Dear HR:

Just received the September 1988 issue of HAM RADIO magazine an hour ago. Naturally, I have not had time to go through it in great detail, but I like what I see and like it so much that I am willing to extend my subscription for another three years.

Now for the bad news. The printing job in my issue leaves much to be desired. Many of the pages have the material printed so close to the edge of the page that a slim portion of the text and advertising is cut off and missing. I assume this is a one-time problem.

Enclosed is my evaluation card. Keep Bill Orr's column coming. His writings are usually the first place to which I open your magazine. I have been a fan of his since the days of his antenna articles featuring Pendergast in the small-format CQ magazines.

Lee G. Andreas, N9BDL
Lake Tomahawk, Wisconsin 54539-9500

Advice for the novice

Dear HR

Can't remember when I wrote a letter to the editor but Marty wrote an editorial (Reflections) in the August issue that I take exception to. He was commenting on the high cost of equipment to get the Novice started, and asking us to dig out the old stuff that is collecting dust to give them a start.

Have we forgotten that a one-tube crystal oscillator is a good CW transmitter? And, a two-tube regenerative receiver (or a transistor and op amp) make a compatible receiver?

We are doing an injustice to the young people when we try to train them to be appliance operators rather than giving them an introduction to the technical world and allowing them to enjoy communications with equipment they've constructed. Many of us have enjoyed careers as electronics engineers because we built our first equipment, and we built it because we could not afford the complete receivers and transmitters. If the beginners don't experience the pleasure of construction, how will they ever know?

If you really want to help the Novice, don't give them a radio, give them help in constructing a radio and a good antenna.

When the old timers get together, they don't talk about their first contacts without going into intricate detail about the design of their first hard-wired radio. Forty years from now, the Novice of today won't even remember which box he bought first.

Ted Hart, W5QJR, Melbourne, Florida 32902

Handling traffic—a challenge

Dear HR

With regard to Mr. Harold P. Morgan, WDOP's letter in the July, "Comments", Ham Radio Magazine, I would like to say that I too am in complete agreement with Mr. Morgan. My situation is only somewhat different, for I am somewhat of a traffic handler.

Traffic is a challenge to me, in whetting my skills to enable me to receive a message, under the worst possible conditions, and to achieve the highest possible rate of accuracy. To take a piece of traffic from a station that is in the noise level, or below, and to have as close to 100-percent accuracy, is the name of the game for me.

Then, along comes our friend with the brand new super-duper, whiz bang, synthesized what's-it, and his Hakensak 5-PW amplifier, blasting the air waves with 3 or 4 kw, running up and down the band, with the key locked down; not just once or twice. No, he's got to run for it at least a half dozen times, before he qualifies. For what, I have yet to determine. And if, after all of this, you have anything left of your already diminishing hearing (having had the phones on, the bandwidth screwed down, and the volume up as high as you could stand it) you're just lucky as all get out.

I take exception to Mr. Morgan's, "wanting to hang them by their thumbs." While this just might keep them from reaching the key, and the VFO knob at the same time, it is quite doubtful that they would have learned anything from the experience. Given the fact that they have an extremely low I.Q. (they have already told this to the whole world) perhaps they need additional protection, namely from themselves. Perhaps an 8 or 9-foot square room, with lots of padding on the floor and walls, and a nice strong door, made from 3 inch thick planks, solidly set into the walls, would be appropriate.

I too have a chart, at the operating position, showing the dial setting for my antenna tuner for every 50 kHz, made some years ago during poor band conditions. With this chart, I am able to set-up a frequency, and not have my VSWR exceed 1.2:1. More than likely, it will be considerably below that value. Those times, when I do wind up with a 2:1 VSWR, it always turns out to be my fault for not reading the dial correctly. I have set the dial at 55 rather than 65, all of this without putting a signal on the air. When the time arrives that I have an amplifier in line, and up and running, it too will have a dial setting chart, compiled by operating the amplifier into a dummy load. If I can do this, so can you!!!

LeRoy E. Smith, WB0LTV, Hot Springs, South Dakota 57747
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 full-featured HT covering 220-225 MHz. Ten memory channels and 2.5 watts of power. (5 W with PB-1 or 12 VDC.) 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!"
Contest and Navtex mode. making it the Radio Magazine controller to C-641128 on thr.

You can link and repeat excif

AMTOR

You can receive 7 bit ASCII using the same shifts and speeds as in the RTTY mode.

You can transmit

ASCII

You can transmit and receive 7 bit ASCII using the same shifts and speeds as in the RTTY mode.

You can transmit

CW

You have a super Morse Keyboard mode that lets you send and receive CW effortlessly, including all pros/cons -- 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 beacons. Memories also work in RTTY and ASCII modes.

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

An AFSK CW mode lets you ID in CW.

You also get an 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 to disk if your terminal can save faster.

You also get ASCII and Weather FAX for transmit and receive 8.5, 12, 17, 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.

Message memories let you store contest calls, name, QTH, rig info -- everything you used to repeat over and over.

You get lambic operation, automatic incrementing serial numbering, weight control to penetrate QRM and more.

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 TTY level serial ports, watch dog timer, FSK and AFSK outputs, output level control, speaker jack, key paddle jack, test and calibration software, Z-60 at 4.9 MHz, 32K EEPROM, and FCC approved. 9x1½x9½ in. 12 VDC or 110 VAC.

Get yours today and join the fun crowd!

New Firmware Update

A new KISS/AMTOR/Navtex Firmware update is available to MFJ-1278 owners. MFJ's powerful update is the most reasonably priced multi-mode upgrade by any manufacturer. Contact your dealer or MFJ for yours today!

MFJ Packet Radio

MFJ-1278

MFJ-1278B

Super clone of TAPR's TNC-2 give you more features than any other packet controller -- for $119.95.

You can double your fun by operating both VHF and HF packet because you get high performance switchable VHF/HF modem.

You get MFJ's new Easy Mail with soft-partitioned memory so you and your friends can leave messages for each other 24 hours a day.

In MFJ's new WeFAX Mode, you can print full fledged weather maps to screen or printer and save to disk using an IBM compatible or Macintosh computer with the MFJ Starter Pack.

A new KISS interface lets you run TCP/IP. They also come NET ROM compatible -- no modification needed!

You also get: 32K RAM, a full one-year unconditional guarantee and you can use 12 VDC or the included 110 VAC power supply.

For dependable HF packet tuning, the MFJ 1274 gives you a high resolution tuning indicator that's accurate to within 10 Hz -- it's only $20.00 more.

FOR YOUR NEAREST DEALER or to order call toll free 800-647-1800

One Year Unconditional Guarantee

MFJ... making quality affordable
A SIMPLE DIRECT CONVERSION TRANSCEIVER

By Rodney A. Kreuter, WA3ENK, 319 McBath Street, State College, Pennsylvania 16801

Here's another project using the NE602

I've always wanted to build a direct conversion receiver, but parts availability was a problem. I needed balanced mixers, matched schottky diodes, a good oscillator, and trifilar transformers. Then I received a sample of the Signetics NE602 and the incentive to build my receiver.

Of course, once you've built a direct conversion receiver, it's a simple matter to add a transmitter. And a keyer. And a good audio filter. And a digital readout. And a wind powered, nuclear backed-up power plant. And... And I wonder why I never get around to so many projects.

NE602

The NE602 is a relatively simple chip. I guess that's why I like it. Contained inside an eight-pin dip is a double-balanced mixer with about 15 db of gain, an oscillator, and a voltage regulator.

The chip was intended for the cellular radio market. The oscillator is good to 200 MHz and the mixer to 500 MHz. Not bad for less than 3 mA at 6 volts. (One of the Signetics application notes mentions that some people have used the mixer to 900 MHz, but they only guarantee it to 500 MHz.) It runs on 4.5 to 8 volts. But please, decouple the supply to the 602 with at least a resistor and a good bypass capacitor.

Inside the NE602

For a look inside the NE602, refer to fig. 1.

Input to the double-balanced mixer is differential (pins 1 and 2). If you don't have a differential signal, feed the signal into either input and bypass the other to ground with a capacitor. Under no circumstance should you provide a DC path from either input to ground. A DC path between inputs is okay. Input resistance is about 1.5k and input capacitance is about 3 pF.

The oscillator is very simple. It's a transistor connected as an emitter follower with an internal resistor of 20k from the emitter to ground. If you want to try to push the upper frequency limit, connect an external resistor (22k minimum) from pin 7 (the emitter) to ground. This will increase the current and raise the Ft of the transistor. The base of the transistor is available at pin 6. It's already DC biased so don't provide a DC path from pin 6 to Vcc or ground. The output of the oscillator is internally connected to the other input of the double-balanced mixer.

The mixer output is also differential (pins 4 and 5) and has an output impedance of 1.5k. If you don't want a differential output, use one output and leave the other disconnected. Remember, this mixer has about 15 db of gain. One bad point — you can't push much of a signal through this mixer. It's third-order intercept is about -15 dBm. This is quite normal for a receiver, but it wouldn't make a great mixer for a transmitter power chain unless you mixed at a low level and provided a lot of gain after it.

The voltage regulator isn't mentioned much in the

FIGURE 1

Basic functional block diagram of NE602.
With our all in one box TC70-1 70cm ATV Transceiver you can easily transmit and receive live action color and sound video just like broadcast N. Use any home TV camera or VCR by plugging the composite video and audio into the front VHS 10 pin or rear phono jacks. Add 70cm antenna, coax, 13.8 Vdc and TV set and you are on the air...it's that easy!

TC70-1 has >1 watt p.e.p. with one xtal on 439.25, 434.0 or 426.25 MHz, runs on 12-14 Vdc @ .5A, and hot GaAsfet downconverter tunes whole 420-450 MHz band down to ch3. Shielded cabinet only 7x7x2.5". Transmitters sold only to licensed amateurs, for legal purposes, verified in the latest Callbook or with copy of license sent with order.

Call or write now for our complete ATV catalog including downconverters, transceivers, linear amps, and antennas for the 70, 33, & 23cm bands.

PORTABLE ANTENNA

MODEL AP-10
Designed for
APARTMENTS
MOTELS
VACATIONS

$64.95
Add $3.00 Shipping and Handling

Quick Simple Installation. Operates on 2, 6, 10, 15, 20, 30 and 40 meters. All coils supplied. Only 22-1/2 inches long. Weighs less than 2 lbs. Supplied with 10 ft. RG 58 coax and counter poison. Whip extends to 57 inches. Handles up to 300 watts. VSMMR-1.1:1 when tuned

Visa, MC, COD

P.C. ELECTRONICS
2522 Paxson Ln Arcadia CA 91006

(818) 447-4565 m-f 8am-5:30pm pst.

Direct conversion receiver basics

Direct conversion receivers have been sort of a fad for the past few years. If you need a refresher on the basics refer to fig. 2.

The RF signal is coupled into the mixer by the RF tank. The oscillator tank determines the oscillator frequency. The mixer combines these two frequencies and produces (at the output) the sum and difference of the two frequencies, plus the two original frequencies (at a minimum). If the oscillator frequency is very near the RF frequency, one of the output frequencies (the difference) will be in the audio range. The other frequency (the sum) will be at RF and will be attenuated by the low-pass filter. The remainder of the receiver is provided by lots of audio gain.

Most direct conversion receivers suffer from two problems:

- Microphonics — Because most (if not all) of the signal gain is at an audio frequency, any slight vibration which might change

Block diagram of a typical direct-conversion receiver.
the local oscillator comes through the speaker.

AC Hum — A 60-cycle hum created when operated from an AC supply.

These aren’t real difficulties with the NE602. Using the NE602 won’t cure the problems completely, but it will reduce them by two orders of magnitude. Most direct conversion receivers use diodes for a mixer. Instead of gain, these actually have about 6 dB of loss. The mixer used in the NE602 has about 15 dB of gain. Therefore the signal coming out of the mixer is about 20 dB higher in amplitude than one from a diode mixer. This means that a lot less audio gain is required after the mixer, and fewer audio problems occur.

Circuit description

Receiver

The receiver is very straightforward. (See figs. 3 and 4.) L2, C1 and C2 provide a broadband balanced input to the double-balanced mixer of the NE602. C13 through C18, and L3 are the tank and feedback circuits for the oscillator section of the chip. I realize you might question using six capacitors for an oscillator, so let me explain.

Capacitors C13 and C14 provide the feedback voltage divider for the oscillator. Capacitor C15 prevents the inductor from upsetting the DC bias of the oscillator. Capacitors C16, C17, and C18 are somewhat tricky. These days it’s very hard to get a good, affordable air-variable capacitor. I decided to use three capacitors instead. You’ll find that by playing with these three capacitors, you can adjust the tuning range to almost anything you want. My prototype tunes from about 6.9 MHz to about 7.4 MHz, using the values shown. (Watch out for those band edges!) Decreasing C17 will make the tuning range smaller. If you have a 100-pF air variable, you may want to decrease C17 in order to make tuning a little easier. You can use a smaller “fine-tuning” capacitor in parallel with C18 with good results. A vernier dial might also come in handy here. Remember that this oscillator is also your transmitter VFO. Stability is everything!

Since I’ve already mentioned that the NE602 contains a voltage regulator, you’re probably wondering why I used a 78L05 to regulate the voltage to the NE602. First, it never hurts to have a good stiff power supply for an oscillator. Second, it’s used to isolate the NE602 from the power supply. My first prototype (there were four) simply used a resistor and a capacitor for power supply decoupling. I had a lot of audio gain and the feedback was terrible. The 78L05 isolates the NE602 very well.

R1 and C4 are used as a low-pass filter for audio (about 4.3 kHz including the 1.5k output impedance of the NE602). R2 and C6 are used to prevent the audio output from reaching Q1 through the power supply.

Q1 is a simple audio-gain stage. I originally used a dual op amp for this function, but found that I didn’t need nearly that much gain. The gain of Q1 in this configuration is about 150–200. Resistor R3, one of the bias resistors, can be varied to adjust the gain if you feel it’s necessary. Lowering R3 will increase the gain. Just be sure not to saturate Q1.

IC2 is an audio power amplifier that seems to be replacing the LM386. The output is differential and doesn’t require a large capacitor to couple it to the speaker. Just keep the speaker leads short (a few inches) and twist them tightly. R9 and C10 decouple the amplifier from the power supply and are necessary to prevent
audio feedback. After all, 80 dB of gain at one frequency is a little hard to control.

Transmitter

For the transmitter description refer to figs. 3 and 4. The oscillator output is coupled to an emitter follower (Q3) by means of C21. This provides buffering of the oscillator so that the transmitter doesn't "pull" it.

Transistor Q4 provides the first voltage gain for the RF signal. Its purpose is to supply enough drive for the next emitter follower, Q5. Most simple crystal-controlled transmitters probably wouldn't need this additional gain because their oscillators provide enough output power to drive a 1-watt output stage directly.

Q5 provides a low impedance drive for the input of the first class "C" amplifier, Q6. Transformer T1 is used mainly to furnish a high impedance load for Q6 and a low impedance drive for Q7. I tried to do away with T1 by using another emitter follower in its place. It worked, but not very well. The two transistors consumed too much power. This was unacceptable because this transceiver was designed to be battery operated.

Q7 is used as the RF power amplifier. A 2N3866 or a 2N3553 seemed to work well. Notice the double pi output filter. I used a double pi filter instead of the more common single pi to ensure a clean output. I would have liked to use variable capacitors for C30, C31, and C32, but I wanted to keep the circuit as simple as possible and I knew that good variables for these capacitors can be hard to obtain. It may be difficult to find a 940-pF capacitor for C31. The pc board is laid out to accept two capacitors in this position. Use any parallel combination to get 940 pF.

IC3 is a 555 used as a side-tone monitor. You can adjust the pitch of the side tone by changing R12. A lower value increases the pitch. Adjust side-tone volume by changing R15.

Capacitor C29 couples energy from the antenna into L1 for the receiver. Diodes D1 and D2 protect the front end of the receiver during transmit. If you're going to build just the receiver, place a jumper (J2) on the board to couple the antenna into L1. You won't use the double pi network unless you're also building the transmitter section. Omit J2 if you're building the complete transceiver.

Transistor Q2 keys the power to transistors Q5, Q6,
and Q7. Resistor R16 and capacitor C24 provide output wave shaping. You may increase capacitor C24 to provide a “softer” output waveform.

Construction

I recommend using the PC layout in figs. 5 and 6. There’s a lot of gain in this receiver and the transmitter has enough of its own.

Fifteen turns of wire on a toroid core sounds simple enough, but don’t believe you can’t tweak a toroid coil. Spreading out or compressing the turns can change the inductance about 10 percent. If you have a grid-dip meter, you must couple into a toroid with a single-turn link. Don’t expect to make any reasonable measurements just by placing the dip meter near a toroid. Remember that turns on a toroid are counted by the number of turns on the inside of the core, not the outside.

Mount the variable capacitor (C18) firmly. Hand
"You're miles ahead with Larsen."

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

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

"That's why he turned to Larsen Antennas."

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

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

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

Rick Woodsome
EIMAC Tubes Provide Superior Reliability at radio station KWAV — over 131,000 hours of service!

Ken Warren, Chief Engineer at KWAV reports that their 10 kW FM transmitter went on the air in November, 1972, equipped with EIMAC power tubes. The original tubes are still in operation after over 15 years of continuous duty!

Ken says, “In spite of terrible power line regulation, we’ve had no problems with EIMAC tubes. In fact, in the last two years, our standby transmitter has operated less than two hours!”

Transmitter downtime means less revenue. EIMAC tube reliability gives you more of what you need and less of what you don’t want. More operating time and less downtime!

EIMAC backs their proven tube reliability with the longest and best warranty program in the business. Up to 10,000 hours for selected types.

Quality is a top priority at EIMAC, where our 50-year charter is to produce long-life products. And our products are backed by the most comprehensive and longest warranty offered in the industry. Send for our free Extended Warranty Brochure which covers this program in detail: Write to:

Varian EIMAC
301 Industrial Way
San Carlos, CA 94070
Telephone: (415) 592-1221

EIMAC®
COMPUTERIZE YOUR SHACK

YAESU 747, 757GX, 757GXI, 767, 9600.
KENWOOD TS 140, 440, 940, 860, 8500.
ICOM R71A, R7000, 735, 751A, 761, 781, AND ALL VHF, UHF, CI-V.
DRIVERS FOR RADIOS ARE MODULAR.
JRC NRD 525.

COMPLETE PROGRAM ENVIRONMENT.
MENU DRIVEN AND DESIGNED FOR EASE OF USE.
SCAN FUNCTION ADDED TO RADIOS THAT DO NOT SUPPORT IT.
ERGONOMICALLY DESIGNED FOR EASE OF OPERATION.
PROGRAM COLOR CODED FOR EASE OF USE, ALTHOUGH WILL STILL
RUN IN A MONOCHROME SYSTEM.

MENUS FOR THE FOLLOWING:
AMATEUR HF — AMATEUR VHF — AMATEUR UHF.
AM BROADCAST — FM BROADCAST — TELEVISION BROADCAST.
SHORT WAVE BROADCAST.
AVIATION HF (SSB) — AVIATION VHF — AVIATION UHF.
HIHG SEAS MARINE — VHF MARINE.
MISCELLANEOUS HF, VHF, UHF.
MOST POPULAR FREQUENCIES ALREADY STORED.
ADDITIONAL LIBRARIES AVAILABLE.
COMPLETE LOGGING FACILITY.
ALL FREQUENCY FILES MAY BE ADDED TO, EDITED OR DELETED.

PROGRAM WITH INITIAL LIBRARIES:
RS-232 TO TTL INTERFACE ONLY (NEEDED IF DON'T HAVE MANUFACTURERS INTERFACE).
INTERNAL PC INTERFACE ALLOWS 4 RADIOS
99.95
SPECTRUM ANALYZER MODULE (CALL FOR PRICE)
INTERNAL PC INTERFACE W/I SERIAL & 1 RADIO PORT
125.95

PROGRAM WITHOUT INITIAL LIBRARIES:
SPECTRUM ANALYZER MODULE (CALL FOR PRICE)

COMPLETE SYSTEMS INCL. RADIO, INTERFACE, COMPUTER, AVAILABLE.

DATACOM, INT.
8081 W. 21ST LANE
HIALEAH, FL 33016
AREA CODE (305) 822-6028

EXCITING OPPORTUNITIES AT cushcraft CORPORATION
IN-HOUSE SALES
Cushcraft, Amateur Radio's innovative antenna manufacturer, is looking for a qualified person for their in-house sales office. Working knowledge of communications and Amateur Radio are required. Good verbal skills and a proven sales track record with two to four years experience a must.

LAB TECHNICIANS
Cushcraft is also expanding its Product Development Lab. Experienced technicians are needed. Applicants should have a working knowledge of RF. A degree is not required if the applicant has equivalent experience. Electro Mechanical experience would be helpful.

Send your resume to:
Cushcraft CORPORATION
48 Perimeter Road
Manchester, NH 03108

The completed unit. Antenna and key connectors are on the rear panel.

capacitance can be a problem before it's put in a metal case. Also make sure that the rotor is the terminal used for ground. See photos A and B for internal details. Photo C shows the completed unit.

Don't expect reasonable performance without a reasonable antenna. Although I've been known to throw a piece of wire on the family room floor and attempt to listen to the receiver, it doesn't work very well. A good ground helps.

I mounted some resistors in a vertical position on the pc board to save room. In these cases, one of the pads will be square. Mount the body side of the resistor to the square pad.

Modifications
You can make the basic transceiver work on almost any band; however, operation above 20 meters might be difficult due to the stability of the oscillator.

An audio filter would make a nice addition. It should be easy to add one in series with the volume control, because wires are brought out from the board at this point.

Stability
Before I address the topic of stability, I'd like to recommend that you don't attempt to build any transmitter if you don't have a scope (or better yet, a spectrum analyzer) or access to one. Tracking down stability problems without one is simply too frustrating. A local ham club certainly should be able to help. I know that many people will think that a properly designed transmitter should be no problem, and if we all used 50-ohm load resistors instead of antennas, that would be true. The difficulty is that it's impossible to design an efficient transmitter that will work with any given load.

My basic philosophy about stability is that I would rather put a clean 1/2-watt signal into an antenna than a dirty 10-watt one. Even if the "spurs" are 30 dB down,
I'm not satisfied. Spurs should be down a minimum of 50 dB.

I did have some stability problems. When I fired up the transmitter, it was into a very good 50-ohm load. The output was about 3/4 watt (17 volts p-p), and it was very clean across the entire tuning range. Then came the antenna test — or rather the antenna disaster. I'll be the first to admit that this antenna leaves a lot to be desired. I've moved recently, and haven't had time to do a proper job of planting the antenna farm. The antenna in question is a simple half-wave dipole about 10 feet off the ground at one end and 20 feet at the other. It resonates somewhere. Anyway, the output was fine at some frequencies. At others there was some 7 MHz energy left, but not much.

The solution wasn't simple. First of all, it seemed that transformer T1 was ringing like mad. Lowering the value of resistor R28 and adding R27 calmed it down. The input of the output transistor (2N3866) I used looks very capacitive at 7 MHz. R28 prevents this capacitance from resonating with the secondary of T1. This cleaned up 90 percent of the problem. Next I "empirically derived" (played with) the turns ratio of T1. This helped a little. I reduced the "Q" of T1 using R27; this helped a little more.

I also found out that I didn't have enough drive, so I went back to the proverbial drawing board and added stage Q4. One tip — if you're not getting at least 600 to 800 mV p-p at the emitter of Q3, play with the ratios of C13 and C14. I tried making C13 as small as possible, but I didn't get enough drive for Q3 until I increased C13 to 100 pF.

Stubborn cases may require a resistor in parallel with RFC1; a thousand ohms should do it. And don't forget the ferrite beads on the collector and base of Q7 and the other transistors.

Table 1 gives typical voltages for troubleshooting purposes.

**Bibliography**

1. Signetics Linear Data Manual Volume 1 — Communications, Signetics Corp.
2. Robert J. Zavrel, Jr., W7SX, "Designing with the NE5602," Signetics Application Note AN198, Signetics Corp.
9. Motorola RF Device Data — DL110 Rev. 1, Motorola, Inc.

**TABLE 1**

<table>
<thead>
<tr>
<th>Antenna Output</th>
<th>AC (p-p)</th>
<th>DC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector of Q3</td>
<td>700 mV</td>
<td>1.9 volts</td>
</tr>
<tr>
<td>Collector of Q4</td>
<td>1.1 volts</td>
<td>6.8 volts</td>
</tr>
<tr>
<td>Emitter of Q5</td>
<td>1.6 volts</td>
<td>2.1 volts</td>
</tr>
<tr>
<td>Collector of Q7</td>
<td>2.9 volts</td>
<td>0 volts</td>
</tr>
<tr>
<td>Base of Q7</td>
<td>18 volts</td>
<td>12 volts</td>
</tr>
<tr>
<td>Antenna Output (50-ohm load)</td>
<td>18 volts</td>
<td>0 volts</td>
</tr>
</tbody>
</table>

The following voltages (p-p and DC) are given as an aid in troubleshooting any problems you might have. All of the signals are 7 MHz sine waves. Data was taken with a 12-volt power supply and the unit was in the transmit mode with a 50-ohm load.

**THE MULTIPLE RECEIVER SOLUTION**

4 Channel Signal-to-Noise Voter
- Expandable to 32 Channel by Just Adding Cards
- Continuous Voting
- LED Indicators of ON and Voted Signal
- Built-in Calibrator
- Remote Voted Indicators Printed Out
- 4 x 6 Double-sided Gold Plated 44 Pin Card
- Remote Bistable Inputs
- MORE

Built, tested and calibrated with manual $350.00

Telephone interface now available
For more information call or write:

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

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

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

IF YOU BUY, SELL OR COLLECT OLD RADIOS, YOU NEED...

ANTIQUE RADIO CLASSIFIED

Antique Radio's Largest-Circulation Monthly Magazine
FREE SAMPLE COPY!
Classifieds - Ads for Parts & Services
Articles - Auction Prices-Fla Market Info.
Also: Early TV, Ham Equip., Books, Telegraph,
Art Deco, 40's & 50's Radios & more...
Free 20-word ad each month. Don't miss out!
6-Month Trial - $11.
1-Year: $19 ($28 by 1st Class)
Foreign by air - Canada $30; Mexico: $29; Other: $55.
A.R.C., P.O. Box 2-A4, Carlisle, MA 01741
THE WEEKENDER

Build this simple L-C checker

This simple capacitance-inductance checker measures capacitance to approximately 1000 pF and inductance to 50 μH. I first saw it described in QST some 36 years ago. That version used a filament-type tube (3A51 in a self-rectifying oscillator powered from 115 volts AC. I built one in a cigar box lined with metal foil. It’s seen constant use in my shack with the original tube!

The initial L-C checker measured capacitance only. I modified it to add inductance measuring capability when I transistorized the unit.

The capacitance circuit measures to 5000 pF or more; however, accuracy and resolution are reduced above 1000 pF because of circuit limitations. But, when you pick a mica capacitor marked with two red dots from your junkbox, this unit will quickly tell you if it’s 2.2, 22, or 220 pF. The device has the advantage of applying no voltage or current (other than a few millivolts of RF) to the capacitance or inductance under test.

How it works

The circuit is based on the “grid-dip” or absorption effect, which occurs when a parallel resonant circuit is coupled to an oscillator of the same frequency. If you look at fig. 1, you’ll see that Q1 operates in a conventional Colpitts oscillator circuit at a fixed frequency of approximately 4 MHz. The exact frequency isn’t critical. A meter connected in series with the transistor’s base-bias resistor serves as the “dip” or absorption indicator.

The variable measuring circuit consists of C1, C2, and L2 and is connected to panel terminals as shown. L2 is loosely coupled to L1 in the oscillator circuit. This measuring circuit is tuned to the oscillator frequency with variable capacitor C2 set at full (or maximum) capacitance. When power is applied to the oscillator the meter shows a dip caused by power absorption by the measuring circuit.

Connecting an unknown capacitor across the test terminals lowers the resonant frequency of the measuring circuit. To restore resonance, tune capacitor C2 lower in capacitance. The meter will dip again when you reach this point. Determine the capacitance across the test terminals by calibrating the dial settings of C2. More on this later.

Capacitor C4, a small variable trimmer in the oscillator circuit, compensates for drift or other variations and is normally set at half capacitance. It’s a panel control, labeled “ZERO”, and is used to set the oscillator exactly at the dip point when C2 is set at maximum capacitance. This corresponds to zero on the calibration scale.

You can also use C4 to compensate for the capacitance inherent in long leads running from the test terminals to the unknown capacitor. The leads are connected to the test terminals and dressed close to the capacitance to be measured, but not connected to it. Adjust C4 for a dip with C2 at zero. Then connect the leads and make your measurement.

By Jack Najork, W5FG, 723 Flamingo Way, Duncanville, Texas 75116
Measuring inductance

After I got the transistorized version working, it occurred to me that I should be able to use the circuit to measure inductance as well. Figure 2 shows how. The oscillator circuit remains unchanged. Add an SPDT switch (S2) to the measuring circuit. With S2 in the "C", or capacitance measuring position, the circuit is as before. In the "L", or inductance measuring position, the switch disconnects the bottom of L2 from ground and connects it to a third panel terminal marked "L".

Connecting an unknown inductance across the "L" and "G" terminals again lowers the resonant frequency of the measuring circuit because the unknown inductance is now in series with L2. You must tune C2 lower in capacitance again to restore resonance. As with capacitance measurements, the best resolution occurs at the lower inductance values.

To measure inductance, set S2 to "C" and adjust the oscillator (ZERO) control for a dip with C2 at zero. Set the switch to "L" and connect the unknown inductance across the "L" and "G" terminals.

Construction notes

You’ll need solid construction for consistent calibration accuracy. Use the VFO construction techniques from any handbook. Choose a good-sized, sturdy metal cabinet so that you can use a large dial or pointer for the measuring capacitor, C2. I glued a 2-inch pointer to my dial and spread the calibration marks across the largest dimension of the cigar box.

The spacing (electrical coupling) between L1 and L2 isn’t critical, though it can be adjusted if necessary. Wider spacing produces a shallower dip, but improves the measuring resolution. Conversely, closer spacing (coupling) produces a more pronounced dip, which lowers resolution.

Make the wiring from the bottom of L2 to switch S2, and from S2 to the panel terminal "L", short and low inductance. Use heavy wire or copper ribbon, because these connections form a portion of the unknown inductance placed across terminals "L" and "G". Too much inductance in these connections produces erroneous inductance readings when measuring very small inductances.

Calibration

Calibrate the capacitance range by placing known values of capacitance across the "C" and "G" terminals and marking these values on the C2 dial or pointer. Most of us have enough well-marked mica and ceramic capacitors in our junkbox to make this easy. Don’t forget, you can also use these capacitors in parallel or series, as needed.

Inductance scale calibration is a bit tougher. You might want to beg, borrow, or otherwise obtain a collection of small, molded RF chokes. I had a half dozen 10-µH chokes and used them in series and parallel to calibrate. This method may not result in laboratory-type accuracy, but it’ll bring you right into the ballpark. Figure 3 shows my unit’s calibration.

Typical range scale calibration made with C2 and 50 pF. Hammarlund HF 50 with semi-circular plates. Capacitors with a different plate shape will yield a different calibration.

Using other parts

You engineering types will by now have observed that juggling the values of C1 and C2 alters the range and linearity of the measuring range. For example, increasing C1 expands the calibration at the low picofarad end but limits the upper capacitance measurement. If L2 is an adjustable coil, as shown, select C1 and C2 for the desired results, retuning L2 as needed to restore resonance.

If your junkbox dictates, use a larger value capacitor for C2. This requires increasing the value of C1. One possible combination is 150 pF for C2 and 130 pF for C1, with L2 reduced to approximately 10 µH. To limit the inductance measuring range with this com-
bination it's necessary to add a small fixed capacitor in parallel with C2. Try 10 to 15 pF.

If the required microammeter isn't available, take heart. Since the unit draws around 3 mA at 9 volts, you can use a zero to 5 mA meter in series with the + lead to the power source. Resonance will now be indicated by a rise in the meter reading instead of a dip. The variation between dip and non-dip won't be as pronounced as with a base current meter, but it will be usable.

If 3/8-inch diameter coils aren't available you can use 1/4-inch forms. Scrounge them from the i-f section of a defunct TV set. You'll need more turns, and the "Q" will be a bit lower, but they'll work. Conversely, for those who want improved resolution, substituting larger diameter coils wound with heavier wire will increase "Q". This enables looser coupling which in turn produces a sharper dip.

References
1. QST, March 1952. Article B

ICM
International Crystal Manufacturing Co., Inc.
P.O. Box 26330, 701 W. Sheridan
Oklahoma City, OK 73126-0330
Phone (405) 236-3741
Telex 747-147
Facsimile (405) 236-1904
December 1988
New Zealand, Maui, and the Solar Cycle

My visit to New Zealand was wonderful! I attended and spoke at the NZART (New Zealand Association of Radio Transmitters) Convention at Whakatane. Then I took a leisurely trip around the North Island, visiting such notables as ZL1AAS, ZL1BRQ, ZL1SZ, ZL2JQ, and ZL2AM. The combination of hospitality and beautiful countryside was overwhelming. I had the privilege of operating with my reciprocal call, ZL0SAI. It’s interesting to hear what a pile-up on 20-meter SSB sounds like from the DX end. After a quick call, the S meter on the KWM-2 went over against the pin and stayed there! Beaming north-east across the United States and into Europe, it was interesting to note that the European signals were almost as loud as the W6s. Ear-splitting signals were also noted from “locals” like UJ8, UD6, 9N1, and 4S7.

I saw more homemade tilt-over towers in New Zealand than I’d ever seen in California. The crank-up tower doesn’t seem to be very popular; many DXers favor the tilt-over type. Most of them use a 20-foot high base structure and a tilt-over top section, ranging from 18 to 25 feet long. Some monster tilt-over towers, like the one at ZL1AAS, are nearly 80 feet high. All of them are counterbalanced so that little effort is required to raise or lower the top section.

Do any of you have a homemade tilt-over tower? If so, I’d like to hear about it; send pictures and drawings, if possible.

The mild climate, beautiful scenery, and friendly people make New Zealand a perfect place to visit. On your way there, stop in Tahiti or Fiji for a touch of the exotic. Truly, New Zealand is a little corner of paradise! Thanks to all who made the visit so pleasant for me.

Next stop Maui

After New Zealand, I stopped at Maui, Hawaii and visited Steve, KH6SB, who runs the island’s NOAA Ionospheric Observatory. Here, talk turned to DX and the sunspot cycle. Steve showed me readings and graphs taken from recent ionospheric sounding measurements. I remembered various statements in DX newsletters predicting that the peak of cycle 22 might be greater than any previously experienced, and that it could be reached as soon as December 1988 — right about now. I queried Steve about this. His data indicated that the International Smoothed Sunspot Number (taken as gospel by many Amateurs) showed a cycle quite different from the Geomagnetic A Index, the Ottawa Radio Flux (10 cm), or the ionospheric measurements of the maximum frequency of F2 reflection measured at Maui. (See fig. 1.) According to Steve, a lot depends upon which cycle you’re talking about.

The Maui vertical sounding of the F2 layer showed a minimum value centered about April/May, 1986. The smoothed sunspot numbers indicated a minimum falling during September 1986 for old cycle 21. The Geomagnetic Index indicated a minimum near January 1987, and the Ottawa Radio Flux had a broad minimum covering April 1985 to October 1986.

So where do we go from here? When will the present ionospheric cycle peak out? QST’s “How’s DX” column indicates a peak at the end of 1988. Steve showed me a graph of the median values of the maximum reflecting frequency of the F2 layer, as measured at his station (fig. 2). He pointed out that the slope of the present increase is just about the same as that of the last cycle. Steve thinks that the peak of the present cycle may arrive around the fall of 1990, and that it will be very similar to the last.

Time will tell. Meanwhile, enjoy 10-meter DX and don’t overlook the amazing things that are happening on the 6 and 2-meter bands.

RFI from cordless phones?

The June issue of Modern Electronics has an article by C. Hall describing TVI from a neighbor’s cordless telephone. The phone transmitted
Comparison of cycles of ionospheric sounder (Maui) with A-index, sunspot number, and radio flux over the period July 1986 to April 1988 shows that the individual cycles have quite different minimums.

Median values for the month of May for the ionospheric readings at Maui, Hawaii in terms of maximum vertical reflected frequency ($F_0F_2$) of the $F_2$ layer. Note that the rising slope of cycle 21 and cycle 22 is approximately the same. The best estimate is that the present cycle will peak out in the fall of 1990.

FM signals on a frequency in the range of 46.61 to 46.97 MHz (base) and 49.67 to 49.99 (handset). These frequencies were perilously close to various TV pictures i-f amplifier circuits that operate at 45.75 MHz.

A high-pass filter on the TV set did no good; the cutoff frequency of the filter was higher than the telephone band. The solution was to cut a linear trap made from 300-ohm ribbon line and place it across the receiver antenna terminals in parallel with the existing transmission line (fig. 3). The trap was cut to a length of 50.25 inches to tune it to the center of the cordless phone band. (This length takes into account the velocity of the propagation factor of the line.) Hall said this eliminated the herringbone lines on the TV screen caused by the cordless telephone.

**A compact wire antenna for 7 and 21 MHz**

It’s hard to be loud on a city lot, and erecting a 66-foot long, 40-meter dipole can be a challenge in some locations. Figure 4 shows a compact, space-saving antenna designed by V. C. Lear, G3TKN. It’s been discussed in RSGB’s Radio Communication and other European magazines. As far as I know, it hasn’t been publicized on this side of the pond. In brief, it’s a 40-meter dipole shortened to about 54 feet by folding the center portion of the radiator up into a two-wire transmission line. The lengths of the top section are chosen to provide two 5/8-wavelength sections in phase on 21 MHz.

The antenna supplies the usual figure eight pattern on 40 meters, and a somewhat narrower figure eight on 21 MHz. Best of all, there’s about a 3-dB gain over an equivalent dipole on 21 MHz.

The folded, two-wire stub has a spacing of 6 inches and is made of no. 16 wire. The end of the stub is matched to a coax line by way of a 1:1 balun, like the Bencher ZA-1A.

The two-wire line is spaced with 3/8-inch diameter spreaders cut from Lucite®, Plexiglas®, or other insulating rod material. Holes are drilled at the outer ends to pass the wires, which are held in position by twisting short pieces of no. 22 wire around the spreader and the antenna wire. The spreaders are spaced about 18 inches.

An easy way to make the line is to stretch two 10-foot lengths of wire...
This particular design (attributed to Willi Richartz, HB9ADQ) is popular with many European stations. It's a loop configured so that the point of maximum current falls in the center of the top wire on the 7, 14, 21, and 28-MHz bands. If the open-wire feedline is cut to length as indicated, the loop may be fed on these bands with a 4:1 balun; no auxiliary tuner is required. A 20-pF capacitor is placed across the antenna feedpoints at the balun. It can be a ceramic or mica unit, or made up of a short length of 300-ohm line trimmed on a capacitance meter.

If you want to operate on 18 or 24 MHz, the antenna must be fed from a balanced tuner at the point where the balun would be attached. The radiation pattern is a figure eight, at right angles to the plane of the loop. On 20 meters and the higher frequency bands, the loop provides a small gain over a dipole. For best operation, the top wire of the loop should be about 30 feet above ground.

More 88-mH inductors!

I just received a note from Ed Wetherhold, W3NQN (102 Archwood Avenue, Annapolis, Maryland 21401), telling me he has a quantity of 88-mH inductors suitable for use in audio filters and networks. If you're interested, send an SASE to Ed at the above address for more information.

Alternator or generator noise

A growing number of Amateurs are operating HF mobile after a lull in this activity for many years. There's still a problem with automobile electrical system noise, and some mobile operators are troubled by alternator or generator noise during reception.

In general, most alternator/generator noise or "whine" can be reduced (but not necessarily eliminated) by placing a 0.5-μF coaxial capacitor on the output, or armature lead. Bypassing the field lead is, however, another matter. "Conventional wisdom" warns not to bypass this lead, or you may harm the voltage regulator unit.

Don Sutherland, ZL2AJL, takes exception to conventional wisdom in this case. He says the field wire may be bypassed to ground to eliminate noise, if the proper precautions are taken (fig. 6). A 300-μH ferrite-core RF choke capable of carrying the field cur-
rent is placed in the lead, and the generator/alternator field wire is bypassed at the case of the unit. He says you'll have no difficulty with contact erosion in mechanical regulators, even with the relatively large value of bypass capacitor on the field lead, provided that you include the RF choke between the capacitor and the regulator. He notes that a British firm, Joseph Lucas (makers of automotive electrical equipment), has recommended this suppression technique for many years. Don says he developed the technique independently, with no knowledge of Lucas' prior work in that field.

The "Dead Band" Contest

Amazing, my dear Watson! More and more faithful readers of this column have correctly identified the quotation from the Sherlock Holmes story, "A Study in Scarlet." The sleuths include: Gerry Skloot, KE2N; Howard Tooker, W3TL; Ben Richardson, WB1CUA; Louis Axeman, Jr., N8LA; Dan Deckert, WA6FQC; Mike Mahoney, WA1KNO; and Chris Kirk, KA1RSV.

Since you're all such a smart bunch, Ed Wetherhold, W3NQN, offers this quiz: name the book, author, and the person to whom this quote is directed — "Call me Ishmael." Good luck!

Article C

HAM RADIO

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

New Mod Kit for Bird Model 43 Wattmeter

MEASURES PEAK POWER OF SSB AND OTHER AM SIGNALS

Bird Model 4300-400 modification kit quickly adapts any Bird Model 43 Wattmeter to measure audio peak power of single sideband and other AM modulated signals.

The 4300-400 kit pc board mounts inside the Model 43 housing, on the meter studs. Estimated conversion time is only 15 minutes from start to finish.

Once modified, you can measure peak power to an 8% F.S. accuracy, without affecting cw operation or accuracy.

And, the Model 4300-400 is surprisingly inexpensive.

Contact your Bird distributor or factory for details.

Bird Electronic Corporation
3030 Aurora Rd., Cleveland (Solon), Ohio 44139—2794
WESTERN REGION OFFICE

Bird Electronic Corp
621 Oka Ave., Suite F, P.O. Box 28, Oka, CA 93023 805-646-7255

The HF4B "Butterfly"™

A Compact Beam
for 20-15-12-10 Meters

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 inex
• 26 ft. tall

Model HF2V

• Designed for the low band DXer
• Automatic bandswitching on 80 and 40 meters
• Add on units for 160 and 130 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

December 1988
Two in one: trace doubler for CRO, and square wave and pulse generator

My circuit (using one quad two-input NAND gate 4011 and one dual op amp LM358) is a simple, low cost, and easy-to-operate trace doubler for CROs. Other uses include: electronic switching, supplying blanking pulses for the z-axis of CROs, keying and synchronizing slave-type multivibrators and trigger circuits, adjusting the component values of CRO probes, and quick checking the frequency responses of amplifiers.

Circuit and working principle

The trace-doubler circuit is shown in fig. 1. IC1a, IC1b, and IC1c are connected as an astable multivibrator; IC1d is connected as an inverter. Terminals 3 and 11 of the 4011 give square waves with opposite phases. The square waves (eP) at the output of IC1a, passing through differentiator C4R13, then form positive and negative pulses (e). The dual op amps of the LM358 are used as two gated amplifiers for the two signals e1 and e2 and fed through terminals 2 and 6, to be displayed simultaneously on the CRO screen.

The two opposite-phase square waves eP and eP are used to gate IC2a and IC2b at terminals 3 and 5 of the LM358, respectively. Resistances R9 and R10 are preadjusted so that one op amp is driven to saturation while the other works normally as an amplifier. Thus they will amplify the two signals e1 and e2 alternately, and two separate traces will be displayed on the screen. Resistance R12 can be varied to adjust

 partes list

<table>
<thead>
<tr>
<th>Parts List (fig. 1)</th>
<th>R3 20k</th>
<th>R4 20k</th>
<th>R5 200k</th>
<th>R6 200k</th>
<th>R7 50k</th>
<th>R8 50k</th>
<th>R9 50k pot</th>
<th>R10 50k pot</th>
<th>R11 100 ohm</th>
<th>R12 300 ohm pot</th>
<th>R13 50k pot</th>
<th>Vcc 6 volts</th>
</tr>
</thead>
<tbody>
<tr>
<td>IC1 4011</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IC2 LM358</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1 0.001 μF</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C2 25 μF</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C3 25 μF</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C4 0.001 μF</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R1 500-ohm + 50 k pot</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R2 500 ohm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(A) Probe adjusting circuit for CRO. (B) Displayed square waves on CRO screen.
the vertical separation of the two traces.

Select a suitable value of $C_1$ with switch $S$ and adjust the pot of $R_1$. The frequency of square waves can be varied from $1 \text{ cps}$ to $10^6 \text{ cps}$. This process is necessary for stabilizing the waveforms displayed on the screen.

A common supply of 6 volts is used in the circuit.

Practical examples
1. Figure 2 shows the oscillograms of the displayed input signals $e_1$ (sine wave) and $e_2$ (square wave).
2. Figure 3A is the probe adjusting circuit for CRO; fig. 3B shows the oscillograms of the displayed square waves of $e_p$ at three different values of $R_{pC}$. $R_1$ is the input resistance of the CRO and $C_1$ is the input capacitance.

By Tseng C. Liao, Peking, China

Calibrating series-resistance capacitance bridges

Bridges like the series-resistance capacitance type shown in fig. 1 are easy to build and operate. But there seems to be some confusion about how to calibrate $C_1$ to indicate the correct load reactance. This confusion seems to result from the fact that there is a fixed capacitor $C_2$ in the load branch, and the signs in the formula used to determine the load reactance are opposite to those you'd expect.

On the series-resistance capacitance bridge, $C_2$ is necessary because it permits nulling the bridge (zero load reactance) with $C_1$ set to the mid-position — namely, $C_1 = C_2 = 70 \text{ pF}$. A capacitively reactive ($-X_2$) load allows nulling the bridge by reducing the capacitance of $C_1$; an inductively reactive ($+X_2$) load requires that $C_1$ be increased in value to do so. The equivalent series reactance ($\pm X_2$) of the unknown load impedance ($Z_L$) is the difference in the setting of $C_1$ between the initial balance when $X = 0$ ($C_1 = 70 \text{ pF}$) and the load reactance, or

$$X_X = \frac{1}{2\pi F} \frac{1}{C_1'} - \frac{1}{C_1''}$$

where $C_1'$ is the first reading of $C_1 = 70 \text{ pF}$ $C_1''$ is the second reading of $C_1$ with the load

$F$ is the test frequency.

