ason's Greetings

DECEMBER 1988 $2.50

HAM RADIO

HAM RADIO

DECEMBER 1988

volume 21, number 12

HAM RADIO Magazine is published monthly by
Communications Technology, Inc.
Greenville, New Hampshire 03048-0498
Telephone: 603-878-1441

subscription rates

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

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

international subscription agents: page 118

Microfilm copies are available from
Buckmaster Publishing
Mineral, Virginia 23117

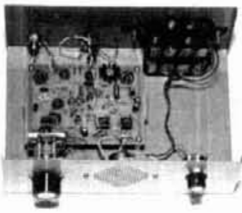
Cassette tapes of selected articles from *HAM RADIO*
are available to the blind and physically handicapped
from Recorded Periodicals,
919 Walnut Street, Philadelphia, Pennsylvania 19107

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

Send change of address to *HAM RADIO*
Greenville, New Hampshire 03048-0498

FEATURES

Joe Reisert's column returns next month.



WA3ENK, page 9

THE WEEKENDER

W5FG, page 19
K3OF, page 88

See page 78 for the winners of October's handheld radio contest.

DEPARTMENTS

Special thanks to Hans Evers, PA0CX, for all his great covers this year.

BACKSCATTER

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 comminications 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 Ham Radio

KENWOOD

...pacesetter in Amateur Radio

Good for Satellite Digital QSOs

Matching Pair

Look for FUJI and PHASE III-C

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.
- **Versatile scanning functions.** Programmable band and memory scan (with channel lock-out). "Center-stop" tuning on FM. An "alert" function lets you listen for activity on your priority channel while listening on another frequency. **A Kenwood exclusive!**
- **RF power output control.** Continuously adjustable from 2 to 25 watts.
- **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

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 applicance 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 haywired 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, WD0P'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-dupper, whiz bang, synthesized whats-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) your'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

MFJ multi-mode data controller

9 modes for only . . . $249.95

Amateur radio's most versatile multi-mode data controller -- the MFJ-1278 -- lets you join the fun on Packet, AMTOR, RTTY, ASCII, CW, Weather FAX, SSTV, Navtex and gives you a full featured Contest Memory Keyer mode . . . you get 9 modes . . . for an affordable $249.95.

Plus you get MFJ's new **Easy Mail**tm so you and your ham buddies can leave messages for each other 24 hours a day.

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

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

Plus you get 32K RAM, KISS for TCP/IP, high performance HF/VHF/CW modems, software selectable dual radio ports, AC power supply and more.

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

You can use the MFJ Starter Pack to get on the air instantly. It includes computer interfacing cable, terminal software and friendly instructions . . . everything you need to get on the air fast. Order MFJ-1282 (disk)/MFJ-1283 (tape) for the C-64/128 and VIC-20; MFJ-1287 for Macintosh; MFJ-1284 for the IBM or compatible, $19.95 each.

Packet

MFJ's new generation packet mode gives you genuine TAPR software and hardware plus many MFJ enhancments like Easy Mailtm.

A new Kiss interface makes the MFJ-1278 TCP/IP compatible.

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

New AMTOR mode!

Now the MFJ-1278 has a new AMTOR and Navtex mode, making it the only controller to feature **nine** digital modes.

MFJ-1278 transmits and receives AMTOR and includes all AMTOR modes: ARQ (Mode A), FEC and MODE S (Mode B).

Baudot RTTY

You can copy all shifts and all standard speeds including 170, 425 and 800 Hz shifts and speeds from 45 to 300 baud. *You can copy not only amateur RTTY but also press, weather and other exciting traffic.*

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

ASCII

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

CW

You get a Super Morse Keyboard mode that lets you send and receive CW effortlessly, including all prosigns -- it's tailor-made for traffic handlers.

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

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

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

An AFSK CW mode lets you ID in CW.

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

Weather FAX

You'll be fascinated as you watch WEFAX signals blossom into full fledged weather maps on your Epson or IBM graphics compatible printer.

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

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

Pictures and maps can be saved to disk or *printed to screen in real time or from disk if you have an IBM or Macintosh* with the MFJ Starter Pack.

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

Slow Scan TV

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

You can print slow scan TV pictures on any IBM or Epson graphics compatible printer. If you have an IBM or Macintosh you can print to screen and save to disk with the MFJ Starter Pack.

You can transmit slow scan pictures right off disk. If your terminal program lets you save ASCII files you can save pictures from over-the-air QSOs.

You can 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 call, name, QTH, rig info -- everything you used to repeat over and over.

You get iambic 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 TTL level serial ports, watch dog timer, FSK and AFSK outputs, output level control, speaker jack, key paddle jack, test and calibration software, Z-80 at 4.9 MHz, 32K EPROM, and socketed ICs. 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 mulit-mode upgrade by any manufacturer. Contact your dealer or MFJ for yours today!

MFJ Packet Radio

MFJ-1274 **$139.95**

MFJ-1270B **$119.95**

MFJ-1270B 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 modems.

You get MFJ's new **Easy Mail**tm 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 an 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 -- and it's only $20.00 more.

MFJ

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

FOR YOUR NEAREST DEALER
or to order call toll free
800-647-1800
One Year Unconditional Guarantee

MFJ . . . making quality affordable

✓ 113

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.

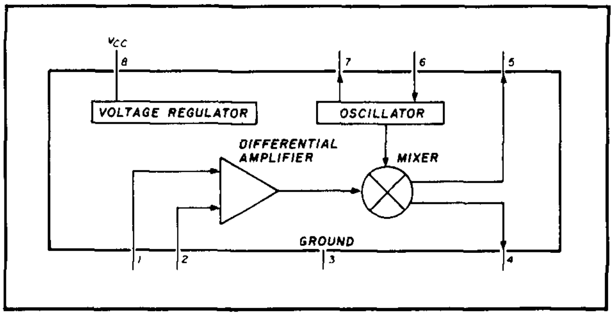
The chip was intended for the cellular radio market. The oscillator is good to 200 MHz and the mixer to 500 MHz. Not bad for less than 3 mA at 6 volts. (One of the Signetics application notes mentions that some people have used the mixer to 900 MHz, but they only guarantee it to 500 MHz.) It runs on 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.

FIGURE 1



Basic functional block diagram of NE602.

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

Signetics literature. My measurements and some data sheet "reading between the lines" lead me to believe it's about 4 volts. The *absolute* maximum input voltage to the regulator is 9 volts; maximum recommended input is 8 volts. It might be nice to use a 12-volt supply but you'll have to knock it down with a Zener or another regulator first.

Basic specifications for the NE602 are:

Power supply	4.5 to 8 volts	
Current consumption	2.4 mA	(typical)
Maximum mixer frequency	500 MHz	(typical)
Maximum oscillator frequency	200 MHz	(typical)
Noise figure	5 dB	(at 45 MHz)
Mixer gain	15 dB	(at 45 MHz)
Third-order intercept	−17 dBm	(maximum)
Mixer input resistance	1.5k	(typical)
Mixer input capacitance	3pF	(typical)
Mixer output resistance	1.5k	(typical)
Mixer input capacitance	3 pF	(typical)
Mixer output resistance	1.5k	(typical)

Direct conversion receiver basics

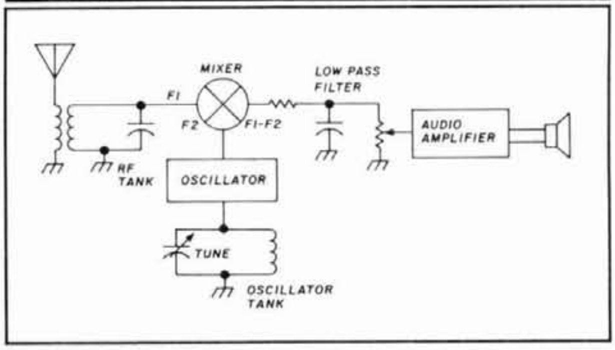
Direct conversion receivers have been sort of a fad for the past few years. If you need a refresher on the basics refer to **fig. 2**.

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:

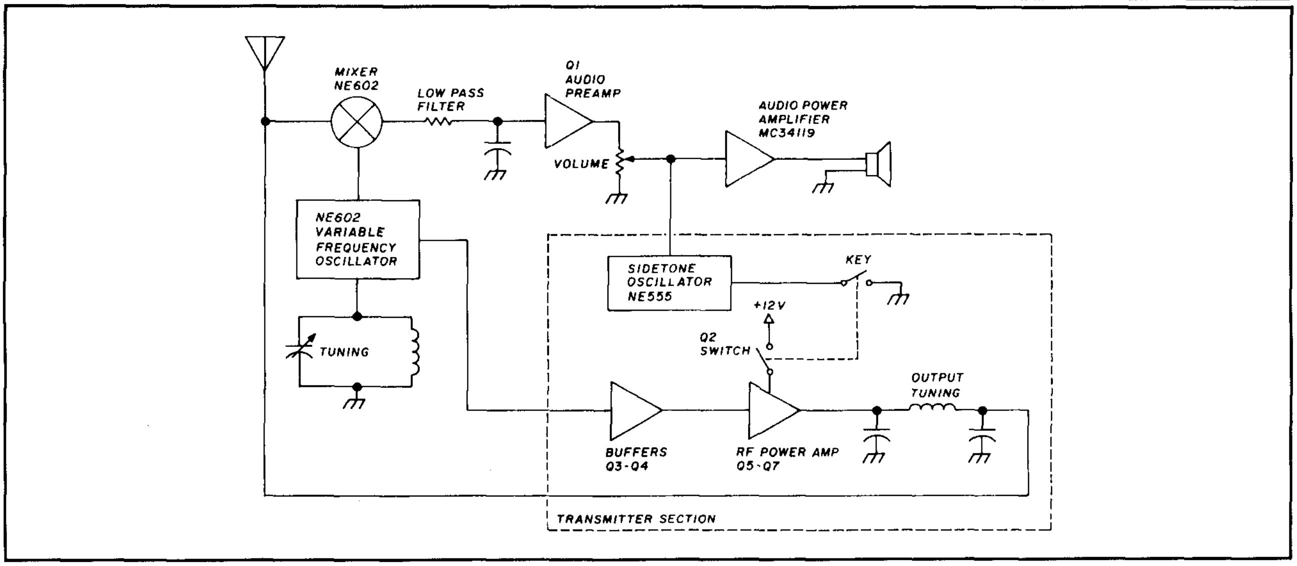
- Microphonics — Because most (if not all) of the signal gain is at an audio frequency, any slight vibration which might change

FIGURE 2



Block diagram of a typical direct-conversion receiver.

FIGURE 3



Block diagram of the direct-conversion transceiver.

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!

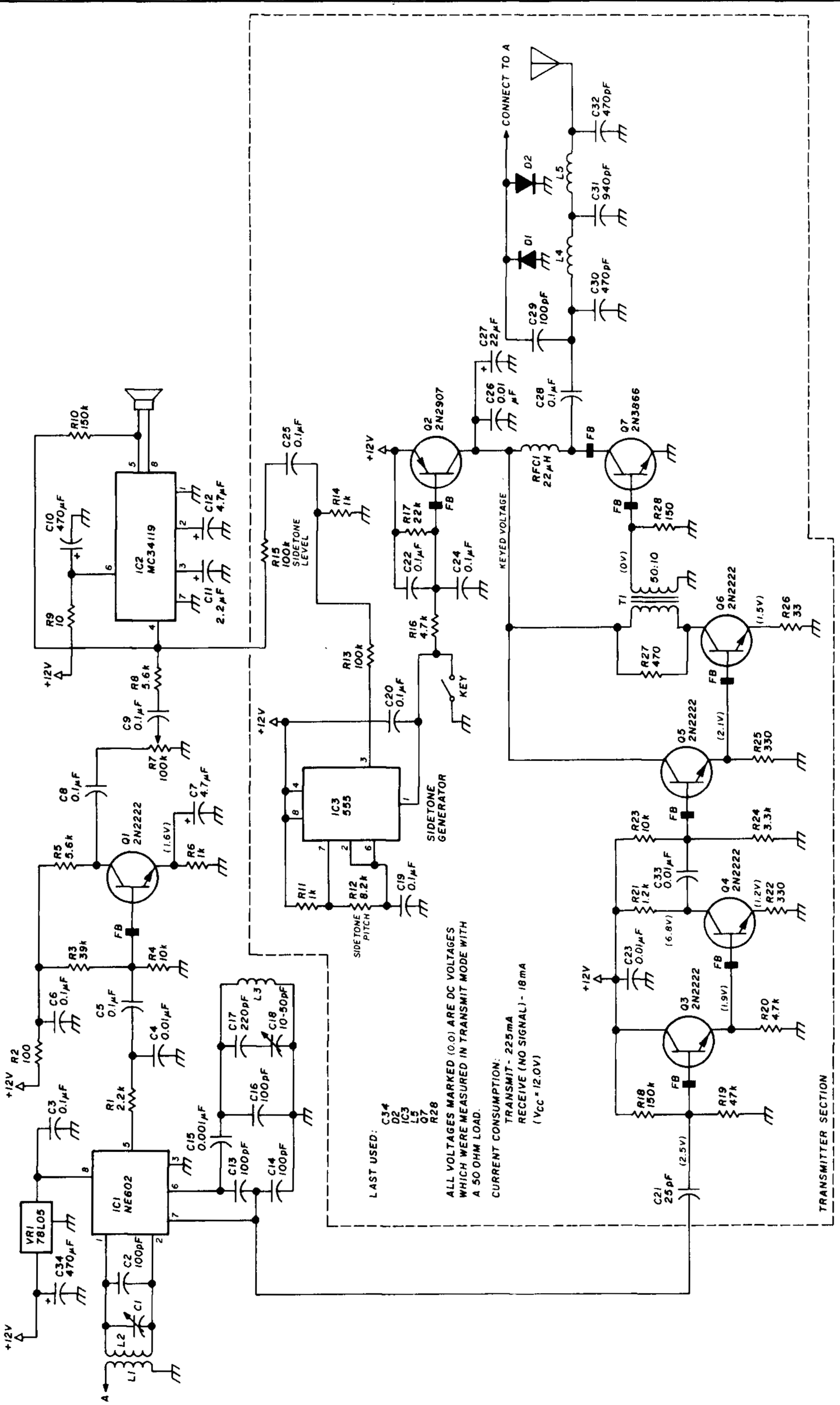
Since I've already mentioned that the NE602 contains a voltage regulator, you're probably wondering why I used a 78L05 to regulate the voltage to the NE602. First, it never hurts to have a good stiff power supply for an oscillator. Second, it's used to isolate the NE602 from the power supply. My first 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.

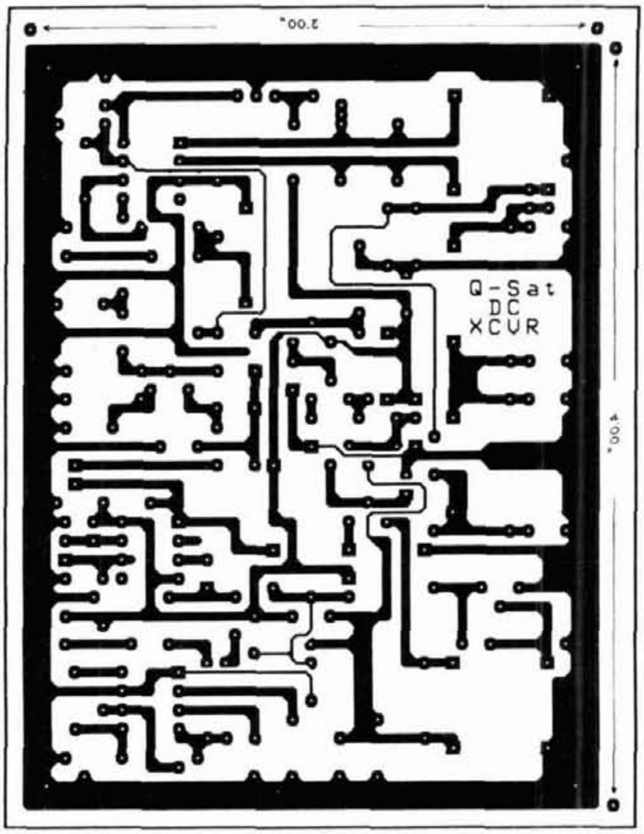
IC2 is an audio power amplifier that seems to be replacing the LM386. The output is differential and doesn't require a large capacitor to couple it to the speaker. Just keep the speaker leads short (a few inches) and twist them tightly. R9 and C10 decouple the amplifier from the power supply and are necessary to prevent

FIGURE 4



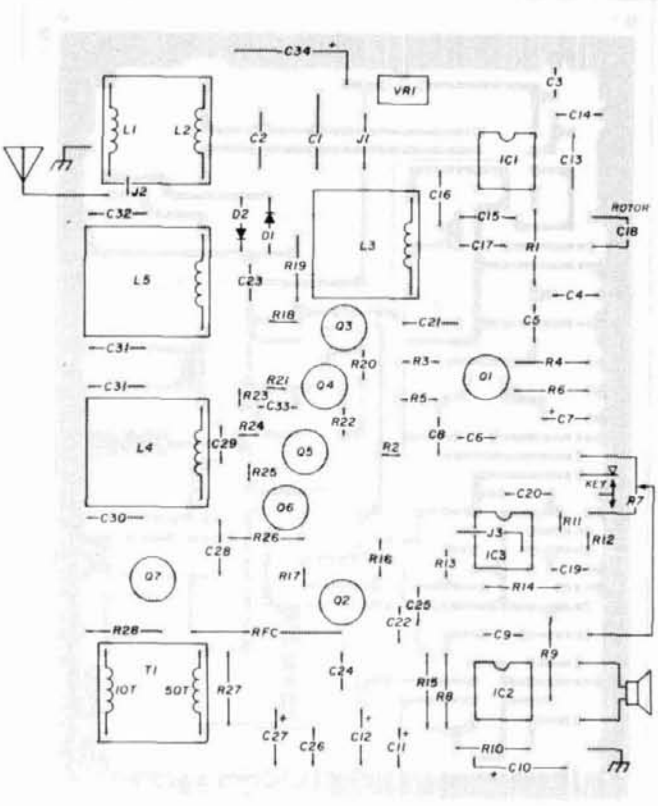
Schematic diagram of a simple direct-conversion CW transceiver.

FIGURE 5



Printed circuit board layout.

FIGURE 6



Parts placement.

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 buliding the complete transceiver.

Transistor Q2 keys the power to transistors Q5, Q6,

PARTS LIST

	Receiver	
*	C1	50 or 60 pF trimmer
	C2,C14,C16,C13	100 pF
	C3,C5,C6,C8,C9	0.1 μF
	C4	0.01 μF
	C7,C12	4.7 μF 16 volt
	C10,C34	470 μF 16 volt
	C11	2.2 μF 16 volt
	C15	0.001 μF
	C17	100 to 220 pF (see text)
*	C18	10-50 pF variable (see text)
*	IC1	Signetics NE602 (Oscillator/mixer)
*	IC2	Motorola MC34119 (Audio power amp)
	L1	30 turns no. 26 on T-37-2 core
	L2	5 turns no. 26 over L1
	L3	25 turns no. 26 on T-37-2 core
*	Q1	2N2222
	R1	2.2k
	R2	100 ohms
	R3	39k
	R4	10k
	R5,R8	5.6k
	R6	1k
	R7	100k audio taper
	R9	10 ohms
	R10	150k
*	VR1	78L05 (5-volt voltage regulator)
*	Printed Circuit Board	
*	(2) T37-2 Toroid cores	
*	(1) Ferrite bead	
	Transmitter	
	C19,C20,C22	
	C24,C25	0.1 μF
	C28	0.1 μF 50-volt minimum
	C21	25 pF
	C23,C26,C33	0.01 μF
	C27	22 μF 16 volts
	C29	100 pF
	C30,C32	470 pF
	C31	940 pF (or two 470 pF in parallel)
*	D1,D2	1N914 or 1N4148
*	IC3	NE555 (Side-tone oscillator)
	L4	15 turns no. 26 on T-37-2 core
	L5	15 turns no. 26 on T-37-2 core
*	Q2	2N2907
*	Q3,Q4,Q5,Q6	2N2222
*	Q7	2N3866 or 2N3553
	R11,R14	1k
	R12	8.2k
	R13,R15	100k
	R16	4.7k
	R17	22k
	R18	150k
	R19	47k
	R20	4.7k
	R21	1.2k
	R22,R25	330 ohms
	R23	10k
	R24	3.3k
	R26	33 ohms
	R27	470 ohms
	R28	150 ohms
*	RFC1	22 μH
	T1	Primary 50 turns no. 30 enamel Secondary 10 turns no. 26 on T-37-2 core
*	(3) T-37-2 Toroid cores	
*	(6) Ferrite beads	

The following may be ordered from:

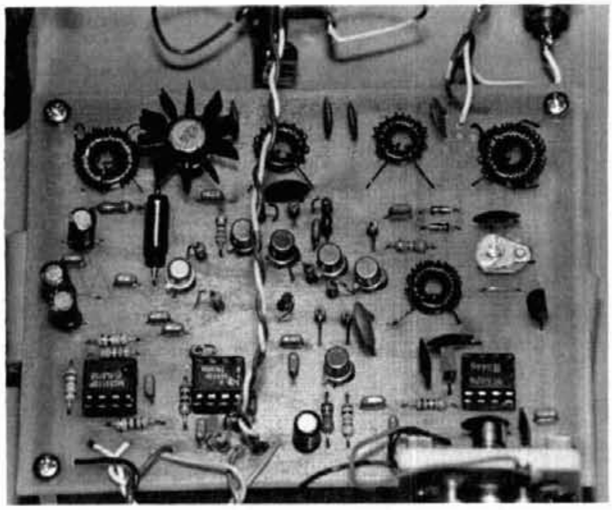
Q-Sat
P.O. Box 110
Boalsburg, Pennsylvania 16827
PC Board—PCB—DXCVR $9 plus $1 postage and handling

*Hard-to-find receiver parts (marked with * above)*
DXCVR—REC $19 plus $2 postage and handling (includes PC Board)

*Hard-to-find parts for transceiver (marked with * above)*
DXCVR—T/R $26 plus $2 postage and handling (includes PC Board)
Pennsylvania residents please add 6 percent sales tax

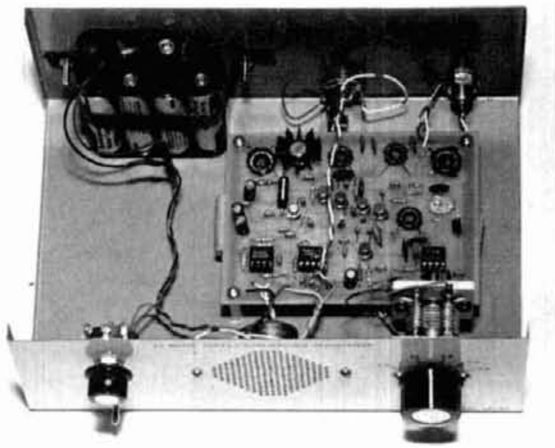
and Q7. Resistor R16 and capacitor C24 provide output wave shaping. You may increase capacitor C24 to provide a "softer" output waveform.

PHOTO A



Top view of pc board. The two 470-μF caps are mounted underneath.

PHOTO B



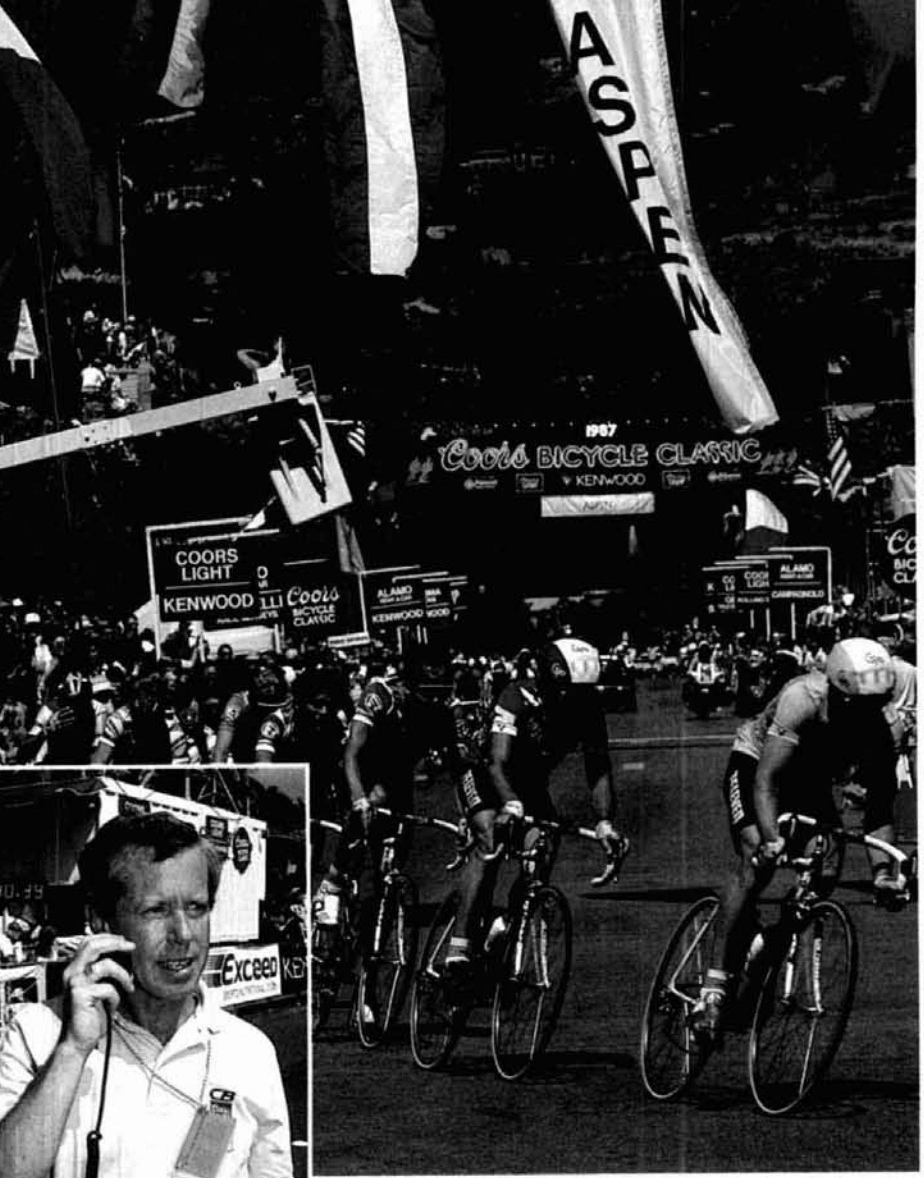
Inside View. There's still plenty of room for an audio filter.

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
Woodsome and Associates, Boulder, Colorado

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

That's why he turned to Larsen Antennas.

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

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

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

Rick Woodsome

THE AMATEUR'S PROFESSIONAL.

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

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

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

Larsen Antennas
The Amateur's Professional™

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

IN USA: Larsen Electronics, Inc., 11611 N.E. 50th Avenue, P.O. Box 1799, Vancouver, Washington 98668 (206) 573-2722.
IN CANADA: Canadian Larsen Electronics, Ltd., 149 West 6th Avenue, Vancouver, B.C. V5Y 1K3 (604) 872-8517.

✓ 116

PHOTO C

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.

TABLE 1

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.

	AC (p-p)	DC
Emitter of Q3	700 mV	1.9 volts
Collector of Q4	1.1 volts	6.8 volts
Emitter of Q5	1.6 volts	2.1 volts
Collector of Q6	17 volts	12 volts
Base of Q7	2.9 volts	0 volts
Collector of Q7	18 volts	12 volts
Antenna Output (50-ohm load)	18 volts	0 volts
NE602 (pin 7)	700 mV	4.5 volts

Bibliography

1. *Signetics Linear Data Manual Volume 1 — Communications*, Signetics Corp.
2. Robert J. Zavrel, Jr., W7SX, "Designing with the NE/SE602," Signetics Application Note AN198, Signetics Corp.
3. Robert J. Zavrel, Jr., W7SX, "New Low Power Single Sideband Circuits," Signetics Application Note AN1981, Signetics Corp.
4. Donald Anderson, "Applying the Oscillator of the NE602 in Low Power Mixer Applications," Signetics Application Note AN1982, Signetics Corp.
5. RCA Solid State Power Circuits, Technical Series SP-52.
6. Wes Hayward, W7ZOI and Doug DeMaw, W1FB, *Solid State Design for the Radio Amatuer*, American Radio Relay League.
7. Doug DeMaw, W1FB, *QRP Notebook*, American Radio Relay League.
8. Chris Bowick, *RF Circuit Design*, Sams Publishing.
9. Motorola RF Device Data — DL110 Rev. 1, Motorola, Inc.

Article A **HAM RADIO**

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.[1] That version used a filament-type tube (3A5) 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.