A + sign indicates that $X_X$ is capacitive, while a - sign corresponds to an inductive $X_X$. This appears to be a contradiction, but remember that $C_1$ is in the opposite branch of the bridge. To obtain the proper sign for the load reactance, simply reverse the sign in the answer.

A reactance plot of the capacitance of $C_1$ is shown in fig. 2 using eqn. 1 and a frequency of 1 MHz. To obtain the reactance at higher frequencies, divide the reactance for 1 MHz by the test frequency. The reactance plot is calibrated in capacitance in several steps from $-70 \text{ pF}$ through 0 pF to $+70 \text{ pF}$, as shown.

In the event that $C_1$ is some value other than $140 \text{ pF}$, $C_2$ must be one-half that of $C_1$. A smaller variable capacitor will limit the useful reactance range of the bridge; a larger variable capacitor will reduce the accuracy of the bridge. The calibration procedure remains the same.

By Wilfred N. Caron, Ridgecrest, California 93555 Article D

SHORT CIRCUIT HOTLINE

Building a current ham radio project? Call the Short Circuit Hotline any time between 9 AM and Noon, or 1 to 3 PM — Eastern time — before you begin construction. We'll let you know of any changes or corrections that should be made to the article describing your project. (See "Publisher's Log," April, 1984, page 6, for details.)

603-878-1441

December 1988 27
HITACHI SCOPES AT DISCOUNT PRICES

V-212
$379
List $560
Save $181

20MHz Dual Trace Oscilloscope
All Hitachi scopes include probes, schematics and Hitachi's 3 year guarantee on parts and labor. Many accessories available for all scopes.

V-425
$835
List $995

DC to 40MHz
Dual Channel
CRT Readout
Cursor Menu
DC Offset
Alt Magnifier
Compact Size

Digital Capacitance Meter
CM-1550
$86.95
9 Ranges
10pF-20.000uf
5% basic accy
Zero control with case

V-1060
$1,285
List $1,595

DC to 100MHz
Dual Channel
Delayed Sweep
CRT Readout
Sweep Time
Autoranging
Trigger Lock
2mV Sensitivity

ELenco PRODUCTS AT DISCOUNT PRICES

20MHz Dual Trace Oscilloscope
NEW! Autoranging DMM
M-5000
$45
9 Functions
Memory and Data hold
ल% basic accy
3½ digit LCD

M-7000
$135
True RMS 4½
Digit Multimeter

35MHz Dual Trace Oscilloscope
NEW! AC Clamp-On
Current Adapter
ST-285
$22
0-1000A AC
Works with most DMM

NEW! Bench DMMS
M-3500
$125
3½ digit
1% accy

M-4500
$175
4½ digit
0.5% accy

NEW! Wide Band Signal Generators
SG-9000
$119
RF Freq 100K-450MHz
AM Modulation of 1KHz
Variable RF output

SG-9500 with Digital Display
and 150MHz built-in Freq Ctr $249

Digital Triple Power Supply
XP-765
$249
0-20V at 1A
0-20V at 1A
5V at 5A

Quad Power Supply
XP-580
$59.95
2-20V at 2A
12V at 1A
5V at 3A
5V at 5A

XP-575 without meters $44.95

“GREAT IDEA” FUNCTION BLOX FOR EASY BREADBOARDING
All blox interlock to make your design work a snap. You can change the configuration

WE WILL NOT BE UNDERSOLD!
UPs Shipping: US 5% ($10 Max) IL Res., 7% Tax

C & S SALES INC.
1245 Rosewood, Deerfield, IL 60015
(800) 292-7711 (312) 541-0710

15 Day Money Back Guarantee
2 Year Warranty
WRITE FOR FREE CATALOG

9550 7.50
550 tie pts

9600
28.95
FUNCTION GENERATOR
1 to 1MHz sine, sq wave

9610 RESISTOR DECABLO
20 resistors 47-1M ohm

9620 CAPACITOR DECABLO
20 capacitors 47p-10uF

9630 DIGITAL CLOCK BLOX
pulses from 1Hz to 50MHz

9640 LOGIC PROBE BLOX
4 logic level ind.

9650 POWER BLOX
5V at 1A 5 at 4A
12V at 3A

125
Try this simple analysis procedure

Over the past year or so, I've been working on a design procedure for developing structurally sound Yagi elements. I spent many hours with Bob Mitchell, N5RM, analyzing the structural integrity of his "Forty-Meter Flame Thrower" and developing the first steps of my procedure. After I completed my initial work, Gerald Williamson, K5GW, used the process to design the elements of two full-size 40-meter beams which are stacked on his rotating tower. He also used it to build his shortened-element 80-meter beam and is now designing a full-size 80-meter beam.

In late spring of 1987, I heard that Dick Fenwick, KSRR, had several identical Yagi elements break in high winds. I asked Dick to send me a sketch of the elements that failed, but not to tell me where they broke. After entering the data into my analysis program and letting it run, I found the element’s weakness. Dick confirmed the correctness of my "after the fact" prediction. The elements of his identical beams failed at the exact spot the program indicated. This procedure should help you evaluate the mechanical integrity of your existing designs or design a homebrew Yagi.

Failure modes

An element has failed if it breaks off or is bent enough to render it useless. There are several causes of in-service failures. The element could be covered with too much ice, the wind hitting the element may impose a load which causes it to fail, or the element may break off because of wind-induced vibration or fluttering. The first two causes have to do with direct loading of the element due to ice and wind; the third generally happens at very low wind speeds. My procedure deals only with the loading of the element, not with vibration-induced fatigue failures.

The environment and survivability

To determine survivability, give careful consideration to the Yagi’s environment. The main environmental problem is loading due to ice and wind. The weight of the ice loads the element and its thickness increases the element diameter. The increased diameter of the element results in a higher wind load.

You must make several choices when designing or evaluating an element. It’s necessary to determine or select the extreme ice and wind conditions the element will have to handle. Consider whether the element is expected to survive those conditions, or have an additional margin of safety. Some manufacturers state their
29th ANNUAL
TROPICAL HAMBOREE
A.R.R.L. FLORIDA STATE CONVENTION
FEBRUARY 4-5, 1989
TAMlAMl PARK
FAIR GROUNDS
10901 S.W. 24th Street (Coral Way), Miami, Florida
HOURS: 9 A.M.-5 P.M. SATURDAY • 9 A.M.-4 P.M. SUNDAY

FREE PARKING 15,000 VEHICLES • 1,000 INDOOR SWAP TABLES • 300 CAMPsites WITH FULL HOOKUPS • 900 COMMERCIAL EXHIBIT BOOTHS • LICENSE EXAMs

Registration: $5.00 Advance — $6.00 Door. Valid Both Days. (Advance deadline January 30th.)
Swap Tables, 2 Days: $16.00 each. Power: $10.00 per User.
All swap table holders must have registration ticket.
Campsites: $12.00 per Day • Includes Water, Power, Sanitary Hookups & Showers.
(All RV vehicles, tent campers, vans, trailers welcome — no ground tents, please.)
Headquarters Hotel: Miami Airport Hilton, 5101 Blue Lagoon Drive, $75.00 Single or Double
Alternate Hotel: Airport Lakes Holiday Inn, 1101 N.W. 57 Avenue, $50.00 Single or Double
Reservation forms available through Hamboree Chairman, December 1st
Make Checks for Registration, Swap Tables & Campsites Payable to: Dade Radio Club
Mail to: Evelyn D. Gauzens, W4WYR, Chairman, 2780 N.W. 3rd St., Miami, FL 33125

Exhibit Booth & Program Booklet Advertising:
Call Evelyn (305) 642-4139 (Home) — or — (305) 233-0000 (Office)
(BROCHURE WITH FULL DETAILS AVAILABLE DECEMBER 1st)
design will survive specific wind speeds. In a strict engineering sense, survivability means that if the stated conditions are exceeded, there will be a failure. If there is a margin of safety, failure will occur at conditions of higher severity. It’s wise to understand all aspects of the loads on an element, the materials used in its construction, and their safety factors. Without this, you could construct an element that costs and weighs more than it needs to survive its environment. This design might place unnecessarily higher loads on the tower and rotator.

**Element analysis**

You can mathematically construct two element models. I call them the Rigid Element Model (REM) and the Flexible Element Model (FEM). REM is an approximation of the more exact and complex FEM version. The REM model assumes the element doesn’t deflect when loaded with ice or wind. It also assumes that all parts of the element are perpendicular to the wind. FEM accounts for the deflections of the element at all points along its length. The actual element length exposed to the wind decreases as it deflects. Figure 1 shows the REM and FEM assumptions applied to an element. With FEM, the wind loading isn’t perpendicular to the element at all points. This decreases the loading on the element as compared to REM. The wind loading of the element is less severe with FEM, but more accurate.

While the FEM version gives a precise description of the actual conditions, modeling is complex and time consuming. REM is easier and faster. The errors introduced by the REM assumptions result in a design more conservative than one using FEM.

**General approach**

Begin your element analysis by selecting the wind and ice conditions it is to survive and calculating the loads these conditions will place on the element. The loads are related to the element’s size. You must know the relationship between the wind, ice, and tubing sizes used in the element to find the resulting loads. Once you’ve determined the loads, find the resulting stress by ascertaining the type of material used along with its geometric properties. Compare the stress to the maximum allowable value for the material used. If the resulting stress is lower than the maximum acceptable level, the design is conservative. If the stress is over the maximum acceptable level, the design won’t survive the wind and ice conditions.

You can identify weak spots when analyzing an existing design or compare it with the relative merit of others. If an existing design is weak, you may choose to reinforce it or purchase another. When planning an element, you can alter the design by using different sizes and lengths of tubing in the element makeup until you find an acceptable combination.

**Element loading**

There are three components to the loading of an element: the weight of any ice on the element section, the weight of the tubing making up the section, and the wind load on the section. They must be determined and summed to yield the total loading. The first step is to break the element into sections as shown in fig. 2. Then find the total load on each individual section.

Two types of ice can form on the element. The most common is solid ice; the least common is rime ice. My equations are based on solid ice weight. Solid ice weighs 56 pounds per cubic foot, rime ice about 30 pounds per cubic foot. Generally, ice accumulation
on round tubes is stated in terms of "radial thickness." For example, if a 1-inch diameter tube has 0.25 inch of radial ice, the effective diameter for the wind loading is 1.5 inches. The inch weight is determined by the volume of ice surrounding the tube as shown in fig. 3.

For solid ice, Wi can be found using eqn. 1.
\[ Wi = 0.102 \times L(D \times I + I^2) \]  
(1)

Wi = weight of ice on section (pounds)
I = radial ice thickness (inch)
L = section length (inch)
D = tube outer diameter (inch)

Wi = weight of ice on section (pounds)

To find the tubing weight in a section take one of two approaches. Either look up the weight of the tubing in a supplier's catalog or calculate it directly. The weight per foot is given on most tubing charts. Calculating the weight directly may be easiest because this method doesn't depend on having a catalog. Because most Yagi elements are made from aluminum tubing, use eqn. 2 to find the section weight. This ignores the weight of the tubing inside the overlap of two telescoped sections.
\[ Wa = 0.31 \times L(D \times T - T^2) \]  
(2)

Wa = weight of aluminum tubing section (pounds)
T = tubing wall thickness (inch)
L = section length (inch)
D = tube outer diameter (inch)

The last load on the element section is wind induced. When the wind strikes a surface, pressure is created by the impact of the air stream on the surface. The wind load depends mainly on the wind velocity and the shape of the impacted surface; some shapes are more or less streamlined than others. Use eqn. 3 to find the wind load on a round tubing section. The drag coefficient is included in the equation to account for the streamlined effect of a round tube, along with the conversion of units for wind pressure.
\[ Fw = 0.0047 \times L \times De \times P \]  
(3)

Fw = wind load on round section (pounds)
L = section length (inch)
P = wind pressure on flat surface (pounds/square foot)
De = effective outer diameter of tube (inch)

The effective diameter of the tube (De) accounts for an increase in diameter due to ice. If there's no ice, the tube's outer and effective diameter are the same.
\[ De = D + I + I \]  
(4)

De = effective outer diameter of tube (inch)
D = tube outer diameter (inch)
I = radial ice thickness (inch)

The total load on a section (Ft) is the sum of the ice weight, element weight, and wind load.
\[ Ft = Wi + Wa + Fw \]  
(5)

Ft = total load on section (pounds)
Wi = weight of ice on section (pounds)
Wa = weight of aluminum tubing section (pounds)
Fw = wind load on section (pounds)

You could argue that the two weights added together are at right angles to the wind load and shouldn't be added directly. There's no guarantee that this will be the case; upward and downward wind streams are a common occurrence.

Wind pressure

Calculate the wind pressure striking a flat surface with eqn. 6. This isn't the wind pressure on a round tube, but a flat surface. Equation 3 includes a "drag coefficient" to alter the wind pressure found in eqn. 6. Equation 6 also includes a gust factor of 1.30 to account for short duration gusts peaking above the mean speed of V. If you select a wind speed and use eqn. 6, you are actually calculating for a wind speed 1.30 times higher. For example, when you select a wind speed of 86.6 mph, you are actually accounting for a peak wind of 112.6 mph.
\[ V = wind speed (miles/hour) \]
\[ P = 0.004 \times V^2 \]  
(6)

P = wind pressure on flat surface with 1.30 gust factor (pounds/square foot)

V = wind speed (miles/hour)

If you don't want to use a gust factor, you can modify eqn. 6 to find the wind pressure at the exact wind speed entered. Removing the gust factor gives you eqn. 7.
\[ P = 0.0024 \times V^2 \]  
(7)

P = wind pressure on flat surface (pounds/square foot)

\[ V = wind speed (miles/hour) \]

What's the proper wind load an element should be expected to handle? You can make the selection in several ways. Research the history of wind speeds in your area. Go back about 20 to 50 years to see what the worst wind has been. Find out if the wind information should have the gust factor applied.

Consult local building codes covering towers and similar structures. EIA standard RS 222C contains information on the wind loading towers should be designed to handle, based on their geographical location. You can also consult the American Standard Building Code. Both EIA RS 222C and the American Standard Building Code include maps of the United States recommending design wind loads. There are small differences between the codes, but for Amateur applications they are basically the same.

According to RS 222C, most of the United States should expect a 50-year mean recurrence wind of 86.6 mph. Certain coastal areas have a 100 mph or higher recommendation. The wind speeds found in EIA RS 222C are mean wind speeds, and are to be used with eqn. 6. The most common wind speed is 86.6 mph; 100.0 and 112.0 mph are the extreme values. Table 1 shows wind pressures at various mean wind speeds and their corresponding peak value with a 1.30 gust factor.

Because the REM procedure errs on the conservative side, using a mean wind speed of 86.6 mph results in a conservative design for most areas and would be a rigid
Wind pressures at various mean wind speeds and their corresponding peak value with a 1.30 gust factor.

<table>
<thead>
<tr>
<th>Mean Wind Speed (mph)</th>
<th>Corresponding peak wind with 1.30 gust factor (mph)</th>
<th>Wind pressure (pounds/square foot)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20.0</td>
<td>26.0</td>
<td>1.6</td>
</tr>
<tr>
<td>30.0</td>
<td>39.0</td>
<td>3.6</td>
</tr>
<tr>
<td>40.0</td>
<td>52.0</td>
<td>6.4</td>
</tr>
<tr>
<td>50.0</td>
<td>65.0</td>
<td>10.0</td>
</tr>
<tr>
<td>60.0</td>
<td>78.0</td>
<td>14.4</td>
</tr>
<tr>
<td>70.0</td>
<td>91.0</td>
<td>19.6</td>
</tr>
<tr>
<td>80.0</td>
<td>104.0</td>
<td>25.6</td>
</tr>
<tr>
<td>86.6</td>
<td>113.0</td>
<td>30.0</td>
</tr>
<tr>
<td>100.0</td>
<td>130.0</td>
<td>40.0</td>
</tr>
<tr>
<td>112.0</td>
<td>145.6</td>
<td>50.0</td>
</tr>
<tr>
<td>115.0</td>
<td>149.5</td>
<td>52.9</td>
</tr>
<tr>
<td>125.0</td>
<td>162.5</td>
<td>62.5</td>
</tr>
</tbody>
</table>

Calculate the worst combinations of conditions in your area for winter and non-winter conditions to evaluate existing design. Numbers shown are for my QTH.

<table>
<thead>
<tr>
<th>Season</th>
<th>Radial ice</th>
<th>Mean wind</th>
<th>Peak wind</th>
<th>Pressure level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter</td>
<td>0.25 inch</td>
<td>40.0 mph</td>
<td>52 mph</td>
<td>6.4 pounds/square foot</td>
</tr>
<tr>
<td>Non-winter</td>
<td>0 inch</td>
<td>86.6 mph</td>
<td>113 mph</td>
<td>30 pounds/square foot</td>
</tr>
</tbody>
</table>

Dimensions for half of a 36-foot Yagi element with four sections as in fig. 2.

<table>
<thead>
<tr>
<th>Section</th>
<th>L (inch)</th>
<th>D (inch)</th>
<th>T (inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>48.0</td>
<td>0.500</td>
<td>0.058</td>
</tr>
<tr>
<td>2</td>
<td>60.0</td>
<td>0.625</td>
<td>0.058</td>
</tr>
<tr>
<td>3</td>
<td>72.0</td>
<td>0.750</td>
<td>0.058</td>
</tr>
<tr>
<td>4</td>
<td>36.0</td>
<td>0.875</td>
<td>0.058</td>
</tr>
</tbody>
</table>

Winter conditions

<table>
<thead>
<tr>
<th>Section</th>
<th>Wi (pounds)</th>
<th>Wa (pounds)</th>
<th>Fw (pounds)</th>
<th>Ft (pounds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.92</td>
<td>0.39</td>
<td>1.45</td>
<td>2.76</td>
</tr>
<tr>
<td>2</td>
<td>1.34</td>
<td>0.61</td>
<td>2.04</td>
<td>3.99</td>
</tr>
<tr>
<td>3</td>
<td>1.83</td>
<td>0.90</td>
<td>2.71</td>
<td>5.44</td>
</tr>
<tr>
<td>4</td>
<td>1.04</td>
<td>0.53</td>
<td>1.49</td>
<td>3.06</td>
</tr>
</tbody>
</table>

Non-winter conditions

<table>
<thead>
<tr>
<th>Section</th>
<th>Wi (pounds)</th>
<th>Wa (pounds)</th>
<th>Fw (pounds)</th>
<th>Ft (pounds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0.39</td>
<td>3.38</td>
<td>3.77</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>0.61</td>
<td>5.29</td>
<td>5.90</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>0.90</td>
<td>7.61</td>
<td>8.51</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>0.53</td>
<td>4.44</td>
<td>4.97</td>
</tr>
</tbody>
</table>

standard by which to evaluate existing designs. Judge
the expected amount of radial ice and, more importantly,
the combination of wind and ice for your own area and
make your evaluations based on these sets of condi-
tions. Here in northern Texas, our highest winds occur
in the spring and early summer. We often have ice
storms in the winter, but the winds are not very high. At
my location I use the two sets of conditions in table 2;
yours may be quite different.

Loading example

Table 3 gives the dimensions for half of a 36-foot Yagi
NYE Takes the fear out of full power antenna tuners, and the guesswork out of PEP measurement with these two MUST SEE PRODUCTS!!

MB-V-A

Discover this durably built, feature packed MB-V-A Antenna tuner. You'll find operating conveniences that make antenna tuning a snap and value engineered to do the job over wide operating ranges. Compare quality, features and the NYE VIKING TWO YEAR WARRANTY.

RFM-003

Get correct easy to read measurements of PEP for SSB, AM, and Pulse along with full time completely automatic SWR display with this unique Power Monitor System. Two models to choose from: The RFM-003 for 3KW indication and The RFM-005 for 5KW.

CHECK THE FEATURES:

- **Pi Network.** Low Pass Pi Network tuning 1.8-30 MHz. Heavy duty silver plated continuously variable inductor with 25-1 vernier dial. 7000 volt variable capacitor and 10,000v switch selected fixed capacitors on output side. Tunes 40-2000 ohms loads. Good Harmonic suppression!
- **Automatic SWR.** Hands free metering of SWR. No reset or calibration needed. Separate power meter—300 or 3000 w.f.s. automatically switched. Easy to read 2.5" recessed and back-lighted taut band meters.
- **Antenna Switch.** PUSH-BUTTON antenna switching to (4) antennas (2 coax single wire and twin lead). Coax bypassed on first coax output. We designed this switch to take the power. Rated at 10KW and 20 amps.
- **3 KW Balun.** Trifier wound triple core torroid gives balanced output to twin feeder from 200 to 10000 ohms and unbalanced output down to 20 ohms.
- **Maximum Power Transfer.** Match your transmitter output impedance to almost any antenna system for maximum power transfer. Amplifiers only run at their designed Q when properly matched.
- **Model Options.** MB-IV-A1 includes all MB-V-A features less antenna switch and balun. MB-IV-A2 is identical to MB-IV-A1 with the addition of a triple core balun.
- **1.8 MHz will not tune on some antennas.**

- **(3) Modes —** Peak Average and Peak and Hold with a unique non-drift Sample & Hold Analog memory circuit.
- **(2) Ranges —** Automatically switched power scales to 5 KW.
- **Fully Automatic SWR —** Full time meter displays ratios directly without drift.
- **Built-in ALO —** Protect your amplifier tube investment with this fast acting lockout.
- **Remote Couplers —** Six feet remotes the interchangeable calibrated couplers.
- **True RMS Conversion —** H.F. couplers use forward biased full wave detection.
- **Rugged Construction —** Heavy gauge aluminum construction. Top quality glass epoxy PCB. This meter is built to last.
- **Accuracy —** Guaranteed to ± 5% F.S.
- **Warranty —** TWO FULL YEARS
- **Added Features —** Switchable reverse power all mode metering — Full status LED Display — Adjustable ALO is switchable SWR/REFL power — Heavy duty Nicad batteries charged by the applied RF for the field and a charger is supplied for fast charging and backlighting of the taut band meters for the ham shack.

OTHER NYE VIKING PRODUCTS

Phone Patches — Electronic and Memory Keyers — Squeeze Keys — Straight Keys — Code Practice Sets — SWR Wattmeter for the blind — Low Pass Filters — All Band Antennas and more... ASK FOR A FREE FULL LINE CATALOG.

TO ORDER, CALL YOUR FAVORITE DEALER

Amateur Electronic Supply
Ham Radio Outlet
Henry Radio
Madison Electronics
EGE
R&L Electronics
rf enterprises

Barry Electronics
C-Comm
Ross Distributing
Quemnet Electronics
LaCue Communications
Ham Station

Wm. M. Nye Co. Inc.
1614 130th Ave. N.E.
Bellevue, WA 98005
TEL: (206) 454-4524
FAX: (206) 453-5704
The joints where progressive sections of an element telescope together are typically the high stress points along the element.

Figure 4

The joints where progressive sections of an element telescope together are typically the high stress points along the element.

Figure 5

Shown here are the three individual distributed forces, the total distributed force, and the total force applied at the element's "center of action."

Element with four sections like those in fig. 2. Tables 4 and 5 show the loads Wi, Wa, Fw, and Ft for the winter and non-winter conditions in table 2. Comparing the Fts for both cases shows the non-winter conditions to be much more severe than the winter ones. Because the non-winter conditions are the most severe, only they will be used in the last stages of the element analysis. When confronted with several sets of conditions, determine which are the most severe and use them in your analysis.

The stress in a section varies along the section length. The highest value occurs at the point where one section ends and another begins, as you approach the boom. In this analysis procedure, you'll calculate only the highest stress value in each section. Figure 4 shows the locations under the greatest stress in a four-section element.

The forces resulting from wind, ice weight, and element weight of each section are evenly distributed over the section's length. The three evenly distributed forces can be replaced by a point force (Ft) applied at a unique location. The location is at the "center of action" — the section's midpoint. Figure 5 shows the three individual distributed forces, the total distributed force, and the total force applied at its center of action. You need Fts and their points of application to find the maximum stress in the sections.

Fts cause the element to bend; this results in bending stresses in the tube sections. These stresses are calculated from the geometry of the tube and the amount of bending action. Use eqn. 8 to find the bending stress when you know the section modulus of the tube and the bending moment at the point of interest. There is another stress at this point, but it's very small and will be ignored.

\[ S_b = \frac{M}{Z} \]  \hspace{1cm} (8)

\[ S_b \] = bending stress (pounds per square inch, psi)
\[ M \] = bending moment (pound per inch)
\[ Z \] = section modulus (inch^3)

The section modulus for a round tube (Z) can be found using eqn. 9.

\[ Z = 0.098 \times \frac{D^4 - (D - 2T)^4}{D} \] \hspace{1cm} (9)

\[ Z \] = section modulus (inch^3)
\[ D \] = tube outer diameter (inch)
\[ T \] = tube wall thickness (inch)

The section modulus describes the geometry of the tube. If you consider tubes of the same material, the one with the larger section modulus can take additional bending. To find the section modulus for two or more close-fitting telescoped tubes, make the combined wall thickness T and the largest outer diameter D. Table 6 gives the section moduli for a number of tube sizes. Table 7 gives the section moduli for various telescoped combinations.

In table 7, the combined wall thickness of 0.116 inch is for two walls of 0.058 inch; the combined wall thickness of 0.174 inch is for three walls of 0.058 inch. The values shown are for standard telescoping combinations. For example, an 0.875 inch outer diameter tube with a combined wall thickness of 0.174 inch is made of three telescoped tubes. It has 0.875, 0.750, and 0.500-inch diameter tubes, each with a wall thickness of 0.058 inch.

To find the bending moment you must know the forces causing the bending and the distances to their points of application. The forces are the Fts found for each section; the distances are taken from the location of the section midpoints. Figure 6A shows the situation for section 1. Find the moment at the point of maximum stress in section 1 with eqn. 10.

\[ Ml = Ft \times \frac{L}{2} \] \hspace{1cm} (10)
The "Hazer"

The HAZER brings the antenna and rotor down to you for safe and convenient maintenance and installation.

- With your beam on the ground you no longer have to wait for spring to make those changes you always wanted.
- Constructed of hot dipped galvanized steel with all stainless steel hardware, you reduce costly maintenance caused by oxidation and corrosion.
- The HAZER is scientifically balanced for easy raising and lowering with the 1000 lb. manual winch and 100 ft. cable included. An optional power winch is also available.
- The specially engineered safety lock guards against slippage and wind vibration while raising and lowering. It can never fall.

AVAILABLE MODELS

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hazer 2</td>
<td>Heavy duty alum. 12 sq. ft. load</td>
<td>$311.95 ppd.</td>
</tr>
<tr>
<td>Hazer 3</td>
<td>Standard alum. 8 sq. ft. load</td>
<td>$223.95 ppd.</td>
</tr>
<tr>
<td>Hazer 4</td>
<td>Heavy galv. steel 16 sq. ft. load</td>
<td>$291.95 ppd.</td>
</tr>
<tr>
<td>Ball Thrust bearing TB-25 for any of above</td>
<td>CALL</td>
<td></td>
</tr>
</tbody>
</table>

CALL 816-882-2734 TODAY

OUR EXPERT STAFF IS WAITING TO HELP YOU ASSESS YOUR NEEDS YOUR SATISFACTION IS GUARANTEED

GLEN MARTIN ENGINEERING INC
Rte 3 Box 322
Boonville, MO 65233

DTMF/steel keys! sealed gold contacts!

P-7V

- Color: All keyboards come in BLACK.
- Optional: Specify DARK BROWN, brown.
- Contacts are: WATER PROOF/DUST PROOF
- Completely self-contained - NO RFI
- Simple 3-wire connection
- Output level adj.
- Wide operating range 4 to 16 VDC
- Wide temperature range -22°F to +160°F
- Supplied with instructions, schematic, template & hardware.

P-7V 12 KEY VERT. $53
P-7H 12 KEY HORIZ. $53
P-8V 16 KEY VERT. $57

CALL OR WRITE

P.O. Box 2020
Pitlock Pines, California 95726
916-644-5444
FAX-916-644-PIPO

NEW! All Band Scanner by AOR

- Covers Low, High, UHF, Aircraft, plus 800/900 MHz
- Scans, Searches, and has priority
- Includes antennas and belt clip
- 20 Channels
- Full range of accessories available
- No frequencies cut out or excluded
- 25 Day Satisfaction Guarantee
- Full refund if not satisfied
- Size: 3" x 5 1/2" x 1 1/2" w/ 12 oz.
- Uses 4 AAA batteries, not included

Cleveland Institute of Electronics
1776 East 17th St., Cleveland, Ohio 44114

CIE is the world's largest independent study electronics school. We offer ten courses covering basic electronics to advanced digital and microprocessor technology. An Associate in Applied Science in Electronics Engineering Technology is also offered.

Study at home — no classes. Programs accredited and eligible for VA benefits.

Address: ____________________________  City: ____________________________  State: ____________________________  Zip: ____________________________  Age: ____________________________  Area Code/Phone No.: ____________________________

Check box for G.I. Bulletin on Educational Benefits
- [ ] Veteran  [ ] Active Duty

MAIL TODAY:

December 1988
TABLE 6

Section moduli and weights for a number of tube sizes.

<table>
<thead>
<tr>
<th>Tube outer diameter (inch)</th>
<th>Wall thickness (inch)</th>
<th>Weight per foot (lbs/ft)</th>
<th>Section modulus (inch⁴)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.25</td>
<td>0.035</td>
<td>0.03</td>
<td>0.0011</td>
</tr>
<tr>
<td>0.25</td>
<td>0.049</td>
<td>0.04</td>
<td>0.0013</td>
</tr>
<tr>
<td>0.25</td>
<td>0.058</td>
<td>0.04</td>
<td>0.0014</td>
</tr>
<tr>
<td>0.375</td>
<td>0.049</td>
<td>0.06</td>
<td>0.0036</td>
</tr>
<tr>
<td>0.375</td>
<td>0.058</td>
<td>0.07</td>
<td>0.0040</td>
</tr>
<tr>
<td>0.50</td>
<td>0.058</td>
<td>0.01</td>
<td>0.0080</td>
</tr>
<tr>
<td>0.50</td>
<td>0.125</td>
<td>0.17</td>
<td>0.0115</td>
</tr>
<tr>
<td>0.625</td>
<td>0.058</td>
<td>0.12</td>
<td>0.0134</td>
</tr>
<tr>
<td>0.625</td>
<td>0.125</td>
<td>0.23</td>
<td>0.0208</td>
</tr>
<tr>
<td>0.75</td>
<td>0.058</td>
<td>0.18</td>
<td>0.0202</td>
</tr>
<tr>
<td>0.75</td>
<td>0.125</td>
<td>0.34</td>
<td>0.0332</td>
</tr>
<tr>
<td>0.875</td>
<td>0.058</td>
<td>0.20</td>
<td>0.0286</td>
</tr>
<tr>
<td>0.875</td>
<td>0.120</td>
<td>0.40</td>
<td>0.0474</td>
</tr>
<tr>
<td>1.00</td>
<td>0.058</td>
<td>0.46</td>
<td>0.0382</td>
</tr>
<tr>
<td>1.00</td>
<td>0.125</td>
<td>0.67</td>
<td>0.0670</td>
</tr>
<tr>
<td>1.125</td>
<td>0.058</td>
<td>0.23</td>
<td>0.0492</td>
</tr>
<tr>
<td>1.125</td>
<td>0.125</td>
<td>0.46</td>
<td>0.0885</td>
</tr>
<tr>
<td>1.25</td>
<td>0.058</td>
<td>0.26</td>
<td>0.0618</td>
</tr>
<tr>
<td>1.25</td>
<td>0.125</td>
<td>0.52</td>
<td>0.1130</td>
</tr>
</tbody>
</table>

TABLE 7

Section moduli for various telescoped combinations.

<table>
<thead>
<tr>
<th>Tube outer diameter (inch)</th>
<th>Combined wall thickness (inch)</th>
<th>Section Modulus (inch⁴)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.375</td>
<td>0.116</td>
<td>0.0051</td>
</tr>
<tr>
<td>0.500</td>
<td>0.116</td>
<td>0.0112</td>
</tr>
<tr>
<td>0.500</td>
<td>0.174</td>
<td>0.0120</td>
</tr>
<tr>
<td>0.625</td>
<td>0.116</td>
<td>0.0202</td>
</tr>
<tr>
<td>0.625</td>
<td>0.174</td>
<td>0.0230</td>
</tr>
<tr>
<td>0.750</td>
<td>0.116</td>
<td>0.0319</td>
</tr>
<tr>
<td>0.750</td>
<td>0.174</td>
<td>0.0379</td>
</tr>
<tr>
<td>0.875</td>
<td>0.116</td>
<td>0.0465</td>
</tr>
<tr>
<td>0.875</td>
<td>0.174</td>
<td>0.0570</td>
</tr>
<tr>
<td>1.000</td>
<td>0.116</td>
<td>0.0639</td>
</tr>
<tr>
<td>1.000</td>
<td>0.174</td>
<td>0.0803</td>
</tr>
<tr>
<td>1.125</td>
<td>0.116</td>
<td>0.0841</td>
</tr>
<tr>
<td>1.125</td>
<td>0.174</td>
<td>0.1078</td>
</tr>
<tr>
<td>1.250</td>
<td>0.116</td>
<td>0.1072</td>
</tr>
<tr>
<td>1.250</td>
<td>0.174</td>
<td>0.1395</td>
</tr>
</tbody>
</table>

M1 = moment in section 1 (pound-inch)
Ft1 = total load on section 1 (pounds)
L1 = length of section 1 (inch)

Using the non-winter conditions of table 5, calculate the bending moment and bending stress for section 1 as follows:

From table 5, Ft1 = 3.77 pounds
From table 3:
L1 = 48.0 inches
D1 = 0.500 inch
T1 = 0.058 inch

and then from table 6

Z1 = 0.0080 inch³

Using eqn. 10

\[ M1 = 3.77 \text{ pounds} \times \frac{48.0}{2} \text{ inch} = 90.5 \text{ pound-inch} \]

Using the bending moment and the section modulus (Z1) calculate the bending stress using eqn. 8.

\[ Sb1 = \frac{90.5 \text{ pound-inch}}{0.0080 \text{ inch}^3} = 11,312.5 \text{ pounds/inch}^2 \]

Or 11,312.5 psi

Sb1 = bending stress for section 1 (pounds per square inch)
To find the bending moment at the highest stress point in section 2, multiply the appropriate Fts by the distance from their centers of action to the highest stress point and then add them together. Figure 6B shows the forces and distances. M2 is the sum of the moments produced by Ft1 and Ft2.

\[ M2 = Ft2 \times \frac{L2}{2} + Ft1 \times \left( L2 + \frac{L1}{2} \right) \]  \hspace{1cm} (11)

\[ M2 = \text{bending moment at end of section 2 (pound-inch)} \]
\[ Ft2 = \text{section 2 total load (pounds)} \]
\[ Ft1 = \text{section 1 total load (pounds)} \]
\[ L1 = \text{section 1 length (inch)} \]
\[ L2 = \text{section 2 length (inch)} \]

Find the stress in section 2 with eqn. 8 using the moment at the point of highest stress and the section modulus at that point.

\[ Sb2 = \frac{M2}{Z2} \]

Continuing with the values from table 3 and the non-winter case from table 5, the variables are as listed:

\[ L1 = 48.0 \text{ inches} \]
\[ L2 = 60.0 \text{ inches} \]
\[ Ft1 = 3.77 \text{ pounds} \]
\[ Ft2 = 5.91 \text{ pounds} \]
\[ D2 = 0.625 \text{ inch} \]
\[ T2 = 0.058 \text{ inch} \]
\[ Z2 = 0.0134 \text{ inch}^3 \] (from table 6)

\[ M2 = 5.91 \text{ pounds} \times \frac{60.0}{2} \text{ inch} + 3.77 \text{ pounds} \times \frac{48.0}{2} \text{ inch} \]

\[ M2 = 177.3 \text{ pound-inch} + 316.7 \text{ pound-inch} = 494.0 \text{ pound-inch} \]

\[ Sb2 = \frac{M2}{Z2} = \frac{494.0 \text{ pound-inch}}{0.0134 \text{ inch}^3} = 36,865.6 \text{ PSI} \]

If there are three sections, M3 is calculated from:

\[ M3 = Ft3 \times \frac{L3}{2} + Ft2 \times \left( L3 + \frac{L2}{2} \right) + Ft1 \times \left( L3 + L2 + \frac{L1}{2} \right) \]

\[ Sb3 = \frac{M3}{Z3} \]

If there are four sections, M4 is calculated from:

\[ M4 = Ft4 \times \frac{L4}{2} + Ft3 \times \left( L4 + \frac{L3}{2} \right) + Ft2 \times \left( L4 + L3 + \frac{L2}{2} \right) + Ft1 \times \left( L4 + L3 + L2 + \frac{L1}{2} \right) \]

\[ Sb4 = \frac{M4}{Z4} \]

If there are more than four sections, the method is expanded following the same pattern. Use what follows as a guide.

The highest stress in a section is determined by finding the bending moment at the point of highest stress and dividing it by the section modulus of the tube at that point. The bending moment is found by multiplying the forces (Fts) causing the bending at the point of highest stress by the corresponding distance to their points of application and then summing.

At this point, it’s easier to either write a program to do all the math, or do it by hand in tabular form. Table 8 shows the complete solution set for the example being used.

The maximum stress in each section has been calculated and must be compared to the allowable maximum. There are three popular aluminum alloys used in commercial Yagis and by Amateur builders. The maximum allowable stress for each is shown in table 9! The most commonly used alloy, 6061-T6, is found in most commercial Yagis; it can be obtained from supply houses and mail-order outlets.

The maximum allowable stress is usually called the “yield stress.” Exceed this stress level and the part may break or be permanently bent. If you go beyond this level only slightly, you may not notice the bend because of the existing element droop. But if you greatly exceed the stress level, your element may incur a large, permanent bend or break. In this situation, a hidden safety factor...
Radio Shack Presents Its All-New
10-Meter Mobile SSB/CW Transceiver

The Perfect First Radio for Novices
...Just in Time for Christmas

259.95 Low As $15 Per Month*

Radio Shack's new HTX-100 is the perfect first rig for a beginning Ham and a superb mobile radio for any amateur. It's compact—2⅞ x 7⅞ x 7⅛"—yet loaded with most-wanted features.

Pushbutton selectors on the mike permit safe and easy QSY while mobilizing and a 10-channel memory stores favorite frequencies. A front-panel frequency-lock switch prevents accidental frequency changes. You can fine-tune reception with ±1.5 kHz RIT and select 25-watt or 5-watt QRP output. Coverage is 28.0 to 29.6999 MHz, SSB or CW with convenient built-in sidetone and semi break-in keying.

The HTX-100 also has an easy-to-see backlit LCD display, hefty 3-watt audio output, built-in speaker, and rear-panel jack for adding an external speaker. Bracket and DC cord included. The 10-meter fun is just beginning. Be a part of it with this affordable, top-quality transceiver!

Radio Shack
The Technology Store™
A DIVISION OF TANDY CORPORATION

Prices apply at participating Radio Shack stores and dealers. Radio Shack ValuePlus® revolving credit. Actual payment may vary depending upon account balance.
ASTRON POWER SUPPLIES
- HEAVY DUTY - HIGH QUALITY - RUGGED - RELIABLE -

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

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

RM SERIES

19" × 5¼ RACK MOUNT POWER SUPPLIES

<table>
<thead>
<tr>
<th>MODEL</th>
<th>Continuous Duty (Amps)</th>
<th>ICS* (Amps)</th>
<th>Size (IN)</th>
<th>Shipping Wt. (lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RM-12A</td>
<td>9</td>
<td>12</td>
<td>5½ × 19 × 8¾</td>
<td>16</td>
</tr>
<tr>
<td>RM-35A</td>
<td>25</td>
<td>35</td>
<td>5½ × 19 × 12¾</td>
<td>38</td>
</tr>
<tr>
<td>RM-50A</td>
<td>37</td>
<td>50</td>
<td>5½ × 19 × 12¾</td>
<td>50</td>
</tr>
<tr>
<td>RM-12M</td>
<td>9</td>
<td>12</td>
<td>5½ × 19 × 8¾</td>
<td>16</td>
</tr>
<tr>
<td>RM-35M</td>
<td>25</td>
<td>35</td>
<td>5½ × 19 × 12¾</td>
<td>38</td>
</tr>
<tr>
<td>RM-50M</td>
<td>37</td>
<td>50</td>
<td>5½ × 19 × 12¾</td>
<td>50</td>
</tr>
</tbody>
</table>

RS-A SERIES

<table>
<thead>
<tr>
<th>MODEL</th>
<th>Continuous Duty (Amps)</th>
<th>ICS* (Amps)</th>
<th>Size (IN)</th>
<th>Shipping Wt. (lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RS-3A</td>
<td>2.5</td>
<td>3</td>
<td>3½ × 6½ × 9</td>
<td>5</td>
</tr>
<tr>
<td>RS-4A</td>
<td>3</td>
<td>4</td>
<td>3½ × 6½ × 9</td>
<td>7</td>
</tr>
<tr>
<td>RS-5A</td>
<td>4</td>
<td>5</td>
<td>3½ × 6½ × 9</td>
<td>9</td>
</tr>
<tr>
<td>RS-7A</td>
<td>5</td>
<td>7</td>
<td>3½ × 6½ × 9</td>
<td>10</td>
</tr>
<tr>
<td>RS-7B</td>
<td>7.5</td>
<td>10</td>
<td>4½ × 8½ × 9</td>
<td>11</td>
</tr>
<tr>
<td>RS-12A</td>
<td>9</td>
<td>12</td>
<td>4½ × 8½ × 9</td>
<td>13</td>
</tr>
<tr>
<td>RS-12B</td>
<td>9</td>
<td>12</td>
<td>4½ × 8½ × 9</td>
<td>13</td>
</tr>
<tr>
<td>RS-20A</td>
<td>16</td>
<td>20</td>
<td>5½ × 9 × 10 ½</td>
<td>18</td>
</tr>
<tr>
<td>RS-35A</td>
<td>25</td>
<td>35</td>
<td>5½ × 11 × 11</td>
<td>27</td>
</tr>
<tr>
<td>RS-50A</td>
<td>37</td>
<td>50</td>
<td>6½ × 13½ × 11</td>
<td>46</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MODEL</th>
<th>Continuous Duty (Amps)</th>
<th>ICS* (Amps)</th>
<th>Size (IN)</th>
<th>Shipping Wt. (lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RS-3A</td>
<td>2.5</td>
<td>3</td>
<td>3½ × 6½ × 9</td>
<td>5</td>
</tr>
<tr>
<td>RS-4A</td>
<td>3</td>
<td>4</td>
<td>3½ × 6½ × 9</td>
<td>7</td>
</tr>
<tr>
<td>RS-5A</td>
<td>4</td>
<td>5</td>
<td>3½ × 6½ × 9</td>
<td>9</td>
</tr>
<tr>
<td>RS-7A</td>
<td>5</td>
<td>7</td>
<td>3½ × 6½ × 9</td>
<td>10</td>
</tr>
<tr>
<td>RS-7B</td>
<td>7.5</td>
<td>10</td>
<td>4½ × 8½ × 9</td>
<td>11</td>
</tr>
<tr>
<td>RS-12A</td>
<td>9</td>
<td>12</td>
<td>4½ × 8½ × 9</td>
<td>13</td>
</tr>
<tr>
<td>RS-12B</td>
<td>9</td>
<td>12</td>
<td>4½ × 8½ × 9</td>
<td>13</td>
</tr>
<tr>
<td>RS-20A</td>
<td>16</td>
<td>20</td>
<td>5½ × 9 × 10 ½</td>
<td>18</td>
</tr>
<tr>
<td>RS-35A</td>
<td>25</td>
<td>35</td>
<td>5½ × 11 × 11</td>
<td>27</td>
</tr>
<tr>
<td>RS-50A</td>
<td>37</td>
<td>50</td>
<td>6½ × 13½ × 11</td>
<td>46</td>
</tr>
</tbody>
</table>

RS-M SERIES

<table>
<thead>
<tr>
<th>MODEL</th>
<th>Continuous Duty (Amps)</th>
<th>ICS* (Amps)</th>
<th>Size (IN)</th>
<th>Shipping Wt. (lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RS-12M</td>
<td>9</td>
<td>12</td>
<td>4½ × 8½ × 9</td>
<td>13</td>
</tr>
<tr>
<td>RS-20M</td>
<td>16</td>
<td>20</td>
<td>5½ × 9 × 10 ½</td>
<td>18</td>
</tr>
<tr>
<td>RS-35M</td>
<td>25</td>
<td>35</td>
<td>5½ × 11 × 11</td>
<td>27</td>
</tr>
<tr>
<td>RS-50M</td>
<td>37</td>
<td>50</td>
<td>6½ × 13½ × 11</td>
<td>46</td>
</tr>
</tbody>
</table>

VS-M AND VRM-M SERIES

<table>
<thead>
<tr>
<th>MODEL</th>
<th>Continuous Duty (Amps)</th>
<th>ICS* (Amps)</th>
<th>Size (IN)</th>
<th>Shipping Wt. (lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VS-12M</td>
<td>9</td>
<td>12</td>
<td>4½ × 8½ × 9</td>
<td>13</td>
</tr>
<tr>
<td>VS-20M</td>
<td>16</td>
<td>20</td>
<td>5½ × 9 × 10 ½</td>
<td>20</td>
</tr>
<tr>
<td>VS-35M</td>
<td>25</td>
<td>35</td>
<td>5½ × 11 × 11</td>
<td>29</td>
</tr>
<tr>
<td>VS-50M</td>
<td>37</td>
<td>50</td>
<td>6½ × 13½ × 11</td>
<td>46</td>
</tr>
<tr>
<td>VRM-35M</td>
<td>25</td>
<td>35</td>
<td>5½ × 19 × 12 ½</td>
<td>38</td>
</tr>
<tr>
<td>VRM-50M</td>
<td>37</td>
<td>50</td>
<td>5½ × 19 × 12 ½</td>
<td>50</td>
</tr>
</tbody>
</table>

VS-S SERIES

<table>
<thead>
<tr>
<th>MODEL</th>
<th>Continuous Duty (Amps)</th>
<th>ICS* (Amps)</th>
<th>Size (IN)</th>
<th>Shipping Wt. (lbs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RS-7S</td>
<td>5</td>
<td>7</td>
<td>4½ × 7½ × 10 ¼</td>
<td>10</td>
</tr>
<tr>
<td>RS-10S</td>
<td>7.5</td>
<td>10</td>
<td>4½ × 7½ × 10 ¼</td>
<td>12</td>
</tr>
<tr>
<td>RS-12S</td>
<td>9</td>
<td>12</td>
<td>4½ × 8 ½</td>
<td>13</td>
</tr>
<tr>
<td>RS-20S</td>
<td>16</td>
<td>20</td>
<td>5½ × 9 × 10 ½</td>
<td>18</td>
</tr>
</tbody>
</table>
may come into play. If the maximum allowable stress is just slightly surpassed, you may not have a failure resulting in element breakage. The only result may be a slight permanent bend, which may not be observable or cause any harm. This safety factor would come into play if the peak wind conditions were exceeded.