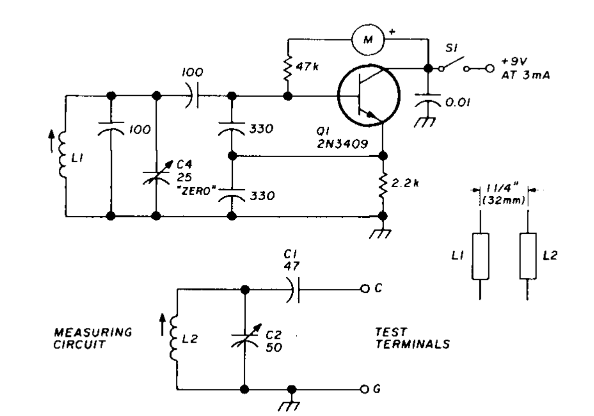
The capacitance circuit measures to 5000 pF or more; however, accuracy and resolution are reduced above 1000 pF because of circuit limitations. But, when you pick a mica capacitor marked with two red dots from your junkbox, this unit will quickly tell you if it's 2.2, 22, or 220 pF. The device has the 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

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

FIGURE 1



L1- 30T. NO. 28E CLOSE-WOUND ON 3/8" (10mm) SLUG-TUNED FORM. APPROX. 7μH.
L2- 50T. SAME AS L1. APPROX. 30μH.
Q1- 2N3904 OR SIMILAR.
M- 0 TO 100 OR 0 TO 200μA.
S1- SPST TOGGLE OR SLIDE SWITCH.

Schematic diagram of L-C checker with measuring circuit for measurement of capacitance only. L1 and L2 should be spaced as shown for optimum electrical coupling.

base-bias resistor serves as the "dip" or absorption indicator.

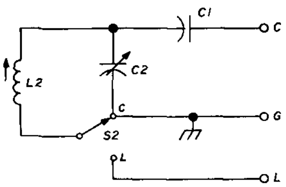
The variable measuring circuit consists of C1, C2, and L2 and is connected to panel terminals as shown. L2 is loosely coupled to L1 in the oscillator circuit. This measuring circuit is tuned to the oscillator frequency with variable capacitor C2 set at full or (maximum) capacitance. When power is applied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

FIGURE 2



Note: Capacitance measurement between terminals C and G. Switch at "C". Inductance measurement between terminals L and G. Switch at "L".

Addition of S2 to the measuring circuit enables measurement of both capacitance and inductance. Note: For capacitance measurement between terminals C and G, switch at "C". For inductance measurement between terminals L and G, switch at "L".

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.

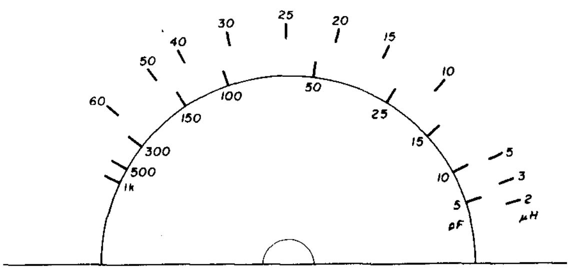
Make the wiring from the bottom of L2 to switch S2, and from S2 to the panel terminal "L", short and low inductance. Use heavy wire or copper ribbon, because these connections form a portion of the unknown inductance placed across terminals "L" and "G". Too much inductance in these connections produces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

FIGURE 3



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 combination 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 **HAM RADIO**

HAM RADIO TECHNIQUES

Bill Orr, W6SAI

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 F_2 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.

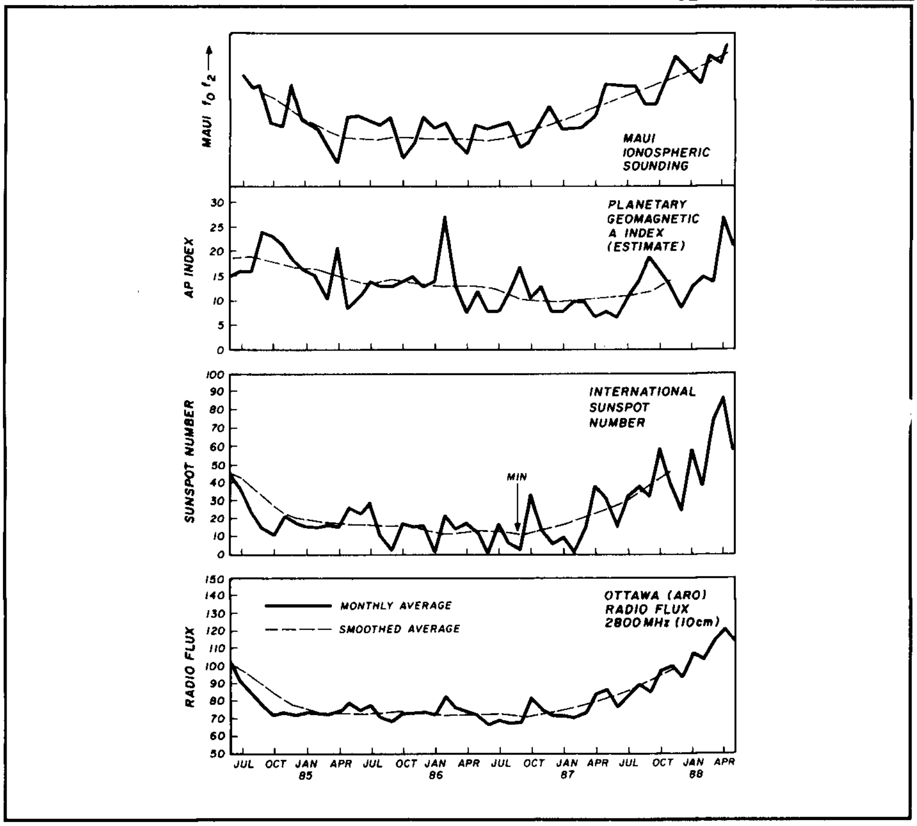
So where do we go from here? When will the present ionospheric cycle peak out? *QST*'s "How's DX" column indicates a peak at the end of 1988. Steve showed me a graph of the median values of the maximum reflecting frequency of the F_2 layer, as measured at his station (**fig. 2**). He pointed out that 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?

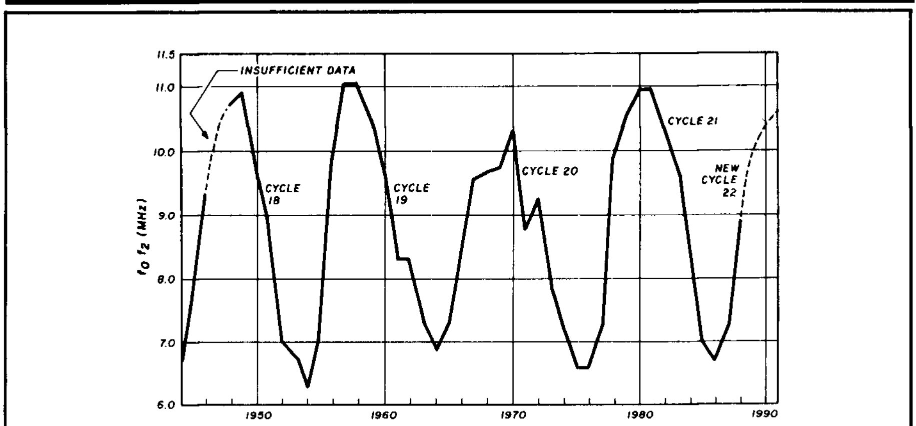
The June issue of *Modern Electronics* has an article by C. Hall describing TVI from a neighbor's cordless telephone. The phone transmitted

FIGURE 1



Comparison of cycles of ionospheric sounder (Maui) with A-index, sunspot number, and radio flux over the period July 1985 to April 1988 shows that the individual cycles have quite different minimums.

FIGURE 2



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 picture 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.

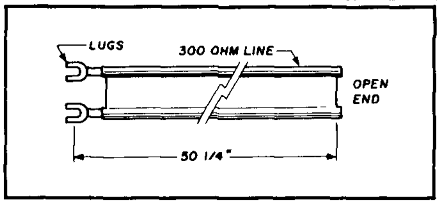
The antenna supplies the usual figure eight pattern on 40 meters, and a somewhat narrower figure eight on 21 MHz. Best of all, there's about a 3-dB gain over an equivalent dipole on 21 MHz.

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.

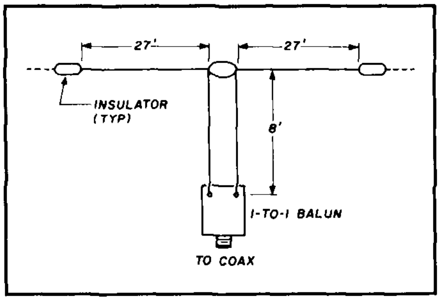
An easy way to make the line is to stretch two 10-foot lengths of wire

FIGURE 3



High-pass filter designed to attenuate TV interference from cordless telephones operating in 49 to 50 MHz region.

FIGURE 4



Compact 7/21 MHz antenna attributed to G3TKN. The 8-foot stub is made of no. 22 enamel coated wire, spaced 6 inches.

under tension between two fixed supports, about waist high. The spreaders are threaded on the wires and fastened in position. When the two-wire line is cut loose, it should be straight and taut.

The antenna is strung up in a straight line, or in an inverted V. An SWR curve should be run across each band, with the maximum indication less than 2:1. The SWR curve can be modified a bit by trimming or lengthening the wires in the stub.

Make sure your coax connection at the balun is waterproof to protect the line from internal moisture and corrosion.

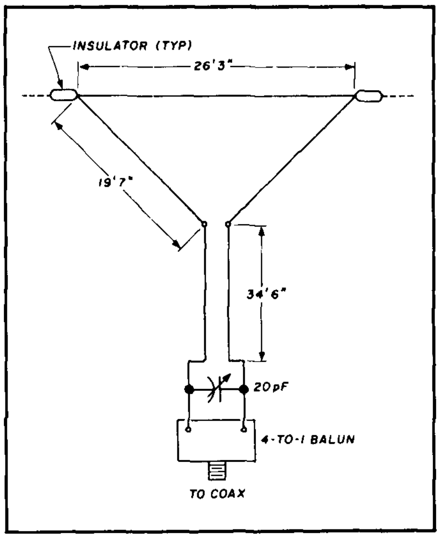
A delta loop for 7, 10, 14, 18, 21, 24, and 28 MHz

In a few months we'll finally have the 18-MHz band! This means there will be seven bands available between 7 and 29.7 MHz. It's time to think about a seven-band antenna.

Why not try a center-fed antenna about 66 feet long in conjunction with a two-wire, balanced transmission line and an antenna tuner? How about using a delta loop in the same fashion (**fig. 5**)? 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.

FIGURE 5



The HB9ADQ multiband delta-loop antenna. The feedline consists of no. 16 wire, spaced 4 inches. Spreaders are spaced 16 inches. Alternatively, 300-ohm ribbon line may be used, with an antenna tuner substituted for the 4:1 balun.

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.

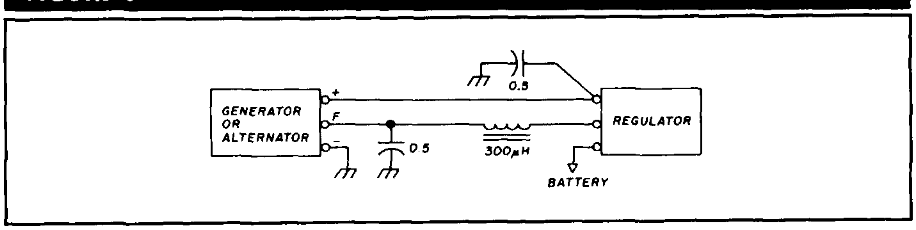
Alternator or generator noise

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-

FIGURE 6



Alternator-generator noise may be substantially reduced by addition of filters, as shown in this simplified circuit. Capacitors are ordinary metal-cased "generator condensers." The 300-μH choke must be capable of carrying the field current. (Circuit courtesy ZL2AJL.)

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**

THE HAM NOTEBOOK

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 of the quad two-input NAND gate 4011 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 (e_p) at the output of IC1a, passing through differentiator C_4R_{13}, then form positive and negative pulses (e_t). The dual op amps of the LM358 are used as two gated amplifiers for the two signals e_1 and e_2 and fed through terminals 2 and 6, to be displayed simultaneously on the CRO screen.

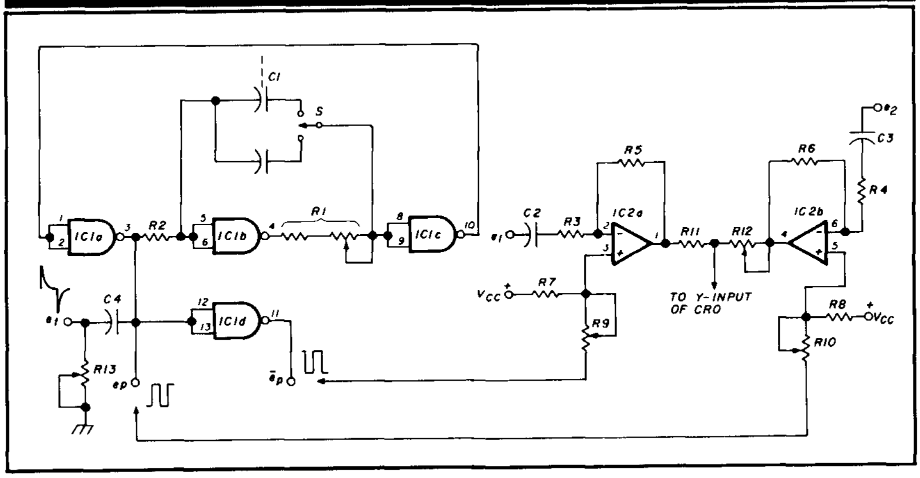
The two opposite-phase square waves e_p and $\bar{e}_p$ are used to gate IC2a and IC2b at terminals 3 and 5 of the LM358, respectively. Resistances R_9 and R_{10} are preadjusted so that one op amp is driven to saturation while the other works normally as an amplifier. Thus they will amplify the two signals e_1 and e_2 alternately, and two separate traces will be displayed on the screen. Resistance R_{12} can be varied to adjust

PARTS LIST

Parts List (fig. 1)

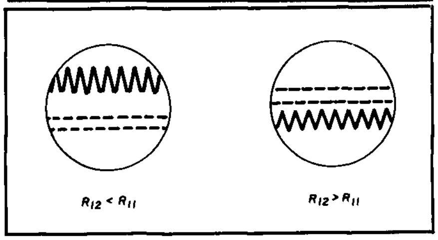
IC1	4011	R3	20k
IC2	LM358	R4	20k
		R5	200k
C1	0.001 μF	R6	200k
	0.01 μF	R7	50k
	0.1 μF	R8	50k
	1.0 μF	R9	50k pot
	10 μF	R10	50k pot
C2	25 μF	R11	100 ohm
C3	25 μF	R12	300 ohm pot
C4	0.001 μF	R13	50k pot
R1	500-ohm + 50-k pot	Vcc	6 volts
R2	500 ohm	S	multipole switch

FIGURE 1



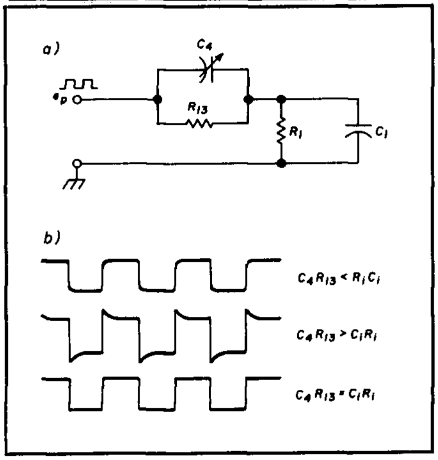
Circuit of the trace doubler for CRO, and square waves and pulse generator.

FIGURE 2



Oscillograms of the displayed input signals e_1 (sine wave) and e_2 (square wave).

FIGURE 3



(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 cps to 10^6 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_p. R_1 is the input resistance of the CRO and C_i 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, $C_1 = C_2 = 70$ pF. A capacitively reactive ($-X_x$) load allows nulling the bridge by reducing the capacitance of C_1; an inductively reactive ($+X_x$) load requires that C_1 be increased in value to do so. The equivalent series reactance ($\pm X_x$) of the unknown load impedance (Z_x) is the difference in the setting of C_1 between the initial balance when X = 0 (C_1 = 70 pF) and the load reactance, or

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

where

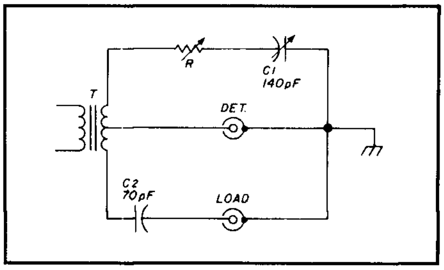
$C_1{'}$ is the first reading of C_1 = 70 pF

$C_1{''}$ 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.

FIGURE 1

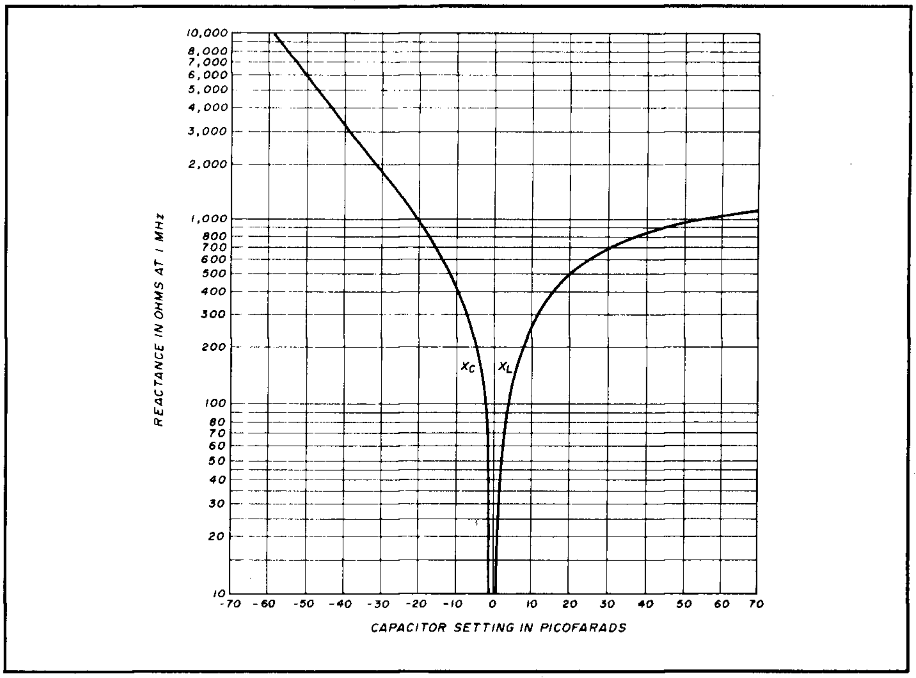


Basic schematic of series-resistance-capacitance bridge.

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 pF through 0 pF to +70 pF, as shown.

In the event that C_1 is some value other than 140 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.

FIGURE 2



Calibration curve for reactance.

Wilfred N. Caron, Ridgecrest, California 93555

Article D


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 guaranty on parts and labor. Many accessories available for all scopes.
• DC to 40MHz
• Dual Channel
• CRT Readout
• Cursor Meas
• DC Offset
• Alt Magnifier
• Compact Size
V-425
List $995
$835
• DC to 100MHz
• Dual Channel
• Delayed Sweep
• CRT Readout
• Sweep Time
• Autoranging
• Trigger Lock
• 2mV Sensitivity
V-1060
List $1595
$1,285
LIST PRICE SAVE
V-223 20MHz D.T., 1mV sens, Delayed Sweep, DC Offset, Vert Mode Trigger $770 $695 $75
V-422 40MHz D.T., 1mV sens, DC Offset Vert Mode Trigger, Alt Mag $875 $695 $180
V-423 40MHz D.T., 1mV sens, Delayed Sweep, DC Offset, Alt Mag $955 $795 $160
V-660 60MHz D.T., 2mV sens, Delayed Sweep, CRT Readout $1,195 $990 $205
V-1065 100MHz D.T., 2mV sens, Delayed Sweep, CRT Readout, Cursor Meas $1,895 $1,575 $320
V-1100A 100MHz Q.T., 1mV sens, Delayed Sweep, CRT Readout, DVM, Counter $2,295 $1,995 $300
V-1150 150MHz Q.T., 1mV sens, Delayed Sweep, Cursor Meas, DVM, Counter $3,100 $2,565 $535
ELENCO PRODUCTS AT DISCOUNT PRICES
20MHz Dual Trace Oscilloscope
$349
MO-1251
• 6" CRT
• Built in component tester
• TV Sync
SCOPE PROBES
P-1 65MHz, 1x, 10x $19.95
P-2 100MHz, 1x, 10x $23.95
with 5 accessories
10 Meg ohm Input impedance
Fits all scopes with BNC connector
TL-3 BNC to Minigrabber $3.49
35MHz Dual Trace Oscilloscope
$498
MO-1252
• High luminance 6" CRT
• 1mV Sensitivity
• 6KV Acceleration Voltage
• 10ns Rise Time
• X-Y Operation • Z Axis
• Delayed Triggering Sweep
Top quality scopes at a very reasonable price. Contains all desired features. Two 1x, 10x probes, diagrams and manual. Two year guarantee.
NEW! Autoranging DMM
M-5000
$45
9 Functions
Memory and Data hold
½% basic acc
3½ digit LCD
True RMS 4½ Digit Multimeter
M-7000
$135
.05% DC Accuracy
.1% Resistance
with Freq. Counter and deluxe case
Multimeter with Capacitance and Transistor Tester
$55 CM-1500A
Reads Volts, Ohms, Current, Capacitors, Transistors and Diodes with case
Digital Capacitance Meter
CM-1550
$58.95
9 Ranges
.1pf-20,000ufd
.5% basic accy
Zero control with case
Digital LCR Meter
LC-1800
$138
Measures
Coils 1uH-200H
Caps .1pf-200uf
Res .01-20M
NEW! AC Clamp-On Current Adapter
ST-265
$22
0-1000A AC
Works with most DMM
NEW! Bench DMMS
M-3500 3½ digit .1% accy $125
M-4500 4½ digit .05% accy $175
50MHz Logic Probe
LP-700
$23
Logic Pulser LP-600 $23
Solderless Breadboards
9430 1,100 pins $15
9434 2,170 pins $25
9436 2,860 pins $35
All have color coded posts
9436 SHOWN
Low Cost Multimeter
M-1600
$25
3½ digit LCD
1% DC Accy
10A Scale
Auto zero /polarity
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
3½ Digit Probe Type DMM
M-1900
$45
Convenient one hand operation
Measures DCV, ACV, Ohms
Audible continuity check, Data hold
with batteries and case
GF-8016 Function Generator with Freq. Counter
$239
Sine, Square, Triangle
Pulse, Ramp, .2 to 2MHz
Freq Counter .1 - 10MHz
GF-8015 without Freq. Meter $179
Digital Triple Power Supply
XP-765
$249
0-20V at 1A
0-20V at 1A
5V at 5A
Fully Regulated, Short circuit protected with 2 Limit Cont., 3 Separate supplies
XP-660 with Analog Meters $175
Quad Power Supply
XP-580
$59.95
2-20V at 2A
12V at 1A
5V at 3A
-5V at 5A
Fully regulated and short circuit protected
XP-575 without meters $44.95
Four-Function Frequency Counters
F-1000 1.2GH
$259
F-100 120MH
$179
Frequency, Period, Totalize, Self Check with High Stabilized Crystal Oven Oscillator, 8 digit LED display
NEW!
"GREAT IDEA" FUNCTION BLOX FOR EASY BREADBOARDING
All blox interlock to make your design work a snap. You can change the configuration
9550 7.50
550 tie pts
9600 28.95 FUNCTION GENERATOR 1 to 1MHz sine, sq wave
9610 18.95 RESISTOR DECADE BLOX 20 resistors 47-1M ohm
9620 18.95 CAPACITOR DECADE BLOX 20 capacitors 47pf-10mfd
9630 22.95 DIGITAL CLOCK BLOX pulses from 1Hz to 50MHz
9640 22.95 LOGIC PROBE BLOX 4 logic level ind.
9650 19.95 POWER BLOX 5V at 1A -5 at .4A 12V at .3A
WE WILL NOT BE UNDERSOLD!
UPS Shipping: US 5% ($10 Max) IL Res., 7% Tax
VISA
MasterCard
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

✓ 125

STRUCTURAL EVALUATION
OF YAGI ELEMENTS

By Dick Weber, K5IU, P.O. Box 44, Prosper, Texas 75078

Try this simple analysis procedure

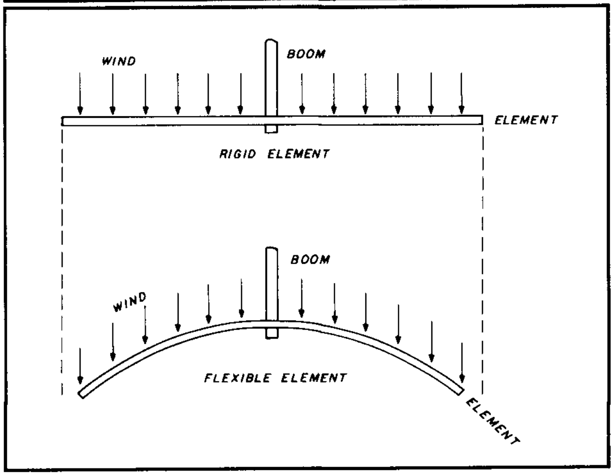
Over the past year or so, I've been working on a design procedure for developing structurally sound Yagi elements. I spent many hours with Bob Mitchell, N5RM, analyzing the structural integrity of his "Forty-Meter Flame Thrower"[1] and developing the first steps of my procedure. After I completed my 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, K5RR, had several identical Yagis 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

FIGURE 1



Graphic illustrations of both the Rigid Element Model and the Flexible Element Model, and how each reacts to a theoretical wind.

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

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.

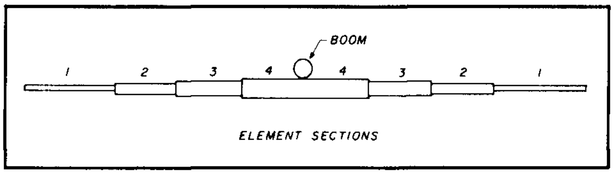
While the FEM version gives a precise description of the actual conditions, modeling is complex and time consuming. REM is easier and faster. The errors introduced by the REM assumptions result in a design more conservative than one using FEM.

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 to make the element 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.

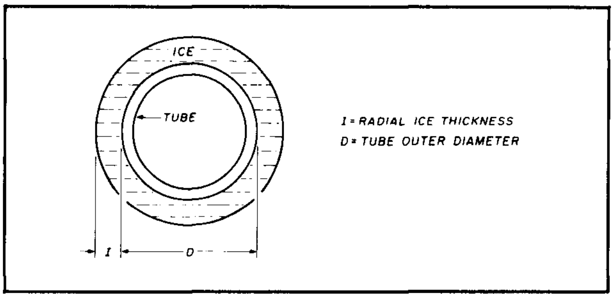
You can identify weak spots when analyzing an existing design or compare it with the relative merit of others. If an existing design is weak, you may choose to reinforce it or purchase another. When planning an element, you can alter the design by using different sizes and lengths of tubing in the element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

FIGURE 2



A typical Yagi element constructed from telescoping sections of aluminum tubing.

FIGURE 3



Yagi element shown with "ice loading." If you know the tube outer diameter and the thickness of the ice on the element, you can closely approximate the amount of loading being placed on the element.

Element description

Figure 2 shows a typical element constructed from various tubing sizes. The outermost element section is called 1; the numbers increase as they approach the boom. Because the element is symmetrical relative to the boom, the other half of the element will have the same numbering scheme. An element section is a part of the element that has the same outer diameter and wall thickness. If one part of the element telescopes into another, a new section is formed. A section can be long or short, but its entire length must have the same wall thickness and outer diameter. If a tube is reinforced either on the outside or inside, a new section is created because its geometric properties are different. **Figure 2** shows a four-section element. Because the sections are the same on both sides of the boom, the analysis procedure will be applied only to one.

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.[2] 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**.

$$Wi = 0.102 \times L(D \times I + I^2) \quad \textbf{(1)}$$

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

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.

$$Wa = 0.31 \times L\ (D \times T - T^2) \quad \textbf{(2)}$$

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,[2] along with the conversion of units for wind pressure.

$$Fw = 0.0047 \times L \times De \times P \quad \textbf{(3)}$$

Fw = wind load on round section (pounds)
L = section length (inch)
P = wind pressure perpendicular to a 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.

$$De = D + I + I \quad \textbf{(4)}$$

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

The total load on a section (Ft) is the sum of the ice weight, element weight, and wind load.

$$Ft = Wi + Wa + Fw \quad \textbf{(5)}$$

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.[3]

Wind pressure

Calculate the wind pressure striking a flat surface with **eqn. 6.**[2] 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.

$$P = 0.004 \times V^2 \quad \textbf{(6)}$$

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.**

$$P = 0.0024 \times V^2 \quad \textbf{(7)}$$

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 reoccurrence 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

TABLE 1

Wind pressures at various mean wind speeds and their corresponding peak value with a 1.30 gust factor.