The example in table 8 shows that, regardless of the alloy used, this design is over stressed in two areas. In addition, it’s marginal in one area and acceptable in another. Using 6061-T6 aluminum throughout this example, the maximum allowable stress is 35,000 psi. Any section stress below this value indicates a section which is not fully utilized; any section stress above the maximum value indicates a section which is overloaded. An overloaded section must be changed to bring the stress level down to an acceptable level. You’ll have equal strength when all section stresses have the same value. There are good reasons to have some sections stronger than others, but this is an economic decision to be discussed later.

What can be done to improve the example element in table 8? Make the 0.500 diameter tube longer to take more load and reduce the length of others while keeping the total length the same. Lengthening the 0.500 diameter tube to allow it to take more load also reduces the total wind load put into the element because the smaller diameter tubing is replacing the larger. Table 10 shows the same element with altered section lengths. Starting at the outer section and working towards the boom, the section lengths were changed to obtain the maximum allowable stress.

Sections 1, 2, and 3 are acceptable; 4 is still unacceptable. There will be slight improvement if you use more of the lighter, less expensive tubing. Section 4 still has a problem, but has improved somewhat. With the smaller sections optimized, improvement in section 4 is impossible without a change in its geometry. Table 11 shows the same element, with section 4 as a telescoped combination of 1.00 and 0.875-inch diameter tubes.

Section 4 has a stress slightly over the maximum. This

### TABLE 8

<table>
<thead>
<tr>
<th>Sec</th>
<th>OD (in)</th>
<th>T (in)</th>
<th>L (in)</th>
<th>Ft (lbs)</th>
<th>Z (in³)</th>
<th>M (lbs-in)</th>
<th>Sb (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.500</td>
<td>0.058</td>
<td>48.0</td>
<td>3.77</td>
<td>0.0081</td>
<td>90.5</td>
<td>11,300</td>
</tr>
<tr>
<td>2</td>
<td>0.625</td>
<td>0.058</td>
<td>60.0</td>
<td>5.90</td>
<td>0.0134</td>
<td>494.0</td>
<td>36,860</td>
</tr>
<tr>
<td>3</td>
<td>0.750</td>
<td>0.058</td>
<td>72.0</td>
<td>8.51</td>
<td>0.0202</td>
<td>1496.3</td>
<td>74,070</td>
</tr>
<tr>
<td>4</td>
<td>0.875</td>
<td>0.058</td>
<td>36.0</td>
<td>4.97</td>
<td>0.0286</td>
<td>2240.2</td>
<td>78,600</td>
</tr>
</tbody>
</table>

### TABLE 9

Maximum allowable stress for the three popular aluminum alloys used in commercial Yagis and by Amateur builders.

<table>
<thead>
<tr>
<th>Aluminum Alloy</th>
<th>Maximum allowable stress (psi) (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6061-T6</td>
<td>35,000</td>
</tr>
<tr>
<td>6063-T6</td>
<td>25,000</td>
</tr>
<tr>
<td>6063-T83</td>
<td>30,000</td>
</tr>
</tbody>
</table>

### TABLE 10

Element with section lengths altered to obtain maximum allowable stress.

<table>
<thead>
<tr>
<th>Sec</th>
<th>OD (in)</th>
<th>T (in)</th>
<th>L (in)</th>
<th>Ft (lbs)</th>
<th>Z (in³)</th>
<th>M (lbs-in)</th>
<th>Sb (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.500</td>
<td>0.058</td>
<td>84.0</td>
<td>6.59</td>
<td>0.0081</td>
<td>276.7</td>
<td>34,580</td>
</tr>
<tr>
<td>2</td>
<td>0.625</td>
<td>0.058</td>
<td>24.0</td>
<td>2.36</td>
<td>0.0134</td>
<td>463.2</td>
<td>34,500</td>
</tr>
<tr>
<td>3</td>
<td>0.750</td>
<td>0.058</td>
<td>24.0</td>
<td>2.84</td>
<td>0.0202</td>
<td>712.0</td>
<td>35,130</td>
</tr>
<tr>
<td>4</td>
<td>1.000</td>
<td>0.116</td>
<td>84.0</td>
<td>14.51</td>
<td>0.0640</td>
<td>2311.5</td>
<td>36,110</td>
</tr>
</tbody>
</table>

### TABLE 11

Element with section 4 a telescoped combination 1.00 and 0.875-inch diameter tube.

<table>
<thead>
<tr>
<th>Sec</th>
<th>OD (in)</th>
<th>T (in)</th>
<th>L (in)</th>
<th>Ft (lbs)</th>
<th>Z (in³)</th>
<th>M (lbs-in)</th>
<th>Sb (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.500</td>
<td>0.058</td>
<td>84.0</td>
<td>6.59</td>
<td>0.0081</td>
<td>276.7</td>
<td>34,580</td>
</tr>
<tr>
<td>2</td>
<td>0.625</td>
<td>0.058</td>
<td>24.0</td>
<td>2.36</td>
<td>0.0134</td>
<td>463.2</td>
<td>34,500</td>
</tr>
<tr>
<td>3</td>
<td>0.750</td>
<td>0.058</td>
<td>24.0</td>
<td>2.84</td>
<td>0.0202</td>
<td>712.0</td>
<td>35,130</td>
</tr>
<tr>
<td>4</td>
<td>1.000</td>
<td>0.116</td>
<td>84.0</td>
<td>14.51</td>
<td>0.0640</td>
<td>2311.5</td>
<td>36,110</td>
</tr>
</tbody>
</table>
Example of section 4 shown as a single tube with marginal strength.

<table>
<thead>
<tr>
<th>Sec</th>
<th>OD (in)</th>
<th>T (in)</th>
<th>L (in)</th>
<th>Ft (lbs)</th>
<th>Z (in')</th>
<th>M (lbs-in)</th>
<th>Sb (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.500</td>
<td>0.058</td>
<td>84.0</td>
<td>6.59</td>
<td>0.0081</td>
<td>276.7</td>
<td>34,580</td>
</tr>
<tr>
<td>2</td>
<td>0.625</td>
<td>0.058</td>
<td>24.0</td>
<td>2.36</td>
<td>0.0134</td>
<td>463.2</td>
<td>34,500</td>
</tr>
<tr>
<td>3</td>
<td>0.750</td>
<td>0.058</td>
<td>24.0</td>
<td>2.84</td>
<td>0.0202</td>
<td>712.0</td>
<td>35,130</td>
</tr>
<tr>
<td>4</td>
<td>1.250</td>
<td>0.058</td>
<td>84.0</td>
<td>16.60</td>
<td>0.0619</td>
<td>2399.4</td>
<td>38,780</td>
</tr>
</tbody>
</table>

Description of a spacer which can be used when making a large decrease in tubing sizes on an element; i.e., two sizes that will not telescope together and allow a compression joint.

design is totally acceptable given the conservative nature of the rigid element model. There are several things to note. As the element gets longer, the strength requirements rapidly increase. This can be seen by the very short lengths of sections 2 and 3. In addition, section 4 had to be drastically reinforced. Table 12 shows the same example, where section 4 is a single tube with marginal strength. Section 4 is a 1.250-inch diameter tube of 0.058-inch wall thickness. This large tube has about the same section modulus as the composite of the 1.000 and 0.875-inch tubes, but has a larger wind load due to its larger diameter. This offsets some of its greater load bearing capacity.

You'll encounter a problem when making a large jump in tubing size. Because the jump from 0.750 to 1.250 isn't a telescoping fit, you need to fabricate a spacer or "donut." Figure 7 shows a spacer used by N5RM to build his 40-meter flamethrower. Several manufacturers swage the end of a larger tube to a smaller size. This is a large diameter reduction allowing a telescoping fit with a smaller tube. This method is not practical for the individual builder.

There are several ways to achieve a significant increase in section strength. One is to try increasingly larger diameter tubes in your calculations, until you find an outcome with an acceptable stress. This could lead to a fabrication problem due to non-telescoping tubing sections. You can also increase the strength of a section by externally or internally reinforcing the tube along part or all of its length. Figure 8 shows three reinforcement methods. In doing the analysis, you will create a new section when there is a change in the tube geometry.

Several methods for reinforcing element tubing are shown: At (A) the base tube with no reinforcing, at (B) the base tube with partial external reinforcement, at (C) the base tube with partial internal reinforcement, and at (D) the base tube as used in a double walled reinforcement.

Figures 8A and 8D are one section while figs. 8B and 8C are two sections. The method you select should be based on cost, ease of construction, availability of materials, total element weight, and total element wind area. There are a large number of possible combinations of tubing sizes which can be successfully used in a design. The final configuration depends on your resources and ingenuity.

It's desirable to have a design with no weak links, but having links of different strengths can be good and bad. It depends on what you want the design to accomplish. If you want the absolutely lightest element, design sections with the same maximum allowable stress. This design may not provide an economical use of tubing; it's usually purchased in finite lengths, and sections may be wasted. Zero waste may not be possible unless you make it a design consideration from the beginning. You could try to put together an element without cutting tubing which could be used for another project. In this case the section stresses might be quite different. This is totally acceptable provided none exceed the maxi-
THE CHOICE IS SIMPLE

Pick a band...pick a power level...pick a price! Picking the right brand is even easier. Henry Radio is the power amplifier specialist. Every one of our 13 models offer superb value, experienced engineering (25 years!) and top quality components.

Since we offer the broadest selection of power amplifiers of any manufacturer, we feel that you should find exactly what you need on the following list:

2K CLASSIC console—a true workhorse HF linear. Loafs along at full legal power. All amateur bands, 80 through 15 meters. 2K & 3K export models include 10 meters.

2K CLASSIC X console—we can't think of any way to make this magnificent 2000 watt HF amplifier better. Rugged and dependable...the last amplifier you may ever need to buy. 80 through 15 meters.

2KD CLASSIC—a desk model designed to operate at 2000 watts input effortlessly, using two Eimac 3-500Z glass envelope triodes. Pi-L plate circuit and a rotary silver plated tank coil. 80 through 15 meters. 3.5-30 MHz.

3K CLASSIC Mk II—uses the Eimac 3CX1200A7 tube. More than 13 db gain. We believe the 3K console to be one of the finest amateur HF linears available. 80 through 15 meters. 3.5-30 MHz.

3K PREMIER console—all of the time tested reliability of the 3K Classic Mk II plus QSK and the 160 meter band. All amateur bands, 160 through 15 meters. 1.8-30 MHz.

3KD PREMIER desk model—the same RF deck as the console, but in a smaller and lighter configuration. Full legal power plus QSK. All amateur bands. 160 through 15 meters. 1.8-30 MHz.

5K CLASSIC console—a rugged and reliable 5000 watt HF linear amplifier. Not available for amateur use in the U.S. 3.5-30 MHz.

2002-A desk model—a superb VHF amplifier. Operates CW, FM, SSB, AM or pulse applications. Uses an Eimac 3CX800A7 ceramic triode for smooth dependable power. Frequency range: 144 to 148 MHz. Commercial models in the 100 to 300 MHz range also available.

2002-A—the same as above, but operating in the 220 to 225 MHz frequency range. These VHF units have proven themselves in the field through thousands of hours of use.

2006-A—offers the same specifications, the same reliability as the 2002-A, but operates in the 50 to 54 MHz. Commercial models in the 30 to 100 MHz range available.

3002-A console—full legal power provided by an Eimac 8877 ceramic triode mated to a heavy duty power supply. Rugged and reliable. Perfect for amateur, commercial, industrial and scientific operations. 144 to 148 MHz. Commercial models in the 100 to 300 MHz range available.

3006-A console—the same rugged construction and the same dependability as the 3002-A, but for operation in the 50 to 54 MHz frequency range. Commercial models in the 30 to 100 MHz range available.

2004-A desk model—a unique UHF linear amplifier for working 440 MHz frequency range. Designed for dependability...built to last.

We realize that these descriptions are much too short. For complete descriptions, specs and prices please call or write. If you have a requirement for a special purpose amplifier please call Ted Shannon, Meredith Henry or Ted Henry at our Los Angeles office.

Henry Radio
2050 S. Bundy Dr., Los Angeles, CA 90025 (213) 820-1234

Toll free order number: (800) 877-7979
TELEX: 67-3625(Henradio)
FAX (213) 826-7790

December 1988
# All Electronics Corp.

**WE STOCK OVER 4,000 ITEMS...**
**CALL OR WRITE FOR OUR FREE CATALOG OF PARTS!**

**RESISTORS** • **CAPACITORS** • **DIODES** • **DIODES** • **CABLES** • **BRIDGE RECTIFIERS** • **CHOKER COILS** • **CRYSTAL CONNECTORS** • **LEAD SAGS** • **VOLTAGE REGULATORS** • **WORLDWIDE CIRCUIT BREAKERS** • **POWER SUPPLIES** • **FUSES** • **SHRINK TUBING** • **TOOL KITS** • **VIDEO ACCESSORIES** • **SOUND SYSTEM ACCESSORIES** • **RELAYS** • **S.S.R.s** • **TRANSFORMERS** • **COMMUNICATION ACCESSORIES** • **TELEPHONE ACCESSORIES** • **RADIO TUBE ACCESSORIES** • **MICRO-TOGGLE SWITCHES** • **VOLTAGE REGULATORS** • **AND MANY OTHER ITEMS...**

**PIEZO WARNING DEVICE**
Murata Ene # PKE1000 High pitched audible alarm. Operates on 3 - 20 Vac @ 20 ma. 1" high X 7/8" dia. P.C. board mount. **CAT# PB2-04 $1.75 each.**

**XENON TUBE**
1" long flat tube prepped with 3/16" red and black leads. Ideal for electronic flash or strobe projects. **CAT# FLT-3 $2.00 each.**

**NICKEL-CAD (RECHARGEABLE) BATTERIES**
**SPECIAL**
- **AA SIZE** Panasonic # P-18AA
  - 1.2 volt @ 180 mAh
  - **CAT# NCB-AAA** $1.75 each
  - 10 for $15.50
  - 100 for $125.00
  - **LARGE QUANTITIES**

- **AA SIZE** $2.00 each
  - 1.25 Volts 500 mAh
  - **CAT# NCB-AAA** $1.75 each
  - 10 for $13.50
  - 100 for $125.00

**WALL TRANSFORMERS**
**SOLDDERS BREADBOARD**
**FULL WAVE BRIDGE RECTIFIERS**
**24 VOLT D.C. SOLENOID**
Intermittent duty cycle. 240 volt coil. Mounting flange is 1 1/8" wide. Solenoid body 11/2" X 1/2" X 2". **CAT# SOL-34 $15.00 each**

**20 AMP 200 P.I.V.**
**SOUND & VIDEO MODULATOR**
T18 UM1381-1. Designed for use with a computer. Can be used with video camera, computers, or any other audio or video signal. Built in A-B switch enables user to switch from TV antenna without disconnection. Operates on channel 3 or 4. Requires 12 vac Hook up diagram included. **CAT# AVMD $5.00 each**

**FULL WAVE BRIDGE RECTIFIERS**
**GRAB BAGS $100 EACH**
- 50 ASSORTED D.C. CAPS. Cut leads. Many common values, some are 500 volts. **CAT# GRABC $2.50 each**
- Approximately 200 pieces of assorted values, some cut leads. **CAT# GRES $5.00 each**

**2 AMP RATING**
- 1 1/4 SQUARE
- Metal epoxy filled case
- 200 P.I.V. $2.50 each
- **CAT# FWB-252**

**N-CHANNEL MOSFET**
- IRF-511
- TO-220 case
- **CAT# IRF 511** $1.00 each
  - 10 for $9.00
  - **LARGE QUANTITY AVAILABLE...**

**LIGHT EMITTING DIODES (L.E.D.)**
**HIGH DENSITY LED ARRAYS**
- **LED HOLDER** No piece holder. **CAT# HLED** $1.65
- **CLIPLET LED HOLDER** Makes a L.E.D. look like a fancy indicator. Fits T1-3/4 size L.E.D. **CAT# LED-10 C**
- **BIPOLAR LED** Red, green the other two leads. **CAT# LED-6** 2 for $1.70

**TRANSISTORS**
**SOLID STATE RELAYS**
**SWITCHES**
**MINI PUSH BUTTON**
S. P. S. T. momentary. Push to make, 1/4" of travel. **CAT# MBP-1 $3.50 each**

**ITT PUSH BUTTON**
ITT MDLP series. 3/4" X 1/2" X 1/2". Non-threaded bushing. **CAT# PB-86 $1.00 each**

**HALL EFFECT SWITCH**
**MICROSWITCH #9103**
Stainless steel switch with hall effect sensor. Snaps into 5/8" square chassis hole. Hall effect sensor can be easily swtiched and can be used in other applications. **CAT# HSBRW $2.50 each**

**10 POSITION MINI-ROTARY SWITCH**
**Graydel**
563P-01-0110-N C Miniature, rotary switch. Non-shorting. 10 positions, 125° dia. shaft X 37° long. **CAT# RSW $2.50 each**

**STORES:**
**MAIL ORDERS TO:**
**ALL ELECTRONICS**
P.O. BOX 567
VAN NÜYS, CA 91408

**TWX-5101010163**
(ALL ELECTRONIC)

**OUTSIDE THE U.S.A.**
SEND $1.50 POSTAGE FOR A CATALOG!!

**TOLL FREE**
800-826-5432
INFO: (818)904-0524
FAX: (818)781-2768
**MINIMUM ORDER $10.00**
QUANTITIES LIMITED
**CALIF. ADD SALES TAX**
**USA SHIPPING**
**FOREIGN ORDERS INCLUDE **
**SHIPPING NO C.O.D.**

**STORES:**
**VAN NUYS**
105 VERMONT AVE.
VAN NUYS, CA 91411
(818)897-1066

<table>
<thead>
<tr>
<th>MAIL ORDERS TO:</th>
<th><strong>ALL ELECTRONICS</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>P.O. BOX 567</strong></td>
<td><strong>VAN NUYS, CA 91408</strong></td>
</tr>
<tr>
<td><strong>TWX-5101010163</strong></td>
<td>(ALL ELECTRONIC)</td>
</tr>
<tr>
<td><strong>OUTSIDE THE U.S.A.</strong></td>
<td>SEND $1.50 POSTAGE FOR A CATALOG!!</td>
</tr>
<tr>
<td><strong>TOLL FREE</strong></td>
<td>800-826-5432</td>
</tr>
<tr>
<td><strong>INFO:</strong> (818)904-0524</td>
<td>FAX: (818)781-2768</td>
</tr>
<tr>
<td><strong>MINIMUM ORDER $10.00</strong></td>
<td>QUANTITIES LIMITED</td>
</tr>
<tr>
<td><strong>CALIF. ADD SALES TAX</strong></td>
<td><strong>USA SHIPPING</strong></td>
</tr>
</tbody>
</table>
| **FOREIGN ORDERS INCLUDE NO C.O.D.** | **STORES:**

**STORES:**
**VAN NUYS**
105 VERMONT AVE.
VAN NUYS, CA 91411
(818)897-1066
mum allowable stress. You can use different alloys of tubing as long as you don’t exceed the maximum allowable stress level for each type.

The section nearest the boom will be the most expensive and minimum waste is a goal. Make section 1 from the least costly tubing. It can give you the largest span for the least money. Look closest at the intermediate sections for waste. Several other considerations mentioned earlier come into play when making tradeoffs between tubing sizes and reinforcement methods. Consider the overall element weight and area. If there is choice between several options, the lighter, smaller area element offers some advantages. If two designs for a four-element, 20-meter beam were found to have acceptable stress levels, choose between them on basis of the amount of wind load they put into the tower and rotator. Because using REM requires finding the weight and wind load of each section, it would be easy to sum the total section weights and wind loads to obtain two other parameters for comparing element designs. Multiply these by 2 to obtain the total for both element halves. 

\[
\text{EWT} = 2 \times \text{sum of all section Was} \quad (12)
\]

\[
\text{EWL} = 2 \times \text{sum of all section Fws} \quad (13)
\]

\[
= \text{total wind load on element (pounds) at maximum wind speed}
\]

I found the element design in Table 13 in an Amateur publication. The tubing sizes for this 36-foot element show that it is a very strong one. Or is it? With the analysis done at 86.6 mph and no ice, this element was found to be poor and the end of section 3 to be very weak. Section 1 could be made a lot longer. I found an acceptable configuration after I made several attempts to improve this design using the same tube sizes. Table 14 shows the improved design.

Section 1 was greatly lengthened, while section 2 was greatly reduced. Section 3 was changed to a shorter section. The new section 4 is the remainder of the old section 3, reinforced on the inside with some of the same material used in section 2. Not only has the strength of the element improved, but there has been a slight drop in element weight and wind load. Was this an efficient use of the material? Table 15 shows the materials used and the waste for the two cases. This was done assuming a 5-inch overlap at each joint and stock tubing lengths of 12 feet. You can make several conclusions when comparing the published design and improved version by looking at

### TABLE 13

Tubing sizes of a 36-foot element with poor design.

<table>
<thead>
<tr>
<th>Section</th>
<th>D (inch)</th>
<th>T (inch)</th>
<th>L (inch)</th>
<th>Sb (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.000</td>
<td>0.058</td>
<td>48.00</td>
<td>4,760</td>
</tr>
<tr>
<td>2</td>
<td>1.125</td>
<td>0.058</td>
<td>96.00</td>
<td>35,050</td>
</tr>
<tr>
<td>3</td>
<td>1.250</td>
<td>0.058</td>
<td>72.00</td>
<td>64,910</td>
</tr>
</tbody>
</table>

### TABLE 14

36-foot element with improved design.

<table>
<thead>
<tr>
<th>Section</th>
<th>D (inch)</th>
<th>T (inch)</th>
<th>L (inch)</th>
<th>Sb (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.000</td>
<td>0.068</td>
<td>131.00</td>
<td>35,450</td>
</tr>
<tr>
<td>2</td>
<td>1.125</td>
<td>0.058</td>
<td>13.00</td>
<td>33,220</td>
</tr>
<tr>
<td>3</td>
<td>1.250</td>
<td>0.058</td>
<td>18.00</td>
<td>33,700</td>
</tr>
<tr>
<td>4</td>
<td>1.250</td>
<td>0.116</td>
<td>54.00</td>
<td>36,930</td>
</tr>
</tbody>
</table>

### TABLE 15

Comparison of materials used in Tables 13 and 14.

<table>
<thead>
<tr>
<th>Tube Diameter size (0.058 wall)</th>
<th>12-foot lengths needed</th>
<th>12-foot lengths needed</th>
<th>waste</th>
<th>waste</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.000</td>
<td>1</td>
<td>38 inches</td>
<td>2</td>
<td>16 inches</td>
</tr>
<tr>
<td>1.125</td>
<td>2</td>
<td>86 inches</td>
<td>1</td>
<td>0 inches</td>
</tr>
<tr>
<td>1.250</td>
<td>1</td>
<td>0 inches</td>
<td>1</td>
<td>0 inches</td>
</tr>
</tbody>
</table>

Copyright December 1988
TABLE 16

Revised element for improved design.

<table>
<thead>
<tr>
<th>Section</th>
<th>D (inch)</th>
<th>T (inch)</th>
<th>L (inch)</th>
<th>Sb (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.500</td>
<td>0.058</td>
<td>84.00</td>
<td>34,580</td>
</tr>
<tr>
<td>2</td>
<td>0.625</td>
<td>0.058</td>
<td>24.00</td>
<td>34,500</td>
</tr>
<tr>
<td>3</td>
<td>0.750</td>
<td>0.058</td>
<td>23.00</td>
<td>34,550</td>
</tr>
<tr>
<td>4</td>
<td>0.750</td>
<td>0.116</td>
<td>30.00</td>
<td>34,640</td>
</tr>
<tr>
<td>5</td>
<td>1.00</td>
<td>0.116</td>
<td>55.00</td>
<td>34,730</td>
</tr>
</tbody>
</table>

EWT = 7.3 pounds  EWL = 42.8 pounds

TABLE 17

Summary of features of element designs in Tables 16, 13, and 14.

<table>
<thead>
<tr>
<th>Survival mean wind speed (peak) (mph)</th>
<th>Table 16</th>
<th>Table 13</th>
<th>Table 14</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survival mean wind speed (peak) (mph)</td>
<td>86.6</td>
<td>64.0</td>
<td>86.6</td>
</tr>
<tr>
<td>Element weight (pounds)</td>
<td>7.3</td>
<td>8.4</td>
<td>8.0</td>
</tr>
<tr>
<td>Element wind load at 86.6 mph (pounds)</td>
<td>42.8</td>
<td>68.4</td>
<td>66.4</td>
</tr>
</tbody>
</table>

Tables 13, 14, and 15. The improved version is lighter, less expensive to build, places less wind load on the tower, and is significantly stronger.

Take care not to generate a design with a hidden problem. The example in table 11 is a buildable design, but has a construction problem. Section 4 is 84 inches long. This is not half of a 12-foot piece where 6 feet are used on each side of the boom. Using the 84-inch section results in a lot of waste, and requires special efforts for mounting and joining at the boom. A design revision uses a piece of section 2 material for internal reinforcement. Two 12-foot telescoped pieces are cut to a length of 110.0 inches with half on each side of the boom. Table 16 shows the improved design.

Table 17 summarizes the features for the element designs in tables 16, 13, and 14's improved version in table 14. This improvement costs less and is slightly lower in weight and wind load. The element in table 16 will withstand the same wind, but have about 35 percent less wind load. You can build Yagis which minimize the loads placed on towers, booms, and rotators, while still surviving very high winds.

Before using this method of element design, determine your constraints, limitations, and objectives. The procedure allows you to generate designs to minimize weight and wind loading, and make optimal use of materials. It can be used to evaluate any existing design.

Summary

This analysis procedure provides a simple and sound method to evaluate the structural integrity of existing element designs and assist in the process of designing an element. I have presented several methods of reinforcing element sections and various criteria by which to judge them. To implement the procedure, you'll need to determine the worst set of survival conditions for your geographical location, your objectives, and restrictions.

References


INVITATION TO AUTHORS

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

ARRL ANTENNA BOOK
by Jerry Hall, K1TD. NEW 15th Edition

The all new 15th edition of this antenna classic represents over two years of hard work by editor K1TD. It's doubled in size too -- from over 300 to over 700 pages big! 950 figures and charts cover just about every subject imaginable. Some of the highlights are: Chapters on Loop antennas, multi-band antennas, low frequency antennas, portable antennas, VHF and UHF systems, coupling the antenna to the transmitter and the antenna, plus l-e-n-y more. Like the 1988 HANDBOOK and new OPERATING MANUAL, the new ANTENNA BOOK is going to be a smash hit. Order yours today. 15th edition 900 + pages ©1988
AR-AM Softbound $17.95

NOVICE ANTENNA NOTEBOOK
by Doug DeMaw W1FB

Novices have long wondered what is the best all around antenna for them to install. Up until now, this was a difficult question to answer. Aimed at the newly licensed Ham, DeMaw writes for the non-engineer in clear concise language with emphasis on easy-to-build antennas. Readers will learn how antennas operate and what governs performance. Also great reading for all levels of Amateur interest. 1st Edition ©1988.
AR-NAN Softbound $7.95

THE 1989 ARRL HANDBOOK
FOR THE RADIO AMATEUR (Avail. late Oct. 1988)

Revised and updated with the latest in Amateur technology, now is the time to order your very own copy of the world famous ARRL HANDBOOK. In addition to being the definitive reference volume for your Ham shack, there are plenty of projects for every interest in Amateur Radio -- from antennas for every application to the latest state-of-the-art projects -- you'll find it all in the 1989 HANDBOOK. Order now and we will ship as soon as the books arrive from the printer. They make perfect gifts for the holiday season for your hard-to-buy for Ham friends or for yourself. Over 1100 pages ©1988.
AR-HB89 Hardbound $20.95

N6RJ's ELECTRONIC SECOND OP
for MS-DOS computers
by Jim Raftery N6RJ

The world famous SECOND OP is now available in a state-of-the-art computerized data base. This program, written for MS-DOS computers, is a must for DX'ers, contesters and all Amateurs interested in reliable DX communication. Data can be displayed either in columnist format or in full screen displays. Unknown callignos can be entered and compared to the ITU calligno allocation for easy identification. There's plenty more too such as postal rates, beam headings and QSL bureaus to name just a few. Great program to have in your shack. Order yours today ©1988 MS-DOS computers. 5¼ and 3½ versions available. Please specify on your order.
N6RJ (MS-DOS Computers) $59.95

1989 AMATEUR CALLBOOKS
(Available late November 1988)

NORTH AMERICAN EDITION

Fully updated and edited to include all the latest FCC and foreign government callignos and addresses for Hams in North America. Includes plenty of handy operating aids such as time charts, QSL bureau addresses, census information and much more. Calls from Northern Canada to Tropical Panama. Now is the time to buy a new Callbook when you'll get the most use out of your investment ©1988
CB-US89 Softbound $25.95

INTERNATIONAL EDITION

QSLs are a very important part of our hobby. All sorts of awards, including the coveted DXCC, require confirmation of contact before the award can be issued. Of special interest, addresses are being added daily for Hams in the USSR and other countries. While in no means complete, it's a start and will be of tremendous help in getting QSLs. Handy operating aids round out this super book value. ©1988
CB-F89 Softbound $28.95

BUY 'EM BOTH SPECIAL
Reg. $54.90 Only $49.95
SAVE $4.95

Please enclose $3.50 shipping & handling.
NEW BOOKS

PASSPORT TO WORLD BAND RADIO 1989 Edition
Brand new and fully revised, SWL's everywhere will want a copy for their library. Expanded to 416 pages, the book now includes a bigger and better buyer's guide, an interview with James Michener, an exciting real life drama of one SWL's escape from Iran plus much more. Also includes all the latest broadcast schedules from countries around the world. You're up-to-date if you have a copy of this new book by your radio. 416 pages 1989 Edition © 1988
• IB9-RD89 Softbound $14.95

MASTERING PACKET RADIO: the hands on guide
by Dave Ingram KATWJ
Packet radio continues to grow at a rate that boggles the mind. This new book appeals to all levels of packet radio enthusiasts from novices to experts alike. Full of illustrations and written in a simple, easy-to-understand style. Topics covered include: a basic primer, home computers and data communications terminals, a survey of equipment available, how to set up a station plus much more. Great compliment to the other packet books available. 208 pages © 1988 1st edition
• 22567 Softbound $12.95

THE ARRL SATELLITE ANTHOLOGY
Taken from the pages of the "Amateur Satellite News" column in QST. Includes the latest information available on OSCARs 9 through 13 as well as the Russian RS satellites. Full coverage is given to Phase III, OSCAR 10 and 13 satellites. Also includes an unpublished article detailing UoSAT-OSCAR 11 operation. Digital modes, tracking, antennas, RUDAK, microcomputer processing of telemetry plus much more is contained in this valuable new volume. 112 pages © 1988
• AR-SA Softbound $4.95

22nd CENTRAL STATES VHFSOCIETY CONFERENCE PAPERS
Papers in this book were submitted for the 1988 Central States VHFSociety meeting. Includes: Microwave EME, predicting 144 MHz 'Es' openings, matching versus noise figure trade-offs in pre-amps, 40/2 MHz transverter, power amplifier and antennae, how to measure your own K index plus much more. A must publication for the active VHF'er. © 1988
• AR-2 CCS Softbound $11.95

GENIUS AT RIVERHEAD a profile of H. H. Beverage
by Alberta Wallen
Born at the very beginning of the radio age, Harold Beverage is one of radio's pioneers. Most knew him from his development of the Beverage or wave type receiving antenna. Learn about the career of this brilliant engineer in this easy-to-read biography. Starting with GE in 1917 and moving to RCA in 1920, Beverage was involved in some of the most exciting aspects of radio. Of particular interest is a reprint of the famous November 1922 QST article describing the wave antenna. Includes 35 photos. 130 pages © 1988
• NH-BEV Hardcover $15.95

THE "GROUNDS" FOR LIGHTNING & EMP PROTECTION
by Roger Block, PolyPhaser Corporation
Here's a subject that has never really been fully covered in Amateur literature. This 116 page text contains a comprehensive analysis of proper grounding and protection against lightning and other EMP disasters. Includes information for all kinds of electronic gear, radios, telephones, computers, Ethernet, CATV, TVRO, and security systems to name just a few. Of special interest to Hams are chapters on low inductance grounds and connections, guy anchor grounding, and how to ground inside the shack. Every Ham should have a copy. 1st edition 116 pages © 1987
• PP-GLEP Softbound $19.95

Please enclose $3.50 shipping & handling.

HAM RADIO
(603) 878-1441
GREENVILLE, N.H. 03048

DATATEL 800™
(800) 341-1522
(ORDERS ONLY)
Do the Hop; up to 2400 Baud Packet!

Faster is Better; Speedy 2400 Baud

Faster is better for files.

2400 baud is twice as fast for files as formerly speedy 1200 baud, reducing chances for error during transmission. And speeding along long data strings, which helps keep the airwaves open. And you can still select 300 or 1200 baud in seconds.

FASTFILE™ is a powerful terminal program for PCs and compatibles that performs neat, fast file transfers.

You'll receive FASTFILE free, but you should also look at its big brother, PACFILE™, an exclusive Kantronics file transfer program for only $29.95.

New! VERY Special Suggested Price

Normal suggested retail for our KPC-2400™ unit was $329.00. The new breakthrough suggested retail is just $199.00! A 40% savings!

FREE Kantronics' FASTFILE™

Advanced Feature List

The KPC-2400 is not only the fastest packet on four rubber feet, but has all these "Designed and Built in the U.S.A." features:

*Watchdog timer
*Personal Packet Mailbox™
*WEFAX command
*Software-selectable 300/1200/2400 baud rate
*KA-NODE™
*TCP/IP compatibility
*32K RAM

Also "built in" is Kantronics' uncomparable commitment to service. So there's no better time than now to get into Packet. Jump in or up with the Kantronics KPC-2400™!

Kantronics
RF Data Communications Specialists

1202 E. 23 St., Lawrence, KS, 66044 (913) 842-7745
**KCMAO**

**LIST**

<table>
<thead>
<tr>
<th>IC</th>
<th>LIST</th>
</tr>
</thead>
<tbody>
<tr>
<td>IC-171</td>
<td>3690.00</td>
</tr>
<tr>
<td>IC-173</td>
<td>4490.00</td>
</tr>
<tr>
<td>IC-174</td>
<td>4490.00</td>
</tr>
<tr>
<td>IC-175</td>
<td>4490.00</td>
</tr>
<tr>
<td>IC-176</td>
<td>4490.00</td>
</tr>
</tbody>
</table>

**DUE**

<table>
<thead>
<tr>
<th>IC</th>
<th>DUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>IC-171</td>
<td>3993.96</td>
</tr>
<tr>
<td>IC-173</td>
<td>4788.96</td>
</tr>
<tr>
<td>IC-174</td>
<td>4788.96</td>
</tr>
<tr>
<td>IC-175</td>
<td>4788.96</td>
</tr>
<tr>
<td>IC-176</td>
<td>4788.96</td>
</tr>
</tbody>
</table>

**ICOM**

**LIST**

<table>
<thead>
<tr>
<th>IC</th>
<th>LIST</th>
</tr>
</thead>
<tbody>
<tr>
<td>IC-171</td>
<td>3690.00</td>
</tr>
<tr>
<td>IC-173</td>
<td>4490.00</td>
</tr>
<tr>
<td>IC-174</td>
<td>4490.00</td>
</tr>
<tr>
<td>IC-175</td>
<td>4490.00</td>
</tr>
<tr>
<td>IC-176</td>
<td>4490.00</td>
</tr>
</tbody>
</table>

**DUE**

<table>
<thead>
<tr>
<th>IC</th>
<th>DUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>IC-171</td>
<td>3993.96</td>
</tr>
<tr>
<td>IC-173</td>
<td>4788.96</td>
</tr>
<tr>
<td>IC-174</td>
<td>4788.96</td>
</tr>
<tr>
<td>IC-175</td>
<td>4788.96</td>
</tr>
<tr>
<td>IC-176</td>
<td>4788.96</td>
</tr>
</tbody>
</table>

---

**MICROPOWER-2** is our remarkably compact, 18-inch unit using upgraded TAPR TNC-2 technology that requires less than 40 millamps! For very portable operation, solar battery, you need not pay more for a TNC that’s about the size of your HT! Was $179.95, now at a low $159.95

- Fully compatible with ROSE & NET/ROM EPROMs.
- 32K RAM, 32K ROM, 4.9 mHz CPU.
- Xiall controlled modem, compatible with use on 10m HVE/HVF.

**MAIL ORDER, toll-free with major charge card, toll-free 1-800-223-3511**

**EVERY ISSUE of HAM RADIO now available on microfiche!**

The entire run of Ham Radio Magazine (March, 1988 thru last year) is ready to ship to you in one, easy to use format.

Our 24x microfiche is easy to read and very compact. We offer a hand held reader for $75, and a desk model for $200. Libraries have these readers.

As a bonus, you will receive Ham Radio Horizons (3/77 thru 12/80) free.

Everything is included, front cover to back - ads too!

Annual updates will be offered for $10.

Send $185 payment (visa/mc accepted) to:

**BUCKMASTER PUBLISHING**

Route 3, Box 56

Mineral, Virginia 23117

703/894-5777

visa/mc 800/282-5528
USING KISS

By Michael Pechura, WA8BXN, CIS Department, Cleveland State University, E. 24th at Euclid Avenue, Cleveland, Ohio 44115

Format your packets for readable display

In the October issue, I talked about the basics of displaying the information found in individual packet radio packets using KISS mode. You'll recall that KISS sends raw packet frames from the TNC to a computer as a set of bytes, without interpreting the header or other content of the packets.

This month I'll look at packet format and how to display the various fields in a readable form. I'll also discuss BASIC programs that can be run on either a C-64 or an IBM PC computer.

Each packet consists of two major portions: the header and the data portion. For some packets, the data portion isn't used. Within the header there are also two parts: the address and the command byte. The address contains the calls of the sending and receiving stations as well as the calls of any digipeaters used. The command byte tells what kind of packet it is along with sequence number information for some types. The relation of these fields is shown below:

<table>
<thead>
<tr>
<th>Packet</th>
<th>Header</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address bytes</td>
<td>Command Byte</td>
<td>PID</td>
</tr>
</tbody>
</table>

The address bytes consist of two or more fields, each 7 bytes long. The first two fields give the destination and origination callsign, respectively. Call these the "tocall" and "fromcall." Any additional fields give digipeater callsigns (the "VIA" list). Thus for the address bytes we have:

<table>
<thead>
<tr>
<th>Address bytes</th>
</tr>
</thead>
<tbody>
<tr>
<td>tocall</td>
</tr>
<tr>
<td>fromcall</td>
</tr>
<tr>
<td>digicall</td>
</tr>
<tr>
<td>digicall</td>
</tr>
</tbody>
</table>

Within each of these callsign fields, the first 6 bytes give the callsign. The last byte gives, among other things, the - # (WA8BXN-01) often found after calls. This byte is called the Secondary Station ID (SSID). These callsign fields can't be printed as ASCII characters as they are found in a packet, because some encoding is done.

The first 6 bytes of each callsign field containing the callsign are each shifted left 1 bit position, making the right bit of each byte equal to zero. If the callsign has less than 6 characters, blanks (also shifted left one bit position) are added on the right to make a total of 6 bytes. The SSID byte also has the SSID number shifted left 1 bit. All these bytes are shifted left one bit position to make room for the bit that indicates the end of the month.
address bytes. All but the rightmost address byte will have a zero bit in its rightmost bit position. The rightmost address byte has a one bit in its rightmost bit position signaling the end of the address bytes.

<table>
<thead>
<tr>
<th>Callsign in address</th>
<th>6-byte callsign shifted left one bit</th>
<th>SSID byte</th>
</tr>
</thead>
</table>

The use of the bits in the SSID byte depend on which callsign it’s associated with -- the to/from calls or digipeater calls. In both cases the SSID number bits are found in the same place:

<table>
<thead>
<tr>
<th>Bit Positions</th>
<th>7</th>
<th>6</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSID number</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

Because the SSID number is a 4-bit number, it can have values of 0 through 15. Callsigns with an SSID number of zero generally don’t show the -0. The rightmost bit of the SSID byte is zero for all SSID bytes (and callsign bytes) except for the last one. Thus the end of the address field of a packet is indicated by a one bit in the rightmost bit of an SSID byte. Bits 5 to 7 of an SSID byte have different meanings. For example, bit 7 in the SSID byte is used with digipeater calls. When set to 1 it means that a digipeater has repeated the packet.

The “tocall” of WA8BXN-3 is an example of a callsign field. The hex for the ASCII representation of WA8BXN is 57 41 38 42 58 4E. Each of these bytes must be shifted left one bit position. Because the ASCII coding of characters uses only 7 bits, no information is lost by this left shift. The W (0101011 in binary) becomes hex AE (10101 110 in binary). The SSID number (3) in binary is 0011. Thus we have:

<table>
<thead>
<tr>
<th>W A 8 B X N - 3</th>
<th>Original callsign</th>
</tr>
</thead>
<tbody>
<tr>
<td>AE 82 70 84 B0 9C 06</td>
<td>Encoded callsign</td>
</tr>
</tbody>
</table>

If this had been the last callsign in the address, the SSID byte would have been 07. If this was the digipeater call of a digipeater that repeated this packet, the SSID byte would be 86 (or 87 if it was the last digipeater).

There are three basic kinds of command bytes for the three kinds of packets. The rightmost 1 or 2 bits of the command byte indicate the type of packet:

<table>
<thead>
<tr>
<th>Command Byte</th>
<th>0</th>
<th>1</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information frame</td>
<td>Supervisory frame</td>
<td>Unnumbered frame</td>
<td></td>
</tr>
</tbody>
</table>

The use of the remaining bits in the command byte depends on the packet type. In the case of an Information frame (I), there are two sequence numbers and a Poll bit. The sequence numbers are N(S), the sequence number of this frame, and N(R), the sequence number of the next I frame expected in reply. The sequence numbers take on values of 0 through 7 and then repeat. Use of the Poll bit varies; its value will be displayed later.

<table>
<thead>
<tr>
<th>N(R)</th>
<th>Poll</th>
<th>N(S)</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information frame</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

There are three kinds of Supervisory frames; all are used to acknowledge receipt of I frames. Each contains an N(R) sequence number; i.e., the sequence number N(S) expected in the next I frame received. This acknowledges reception of all lower numbered I frames. A Poll/Final bit is also found in the command byte. It, too, will be displayed later.

<table>
<thead>
<tr>
<th>N(R)</th>
<th>P/F</th>
<th>0</th>
<th>0</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Receive Ready (RR)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N(R)</td>
<td>P/F</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Receive Not Ready (RNR)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N(R)</td>
<td>P/F</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Reject (REJ)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The final command type (Unnumbered) has the most variations. The majority of them have to do with connecting and disconnecting. This group contains beacon transmission information. In each command byte of this group the rightmost 2 bits are both 1s, indicating that it’s a U frame. Five bits are used to specify the particular command. They are split into groups of 3 bits and 2 bits with a Poll and/or Final bit in between them.

<table>
<thead>
<tr>
<th>0</th>
<th>0</th>
<th>0</th>
<th>P/F</th>
<th>0</th>
<th>0</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unnumbered Information</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>F</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Disconnected Mode</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>P</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Set Async Balanced Mode</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>P</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Disconnect</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1</td>
<td>F</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Unnumbered Acknowledge</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>F</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Frame Reject</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

With 5 bits to specify the particular function to be done, there could be as many as 32 different functions. Only the 6 given above are typically used in packet radio. Unnumbered Information frames contain data bytes following the command. These frames are often used for beacons and are sent when a TNC is used in Converse mode, while not connected to another station.

Some of these commands are often used in pairs. For example, to establish a connection the Set Asynchronous Balanced Mode (SABM) command is sent. The expected reply to this is Unnumbered Acknowledge (UA). If the station to which the SABM is sent doesn’t wish to enter into a connection, the reply will be Disconnected Mode (DM). This usually causes a "Busy" message to be displayed.

52 December 1988
Disconnect (DISC) is sent to terminate a connection. The reply to this is normally UA.

The last of the Unnumbered frame types is Frame Reject (FRMR). This packet type is sent when an error is detected that can’t be corrected by simply resending an improperly received frame. Three data bytes that try to indicate what went wrong follow the command byte.

The last packet field requiring some explanation, contains the data bytes. Data bytes are found only in I frames and UI frames. The data field contains a Protocol Identifier (PID) byte followed by zero or more actual data bytes. Normally the PID is FO in hex. Other PID values may be used by some variations of the standard protocol. A PID of hex CF is used between NET/ROMS nodes, for example.

This short explanation of the fields found in packets gives the basic information you need to understand what the program displays. A more complete description of the AX.25 protocol is found in the book AX.25 Amateur Packet-Radio Link-Layer Protocol, published by the ARRL. This book discusses how these fields are used and the way they inter-relate to each other, along with details on their format.

The program presented in this article gives you another way to understand how all these formats and commands fit together. It lets you watch the packets in action, with all the fields displayed in a readable fashion. The only thing you can’t see are the CRC bytes in the packets. These are checked by the TNC and not made available to the computer.

I’ve provided two versions of the program — one for the IBM PC (and clones) in fig. 1 and one for the C-64 in fig. 2. Both are very similar so the program discussion applies to either. They’ve been written for use with a Kantronics TNC that has been set up for operation at 600 baud between the TNC and computer.

I minimized the program comments in the interest of increased speed and reduced typing. The program can be divided into the following sections:

Lines | Purpose
---|---
20 — 30 | Initialize serial port and screen colors. In IBM PC version, substitute COM1 or COM2 where appropriate.
40 | Put TNC in KISS Mode. Modify or delete as needed for non-Kantronics TNCs.
50 | Wait for beginning of frame (hex CO = 192 decimal).
60 | Get & ignore 0 byte, print separator line.
70 | Clear string TXT$ (will be used in later addition).
80 | Get & print tocall <---from call.
90 — 120 | Get & print digipeater list.
140 | Get command byte.
150 | If other than I frame continue at 270.
160 — 170 | Display I frame command fields.
180 | Get & display PID byte in hex.
190 | Get & test next byte. If hex CO it’s end of frame, so go back to 50 to wait for next packet.
200 — 250 | If data byte is printable, print as character. If not, then line 250 displays it in Hex in a different color. The C-64 version swaps capital and lower case letter codes to make them appear right on the screen.
280 — 330 | If it’s a Supervisory frame, print fields of command then continue at line 190 to print any data found (there shouldn’t be any).
350 — 430 | Display Unnumbered frame’s command name and P/F bit. If frame is UI frame, go to line 180 to show PID and data. Otherwise go to line 190 to read hex CO byte that ends frame.
450 — 490 | Subroutine to read 6 bytes of callsign (shifting each right 1 bit by dividing by 2) and print them. SSID number is extracted from 7th byte read and printed if not zero.
500 — 550 | Wait for byte to arrive from TNC then read it. If it’s one of the special pairs (DB DC or DB DD) return the single byte for which they appear.
560 | Print the number in A as two hex characters.

After typing the appropriate version of the program into the computer, be sure to save it before you proceed. If you find and correct any syntax errors, save the program again before running. Before running the program make sure the TNC is set up for 600 baud operation to the computer.

The following is representative of what you should see as output from the program. The actual number of characters per line seen on the screen will be different from the lines lengths used here. Those data bytes that aren’t printable as characters are represented instead as two hex digits, displayed in a different color from other data bytes.

```
W8XXX<--KX8XX: UNNUMBERED FRAME
UNNUMBERED ACKNOWLEDGE F = 0
--------------------------------
W8XXX<--KX8XX: SUPERVISORY FRAME  N(RCV) = 1 P/F = 0  RECEIVE READY
--------------------------------
BEACON<--AX6X: UNNUMBERED FRAME
UNNUMBERED INFORMATION P/F = 0  PID = F0
: AX6X HIGHLAND HTS -- BBS AX6X-20D
--------------------------------
W8XXX<--KX8XX: INFO FRAME  N(RCV) = 0
P = 0  N(SENT) = 1  PID = CF: 9688p8
E86@ AEpA298B2@a@02FB00003
```

December 1988

53
Figure 1

IBM PC version.

KX8XX <- W8XXX: SUPERVISORY FRAME  N(RCV) = 2  P/F = 0  RECEIVE READY

ID <- W8XXX: UNNUMBERED FRAME
UNNUMBERED INFORMATION P/F = 0  PID = F0: Network node (CLEIOID)

KAXXXX-1 <- W8XXX: SUPERVISORY FRAME  N(RCV) = 1  P/F = 0  RECEIVE READY

BEACON <- KX3X VIA KXXX: UNNUMBERED FRAME
UNNUMBERED INFORMATION P/F = 0  PID = F0: Mail for: NWPAWX ALL DX KE3XX NETCOM N3XXX VE3XXXOD

WA8XXX <- W8XXX: INFO FRAME  N(RCV) = 1  P = 0  N(SENT) = 1  PID = F0: ok0D

WA8XXX <- KXXX: UNNUMBERED FRAME  DISCONNECT REQUEST P = 0

NX8 <- KXXX: UNNUMBERED FRAME  DISCONNECT REQUEST P = 0

WA8XXX <- KXXX: INFO FRAME  N(RCV) = 3  P = 0  N(SENT) = 0  PID = F0: ka = po of 10D

C-64 version.

WA8XXX <- KXXX: UNNUMBERED FRAME  DISCONNECT REQUEST P = 0

Most of this information can be displayed using the monitor commands found in most current TCNs, without your having to do any programming. The point of this program isn’t so much to provide a way to display such information, but rather to show how it can be done — and relate what’s in a packet to what’s displayed.

Many program modifications are possible. I strongly suggest that you run it without modification first. One of your initial additions to the program might be to put an asterisk after the call of the station that actually sent an asterisk after the call of the station that actually sent...
HOW DO YOU PACK 7 WATTS, 20 MEMORIES AND SCANNING INTO A HANDHELD?

**IC-2GAT:** 7 Watts
Rx 138-174MHz; Tx 140-150MHz

**IC-4GAT:** 6 Watts
440-450MHz

**IC-32AT:** 5 Watts
Rx 138-174MHz/440-450MHz; Tx 140-150MHz

A New Generation of Powerful, Versatile Handhelds.
Select a new "G Series" or dual band ICOM transceiver and enjoy full base station luxury in a portable unit designed especially for you!

- **Maximum Frequency Coverage.** The IC-2GAT receives 138-174MHz, including NOAA, and transmits 140-150MHz to include CAP and MARS frequencies. The IC-4GAT operates 440-450MHz, and the IC-32AT receives 138-174MHz and operates 140-150MHz/440-450MHz.

- **Most Powerful Handheld!** The IC-2GAT delivers seven watts! The IC-4GAT is six watts and the IC-32AT is five watts! One watt level selectable for local QSO's.

- **20 Memories.** Store any frequency, Tx offset and subaudible tone in any memory. Total flexibility!

- **Programmable Scanning** of band and memories plus easy lockout and instant memory recall.

- **Additional Features.** Battery saver, call channel, all subaudible tones, multi-function LCD readout and DTMF pad.

- **Compatible Accessories.** All ICOM IC-2AT/02AT series battery packs, headsets and speaker mics are interchangeable.

- **Optional UT-40 Beeper** silently monitors a busy channel for your calls. When the pre-programmed subaudible tone is received, the unit beeps and the LCD flashes.
REMEMBER - BUY EARLY
YOUR BEST CHRISTMAS BUYS
GIFT SUGGESTIONS

New Hampshire
New Store Location

UNDER $25
BK136 TECHGEN MANUAL 5.00
CALL BOOKS 1988 24.95
BK141 EXTRA CLASS 5.00
BK120 REPEATER DIRECT. 5.00
BK102 *NEW* ANTENNA BK 18.00
LARSEN KD412HQ 16.95
KANTONICS KF-FAX 19.95
ICOM HS10 HEADSET 24.50
ICOM HS10SA/B 24.50
ICOM LC11, 12, OR 14 20.50
ICOM LC24A, 25B, OR 27 13.95
MFD 109 WORLD CLOCK 18.95
MFD 108 24HR, DUAL LCD 19.95
MFD1262 STARTER KIT DISK 19.95
MFD1294 STARTER KITTAPE 19.95
MFD 284 SPEAKMIC 24.95
MFD1702 PPOS, ANT, SWITCH 19.95
UNIDELLA W2AU11 16.95
VANGORDEN HQ-G 14.95
VANGORDEN D10 10M 19.90
VANGORDEN D15 10M 22.95
VANGORDEN D20 20M 22.95
VANGORDEN D40 40M 24.95
VANGORDEN QSL CARD 4.95
ARRL 1989 HANDBOOK 21.95

UNDER $50
ALLIANCE U110 49.95
ANT SPEC AP1513G 35.95
ANT SPEC AP4503G 35.95
CUSHCRAFT CS147M 38.95
CUSHCRAFT ARX28 40.95
CUSHCRAFT ARX450B 40.95
CUSHCRAFT 1248W 38.95
CUSHCRAFT HS10 31.90
ICOM HM46L SPKR MIC 31.99
K2RAG RAG10,15,20 49.95
K2RAG RAG4 2KW BALUN 24.95
K2RAG RAG800M DIPOLE 49.95
KANTRONICS KANTER 29.95
KENWOOD SMCC 30.95
KENWOOD SMCS 49.95
KETSU6 ENCODER 49.95
KETSU6 ENCODER 45.95
LARSEN KG114 49.95
LARSEN KG414PL 49.95
LARSEN AD2/70 43.95
LARSEN KD1412 HQW 29.95
MIF 250 1KW WET 40.95
MIF 200 300W DRY 26.95
MIF 1286 GREY LINE ADV. 29.95
NYE0200 LOWPASSFIT 31.95
NYE 4000PC S.G /MIKEY 29.95
VAN GORDEN QSTV 45.95
VAD 284 SPEAKE BATTERY 41.95
YAESU MH122B 41.95
YAESU MH182B 41.95

UNDER $75
ALINCO ELH230G 2M AMP 72.95
ASTRON RS19A PWR SPLY 61.95
ASTRON RS124PWR SPLY 71.95
B&W ASW60LW, ANT 66.95
BENCHER BY1 BLACK 54.00
BENCHER BY2 CHROME 66.95
ICOM EC143 SPEAKMIC 65.00
ICOM FNB4 64.50
ICOM FNB4 59.95
MC STEREO ENCODER 61.95

UNDER $150
ALLINCO ELH240D 2M AMP 124.95
UNIDEN S3XL SCANNER 135.95
BUTTERNUT HFP6XV 129.00
DIWAL LA2065R 2M AMP 122.95
HYGAIN 18AT/VB 137.95
ICOM SM10 DECK MIC 130.95
MFJ 7270B PCB 119.95
YAESU MD168 DECK MIC 109.95
YAESU SU276 129.95

UNDER $200
CUSHCRAFT AP9 48 4.25 142.95
DOCKING BOOSTER PW20 169.95
HYGAIN 105BS 10M BEAM 173.95
HYGAIN CD4510 Rotor 199.95
ICOM FL44A SSB FILTER 164.95
JPM 15P RWR SUPPLY 156.95
KENWOOD AT130 TUNER 184.95
KENWOOD PS430S 175.00
MFJ 1274 PACKET 152.95
SANGEAN AS7803 RCVR 179.95
UNIDEN 70XLT SCANNER 174.95

UNDER $250
CUSHCRAFT A3 48 HF BEAM 249.95
CUSHCRAFT A4 48 HF BEAM 249.95
DIWAL CNDW19 TUNER 225.95
HEATHKIT HK21 PACKET 215.95
KENWOOD KD317B 220 HZ 239.95
MFJ 1279ALL MODE NCI 225.05
SANGEAN AS5801 RCVR 249.95
SAGENE 2003 SWL RECEIVER 249.95
YAESU 6M726 6M MODULE 234.95

PACKAGE DEALS YAESU
FT-726R
OSCAR SPECIAL $1079.95 includes
FT726A 2m Transceiver
MH186 Hand Mic
430 MHz UHF Module
SU726 Duplex Unit
UPS Brown Shipping

MFJ 1278 $244.95 includes
MFJ 1278 TNC
1284 Starter Package
UPS Brown Shipping

PARAGON $2250.00 includes
585 Paragon
961 Power Supply
705 Desk Mic
UPS Brown Shipping

Orders & Quotes Toll Free 800-444-4799
Prices are subject to change without notice or obligation

ege inc
New Fall1988 Buyers Guide/Catalog
Available-Send $1

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

EVE NEW ENGLAND
224 N. Broadway
Salem, New Hampshire 03079
New England (NH Included)
Toll Free: 800-444-0047
Info & Service: (603) 681-3750

Store Hours: M - F 10-6; Sat: 10-4
Order Hours: M - F 9-6; Sat: 10-2

We Accept:

Our Associate store:
Lachambro Distributors
1225 Johnson Road
P.O. Box 293
Lacombe, Louisiana 70445
Phone: (504) 885-5555

12/88
Choice Selection.

Now you can have it all! Take all the qualities you've come to depend on in our programmable CTCSS tone equipment: Astonishing Accuracy, Instant Programming, Unequaled Reliability, and add full spectrum tone versatility multi-tone capability without diodes, a reprogrammable memory... It's our new harvest of CTCSS tone equipment.

The choice is yours! If standard CTCSS EIA tones do not suit your taste, select any 32 tones of your liking from 15.0Hz to 255.0Hz. And if you change your mind, no problem; the memory can be changed in your shop with our HHPI programmer, or at our factory for free. Your working tone is accessed by a simple DIP switch, so there's no fussing with counters or other test equipment.

Call today toll-free and find out more about this fresh new flexibility in tone signalling, and don't forget to ask about multi-tone switching without cumbersome diode networks or binary switches. It's all brought to market by the people who introduce the freshest ideas in tone signalling, and of course our customary same day shipping and one year warranty apply.

TS-32P CTCSS ENCODER-DECODER Based on the time proven TS-32, the industry standard for over a decade. The TS-32P gives you the added versatility of a custom, changeable memory base. A low price of $57.95 makes it an even sweeter deal.

SS-32P ENCODER Based on the equally popular SS-32 encoder. Available for CTCSS, or audible burst tones up to 6550.0Hz. Price is $28.95.

SS-32SMP SUB-MINIATURE ENCODER Our smallest encoder for handheld applications. Now you can satisfy that customer that needs to access multiple repeater sites with a radio that has precious little space inside. At $27.95, the price is small too.

HHPI HANDHELD PROGRAMMER For programming the 32 memory locations in any of our new programmable products, including our SD-1000 Two-Tone Sequential decoder. The HHPI is battery operated for field use, and will program ANY 32 tones from 15.0 to 6550.0Hz in .1Hz. increments. Price is $199.95.

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
Super Comshack 64
Model CS64S $349.95 + $4.00
shipping USA; incl. pre-wired, tested computer interface, disk, cables & manual (simplex version on request)

SYSTEM OPTIONS
*External Relay Controls 3 DPDT relays; 5 Open col. out...CS-8 $79.95
*Convert rotor D.C. meter voltage to digital display & voice...HM1 $49.95
*2 Voice Meter & Alarm inputs/8 On/off cont. /Packet.BBS..PK8 $149.95
*EPROM Auto boot Cartridge custom with your system.......CART...$99.95
*Manual (Refunded)..........MN1 $15.00

12 volt C64 SWITCHER
*Power C64 & 1541
*70Khz 75% efficient
*Outputs 5v.@2A & 9 VAC @ 60Hz
*Crystal time base
*Plugs into C64
MODEL DCPS...........$119.95

Touchtone 4 Digit Decoder & Quad Relay Expansion
*TSDQ Decoder AQUAD Option
*+8 to +20 V. supply; low power drain
*Field prog. jumpers; 50,000 codes
*Momentary & Latching; DPDT relay
*Wrong dig. reset; LED's digits+ latch
*24 Pin Conn. hook up & Expansion
*Quad adds (4) DPDT 2A. Relays & Individual 3 to 5 Digit on/off codes
*Status outputs; wired & tested
TSDQ $79.95 QUAD $99.95 wired & tested
Cushcraft R4 vertical antenna

The Cushcraft R4 vertical antenna is a newly designed version of the popular R3 model. Like the R3, the R4 is a half-wave no-radial design which covers 20, 15, and 10 meters. Unlike the R3, the R4 adds 12 meters to its frequency coverage, and eliminates motorized tuning in favor of a network which provides fully automatic frequency selection. Physically, the R4 is 18-feet long and approximately the same weight as its predecessor. (All hardware is stainless steel.) The R4 also looks different, sporting newer style traps, a capacitive hat, and 4-foot decoupling radials at the base. Maximum power rating is 1800 watts PEP.

Assembly

I found the R4 easy to assemble. Cushcraft’s step-by-step instruction sheet was visual, showing the path of least resistance to final set-up without wasting a lot of words. For tools, I used a straight-blade screwdriver, a small wrench, and a steel measuring tape. The only assembly operation requiring patience was the decoupling radial bracket, a 4-piece affair held together by 12 screws. The rest of the job was easy. The most critical part of the antenna, a section lined with traps and stubs, comes fully pre-assembled from the factory. Only three simple measurements were needed during final assembly to “tune” the antenna.

Installation

The R4 is especially suited to places where installing a beam or horizontal dipole would be difficult or visually unacceptable. The antenna is very light in weight (8 lbs.), with only 1.4 square feet of wind-loading surface. Thus, I was able to mount mine on top of a 10-foot TV-mast pipe and clamp it to the chimney with Radio Shack® ratchet mounts. No guys were needed. When mounting on a small-diameter mast, check to make sure the end of the pipe doesn’t extend past the mounting sleeve and up into the R4’s fiber glass base insulator, since this will detune the antenna. Also, when connecting feedline, use the silicon sealer provided in the hardware pack. Without this, the aluminum UHF connector will eventually corrode, making it impossible to disconnect the coax! Finally, try to mount the antenna up in the clear. The manual warns that close proximity to trees, buildings, feedlines, etc., will upset tuning and degrade performance.

Because the R4 is so easy to assemble and erect, I think it would make a great antenna for portable installations. It quickly breaks into two or three sections for transport, and the decoupling radials (four indestructible mobile-type whips) remove in seconds. Add a telescoping 18-foot mast, and you could be motor-home portable from almost any location!

Performance

The R4 is much simpler to use than the R3, since there are no remote-tuning adjustments to deal with. Band switching is fully automatic. You simply plug in the antenna, and operate.

I conducted my first on-air tests on 20 meters — the band most likely to show any compromise in performance. To keep things interesting, I used relatively low power (a Ten-tec Arcogyo, 50-watt PEPI). I also placed a 20-meter dipole at 55 feet on-line for signal-strength comparisons. My prediction was that the 32-foot dipole would significantly outperform the 18-foot R4 — which had the additional handicap of being parked down between the trees on a single-story roof. However, I was in for a pleasant surprise! After several QSOs, I found both antennas generally performed within one S-unit of each other. While this in no way constitutes reliable “antenna range” testing, it did convince me that any compromise in the R4’s performance due to its shorter length is minor, and possibly offset by a more favorable TOA.

Performance on the other bands was equally impressive. For example, I called CQ on a seemingly-dead 15-meter band, and was answered by FG5T, who gave me a 579 report. At noon, 10-meters yielded several good reports from South America.

Next, I ran SWR curves to see how closely this particular antenna, assembled on a picnic table and installed at my less-than-perfect location, matched those provided by Cushcraft. On all bands, I obtained readings of 1.2:1 or better at the point of resonance, with readings below 2:1 at the band edges. However, not all minimum SWR points landed where Cushcraft predicted they would — or in my favorite band segments. Although it will probably have little impact on actual performance, one day I plan to indulge my compulsion to tweek things just a bit closer.

Conclusion

Overall, I found the Cushcraft R4 easy to assemble and install. It’s also easy to look at. For those reasons alone, I think it would make a great antenna for apartment, condo, motorhome, or portable use. But, beyond that, I was especially impressed with how well it worked. I think the R4 is a winner and I can recommend it.

K1BQT

DRSI PC*Packet Adapter and software

In twenty years, we’ll look back at the ’80s as the decade of the computer. Oh sure, they were available earlier, but they were more a curiosity and had limited capacity. Today there’s a wealth of different machines available and you can pick and choose.

One of the most popular computer designs is the IBM PC and its various clones. Prices range from less than $800 for a basic 8088 machine to well the sky’s the limit.

Another revolution has occurred in the Amateur field of digital communications. CW and RTTY have been around for years. But Packet Radio (computer to computer communications) has exploded and shows no sign of abating. It was only logical that, sooner or later, someone would mix the two technologies together and come up with a product that includes all the benefits and none of the limitations. One of the biggest complaints many packet users express is that when operating in packet mode, their machine could do nothing else. However, the Packet Adapter and controller software can be turned on and then run in a background mode, freeing you to do whatever you want — without disconnecting from packet. This “running in the background mode” is what distinguishes the PCPA from other packet units.

DRSI’s PC Packet Adapter is a plug-in, state-of-the-art, dual-port communications adapter card for the PC/clone computer. The PCPA has a 1200-baud modem for standard VHF/UHF packet operation. It connects directly to your radio through a DB-9 connector. The second port can be configured for either RS-232 or TTL level outputs. You can use the second port for either a HF modem or connection to a high-speed RF modem, among other possibilities.

The PCPA uses a 9390 serial communications controller running at just a hair under 5 MHz. It has flexible addressing and interrupt provisions. The “guts” of the PCPA include a complete 1200-baud modem on a single chip, controlled by the serial communications controller.

Installation is quick and simple. Disconnect all cables, open the computer, install the board, make up a cable to connect the radio to the TNC, put the computer back together and you’re done. Total time—15 minutes. The toughest part of the job is wiring the cables; DB-9s are awfully small for my big hands. (Pre-made cables are also available from DRSI.)

The key to the PCPA is the controller’s software. The review unit arrived with version 1.0 software. DRSI has since released version 1.2. The program can handle up to 4 connections simultaneously using either version 1 or 2 AX.25 protocol. You’ll be interested to know that the software can run both ports at the same time.

K1BQT (continued on page 70)
Algorithm improves teletype™ performance in noisy environment

Increasing numbers of Amateurs are involved in data communications. On VHF, many hams use fm transmitters to broadcast via Audio Frequency Shift Keying (AFSK). Direct FSK is the normal mode of transmission on hf.

In the absence of fm, hf data transmission is particularly sensitive to noise — especially at the higher data rates. Packet radio, even with its automatic error correction, is affected by high noise sensitivity. This results in frequent retransmission of packets, slowing the data transmission rate. Packet ensures the information will be correctly received eventually. I thought it was possible to do better and looked into ways to minimize this sensitivity.

Hardware fixes

An obvious way to improve noise rejection is to modify the hardware used to convert audio signals into pulses for the computer or TTY. Line A of fig. 1 shows the pulses transmitted to send the letter "R" in Baudot. Figure 2 is a block diagram of a typical demodulator, similar to the ST-5 or the demodulator used in the PK-232. It consists of a limiter followed by a bandpass filter that removes all signals above and below the mark and space tones. A linear discriminator converts the frequency shift information to varying dc levels. The "slicer", a high-gain comparator, converts the discriminator output levels to discrete pulses which can be used to key a TTY or computer. The circuit is vulnerable to interference from spurious signals between the mark and space frequencies.

Figure 3 shows an improved demodulator. It uses separate filters to select the distinct mark and space frequencies, reducing the vulnerability to spurious signals and improving the signal to noise ratio. Other hardware improvements are possible but difficult, so I turned to improving the computer.

Software solutions

The flow chart in fig. 4 shows how computer programs convert serial data to parallel information for storage and display. The input line is sampled at a rate that is a multiple of the bit rate. For this example, I've chosen a factor of 7. The computer samples the input for a start pulse. If one is present, the computer waits for one-half of the bit time and samples again. If the start bit is still there, the computer accepts this as a valid start pulse rather than noise. Delaying half a bit time puts the sample window near the center of each bit. The computer now delays a whole bit time and samples the input line for the first bit. After another full bit time delay, the computer gets the next bit. This continues until the last bit has been received and the entire character has been assembled. The character is now placed in a buffer to be stored, processed, or displayed. In fig. 1, line B shows the sample window. It is shown as a spike because it is so much shorter than the bit time (typically a few microseconds). Line C shows the data as the computer receives it — displaced by one-half bit time. The original pulse relationships and timing are maintained despite the delay. This sampling method resembles that used by hardware serial to parallel converters (ACIAs) like the 6551 and 6850.

In a noise-free system, the pulses emerging from the demodulator are identical to the original. In a noisy environment, the demodulator's discriminator contains noise which can corrupt the slicer's output (even though it's low-pass filtered). Line G of fig. 1 shows the slicer output, and line H shows what the computer sees — an incorrect character which occurs because the computer looks at such a small window of the total bit time. A single noise pulse can corrupt the data, even though most of the bit is intact. Most Amateur systems waste time between samples; it is possible to use this time to make the computer smarter.
Waveform renditions of the letter "R" at various system locations.
Typical RTTY demodulator.

Improved RTTY demodulator.

If you are monitoring only voice shortwave stations, you are missing half the action! Thousands of shortwave stations transmit in non-voice modes such as Morse code, various forms of radioteletype (RTTY) and facsimile (FAX). The Universal M-7000 will permit you to easily intercept and decode these transmissions. Simple connections to your shortwave receiver and video monitor will enable you to monitor with the most sophisticated surveillance decoder available. No computer is required. See the world of shortwave excitement you have been missing. Requires 115 or 230 VAC. Six month limited warranty.

**Partial List of Modes & Features**
- Morse Code (CW)
- Regular Baudot RTTY
- Variable Speed Baudot
- Bit Inverted Baudot
- ASCII Low Speed
- ASCII High Speed
- ASCII Variable Speed
- SITOR Mode A (ARQ)
- SITOR Mode B (FEC)
- Autor
- ARQ 2 & 4 channel (TDM)
- VFT modes (FDM)
- Russian 3rd Shift Cyrillic
- Facsimile (FAX) AM
- Facsimile (FAX) FM
- Packet AX.25
- Literal Mode
- Databit Mode
- Diversity Reception
- Dual Metering
- Remote Terminal
- Low Tone & High Tone
- Option: Real Time Clock
- Variable & Standard Shift
- Option: Video Display of Facsimile (FAX)
- Option: Rack Mounting Brackets (For 19")

**Universal M-7000 Introductory Pricing:**
- Standard M-7000 ........................................ $ 999.00
- With Real Time Clock Option .................... $1059.00
- With Video FAX Option ........................... $1089.00
- With Clock & Video FAX Option ... $1129.00
- Shipping/Handling (USA) ........................ $ 11.00

**Universal Radio**
1280 Aida Dr. Dept. H
Reynoldsburg, OH 43068
Toll Free: 800 431-3939
In Ohio: 614 866-4267

If you are monitoring only voice shortwave stations, you are missing half the action! Thousands of shortwave stations transmit in non-voice modes such as Morse code, various forms of radioteletype (RTTY) and facsimile (FAX). The Universal M-7000 will permit you to easily intercept and decode these transmissions. Simple connections to your shortwave receiver and video monitor will enable you to monitor with the most sophisticated surveillance decoder available. No computer is required. See the world of shortwave excitement you have been missing. Requires 115 or 230 VAC. Six month limited warranty.

**Partial List of Modes & Features**
- Morse Code (CW)
- Regular Baudot RTTY
- Variable Speed Baudot
- Bit Inverted Baudot
- ASCII Low Speed
- ASCII High Speed
- ASCII Variable Speed
- SITOR Mode A (ARQ)
- SITOR Mode B (FEC)
- Autor
- ARQ 2 & 4 channel (TDM)
- VFT modes (FDM)
- Russian 3rd Shift Cyrillic
- Facsimile (FAX) AM
- Facsimile (FAX) FM
- Packet AX.25
- Literal Mode
- Databit Mode
- Diversity Reception
- Dual Metering
- Remote Terminal
- Low Tone & High Tone
- Option: Real Time Clock
- Variable & Standard Shift
- Option: Video Display of Facsimile (FAX)
- Option: Rack Mounting Brackets (For 19")

**Universal M-7000 Introductory Pricing:**
- Standard M-7000 ........................................ $ 999.00
- With Real Time Clock Option .................... $1059.00
- With Video FAX Option ........................... $1089.00
- With Clock & Video FAX Option ... $1129.00
- Shipping/Handling (USA) ........................ $ 11.00

**Universal Radio**
1280 Aida Dr. Dept. H
Reynoldsburg, OH 43068
Toll Free: 800 431-3939
In Ohio: 614 866-4267

If you are monitoring only voice shortwave stations, you are missing half the action! Thousands of shortwave stations transmit in non-voice modes such as Morse code, various forms of radioteletype (RTTY) and facsimile (FAX). The Universal M-7000 will permit you to easily intercept and decode these transmissions. Simple connections to your shortwave receiver and video monitor will enable you to monitor with the most sophisticated surveillance decoder available. No computer is required. See the world of shortwave excitement you have been missing. Requires 115 or 230 VAC. Six month limited warranty.

**Partial List of Modes & Features**
- Morse Code (CW)
- Regular Baudot RTTY
- Variable Speed Baudot
- Bit Inverted Baudot
- ASCII Low Speed
- ASCII High Speed
- ASCII Variable Speed
- SITOR Mode A (ARQ)
- SITOR Mode B (FEC)
- Autor
- ARQ 2 & 4 channel (TDM)
- VFT modes (FDM)
- Russian 3rd Shift Cyrillic
- Facsimile (FAX) AM
- Facsimile (FAX) FM
- Packet AX.25
- Literal Mode
- Databit Mode
- Diversity Reception
- Dual Metering
- Remote Terminal
- Low Tone & High Tone
- Option: Real Time Clock
- Variable & Standard Shift
- Option: Video Display of Facsimile (FAX)
- Option: Rack Mounting Brackets (For 19")

**Universal M-7000 Introductory Pricing:**
- Standard M-7000 ........................................ $ 999.00
- With Real Time Clock Option .................... $1059.00
- With Video FAX Option ........................... $1089.00
- With Clock & Video FAX Option ... $1129.00
- Shipping/Handling (USA) ........................ $ 11.00

**Universal Radio**
1280 Aida Dr. Dept. H
Reynoldsburg, OH 43068
Toll Free: 800 431-3939
In Ohio: 614 866-4267

If you are monitoring only voice shortwave stations, you are missing half the action! Thousands of shortwave stations transmit in non-voice modes such as Morse code, various forms of radioteletype (RTTY) and facsimile (FAX). The Universal M-7000 will permit you to easily intercept and decode these transmissions. Simple connections to your shortwave receiver and video monitor will enable you to monitor with the most sophisticated surveillance decoder available. No computer is required. See the world of shortwave excitement you have been missing. Requires 115 or 230 VAC. Six month limited warranty.

**Partial List of Modes & Features**
- Morse Code (CW)
- Regular Baudot RTTY
- Variable Speed Baudot
- Bit Inverted Baudot
- ASCII Low Speed
- ASCII High Speed
- ASCII Variable Speed
- SITOR Mode A (ARQ)
- SITOR Mode B (FEC)
- Autor
- ARQ 2 & 4 channel (TDM)
- VFT modes (FDM)
- Russian 3rd Shift Cyrillic
- Facsimile (FAX) AM
- Facsimile (FAX) FM
- Packet AX.25
- Literal Mode
- Databit Mode
- Diversity Reception
- Dual Metering
- Remote Terminal
- Low Tone & High Tone
- Option: Real Time Clock
- Variable & Standard Shift
- Option: Video Display of Facsimile (FAX)
- Option: Rack Mounting Brackets (For 19")

**Universal M-7000 Introductory Pricing:**
- Standard M-7000 ........................................ $ 999.00
- With Real Time Clock Option .................... $1059.00
- With Video FAX Option ........................... $1089.00
- With Clock & Video FAX Option ... $1129.00
- Shipping/Handling (USA) ........................ $ 11.00

**Universal Radio**
1280 Aida Dr. Dept. H
Reynoldsburg, OH 43068
Toll Free: 800 431-3939
In Ohio: 614 866-4267
Track The Weather With Your Own Personal Weather Station

Don't let the weather catch you off guard. Plan your activities using the precision-crafted Heathkit® ID-5001 Advanced Weather Computer.

Powerful enough for commercial use, the ID-5001's striking cobalt blue liquid crystal display indicates wind speed, humidity, rainfall, high and low temperatures, and more. You'll find at your fingertips everything you need to keep you up-to-date on changing climate conditions.

The Advanced Weather Computer is an intelligent system, sounding alarms whenever threatening weather approaches. In addition, the ID-5001 is the only weather instrument known which automatically averages wind speed and direction to FAA/NWS standards and gives true values for wind speed and wind direction.

The ID-5001 features: • High accuracy digital barometer • Display of indoor and outdoor temperatures • Push-button display of minimum and maximum readings • 32-point wind direction resolution • Display of indoor and outdoor relative humidity • Digital clock/calendar and much more!

Attractive enough to display in your home, the Advanced Weather Computer is just one of many exciting products in the Heathkit catalog. You'll discover 108 color pages packed full of electronic products in kit and assembled form including TVs, VCRs, computers, test instruments, as well as our new high-tech audio line.

The ID-5001 and all our other fine electronic products can be found in our FREE Heathkit catalog. For your copy, call 24 hours a day TOLL FREE:

1-800-44-HEATH
(1-800-444-3284)

Heath Company
THE ULTIMATE YOU CAN OPERATE SIX BANDS 150 W. WITH ONE CONTROLLER!

HF TRANSCEIVER

ICOM IC-761

A Models 25W, H Models 100 W

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

LOW PRICE!

ICOM IC-735

100 W, 100 KHz-30 MHz
Dual VFO Receiver

CALL FOR LOW, LOW PRICE

NOW! RAPID DELIVERIES FROM STORE NEAREST YOU

COAST TO COAST

COAST TO COAST

ICOM IC-781

THE ULTIMATE 150 W, ALL BAND HF TRANSCEIVER

GREAT PRICE!

ICOM IC-900 MULTI-BAND MOBILE

YOU CAN OPERATE SIX BANDS WITH ONE CONTROLLER!

2 MTR/25/45/8W, 440 MHz, 10 MTR, 6 MTR, 220 MHz & 1.2 GHz, 10 MEMORIES

ARE YOU READY FOR 1.2 GHz OPERATION?

ICOM HAND-HELD VHF/UHF

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

SALE 269.95

SALE: 329.95

ICOM IC-38A/TT*

220 MHz

(RECENT FCC CHANGES DID NOT EFFECT NORMAL 220 MHZ FM OPERATING FREQUENCIES)

*Includes touchtone

All Major Brands in Stock Now!

Anaheim, CA 92801
3265 W. La Palma
(714) 761-3033. (213) 380-2840
Between Disneyland & Knotts Berry Farm

Atlanta, GA 30324
6661 Buford Hwy
(404) 263-0100
Larry Mgr. WB4AGW
Doraville 1 mi. north of I-285

Burlingame, CA 94010
669 Howard Ave
(415) 343-5757
George Mgr. W8BDSV
5 miles south on 101 from SFO

Oakland, CA 94606
2210 Livingston St
(415) 544-5757
Al Mgr. WA6ASY
1749 16th Ave /175-18th Ave

PHOENIX, AZ 85015
1702 W. Camelback Rd
(602) 242-3515
Bob Mgr. K7QPR
EAST OF MARY 17

San Diego, CA 92123
5215 Kearny Villa Rd
(619) 560-4500
Tom, Mgr. KEMK
Hwy. 163 & Claremont Mesa Blvd

VAN NUYS, CA 91411
6255 Sepulveda Blvd
(818) 988-2127
Al Mgr. K5RBA
San Diego Hwy at Victory Blvd

STORE HOURS
10 AM-5:30 PM
CLOSED SUNDAYS

OUTSIDE CALIFORNIA CALL TOLL FREE (800) 854-6046 INSIDE CALIFORNIA CALL STORES DIRECT

Toll free including Hawaii. Phone hrs: 7:00 am to 5:30 pm. 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.

Reader Service CHECK-OFF Page 126
Symbol of Engineering Integrity... Quality Workmanship... Reliable Long-Life Performance

AL-80A Linear Amplifier

The AL-80A will provide a signal output that is within 1/2 "S" unit of the signal output of the most expensive amplifier on the market—and at much lower cost.

The Ameritron AL-80A combines the economical 3-500Z with a heavy duty tank circuit to achieve nearly 70% efficiency from 160 to 15 meters. It has wide frequency coverage for MARS and other authorized services. Typical drive is 65 watts to give over 1000 watts PEP SSB and 850 watts CW RF output. A new PI-L output circuit for 80 and 160 gives full band coverage and exceptionally smooth tuning.

Size: 15½"D x 14"W x 8"H Wgt: 52 lbs.

AL-1200 Linear Amplifier

3CX1200 Tube

Full legal output with 100 watts drive.

AL-1500 Linear Amplifier

8877 Tube

Full legal output with 65 watts drive.

The cooling system in both amplifiers keeps the tube safely below the manufacturer's ratings even when operating at 1500 watts output with a steady carrier. The filament supply has inrush current limiting to insure maximum tube life.

Size: 18½"D x 17"W x 10"H Wgt: 77 lbs.

AL-84 Linear Amplifier

The Ameritron AL-84 is an economical amplifier using four 6MJ6 tubes to develop 400 watts output on CW and 600 watts PEP on SSB from 160 through 15 meters. Drive required is 70 watts. The passive input network presents a low SWR input to the exciter. Power input is 900 watts. The AL-84 is an excellent back-up, portable or beginner's amplifier.

Size: 11½"W x 6"H x 12½"D Wgt: 24 lbs.

ATR-15 Tuner

The Ameritron ATR-15 is a 1500 watt "T" network tuner that covers 1.8 through 30 MHz in 10 dedicated bands. Handles full legal power on all amateur bands above 1.8 MHz.

Five outputs are selected from a heavy duty antenna switch allowing the rapid choice of three coaxial lines, one single terminal feed or a balanced output. An internal balun provides 1.1 or 4:1 ratios (user selectable) on the balanced output terminals.

A peak reading wattmeter and SWR bridge is standard in the ATR-15. It accurately reads envelope powers up to 2KW.

Size: 6"H x 13½"W x 16"D Wgt: 14 lbs.

RCS-4 Remote COAX Switches

No control cable required. Selects one of four antennas. VSWR: under 1.1 to 1 from 1.8 to 30 MHz. Impedance: 50 ohms. Power capability: 1500 watts average, 2500 watts PEP maximum.

Available at your dealer. Send for a catalog of the complete AMERITRON line.

Ameritron

9805 Walford Avenue • Cleveland, Ohio 44102
For more information: (601) 323-9715 • Technical inquiries: (216) 651-1740
Figure 5 shows a flow chart for an improved algorithm. Initially, the computer takes seven samples per bit time, looking for a start pulse. When it detects a possible start bit, the computer waits two sample periods and takes another sample. (The delay prevents

Serial to parallel decoding algorithm.

December 1988
Every month Monitoring Times brings everything you need to make the most of your general coverage transceiver: the latest information on international broadcasting schedules, frequency listings, international DX reports, propagation charts, and tips on how to hear the rare stations. Monitoring Times also keeps you up to date on government, military, police and fire networks, as well as tips on monitoring everything from air-to-ground and ship-to-shore signals to radiotelephone, facsimile and space communications.

ORDER YOUR SUBSCRIPTION TODAY before another issue goes by. In the U.S., 1 year, $18; foreign and Canada, 1 year, $26. For a sample issue, send $2 (foreign, send 5 IRCs). For MC/VISA orders ($15 minimum), call 1-704-837-9200.

**MONITORING TIMES**

Your authoritative source, every month.

P.O. Box 98 A
Brasstown, N.C. 28902

---

**FIGURE 6**

| Assembly language decoding algorithm for the 6809 microprocessor. |   |

---

<table>
<thead>
<tr>
<th>00100</th>
<th>00110</th>
<th>00120</th>
</tr>
</thead>
<tbody>
<tr>
<td>00125</td>
<td>00135</td>
<td>00145</td>
</tr>
<tr>
<td>00150</td>
<td>00155</td>
<td>00160</td>
</tr>
<tr>
<td>00165</td>
<td>00170</td>
<td>00175</td>
</tr>
<tr>
<td>00180</td>
<td>00185</td>
<td>00190</td>
</tr>
<tr>
<td>00195</td>
<td>00200</td>
<td>00205</td>
</tr>
<tr>
<td>00210</td>
<td>00215</td>
<td>00220</td>
</tr>
<tr>
<td>00225</td>
<td>00230</td>
<td>00235</td>
</tr>
<tr>
<td>00240</td>
<td>00245</td>
<td>00250</td>
</tr>
<tr>
<td>00255</td>
<td>00260</td>
<td>00265</td>
</tr>
<tr>
<td>00270</td>
<td>00275</td>
<td>00280</td>
</tr>
<tr>
<td>00285</td>
<td>00290</td>
<td>00295</td>
</tr>
<tr>
<td>00300</td>
<td>00305</td>
<td>00310</td>
</tr>
<tr>
<td>00315</td>
<td>00320</td>
<td>00325</td>
</tr>
<tr>
<td>00330</td>
<td>00335</td>
<td>00340</td>
</tr>
<tr>
<td>00345</td>
<td>00350</td>
<td>00355</td>
</tr>
<tr>
<td>00360</td>
<td>00365</td>
<td>00370</td>
</tr>
<tr>
<td>00375</td>
<td>00380</td>
<td>00385</td>
</tr>
<tr>
<td>00390</td>
<td>00395</td>
<td>00400</td>
</tr>
<tr>
<td>00405</td>
<td>00410</td>
<td>00415</td>
</tr>
<tr>
<td>00420</td>
<td>00425</td>
<td>00430</td>
</tr>
<tr>
<td>00435</td>
<td>00440</td>
<td>00445</td>
</tr>
<tr>
<td>00450</td>
<td>00455</td>
<td>00460</td>
</tr>
<tr>
<td>00465</td>
<td>00470</td>
<td>00475</td>
</tr>
<tr>
<td>00480</td>
<td>00485</td>
<td>00490</td>
</tr>
<tr>
<td>00495</td>
<td>00500</td>
<td>00505</td>
</tr>
<tr>
<td>00510</td>
<td>00515</td>
<td>00520</td>
</tr>
<tr>
<td>00525</td>
<td>00530</td>
<td>00535</td>
</tr>
<tr>
<td>00540</td>
<td>00545</td>
<td>00550</td>
</tr>
<tr>
<td>00555</td>
<td>00560</td>
<td>00565</td>
</tr>
<tr>
<td>00570</td>
<td>00575</td>
<td>00580</td>
</tr>
<tr>
<td>00585</td>
<td>00590</td>
<td>00595</td>
</tr>
<tr>
<td>00600</td>
<td>00605</td>
<td>00610</td>
</tr>
<tr>
<td>00615</td>
<td>00620</td>
<td>00625</td>
</tr>
<tr>
<td>00630</td>
<td>00635</td>
<td>00640</td>
</tr>
<tr>
<td>00645</td>
<td>00650</td>
<td>00655</td>
</tr>
<tr>
<td>00660</td>
<td>00665</td>
<td>00670</td>
</tr>
<tr>
<td>00675</td>
<td>00680</td>
<td>00685</td>
</tr>
<tr>
<td>00690</td>
<td>00695</td>
<td>00700</td>
</tr>
<tr>
<td>00705</td>
<td>00710</td>
<td>00715</td>
</tr>
<tr>
<td>00720</td>
<td>00725</td>
<td>00730</td>
</tr>
<tr>
<td>00735</td>
<td>00740</td>
<td>00745</td>
</tr>
<tr>
<td>00750</td>
<td>00755</td>
<td>00760</td>
</tr>
<tr>
<td>00765</td>
<td>00770</td>
<td>00775</td>
</tr>
<tr>
<td>00780</td>
<td>00785</td>
<td>00790</td>
</tr>
<tr>
<td>00795</td>
<td>00800</td>
<td>00805</td>
</tr>
<tr>
<td>00810</td>
<td>00815</td>
<td>00820</td>
</tr>
<tr>
<td>00825</td>
<td>00830</td>
<td>00835</td>
</tr>
<tr>
<td>00840</td>
<td>00845</td>
<td>00850</td>
</tr>
<tr>
<td>00855</td>
<td>00860</td>
<td>00865</td>
</tr>
<tr>
<td>00870</td>
<td>00875</td>
<td>00880</td>
</tr>
<tr>
<td>00885</td>
<td>00890</td>
<td>00895</td>
</tr>
<tr>
<td>00900</td>
<td>00905</td>
<td>00910</td>
</tr>
<tr>
<td>00915</td>
<td>00920</td>
<td>00925</td>
</tr>
<tr>
<td>00930</td>
<td>00935</td>
<td>00940</td>
</tr>
<tr>
<td>00945</td>
<td>00950</td>
<td>00955</td>
</tr>
<tr>
<td>00960</td>
<td>00965</td>
<td>00970</td>
</tr>
<tr>
<td>00975</td>
<td>00980</td>
<td>00985</td>
</tr>
<tr>
<td>00990</td>
<td>00995</td>
<td>01000</td>
</tr>
</tbody>
</table>
framing errors.) This pattern continues until three samples have been made. If two or three of the samples indicate that a start bit was present, a valid start is assumed. If not, the computer reverts to sampling each sample period in search of a start bit.

When a valid start bit is detected, the computer waits three sample periods and makes the first sample in the first bit. Three samples are taken per bit, with a delay of two periods between stored samples. After the samples for each bit have been collected, it is determined if the bit was a zero or a one. (I've chosen a simple majority of samples scheme; more sophisticated methods are possible.) This continues until all bits have been received and the character is stored in the buffer. Line I of fig. 1 shows the revised sampling process; line J shows what the computer sees, given the noisy signal shown in lines F and G. Line K shows how the sample results are interpreted, and line L shows the results of the majority of samples. Line M shows the correctly reconstructed pulse train. Obviously, this process is not perfect. A long noise pulse which corrupts several samples within a bit can still corrupt the entire character.

This generic process can be enhanced in several ways. More samples per bit time yield greater noise immunity. The upper limit is determined by the amount of other processing your machine needs to do between samples.

You may wish to sample five times per bit at each sample period instead of every other sample period.

Although I've demonstrated the concept using Baudot code, the data can be simple ASCII or any other serial format. As mentioned earlier, using this process in a packet or AMTOR system can improve throughput by reducing the number of error-related retransmissions.

**Implementation**

How do you put this to use in your system? The timing involved is too fast and critical for interpreted languages like BASIC. I used assembly language for the 6809 microprocessor with 21 samples per bit. (See fig. 6.) A compiled language like C will probably work as well, depending on the speed of your machine and the efficiency of your compiler. While I don't have the test equipment to make quantitative comparisons, on-the-air tests show that the “smart” algorithm is a noticeable improvement over a more conventional scheme.

I'm interested in any results you get using this method, suggestions you may have for improving the technique, or other ways you've found to improve data copy.

**NOTE:** A complete working program for the Radio Shack® TRS80 color computer 3 is available from the author for $15.00. It features split screen, auto capture buffer (SELCALL), and several Baudot speeds as well as 300 baud ASCII.

---

**HAM RADIO SHIRTS and HATS GREAT Holiday Gift Ideas!**

Here's a great way to say you're a HAM RADIO reader. Get a hat with your name and call and wear your HAM RADIO Magazine shirt!

![Hat](image)

Baseball Caps come in gold, blue, red and Kelly green. Please give us the name and call sign you want lettered on the hat (maximum of 6 characters per line.)

- UFBC (comes in gold, blue, red, Kelly green) ........................................ $5.95

**SIZES AVAILABLE:**
- S, M, L, XL

**HAM RADIO shirts come in two attractive styles. The TEE shirt is great for general everyday use. The HAM RADIO polo is for a more formal occasion. Each shirt is made of a 50/50 blend and comes in either blue or red. The new HAM RADIO logo is silk-screened in a vibrant yellow color on the front of each shirt.**

<table>
<thead>
<tr>
<th>Style</th>
<th>Color</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>HR-TEE B</td>
<td>Blue</td>
<td>$9.95</td>
</tr>
<tr>
<td>HR-TEE R</td>
<td>Red</td>
<td>$9.95</td>
</tr>
<tr>
<td>HR-PLO B</td>
<td>Blue</td>
<td>$19.95</td>
</tr>
<tr>
<td>HR-PLO R</td>
<td>Red</td>
<td>$19.95</td>
</tr>
</tbody>
</table>

Please enclose $3.50 to cover shipping and handling.
facilitating “Gateway” station operation — VHF to HF digipeating.