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

TABLE 2

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.

Season	*Radial ice*	*Mean wind*	*Peak wind*	*Pressure level*
Winter	0.25 inch	40.0 mph	52 mph	6.4 pounds/square foot
Non-winter	0 inch	86.6 mph	113 mph	30 pounds/square foot

TABLE 3

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

Section	L (inch)	D (inch)	T (inch)
1	48.0	0.500	0.058
2	60.0	0.625	0.058
3	72.0	0.750	0.058
4	36.0	0.875	0.058

TABLE 4

Winter conditions

Section	Wi (pounds)	Wa (pounds)	Fw (pounds)	Ft (pounds)
1	0.92	0.39	1.45	2.76
2	1.34	0.61	2.04	3.99
3	1.83	0.90	2.71	5.44
4	1.04	0.53	1.49	3.06

TABLE 5

Non-winter conditions

Section	Wi (pounds)	Wa (pounds)	Fw (pounds)	Ft (pounds)
1	0	0.39	3.38	3.77
2	0	0.61	5.29	5.90
3	0	0.90	7.61	8.51
4	0	0.53	4.44	4.97

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 conditions. 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 10KV and 20 amps.
- **3 KW Balun.** Trifler wound triple core torroid gives balanced output to twin feeder from 200 to 1000 ohms and unbalanced output down to 20 ohms.
- **Maximum Power Transfer.** Match your transmitter output impedence 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

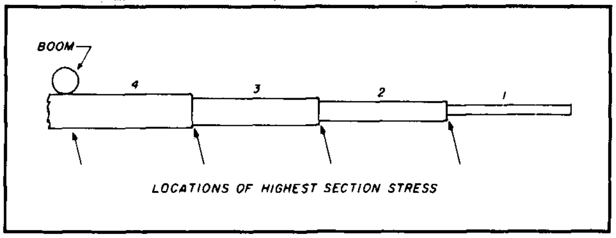
Amateur Electronic Supply
Ham Radio Outlet
Henry Radio
Madison Electronics
EGE
R&L Electronics
r f enterprises
Barry Electronics
C-Comm
Ross Distributing
Quement Electronics
LaCue Communications
Ham Station

Nye Viking

Wm. M. Nye Co. Inc.
1614 130th Ave. N.E.
Bellevue, WA 98005
TEL: (206) 454-4524
FAX: (206) 453-5704

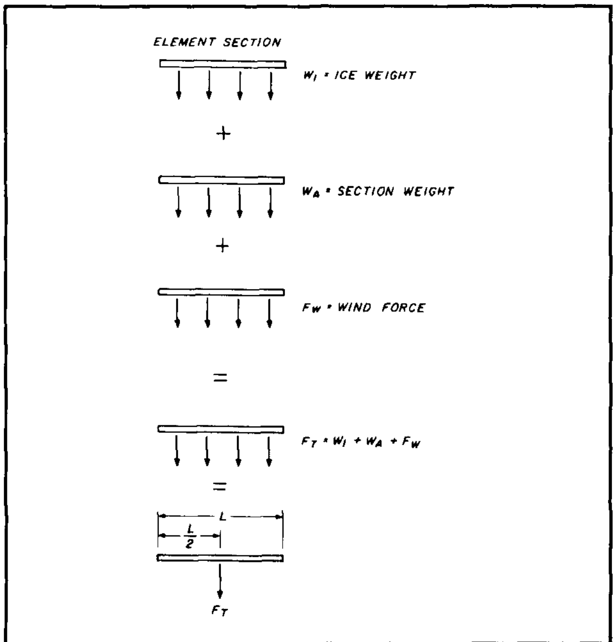
✓ 126

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.

$$Sb = \frac{M}{Z} \tag{8}$$

Sb = 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**.

$$Z = 0.098 \times \frac{D^4 - (D - 2T)^4}{D} \tag{9}$$

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**.

$$M1 = Ft1 \times \frac{L1}{2} \tag{10}$$

TABLE 6

Section moduli and weights for a number of tube sizes.

Tube outer diameter (inch)	Wall thickness (inch)	Weight per foot (lbs/ft)	Section modulus ($inch^3$)
0.25	0.035	0.03	0.0011
0.25	0.049	0.04	0.0013
0.25	0.058	0.04	0.0014
0.375	0.049	0.06	0.0036
0.375	0.058	0.07	0.0040
0.50	0.058	0.01	0.0080
0.50	0.125	0.17	0.0115
0.625	0.058	0.12	0.0134
0.625	0.125	0.23	0.0208
0.75	0.058	0.15	0.0202
0.75	0.125	0.	0.0332
0.875	0.058	0.18	0.0285
0.875	0.120	0.34	0.0474
1.00	0.058	0.20	0.0382
1.00	0.125	0.40	0.0670
1.125	0.058	0.23	0.0492
1.125	0.125	0.46	0.0885
1.25	0.058	0.26	0.0618
1.25	0.125	0.52	0.1130

TABLE 7

Section moduli for various telescoped combinations.

Tube outer diameter (inch)	Combined wall thickness (inch)	Section Modulus ($inch^3$)
0.375	0.116	0.0051
0.500	0.116	0.0112
0.500	0.174	0.0120
0.625	0.116	0.0202
0.625	0.174	0.0230
0.750	0.116	0.0319
0.750	0.174	0.0379
0.875	0.116	0.0465
0.875	0.174	0.0570
1.000	0.116	0.0639
1.000	0.174	0.0803
1.125	0.116	0.0841
1.125	0.174	0.1078
1.250	0.116	0.1072
1.250	0.174	0.1395

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 $inch^3$

Using **eqn. 10**

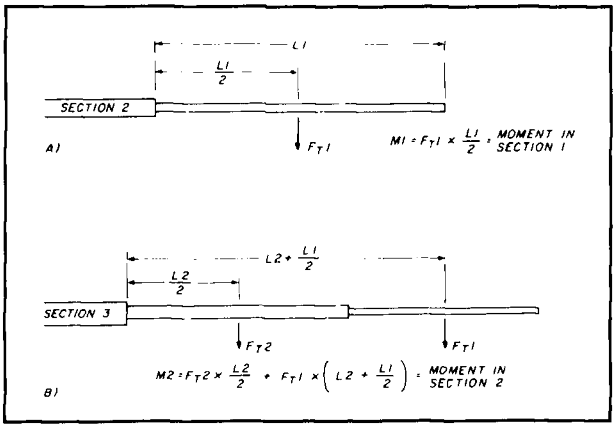
$$M1 = 3.77\,pounds \times \frac{48.0}{2}\,inch = 90.5\,pound\text{-}inch$$

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

$$Sb1 = \frac{90.5\,pound\text{-}inch}{0.0080\,inch^3} = \frac{11{,}312.5\,pounds}{inch^2}$$
$$Or\ 11{,}312.5\ psi$$

Sb1 = bending stress for section 1 (pounds per square inch)

FIGURE 6



(A) Determining the moment for section one of the element. (B) Determining the moment for section two, and showing how the moment of the previous section(s) are added together for each new section calculated.

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.

$$M2 = Ft2 \times \frac{L2}{2} + Ft1 \times \left(L2 + \frac{L1}{2}\right) \quad \textbf{(11)}$$

M2 = bending moment at end of section 2 (pound-inch)
Ft2 = section 2 total load (pounds)
Ft1 = section 1 total load (pounds)
L1 = section 1 length (inch)
L2 = 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 inches
L2 = 60.0 inches
Ft1 = 3.77 pounds
Ft2 = 5.91 pounds
D2 = 0.625 inch
T2 = 0.058 inch
Z2 = 0.0134 inch^3 (from **table 6**)

$$M2 = 5.91\,pounds \times \frac{60.0}{2}\,inch + 3.77\,pounds \times$$

$$(60.0\,inch + \frac{48.0}{2}\,inch)$$

M2 = 177.3 pound-inch + 316.7 pound-inch = 494.0 pound-inch

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

If there are three sections, M3 is calculated from:

$$M3 = Ft3 \times \frac{L3}{2} + Ft2 \times \; L3 + \frac{L2}{2}$$

$$+ Ft3 \times \left(L3 + L2 + \frac{L1}{2}\right)$$

$$Sb3 = \frac{M3}{Z3}$$

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—$2^7/_{16} \times 7^1/_4 \times 7^7/_8$"—yet loaded with most-wanted features.

Pushbutton selectors on the mike permit safe and easy QSY while mobiling 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 CORPORATION
9 Autry
Irvine, CA 92718
(714) 458-7277

INSIDE VIEW — RS-12A

ASTRON POWER SUPPLIES

• HEAVY DUTY • HIGH QUALITY • RUGGED • RELIABLE •

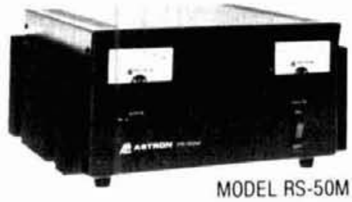
SPECIAL FEATURES

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

PERFORMANCE SPECIFICATIONS

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

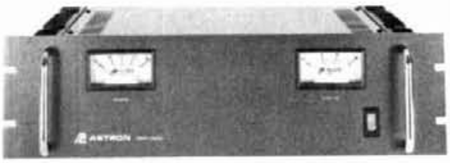
MODEL RS-50A



MODEL RS-50M

MODEL VS-50M

RM SERIES



MODEL RM-35M

19″ × 5¼ RACK MOUNT POWER SUPPLIES

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

RS-A SERIES

MODEL RS-7A

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

RS-M SERIES

MODEL RS-35M

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

VS-M AND VRM-M SERIES

MODEL VS-35M

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

MODEL	Continuous Duty (Amps) @13.8VDC	@10VDC	@5VDC	ICS* (Amps) @13.8V	Size (IN) H × W × D	Shipping Wt. (lbs.)
VS-12M	9	5	2	12	4½ × 8 × 9	13
VS-20M	16	9	4	20	5 × 9 × 10½	20
VS-35M	25	15	7	35	5 × 11 × 11	29
VS-50M	37	22	10	50	6 × 13¾ × 11	46
• Variable rack mount power supplies						
VRM-35M	25	15	7	35	5¼ × 19 × 12½	38
VRM-50M	37	22	10	50	5¼ × 19 × 12½	50

RS-S SERIES

MODEL RS-12S

- Built in speaker

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

TABLE 8

Complete solution set.

Sec	OD (in)	T (in)	L (in)	Ft (lbs)	Z (in^3)	M (lbs-in)	Sb (psi)
1	0.500	0.058	48.0	3.77	0.0081	90.5	11,300
2	0.625	0.058	60.0	5.90	0.0134	494.0	36,860
3	0.750	0.058	72.0	8.51	0.0202	1496.3	74,070
4	0.875	0.058	36.0	4.97	0.0285	2240.2	78,600

TABLE 9

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

Aluminum Alloy	Maximum allowable stress (psi) (4)
6061-T6	35,000
6063-T6	25,000
6063-T83	30,000

TABLE 10

Element with section lengths altered to obtain maximum allowable stress.

Sec	OD (in)	T (in)	L (in)	Ft (lbs)	Z (in^3)	M (lbs-in)	Sb (psi)
1	0.500	0.058	84.0	6.59	0.0081	276.7	34,580
2	0.625	0.058	24.0	2.36	0.0134	463.2	34,500
3	0.750	0.058	24.0	2.84	0.0202	712.0	35,130
4	0.875	0.058	84.0	11.69	0.0285	2189.0	76,720

TABLE 11

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

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

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.

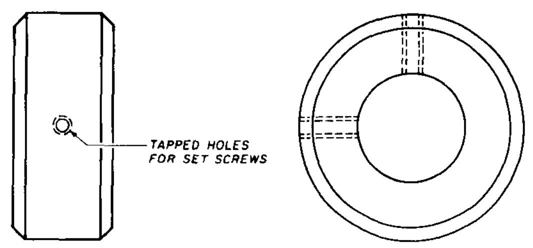
Section 4 has a stress slightly over the maximum. This

TABLE 12

Example of section 4 shown as a single tube with marginal strength.

Sec	OD (in)	T (in)	L (in)	Ft (lbs)	Z (in³)	M (lbs-in)	Sb (psi)
1	0.500	0.058	84.0	6.59	0.0081	276.7	34,580
2	0.625	0.058	24.0	2.36	0.0134	463.2	34,500
3	0.750	0.058	24.0	2.84	0.0202	712.0	35,130
4	1.250	0.058	84.0	16.60	0.0619	2399.4	38,780

FIGURE 7



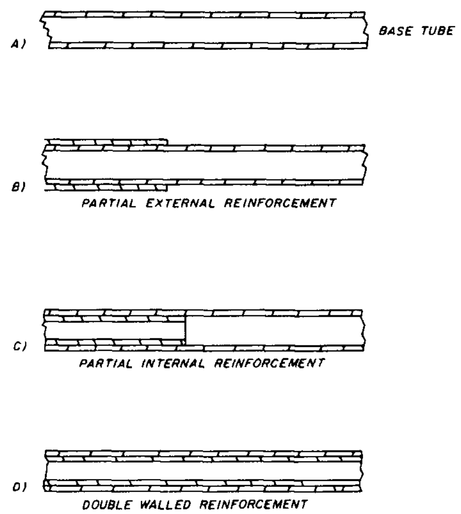
Description of a spacer which can be used when making a large decrease in tubing sizes on an element; i.e., two sizes that will not telescope together and allow a compression joint.

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 flame thrower.[1] Several manufacturers swage the end of a larger tube to a smaller size. The result 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.

FIGURE 8



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 differents 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 5,000 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 61 YEARS OF SERVICE

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

✓ 133

TABLE 13

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

EWT = 8.4 pounds   EWL = 68.4 pounds

Section	D (inch)	T (inch)	L (inch)	Sb (psi)
1	1.000	0.058	48.00	4,760
2	1.125	0.058	96.00	35,050
3	1.250	0.058	72.00	64,910

TABLE 14

36-foot element with improved design.