Version 1.2 of the controller software is greatly expanded and includes many of the features advanced packeters are looking for. Significantly updated is the basic TNC controller. Also included is a Terminate and Stay Resident, TSR, driver and THS, a split screen full color terminal program. The TSR program allows you to run the TNC in the “background” while running other PC programs. TSR also has a user-accessible programming interface should you want to customize the program. THS includes pop-up windows for menus and support functions, scroll buffer, ASCII file transfers, connect directory, message storage and printer support. A more complete description is beyond the scope of this review. Also included is Packet Bat, which loads the AX.25 driver and then starts the terminal program.

Using the PCPA is fun, especially if you want to use your computer as more than just a TNC controller. I’m sure that as more people use the card, new and more powerful software will be written to run the PCPA. DRSI has done its homework and offers a very good way to get into packet. Price for the PCPA is $139.95; the HF modem is $7(99,576),(135,686)

DRSI is also distributing AA4RE’s Multi Connect Bulletin Board System. This package is fully compatible with “RLI/MBL” systems, but has the advantage of supporting multiple simultaneous user connections on the same frequency. It does this without using any extra software, like Descview or DoubleDOS. The AA4RE BBS is included with the DRSI PC-Packet Adapter at no cost.

For more information contact: DRSI, 2065 Range Road, Clearwater, Florida 34625.

New Kantronics publications released


The books retail in the United States for $2.95 each, plus $1.00 shipping and handling. To order, contact your Kantronics dealer, HAM RADIO’s Bookstore, or the factory.

For more information contact, Kantronics, Inc., 1202 E. 23rd Street, Lawrence, Kansas 66046.

Circle 302 on Reader Service Card.

Heavy duty antenna rotator

The R9100 rotator is a heavy duty, state-of-the-art unit from the company that brought you the microprocessor controlled 230-series linear amplifier. The R9100 provides 10,000 in-pounds of torque, 23,000 in-pounds braking, and will support a 2,000 pound vertical load. The unit is 14.9 x 25 x 15.1 inches, fits inside Rohn 45 ground tower, and weighs 230 pounds. The control unit provides both analog and digital displays, manual control, and an RS-232 interface for external computer control. Software is provided (enter a prefix and the rotator will turn to the appropriate heading automatically). The unit is sold exclusively by EEB, Vienna, Virginia. The suggested list price is $4,975.

Contact EEB for additional information at 800-368-3270 or 703-938-3350.

Circle 303 on Reader Service Card.

ICOM IC-448, 440-MHz mobile

ICOM is proud to introduce the new IC-448 25-watt 440-MHz mobile. The IC-448 features: a multi-colored LCD, frequency coverage 440-450 MHz, twenty memory channels, programmable scan, memory scan, and priority watch. The IC-448 will be available in October 1988. Suggested retail price is to be announced.

Circle 304 on Reader Service Card.

Versatile CTCSS encoder-decoder

Communications Specialists introduces the TS-32P Programmable CTCSS Encoder-Decoder. It has all the features of the TS-32, but uses a new microcircuit for more tone versatility. The new IC-110 microcircuit in the TS-32P contains a 32-bit reprogrammable memory that allows specification of any 32 tone frequencies from 15.0 Hz to 255.0 Hz. The desired tone frequency can be called from the memory with a five-position DIP switch mounted on the TS-32P circuit board. Frequency accuracy is ±0.01 Hz.

The TS-32P uses custom memory programming to provide multi-tone switching of up to six tones without requiring diode networks. The TS-32P allows easy access to any non-standard tone frequency. The 32-location tone memory can be changed with a handheld programmer available from Communications Specialists, or by returning it to the factory for re-programming at no charge.

The TS-32P measures 1.25" wide x 2.0" long x 0.40" high and operates on 6 to 25Vdc. The retail price of the TS-32P is $57.95. A catalog is available on request.
If you are like our friend on the island, living with limited space, R4 is for you.

That's right, you can forget about towers and rotators. Put away your spade, wire and insulators because you won't need a ground radial system. Cushcraft engineers have performed a miracle by developing a new half wave vertical for 10, 12, 15 and 20 meters that provides great performance using a simple counterpoise ground of four 48" stainless steel rods.

The new R4 has broadband impedance matching giving full coverage and automatic frequency selection of all four bands. All of this with an 18' high, 8 lb. vertical that will handle 1800 watts of power!

With R4 you get quick assembly, easy installation and top gun performance. Whatever your space, large or small, R4 will make ham radio more fun.

Buy R4 and talk to your friends around the world today!

Available through dealers worldwide
48 Perimeter Road, Manchester, NH 03108 USA
603-627-7877 Telex 4949472
Fax 603-627-1764
here is the next generation Repeater
2 meters - 220 - 440

MARK 4CR

The only repeaters and controllers with REAL SPEECH!

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

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

MICRO CONTROL SPECIALTIES
Division of Kendecom Inc.
23 Elm Park, Groveland, MA 01834 (508) 372-3442

TELEX 4932256 Kendecom
FAX 508-373-7304

5-1000 MHZ PREAMPLIFIERS
NF G P(1dB) $ WLA21m 3dB 13dB 8dBm 57 WLA22m 4 11 12 61 WLA23m 4 23 12 87 WLA24m 3 20 18 109

430/50MHZ CONVERTER RCX431 .15Y2 20dB 99

INTERNATIONAL RADIO AND COMPUTERS, INC.

Is pleased to announce that we are now an authorized dealer for ICOM Products.

- We service All ICOM products and, of course, use Factory Service parts.
- We provide a complete check for performance and function on each radio we sell.
- Call us for a quotation on your next ICOM purchase. Master, Visa, American Express cards accepted.
- Servicing Amateur Radio Operators for eight years. Send for your FREE Brochure.

INTERNATIONAL RADIO AND COMPUTERS, INC.
751 South Macedo Blvd.
Port St. Lucie, FL 34983
(407) 879-6868
It's a lesson you learn very early in life. Many can be good, some may be better, but only one can be the best. The PK-232 is the best multi-mode data controller you can buy.

1 Versatility

The PK-232 should be listed in the amateur radio dictionary under the word Versatile. One data controller that can transmit and receive in six digital modes, and can be used with almost every computer or data terminal. You can even monitor Navtex, the new marine weather and navigational system. Don't forget two radio ports for both VHF and HF, and a no compromise VHF/HF/CW internal modem with an eight pole bandpass filter followed by a limiter discriminator with automatic threshold control.

The internal decoding program (SIAM™) feature can even identify different types of signals for you, including some simple types of RTTY encryption. The only software your computer needs is a terminal program.

2 Software Support

While you can use most modem or communications programs with the PK-232, AEA has two very special packages available exclusively for the PK-232...PC Pakratt with Fax for IBM PC and compatible computers, and Com Pakratt with Fax for the Commodore 64 and 128.

Each package includes a terminal program with split screen display, QSO buffer, disk storage of received data, and printer operation, and a second program for transmission/reception and screen display of facsimile signals. The IBM programs are on 5-1/4” disk and the Commodore programs are plug-in ROM cartridges.

3 Proven Winner

No matter what computer or terminal you plan to use, the PK-232 is the best choice for a multi-mode data controller. Over 20,000 amateurs around the world have on-air tested the PK-232 for you. They, along with most major U.S. amateur magazines, have reviewed the PK-232 and found it to be a good value and excellent addition to the ham station.

No other multi-mode controller offers the features and performance of the PK-232. Don't be fooled by imitations. Ask your friends, or call the local amateur radio store. We're confident the PK-232 reputation will convince you that it's time to order your very own PK-232.

Call an authorized AEA dealer today. You deserve the best you can buy, you deserve the PK-232.

Advanced Electronic Applications, Inc.
P.O. Box C-2160
Lynnwood, WA 98036
206-775-7373
A HOMEBREW TUNING DIAL

By John Pivnichny, N2DCH, 3824 Pembrooke Lane, Vestal, New York 13850

Build a smooth, low cost, accurate dial for your next rig

Modern transceivers require precision tuning with zero backlash. This analog dial has 1-kHz markings and a 250-kHz tuning range. I used a commercial plastic circular disc protractor for the dial scale. The dial can be constructed with home workshop tools. The information below can also be used to modify the dimensions, tuning ratio, tuning range, or tuning capacitor for your own homebrew equipment needs.

String drive

The dial's key feature is the use of dial cord and pulleys for the drive mechanism. Selecting the proper pulley diameter makes almost any tuning ratio possible. For example, I wanted to use 250 degrees of dial rotation for a 0 to 250 kHz tuning range and 25 to 30 kHz per turn of the main knob to give a good tuning rate. This is about a 14:1 ratio.

I also wanted to use 160 degrees rotation of the tuning capacitor for this 250-kHz range. The capacitor shaft rotates 1.6 times slower than the dial shaft. A larger pulley provides the right ratio.

Calculations show that you need a 1/16-inch shaft for the main tuning knob, a 2-inch pulley for the dial shaft, and a 3-1/4 inch pulley for the capacitor shaft.

I used a variable capacitor, enclosed in a shield can with an oscillator coil, salvaged from the rear of an ARC5 Command set transmitter. Its ball bearing construction allows the shaft to rotate with very low friction. Most variable capacitors will work, but try to find one of these. Check with the old-timers at your local club or Fair Radio Sales.

Pulley construction

You'll have to make the pulleys, but this isn't hard. The raw material is Plexiglas™ sheets 3/16 or 1/4 inch thick available from glass supply shops. Pulleys with a diameter of 2-3/8 inch or less can be cut with the an electric drill hole cutter. The drill attachment (fig. 1) found in most hardware stores has a series of removable blades. (Another style is also shown.) Cut larger diameters with a jigsaw, coping, or saber saw.

After cutting the disc, remove any imperfections and cut the groove in the outer surface. Enlarge the center hole to 3/8 inch diameter. Find a potentiometer with a locking shaft (fig. 2). It looks like an ordinary potentiometer, but the mounting bearing has four or six slots and a one-way locking nut with a tapered diameter that can be tightened to secure the bearing to the shaft. You will also need five ordinary potentiometers. The resistance value doesn't matter because only the bearing will be used.
of the file to cut the groove. Drill small holes as shown (fig. 3) for the dial cord. This simple operation makes an excellent drive pulley.

**panel mounting**

Bearings, salvaged from the potentiometers, are fixed in a section of sheet aluminum mounted 1-1/16 inches behind the front panel. See fig. 4 for details. A 1 x 3 inch opening is cut in the main panel for the dial window. Two pieces of clear Plexiglas, 1/16 inch thick or less and 1-1/2 by 4 inches, are needed to cover the window opening and serve as a backup for the dial. Scribe a vertical line in the center of the front face on the rear Plexiglas piece. Fill the line with black ink to serve as a cursor. Use machine screws 4-40 x 3/4 inch to mount the Plexiglas parts to the front panel.

**main drive shaft**

A shaft 1/16 inch in diameter used with the main tuning knob drives the dial cord. Make this with brass rod, available at hobby shops. Cut 6-32 machine screw threads with a die as shown. Then thread on 1/4 inch spacers to fit the bearings and permit mounting the tuning knob. I used a 1-3/4 inch knob with two set screws.  

**dial**

Most of the circular protractors I have seen have two sets of numbers, one reading forward and one backward. I recommend you cut a circular disc of just the right diameter from Plexiglas to cover the inner set of numbers. Paint it an opaque color. I also filed a small notch for the 0 and 180 degree markings.

**final assembly**

The capacitor drive and dial pulleys are assembled as shown in figures 5A and 5B. Complete the assembly by mounting three bearings in the mounting bracket and one in the main panel. This one must be aligned with the shaft in place; first tighten the front bearing, then the rear one. You may need to use emery cloth on the shafts to insure smooth operation. Finally, string the dial cord as shown in fig. 6.

**additional notes**

I used the capacitor mentioned earlier by mounting it 5/8 inch off the bottom panel on two brackets.

My favorite oscillator circuit is one that always works with any combination of L and C. Use silver mica capacitors in the tank circuit.

You can do some calculations to determine how far off a linear frequency dial will be with a linear capacitance tuning capacitor (see Appendix). In my case I wanted to tune 11.5 to 11.75 MHz. I calibrate the two ends of the dial, adjust L at the low frequency end and C at the high frequency end. The error at the center
will be theoretically 2.0 kHz low. You can improve this by calibrating the ends 1 kHz high.

Because of the fairly large tuning capacitor I selected, I needed a very small inductor (about two turns on a 1/4 inch form). To allow for a more reasonable inductor, I modified the tank circuit to that shown in fig. 8. This reduces the effective capacitance by a factor of 4 and increases the allowable inductance by

**FIGURE 5**

![Diagram of Pulley Assembly](image)

A. Pulley assembly.

**FIGURE 6**

![Diagram of Drive Shaft](image)

B. Drive shaft.

---

**AMATEUR TELEVISION**

**NOVICES: NOW YOU CAN TRANSMIT VIDEO WITH OUR NEW TX23-1**

Did you know that you as well as all classes of licensed amateurs can easily transmit live action color and sound video just like broadcast TV with our TX23-1 transmitter. Use any home TV camera and/or VCR, computer, etc. by plugging the composite video and audio into the front 10 pin or rear phono jacks. Call or write now for our complete ATV catalog including downconverters, transceivers, linear amps, and antennas for the 70, 33, & 23cm bands.

Only $299

TX23-1 one watt ATV transmitter crystalized for 1289.25 MHz runs on 12-14 Vdc @ .5A. PTL T/R switching, 7x7x2.5". Transmitters sold only to licensed amateurs for legal purposes verified in the latest Callbook or with copy of license sent with order.

(818) 447-4565 m-f 8am-5:30pm pst.

P.C. ELECTRONICS

2522 Paxson Ln Arcadia CA 91006

---

**LET THE SUN DO THE WORK**

- Charge batteries on stored machinery
- Light your tent
- Run fans
- Run remote transmitters
- Light signs
- Pump water for your animals
- Power for your motor home
- Run your radio without batteries
- Light your home
- Yard lights
- Charge flashlight batteries
- Light your cabin
- Run electric fences
- Charge your boat battery
- Run appliances in your home
- Charge hand held radio batteries
- Fish shanty lights
- Charge your Camcorder battery pack

**LET THE SUN DO THE WORK**

![Diagram of Dial String](image)

Dial string diagram.

---

**HAL-TRONIX, INC.**

12671 Dix-Toledo Hwy
P.O. Box 1101
Southgate, MI 48195

152 "HAL" HAROLD C. NOWLAND
W8ZXH
that same factor. Note, however, that the theoretical error also increases to 4.7 kHz at the center of the dial.

measured results

Table 1 lists actual frequency counter readings taken with the circuits in figs. 7 and 8. The +2 to −3 kHz errors agree with the calculated figure of 4.7 worst case.

Resettability is excellent. Returning the dial to 0 degrees puts the output right back at 11,500. One turn of the main tuning knob covers 28 kHz.

There is no backlash or slippage, and because of the high pulley ratio, no force is required to turn the knob. In these respects the dial is equivalent to an expensive zero backlash gear train drive like those used in modern transceivers.

Give this homebrew dial a try. I'm sure you'll enjoy its economy and accuracy.

references

1. Available at most stationery supply stores in the drawing instrument section.
2. Fair Radio Sales, Lima, Ohio.
3. Other sources of bearings are phone jacks and rotary switches.
4. The knob shown in the photograph is Electronic Hardware Corporation model EH71-4D skirted round Regent Series.

Appendix

Assume you are using a linear capacitance variable which goes from $C_{\text{max}}$ to $C_{\text{min}}$. (These values are not necessarily the maximum or minimum values but the ones used for the actual degrees of rotation.)

The low frequency will be:

$$F_{lo} = \frac{1}{2\pi} \sqrt{L \left(C + C_{\text{max}}\right)}$$

and the high frequency:

$$F_{hi} = \frac{1}{2\pi} \sqrt{L \left(C + C_{\text{min}}\right)}$$

These two equations (1) and (2) can be solved for the required fixed capacitance $C$.

$$C = \frac{(C + C_{\text{max}}) \times F_{lo}^2 - (C + C_{\text{min}}) \times F_{hi}^2}{F_{hi}^2 - F_{lo}^2}$$

Then at the center of the dial, the variable capacitor will be at:

$$\left(\frac{(C_{\text{max}} - C_{\text{min}})}{2} + C_{\text{min}}\right) / C = \left(\frac{C_{\text{max}} + C_{\text{min}}}{2}\right)$$

and the frequency will be:

$$F_{mid} = \frac{1}{2\pi} \sqrt{L \left(C + \left(C_{\text{max}} + C_{\text{min}}\right) / 2\right)}$$

In my case $C_{\text{max}} = 220$ pF, $C_{\text{min}} = 60$ pF, $F_{lo} = 11.5$ MHz, $F_{hi} = 11.75$ MHz.

$$C = \frac{220 \times 11.5^2 - 60 \times 11.75^2}{11.75^2 - 11.5^2}$$

$$F_{mid} = \frac{708.9477 / \sqrt{3580.43}}{220}$$

From equation (1):

$$F_{lo} = \frac{k}{\sqrt{3580.43}} + 220$$

At $F_{lo} = 11.5$, $k = 708.9477$ then:

$$F_{hi} = \frac{708.9477 / \sqrt{3580.43}}{60} = 11.74999$$

$$F_{mid} = \frac{708.9477 / \sqrt{3580.43}}{140} = 11.62298$$

which for a correct dial should be 11.625 MHz, error = 2.0 kHz.

article H

OCTOBER WINNERS

A round of applause for Ronald Murdock, WBBSFX, our October sweeps winner and Joel Eschmann, K9MLD, author of October's most popular WEEKENDER -- "Remote Tuner for 75-Meter Mobiles." Both will receive a handheld radio. To enter for December's drawing, send in the evaluation card bound into this issue, or submit a WEEKENDER project. You could be our next winner! Ed.
Harris introduces the RF-3200, a new series of HF-SSB high-performance, long-range voice-and-data communications transceivers. The RF-3200 Series rugged design, outstanding reliability, and minimal maintenance costs, make them ideal for:

- Federal, state, and local agencies
- Police and security forces
- Foreign embassy communications
- Natural resource exploration
- Rural development agencies
- Public and private utilities

Does your program need a low cost state-of-the-art transceiver system? Then call us today. (716) 244-5830, Extension 3681. Or write RF Communications Group, Long Range Radio Division, 1680 University Avenue, Rochester, New York 14610.
Every issue is chock-full of the kind of articles Hams are looking for. Each month there’ll be at least two Weekenders — the kind of projects you really want to build. Extra emphasis is also given to excellent short technical pieces. In addition, HAM RADIO will continue to carry high quality technical articles.

HAM RADIO Magazine has monthly columns from some of the best authors in the radio field: Bill Orr, W6SAI, on antennas and general radio subjects; Joe Reisert, W1JR, spotlighting VHF/UHF technology; Garth Stonehocker, K0RYW’s monthly propagation forecasts; Joe Carr, K4PV, concentrating on equipment repair and Tom McMullen, W1SL, covering basic operating procedures and theory.

You also get four, highly regarded, very special issues. January brings the Annual Construction issue — put together to exemplify Ham Radio’s new emphasis on building. In May, there’s our annual Antenna Special—antenna designs and ideas from some of the world’s best antenna experts. July means VHF and UHF with the latest in state-of-the-art. And in November, you’ll receive the annual Receiver issue, full of high performance designs and technology. They all come absolutely FREE as part of your subscription.

HAM RADIO Magazine also has new graphics, design and layout that enhance HR’s readability and give it a pizzazz not found elsewhere in the Amateur Radio field.

There’s no time like now to give a HAM RADIO Magazine subscription as a present for that hard-to-buy-for Ham friend. While you’re at it — why not renew your own subscription and take advantage of the special low one year rate.

An attractive gift card will be sent if your order is received before December 16, 1988

Please enter my one year gift/renewal subscription(s) to HAM RADIO Magazine as follows:

First gift renewal $19.95 SAVE $3
Two or more $15.95 SAVE $7

Name ____________________________ Call ____________________________
Address ___________________________________________________________
City __________________ State ______ Zip ____________________________

Name ____________________________ Call ____________________________
Address ___________________________________________________________
City __________________ State ______ Zip ____________________________

Name ____________________________ Call ____________________________
Address ___________________________________________________________
City __________________ State ______ Zip ____________________________

Name ____________________________ Call ____________________________
Address ___________________________________________________________
City __________________ State ______ Zip ____________________________

For extra fast service, call toll free to order your gift subscriptions or books.

Call toll free 800-341-1522
M-F 8-9 EST, Sat. 9-5
Datatel 800-341-1522
Orders only

Prices U.S. only. Foreign prices upon request.
YOU COULD WIN...

a hand-held radio.

Here's how.

Please fill out the Magazine evaluation card and mail it to us. We'll tabulate all the responses to see what you do and do not like.

There will be a drawing of evaluation cards. The person whose card is picked will win a hand-held. Help us make the best Amateur magazine even better. You could WIN a radio for your efforts!

Also, each month the author of the most popular WEEKENDER will be given a hand-held radio.

Special Holiday Rates
First Gift or Renewal $19.95, Save $3.00
Two or more Gift or Renewals $15.95, Save $7.00

Subscribe to HAM RADIO today. Tap into Amateur Radio's #1 technical and building journal. You'll also save $7.05 off the newsstand price ($30 per year)! Fill out this card and mail it in.

For even more prompt service, call TOLL FREE (800) 341-1522, MasterCard, VISA and Bill Me orders accepted. Phone lines open Monday thru Friday 8 a.m. to 9 p.m. Please, orders only.

Bill me Payment enclosed
Name ____________________________
Address __________________________
City ____________________________ State ______ Zip ______

Please allow 4-6 weeks for delivery of first issue.

FOREIGN RATES: Europe via Air Forwarding Service $40 per year. All other countries $31.00 per year.

For FREE literature or more information, first locate the company number at the bottom of the ad. Circle the appropriate number on this card, affix postage and drop into the mail. We'll hustle your request off to the companies you are interested in!

NAME ____________________________
ADDRESS ____________________________
City ____________________________ State ______ Zip ______

Limit 15 inquiries per request.

PLEASE USE BEFORE FEBRUARY 28, 1989

DECEMBER 1988
Overview of Operational Amplifiers: Part 2 — Inverting and Noninverting Follower Circuits

Last month I gave you the basics of the operational amplifier and other linear IC devices. I discussed the properties of the ideal op amp, and some common problems that represent departures from that ideal. This month I’ll take a look at the standard circuit configurations and the derivation of transfer functions. Let’s start with the inverting follower configuration.

Inverting follower circuits

Figure 1A shows the inverting follower circuit. It is characteristic of an inverting follower that the output signal is 180 degrees out of phase with the input signal (photo A). The transfer function is $A_v = V_o/V_{in}$.

The noninverting input is grounded in the inverting follower circuit, so you must treat the inverting input as if it were also grounded. Ideal property number 6 (see last month) requires that the inverting input be treated as if it were also grounded, as at zero volts potential. This gives rise to a somewhat confusing concept — virtual ground. The inverting input isn’t actually grounded, but since it’s at zero potential because the other input is grounded, you can say that it is “virtually” grounded. The concept is simple; only the semantics are confusing.

Let’s consider the currents appearing in node “A” of fig. 1. You know from ideal property number 3 ($Z_{in}$ is infinite) that $I_3$, the input bias current, is zero. You also know from Kirchoff’s Current Law (KCL) that all currents into and out of a junction algebraically sum to zero. Thus,

$$I_i = -I_2$$  \hspace{1cm} (1)

You also know from Ohm’s law that

$$I_1 = V_{in}/R_f$$  \hspace{1cm} (2)

and,

$$I_2 = V_o/R_{in}$$  \hspace{1cm} (3)

Thus, when you substitute these two equations into KCL:

$$V_{in}/R_{in} = -(V_o/R_f)$$  \hspace{1cm} (4)

You know that a voltage amplifier’s transfer function is:

$$A_v = V_o/V_{in}$$  \hspace{1cm} (5)

Solving eqn. 4 for the transfer function (eqn. 5) yields:

$$V_o/V_{in} = -R_f/R_{in}$$  \hspace{1cm} (6)

Thus, the voltage gain $A_v$ of the inverting follower is given by the ratio of two resistors:

$$A_v = -R_f/R_{in}$$  \hspace{1cm} (7)

You can design the inverting amplifier by manipulating the values of these two resistors (see fig. 1). That’s the exciting part of op amp theory, and what makes the device so simple to apply.

There’s a constraint on the minimum allowable value of $R_{in}$. Point A is virtually grounded, so the input impedance of this circuit is the resistance of $R_{in}$. One rule of thumb of voltage amplifier design says the input impedance of a stage must be five times (some people, myself included, prefer ten times) the source impedance of the signal source.

Example:

Design a gain of 100 inverting amplifier that has an input impedance of 10k or more.

Solution:

Since the input impedance must be 10k, $R_{in}$ must be 10k or more. Set it
at 10k. Solving the gain equation for
Rf yields:
\[ R_f = A_v \times R_{in} \]
\[ R_f = (100) \times (10,000 \text{ ohms}) \]
\[ R_f = 1,000,000 \text{ ohms} \]
So, a 10k input resistor and a 1 meg feedback resistor yield a gain of 100. Since this is an inverting follower, the gain is actually -100. (The "-" sign indicates the 180-degree phase reversal between input and output normal to inverting amplifiers.)

**Noninverting followers**

The noninverting follower applies a signal to the noninverting input. The output signal is in phase with the input signal (zero degree) phase shift (photo B). There are two basic configurations for the noninverting follower:
- Unity gain noninverting follower
- Noninverting follower with gain.

**Figure 2A** shows the unity gain noninverting follower. The output terminal is connected to the inverting input, producing 100 percent feedback. The output voltage is equal to the input voltage. So of what use is a unity gain (i.e., gain of 1) voltage amplifier? There are three principal uses: buffering, impedance transformation, and power amplification. Buffering means using an amplifier to isolate a circuit from its load. Some oscillators and astable multivibrators change frequency if the load impedance changes, so a unity gain noninverting follower helps "buffer" the circuit. Also, some transducers with high source resistances load badly if not buffered by an extremely high input impedance amplifier; the crystal microphone is one example.

Impedance transformation occurs because the input impedance is very high, while the output impedance is very low. You can use this circuit when acquiring a signal from biological electrodes or chemical transducers, etc., where the source impedance is extremely high. A pH electrode, for example, has source impedances ranging from 10 to 100 megohms.

The voltage amplification is unity. This is illustrated by the fact that the voltage remains constant (\( V_o = V_{in} \)). Consider also that the impedances are unequal. Obviously, since power is defined by \( P = V^2/R \), reducing R while keeping V constant results in higher power (P).

The noninverting follower with gain circuit in **fig. 2B** retains the properties of the unity gain circuit, but produces voltage gain as well. Keep in mind that the inverting input (point A) is at \( V_{in} \). Analysis similar to the previously used
method produces a voltage gain of:

\[ A_v = \frac{R_f}{R_{in}} + 1 \]  \hspace{1cm} (8)

The noninverting follower circuits are used wherever extremely high input impedance is needed, or where no phase reversal can be tolerated. In communications circuits the noninverting gain follower is often used for audio microphone preamplifiers.

**Operation from a single power supply**

Operational amplifiers are normally operated from a bipolar DC power supply. Such a power supply has \( V^+ \) and \( V^- \) voltages that are each referenced to common. This system essentially requires two independent DC supplies. In some cases, however, either ultimate use or other design constraints lead to the necessity of a single (monopolar) DC power supply. An example is +13.8 mobile circuits. In this section I’ll discuss simple methods for operating the amplifier from a single DC power supply.

Some schemes exist for creating a split power supply from a monopolar one in order to mimic bipolar power supply operation. One scheme connects two zener diodes in series across the single supply, along with the necessary current-limiting resistors. The junction between the two zener diodes becomes the signal common. A severe limitation of this method is that the DC supply common can’t be chassis referenced.

Another scheme is to use the regular monopolar DC power supply for \( V^+ \), and a DC-to-DC converter circuit for \( V^- \). Such a circuit is little more than an AC or square wave oscillator in the 20 to 500-kHz range, with its output signal rectified and filtered to produce the \( V^- \) voltage.

Figure 3A shows the method for biasing the operational amplifier inputs to permit single supply operation. This technique is based on the simple resistor voltage divider circuit in fig. 3A. The output voltage \( V_1 \) is given by the standard voltage divider equation:

\[ V_1 = \frac{R_2}{R_1 + R_2} \]  \hspace{1cm} (9)

The value of \( R_1 \) is selected so that it falls between 1k and 10k. The capacitor shunting resistor \( R_2 \) is used to decouple AC variations on the power supply line. The capacitance value is selected for a reactance equal to \( 1/(6.28 R_2 C) \) lower than the lowest operating frequency.

In most cases, the value of \( V_1 \) will be one-half \( V^+ \), so the operational amplifier has a quiescent output point that is midway between extremes. This bias level is achieved by making \( R_1 = R_2 \). The value of \( R_1 \) and \( R_2 \) is usually selected so that it falls between 1k and 100k. The capacitor shunting resistor \( R_2 \) is used to decouple AC variations on the power supply line. The capacitance value is selected for a reactance value of one-tenth \( R_2 \) (i.e., \( R_2/10 \)) at the lowest frequency of operation. For example, suppose \( R_2 = 10k \), and the lowest frequency of operation is 10 Hz. If \( R_2 = 10k \), then the capacitive reactance of the shunt capacitor should be:

\[ R_2/10 = (10k)/10 = 1k \]

Solving the usual capacitive reactance equation for \( C \) gives you:

\[ C_{\mu F} = \frac{1,000,000}{2 \pi F \times 15.9} \]  \hspace{1cm} (10)

The value 15.9 \( \mu \)F is non-standard, so you’d select a 16, 20, or 22 \( \mu \)F standard unit.

Figure 3B shows the method for biasing an operational amplifier in the inverting follower configuration. In the bipolar supply version of this circuit the noninverting input is grounded (i.e., set to zero volts). But in single supply operation, you apply bias voltage \( V_1 \) to the noninverting input. This voltage \( V_1 \) also appears on the inverting input, making DC blocking capacitor \( C_1 \) necessary. The output terminal is biased according to the value of \( V_1 \), and may also require a DC blocking capacitor (shown in fig. 3C) if such a voltage adversely affects the following stage.

Select the value of capacitor \( C_1 \) to have a low impedance at the lowest frequency of operation, using a protocol similar to that discussed for the voltage divider shunt capacitor. A general rule of thumb is to regard \( R_{in} \) as a high-pass filter with a cut-off frequency, \( F_c \), equal to \( 1/(6.28 R_{in} C_1) \). The object is to choose a value of \( C_1 \), given a value for \( R_{in} \), that results in a value of \( F_c \) lower than the lowest operating frequency.

The circuit configuration for noninverting follower circuits is shown in fig. 3C. This circuit is the same as for inverting followers, except for resistor \( R_3 \). The purpose of \( R_3 \) is to maintain a high input impedance to signals applied to the noninverting input. The minimum value of \( R_3 \) is at least ten times the output resistance of the driving stage. In practical cases, however, the source impedance is usually low enough that it’s possible to set \( R_3 \) to
100 or 1000 times the source impedance. Typical values range from 10k to 1 meg, with 100k predominating.

Select the value of C1 so that the cutoff frequency of the filter formed by C1R3 is lower than the lowest operating frequency. The same equation applies here as before. Use capacitor C4 and resistor R4 when the $V_{+1/2}$ bias on the output terminal will adversely affect a following stage or instrument. Again, the “lowest frequency of operation” rule is invoked when setting the value of C1, with the resistance being the input resistance of the following stage.

Some common problems

I find it almost impossible to wire up a circuit without making at least one mistake. Check your wiring before applying power to the circuit. Fortunately, most op amps will survive a whole host of errors — except reversed DC power supply polarity!

Before applying power you’ll need to check a few things. Don’t send a signal until after power is applied. Ground the input to simulate a signal of zero volts. Next, turn on the power and use a DC voltmeter to check the V− and V+ power supplies. Make sure these potentials are proper. Now check the output terminal. It should be 0 Vdc if you use bipolar supplies, or at the potential set by the voltage divider if you do otherwise ($1/2 \cdot V_{+}$ is common). If all’s well, turn on the signal and check the circuit operation. If not, then turn off the power and look for the problem — you’ve probably miswired something. (An op amp from a “cheapie” source may well be defective.)

Photo C shows the result when the amplifier inputs are overdriven for the circuit conditions. Three factors can lead to the clipping shown in the output signal (lower trace). The first is excessive input signal. (This situation can also be dangerous to the op amp’s health.) The second is a value that’s too low for the DC power supplies (e.g., ±6 Vdc when ±10 volt output signals might be expected). The third factor is a gain that’s too high for the

Input (top) and output (bottom) waveforms of an overdriven amplifier showing “clipping.”

Ooops! Forgot the decoupling capacitors! Power supply value (i.e., when the V− and V+ supplies are maximum).

Photo D shows oscillation superimposed on a sine wave output signal. I took this photo from an oscilloscope connected to the output of a 741 amplifier in which the decoupling capacitors on the V− and V+ power supplies were missing. The solution is to place at least some decoupling at each op amp terminal as close as possible to the body of the device. Note that 741 devices are called “unconditionally stable” in some texts, so some people believe that they won’t oscillate.

Conclusion

Applying operational amplifiers is easy. The one simple rule to remember is that the output/input transfer function is governed by the feedback network. For simple voltage amplifiers you need only remember that the ratio of the resistors is the determining factor. For AC amplifiers you'll also need to crank in the bypass capacitor values.

This article is based on my new book: IC User's Casebook (Sams No. 22488), available from the HAM RADIO Bookstore for $12.95, plus $3.50 shipping and handling. I can be reached at POB 1099, Falls Church, Virginia 22041, and would like to have your comments and suggestions for this column.
Get the most from your NiCds.

One way to maximize the useful life of your NiCds is to use them; they thrive on it! Part of this use should include full discharge and full charge cycles.

Many devices using NiCds come with a charger. Proper charging is usually easy to accomplish; it’s simply a matter of charging them for a fixed period of time — often 16-20 hours. Proper discharge is not quite as easy to achieve.

My first experience with NiCds was in 1960. The military used NiCd wet cells to power selected equipment. These NiCd power supplies were stored fully discharged and shorted. They were removed from storage periodically, checked for proper electrolyte level, and charged. Then they were discharged at a specific load for a specific time to test their capacity. Individual cell voltages were checked during the discharge cycle, and any cells which discharged prematurely were removed and replaced. The battery was again charged and given the timed discharge test to be sure that it met the capacity requirements. A NiCd battery is only as good as its weakest cell. I have some of those early NiCd cells. They’re now about 30 years old, but still usable!

The first commercially available NiCds I purchased in the mid-sixties were C and D cells. I periodically ran discharge capacity tests, almost from the time I bought them. I dated and numbered each cell so that I could track its performance. Some of those cells lasted over 10 years. I’ve found that neither age nor number of cycles is necessarily an indicator of when a NiCd cell needs to be replaced.

For years I discharged NiCds with almost anything...
that would place a suitable load on them. I used flashlight bulbs, automotive accessories, high-wattage resistors, and 12-volt automotive bulbs. I also used an assortment of clip leads, ammeters, voltmeters, and battery holders. It was a mess, but it worked! There are still times when I use a gang of automotive bulbs (photo A).

I had known for years that it would be nice to have a clean, functional test load. I spotted a multi-tapped 200-watt 6.5Ω resistor in a catalog. A year or so later I ordered two of the resistors. I looked at them for another year. Then, one weekend I finally constructed my test load (photo B).

The circuit shown in fig. 1 is simple; it's basically an old-fashioned resistance substitution box. But remember, all power from the discharge of the NiCd battery is dissipated in heat, so the resistors must be capable of handling the required power level. The power dissipation is calculated with either $P = IE$ or $P = I^2R$.

A 13.8-ohm load across 13.8 volts equals 13.8 watts ($P = 1 \times 13.8 = 13.8$ watts). Because five resistors ($R_1$, $R_4$, $R_5$, $R_6$, and $R_7$) share varied amounts of the 13.8 watts, no resistor needs to be rated over 10 watts. Switch $S_4$ is a shorting type; I used it because that's what I had in my junkbox. If you use a non-shorting switch, calculate the values and maximum load on any single resistor and use a higher wattage resistor where required. Table 1 gives the approximate resistance ranges of switch $S_4$, when used with switch $S_3$ for fine adjustment.

### TABLE 1

<table>
<thead>
<tr>
<th>Range</th>
<th>1.1 – 7.0 ohms</th>
<th>9.8 – 15.6 ohms</th>
<th>16.6 – 22.4 ohms</th>
<th>24.1 – 29.8 ohms</th>
<th>31.2 – 37.0 ohms</th>
</tr>
</thead>
</table>

**Construction**

There's nothing special about the construction (photo C). Just about everything I used came from my junkbox. $R_1$ is the only component purchased specifically for this project. Even the wires with the terminals were "cut-offs" from disassembled equipment. Switches $S_3$ and $S_4$ were what I had available. The meter is a 0-1 mA movement with shunts for 0-1 and 0-2 A. The shunts are lengths of resistance wire removed from some old wire-wound resistors.

Start by connecting one end of the resistor wire to the meter. Use a clip lead on the other terminal of the meter, and slide the other end of the clip lead along the resistance wire until you get the proper reading. Place another ammeter in series for reference. Solder a wire to the resistance wire at this point, and connect the wire to the meter. I added switch $S_1$ and another shunt resistor to give the meter two ranges. The tip jacks for an external voltmeter were added as a convenience as was switch $S_2$, which allows the load to be turned off or on without disturbing the load settings.

I also needed a high amp load capability to make power supply tests, so I added a second load circuit consisting of switch $S_5$ and jack $J_3$. The high amp section will handle loads of about 5 to 15 amps on a 13.8-volt power supply. Fifteen amps at 13.8 volts is pushing the rating of $R_1$ and is used only for short times.

**Using the test load**

The capacity of NiCd cells is usually stated for the 1-hour discharge rate. That is, a 450-mAh (milliamp hour) AA cell will support a 450-mA load for one hour if it's fully charged and has 100 percent capacity. C

---

**PHOTO C**

Foreground: Load resistor $R_1$ before installation. Center: 10-A continuous-duty test load is guaranteed to brighten up your shack.

**PARTS LIST**

- $R_1$ 6.5Ω 200 watt multi-tapped resistor
- $R_4$ 100 ohm 10 watt
- $R_5$ 50 ohm 10 watt
- $R_6$ 25 ohm 10 watt
- $R_7$ 20 ohm 10 watt
- $S_3$ 4 pole rotary switch
- $S_4$ 5 pole shorting rotary switch
- $S_5$ 4 pole high amp ceramic switch
- Meter 0-1 mA, or to suit
- $R_2, R_3$ shunt resistors to suit meter
- $J_1, J_2, J_3$ Jacks to suit needs

*H & R Corporation, 401 E. Erie Avenue, Philadelphia, Pennsylvania 19134
Part number TM23K513 $5.50 in December 1986 catalog.*
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

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!

- 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

Discharge capacity test using adjustable battery holder.

and D cells are typically 1200 mAh (1.2 Ah). For capacity tests, I use the 1C rate (one times capacity); i.e., 450 mA for AA cells.

The first step is to discharge all cells. I use a homemade battery holder (photo D) for single cells. It's easy to check each cell voltage individually with a voltmeter during discharge. One of the advantages of a NiCd cell is a relatively flat discharge curve. Notice, I said “relatively” flat. Voltage under 1C load will be about 1.2 volts for a long time. As it nears discharge, it will drop to 1.1 volts and — a very short time later — to 1.0 volt. The change in voltage at near discharge can take place in a matter of a few minutes, so watch the cells carefully. This isn’t a “set it and leave it” test procedure. At 1.0 volt you can consider the cell discharged and pull it. However, don’t let the cell drop below 1.0 volt, or it might reverse polarity and not recover when recharged. If you’re discharging a fixed battery, like an HT battery pack with seven cells (8.4 volts nominal), stop the discharge when the battery reaches 7.0 volts, or 1.0 volt per cell average.

Fully charge the cells or battery as recommended and you’re ready for the discharge capacity test. I connect a digital voltmeter to the jacks on the test load to monitor total voltage. If I’m testing an HT battery pack, this is the only voltmeter I’ll need. If I’m testing a group of individual cells as shown in photo D, I use a second voltmeter to monitor and pull individual cells whenever they drop to 1.0 volt.

Turn on the test load and set for 1.2 A (for 1.2 Ah cells). Be sure to log in the start time, or use a stopwatch or timer. You’ll have to readjust the test load as voltage drops to maintain a constant load. If the first cell takes 45 minutes or 0.75 hours to drop to 1.0 volt, multiply the 1.2 A load times 0.75 hours. The capacity of that cell is 0.9 Ah or 75 percent of rated capacity. I pull each cell as it reaches 1.0 volt and calculate its capacity. Use the same time/load procedure to discharge a battery pack, but stop when the volt-
age drops to 1.0 volt times the number of cells in the battery pack. The same quick calculation will give you the capacity of your battery pack.

I keep records on my cells and battery packs. The original, and only, battery pack for my TR2500 HT is almost 4 years old but still has over 80 percent of its original capacity. As cells get older, they may not hold 1.2 volts at load for as long, but may drop slowly to and through the 1.1-volt range. In other words, the cell can no longer hold the relatively flat discharge curve. Such cells may or may not be suitable, depending on the type of equipment in which they are used. In any case they are “suspect,” and should be watched more closely than normal.

You may also want to let fully charged NiCds sit for up to 30 days, run a discharge test, calculate the capacity, and compare it to the capacity of the cells or battery when just charged. The results of age or premature self-discharge can be quite noticeable here.

Remember, your NiCds actually like this kind of testing. In fact, a couple of complete charge/discharge cycles may actually improve their capacity. And...you’ll have the added benefit of knowing just what condition they’re in!

References

**References**

**HAM RADIO**

---

**SYNTHESIZED SIGNAL GENERATOR**

**MODEL** 3G-100F   **PRICE** $429.95

- 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.

---

**NEMAL ELECTRONICS**

**GREAT HOLIDAY GIFT IDEA**

**AMBER LOG**

**NOW BACK IN STOCK**

**HAM RADIO LOG BOOKS**

back by popular demand!

Room for over 2100 QSO—that’s over twice as many as the other log books. For contesters, each page contains 30 QSO’s for easy counts. You also get the latest up-to-date frequency spectrum chart. ITU call sign list and ARRL DXCC list. Spiral bound to lay flat on your desk. Unquestionably the best log book value around.


**HR-LB** .......................... Spiralbound $2.95

**HR-3LB Special**

Buy 3 Price. Save 22% .......................... Get 3 offer $6.95

Please add $3.50 for shipping and handling.

**HAM RADIO**

GREENVILLE, NH 03048

**BOOKSTORE**

(603) 978-1441

---

**NEMAL ELECTRONICS, INC.**

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

---

December 1988 **PP** 91
Every preamplifier is precision aligned on ARR’s Hewlett Packard HP8670A/HP566A state-of-the-art noise figure meter. RX only preamplifiers are for receive applications only. Inline preamplifiers are for switch (for use with transceivers) and handle 25 watts transmitter power. Mount inline preamplifiers between transceiver and power amplifier for high power applications. Other amateur, commercial and special preamplifiers available in the 1-1000 MHz range. Please include $2 shipping in U.S. and Canada. Connecticut residents add 7-1/2% sales tax. O.D.D. orders add $2. Air mail to foreign countries add 10%. Order your ARR RX only or inline preamplifier today and start hearing like never before!

Advanced Receiver Research

Box 1242 • Burlington, CT 06013 • 203 582-9409
**Aries-1...**

- Inserts DATE / TIME from Computer.
- FREQUENCY / MODE from Transceiver (certain Kenwood and Icom models) into log.
- Interfaces with Kenwood TK and ICOM-232 Terminal Units (or 1/2 Duplex/1/4 Duplex between)
- Works with a Mouse and/or Function Keys for fast and easy control of Terminal Units and Data Entry.
- Is useful with or without interfacing to Terminal Units and Transceivers.
- Changes 25 Modes, operating parameters and file data into the Log file with the press of a key or the click of a mouse.
- Has a Contact Mode and automatic string replacement capability which gives new meaning to quick exchanges.
- Has Automatic Duplex checking and the ability to search / print data bases by Git, Country, Freq, QSO info, etc.
- Lets you run other programs (or access DOS) while storing events in memory along with your data.
- Logs voice contacts, while simultaneously connected to a pocket mail box and down-loading messages into a coputer file.

An Extremely useful program! Most Aries-1 Users "fire up" the program whenever they are in the shack. Whether operating Voice, AMTOR, Packet or any other mode, you will enjoy having your Log available on screen simultaneously with your Terminal Unit and access to your other ham software just a keypress away.

**VISA**  Our 10th year of delivering Quality Software to the International market  **MasterCard**

Dick Smith is alive and well in Indiana and the 1989 CATALOG is NOW AVAILABLE!

The Dick Smith Electronics Catalog is the fun way to find the electronic things you need. And now the 1989 Catalog is bigger - 160 pages crammed full of the things the other guys don't offer - and better with more of our exclusive data pages including the new "feedback" section that invites your participation. And now the 1989 Catalog is as dynamic as Dick himself with a new issue each quarter to keep you up-to-date. Join the fun! Send us your name, address, and $2 for your 1989 Catalog subscription today!

**LOGWRITE™**

Bring your station into the computer age with LOGWRITE, the menu driven, user friendly logging program written by Ed Theo (N03W). LOGWRITE is the perfect accessory for the complete ham station. It simplifies your operation and gives you the competitive edge in contesting and DXing. LOGWRITE works with all IBM PCs and compatibles.

LOGWRITE unique split screen frame allows for simultaneous logging and test processing. Logging features include:
- Instant call sign or prefix search
- Print, Edit, or View records
- Plenty of room for notes & addresses
- Automatic immediate stamping

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

To order your copy of LOGWRITE, complete with instruction manual, send $24.95 (Va. residents add $1.50 sales tax too.)

Aerospace Consulting
P.O. Box 156, Gwynedd, Pa. 19436
Or call 1-800-384-4166 ext. 54. to order with Visa/Master Card. (Please specify 3-5 or 5-2 inch floppy.)

**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 8½ x 11 size

5-Sheets for $3.95
10 sheets only $5.95
add $1.25 postage - NY res. add sales tax

The MEADOWLAKE Corp.
DEPT. K, P.O. Box 497
Northport, New York 11768

**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 199 or 6-20 for construction details.)

- 100 Watt (3.1, 6.9, 9.9, or 11.1 impedance - select one) $19.50
- Universal Transmatch 1 KW (4.1 impedance) 14.50
- Universal Transmatch 2 KW (4.1 impedance) 17.50
- Universal Transmatch 1 KW (6.9, 9.9, or 11.1 impedance - select one) 16.00
- Universal Transmatch 2 KW (6.9, 9.9, or 11.1 impedance - select one) 18.50

Please send large SASE for info.
Elmer's notebook: transmission lines
W1SL  p 90, Mar 88
General purpose line transformers
W1SL  p 92, Aug 86
Ham radio techniques, fifty years ago
W5SAI  p 58, Jun 84
Measuring transmission line parameters
OE2APMA/AA3K  p 22, Sep 88
Open-wire line for 2 meters
W5FX  p 94, Jan 87
Practically speaking: transmission lines and their typical AC responses
K3AO  p 34, Sep 86
Practically speaking: standing waves - a review
W5J  p 85, Oct 88
Real coax: impedance and phase relations
K2B  p 8, Apr 87
Short circuit  p 91, Jul 87
Practically speaking: amplifying tuner problems
K4PV  p 78, Nov 86
Real coax: impedance and phase relations
K2B  p 8, Apr 87
Short circuit  p 91, Jul 87
RF transmission cable. microwave applications
K3HW  p 106, May 85
Solving transmission line problems on your Commodore 64
K9CZB  p 74, May 86
W1MR  p 77, Jul 86
WVHF/HF World-transmission lines
W1JMR  p 83, Oct 85
Comments W9RICZ  p 9, Apr 86
WVHF/HF World  p 85, Dec 85

AUDIO
Advanced CW processor
W2AA  p 25, Dec 86
Audio Filter design, computer-aided
KEJ  p 15, Oct 85
Audio filter design, elliptic filter
W3NQN  p 20, Feb 84
Audio oscillator to power generator conversion
WHDO  p 50, Oct 84
Audio to microwave amplifier, build your own!
Gruchalla, Michael  p 12, Mar 86
Aural vocs provides relative metering
K1GH  p 31, Jan 87
Automatic gain control, an audio
KTM  p 24, Sep 84
Build a QSO "beeper"
KF8JQG  p 38, Jan 88
Code practice oscillator (weekender)
N2NC  p 65, Oct 88
Converting mobiles microphone for handheld VHF transceivers
KD8HZ, WB3JCC  p 79, Mar 86
Short circuit  p 119, Aug 84
Extended-range VU meter
WB2JHN  p 59, Sep 86
Improving the audio on the IC-251
KD8HZ  p 61, Feb 86
Modifying microphones
WEQ2VW  p 81, Jan 87
Passive audio filter design, part 2: highpass and bandpass filters
N3EK  p 41, Oct 85
Comments W3NQN  p 8, Nov 85
 Passive audio filter design: part 3
Stefan Niewiadomski  p 29, Jan 86
Phone patches, building and using
K1GH  p 38, Oct 85
Power speaker enhances mobile operation
K1GH  p 83, Jan 88
Processor for code taps
WB4ULD  p 61, Sep 88
Radio receiver, speech synthesis for
N8EE  p 79, Mar 84
Sight and sound CW
WB2LW  p 10, Jan 88
Telephone ringing indicator, visual (HN)
W8LZI  p 62, Apr 84
Understanding telephones
N6ARE  p 39, Sep 85
Comments, K7DLW  p 9, Apr 86

COMPUTER-AIDED DESIGN
Bandpass filter design, digital interfaced, computer-aided
NMN, Monemzadeh  p 12, Jan 85
Short circuit  p 117, Jun 85
Computer-aided design of long VHF Yagi antennas
W5KZH  p 28, May 86
Design a no-tune amplifier with your personal computer
W7DDH  p 8, Sep 78
Designing Yagis with the Commodore 64
W1MR  p 107, Jan 86
Diagnostic sensor data latch
K9SNF  p 56, Apr 88
Direct current controls core permeability
KB5VM  p 58, Jul 86
Short circuit  p 87, Aug 86
Lab equipment: modern “chips”
W5LL  p 113, Oct 88
Gamma matching programs for the CH712
N9CA  p 87, May 87
Ham notebook: rebuild your C-64 key- board with C-7 parts
AF8B  p 74, Feb 88
Linear design by computer
W6JE  p 37, Feb 87
Low-cost pc board layout software
Freeman, Eva  p 8, Oct 87
Remote computer programming using a computer and a telephone
KD9BC  p 89, Mar 86
RF filters: built narrowband
WB4EHE  p 10, Mar 66
Short circuit  p 36, Jun 86
Solving transmission line problems on your Commodore 64
K9CZB  p 74, May 86
Tunable filter design
W8JRI  p 41, Jan 87
VHF Yagi CAD on the C-64
W4HMR  p 74, May 86
Comments: Yagi design program
WB8NJ  p 6, May 87
Yagis, designing with the Commodore 64
WA3EKL  p 59, Jul 85

CONSTRUCTION TECHNIQUES
Advanced CW processor
W2AA  p 25, Dec 86
Air-wound coils, constructing
WB7BE  p 37, Aug 84
Battery charger, NiCd, constant current, a pulsed
K2MUW  p 67, Aug 85
Build a better box
Gruchalla, Michael  p 45, Aug 84
Build narrowband RF filters, Comments WB4QPC  p 9, Sep 86
Bulkhead connector (HN)
K9CZB  p 78, Apr 86
Cabinet samples in the ham shack
K1GH  p 82, Sep 87
Code practice oscillator
N2NC  p 65, Oct 88
Construction techniques using PVC pipe to make antennas
W8JRI  p 98, Sep 88
Cooling semiconductors part 1: designing and using heat sinks
Martin, Vaughn D  p 33, Jul 84
Cooling semiconductors part 2: blowers and fans
Martin, Vaughn D  p 52, Aug 88
Design an amplifier around the 3321/2007A?
W7DQG  p 33, Dec 87
DTMF tone signaling circuit
WB6F  p 42, Sep 88
Dummys load, DC
W4MLE  p 91, Apr 85
Elevation indicator, inexpensive
WB4QPC  p 67, Jun 87
Elmer’s notebook: the mysterious “Q”
W1SL  p 110, Sep 87
Get the most from your NiCos
W6JE  p 10, Dec 87
Ham notebook: the mysterious “Q”
W1SL  p 110, Sep 87

TRANSMISSION LINES
Artificial Transmission Lines
KB0BL  p 21, Jul 86
Bridge measurements, the half-wave transmission line in (HN)
K4KI  p 108, Nov 84

transmission lines
KB0BL  p 21, Jul 86
Bridge measurements, the half-wave transmission line in (HN)
K4KI  p 108, Nov 84
**DIGITAL TECHNIQUES**

Add a digital readout to the “poor man’s spectrum analyzer”
W2JZO p 84, Sept 88

Amateur FSK: A spectral analysis
WANCCX p 42, Dec 88

AMTOR, AX 25, and HERMES: A performance analysis of three systems
WSJO p 63, Dec 85

Comments, G3PLX p 9, May 86

Antenna feed (for the Kenwood TK-66)

K1S2H p 22, Aug 86

Author’s design, computer simulation
K1JZ p 15, Oct 85

AUTOTRACK: simple rotator interface for a VHF, C100-200 and applicable to other popular computers
K7NH p 10, Dec 87

Building an “amos” - super "bipper"
K7ECU p 38, Jan 88

CAT control system for the Yaesu FT-288A
SMCP p 26, Nov 87

Commodore, $100 printer (HH)
W4QLI p 59, Aug 85

Computer control of ICOM R-71, 271, 471, and 751 radios
N9GO p 47, Apr 86

Comments: Continuous phase tones
G3VMK p 6, Aug 87

Decoding data signals
W3WGC p 50, Dec 88

Deluxe logic probe
W2Wdle p 3, Jan 87

Digital can do more, Comments
K4JFO p 9, Mar 86

Digital clock, build a fail-safe
K1MCX p 54, Oct 85

Digital frequency readout using the Commodore 64
W4UH p 83, Nov 85

Digital HF radio: a sampling of techniques
K4AJUL2SLR p 19, Apr 85

Direct current VFO
W3MWM p 121, May 85

DTMF controller for repeaters
W4BXO p 47, Sep 85

DTMF controlling signaling circuit
W6V6A p 42, Sep 88

Emile’s notebook: An introduction to digital communications
W1SL p 92, Jul 87

Emile’s notebook: An introduction to AM
W1SL p 101, Sep 87

Emile’s notebook: packet radio
W1SL p 100, Oct 87

Frequency synthesis up to 2 GHz
W4DIY p 22, Apr 88

Get on SSTV with the C-64
G2CB and I2AED, edited by K9EJ p 43, Oct 86

Get Signal
W2SL p 97, Oct 87

HP-IL serial loop
Martin, Vaughn D p 101, Apr 84

Improving the WB3CZE programmable call-sign identifier (HN)
K4L7XO p 82, Sep 87

Packet board: Packet board overhead
VE3LNY p 56, Jan 87

Packet radio and area networking
WB0NBW p 36, Dec 84

Packet radio, automatic frequency and deviation tester
WB205Z p 41, Dec 84

Packet radio prime
W41FH B p 30, Dec 85

Packet radio: the software approach
W4UJCH p 63, Sep 84

Packet radio TNC for the IBM PC
VE3LNY p 57, Sep 88

PL tone generator, a programmable
WB0WSZ p 51, Apr 84

Power control circuits to suit your needs
K4JH p 47, Apr 88

RAM drive for packet radio
AD1B p 44, Dec 87

RTTY, receiver, interm-diplexer
K4N L p 72, Sep 84

Run RTTY on your Times
WB205Z p 110, Apr 85

Run RTTY on your VIC-20
WB205Z p 120, Apr 85

Satellite tracker, digitally-controlled
K4OBL p 102, Sep 85

Shortwave impedance matching on your Commodore 64
W4GKF p 120, Oct 84

Solderless interconnect (HN)
Forrely, Mike p 8, Sep 84

Spread spectrum and digital communication: techniques, a primer
N9PB p 13, Dec 85

The Guernsey radio computer technology
W3WGC p 54, Nov 84

Short circuit
W2CH p 128, Aug 86

The Guernsey report: signal processing
W51YJ p 156, Dec 84

The Guernsey report
W3WSI p 124, Jan 86

The Guernsey report
W3WSI p 125, Apr 86

Thumbwheel frequency selector for the Yaesu FT-75GX5
KA2SNF p 33, Nov 87

True frequency digital readout for the 100-1, A
NUAF p 8, Jan 87

Use circuit: Using an RTTY term? in the Heathkit HD 4040 TNC
AAVY p 59, Aug 87

VIC-20 printer (HN)
WOLI p 88, Sep 84

**FEATURES AND FICTION**

Electromagnetic jargon generator, state-of-the-art
NBX p 75, Apr 85

Ham radio techniques: Ever work a W10
WS2AI p 43, Feb 87

Short circuit
W3WSI p 50, Apr 87

Ham radio techniques: Xiangjiang
Province the last frontier
WSSAI p 55, Apr 87

Ham Radio techniques: the year was 1932
W3WSI p 89, Jan 88

Ham Radio techniques: “the greatest hit of all time in the world”
W3WSAI p 68, Feb 88

One hundred years of electric waves
W1SL p 88, Sep 87

Radio addition: case history of an enthusiast
WI7XV p 52, Jan 88

Reflections: Returning the spectrum to chaos... courtesy of the FCC (General 87-389)
W4JUV p 6, Feb 88

Reflections: Noise enhancement and the future of amateur radio
W3WSI p 6, Jun 88

**FILTERS**

Simple VHFL/HUF multiple-quarter-wave filters
WA3EW T p 37, Sep 87

Automatically switched half-octave filters: part 1
WB3JZ0 and Watkins, Lee R. p 10, Feb 88

Automatically switched half-octave filters: part 2
WB3JZ0 and Watkins, Lee R. p 29, Mar 88

Top-down filter design
VE5FP p 41, Jan 87

**HAZARDS**

AGC line transient protection
W3WSI p 59, Aug 86

Electric shock, the effects and treatment of
NYSU p 85, Mar 84

**INTEGRATED CIRCUITS**

Low-pass filter, integrated circuit
WB3JZ0 p 59, Jan 85

Static electricity and modern integrated circuits
K4L7XO p 33, Mar 84

The Guerri report: superchops come of age
W3WSI p 126, Feb 85

The Guerri report: W4MF G
W3WSI p 124, Jan 86

The Guerri report: microchip
W3WSI p 109, Jul 86

**KEYING AND CONTROL**

Call sign identifier: programmable
WB3C E p 33, Feb 85

Ham radio techniques
W3WSAI p 108, Oct 84

Improving the WB3CZE programmable call-sign identifier
K4L7XO p 82, Sep 87

Kerby, simple, compact QRP (40meter)
W6FG p 62, Oct 84

Micros and VHF beacons transmit messages automatically
K9EI p 51, Jul 85

Morse Code tutor
W3WSI p 45, Jun 85

Morse keyboard, an easier approach to
WK1Z p 80, Apr 84

Remotely controlled stations: a look at a successful remote base
W4EJO p 48, Sep 86

**MEASUREMENTS AND TEST EQUIPMENT**

Add a digital readout to the “poor man’s spectrum analyzer”
W2JZO p 84, Sep 88

An 41,982 sweep generator
W2ZUC p 101, Jan 87

An rf voltmeter
G4COL p 85, Nov 87

Bridge measurements, the half-wave transmission line in (HN)
K4K I p 108, Nov 84

Build this simple LC checker
W3NEE p 19, Dec 88

Calibrating series-resistance capacitance bridges (HN)
C4200A p 27, Dec 88

Continuity tester, simple
W2WBQ p 130, Sep 88

Deluxe logic probe A
M. Wilde p 74, Jan 87

Detail look at probes
Martin, and Davis p 75, Sep 85

Detector, logarithmic, broadband
PA4C/WW2SA p 75, Jul 86

Dual wattmeter, 50 500 MHz
WB4EHS p 67, Jul 85

Elmer’s notebook: power measurements
W3WSI p 100, Jan 88

Elmer’s notebook: standing wave ratio: does it mean?
W3WSI p 98, Feb 88

EMIFRII shielding: new techniques part 1
W3WSI p 109, Jan 88

EMIFRII shielding: new techniques part 3
Martin, Vaughn D p 72, Jan 84

EMIFRII shielding: new techniques part 2
Martin, Vaughn D p 85, Feb 84

Extended-rangue VU meter
WB3JZ0 p 59, Sep 86

96 December 1988
BEVERAGE ANTENNA HANDBOOK
by Vic Misek, W1WCR
New Edition

W1WCR has spent countless hours developing new antenna ideas and optimizing the SWA (Steerable wave antenna.) Misek delves deep into the secrets of the simple 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

$14.95

FULLY REVISED

The Beverage Antenna Handbook

January 1988

JUN’S BARGAIN BOX
SPECIAL BARGAIN PRICES
THIS MONTH ONLY

Call for Special Price

ICOM
03AT
IC3200A
IC38A

YAESU
FT72TR
FT311RM
FT109RH

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

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

1988 U.S. CALL DIRECTORY
(on microfiche)

Call Directory - by callsign...........$5
Name Index - by last name...........$5
Geographic Index - by state/city.....$8
All three - $20
$3 shipping per order

Buckmaster Publishing
Route 3, Box 56
Mineral, Virginia 23117
703/894-5777

VISA/MASTERCARD

172

173

December 1988
alpha delta model delta-4 lightning surge protected 4-position rf coax switch

superior rf switching and equipment protection for amateur, military and government communications stations.

- exclusive center "off" (ground) position internally disconnects and grounds all antenna circuits for maximum protection when operator is away from the station — an alpha delta first!
- incorporates the famous replaceable arc-plug® cartridge for continuous protection of the active antenna circuit. unused antenna circuits are automatically grounded — an alpha delta first!
- the model delta-4 switch features a custom designed cast housing with constant impedance micro-srip cavity construction for outstanding performance through uhf. no lossy wafer switches are used.

model delta-4 (uhf connectors, 500 mhz) ........................................... $74.95
model delta-4/n (n-type connectors, 1.3 ghz) ........................................ $89.95

available from your local alpha delta dealer or direct. add $4.00 shipping and handling (u.s.a. only) exports quoted.

see data sheet for surge limitations.

alpha delta communications, inc.

p.o. box 571, centerville, ohio 45459 • (513) 435-4772
current solutions to current problems

black dacro® 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 dacro® 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

Ham radio Bookstore
Greenville, NH 03048
603-878-1441

low band dx'ing
computer programs
by john devoldere, on4un, for apple ilee/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. © 1996.

- UN-Aple ilee/lc .............................. $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, slivers, 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

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

ham radio bookstore

Greenville, NH 03048

175

182

180

198 December 1988
Two-tone signal generator
YBATAW4AQN p 25, Feb 86
Short circuit p 45, Apr 86
Short circuit p 36, Jun 86
2 GHz preamplifier N9UH p 21, Jan 87
Understanding noise figure
Grubrich, Michael p 89, Apr 87
VHF noise bridge, a OZAPAM/A3K p 10, Jul 86
Widerange RF world W1JR p 55, Oct 84
SWR bridges K2LJ p 37, Mar 86
Wide-range RF power meter KABOB p 24, Apr 86

MICRO-SYSTEMS

ALC circuits, improving amplifier: part 1
WABJN p 40, Aug 84
ALC circuits, improving amplifier: part 2
WABJN p 38, Sep 84
Amateur FSK: A spectral analysis
WAGNXC p 42, Dec 86
Audio to microwave amplifier, build your own
Gruchalla, Michael p 12, Mar 84
Biased MOSFET, integrated circuit
W1NF p 25, Mar 85
Branch-line hybrid: part 1
WAEZW p 107, Apr 84
Branch-line hybrid: part 2
WAEWT p 93, May 84
Broadband attenuator
WTSX p 59, Jul 85
Build a 1-1000 MHz amplifier using
MAR-4 MMICS WBB6BN p 33, Jul 87
Build a QSO “beeper”
K6GCD p 38, Jan 88
Buying tops maps, Comments.
K3SEE p 9, Dec 85
Can you patent it?
K2LJ p 8, Mar 87
Comments: changing fundamental concepts of science
W4SSX p 6, Oct 87
Communicating on 474.063 GHz (light wave communications)
WAEJO p 10, Dec 86
Decibel, defining the
Gruchalla, M p 51, Feb 85
Electromagnetic interference and the digital era
K3PUR p 114, Sep 84
Elmer’s notebook: The mysterious “O”
W1SL p 110, Sep 88
EMIRF shielding: new techniques part 1
Martin, Vaughn D p 84, Oct 84
EMIRF shielding: new techniques part 2
Martin, Vaughn D p 84, Oct 84
Filter design, graphic
WENRW p 37, Apr 84
Short circuit W2BU p 13, Jul 84
Function Generator: circuits from your signal generator-part 1
K4IPV p 89, Nov 87
Ham Radio techniques
WESAI p 63, May 84
Ham Radio techniques, fifty years ago
W5ER p 58, Jun 84
Ham Radio techniques
WESAI p 106, Oct 84
Ham Radio techniques
WESAI p 75, Jan 85
Ham Radio techniques
WESAI p 59, Feb 85
Ham Radio techniques
WESAI p 83, Mar 85
Ham Radio techniques: electron-hole theory exposed as fraud
W2YV p 67, Apr 85
Ham Radio techniques
WESAI p 66, May 85
Ham Radio techniques
WESAI p 51, Jun 85
Ham Radio techniques
WESAI p 59, Jul 85
Ham Radio techniques: I have seen the future and it works
WESAI p 90, Aug 85
Ham Radio techniques
WESAI p 75, Oct 85
Ham Radio techniques
WESAI p 67, Nov 85
Ham Radio techniques: 9CX7 revisited
WESAI p 83, Dec 87
Ham Radio techniques: line voltage and power tube life
WESAI p 60, Jul 88
Ham Radio techniques: the joys of TVI or, were you on the air last night?
WESAI p 37, Aug 88
Harmonics, Trapping stubborn N1RC p 98, Jan 86
Interference matching: a brief history
W2ODC p 49, Jun 84
Intermittent reception due to lightning
K5WH p 39, Sep 88
Lightning location and detection
W2YW p 25, Sep 87
Linear amplifier, 3C800A7
K8BA p 17, Aug 84
Low-pass filter, integrated circuit
WB2KTG p 59, Jan 85
Mobile theft deterrent: The Weekender
K41PV p 101, Sep 87
Modifying the Trio-Kenwood TS2000
WB9IKX p 67, Apr 86
Modifying the Trio-Kenwood RF amplifiers
N0JH p 22, Mar 86
NE5025 wideband RF amplifier
Gruchalla, Michael p 30, Sep 86
Short circuit p 72, Jan 87
Neutralizing 5728S final at 1500 watts output
(W1B) WESAI p 63, Jun 84
New uses for old tunes
W5TTU p 25, Jan 84
Noise injection circuit
K1RQG p 75, Mar 84
Peaked lowpass: a look at the ultraflat filter
W7ZO p 96, Jun 84
Phase modulator, PLL (HN)
VE3JHM p 117, Jun 85
Comments, K6KVX, Sample Martin, W5DBAO, WB4APF p 10, Feb 84
Polymer film transforms mechanical energy to electrical energy
W2DZ p 55, Dec 84
Power FETs: trend for VHF amplifiers
Peters, Daniel, and W1UPU W2LQ p 12, Jan 84
Power supply enhances mobile operation (weekender)
K2LJ p 83, Jan 88
Practically speaking: repairing flood damage
K4IPV p 95, Oct 85
Practically speaking: intermittents, pl. 1
K4IPV p 75, Nov 85
Practically speaking: intermittents, pl. 2
K4IPV p 79, Dec 85
Practically speaking: battery problems, pl.
K4IPV p 62, Jul 87
Practically speaking: feedback
K4IPV p 57, May 86
Practically speaking: Overview of op amps-part 1
K4IPV p 100, Nov 88
Practically speaking: overview of op amps-part 2
K4IPV p 63, Dec 88
Prerecorded messages help the hearing impaired (HN)
W2WIC p 67, Sep 84
Quartz crystal resonators
Boddaert, Peter p 85, Feb 86
Remedies for RFI (comment)
K6KX p 9, Jul 88
Resonant circuits
W2H4C p 12, Apr 84
RFI filters, build a
W2VHS p 10, Mar 86
Shaded, a
W2VHS p 36, Jun 86
RFI, solving the problems of
W2YW p 124, Sep 84
Russell Woodpecker, the annoying nuisance
K4RQG p 37, Nov 84
Solar power for your ham station
N6HN p 14, Dec 84
Shield circuit
W2YW p 17, Aug 85
The Guern report computer technology
W6MGI p 54, Nov 84
Shaped circuit W2YW p 6, Dec 84
The Guern report
W6MGI p 124, Jan 85
The Guern report: superchips come of age
W6MGI p 126, Feb 85
The Guern report
W6MGI p 156, Mar 85
The Guern report
W6MGI p 157, Apr 85
The Guern report: a busy signal from space
W6MGI p 165, May 85
The Guern report predicting equipment failures
W6MGI p 125, Jun 85
The Guern report
W6MGI p 124, Aug 85
The Guern report: RF power supplies achieve high efficiency
W6MGI p 157, Sep 85
The Guern report: RF effects the good and the bad
W6MGI p 142, Oct 85

NOVICE READING

Cheers from down under, Comments.
W4KJQA p 9, Dec 86
Ham radio techniques
W4KJQA p 59, Dec 86
Elmer’s notebook: novice enhancement
W1SL p 95, Jun 87
Shower circuit
W2W3U p 91, Aug 87
Elmer’s notebook: 220 MHz
W1SL p 101, Sep 87
Elmer’s notebook: packet radio
W1SL p 100, Oct 87
Morse code tutor tutorial
W4KJQA p 45, Jun 85
New band privileges for Novice opera-
tors (letter)
W2WAQ p 15, Sep 85
Comments, W3YBF p 9, Jan 86
Comments, KD6EV p 9, Jun 86
Comments, K6DW p 5, Jun 86
Novice privileges (letter)
W2W3YR p 9, Oct 85
Practically speaking
K4IPV p 79, Dec 85
Radioelements codes: there’s just not
K4EAJ p 82, Sep 88
Reflections: Novice enhancement and the 220 MHz band
W5JUV p 4, Apr 87

OPERATING

Buying topo maps, Comments.
K3SEE p 9, Dec 86
Carrier complaint (comment)
W3GQ p 9, Jul 88
Carrier-operated CW reception
W1SL p 93, Sep 88
Comments: DARC awards information
K3RH p 6, Jul 87
Elmer’s notebook: 220 MHz
W1SL p 91, Aug 84
Short circuit p 95, Aug 87
Elmer’s notebook: an introduction to
AMTOR W1SL p 101, Sep 87
Elmer’s notebook: packet radio
W1SL p 100, Oct 87
Morse code tutorial
W36QJ p 45, Jun 85
New band privileges for Novice opera-
tors (letter)
W2WAQ p 15, Sep 85
Comments, W3YBF p 9, Jan 86
Comments, KD6EV p 9, Jun 86
Comments, K6DW p 5, Jun 86
Novice privileges (letter)
W2W3YR p 9, Oct 85
Practically speaking
K4IPV p 79, Dec 85
Radioelements codes: there’s just not
K4EAJ p 82, Sep 88
Reflections: Novice enhancement and the 220 MHz band
W5JUV p 4, Apr 87

December 1988
PL tone generator, a programmable WNBWST p 51, Apr 84 Synchronous circuit p 125, May 84 Practically speaking: drifting and shift K4IPV p 75, Jan 86 Unipolar oscillator circuit VCOIFRF p 38, Apr 86 Wideband VCO design WA4IMX p 49, Jul 84

PACKET


Regulated screen grid power supply, A AG6K p 51, Jan 86 Storing lead-acid batteries and NSOP p 9, Sept 88 Batteries on concrete (comment) NSOP p 79, Sept 88 Temperature control, automatic W2BFSF p 75, Jun 85 The Guerrin report: RF power supplies achieve high efficiency WA4ICG p 157, Sep 85 Transformers, wind your own inap- ICV p 79, Mar 88 3X frequency: DX signal quality WA4GDW p 80, Apr 88

PROPAGATION

Achieve polarization diversity through variable power splitting W3NJO p 10, Feb 86 DX forecaster p 63, Jan 84 p 79, Feb 84 p 93, Mar 84 Comments: Current Propagation WA4MGX p 119, May 84 WA4MGX p 157, Sep 85

POWER SUPPLIES

RECEIVERS AND CONVERTERS

general

Cascaded stages, IMD and intercep- p points
W3MG p 28, Nov 84
CB 10-meter converters, scanner
W2FYM, KB2GJA p 98, Nov 84
Compact 75-meter monoband tran- sceiver K1BGT p 13, Nov 85
Short circuit p 66, Jan 86
Digital frequency readout to the Com- modore 64 W3NLL p 83, Nov 85
Elmer’s notebook: receiver buzzwords W1SL p 100, Nov 87
Extending receive coverage for the IC-02 as a receiver WB6GTM p 77, Jul 86
External product detector Improves WB6G p 107, Nov 85
High dynamic range mixing with the Mixer W4ZPS p 45, Mar 88
High-frequency receive performance G3URJ p 11, Mar 88
Peppermint receiver W8QIF p 33, Nov 88
Receiver, Pocket-portable LSB WBBBH p 55, Nov 88
Receiver sweep alignment system WBBBH p 124, Nov 84
Shortwave receiver, portable P2YUCIC p 67, Apr 84
Superheterodyne receiver W2AENK p 9, Dec 88
Simple receivers from complex ICs W5VGH p 10, Nov 88
Solid-state 75A4 receiver K7FM p 67, Nov 88
Solderless, colset, design with a W2CJF p 31, Nov 86
Small, double conversion portable W2AENK p 9, Dec 88
Shortwave receiver, portable P2YUCIC p 67, Apr 84
Superheterodyne receiver W2AENK p 9, Dec 88
Simple receivers from complex ICs W5VGH p 10, Nov 88
Solid-state 75A4 receiver K7FM p 67, Nov 88
Solderless, colset, design with a W2CJF p 31, Nov 86
Small, double conversion portable W2AENK p 9, Dec 88

SEMI-CONDUCTORS

Cooling semiconductors part 1: design- p 121, May 85
ing and using heatsinks Martin, Vaughn D p 33, Jul 84
Cooling semiconductors part 2: Claire p 52, Aug 84
fan and fans Martin, Vaughn D p 33, Jul 84
High dynamic range mixing with the SI- BBO1 K4BQJ p 11, Mar 88
K6QOB Practicaly speaking: solid state rectifiers K4IP3V p 51, Aug 86
Practically speaking: substituting transistors-part 1 K4IP3V p 92, Sep 86
Practically speaking: substituting transistors-part 2 K4IP3V p 66, Oct 86
Practically speaking: non-ideal linear IC amplifiers: typical problems and how to solve them p 72, Jul 88
Transistor biasing, back to basics W4DN p 91, Dec 84
HWFHF: world the ubiquitous diode part 2 W1JR p 51, Feb 87
HWFHF: WORLD: the ubiquitous diode part 1 W1JR p 55, Mar 87

SINGLE SIDEBAND

ACSSB: a level-one adapter W2AENK p 10, Oct 86
Adjusting SSB amplifiers AG5K p 33, Sep 85
Better sounding SSB AG5K p 33, Sep 85
Comments W2OZH p 58, Feb 84
Development of Amateur SSB: a brief K4MD history W1JR p 106, Jun 84
Intermodulation with the Si 8001 K4BQJ Practicaly speaking: solid state rectifiers K4IP3V p 51, Aug 86
Practically speaking: substituting transistors-part 1 K4IP3V p 92, Sep 86
Practically speaking: substituting transistors-part 2 K4IP3V p 66, Oct 86
Practically speaking: non-ideal linear IC amplifiers: typical problems and how to solve them p 72, Jul 88
Transistor biasing, back to basics W4DN p 91, Dec 84
HWFHF: world the ubiquitous diode part 2 W1JR p 51, Feb 87
HWFHF: WORLD: the ubiquitous diode part 1 W1JR p 55, Mar 87

SATELLITES

Demodulator, telemetry, PSK, for OS- CAMELLIA: from ground to space G3URJ p 50, Apr 85
Elevation indicator, inexpensive WA2LQO p 19, Jun 85
First HT-60 HT QSO via OSCAR 10 WA2QZC p 37, Sep 84
G.O.S. reception: a simple approach WA4WDL p 46, Jan 84
Introducing satellite communications G3ZGC p 101, Apr 86
Moon-tracking by computer K6WX p 38, Mar 84
Packet radio PSK modem for JAS-1F0-12 G3PRU p 8, Feb 87
Satellite receiver, digitally-controlled KA8BLC p 102, Sep 85
Signals from space, receiving K6QOB p 57, Nov 84
K5RJ The Guerry report: super speed semicon- ductors W1JR p 109, Oct 86
K7BQJ The Guerry report: communication satellites W8MOI p 108, Jun 86
Comments: update on ACSSB SWOSMJ p 6, Nov 86
Work OSCAR 10 with your HT WA2LQO p 29, Sep 84

SOFTWARE

Basic program analyzes simple ladder networks W2OZH p 32, Aug 87
Better tuned amateur computer design W7DHD p8, Sep 87
Design program for the grounded-grid 3-500Z W7DHD p 8, Jun 88
EML eye link communicator KNZ2E p 70, Feb 86
Comments, K9C0H p 49, Apr 86
Get on SSTV with the C-64 KS9D and 12AEX. edited by K9EI p 43, Oct 86
Great circle computations using LOTUS 1-2-3 AD1B p 31, Sep 86
L-band ground wave propagation program W4QGRF and Joseph R. Hennek p 103, Jan 86
Morse code teaching tools for the C-64 KF3R p 26, May 88
Pathfinder-2 K4IP3V p 47, Oct 88
Using macros with packet AD1B p 82, Oct 88
Using spreadsheet programs for amateur radio projects AD1B p 95, Dec 86

TELEVISION

A tour through an NTSC TV station-part 1 (hardware aspects) KL7AJ p 57, Dec 87
Get on SSTV with the C-64 KL7AJ p 43, Oct 86
Short Circuit KL7AJ p 97, Oct 87
Remarks on television series (comments) KBF6O p 26, May 88
Technology of commercial television-part 2 KL7AJ p 54, Jan 88

TRANSMITTERS AND POWER SUPPLIES

general

Adjusting SSB amplifiers AG5K p 33, Sep 85
Aural vco provides relative metering K1ZSJ p 8, Sep 87
Design a tone-amp with your personal W7DHD p 58, Sep 87
P445 ground grid amplifier parascens AG5K p 31, Apr 86
Comments, N4MG p 9, Jun 86
Comment, W2YXW p 6, Jul 86
Ham radio techniques: super cathode drive amplifier W6SAI p 73, Nov 86
Ham radio techniques: “white noise” technology bites back W6SAI p 55, Jan 87
Ham radio techniques: “white noise” reversed WA6SI p 79, Oct 87
MC1496, improved carrier suppression K1ZSJ p 78, Apr 85
Short circuit p 74, Jul 85
MMIC multiplier chains for the 902 MHz W7DHD p 69, Jul 86
Short circuit KL7AJ p 64, May 87
Practically speaking: noise, signals and amplifiers K4IP3V p 77, Feb 88
RF switching, high power with pin diodes K6K8Q p 82, Jan 85
Three-pipe 4X250B linear amplifier Y9AW p 63, Apr 87
True frequency digital readout for the HW-101 NUAF p 87, Nov 87

hf
Better frequency stability for the Drake TR7 HBAABO p 21, Aug 87
CAT control system for the Yaesu FT-757CX SM6CPJ p 26, Nov 87
Comments K4GPE p 30, Mar 84
Compact 20-meter CW receiver K1BGT p 8, Jun 86
Short circuit p 28, Oct 86
Short circuit p 81, Sep 87
Designing a state-of-the-art receiver K3AULJW p 11, Nov 87
Digital HF radio: a sampling of tech- niques K2AWEUD2LR p 19, Apr 85

December 1988
VHF AND UHF general

ATV power amplifier, fast-scan
WB2CJF p 67, Mar 85
Audio for microwave amplifier, build your own
Gruchalla, Michael p 12, Mar 84
Barlow antenna design, interdigital, computer-aided
NN3H, Morzerdah p 30, Jan 85
Short circuit
W7BLY p 32, Jan 87
Bicycle mobile
NN4EN p 58, Sep 87
Clocks, microwave mobiles for hand-held VHF transceiver
KD7BZC and W3BUC p 79, Mar 86
Designing a microwave amplifier
Domasinski, S p 30, Sep 87
Dual wattmeter, 50-500 kHz
W4WQH p 67, Jul 85
Duplexers, six cavity, home-brewed
K9EY p 12, Feb 86
EMI halfwave calculator program
K6E2E p 70, Feb 86
Elmer’s notebook: 220 MHz
W1SL p 51, Aug 87
Elmer’s notebook: 1200 MHz band extension
W1SL p 51, Aug 87
Get on 6 meters the inexpensive way
K9IJJ p 91, Mar 85
GOES reception: a simple approach
WA4WDL p 46, Jan 84
Halogen ground wave propagation program
WA4GFR and Joseph R Hennel p 13, Jan 86
Local oscillators, high stability for microwave receivers and other applications
W4GMR p 29, Nov 87
Measuring noise figure
K2BLA p 26, Jan 84
Micros and VHF beacon transmits messages automatically
K9RR p 51, Jul 85
Microstrip impedance program
KBUR p 84, Dec 84
MMIC multichip amplifiers for the 902 MHz band
N6JH p 72, Feb 87
Short circuit
W7ZJL p 84, May 87
Modular transistors and receivers for 902 MHz
N6JH p 17, Mar 87
Monolithic RF amplifiers
N6JH p 22, Mar 86
Monolithic, determines, dual, single
K2WVO p 36, Jan 85
Moon-tracking by computer
K6YN p 38, Mar 84
Noise figure and the 220 MHz band. Reflections:
W9JUJ p 4, Apr 87
Power dividers, extended/extended
W7JTL p 73, Oct 84
Power:FETs: trend for VHF amplifiers
W7FBUA and Peters, Del DrVLU p 12, Jan 84
Practically speaking: parametric amplifiers
K4PV p 65, Mar 88
Preamp at work, Quiet!
N9TX p 14, Nov 84
Remote base/singleplex phone patch control
AN3XXX and K4KLX p 54, Aug 88
RF transmission cable, microwave applications
KD3NQ p 106, May 85
Silverplating, safe, sensible
K9ETY p 29, Feb 85
Simple VHF/UHF multiple quartz wave filters
WE3ETW p 37, Sep 87
Split-feed and 50-50 MHz transatlantic propagation during 1987
G3NAQ p 10, Jul 88
The Great report: signal polaritons
W6MGi p 156, Dec 84
The Guern report: mm waves, part 1
W1SFC and W1GBS p 109, Dec 86
The Guern report: mm waves, part 2
KG7JH p 117, Mar 86
The Guern report: fiber optics
W6MGi p 141, May 86
Trade off power for antenna gain at
W9HSAH, Henkel p 32, Jul 85
Comment, W8GFR p 9, Apr 86
24 GHz precaster
W4JN p 21, Jan 87
UHF antenna tower, low-cost
K6AUVY p 30, Oct 84
VHF amplifiers, carrier-operated relay
W8JCC, KD7BZC p 45, Apr 85
VHF meter scatter communications
W2DR p 69, Feb 84
VHF noise bridge
OE2AFL/AADK p 10, Jul 86
VHF noise generation, heterodyne
K1ZJH p 40, Mar 85
Short circuit
W1SFC p 121, May 85
VHF world: the VHFIUHF challenge
W2JR p 42, Jan 87 VHF world: improving meter scatter communications
W2JR p 82, Jun 84
VHF/UHF world: microwave bands
W1SFC and W1GBS p 38, Jan 86
VHF/UHF world: the VHF/UHF primer, an introduction to propagation
W1SFC and W1GBS p 42, Jun 84
VHF/UHF world: the VHF/UHF Primer, an introduction to filters
W1SFC and W1GBS p 112, Aug 84
VHF world
W2JR p 45, Sep 84
W1SFC world
W2JR p 55, Oct 84
W4WQH world
W2JR p 99, Dec 84
W6KFO world: high power amplifiers
W2JR p 97, Jun 85
W7QMS world: high power amplifiers
W2JR p 97, Jun 85
W1SFC world: keeping VHF/UHFers informed
W2JR p 38, Feb 85
W2JR world
W2JR p 126, Mar 85
W1SFC world: protecting equipment
W2JR p 37, Aug 85
W2JR world: propagation update
W2JR p 86, Jul 85
W1SFC world: designing and building loop Yagis
W2JR p 58, Sep 85
VHFIUHF world: transmission lines
W1JR p 83, Oct 85
Comment, W8NZE p 9, Apr 86
VHFIUHF world
W1JR p 54, Nov 85
W1JR world
W1JR p 85, Dec 85
W1SFC world: ,w and mm-wave propagation, part 2
W1SFC p 69, Aug 86
W1SFC world: meteor scatter communications
W2JR p 68, Jun 86
Short circuit
W1SFC p 87, Jul 86
VHFIUHF world: microwave bands
W1SFC p 33, our newest band
W1SFC p 83, Apr 86
Short circuit (p 77, July 86)
p 9, Aug 86
VHFIUHF world: rf connectors, part 1
W1SFC p 77, Sep 85
VHFIUHF world: rf connectors, part 2
W1SFC p 59, Oct 86
VHFIUHF world: microwave and millimeter-wave update
W1SFC p 63, Jan 87
VHFIUHF world: 33 cm update
W1JR p 74, Apr 87
Short circuit
W1SFC world portable operation
W1SFC p 75, Jun 87
Short circuit
W1SFC world: minimum requirements for 2-meter EME-p1
W1SFC p 85, Sep 87
VHFIUHF world: Operating a VHFIUHF microwave station
W1SFC p 38, Aug 87
Comment, W7WRO p 85, Apr 87
VHFIUHF world: impedance matching techniques
W1SFC p 77, Oct 87
VHFIUHF world: long ends
W1SFC p 82, Feb 88
VHFIUHF world: power splitters and summer
W1SFC p 80, May 88
VHFIUHF world: IMD and splatter
W71JR p 71, Oct 88
23 GHz precaster
W1SFC p 21, Jan 87
Antennas
Antennas, isotropic, directional, and parasitic
WA3ENK p 85, Oct 87
Conversion and splatter
W4IHU p 58, Oct 87
Coax velocity factor
W5JTL p 141, May 86
Dipoles (Weekender)
WA3ENK p 37, Aug 85
Dipole antennas (p 103, May 86)
TL60S p 129, Apr 85
Dipole antennas, part 2
W1SFC p 97, Oct 87
2-meter rotor
W3WEK p 64, Jul 88
1295-MHz low noise amplifier
W3WEK p 60, Nov 88
Transmitters
Amplifier, 432-MHz, 1500-watt
W6QGG p 40, Jul 85
Low-noise phase-locked VHF CVO part 1: the noise problem
W4DUM p 33, Jul 86
Short circuit
W1SFC p 9, Dec 86
Low-noise phase-locked VHF CVO part 2: construction and testing
W1SFC p 25, Aug 86
Temperature control, automatic
W6QGG p 79, Jul 85
TR-2500/2600 2-channel programming (HN)
K9QLD p 128, Oct 85
VHFIUHF world: VHFIUHF receivers
W1JR p 42, Mar 84
VHFIUHF world: low-noise GaAs FET technology
W1JR p 99, Dec 84
W1SFC world
W1JR p 54, Nov 85
VHFIUHF world: low noise update, part 2
W1JR p 72, Dec 87
Yaesu’s latest VHF/UHF receiver, add generic coverage
W6MGi p 67, Oct 85
Short circuit
W1SFC p 97, Oct 87
2-meter rotor
W3WEK p 64, Jul 88
VHFIUHF world: medium power amplifiers
W1JR p 39, Aug 85
VHFIUHF world: VHFIUHF exciters
W1JR p 84, Aug 84
Short circuit
W1SFC p 60, Oct 84
Waveguide modulation, 2-meter rotor transmitter
N1COX p 12, Jul 85
X-band beacon
W1SFC p 29, Jan 87
Microwave techniques
Designing a station for the microwave bands: part 1
N3G0G p 41, Feb 88
Designing a station for the microwave bands: part 2
N3G0G p 19, Jun 86
Short circuit
W1SFC p 35, Oct 85
Designing a station for the microwave bands: part 3
N3G0G p 17, Oct 88
Radial line stub design
N1SEP p 65, Feb 88
VHFIUHF world: microwave components and terminology part 1
W1JR p 71, Mar 86
VHFIUHF world: microwave components and terminology part 2
W1JR p 67, Apr 88
Kitty says: We are now open 7 days a week.
Saturday & Sunday 10 to 5 P.M.
Monday-Friday 9 to 6:30 P.M. Thrus. to 8 P.M.
Come to Barry’s for the best buys in town.

ONV Safety belts-in stock

Antennas in stock

KENWOOD

Antennas
A5, A5S, Cushcraft, Hy-Gain, Hustler, KLM, METZ, Molesky, NODIBOX, TONIA


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

FLUKE 77 Multimeter

Media Mentors—
Amateur Radio Course $399.95

VoCom/Mirage/Alinco

Tokyo Hy-Power/TE SYSTEMS

Amplifiers &
5/8, HT Gain

Antennas IN STOCK

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

Soldering Station 48 Watts $68.

FLUKE 77 Multimeter

Motorola Authorized Dealer

KACHINA COMMUNICATIONS DEALER

Shortwave Receivers

Stocked

EIMAC 3.50/2G
572B, 6J5C6
12BY7A & 6146B

Bench Paddles

Baluns, Low Pass Filters

In Stock

ASTRON POWER SUPPLIES

Saxton Wire & Cable, Int’l Wire

METRON MA-1000 8 Stocked

New Tec Tuner 2298

Sangean Portable Shortwave Radios

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


We NOW STOCK COMMERCIAL COMMUNICATIONS SYSTEMS

HAM DEALER INQUIRIES INVITED PHONE IN YOUR ORDER & BE REIMBURSED COMMERCIAL RADIOS stock & serviced on premises.

Amateur Radio Courses Given On Our Premises, Call Export Orders Shipped Immediately. TELEX 12-7670 FAX: 212-925-7001
RF prototype systems adds the PLL1 to its QUICK BOARD product line. The board is the basis for a 900-MHz phase-lock loop synthesizer. Several PLL configurations can be implemented with user selected divide ratios, VCO, loop filter, and associated components to be installed in the PLL1. The PLL1 lets you build a PLL that allows you to optimize parameters, or produce a low cost frequency source.

The design is based on the Motorola MC145152 dual-modulus, parallel-interface synthesizer IC and uses common dividers and op amps. The loop filter is laid out for a standard third order type 2 PLL. Frequencies are programmed with parallel data input provided by onboard dip switches.

The PLL1 includes a circuit board, schematic, assembly drawing, and an application note on how to build a PLL using the PLL1 QUICK BOARD.

The price in quantities of 1-9 is $95.00. For more information, please contact RF prototype systems, (619) 586-6771, 12730 Kestrel St, San Diego, California 92129.

Circle #307 on Reader Service Card.

Rad-com soft-control

Soft-Control software provides remote access to your radio's functions via a serial link from your PC. Using the radio's built-in command set, the program lets you control the functions of your transceiver from a simple menu. Soft-Control also includes complete maintenance of the radio's memory channels. Memory data can be added, deleted, or edited and then saved to, or restored from disk.

Available immediately for the Kenwood TS-440S and IBM PC or compatible, other radiocomputer combinations are expected to be available soon. The program can be purchased directly from Rad-Com and sells for $59.95.

For more information, or to order contact: Rad-Com, P.O. Box 1166, Pleasanton, California 94566.

Circle #306 on Reader Service Card.

900-MHz phase lock loop synthesizer

4-digit sequence decoder and "Quad" option

The new model TSDQ 4-digit sequence decoder replaces the TSD decoder. Its features include a DPDT 2-A relay, on board 5-volt regulator, digit valid indicator, and expansion connector. Connections to the board are via a 24-pin card-edge connector, which provides quick disconnect and expansion with the new Model "QUAD" 4-relay expansion card.

The TSDQ operates as a stand-alone 2-4 digit touchtone sequence decoder. Output may be either latching or momentary control of the DPDT relay. All 16 digits are output to the card-edge connector and can be used for single digit commands. The relay turns on when it receives a 4-digit code and turns off when the code is received again. When the QUAD option is plugged in, four DPDT relays may be turned on and off with individual access codes. A master "on" code, followed by the relay number, turns on a relay; a master "off" code, followed by the relay number, turns the relay off. These relay on/off codes can be a total of 3-5 digits long. In addition to the relay outputs there are four transistor outputs to provide LED readouts of the relay states, or act as control voltage for other devices. All output connections are via a 24-pin card-edge connector which uses the same pin numbers for all inputs as the TSDQ card. This allows instant compatibility when the QUAD expansion card is added.