EWT = 8.0 pounds   EWL = 66.4 pounds

Section	D (inch)	T (inch)	L (inch)	Sb (psi)
1	1.000	0.058	131.00	35,450
2	1.125	0.058	13.00	33,220
3	1.250	0.058	18.00	33,700
4	1.250	0.116	54.00	35,830

TABLE 15

Comparison of materials used in *Tables 13* and *14*.

	Case 1 (Table 13)		Case 2 (Table 14)	
Tube Diameter size (0.058 wall)	12-foot lengths needed	waste	12-foot lengths needed	waste
1.000	1	38 inches	2	16 inches
1.125	2	86 inches	1	0 inches
1.250	1	0 inches	1	0 inches

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.

EWT = 2 × (sum of all section Was) **(12)**
= total element weight (pounds) ignoring overlap

EWL = 2 × (sum of all section Fws) **(13)**
= 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 16

Revised element for improved design.

EWT = 7.3 pounds   EWL = 42.8 pounds

Section	D (inch)	T (inch)	L (inch)	Sb (psi)
1	0.500	0.058	84.00	34,580
2	0.625	0.058	24.00	34,500
3	0.750	0.058	23.00	34,550
4	0.750	0.116	30.00	34,640
5	1.00	0.116	55.00	34,730

TABLE 17

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

	Table 16	Table 13	Table 14
Survival mean wind speed (peak) (mph)	86.6 (112.5)	64.0 (83.2)	86.6 (112.50)
Element weight (pounds)	7.3	8.4	8.0
Element wind load at 86.6 mph (pounds)	42.8	68.4	66.4

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 **table 13**'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

1. R.H. Mitchell, N5RM, "The Forty-Meter Flame Thrower, A 3-Element 40-Meter Beam," *CQ*, December 1987, page 36.
2. "RS 222c, Structural Standards for Steel Antenna Towers and Antenna Supporting Structures," Electronic Industries Association, March 1976.
3. C.J. Richards, et al., "Mechanical Engineering in Radar and Communications," D. Van Nostrand Reinhold Company, 1969, page 150.
4. Alcoa Handbook of Design Stresses for Aluminum, Aluminum Company of America, 1966, page 92.

Article E **HAM RADIO**

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 p-l-e-n-t-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 Rafferty N6RJ

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

☐**CB-RJ** **(MS-DOS Computers)** **$59.95**

1989 AMATEUR CALLBOOKS

(Available late November 1988)

NORTH AMERICAN EDITION

Fully updated and edited to include all the latest FCC and foreign government callsigns 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

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 $28.95***

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

Please enclose $3.50 shipping & handling.

✓ 137

FORMATTED DISPLAY OF PACKETS
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 (which may be absent). When operating in KISS mode, the TNC sends a packet to the computer by starting with a byte that is **C0** in hex, followed by a byte that is usually zero. This is followed by all the bytes of a packet and finally ends with another byte of hex **C0**.

The TNC mmakes the following replacements to avoid problems with packets that themselves contain bytes of hex **C0**. A byte of hex **C0** found in a packet to be sent to the computer is replaced by 2 bytes, **DB DC**. A byte of hex **DB** found in a packet is replaced by **DB DD**. This solves the transparency problem. When the computer receives either of these byte pairs from the TNC, it must replace them with the corresponding single byte to get the actual packet content.

For example, if a packet actually contained the data bytes **DA DB DC DD** the computer would receive the following from the TNC: **DA DB DD DC DD**.

As I've already mentioned, a packet contains two major parts: 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:

Packet			
Header		Data	
Address bytes	Command Byte	PID	Data Bytes

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:

Address bytes			
tocall	fromcall	digicall	digicall

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 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.

Callsign field in address	
6-byte callsign shifted left one bit	SSID byte

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:

Bit Positions							
7	6	5	4	3	2	1	0
			SSID number				0

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 (01010111 in binary) becomes hex **AE** (10101110 in binary). The SSID number (3) in binary is 0011. Thus we have:

W	A	8	B	X	N	−3	Original callsign
AE	82	70	84	B0	9C	06	Encoded callsign

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:

Command Byte								
							0	Information frame
						0	1	Supervisory frame
						1	1	Unnumbered frame

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.

N(R)	Poll	N(S)	0	Information frame

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.

N(R)	P/F	0	0	0	1	Receive Ready (RR)
N(R)	P/F	0	1	0	1	Receive Not Ready (RNR)
N(R)	P/F	1	0	0	1	Reject (REJ)

The final command type (Unnumbered) has the most variations. The majority of them have to do with connecting and disconnecting. This group also 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.

0	0	0	P/F	0	0	1	1	Unnumbered Information
0	0	0	F	1	1	1	1	Disconnected Mode
0	0	1	P	1	1	1	1	Set Async Balanced Mode
0	1	0	P	0	0	1	1	Disconnect
0	1	1	F	0	0	1	1	Unnumbered Acknowledge
1	0	0	F	0	1	1	1	Frame Reject

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.

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 **F0** 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 **C0** = 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 **C0** 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 **C0** 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.

```
---------------------------------
WA8XXX<--K8XXX: UNNUMBERED FRAME
UNNUMBERED ACKNOWLEDGE F=0
---------------------------------
WA8XXX<--K8XXX: 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@02FB000003
```

FIGURE 1

```
10 REM DISPLAY PACKETS USING KISS --- IBM PC VERSION (600 BAUD)
20 CLOSE 2:COLOR 7,0,0: CLS
30 OPEN "COM2:600,N,8,1,CS,DS,CD" AS 2: H$="0123456789ABCDEF"
40 PRINT#2,"KISS ON"+CHR$(13)+"RESET"
50 GOSUB 500:IF A<>192 THEN 50
60 GOSUB 500: PRINT "--------------------------------------"
70 TXT$=""
80 GOSUB 450: PRINT "<--";: GOSUB 450
90 IF (A AND 1)=1 THEN 120
100 PRINT " VIA ";
110 GOSUB 450: IF (A AND 1)=0 THEN PRINT ",";: GOTO 110
120 PRINT ": ";
130 REM
140 GOSUB 500: REM GET COMMAND BYTE
150 IF A AND 1 THEN 270 ELSE REM ITS AN INFORMATION FRAME
160 P=(A AND 16)/16:PRINT "INFO FRAME  N(RCV)=";INT(A/32);" P=";P;
170 PRINT " N(SENT)=";(A AND 14)/2;
180 GOSUB 500: PID=A : PRINT " PID=";: GOSUB 560: PRINT ": ";
190 GOSUB 500: IF A=192 THEN PRINT: GOTO 50
200 IF PID=207 THEN TXT$=TXT$+A$
210 IF A<32 OR A>126 THEN 250
220 IF A>=65 AND A<=90 THEN PRINT A$;: GOTO 190
230 IF A>=97 AND A<=122 THEN PRINT A$;: GOTO 190
240 PRINT A$;: GOTO 190
250 COLOR 1: GOSUB 560: COLOR 7: GOTO 190
260 REM
270 IF A AND 2 THEN 350 ELSE REM ITS A SUPERVISORY FRAME
280 PRINT "SUPERVISORY FRAME  N(RCV)=";INT(A/32);"P/F=";P;
290 SS = (A AND 12)/4
300 IF SS=0 THEN PRINT " RECEIVE READY";
310 IF SS=2 THEN PRINT " RECEIVE NOT READY";
320 IF SS=3 THEN PRINT " REJECT";
330 GOTO 190
340 REM
350 PRINT "UNNUMBERED FRAME  ";: B=(A AND 12)/4 + (A AND 224)/8
360 IF B=7  THEN PRINT "CONNECT REQUEST P=";
370 IF B=8  THEN PRINT "DISCONNECT REQUEST P=";
380 IF B=3  THEN PRINT "DISCONNECTED MODE F=";
390 IF B=12 THEN PRINT "UNNUMBERED ACKNOWLEDGE F=";
400 IF B=17 THEN PRINT "FRAME REJECT F=";P;":";
410 IF B THEN PRINT P;: GOTO 190
420 PRINT "UNNUMBERED INFORMATION P/F=";P;: GOTO 180
430 PRINT "UNKNOWN TYPE ";: GOSUB 560: PRINT " P/F=";P;"";: GOTO 190
440 REM
450 FOR I=1 TO 6:  REM MAKE A CALLSIGN PRINTABLE
460 GOSUB 500: A=INT(A/2):IF A<>32 THEN PRINT CHR$(A);
470 NEXT I
480 GOSUB 500: B=(A AND 30)/2:IF B THEN PRINT -B;
490 RETURN
500 A$=INPUT$(1,2) :REM GET BYTE FROM TNC
510 IF A$=""THEN A$=CHR$(0)
520 A=ASC(A$):IF A<>219 THEN RETURN
530 A$=INPUT$(1,2)
540 IF ASC(A$)=220 THEN A$=CHR$(192): A=192: RETURN
550 A$=CHR$(219):A=219: RETURN
560 PRINT MID$(H$,INT(A/16)+1,1)+MID$(H$,(A AND 15)+1,1);:RETURN
```

IBM PC version.

FIGURE 2

```
10 REM DISPLAY PACKETS USING KISS --- C-64 VERSION (600 BAUD)
20 CLOSE 2:PRINT CHR$(147)+CHR$(5)+CHR$(14);: POKE 53280,
   0:POKE 53281,0
30 OPEN 2,2,3,CHR$(7):H$="0123456789ABCDEF":GET#2,A$
40 PRINT#2,"KISS ON"+CHR$(13)+"RESET"
50 GOSUB 500:IF A<>192 THEN 50
60 GOSUB 500: PRINT "--------------------------------------"
70 TXT$=""
80 GOSUB 450: PRINT "<--";: GOSUB 450
90 IF (A AND 1)=1 THEN 120
100 PRINT "VIA ";
110 GOSUB 450: IF (A AND 1)=0 THEN PRINT ",";: GOTO 110
120 PRINT ": ";
130 REM
140 GOSUB 500: REM GET COMMAND BYTE
150 IF A AND 1 THEN 270 ELSE REM ITS AN INFORMATION FRAME
160 P=(A AND 16)/16:PRINT "INFO FRAME  N(RCV)=";INT(A/32);" P=";P;
170 PRINT " N(SENT)=";(A AND 14)/2;
180 GOSUB 500: PID=A : PRINT " PID=";: GOSUB 560: PRINT ": ";
190 GOSUB 500: IF A=192 THEN PRINT: GOTO 50
200 IF PID=207 THEN TXT$=TXT$+A$
210 IF A<32 OR A>126 THEN 250
220 IF A>=65 AND A<=90 THEN PRINT CHR$(A OR 32);: GOTO 190
230 IF A>=97 AND A<=122 THEN PRINT CHR$(A AND 223);: GOTO 190
240 PRINT A$;: GOTO 190
250 PRINT CHR$(158);: GOSUB 560:PRINT CHR$(5);: GOTO 190
260 REM
270 IF A AND 2 THEN 350 ELSE REM ITS A SUPERVISORY FRAME
280 PRINT "SUPERVISORY FRAME  N(RCV)=";INT(A/32);"P/F=";P;
290 SS = (A AND 12)/4
300 IF SS=0 THEN PRINT " RECEIVE READY";
310 IF SS=2 THEN PRINT " RECEIVE NOT READY";
320 IF SS=3 THEN PRINT " REJECT";
330 GOTO 190
340 REM
350 PRINT "UNNUMBERED FRAME  ";: B=(A AND 12)/4 + (A AND 224)/8
360 IF B=7  THEN PRINT "CONNECT REQUEST P=";
370 IF B=8  THEN PRINT "DISCONNECT REQUEST P=";
380 IF B=3  THEN PRINT "DISCONNECTED MODE F=";
390 IF B=12 THEN PRINT "UNNUMBERED ACKNOWLEDGE F=";
400 IF B=17 THEN PRINT "FRAME REJECT F=";P;":";
410 IF B THEN PRINT P;: GOTO 190
420 PRINT "UNNUMBERED INFORMATION P/F=";P;: GOTO 180
430 PRINT "UNKNOWN TYPE ";: GOSUB 560: PRINT " P/F=";P;"";: GOTO 190
440 REM
450 FOR I=1 TO 6:  REM MAKE A CALLSIGN PRINTABLE
460 GOSUB 500: A=INT(A/2):IF A<>32 THEN PRINT CHR$(A);
470 NEXT I
480 GOSUB 500: B=(A AND 30)/2:IF B THEN PRINT -B;
490 RETURN
500 IF PEEK(667)=PEEK(668) THEN 500 :REM GET BYTE FROM TNC
510 GET#2,A$:IF A$=""THEN A$=CHR$(0)
520 A=ASC(A$):IF A<>219 THEN RETURN
530 IF PEEK(667)=PEEK(668) THEN 530
540 GET# 2,A$:IF ASC(A$)=220 THEN A$=CHR$(192): A=192: RETURN
550 A$=CHR$(219):A=219: RETURN
560 PRINT MID$(H$,INT(A/16)+1,1)+MID$(H$,(A AND 15)+1,1);:RETURN
```

C-64 version.

```
--------------------------------
KX8XX<--W8XXX: SUPERVISORY FRAME   N(RCV)=
2  P/F=0  RECEIVE READY
--------------------------------
ID<--WB8XXX: UNNUMBERED FRAME
UNNUMBERED INFORMATION P/F=0  PID=
F0: Network node (CLE)0D
--------------------------------
KA8XXX-1 <--WB8XXX: SUPERVISORY
FRAME  N(RCV)=1  P/F=0  RECEIVE READY
--------------------------------
BEACON<--KX3X VIA K3XXX: UNNUMBERED FRAME
UNNUMBERED INFORMATION P/F=0  PID=F0:
Mail for: NWPAWX ALL DX KX3X NETROM N3XXX
VE3XXX0D
--------------------------------
WA8XXX<--K8XXX: INFO FRAME  N(RCV)=1  P=
0  N(SENT)=1  PID=F0: ok0D
--------------------------------
WA8XXX<--K8XXX: UNNUMBERED FRAME
DISCONNECT REQUEST P=0
--------------------------------
NX8X<K8XXX: UNNUMBERED FRAME  CONNECT
REQUEST P=0
--------------------------------
WA8XXX<--K8XXX: INFO FRAME  N(RCV)=3
P=0  N(SENT)=0  PID=F0: ka=po of!0D
--------------------------------
WA8XXX<--K8XXX: SUPERVISORY FRAME
N(RCV)=4  P/F=0  RECEIVE READY
--------------------------------
WA8XXX<--K8XXX: UNNUMBERED FRAME
DISCONNECT REQUEST P=0
```