Model "TSDQ" is $79.95 including 24-pin edge connector. Model "QUAD" is $99.95 (requires "TSDQ"). Add $3.00 shipping. California residents add 6 percent.

Additional information can be obtained by contacting, Engineering Consulting, 583 Candlewood Street, Brea, California 92621.

NCG Co. introduces new items

NCG Co. has the following new items available:

- 900-MHz mobile antenna. Model no. CMW3-71 is a 5/8 wave x 3-step wide-band antenna. Gain is 7.14 dB, maximum power is 50 watts. Length is 2'7". Frequency for a 1.5 VSWR is 910-940 MHz, the base has a fold-over design for low garage parking.
- Dual-band UHF/1.2-GHz mobile antenna. The Model CHL-120 is a wide-band low VSWR mobile antenna for the high frequencies. Gain is 2.15 dB for UHF and 5.6 dB for 1.2 GHz. Maximum power is 50 watts, VSWR is 1.8 or less, length is 1'2". Simulcast operation is possible when used with the CF-413 duplexer.
- CM-900 mini meter. Designed for the 900-MHz band, insertion loss is less than 0.2 dB; measurable power is from 0 to 120 watts. SWR is 1.0-5, power range 10/120W accuracy is 0.55 ± , dimensions are 2.25"W x 2.55"H x 1.1"D.
- CM-300 mini meter. Designed for the 200-240 MHz, insertion loss is less than 0.2 dB; measureable power is from 0-60 watts. SWR measurement 1.0-5 to 1. Accuracy is 0.50 ± , dimensions are 2.25"W x 2.55"H x 1.1"D. The CM-300 is equipped with UHF connectors.
- Low-loss coax mounting kits. The CK-5LX is the 500V + RG188A/u. The CK-5LX is usable from 1 MHz to 1.5 GHz. The CK-3LX is the 3.500V + RG188A/u. The CK-3LX is usable from 1 MHz to 900 MHz. The loss for the coax is 3.500V at 400 MHz 3.5, at 1000 MHz 5.6 per 100 feet. 50Q at 400 MHz 3.2, at 1000 MHZ 5.3.

For further information on any of these items, contact NCG Co. 1275 N. Grove Street, Anaheim, California 92806.

Circle #308 on Reader Service Card.
## Frequency Counters

<table>
<thead>
<tr>
<th>Model</th>
<th>Freq Range (MHz)</th>
<th>Sensitivity</th>
<th>Accuracy</th>
<th>Digit</th>
<th>Resolution</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT-70</td>
<td>2 to 60 MHz</td>
<td>0.01%</td>
<td>0.01%</td>
<td>3</td>
<td>300 Hz</td>
<td>$189.55</td>
</tr>
<tr>
<td>CT-90</td>
<td>10 to 500 MHz</td>
<td>0.05%</td>
<td>0.05%</td>
<td>3</td>
<td>600 Hz</td>
<td>$189.55</td>
</tr>
<tr>
<td>CT-50</td>
<td>5 to 50 MHz</td>
<td>0.1%</td>
<td>0.1%</td>
<td>2</td>
<td>300 Hz</td>
<td>$189.55</td>
</tr>
<tr>
<td>CT-125</td>
<td>10 to 125 MHz</td>
<td>0.2%</td>
<td>0.2%</td>
<td>2</td>
<td>600 Hz</td>
<td>$189.55</td>
</tr>
</tbody>
</table>

## Accessories for Counters

- Telescopic whip antenna: $1.50
- High-performance transistor: $1.50
- Low-pass probe: $1.50
- Test leads: $1.00
- Battery: $0.50

## Mini Kits—Easy to Assemble—Fun to Use

<table>
<thead>
<tr>
<th>Kit</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT-70</td>
<td>2 to 60 MHz</td>
<td>$5.95</td>
</tr>
<tr>
<td>CT-90</td>
<td>10 to 500 MHz</td>
<td>$6.95</td>
</tr>
<tr>
<td>CT-50</td>
<td>5 to 50 MHz</td>
<td>$6.95</td>
</tr>
</tbody>
</table>

## Tone Decoders

- Quality tone board, easy to assemble: $8.95
- Complete kit: $10.95

## Tone Modulation

- Outputs 100 Hz, 100 microsecond pulse train: $2.95

## LED Blaster

- 50 Hz, 500 microsecond pulse train: $2.95

## Universal Timer

- Provides the basic building block for a complete timer: $2.95

## Whistle Light

- Produces a whistle sound: $4.95

## Siren

- Produces a siren sound: $4.95

## New New Kits

- Broadband Preamp: $2.95
- Light Beam Communicator: $9.95
- High Power FM Wireless Mic: $9.95

## 2 MTR & 220 Booster Amp

- Great booster for any 2 meter or 220 MHz handheld unit. These power boosters deliver over 30 watts of output allowing you to hit the repeaters full quieting while the low noise preamp dramatically improves reception. Ramsey Electronics has sold thousand of 2 MTR amp kits but now, we offer for the first time a complete 220 MHz line. Both have all the features of the 2 MTR amp plus some unique 220 MHz features, plus our PA 122 220 MHz power booster (10 X power gain) fully wired & tested $34.95

## Ramsey Electronics

Quality Test Gear & Electronic Kits for Professionals and Hobbyists

**All New Kits**

- Personal Speed Radar $82.99
- New low noise, high power RF/Video decoder for sale. $129.95
- New high power long range decoder, 2 MTR/220 MHz, $99.95
- All new Mini Kits—Easy to assemble—Fun to use

**Phone Orders Call 716-586-3950**

Fax 716-586-4754

**Credit Card Orders**

- Mastercard
- Visa

**Guaranteed Service**

- 30 days to return unused equipment
- 90 days to return defective equipment
- Free shipping on orders over $20.00
- No minimum order required
<table>
<thead>
<tr>
<th>State</th>
<th>Store Name</th>
<th>Address</th>
<th>Phone Numbers</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>California</td>
<td>A-TECH ELECTRONICS</td>
<td>1033 HOLLYWOOD WAY BURBANK, CA 91505</td>
<td>(818) 845-9203</td>
<td>New Ham Store and Ready to Make a Deal</td>
</tr>
<tr>
<td></td>
<td>JUN'S ELECTRONICS</td>
<td>3919 SEPULVEDA BLVD. CULVER CITY, CA 90230</td>
<td>213-390-8003</td>
<td>Habla Espanol</td>
</tr>
<tr>
<td>Colorado</td>
<td>ALLIED APPLIANCE &amp; RADIO</td>
<td>4253 SOUTH BROADWAY ENGLEWOOD, CO 80110</td>
<td>(303) 761-7305</td>
<td>Stocking all major lines</td>
</tr>
<tr>
<td></td>
<td>Rocky Mt Amateur/Shortwave Specials, Ten-Tec, Yaesu, JRC-NRD, NRD, Sony, MFJ, KLM, and other fine gear. New and used. Vise/MC. Antennas, books, discount prices too!</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connecticut</td>
<td>HATRY ELECTRONICS</td>
<td>500 LEDYARD ST. (SOUTH) HARTFORD, CT 06114</td>
<td>203-527-1861</td>
<td>Call today. Friendly one-stop shopping at prices you can afford.</td>
</tr>
<tr>
<td>Delaware</td>
<td>AMATEUR &amp; ADVANCED COMMUNICATIONS</td>
<td>3208 CONCORD PIKE WILMINGTON, DE 19803</td>
<td>(302) 478-2757</td>
<td>Delaware's Friendliest Ham Store</td>
</tr>
<tr>
<td></td>
<td>DELAWARE AMATEUR SUPPLY</td>
<td>71 MEADOW ROAD NEW CASTLE, DE 19720</td>
<td>302-328-7728</td>
<td>One mile off I-95, no sales tax.</td>
</tr>
<tr>
<td>Florida</td>
<td>AMATEUR ELECTRONIC SUPPLY</td>
<td>1896 DREW STREET CLEARWATER, FL 33575</td>
<td>813-461-4267</td>
<td>West Coast's only full service Amateur Radio Store.</td>
</tr>
<tr>
<td></td>
<td>Clearwater Branch</td>
<td></td>
<td></td>
<td>Hours M-F 9-5:30, Sat. 9-3</td>
</tr>
<tr>
<td></td>
<td>AMATEUR ELECTRONIC SUPPLY</td>
<td>621 COMMONWEALTH AVE. ORLANDO, FL 32803</td>
<td>305-894-3238</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Fia. Wats: 1 (800) 432-9424</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Outside Fla: 1 (800) 327-1917</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Hours M-F 9-5:30, Sat. 9-3</td>
<td></td>
</tr>
<tr>
<td>Georgia</td>
<td>DOC'S COMMUNICATIONS</td>
<td>702 CHICKAMAUGA AVENUE ROSSVILLE, GA 30741</td>
<td>(404) 866-2302 / 861-5610</td>
<td>ICOM, Yaesu, Kenwood, Bird...</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9AM-5:30PM</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>We service what we sell.</td>
<td></td>
</tr>
<tr>
<td>Hawaii</td>
<td>HONOLULU ELECTRONICS</td>
<td>819 KEAAUMOKU STREET HONOLULU, HI 96814</td>
<td>(808) 949-5564</td>
<td>Kenwood, ICOM, Yaesu, Hy-Gain, Cushcraft, AEA, KLM, Tri-Ex Towers, Fluke, Belden, Astron, etc.</td>
</tr>
<tr>
<td>Idaho</td>
<td>ROSS DISTRIBUTING COMPANY</td>
<td>78 SOUTH STATE STREET P.O. BOX 234 PRESTON, ID 83263</td>
<td>(208) 852-0630</td>
<td>M 9-2; T-F 9-6; S 9-2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Stock All Major Brands</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Over 7000 Ham Related Items on Hand</td>
<td></td>
</tr>
<tr>
<td>Illinois</td>
<td>ERIICKSON COMMUNICATIONS, INC.</td>
<td>5456 N. MILWAUKEE AVE. CHICAGO, IL 60630</td>
<td>312-631-5181</td>
<td>Hours: 9:30-5:30 Mon, Tu, Wed &amp; Fri; 9:30-8:00 Thurs; 9:00-3:00 Sat.</td>
</tr>
<tr>
<td>Indiana</td>
<td>THE HAM STATION</td>
<td>220 N. FULTON AVE. EVANSTON, IL 60610</td>
<td>(800) 529-7372</td>
<td>ICOM, Yeasu, Ten-Tec, Cushcraft, Hy-Gain, AEA &amp; others.</td>
</tr>
<tr>
<td>Maryland</td>
<td>MARYLAND RADIO CENTER</td>
<td>8576 LAURELDALE DRIVE LAUREL, MD 20707</td>
<td>301-725-1212</td>
<td>Kenwood, Ten-Tec, Kantronics. Full service dealer. M-F 10-7</td>
</tr>
<tr>
<td>Missouri</td>
<td>MISSOURI RADIO CENTER</td>
<td>102 NW BUSINESS PARK LANE KANSAS CITY, MO 64150</td>
<td>(816) 821-7323</td>
<td>Missouri: (816) 741-8118</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ICOM, Kenwood, Yaesu</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Same day service, low prices.</td>
<td></td>
</tr>
<tr>
<td>Nevada</td>
<td>AMATEUR ELECTRONIC SUPPLY</td>
<td>1072 N. RANCHO DRIVE LAS VEGAS, NV 89106</td>
<td>702-647-3114</td>
<td>Dale Porray &quot;Squeak,&quot; AD7K</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Outside Nev: 1 (800) 834-6227</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Hours M-F 9:30, Sat. 9-3</td>
<td></td>
</tr>
<tr>
<td>New Hampshire</td>
<td>RIVENDELL ELECTRONICS</td>
<td>8 LONDON DERRY ROAD DERRY, N. H. 03038</td>
<td>603-434-5371</td>
<td>Closed Sun/Holidays</td>
</tr>
</tbody>
</table>

Dealers: YOU SHOULD BE HERE TOO! Contact Ham Radio now for complete details.
short circuits

Wrong ZIP!
The ZIP code for FAR Circuits (see W4ULD article, September 1988) was incorrectly shown as 60188. Please note that the correct ZIP is 60118. Ed.

Correct equations
In equation 4, (see K41PV column, August 1988) R3 should have been R1. Equation 9 should have read:

\[ X_C = \frac{R_2}{(Q_2 + 1) - (R_1/R_2)} \]

Equation 12 should have read:

\[ X_{C1B} = \sqrt{\frac{R_1(Q_2 + 1) - 1}{R_2}} \]

Ed.

Corrected drawing

Ed.

The primary is the antenna feed under test. The split core opens up by compressing the clothespin type device to accept the antenna feed wire. For higher power, drop the secondary down to five turns.

December 1988
THE 1989 ARRL HANDBOOK FOR THE RADIO AMATEUR

Revised and updated with the latest in Amateur technology, now is the time to order your very own copy of the world famous ARRL HANDBOOK. In addition to being the definitive reference volume for your Ham shack, there are plenty of projects for every interest in Amateur Radio — from antennas for every application to the latest state-of-the-art projects — you'll find it all in the 1989 HANDBOOK. Order now and we will ship as soon as the books arrive from the printer. They make perfect gifts for the holiday season for your hard-to-buy for Ham friends or for yourself. Over 1100 pages ● 1988

AR-HB89 Softbound $20.95

NOVR'S ELECTRONIC SECOND OP for MS-QSO computers by Jim Raftery, N9V

The world famous SECOND OP is now available in a state-of-the-art computerized database. This program, written for MS-QSO computers, is a must for DXers, contesters and all Amateurs interested in reliable DX communication. Data can be displayed either in columnar format or in full screen displays. Unknown callsigns can be entered and compared to the ITU callsign allocation for easy identification. There's plenty more too such as: power, beam headings and QSO bureau numbers to name just a few. Great program to have in your shack. Order your's today ● 1988 MS-QSO computers 5½x and 3½ versions available. Please specify on your order:

☐ CB-JR (MS-QSO Computers) $59.95

THE 'GROUNDS' FOR LIGHTNING & EMP PROTECTION by Roger Block, Polyphasor Corporation

Here's a subject that has never really been fully covered in Amateur literature. This 116 page text contains a comprehensive analysis of proper grounding and protection against lightning and other EMP exposures. Includes information for all kinds of electronic gear; radios, telephones, computers, Ethernet, CATV, TVRO, and security systems to name just a few. Of special interest to Hams are chapters on low inductance grounds and connections, guy anchor grounding, and how to ground inside the shack. Every Ham should have a copy. 1st edition 116 pages ● 1997

PG-QEP Softbound $19.95

GENIUS AT RIVERHEAD a profile of H.H. Beverage by Albert Wallen

Born at the very beginning of the radio age. Harold Beverage is one of radio’s pioneers. Most know him from his development of the Beverage or wave type receiving antenna. Learn about the career of this brilliant engineer in this easy to read biography. Starting with GE in 1917 and moving to RCA in 1920. Beverage was involved in some of the most exciting aspects of radio. Of particular interest is a reprint of the famous November 1922 QST article describing the wave antenna. Includes 35 photos 130 pages ● 1987

NH-BEV Softbound $15.95

SHORTWAVE DIRECTORY by Bob Grove, 1988 Edition

Now including SWL and broadcasting information! This SWL's bible is crammed with all the latest up-to-date frequencies and callsign information. Covers 10 kHz to 30 MHz and has listings for every user possible from the U.S. Government to many clandestine stations as you can imagine. Most stations are cross-referenced by agency and frequency for rapid identification. Also contains a glossary of terms, acronyms and abbreviations commonly heard on the air. 4th edition 500+ pages ● 1988

GE-SD Hardcover $15.95

HAM RADIO BOOKSTORE

HOLIDAY GIFT IDEAS

NEW BOOK PAGE

ARRL ANTENNA BOOK by Jerry Hall, K1TD. NEW 15th Edition

The all new 15th edition of this antenna classic represents over two years of hard work by editor K1TD. It's doubled in size too — from over 300 to over 700 pages! 350 figures and charts cover just about every subject imaginable. Some of the highlights are: Chapters on Loop antennas, multi-band antennas, low frequency antennas, portable antennas, VHF and UHF systems, coupling the antenna to the transmitter and the antenna, plus a captions and index. Like the 1988 HANDBOOK and new OPERATING MANUAL, the new ANTENNA BOOK is going to be a smash hit. Order yours today. 15th edition 900 + pages ● 1988

AR-AN Softbound $17.95

NOVICE ANTENNA NOTEBOOK by Doug DeMaw, W1TPB

Novices have long wondered what is the best all around antenna for them to install. Until now, this was a difficult question to answer. Answered at the newly licensed Ham. DeMaw writes for the non-engineer in clear concise language with emphasis on easy-to-build antennas. Readers will learn how antennas operate and what governs performance. Also great reading for all levels of Amateur interest 1st Edition ● 1988

AR-NA Softbound $7.95

1989-89 ARRL REPEATER DIRECTORY

Bigger and better than ever! Over 13,300 listings including 1400 digipeaters! Every Ham should have a copy of this book in their car or shack. Handy resource book has listings by frequency and location. Invaluable aid while travelling ● 1989

AR-RD88 Softbound $4.95

AR-RD88B (Buy 2 & Save) $7.95

ANTENNAS by John Kraus, WBJSX. New 2nd Edition

Kraus's classic antenna book has been extensively revised and up-dated to reflect the latest state of the art in antenna design and theory. Includes over 1,000 illustrations and nearly 600 worked examples and problem solutions. Chapters cover basic concepts: point sources and point source arrays; dipoles, helices, broadband and frequency independent antennas; special applications and tons more of information. Also includes 5 appendices: reference tables; computer programs; books and video tapes; answers to problems and a problem supplement; College level text for the Amateur — 2nd edition 917 pages ● 1988

MH-3542 Softbound $59.95

1988 CALLBOOK SUPPLEMENT

The CALLBOOK SUPPLEMENT contains all the new licenses, address and call changes from all the countries around the world. It also includes all of the new postal rate changes, current QSL, Outbacks, and many other helpful, handy features. A must for the active Ham — it's the only way to have all the current addresses and call signs. 320 pages ● 1988

CB-588 Softbound $9.95

EASY-UP ANTENNAS for Radio Listeners and Hams by Ed Noll, WFO/GJF

Not long been known for easy-to-build antenna articles for all levels of Amateur operation. This book covers basic do-it-yourself antennas for SWLs. AM and FM BQS ers. present and prospective Hams and scanner listeners — includes antennas: verticals, beams, long-wires, and several special types and configurations. Also has time saving look-up dimension tables. constants and other helpful hints for antenna design. It's nice to have Noll back in print as his other two best selling antenna books have been out of print for years. 1st edition 164 pages ● 1988

22495 Softbound $16.95

1989 RADIO AMATEUR CALLBOOKS (Available late November 1988)

NORTH AMERICAN EDITION

Fully updated and edited to include all the latest FCC and foreign government call signs, addresses and call signs for Hams in North America includes plenty of handy operating aids such as time charts, QSL bureau addresses, census information and much more. Calls from a remote island in Canada to tropical Panama. Now is the time to buy a new Callbook. When you get the most use out of your investment. ● 1988

CB-US89 Softbound $25.95

INTERNATIONAL EDITION

QSL's are a very important part of our hobby. All sorts of awards, including the coveted DXCC, require confirmation of contact before the award can be issued. Of special interest, addresses are being added daily for Hams in the USSR and other countries. While in no means complete, it's a start and will be of tremendous help in getting QSLs. Handy operating aids round out this super book value. ● 1988

CB-F89 Softbound $26.95

BUY 'EM BOTH SPECIAL Reg. $54.90 Only $49.95 SAVE $4.95

MASTERING PACKET RADIO: the hands on guide by Dave Ingram K4MJW

Packet radio continues to grow at a rate that boggles the mind. This new book appears to cover all levels of packet radio enthusiasts from novices to experts alike. Full of illustrations and written in a simple, easy-to-understand style. Topics covered include: a basic primer, home computers and data communications terminals, a survey of equipment available, how to set up a station at home for much more. Great compliment to the other packet books available. 206 pages ● 1988 1st Edition

12267 Softbound $12.95

THE ARRL SATELLITE ANTHOLOGY

Taken from the pages of the "Amateur Satellite News" column in QST. Includes the latest information available on OSCARS 9 through as well as the Russian RS satellites. Full coverage is given to Phase III, OSCAR 10 and 13 satellites. Also includes an unpublished article detailing USAT-GOSCAR II 1 operation. Digital modes, tracking antennas, RUDAK, microcomputer processing of telemetry plus much more is contained in this valuable new volume. 212 pages ● 1988

AR-SA Softbound $11.95

22nd CENTRAL STATES VHF SOCIETY CONFERENCE PAPERS

Papers in this book were submitted for the 1988 Central States VHF Society meeting. Includes: Microwave EME; predicting 220 MHz opening, matching versus noise figure trade offs in pre-amps, 902 MHz transverter, power amplifier and antennas, how to measure your k index plus much more. A must publication for the active VHF'er. ● 1988

AR-ZC5 Softbound $11.95

PASSPORT TO WORLDWIDE RADIO 1989 Edition

Brand new and fully revised. SWL's worldwide will want a copy for their library. Expanded to 416 pages, the book now includes a bigger and better buyer's guide. An interview with James Michener, an exciting real life drama of one SWL's escape from Iran plus much more. Also includes all the latest broadcast schedules from countries around the world. You're too late if you have a copy of this new book by your radio. 416 pages 1989 Edition ● 1988

185-RD89 Softbound $14.95

CONFIDENTIAL FREQUENCY LIST 7th Edition now includes RTTY stations Compiled by Geoff Hulligeg

This new edition is jam-packed with all the latest frequencies, call signs and other important information. Inside will find listings for aeronautical, military, embassy, VOLMET, INTERPOL, weather and RTTY stations. Also included is a thorough discussion on how to listen to RTTY stations. explanations of the abbreviations used by utility stations, the reasons behind international jamming and much, much more. Every radio enthusiast should have a copy in their shack. ● 1988 7th Edition 376 pages Published by MGF

GL-CC Softbound $19.95
ANTENNA BOOKS

AM RADIO LOG BOOKS

RIDER IN TIME FOR HOLIDAY GIVING

ick by popular demand

om for over 2100 QSO — that's over twice as many as e other log book. For contesters, each page contains 30 30's for east counts. You also get the latest up-to-date forness spectrum chart. ITU callign list and ARRL XXCC
t. Spiral bound to lay flat on your desk. Unquestionably the best log book value around. © 1986

HR-LB

Spiralbound $2.95

HR-3LB Special buy 3 price. Save 22% Get 3 offer $6.95

EVERAGE ANTENNA HANDBOOK

Victor Misek, W9CR

recognized around the world as the definitive work on average antennas. Misek delves deep into the secrets of single wire Beverage and SWA (Steady Wave Antenna) with helpful hints and tips on how to maximize performan
cased upon wire size, height above ground, overall wire length and impedance matching. Also includes information on center fed Beverages constructed from several wire terms and feedline matching is completely revised.1987 60 pages 2nd Edition

VM-BAH

Softbound $14.95

RANSMSION LINE TRANSFORMERS

Jerry Svevik, W9FMI

contains a complete explanation and discussion of transm
casion line transformers and how to use them. Written by

e of the experts in the field—this book is full of helpful formation. © 1987 1st Edition 144 pages

AR-TLX

Softbound $9.95

AGI ANTENNA DESIGN

Dr. James Lawson, W2PV

pued upon the popular Ham Radio Magazine series, this

xk includes notes, charts, graphs as well as other addi
tional information not found in the original text. W2PV was

pond world as well as one of the most knowledgeable ex

terts on antenna design and optimization. This book is full of

his contest winning "trade secrets." Eight chapters cover

erformance calculations. Simple Yagi antennas, dipole

performance optimization, Loop antennas, the effects of ground, Stecking, Practical design, and

ical Amateur Yagi antennas. A wealth of information a modest price—Lawson's book should be in every ham's library. © 1986 1st edition

AR-YD

Hardbound $14.95

THE AMATEUR RADIO VERTICAL HANDBOOK

Capt. Paul H. Usen, (Ret.), NEPL

ed upon the author's years of work with a number of d

tent vertical antennas, you'll get plenty of the L

nd design information along with a number of practi

construction ideas. Included are designs for simple 1/4 5/8 wave antennas as well as broadband and mult

antenna designs. Paul is an engineer and his book is Amateur Radio's resident expert on the vertical antenna. © 1984, 2nd edition

CO-VH

Softbound $9.95

IFB'S ANTENNA NOTEBOOK

Doug DeMaw, W1FB

has been one of Demaw's passions in Amateur Radio. He has worked with countless designs of all shapes, s

formulations. This illustrated book gives you

guidelines and instructions on a number of different wire and vertical antennas for 160 to 10 meters. Also includes information on radial systems, tuners, baluns and impedance

nestrance. Easy and fun reading. 1967 120 pages

AN

Softbound $7.95

GB HF ANTENNAS FOR ALL LOCATIONS

$11.95

RL ANTENNA COMPLEMENT

AC

$9.95

Special Low Price Books

SOFTWARE FOR AMATEUR RADIO by G3ZCZ

T-1569 $4.95

MICROCOMPUTER IN AMATEUR RADIO by G3ZCZ

T-1305 $4.95

PROGRAMMING FOR THE TR-59 & HP41

T-2127 $4.95

TTL CIRCUITS

21035 REG. $14.95

REPAIR AND TROUBLESHOOTING GUIDES

22353 APPLE II, II+, IIE REG. $19.95

22338 IBM PC REG. $19.95

22363 E-M REG. $19.95

MICROPROCESSOR CIRCUITS

21877 VOL. 1 REG. $9.95

COMMODORE PROGRAMMER'S HANDBOOK

20006 REG. $19.95

APPLE PROGRAMMER'S HANDBOOK

21735 REG. $27.95

COMMODORE C-64 STARTER BOOK

22923 REG. $17.95

PACKET

YOUR GATEWAY TO PACKET RADIO

by Stan Harpea, W4LOU

Here is the complete beginner's guide to Packet Radio written by ARRL Packet expert, W4LOU. Beginners will find the complete, easy-to-understand explanations eliminate most of the frustrating aspects of packet operation. Full of helpful hints and tips that come from thousands of hours of actual air experience. K emo from re learning the wheel — learn from an expert 208 pages. 1987

AR-PKT

Softbound $9.95

GET CONNECTED TO PACKET RADIO

by Jim Grubbs KX1E

This is your Packet Radio Handbook! Over 17 chapters cover every aspect of packet operation from choosing a packet controller (TNC), an explanation of packet protocol and packet interfaces to a primer on how to make your first packet contact to how packet bulletin boards (BBS) operate. Plus more! Also has complete appendix with more information on definitions, bibliography, frequencies, organizations, KLITAFP cross reference guide, Xerox 820 info, other publications, suppliers and W4/R1 commands. This book is most reading for all packet users 1986 208 pages 1st edition

AR-PKT

Softbound $12.95

THE PACKET RADIO HANDBOOK

by Jonathan May, KX3T

Packet radio is the fastest growing mode in Amateur oper

tion today. No wonder — it combines the power of today's computer with worldwide digital communica
tions. Newcomers will find this book to be full of helpful hints and tips that will help them get started with Packet as quickly as possible. Providing you with first packet basi

cs, this book progresses through the inner workings of the operating systems of packet to a look at future technology still in developmental stages. Also in
cudes : using bulletin boards, traffic handling on packet, modem software, and networking. © 1987 220 pages

AR-PKT

Softbound $19.95

5TH ARRL COMPUTER NETWORKING CONFERENCE PAPERS

AR-CNC

Softbound $9.95

6TH ARRL COMPUTER NETWORKING CONFERENCE

AR-CNC

Softbound $9.95

ARRL OPERATING MANUAL

This book has been completely revised and updated! Over 600 pages are examined fully the theoretical applications protocols, software and hardware subjects. You also get a complete up-to-date collection of all published "Gateways", ARRL Packet Radio newsletter as well as the ARRL

HANDBOOK over 1985 over 1000 pages

AR-GM

Softbound $15.95

THE BASIC GUIDE TO VHF-UHF HAM RADIO by Ed Neil W3FGU

Written for the beginner, this book is designed to answer all the questions normally asked about getting on the higher frequencies. Set-up and operation of your

TF packet transceiver and easy to install antennas get prior

edgeincludes hints on repeater operation, cont

cludes modems and a complete table of need

pons on 2, 135 cm and 70 cm bands 1st edition /8 pages 1987

TP-VHF

Softbound $6.95

lease enclose $3.50 shipping & handling.

GREENVILLE, N. H. 03048

(603) 878-1441


Winter DX Anomalies

The winter DX season usually has higher signal strengths and lower thundershowers than the summer, particularly on the lower bands. Both of these conditions increase the signal-to-noise ratio at our receivers, making winter the enhanced DX season. These geophysical conditions occur at this time because the sun’s subsolar point (spot on earth directly under the sun) moves down to the Southern Hemisphere. The big thundershowers are located around the southern land masses, so an added F-region hop is needed to propagate to those of us in the northern mid- to-high latitudes. The amount of signal absorbed is related to the solar zenith angle present at the D-region transit points on the signal’s propagation path. The southern position of the sun lowers this angle and, in turn, lowers the absorption.

The anomaly of this ordinarily improved wintertime signal is the five to six day periods of 20 to 40-dB weaker signals (more like summertime) through the mid- to-high latitude paths providing our communication links to European, Asian, and Japanese Amateurs. I’ve discussed the cause in detail in past December columns; it affects those latitudes in 90 degree increments of longitude. The latitudes directly opposite each other have higher than normal winter signals, and those opposite but on different longitudes have lower than normal winter signals. The areas rotate 30 degrees (two time zones) per day, while decreasing from 65 down to 30 degrees latitude in the five days of rotation.

To take advantage of the decreased absorption that provides strong DX signals on east, west, and transpolar paths, access WWV or the bulletin board to keep track of the daily geomagnetic A value during the winter (mainly January). Continue to keep track after each A value of 15 or higher, until a STRATWARM is given. Then, consult your map or globe to find the 90-degree position between the location given for the STRATWARM and its 180-degree companion. Coordinate your beam bearings and the DX path control points (1200 miles from the QTHs “on” the great circle) with the areas of lower absorption on both ends, or at least one end. If the area isn’t right for your DX on that particular day, you can forecast — at 30 degrees of longitude and lower latitude per day — when you can expect good results during the five to six days to come.

Another geophysical winter effect that seems like an anomaly is the higher wintertime maximum usable frequencies (MUFs). True, the D, E, and lower F region have larger electron densities in summer, but the maximum density of the F-region (which usually sets the day’s MUF) peaks during the winter instead. This peak isn’t as broad (measured by hours of the day) as it is in the summer — it’s narrower and higher. You have to be right there when the band opens (on 10 meters, for instance) to catch these few hours. This same effect makes the one-long-hop transequatorial propagation possible in the evenings.

Last-minute forecast

The second and third full weeks of the month should have excellent higher frequency (10 to 30 meter) DX band openings. Expect both long-skip and extra DX transequatorial openings from high MUF build-up during the day and evenings. Some short-skip sporadic E openings might even help your DX. The lower bands should be the best the first and fourth weeks. (This includes Christmas weekend for those trying out some new equipment from under the tree!) Low bands are a great way to spend these long nights by the fire with friends.

The Geminids meteor shower, which peaks on December 13th and 14th, will provide the richest and most reliable display of the year, with rates of 60 to 70 per hour. Because optical observations may be difficult or impossible to make during periods of poor December weather, determine the actual numbers by radio reception. A smaller version of the shower will occur on December 22nd. The full moon appears on the 23rd, and lunar perigee happens on the 16th. Winter solstice is on December 21st at 1528 UTC.

Band-by-band summary

Ten, 12, 15, and 20 meters will be open from morning until early evening almost every day to most areas of the world. The openings on the higher of these bands will be shorter and occur closer to local noon. Transequatorial propagation on the higher bands will probably occur toward evening, during times of high solar flux and disturbed geomagnetic field conditions.
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.

<table>
<thead>
<tr>
<th>DECEMBER</th>
<th>0000</th>
<th>0400</th>
<th>0800</th>
<th>1200</th>
<th>1600</th>
<th>2000</th>
<th>0200</th>
<th>0600</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASIA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FAR EAST</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EUROPE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. AFRICA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S. AMERICA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ANTARCTICA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NEW ZEALAND</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OCEANIA AUSTRALIA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JAPAN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**WESTERN USA**

**MID USA**

**EASTERN USA**

*Look at next higher band for possible openings.*
You'll find 30 and 40 meters useful almost 24 hours a day. Daytime conditions will resemble those on 20 meters. Skip distances and signal strengths may decrease during midday on days that coincide with these higher solar flux values. Expect good nighttime DX, except after days of high MUF conditions and during geomagnetic disturbances. Look for DX from unusual places on eastern, northern, and western paths during this time. The usable distance is expected to be somewhat less than on 20 in the daytime and greater than on 80 at night.

Eighty and 160 meters will exhibit short-skip propagation during daylight hours and lengthen for DX at dusk. These bands follow the darkness regions opening to the east just before your sunset, swinging more to the south around midnight, and ending up in the Pacific areas an hour or so before dawn.

**Article K**
KENWOOD
RZ-1
RECEIVER
500 kHz - 905 MHz
$509.95
CASH OR CHECK PRICE

Call Toll
695
Easy.
Eugene, OR 97405
Electronics
MoTron
GIVE
Unrestricted
Bull-in
12
w~lh
program
~ree1-800-338-9058
*aka
nlob!nt
12
kHz
FM or AM
:SEII~I
FM or AM
3395.9kHz $65 $45

SONY
ICF-2010
RECEIVER
Air: 116-136 MHz
FM: 76-108 MHz
AM: 150 kHz-30 MHz
$344.95
Cash or Check Price

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

GIVE YOUR EARS A BREAK!
Auto-Kall
AK-10
- Complete ready to use DTMF selector calling unit
- Use with FM or AM transceiver, scanner, etc
- Built-in speaker ● Automatic speaker reset
- Easy programming with switches ● Call light
- Unrestricted 3-digit code: all 16 digits ● Wrong number reset
- 12 VDC mobile or base with 117 VAC power pack (included)

MoTron
Electronics
$89.95
695 W. 21st Ave.
Eugene, OR 97405
Call Toll Free 1-800-338-9058 or (503) 687-2118

TEL-COM
Electronic Communications

NEW ENGLAND'S FACTORY-
AUTHORIZED SALES & SERVICE
FOR
KENWOOD O 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.

WORLD'S SMALLEST
WEATHER STATION

THE AMAZING WEATHER COMPUTER THAT
YOU CAN HOLD IN THE PALM OF YOUR HAND.
DIGITAR's new TWVR-3 Micro Weather Station includes a
computer, precision wind vane and speed sensor with
mounting hardware, and 40 feet of cable. For only
$159.95. With the optional, automatic-emptying KG-2
Rain Collector ($49.95) you can even monitor rainfall!
- Wind Speed
- Wind Direction
- Wind Chill
- Wind Gust Record
- Wind Temp Record
- Temperature
- Humidity
- Barometric Pressure
- Rainfall (optional)
- Altimeter
- RAINFALL (optional)
- AUTO SCAN
- HAIL TEMP RECORD
- ONE YEAR WARRANTY
- UNLIMITED RAINFALL

DIGITAR INC.
110 PIKE STREET N.W.
MADE IN U.S.A.
AUBURN, WA 98002
INFORMATION: 206-735-0774
ORDERs: 800-322-1582
FAX: 206-735-9044

BEtTER FILTERS — BEtTER PRICES!
Big ads are costly. Small ones don’t tell the whole
story, but just hold down the prices of
our top-rated FOX TANGO 8-pole filters for
Kenwood, Yaesu, Drake, Heath, and Collins.
Most are still only $60 — same as five years
ago. Phone or send an SASE for our complete
Price List and Information Sheets. Or order
from our drop-in Super-Specials below. Limited-
stock: first come, first served. No COD’s —
phoned VISAMC orders get priority. Shipping:
US $5, Canada $6, Other $13.

Make Model: Mode-B/dwth IF Freq. Reg. Sale
- DRAKE
R-4C
SSB-2 kHz 5895.9kHz $65 $50
- HEALTH
SB-104A
CW-4kHz 3395.7kHz $65 $35
Other
SSB-1 kHz 3395.9kHz $65 $45
- KENWOOD
TS490
AM-6kHz 8821kHz $65 $50
TS500
SSB-2 kHz 3395kHz $65 $45
TS800
CW-4kHz 455kHz $110 $75
- YAESU
FT-102
CW-2kHz 430kHz $75 $55
FT-2500
SSB-2 kHz 8987kHz $65 $45
FT107/107/701-2
SSB-2 kHz 8987kHz $65 $45

Use the above to improve your selectivity by:
filter cascading; replacing your present aging
filter with one of narrower bandwidth; or in
a homebrew design. The bargain SB-104A CW
can be used in any Heath rig by changing one
low-cost crystal; instructions supplied.

BONUS
14-year Fox Tango Newsletter Index —
Reg. $5, Now FREE!
(with purchase of any filter for a Yaesu rig)

FOX TANGO CORPORATION
Box 15944, West Palm Beach, FL 33416
Telephone: (407) 693-9587
QUARTZ CRYSTALS/OSCILLATORS FOR ELECTRONIC - INDUSTRIAL
- Micro-Processor Control
- Computers/Modems
- Test/Measurement
- Medical

COMMUNICATIONS — REPLACEMENT
- Mobile/2-way/Channel Elements
- Pagers
- Marine
- Radio
- Telemetry
- Monitors/Scanners

AMATEURS
- CB
- Hamming
- Experimenters

COST EFFECTIVE
MODERATE PRICING
FAST DELIVERY

The Pulse of Dependable Communications
Crystek Crystals offers the new high-page FREESTATING catalog of crystals and oscillators. Offering state-of-the-art crystal components manufactured by the same automated technology. Custom designed "off the shelf," Crystek meets the need, worldwide, direct or call today!

CRYSTEK CORPORATION
DIVISION OF WHITEHALL CORPORATION
23510/2371 Crystal Dr. • Ft. Myers, FL 33907
P.O. Box 68125 • Ft. Myers, FL 33906-6125
TOLL FREE 1-800-237-3061
(813) 936-2109 • TWX 310-951-7448

NO TUNERS!
NO RADIALS!
NO RESISTORS!
NO COMPROMISE!
THREE EXCELLENT REVIEWS JUST DON'T HAPPEN BY CHANCE.
CALL US FOR A FREE CATALOGUE.

*S eer review in Oct. 1984
Sept. 1985 • March 1986

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

U.S. AMATEUR RADIO MAIL LISTS
Labels, floppy disks, CD-ROM, mag tape.
- Newly licensed hams
- All upgrades
- Updated each week

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

ALSO HAS THE MOST IMPRESSIVE PERFORMANCE FEATURES

KIT, ONLY $675
WIRED $975
VHF OR UHF

FEATURES:
- SENSITIVITY SECOND TO NONE! GaAsFET front end on vhf models gives 12 dB 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 ±12kHz. Helical resonator front end to combat desense & intermod.
- CLEAN, STABLE TRANSMITTER, with respect to CW, SSB, FM, AM, and CW signals.
- FCC TYPE ACCEPTED for commercial high band and uhf.
- Full range of options available, such as autopatch, phone line or remote control, sub-audible tones, duplexers.

HIGH PERFORMANCE TRANSMITTERS & RECEIVERS FOR REPEATERS, AUDIO & DIGITAL LINKS, TELEMETRY, ETC.

- FM EXCITERS: Kits $99, Wt $179. 2W continuous duty. TCXO & xtal oven options available.
- TA51 for 10M, 6M, 2M, 150-174, 229 MHz.
- TA451 for uhf.

GaAs FET PREAMPS

AT $59! Wired/field tested.

LNG -(*)
GaAs FET PREAMP

FEATURES:
- Very Low Noise: 0.75uV VHF, 0.85uV UHF
- High Gain: 12-20dB, depending on frequency
- Wide Dynamic Range: to resist overload
- Stable: new-type dual-gate GaAs FET

CALL FOR DETAILS.

LNW - (*)
MINIATURE GaAs FET PREAMP

ONLY $24/kit.
Wired/field tested.

GaAs FET Preamp similar to LNG, except designed for use on 2M, 150-240, 229, 400-470 MHz.

LNS- (*)
IN-LINE PREAMP

ONLY $79/kit.
Wired/field tested.

GaAs FET Preamp with features similar to LNG series, except automatically switches out of line during transmit.

SEND $1 for 36 page catalog by return mail. (Send $2.00 or 4 IRC's for overseas mailing)

Our 25th Anniversary

hamtrons, inc.
65-H Moul Road • Hilton NY 14468-9535
Phone: 716-392-9430
Hamtronics* is a registered trademark

NEW

HIGH-SPEED DIGITAL RF LINKS

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 digital transmitters and receivers for 220 or 440 MHz interface directly with most TNC's. Fast data switched PA's output 15 or 50W. Call for complete info on the right system for your application.

ACCESSORIES

- COR-3 Kit. Control cks and audio mixers needed to make a repeater. Tail & time-out timers, local spkr ampl, courtesy beep
- CWD Kit. Field programmable, timers, the works...
- TD-2 DTMF DECODER/CONTROLLER Kit. Full 16 digits, switches 5 functions, toll call restrictor, programmable, much more. Great for selective calling tool...
- AP-3 AUTOPATCH Kit. Use with above for repeater autopatch. Reverse patch and phone line remote control std...
- 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...
- DE-202 FSK DATA DEMODULATOR Kit. For r.f. end of link...

RECEIVING CONVERTERS

Our 25th Anniversary

hamtrons, inc.
65-H Moul Road • Hilton NY 14468-9535
Phone: 716-392-9430
Hamtronics* is a registered trademark

FEATURES:
- For Commercial High Band and UHF.
- With optional helical resonator preamp.
- 180dB SlNAD of 12kHz.
- 12dB осо ranging.
- 10M, 143.172, 150-250, 229-230, 400-470 MHz.
- See catalog for full line of 2W transmitting converters for vhf & uhf. Kits only $78
- 50W Linear Amplifiers avail. up to 50W.
EVERY DAY A HAMFEST
BUY — SELL — TRADE
ALL BRANDS NEW AND RECONDITIONED

I
EVERY DAY A HAM

I
BUY — SELL — TRADE

ALL BRANDS NEW AND RECONDITIONED

I
WE’LL BUY YOUR EXTRA RIG

I
STATIONS-ESTATES ETC.

I
Call 913/381-5900

I
FAX 913 648 3020

I
SEND $2 FOR CATALOG AND WHOLESALE LIST

I
WE’LL BUY YOUR EXTRA RIG

I
STATIONS-ESTATES ETC.

I
Call 913/381-5900

I
FAX 913 648 3020

I
SEND $2 FOR CATALOG AND WHOLESALE LIST

Please send all reader inquiries directly.

1989
Ham Radio
Calendar and Op Aid
Great for home, office, shack, or as a gift!

Now, a calendar and operator aid combined. Operating events and over 30 radio history dates, plus 10 pages of DX and contest data, maps, Oblast lists, etc. Historic, DX, personality photo each mo. Calendar is 11" x 17" (unfolded), and spiral bound for flat wall hanging. Two colors.

Send $9.95 (10.95 DX) ea. $2.00 shipping for any quantity up to 9. Avoid shipping. See your local dealer. Clubs call 603-673-4100.

KBIT, Box 1015-H, Amherst, NH 03031

Discover -
CAROLINA WINDOM

HIGH PERFORMANCE PROVEN RESULTS $70 Beam?

You are Passport
To a World
Of exceptional
HF wire antennas
Rugged new designs.
Full range of HF, UHF, and VHF antennas, axis, disc, single, double.
SEE WHAT WE’RE DOING NOW!
Contact Jim, W4THU.
-free discount catalog
Send $1 for catalog by First Class mail.
Box 8199, Potsdam, NY 13676

Made with pride by The RADIO WORKS in VAUSA

804-484-0140

Radio Works

SEE THE REVIEW IN JUNE ’88 WORLD RADIO MAGAZINE.

Enthusiastic users say it’s the best wire antenna. Outperforms wire antennas previously used. Knock-your-socks-off performance at 50 to 100 MHz.

If you hear one, you’ll want one.

ELIMINATES RF INTERFERENCE IN: TV sets, Radaris, Hi-Fi, PA systems, Telephones, VCRs, Test equipment, Burglar and Fire alarms, Modems, Monitors, Computers, Radio and TV stations, etc.

EASY TO USE. Fits over and snaps onto small, large and ribbon cables. No need to remove connections. Unique, split ferrite core design fits up to RG59 coax cables. WORKS IN "COMMON MODE" interference induced in the braid of shielded cables and ground wires!

Special ferrite material effective 0.5 - 200 MHz.

DOES NOT VOID EQUIPMENT WARRANTY

Available from your dealer or order direct from:

Box 262, Pinhook, NJ 08035

Telephone: (215) 227-0712

Snap-o-Choke

Send personal check with order, we ship same day. First Class, 30-day money-back warranty. Quantities discretion.

1989
Ham Radio
Calendar and Op Aid
Great for home, office, shack, or as a gift!

Now, a calendar and operator aid combined. Operating events and over 30 radio history dates, plus 10 pages of DX and contest data, maps, Oblast lists, etc. Historic, DX, personality photo each mo. Calendar is 11" x 17" (unfolded), and spiral bound for flat wall hanging. Two colors.

Send $9.95 (10.95 DX) ea. $2.00 shipping for any quantity up to 9. Avoid shipping. See your local dealer. Clubs call 603-673-4100.

KBIT, Box 1015-H, Amherst, NH 03031

Discover -
CAROLINA WINDOM

HIGH PERFORMANCE PROVEN RESULTS $70 Beam?

You are Passport
To a World
Of exceptional
HF wire antennas
Rugged new designs.
Full range of HF, UHF, and VHF antennas, axis, disc, single, double.
SEE WHAT WE’RE DOING NOW!
Contact Jim, W4THU.
-free discount catalog
Send $1 for catalog by First Class mail.
Box 8199, Potsdam, NY 13676

Made with pride by The RADIO WORKS in VAUSA

804-484-0140

Radio Works

SEE THE REVIEW IN JUNE ’88 WORLD RADIO MAGAZINE.

Enthusiastic users say it’s the best wire antenna. Outperforms wire antennas previously used. Knock-your-socks-off performance at 50 to 100 MHz.

If you hear one, you’ll want one.