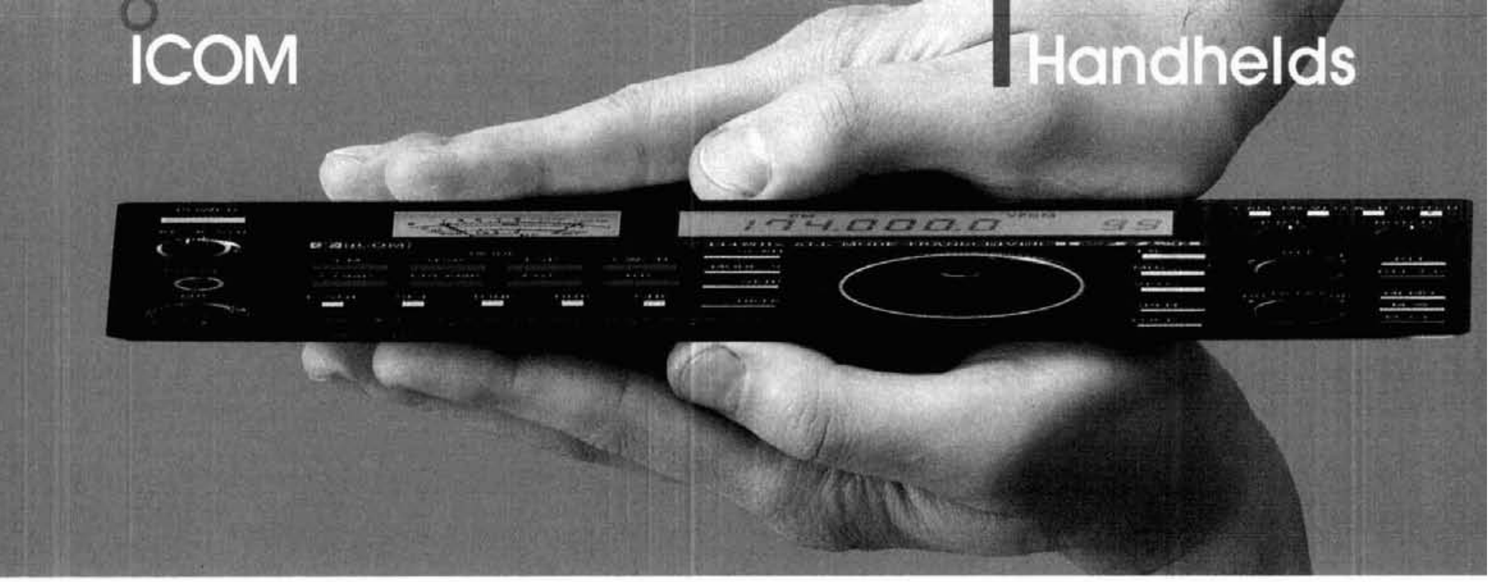
Most of this information can be displayed using the monitor commands found in most current TNCs, without your having to do any programming. The point of this program isn't so much to provide a way to display such information, but rather to show how it can be done — and relate what's in a packet to what's 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 the packet (the one that was heard when digipeater calls are present in the header). Here's a chance to experiment, to build something new, without any additional expense other than time.

An unreduced copy of the program is available for an SASE. Ed.

Article F **HAM RADIO**

ICOM **Handhelds**



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/440-450MHz

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.

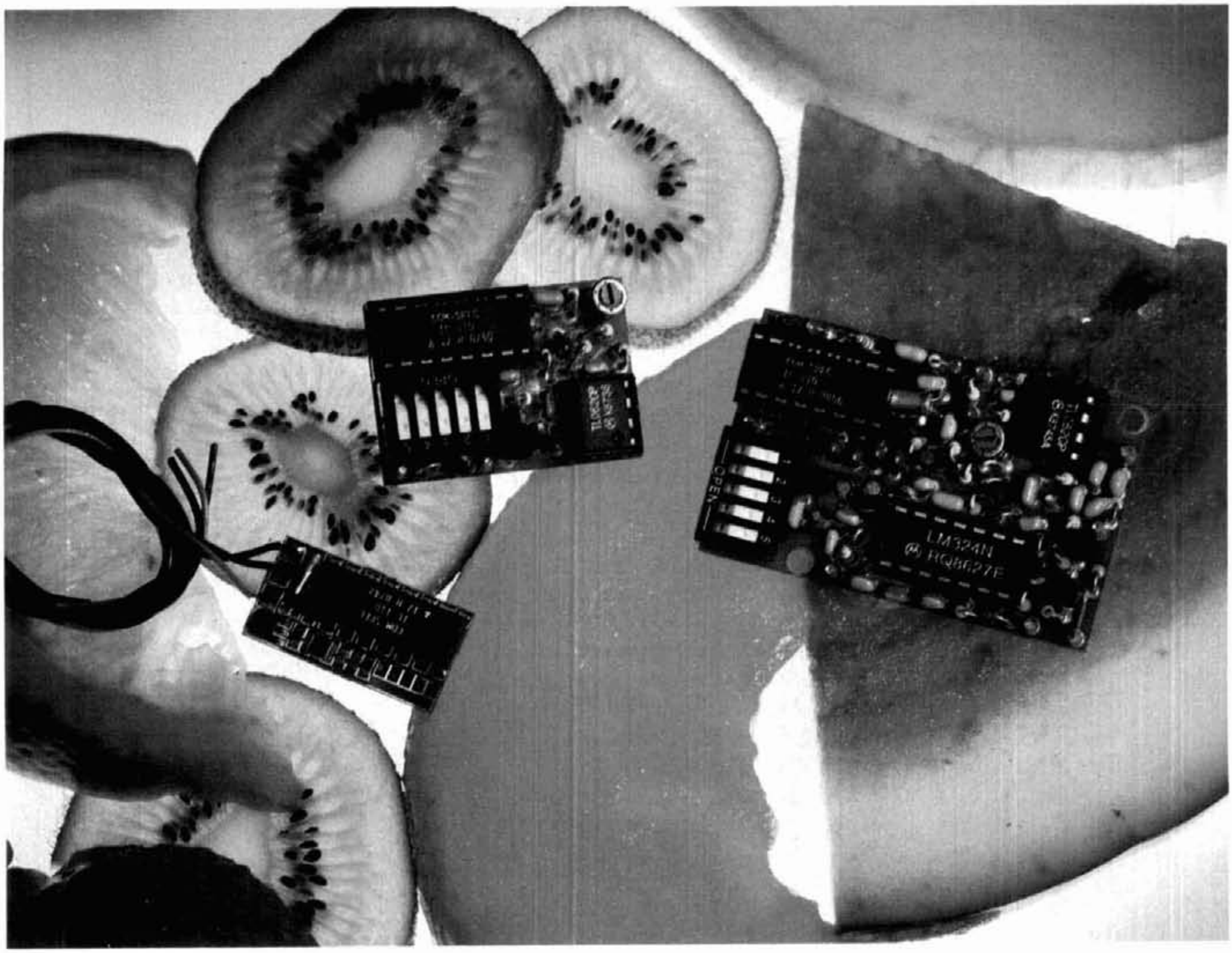
IC-32AT 2 Meters and 440MHz | **IC-2GAT** 2 Meters | **IC-4GAT** 440MHz

ICOM

First in Communications

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

All stated specifications are subject to change without notice or obligation. All ICOM radios significantly exceed FCC regulations limiting spurious emissions. HH488.



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 HHP-1 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.

HHP-1 HANDHELD PROGRAMMER For programming the 32 memory locations in any of our new programmable products, including our SD-1000 Two-Tone Sequential decoder. The HHP-1 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.

MasterCard VISA

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**

✓ 139

product REVIEW

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 Argosy, 50-watt PEP). 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 F5GT, 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 tweak 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, motor-home, 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 PC Packet Adapter and controller software can be turned on and then run in a background mode, freeing you to do whatever else 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 8530 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

(continued on page 70)

DECODING DATA SIGNALS

By James A. Sanford, WB4GCS, 20 Glen Forest Drive, Hampton, Virginia 23669

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.

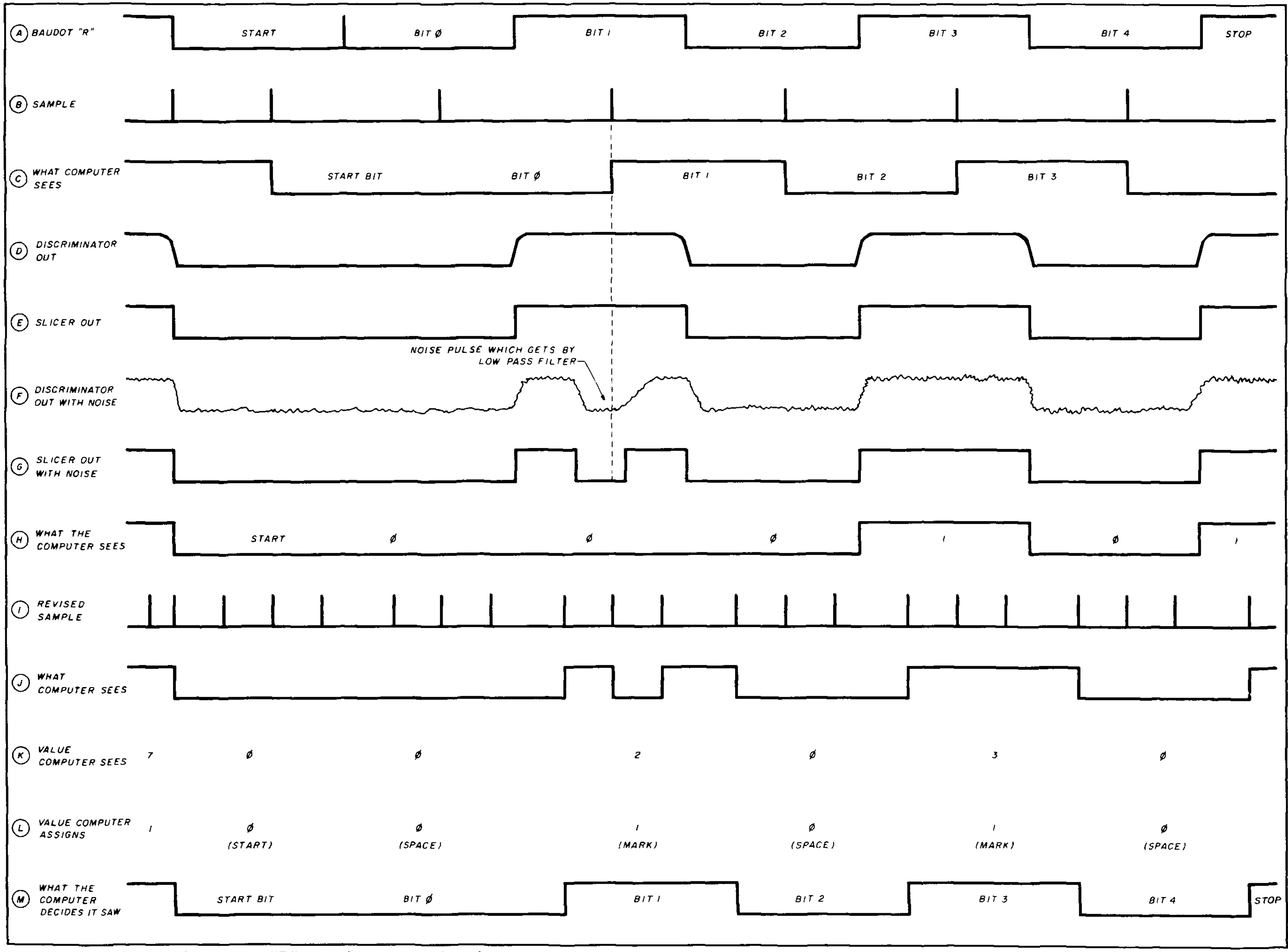
Figure 3 shows an improved demodulator. It uses separate filters to select the distinct mark and space frequencies, reducing the vulnerability to spurious signals and improving the signal to noise ratio. Other hardware improvements are possible but difficult, so I turned to improving the computer.

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.

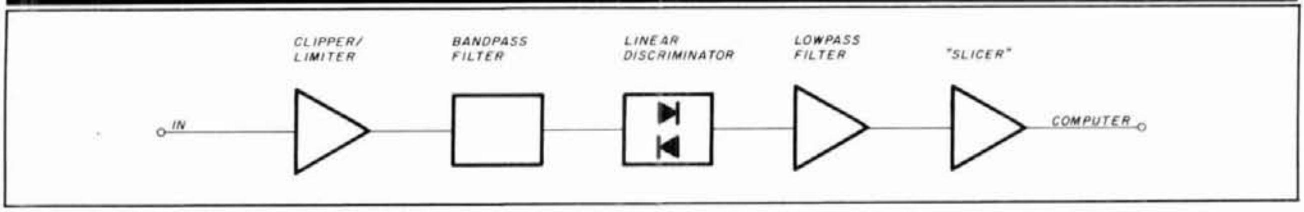
In a noise-free system, the pulses emerging from the demodulator are identical to the original. In a noisy environment, the demodulator's discriminator contains noise which can corrupt the slicer's output (even though it's low-pass filtered). Line G of **fig. 1** shows the slicer output, and line H shows 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.

FIGURE 1



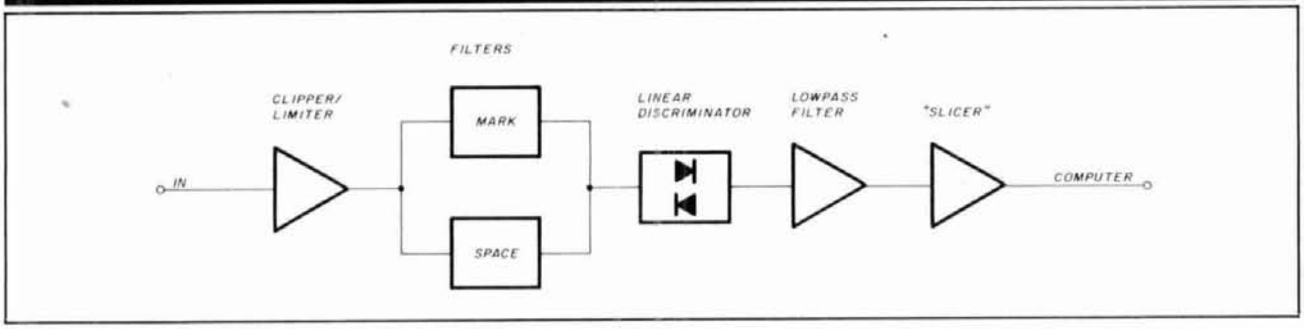
Waveform renditions of the letter "R" at various system locations.

FIGURE 2



Typical RTTY demodulator.