ELIMINATES RF INTERFERENCE IN: TV sets, Radaris, Hi-Fi, PA systems, Telephones, VCRs, Test equipment, Burglar and Fire alarms, Modems, Monitors, Computers, Radio and TV stations, etc.

EASY TO USE. Fits over and snaps onto small, large and ribbon cables. No need to remove connections. Unique, split ferrite core design fits up to RG59 coax cables. WORKS IN "COMMON MODE" interference induced in the braid of shielded cables and ground wires!

Special ferrite material effective 0.5 - 200 MHz.

DOES NOT VOID EQUIPMENT WARRANTY

Available from your dealer or order direct from:

Box 262, Pinhook, NJ 08035

Telephone: (215) 227-0712

Snap-o-Choke

Send personal check with order, we ship same day. First Class, 30-day money-back warranty. Quantities discretion.
SSB basics — receiving the signal

This is the second half of a discussion of SSB begun in November. Last month I explained how SSB was generated and translated (heterodyned) to the Amateur bands, and touched on some benefits of using that mode of communication. This month, I’ll look at how SSB is received and talk about the peculiarities of the mode that make receiver design a bit tricky.

The first part of a receiver that SSB signals encounter after being picked up by the antenna is the front end, or RF amplifier stage(s). There are no unusual features making the front end for SSB any different from that for any other mode. The usual criteria apply — low noise, freedom from overload by strong signals, and enough selectivity to reject out-of-band signals.

The next stage encountered is an i-f amplifier. Some receivers have two intermediate frequencies with an extra conversion to get from one to the other; others have only one conversion to a single i-f. Common frequencies are 10.7, 9.0, and 5.5 MHz, but others can work as well. In either case, a local oscillator is mixed with the incoming SSB signal to produce the i-f. This is done in a heterodyning system, just as it was at the transmitting end to get the generated sidebands on the ham band of interest. In the example given last month, a 19.5-MHz signal was mixed with 9.0-MHz SSB to produce output on 28.5 MHz. The same process works in reverse — mixing 28.5-MHz SSB with a local oscillator of 19.5 MHz produces an i-f at 9.0 MHz. These 9-MHz sidebands are pretty much carbon copies of the ones generated by the balanced modulator and filter combination discussed in last month’s column.

Putting the carrier back

At this point, a common diode detector like that used for AM signals wouldn’t be able to translate these sidebands into anything useful. The next step is to add an RF carrier in exactly the same relationship as the one that was suppressed in the transmitter. This isn’t hard to do. All it takes is an oscillator at the right frequency and a mixer to combine the sidebands with the signal from that oscillator. You’ll then have an AM carrier with one sideband, which an ordinary diode detector can turn into audio. Some early attempts at receiving SSB with the AM/CW receivers of the day showed how poor an idea this is.

In the early days of SSB, the receiver’s beat-frequency oscillator (BFO) used for CW reception was pressed into service to supply the missing carrier, and the AM detector took over from there. The trick was to tune in the sidebands for maximum loudness (even if you couldn’t understand the voice), then move the BFO around until you heard something you could understand. Hopefully, you could get a somewhat normal-sounding voice.

UHF PARTS. GaAs Fets, mmics, chip caps, feedthru, telemetry pcb, high Q trimmers. Moenbourn quality preamps. Electronic sequence boards. Send SASE for complete list or call (313) 793 4981 evenings. MICROWAVE COMPONENTS, PO Box 1697, Taylor, MI 48180.

KITS/PLATES/PLANS. We have to find parts! Variable tuning capacitors, tuning coils, crystal and magnetic head- phones, germanium diodes, crystal, shortwave and tube type kits. Very few copies left. Send 25 cent stamp for catalog. Yeary Communications, 12922 Harbor Blvd #H00R, Garden Grove, CA 92640.

CUSTOM EMBROIDERED EMBLEMS, By Embroidered Pine, your design, excellent quality, low prices, free booklet. A.T. PATCH CO, Box 862 Dept 15, Littleton, NH 03225. (603) 444-3432.

QUALITY HAM SOFTWARE for the IBM-PC and compatibles. New现象 and popular software disk packs for all aspects of ham radio. Business SASE for catalog, JK & S Dept HC, PO Box 50521, Indianapolis, IN 46250 0521.

RATES Noncommercial ads 10c per word; commercial ads 60c per word both payable in advance. No cash discounts or agency commissions allowed.

HAMFESTS Sponsored by non-profit organizations receive one free Flea Market ad (subject to our editing) on a space available basis only. Repeat insertions of hamfest ads pay the non-commercial rate.

COPY No special layout or arrangements available. Material should be typewritten or clearly printed (not all capitals) and must include full name and address. We reserve the right to reject unsuitable copy. Ham Radio cannot check each advertiser and thus cannot be held responsible for claims made. Liability for correctness of material limited to corrected ad in next available issue.

DEADLINE 15th of second preceding month.

SEND MATERIAL TO: Flea Market, Ham Radio, Greenville, N. H. 03048.

BEGINNER'S RADIO CLEARANCEHOUSE. On a space available basis, we are going to offer you, OUR SUBSCRIBER, free of charge, a chance to find a home for your used equipment by a new ham. Please send us a short description of what you want to sell along with price, name, address and phone number. We'll run it once in a special section of the classified ads under the heading of BEGINNER'S RADIO CLEARANCEHOUSE. Please limit your ad to 20 words or less.

HELP? Building Nudey inherited Galaxy Xcvr w/out power sup- ply. Desperately need help to get it going. M.C. Mac Donald, 333 No. 17th St, San Jose, CA 95112.

BEGINNER needs MorseMaster II by Stone Mountain Engineer- ing. Advise your selling price. Roy Keetey, Rb 316, Theodore, AL 36302.

SELL: N/CX-3 transceiver with ac supply. 80-40-20 SSW, CW, 1100 or best offer. Grant Zehr, WASFTF (303) 682-8210.

SWAP Hamfurland 180 Rcv, mint, for Drake T4X, Ed Malrowski, Rt 1, Loyel, WI 54446. Phone 1-715-295-9596.

FLEA MARKET

COMING EVENTS Activities — "Places to go . . ."

SPECIAL REQUEST TO ALL AMATEUR RADIO PUBLICITY COORDINATORS: PLEASE INDICATE IN YOUR ANNOUNCE- MENTS WHETHER OR NOT YOUR HAMFEST LOCATION, CLASSIC HAMS, MEETINGS, FLEA MARKETS, ETC. ARE WHEELCHAIR ACCESSIBLE. THIS INFORMATION WOULD BE GREATLY APPRECIATED BY OUR BROTHER/SISTER HAMS WITH LIMITED PHYSICAL ABILITY.


WISCONSIN: January 14. The West Allis Radio Amateur Club's 17th annual Midwinter Swapfest, Waukesha Co. Expo Center Forum, 8 to 3 PM. Admission $2 advance; $3 door: 4 tables $32 advertised. Amateur exams — write for details. For tickets or information write WARAC Swapfest, POB 1072, Milwaukee, WI 53201. SASE please.

RECONDITIONED TEST EQUIPMENT $1.25 for catalog. Walter, 2867 Nickel, San Fabo, CA 94066.

OPERATING EVENTS "Things to do . . ."

December 3: The Everglades ARC will operate W4SVI 14002, December 3 to 14006 December 4 from Florida, to celebrate the 41st anniversary of Everglades National Park. Send QSL, and 2 unit stamps for unbold certificate to W4ARC, PO Box 113, Homestead, FL 33030-0113. Novice certificate for those who identify as Novices on 2 of 3 bands. No stamps required.

December 17-23: The Iowa Radiosport Society will be operat- ing special event station K200IR in celebration of the Con- stitutional Bicentennial and the 190th anniversary of Burlington, Iowa as the first territorial capital of the State of Iowa. Special QSL cards will be available for SASE. SAE and IRC sent to 923 N. 9th Street, Burlington, IA 52601.

December 4: The Garland Amateur Radio Club will operate $2000G from Garland, Texas. 00021 to December 30 02000, 80 10m, CW, SSB and Digital. For a special QSL send your QSL and SASE to K6SPF, 204 Cotton Gum Road, Garland, TX 75044.

THE MIT UHF REPEATER ASSOCIATION and the MIT Radio Amateur Clubs will conduct a special event on December 21, 7 PM, MIT Room 1-150, 77 Mass Avenue, Cambridge, MA. Reservations requested 2 days in advance. Contact Ron Hoffmann at (617) 498-2008. Exam fee $45. 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.

REGENERATION TECHNIQUE, $1.25 for catalog. Walter, 2867 Nickel, San Fabo, CA 94066.

Foreign Subscription Agents for Ham Radio Magazine

Ham Radio Austria Karl Jager Postfach 2964 D 1020 Wien Austria West Germany

Ham Radio Belgium Rene Verwimp Postbus 443 B 5070 Geetmarck Belgium

Ham Radio Holland Postbus 413 NL-3580 ER Oranienburg Holland

Ham Radio Europe Box 11 B-174 62 Unipolna Yekaterina Turkey

Ham Radio France B.P. 515 93420 Udingen Vandy Switzerland

Ham Radio Germany Karl Ueter Postfach 245 D 7938 Lorch West Germany

Ham Radio Japan Ito Masahito Yamagata 4 Chome, Ota-Ku Tokyo 110 Japan

Ham Radio Italy Vito Vanderi Posta Aerea 15-35233 Monza Italy

Ham Radio Netherlands Herman van den Boer Post P. O. Box 2081, 2504 AV Den Haag The Netherlands

Ham Radio Switzerland Karl Ueter Postfach 245 D 7938 Lorch West Germany

Ham Radio UK Ron Rollinson, Dept 301, 4200 N. Drake, Elsinboro, DE 19880 USA

Ham Radio USSR Leonid N. Krapchận Postbox 50 Moscow USSR
Simplified versions of two product detector circuits. Diodes, as at A, involve the least number of components and offer great simplicity. The dots on T1 indicate wiring polarity. An integrated circuit at B can provide gain and increased sensitivity. Bias and decoupling components for U1 are not shown.

out of this. The poor quality, frequency drift, and constant “tweaking” to keep the signal tuned in, turned many hams away from this “new mode”.

Better circuits were not long in coming, and their improvements led to today’s increased efficiency and better quality SSB. One of these circuits is called the “product detector.” This type of circuit produces an output only when both inputs are present; that is, the BFO must be on and the SSB signal must be present before the detector provides an audio signal output. Diagrams of two types of product detector are shown in fig. 2.

There are many versions of product detectors and most work quite well. Some equipment manufacturers are going for the simplicity of the diode circuit; others are using integrated circuit types, often combining the detector function with an audio preamplifier or some other part of the receiver circuit. Another type of detector circuit uses JFETS or MOSFETS as the active element.

Sounds good but...

Sometimes you get funny “audio” when you tune in an SSB signal. To understand how this happens, let’s look at fig. 3. In 3A, the carrier is placed in its correct relationship to the sidebands. In this example, the signal is upper sideband so the carrier is below, and the lower voice frequencies are closest to the carrier. The higher frequencies are farther from the carrier, just as they were when the original sidebands were generated.

Switch the carrier to the other side of the sidebands, as in fig. 3B and watch what happens. The higher voice frequencies are now close to the carrier, while the low frequencies are farther away. The result is an “inverted” voice that’s impossible to understand. The range of speech frequencies has been inverted.

This “inversion” is something that receiver designers have to watch for when they heterodyne signals from the various Amateur bands down to an i-f, or mix generated SSB with a local oscillator to get to an Amateur band. For instance, look at my earlier example of mixing 28.5 MHz with 19.5 MHz to obtain 9-Mhz i-f output. You can also get a 9-MHz difference (i-f) by mixing 28.5 MHz with 37.5 MHz, but the signal will be inverted compared to that obtained with 19.5 MHz. The 9.0-MHz sidebands in your detector will sound just as scrambled as if you tuned them in wrong, or selected the wrong position of your upper/lower sideband switch. You can correct this inversion by selecting the other sideband to “uninvert” the audio. In some receivers and transceivers, just such a scheme is used in order to use simplified circuitry for local oscillators. A 9.0-MHz SSB signal mixed with 5.0 MHz produces 4.0 MHz for 75-meter work (9.0 - 5.0 = 4.0), and can also produce 14.0 MHz for 20 meters (9.0 + 5.0 = 14.0). The sidebands will be inverted for one band, so the correct BFO crystal for generating (or receiving) the signal must be used as required to produce audio that is “right-side-up.” Some early receivers had colored dial and knob markings as a reminder to switch to upper or lower sideband to match the Amateur band you were listening to. Incidentally, in the frequency-mixing example just used, the sidebands are not the only inversion — look what happens if you make the 5.0-MHz oscillator signal variable (VFO) to tune across the band. In the 75-meter case, if you increase the VFO frequency to 5.1 MHz, subtracting that...
Generate Your Own Electricity

Hundreds of satisfied owners are now using the Windstream Wind Generator to provide power for RVs, weekend cottages, boats, workshops, remote locations, emergency back up power and much more. Portable—weights only 20 lbs—easily installed with our comprehensive installation manual—minimum maintenance—full warranty.

Thermex Corporation
P.O. Box 3128, Burlington, VT 05401-3128

Uncle Bill’s Commodore C-64 Computer Software
by Bill Clarke WA4BLC

CODE COURSE
This computer program is broken into three user friendly parts. Part one introduces the beginner to the different Morse characters. The student simply presses a key and the character is sent and displayed on the screen. Part two generates the Morse character and the student is required to press the correct key on the computer. If the student answers incorrectly, the character is automatically repeated. Part three sends Morse characters in random groups of five. The computer can tailor what is sent to their particular needs, numbers only, letters only or a combination of both. Speeds are from 5 to 20 groups per minute. The computer can also be configured to send the Farnsworth method (high speed slow spacing code) or 2.2 WPM.

- UB-CC (For C-64) $9.95
- UB-KN Novice Class (For C-64) $14.95
- UB-KG (For C-64) $14.95
- UB-KC Extra Class (For C-64) $14.95

ANTENNA SYSTEM
This nifty antenna modeling and development program will help you get the most from your antenna projects while eliminating much of the drudgery of antenna calculations. Part one covers standard antenna designs—dipoles, verticals and Yagis designs. Part two designs shorted dipole antennas for space limited hams. Great for shortened 160/80 meter antennas. All dimensions are listed. At this price it’s not an engineering program but a neat program to have around.

- UB-AS (For C-64) $9.95

WINDSTREAM WIND GENERATOR

QRH CONTEST!™
VHF Contest Software
for PC Compilables
$39.95 postage paid
- Covers all VHF and UHF contests
- Includes the 70 MHz European band
- Menu driven and user friendly
- Color and options user configurable
- Grids worked display on-line!
- Full dupe checking
- Complete log editor included
- Handles 4000 contacts with 512K
- Demo version available $5.00
- HF Version to be available soon!

ATFAB Computers and Electronics
P.O. Box 4766
Maineville, OH 45039
(513) 683-2042
Accepted

NEW! The classic "Antenna Bible" now in a thoroughly-revised, much-enlarged edition

ANTENNAS
2nd edition
by John Kraus, W8JK
Ohio State University
Covers both theory and its applications to practical systems. Over 1000 illustrations and nearly 600 worked examples and problems. Over 100 new topics. Complete with design formulas, tables and references

917 pages, hardcover. $51.95
Add $2.50 per book for shipping and handling U.S., $5.00 elsewhere.

CYGNOUS QUASAR BOOKS
P.O. Box 85, Powell, Ohio 43065
Tel. 614-545-7895

Where’s the Beam?
There’s a 20-meter antenna with real DX Patch hidden in this picture. You can’t see it, and you neighbors can’t either. But the DX team in anyway. How about a low profile 60/40/30 or 40/30/15 m beam? Or a pair of DX gridding antennas for the world? All ready for the pothoek-from $29 to $99

Subtractive DX Gain Antennas for 60 thru 10
Easily hidden • Install Fast • Fixed Portable

Work DX without selling the neighbors

FREE CATALOGUE TO YOUR HAM

ANTENNA WEST
(800) 373-8455

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. 249 pages

- T-1442 Was $12.95 SAVE $8 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

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 microcomputer and much more. Great reading. 1981. 307 pages.

- T-1305 Was $15.95 SAVE $4.95 Softbound $4.95

BUY ALL 3 SPECIAL
$44.85 VALUE at retail

- T-SPB $10.95

SPECIAL $33.90 WOW What a Deal!!! Please enclose $3.50 shipping and handling.

HAM RADIO’S BOOKSTORE
Greenville, NH 03048
603-878-1441

December 1988
from 9.0 shows that you are now tuned to 3.9 MHz. So to tune “down” the band, you increase the frequency of the VFO. For 20 meters, the opposite is true — 5.1 + 9.0 = 14.1 MHz. This is a case where you must keep your pluses and minuses straight!

Happily, improved circuit design and manufacturing techniques make it easy to build oscillators and mixer circuitry that is tailored to each band. Now it’s no great chore to avoid this inversion problem in modern transceiver design, unless you are striving for the minimum number of parts.

Other modes

An additional benefit of modern circuitry for receiving SSB is better reception of CW. The product detector, with its lower noise, helps in weak signal reception. The improved oscillator stability needed for constant voice quality also helps the CW signal stay put on the dial. The SSB filters used in the receiver i-f work okay for CW reception, but most people who use code a lot prefer an additional set of filters that narrow the “window” to only that necessary to receive a few hundred hertz of spectrum. Why listen to more signals than you absolutely have to?

The product detector also works for AM reception; just turn off the local BFO and let the original carrier ride through. The narrow filter for SSB will restrict AM quality somewhat, but it’s still adequate. Wider filters are available that can be switched into the i-f system for AM use if better audio quality is desired.

I’d like to thank those of you who have taken the time to write to me about what you’ve seen in this column, and on many other interesting subjects. I can’t answer each letter personally, but each is carefully read. Your thoughts and comments are appreciated. The article about “Q” signals generated several interesting letters (as did the mention of “Z” signals in that article). Some letters provided me with new information. Again, many thanks to each of you.

Article L

CALL FOR ORDERS
1 (800) 231-3057
1-713-520-7300 OR 1-713-520-0550
TEXAS ORDERS CALL COLLECT FAX 1-713-771-7759

ALL ITEMS ARE GUARANTEED OR SALES PRICE REFUNDED

New Icom IC-761 Call for list trade
Kenwood TH-251A, TH-251T Trade in your old HT
New Kenwood TM-621A, 144/220 MHz FM

Kenwood TS-140S

New Kenwood TM-731A mobile

IC-761
Icom 2300.00

Shure 444D 56.95

HEIL BM10 Boom Mike, w red pin 69.00

HEIL HMS Desk Mike 62.00

NYE MBOA Tuner 569.00

Alpha Delta Trans-trap HV 33.00

CSI Private Patch IV 469.00

Ampex PT 3 Pre Amp 99.00

Larsen 2-meter on glass 49.95

Antec 2M, SLB, Mag. Mount Comp 25.00

Van Gordon GS9 44.00

Valco AB5 mobile 79.00

Thousands of panel meters .39 up CALL

Aerovox 1000 pF 500 V through capacitors 1.95

Transformer, 120 V Pl, 105V/11A (Sec #18 Wire) 50.00

100 mh 150V Avail Cap 2.20

120 mh 450V Avail Cap 3.00

Arctic SWR Bridge 3-30 MHz 19.95

831SP PL, 250 Swivelplate (Amphenol) 1.50

82 61 N Male (Amphenol) 3.50

82 202 1006 N Male (9913) 3.50

Double Female Light 1.00

UG176 RGBX (each) 75.00

Receiving tubes 50-900s off list price

Santea Boom Mics/Headsets (hts. Icom) 20.00

Robins 2A5G 57 (67-trade arm) each 125.00

USED EQUIPMENT

All equipment, used, clean, win 90 day warranty and 30 day trial! Six months full trade against new equipment. Sale price refunded if satisfied. Call for list used gear (800) 231-3057

Don’s Corner:

Have you heard the new “Delta Loop” Antenna?

I have, and it works great!

Contact: Delta Loop Antenna

P. O. Box 8863

New Fairfield, CT 06812

See QJ June ’88 Review

Bag Systems 21 Amp 20.00 per watt $229.00

POLICIES

Minimum order $10.00. Mastercard, Visa, or C.O.D. All items

POLICIES

Minimum order $10.00. Mastercard, Visa, or C.O.D. All items

Madison Electronics Supply

3621 Fannin

Houston, Texas 77004

VISA

Yes, please send information on your line of amateur antennas to:

NAME

ADDRESS

POLICIES

Minimum order $10.00. Mastercard, Visa, or C.O.D. All items

Madison Electronics Supply

3621 Fannin

Houston, Texas 77004

VISA

Yes, please send information on your line of amateur antennas to:

NAME

ADDRESS

POLICIES

Minimum order $10.00. Mastercard, Visa, or C.O.D. All items

Madison Electronics Supply

3621 Fannin

Houston, Texas 77004

VISA

Yes, please send information on your line of amateur antennas to:

NAME

ADDRESS

POLICIES

Minimum order $10.00. Mastercard, Visa, or C.O.D. All items

Madison Electronics Supply

3621 Fannin

Houston, Texas 77004

VISA

Yes, please send information on your line of amateur antennas to:

NAME

ADDRESS

POLICIES

Minimum order $10.00. Mastercard, Visa, or C.O.D. All items

Madison Electronics Supply

3621 Fannin

Houston, Texas 77004

VISA

Yes, please send information on your line of amateur antennas to:

NAME

ADDRESS

POLICIES

Minimum order $10.00. Mastercard, Visa, or C.O.D. All items

Madison Electronics Supply

3621 Fannin

Houston, Texas 77004

VISA

Yes, please send information on your line of amateur antennas to:

NAME

ADDRESS

POLICIES

Minimum order $10.00. Mastercard, Visa, or C.O.D. All items

Madison Electronics Supply

3621 Fannin

Houston, Texas 77004

VISA

Yes, please send information on your line of amateur antennas to:

NAME

ADDRESS

POLICIES

Minimum order $10.00. Mastercard, Visa, or C.O.D. All items

Madison Electronics Supply

3621 Fannin

Houston, Texas 77004

VISA

Yes, please send information on your line of amateur antennas to:

NAME

ADDRESS

POLICIES

Minimum order $10.00. Mastercard, Visa, or C.O.D. All items

Madison Electronics Supply

3621 Fannin

Houston, Texas 77004

VISA

Yes, please send information on your line of amateur antennas to:

NAME

ADDRESS

POLICIES

Minimum order $10.00. Mastercard, Visa, or C.O.D. All items

Madison Electronics Supply

3621 Fannin

Houston, Texas 77004

VISA

Yes, please send information on your line of amateur antennas to:

NAME

ADDRESS

POLICIES

Minimum order $10.00. Mastercard, Visa, or C.O.D. All items

Madison Electronics Supply

3621 Fannin

Houston, Texas 77004

VISA

Yes, please send information on your line of amateur antennas to:

NAME

ADDRESS

POLICIES

Minimum order $10.00. Mastercard, Visa, or C.O.D. All items

Madison Electronics Supply

3621 Fannin

Houston, Texas 77004

VISA

Yes, please send information on your line of amateur antennas to:

NAME

ADDRESS

POLICIES

Minimum order $10.00. Mastercard, Visa, or C.O.D. All items
1989 marks the 75th anniversary of the founding of the League. There’s no better way of celebrating this momentous occasion, than with the new 1989 ARRL Handbook for the Radio Amateur!

The 1200-page sixty-sixth edition contains over 2100 tables, figures and charts. The new Handbook is better than ever with revised information on phase noise measurement, direct frequency synthesis and spread spectrum communication techniques. The section on repeaters has been updated including a new CW identifier circuit. You’ll find new spectrum analyzer and oscilloscope material, as well as several new projects in the test equipment chapter.

As always, we’ve added a host of new construction projects to this new edition. Just some of the new projects include: A 500-MHz frequency counter, 160 through 10 meter legal limit amplifier, simple CMOS keyer project, digital audio memory keyer and a L/Q meter for measuring coil inductance.

But that’s not all. You’ll find many other popular construction projects that can be built in a weekend such as power supplies and VHF/UHF preamps. For the more ambitious builder there are projects like the 1.8 MHz QSK transverter (there are VHF/UHF transverter projects too) and there are many amplifier designs to suit your needs from HF through microwaves.

The Handbook has always been famous as a reference for component data and you will find an entire chapter devoted to everything from transmitting tube and transistor specifications to aluminum tubing sizes. Satellite enthusiasts will find that the digital TR sequencer will add operating convenience to your station. Of course, you’ll find the most up-to-date information on digital techniques, and the video communications chapter is packed with information not only on SSTV, ATV and FAX but Weather FAX as well. QRP enthusiasts will find the familiar “Cubic incher” transmitter; not much bigger are the QRP SWR indicator and QRP Transmatch. There is also a VXO-controlled 6-watt CW transmitter for your favorite band between 80 and 15 meters. There are a number of useful station accessories that you can build like DTMF encoders and decoders, PIN-diode TR switch, digital PEP wattmeter and SWR calculator, Transmatches and dummy loads.

For $21, The ARRL 1989 Handbook for the Radio Amateur, remains an exceptional value for a hardcover technical publication. The price outside the US is $23. For postage and handling, add $2.00 (or $3.50 for insured mail or UPS — please specify)
**the 230A Linear Amplifier**

Something new in a high power, high quality, HF linear amplifier

The Advanced Radio Devices (ARD) 230 series represents a new generation in high power linear amplifiers. Utilizing microprocessor control, the 230 provides full "HANDS OFF" automatic operation.

- Full power is always available
- Completely automatic
- Microprocessor controlled tuning
- No time limit for QRO
- Full QSK
- LCD metering
- VSWR readout
- Microprocessor controlled protection
- Automatic tube monitoring
- Easy modification for 10 meters
- RS-232C output for external control
- Modular construction
- Export/commercial versions available
- Remote antenna switching control
- Remote control up to 250 feet away
- UPS shippable (3 boxes)

Orders: 800-368-3270
Electronic Equipment Bank
516H Mill St. NE, Vienna, VA 22180
(just minutes from Washington, DC)

---

**R9100 SUPER ROTATOR**

The Advanced Radio Devices (ARD) R9100 is the heavy duty antenna rotator designed for the big gun with antenna loads to one ton. All components are designed and selected for durability and long life, a quality often over looked.

The control system provides both analog and digital readout of direction to within ±1 degree. Provisions for external computer control which allows rotor positioning by the mere keyboard entry of a target country's prefix. Software is provided for use with most popular computers.

This quality rotor is the most capable and powerful unit designed for the amateur market today. You can pay more and get less.

**SPECIFICATIONS**

- Rotating torque: 10,000 inch lbs.
- Braking torque: 24,000 inch lbs.
- Vertical load: 2000 lbs.
- Mast sizes: 2.0 to 3.5 inch O.D.
- Motor: 1/3 HP
- Rotation speed: 1 RPM
- Weight: 230 lbs.
- Size: 14.9x25x15.1 inches (wh)

Write for complete specs and installation information.

Orders: 800-368-3270
Electronic Equipment Bank
516H Mill St. NE, Vienna, VA 22180
(just minutes from Washington, DC)
In 1937, Stan Burghardt (W0IT), because of his intense interest in amateur radio, began selling and servicing amateur radio equipment in conjunction with his radio parts business. We stand proud of this long-lasting tradition of Honest Dealing, Quality Products and Dependable "S-E-R-V-I-C-E"!

Above all, we fully intend to carry on this proud tradition with even more new product lines plus the same "fair" treatment you've come to rely on. Our reconditioned equipment is of the finest quality with 30, 60 and even 90-day parts and labor warranties on selected pieces. And always remember:

— WE SERVICE WHAT WE SELL —

AEA Belden Icom Nye
Alinco Benchcer Jerold/DeliPalomar
Ameritron Bird Kantronics Radio Calibook
Amphenol Butternut KDL/Encomm Rohn
Amp Supply Centurion KLM Telex/Hygain
Antenna CES Larsen Ten-Tec
Specialists Cushcraft MFJ TriosKenwood
Astron Daiwa Mirage Unadilla/Reyco
B & W Hustler Moseley Yaesu

Write today for our latest Bulletin/Used Equipment List.

HF-Amplifier arcs, pops or loud bangs are not normal.

After hearing one of these unpleasant noises, have you ever considered a grid to filament short in one of your tubes, burned broadcast contacts, pitted tuning capacitor plates, a shorted zener bias diode or other, kaput amplifier parts? If the answer to one or more of these questions is yes, the damage was almost certainly not your fault. It is very likely that your amplifier is not unconditionally VHF stable. This problem can be corrected by replacing the standard, [high VHF-Q] parasitic suppressors with Low VHF-Q Parasitic Suppressors. For more information, see QST Magazine, Oct. 1986, page 36. Complete, all materials and parts furnished, nothing else to roundup. LOW VHF-Q Parasitic-Suppressor Kits are now available from the author of this article. Complete kit info, and diagram for up to two-tubes and 600mA maximum Ip, for SSB-CW duty cycle, $12, shipped via First Class Mail®. Add $2 for increased duty cycle option. Include the amplifier model, and/or the tube type and quantity used, plus your phone number. R. L. (Rich) Measures, AG6K, 8455 La Cumbre Road, Soms, CA. 93066; 805-482-3034. Phone for special requirement orders is...

GALLATIN RADIO SUPPLY

Expert repair of Ehrhorn ALPHA 76A, 374A, 78 and 77D series amplifiers.

Also specializing in state-of-the-art repair and modification of the Collins KWM/HF-380 series radios. Latest up-dates available. Factory Authorized. You won't believe the improvement in your radio when it gets back!

Call for more information or to schedule your work.

Gallatin Radio Supply
Attn: Kirby Van Horn P.O. Box 60064 Houston, Texas 77205 (713) 320-2324

Authorized MADISON Electronics repair facility.
AVCOM’s agile SCPC demodulator

AVCOM introduces a Single Channel Per Carrier Demodulator, the SCPC-3000E.

The SCPC-3000E Demodulator features a high-performance synthesized 50-90 MHz tuning module. Frequencies are tunable in 800 steps of 50 kHz each. Standard expansions are 3:1 and 2:1, with other expansion formats available. Deemphasis is switchable between 0, 25, 50, and 75 microseconds. Selectable low-pass 15, 7.5, and 5 kHz audio filters are also standard. Wideband and narrowband versions are available.

The price of the SCPC-3000E is $1378; the SCPC-3000E is rack-mountable and available for immediate delivery.

For more details contact AVCOM, 500 Southlake Boulevard, Richmond, Virginia 23236.

Circle 310 on Reader Service Card.

Clamp-on multimeter accessory measures DC and AC current

The new 80i-kW Current/Power Probe, from John Fluke Co., Inc., is a clamp-on multimeter accessory for measuring DC or AC current, and AC power in kilowatts. The probe accepts conductors of up to 2-1/4 inches in diameter.

Measurement range of the 80i-kW is 1A to 13000A DC, 1A to 1000A AC, and 0.5 kW to 330 kW. The switch-selectable output signal is 1mV per amp or 1mV per kW. The power factor can also be calculated from data measured by the 80i-kW.

The probe comes with voltage test leads that have safety alligator clips. Designed specifically for the 80i-kW, these test leads provide a voltage input that, in conjunction with the current input, give a readout in kilowatts on the multimeter.

The 80i-kW comes with a carrying case with space for accessories. An instruction booklet, a battery, and quick reference guide are included in the case, which can also hold any Fluke hand-held multimeter, a Fluke 80TK thermocouple module, or one or more of the Fluke 80PK Series temperature probes.

The 80i-kW is available for immediate delivery at a U.S. list price of $395 from over 600 distributor locations in the United States, or through Fluke’s worldwide sales network.

For more information on the Fluke 80i-kW Current/Power Probe, in North America and non-European countries write to John Fluke Mfg. Co., Inc., P.O. Box C9390, Everett, Washington 98206 or call toll free 800-443-5803, ext. 77.

In Europe, contact Philips Test and Measurement, Building HFK, 5600 MD Eindhoven, The Netherlands.

Circle 311 on Reader Service Card.

New SMT trials kit

OK Industries has introduced the SMT-K1, a kit that enables those who work with surface mounted devices to evaluate, practice, or train on assembly, production, or rework techniques.

The kit includes a full range of surface mounted components including chip capacitors, transistors, PLCCs, and 100-pin gull-wing flat packs. The SMT-K1 also contains a trial board designed to accommodate a wide variety of components. The board and components come complete in a reusable conductive tray.

The list price for the SMT-K1 is $64.95.

For further information contact OK Industries, 4 Executive Plaza, Yonkers, New York 10701.

Circle 312 on Reader Service Card.

New series of Kelvin Probes

O.K. Industries Inc. Electronics Division introduces a new series of Kelvin Probes. The TK800 Series probes are very low resistance, precision test lead kits ideal for LCR bridges or microhmeters.

Circuit connection: (2) flat tweezers with special gripping surfaces ensure precise contact to the components to be measured. Contacts are gold plated for optimum electrical performance. An additional alligator clip, ground lead connection is also provided.

Instrument connection: (4) BNC or banana connectors with color-coded strain relief boots. Specifications: 250V rms, 5A current with 0.8M cable length.

The TK800 series is Ex-stock. The list price is $119.00.

For details contact OK Industries, 4 Executive Plaza, Yonkers, New York 10701, 1-800-523-0667.

Circle 313 on Reader Service Card.

Multi-mode autopatch and repeater controller

Connect System Inc.’s new Private Patch V can be user programmed into four selectable operating modes: Sampling Patch (vox enhanced), Vox Patch (can operate through remotely located repeaters), Duplex Patch, and Repeater Controller with Duplex Patch (perfect for club systems).

Private Patch V has a built-in keyboard and digital display that gives you complete control of all features and operating modes. Features include: a ninety number auto-dialer, last number radial, remote hook flash, keyboard programmable CW ID, toll protection, 1-5 digit access code, 2-5 digit secret toll override code, telephone remote base, remote controlled relay, and regenerated tone/pulse dialing.

A plug-in CTCSS board that converts all modes to CTCSS operation (32 selectable tones) and an Electronic Voice Delay board which enhances performance in vox mode are optional.

For more information, contact: Connect Systems Inc. 23731 Madison Street, Torrence, California 90505.

Circle 314 on Reader Service Card.
ADVERTISER'S INDEX AND READER SERVICE NUMBERS

Listed below are the page and reader service number for each advertiser in this issue. For more information on their products, select the appropriate reader service number make a check mark in the space provided. Mail this form to ham radio Reader Service, I.C.A., P.O. Box 2558, Woburn, MA 01801.

<table>
<thead>
<tr>
<th>Name</th>
<th>Call</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address</td>
<td></td>
</tr>
<tr>
<td>City</td>
<td>State</td>
</tr>
</tbody>
</table>

*Please contact this advertiser directly.

READER SERVICE # PAGE #

<table>
<thead>
<tr>
<th>PAGE #</th>
<th>READER SERVICE #</th>
</tr>
</thead>
<tbody>
<tr>
<td>130</td>
<td>Ace Communications, IN</td>
</tr>
<tr>
<td>163</td>
<td>Advanced Receiver Research</td>
</tr>
<tr>
<td>156</td>
<td>AEA</td>
</tr>
<tr>
<td>170</td>
<td>Aerospace</td>
</tr>
<tr>
<td>202</td>
<td>AG&amp;K</td>
</tr>
<tr>
<td>134</td>
<td>All Electronics Corp</td>
</tr>
<tr>
<td>175</td>
<td>Alpha Delta Communications</td>
</tr>
<tr>
<td>189</td>
<td>AMC Sales, Inc</td>
</tr>
<tr>
<td>142</td>
<td>Ameritron</td>
</tr>
<tr>
<td>185</td>
<td>AMSAT</td>
</tr>
<tr>
<td>122</td>
<td>Antennas West</td>
</tr>
<tr>
<td>120</td>
<td>Antique Radio Classified</td>
</tr>
<tr>
<td>195</td>
<td>ARRL</td>
</tr>
<tr>
<td>167</td>
<td>Ashton ITC</td>
</tr>
<tr>
<td>132</td>
<td>Astron Corp</td>
</tr>
<tr>
<td>193</td>
<td>AT&amp;FAB Computers and Electronics</td>
</tr>
<tr>
<td>134</td>
<td>Banker &amp; Williamson</td>
</tr>
<tr>
<td>193</td>
<td>Barry Electronics</td>
</tr>
<tr>
<td>186</td>
<td>Bial Company</td>
</tr>
<tr>
<td>123</td>
<td>Bird Electronics</td>
</tr>
<tr>
<td>173</td>
<td>Buckmaster Publishing</td>
</tr>
<tr>
<td>197</td>
<td>Buckmaster Publishing</td>
</tr>
<tr>
<td>198</td>
<td>Buckmaster Publishing</td>
</tr>
<tr>
<td>200</td>
<td>Burghardt Amateur Center</td>
</tr>
<tr>
<td>144</td>
<td>Butternut Electronics</td>
</tr>
<tr>
<td>125</td>
<td>C&amp;G Sales</td>
</tr>
<tr>
<td>129</td>
<td>Caddell Coil Corp</td>
</tr>
<tr>
<td>129</td>
<td>CIE</td>
</tr>
<tr>
<td>156</td>
<td>Communication Concepts, Inc</td>
</tr>
<tr>
<td>139</td>
<td>Communications Specialists</td>
</tr>
<tr>
<td>191</td>
<td>Computeradio</td>
</tr>
<tr>
<td>112</td>
<td>Connect Systems Inc</td>
</tr>
<tr>
<td>184</td>
<td>Crystal Crystals</td>
</tr>
<tr>
<td>184</td>
<td>Crystek Crystals</td>
</tr>
<tr>
<td>144</td>
<td>Cruciln Corp</td>
</tr>
<tr>
<td>194</td>
<td>Cymous-Quasar Books</td>
</tr>
<tr>
<td>117</td>
<td>Datacom, International</td>
</tr>
<tr>
<td>166</td>
<td>Dick Smith Electronics</td>
</tr>
<tr>
<td>118</td>
<td>Doug Hall Electronics</td>
</tr>
<tr>
<td>201</td>
<td>Down East Microwave</td>
</tr>
<tr>
<td>140</td>
<td>EGE, Inc</td>
</tr>
<tr>
<td>196</td>
<td>Electronic Equipment Bank</td>
</tr>
<tr>
<td>199</td>
<td>Electronic Equipment Bank</td>
</tr>
<tr>
<td>130</td>
<td>Engineering Consulting</td>
</tr>
<tr>
<td>130</td>
<td>Fox Truck Corp</td>
</tr>
<tr>
<td>203</td>
<td>Gallatin Radio Supply</td>
</tr>
<tr>
<td>166</td>
<td>Gary Appel</td>
</tr>
<tr>
<td>166</td>
<td>Gillette Shortwave</td>
</tr>
<tr>
<td>119</td>
<td>GIT-Electronics</td>
</tr>
<tr>
<td>124</td>
<td>GIT-Electronics</td>
</tr>
<tr>
<td>152</td>
<td>Halonix</td>
</tr>
<tr>
<td>141</td>
<td>Ham Radio Outlet</td>
</tr>
<tr>
<td>141</td>
<td>Ham Radio's Bookstore</td>
</tr>
<tr>
<td>153</td>
<td>Harris</td>
</tr>
<tr>
<td>130</td>
<td>Henry Radio</td>
</tr>
<tr>
<td>197</td>
<td>Hustler</td>
</tr>
<tr>
<td>111</td>
<td>ICOM America, Inc</td>
</tr>
<tr>
<td>136</td>
<td>ICOM America, Inc</td>
</tr>
<tr>
<td>149</td>
<td>International Crystal Mfg Co, Inc</td>
</tr>
<tr>
<td>149</td>
<td>International Radio</td>
</tr>
<tr>
<td>127</td>
<td>John's Electronics</td>
</tr>
<tr>
<td>135</td>
<td>Kantronics</td>
</tr>
</tbody>
</table>

*Please use before January 31, 1989.

PRODUCT REVIEW/NEW PRODUCT

<table>
<thead>
<tr>
<th>PRODUCT REVIEW/NEW PRODUCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>310</td>
</tr>
<tr>
<td>306</td>
</tr>
<tr>
<td>313</td>
</tr>
<tr>
<td>315</td>
</tr>
<tr>
<td>321</td>
</tr>
<tr>
<td>302</td>
</tr>
<tr>
<td>302</td>
</tr>
<tr>
<td>311</td>
</tr>
<tr>
<td>304</td>
</tr>
<tr>
<td>305</td>
</tr>
<tr>
<td>305</td>
</tr>
<tr>
<td>309</td>
</tr>
<tr>
<td>312</td>
</tr>
<tr>
<td>309</td>
</tr>
<tr>
<td>305</td>
</tr>
<tr>
<td>307</td>
</tr>
</tbody>
</table>

Ilsana residents please add 6% 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

126 December 1988  205
At The Right Price

Everytime

MasterCard—VISA—Discover

Missouri Radio Center

KENWOOD

TS-940 "DX-CELLENCE"
- All Band, All Mode Transceiver
- Direct Keyboard Entry
- Engineered for the DX-Minded
- Its Got It All!

YAESU

FT-767GX
- HF/VHF/UHF Base Station
- Add Option 6m, 2m & 70cm Modules
- Dual VFO's
- Full CW Break-in
- Lots More Features

ICOM

IC-761 "PERFORMANCE" RIG
- 160-10M/General Coverage Receiver
- Built-in Power Supply and Automatic Antenna Tuner
- SSB, CW, FM, AM, RTTY
- QSK to 60 WPM

uniden

HR-2510
- Mobile 10 Meter Transceiver
- SSB/AM/FM/CW
- 25 Watts PEP
- Computer Controlled Operation

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 70cm
- 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-781 NEWEST SUPER RIG
- 5 Function Display Screen
- Built-in Spectrum Scope
- 150 Watts Output
- Built-in PS and AT

ASTRON

TH-25 AT 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

TH-23/73R
- 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-72AT IC-74AT
- Micro HT's for 2M, 440
- Pocket Size HF Fun
- Ten Memories
- LCD Readout
- Wideband Coverage
- Up to 3 Watts Output
- 32 Built-in Subaudible Tones

KAM

Packet, WEFAX, ASCII, AMTOR, RTTY, CW
- Simultaneous Operation on HF and VHF
- Personal Packet Mailbox™

102 N.W. Business Park Lane
Kansas City, MO 64150

Call Toll Free—9am - 6pm Mon.-Fri. 9am - 2pm Sat.
In Missouri Call—816-741-8118

Call For Best Trade-In Deal

MOST ORDERS SHIPPED SAME DAY
NEW

POCKET SIZE

SIZE: 4" H x 3.5" W x 1" D
MADE IN USA

#TA-100S

Small enough to fit into a shirt pocket, our new 1.3 GHz and 2.4 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 1300H/A 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:

#1300H/A  Model 1300H/A 1-1300 MHz counter with preamp, sensitivity, < 1mV 27MHz to 450MHz includes Ni-Cad batteries and AC adapter $169.95
#2400H  Model 2400H 10-2400 MHz microwave counter includes Ni-Cad batteries and AC adapter $299.95
#CCA  Model CCA counter/counter, for debugging, ultra sensitive, < 50 micro volts at 150Mhz 1-600 MHz with adjustable threshold, RF indicator LED, includes Ni-Cad batteries and AC adapter $299.95

ACCESSORIES:

#TA-100S  Telescoping RF pick-up antenna with BNC connector $12.00
#P-100  Probe, direct connection 50 ohm, BNC connector $20.00
#CC-12  Carrying case, gray vinyl with zipper opening. Will hold a counter and #TA-1000S antenna $10.00

ORDER FACTORY DIRECT
1-800-327-5912

OPTOELECTRONICS INC.
5821 N.E. 14th Avenue
Ft. Lauderdale, Florida 33334

Orders to US and Canada add 5% of total ($2 min, $10 max)
Florida residents add 6% sales tax. COD fee $2.
Foreign orders add 15%
You'll be hard-pressed to beat the performance of Yaesu's new FT-411 handheld.

Let Yaesu's "next generation" handheld lighten your load! Picking up where our popular FT-209R Series left off, the 2-meter FT-411 will amaze with its astounding array of features!


Not bad for a handheld measuring just 55(w) x 32(d) x 139(h) mm (the same size as our FT-23R Series HTs)!

**Friendly operation.** For operating convenience, the FT-411's keypad features a "do-re-mi" audible command verification. Both the display and keypad can be backlit (brightly!) for night operation at the push of a button. A rotary channel selector allows fast manual tuning. Or key in the frequency directly. Operate VOX (with YH-2 headset option). Plus you get a battery saver to conserve power while monitoring. And a (deletable) automatic power-off feature that shuts down your radio if you forget to turn it off!

**High power capability.** The FT-411 comes equipped with the 2.5-watt, 600-mAh FNB-10 battery pack. Try our optional FNB-12 5-watt, 500mAh pack or tiny FNB-9 2.5-watt, 200-mAh pack. Or get 6 watts output by applying 13.8-volts DC from an external power supply.

**Swap options with Yaesu's FT-23R Series.** Our rugged best-seller's chargers, batteries, and microphones are fully compatible with the FT-411. The FT-23R is the perfect companion for the FT-411, and at a great price!

**Try out an FT-411 today.** Ask for it now at your local Yaesu dealer. Or call 1-800-999-2070 for a free brochure. And experience the legendary Yaesu HT performance!  

---

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. Specifications guaranteed only within amateur bands.
Kenwood's advanced digital know-how brings Amateurs world-wide "big-rig" performance in a compact package. We call it "Digital DX-citement!"—that special feeling you get every time you turn the power on.

- Covers All Amateur bands
- General coverage receiver tunes from 100 kHz—30 MHz. Easily modified for HF MARS operation.
- Direct keyboard entry of frequency
- All modes built-in USB, LSB, CW, AM, FM, and AFSK. Mode selection is verified in Morse Code.
- Built-in automatic antenna tuner (optional)
- Covers 80-10 meters.
- VS-1 voice synthesizer (optional)

Superior receiver dynamic range
Kenwood DynaMix™ high sensitivity direct mixing system ensures true 102 dB receiver dynamic range. (500 Hz bandwidth on 20 m)

100% duty cycle transmitter
Super efficient cooling permits continuous duty in a compact package. We mix power on!

Superb interference reduction
IF shift, tuneable notch filter, noise blanker, all-mode squelch, RF attenuator, RIT/XIT, and optional filters light QRM.

MC-43S UP/DOWN mic. included
Computer interface port

5 IF filter functions
Dual SSB IF filtering
A built-in SSB filter is standard. When an optional SSB filter (YK-88S or YK-88SN) is installed, dual filtering is provided.
VOX, full or semi break-in CW
AMTOR compatible

Kenwood takes you from HF to OSCAR!

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