FIGURE 3



Improved RTTY demodulator.


HAM RADIO OUTLET
LARGEST HAM OUTLET IN THE WORLD
CALL FOR HOLIDAY SPECIALS
7 STORE BUYING POWER
ICOM IC-761
HF SUPERIOR GRADE TRANSCEIVER
SALE! CALL FOR PRICE
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 25/45W, 440 MHz 10 MTR, 6 MTR, 220 MHz & 1.2 GHz 10 MEMORIES
ARE YOU READY FOR 1.2 GHz OPERATION?
ICOM
A Models 25W, H Models 100 W
IC-275A/275H, 138-174 MHz
IC-375A, 220 MHz SALE 799.95
IC-475A/475H, 430-450 MHz
LOW PRICE!
NOW! RAPID DELIVERIES
COAST TO COAST
FROM STORE NEAREST YOU
ICOM HAND-HELD VHF/UHF
IC-03AT REG. 449.95 SALE 269.95
IC-02AT IC-2AT 2MTR
IC-03AT IC-3AT 220 MHz
IC-04AT IC-4AT 440 MHz
ICOM IC-735
100 W, 100 KHz-30 MHz Dual VFO Receiver
CALL FOR LOW, LOW PRICE
ICOM IC-R7000
25 MHz-1300 MHz SCANNING RECEIVER
GREAT PRICE!
ICOM IC-38A/TT* 220 MHz
(Recent FCC changes DID NOT effect normal 220 MHz FM operating frequencies)
*Includes touchtone mike.
REG. 489.95 SALE 329.95
All Major Brands in Stock Now!
Bob Ferrero W6RJ
President
Jim Rafferty N6RJ
VP So. Calif Div.
Anaheim Mgr.
ANAHEIM, CA 92801
2620 W. La Palma
(714) 761-3033, (213) 860-2040
Between Disneyland & Knotts Berry Farm
ATLANTA, GA 30340
6071 Buford Hwy.
(404) 263-0700
Larry, Mgr. WD4AGW
Doraville, 1 mi. north of I-285
BURLINGAME, CA 94010
999 Howard Ave.
(415) 342-5757
George, Mgr. WB6DSV
5 miles south on 101 from SFO
OAKLAND, CA 94606
2210 Livingston St.
(415) 534-5757
Al, Mgr. WA6SYK
17N-5th Ave /17S-16th Ave
PHOENIX, AZ 85015
1702 W. Camelback Rd.
(602) 242-3515
Bob, Mgr. K7RDH
East of Hwy. 17
SAN DIEGO, CA 92123
5375 Kearny Villa Rd.
(619) 560-4900
Tom, Mgr. KM6K
Hwy. 163 & Claremont Mesa Blvd.
VAN NUYS, CA 91411
6265 Sepulveda Blvd.
(818) 988-2212
Al, Mgr. K6YRA
San Diego Fwy at Victory Blvd.
STORE HOURS
10 AM-5:30 PM
CLOSED SUNDAYS
FREE SHIPMENT
Most items UPS surface
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 p.m. Pacific Time. California, Arizona and Georgia customers call or visit nearest store.
California, Arizona and Georgia residents please add sales tax. Prices, specifications, descriptions subject to change without notice.
MasterCard
VISA

AMERITRON

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 tne 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 85 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 manufacturers 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 w typical, 100 w max. 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 13¼"W. x 16"D. Wgt. 14 lbs.

Remote COAX Switches

RCS-4 FOR CONVENIENT INSTALLATION

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.

RCS-8V FOR SPECIAL APPLICATIONS

Selects up to five antennas.
Loss at 150 MHz: less than .1 dB.
VSWR: under 1.2 to 1 DC to 250 MHz.
Impedance: 50 ohms.
Power capability: 5 kW below 30 MHz, 1 kW at 150 MHz.

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

AMERITRON

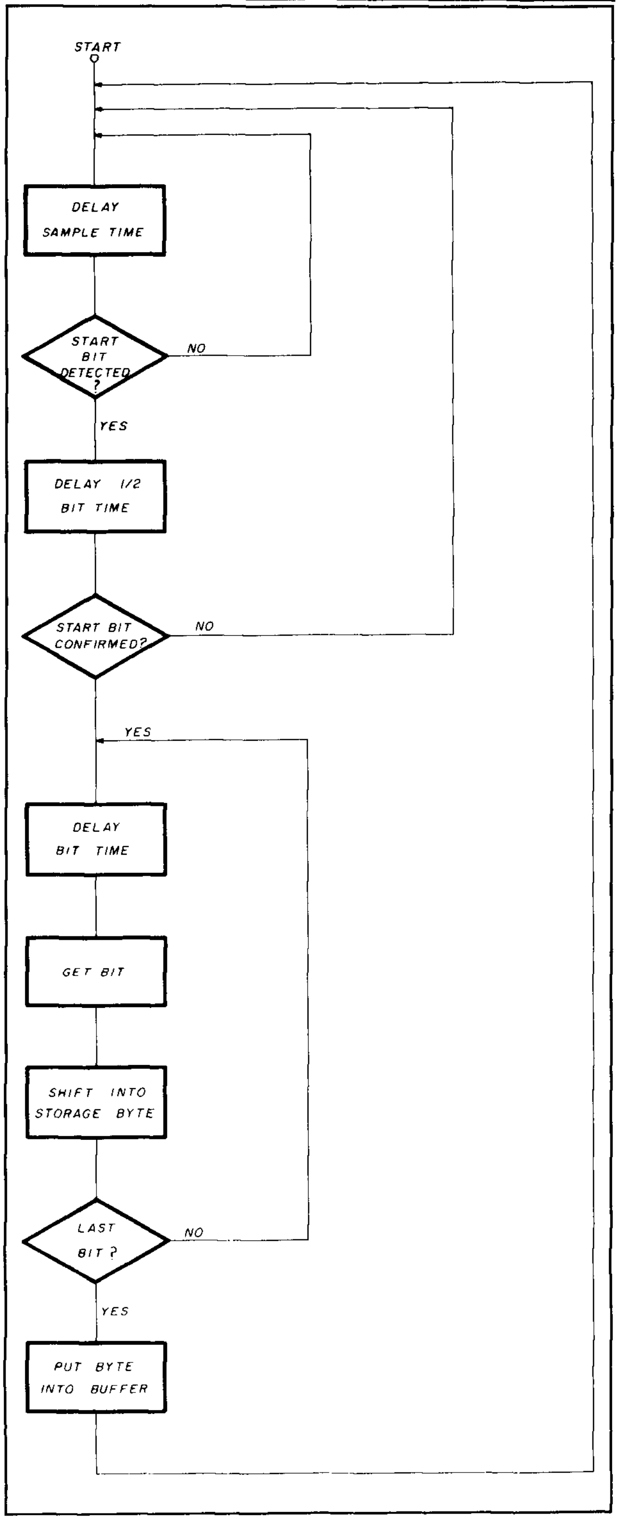
9805 Walford Avenue • Cleveland, Ohio 44102

For more information: (601) 323-9715 • **Technical inquiries:** (216) 651-1740

✓ 142

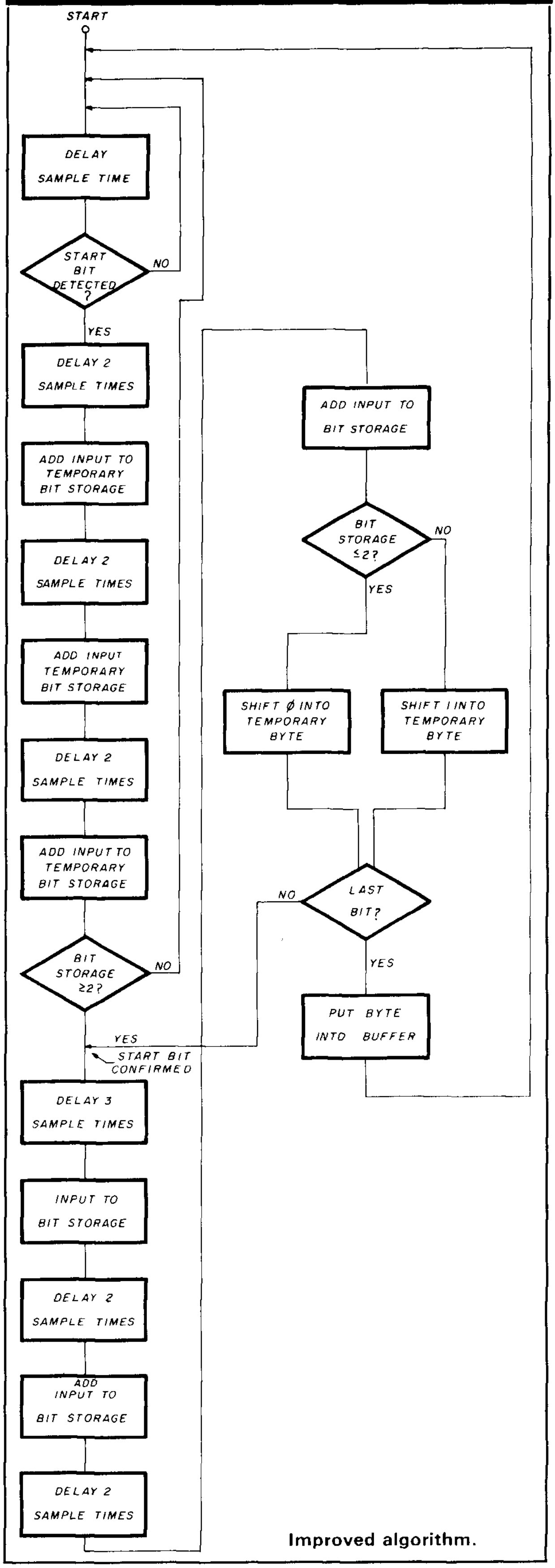
Figure 5 shows a flow chart for an improved algorithm. Initially, the computer takes seven samples per bit time, looking for a start pulse. When it detects a possible start bit, the computer waits two sample periods and takes another sample. (The delay prevents

FIGURE 4



Serial to parallel decoding algorithm.

FIGURE 5



Improved algorithm.

U.S. Postal Service

STATEMENT OF OWNERSHIP, MANAGEMENT AND CIRCULATION

Required by 39 U.S.C. 3685

1A. TITLE OF PUBLICATION: Ham Radio Magazine

1B. PUBLICATION NO.: 0 1 4 8 5 9 8 9

2. DATE OF FILING: 9/26/88

3. FREQUENCY OF ISSUE: Monthly

3A. NO. OF ISSUES PUBLISHED ANNUALLY

3B. ANNUAL SUBSCRIPTION PRICE

4. COMPLETE MAILING ADDRESS OF KNOWN OFFICE OF PUBLICATION: Main St., Greenville, New Hampshire 03048

5. COMPLETE MAILING ADDRESS OF THE HEADQUARTERS OF GENERAL BUSINESS OFFICES OF THE PUBLISHER: Main St., Greenville, New Hampshire 03048

6. FULL NAMES AND COMPLETE MAILING ADDRESS OF PUBLISHER, EDITOR, AND MANAGING EDITOR

PUBLISHER (Name and Complete Mailing Address): T.H. Tenney, Jr., Main St., Greenville, New Hampshire 03048

EDITOR (Name and Complete Mailing Address): T.H. Tenney, Jr., Main St., Greenville, New Hampshire 03048

MANAGING EDITOR (Name and Complete Mailing Address): Terry Northup, Main St., Greenville, New Hampshire 03048

7. OWNER

FULL NAME	COMPLETE MAILING ADDRESS
T.H. Tenney, Jr.	Main St., Greenville, NH 03048

8. KNOWN BONDHOLDERS, MORTGAGEES, AND OTHER SECURITY HOLDERS OWNING OR HOLDING 1 PERCENT OR MORE OF TOTAL AMOUNT OF BONDS, MORTGAGES OR OTHER SECURITIES

FULL NAME	COMPLETE MAILING ADDRESS
T.H. Tenney, Jr.	Main St., Greenville, NH 03048

9. FOR COMPLETION BY NONPROFIT ORGANIZATIONS AUTHORIZED TO MAIL AT SPECIAL RATES

(1) ☒ HAS NOT CHANGED DURING PRECEDING 12 MONTHS (2) ☐ HAS CHANGED DURING PRECEDING 12 MONTHS

10. EXTENT AND NATURE OF CIRCULATION	AVERAGE NO. COPIES EACH ISSUE DURING PRECEDING 12 MONTHS	ACTUAL NO. COPIES OF SINGLE ISSUE PUBLISHED NEAREST TO FILING DATE
A. TOTAL NO. COPIES (Net Press Run)	32,300	34,500
B. PAID CIRCULATION 1. Sales through dealers and carriers, street vendors and counter sales	2,693	2,804
2. Mail Subscription	28,204	30,339
C. TOTAL PAID CIRCULATION	30,897	33,143
D. FREE DISTRIBUTION BY MAIL, CARRIER OR OTHER MEANS SAMPLES, COMPLIMENTARY, AND OTHER FREE COPIES	200	250
E. TOTAL DISTRIBUTION	31,097	33,393
F. COPIES NOT DISTRIBUTED 1. Office use, left over, unaccounted, spoiled after printing	910	1,000
2. Return from News Agents	293	107
G. TOTAL	32,300	34,500

11. I certify that the statements made by me above are correct and complete

SIGNATURE AND TITLE OF EDITOR, PUBLISHER, BUSINESS MANAGER, OR OWNER

PS Form 3526

FIGURE 6

```
*****************************************
*SMART DEMODULATION ALGORITHM           *
*THIS INTERRUPT ROUTINE IS DESIGNED     *
* TO BE CALLED 21 TIMES PER BIT TIME    *
* IT ASSEMBLES THE RECEIVED CHARACTER   *
* AND STORES IT IN A BUFFER.  BETWEEN   *
*INTERRRUPTS, THE MAIN PROGRAM CAN GET  *
*THE CHARACTER AND DISPLAY IT.  NOTE    *
* THAT A BAUDOT CHARACTER WILL BE       *
*AS SENT, AND LEFT JUSTIFIED.  THE MAN  *
*PROGRAM MUST SHIFT THE CHARACTER INTO  *
*THE LSB'S AND TRANSLATE TO ASCII FOR   *
*STORAGE.  (USE A TRANSLATION TABLE.)   *
*COPYRIGHT 1987 BY JAMES A. SANFORD     *
*    WB4GCS/NNN0HDF                     *
*****************************************

*WRITTEN IN 6809 ASSEMBLY LANGUAGE      *
*INCOMING DATA RECEIVED AT $FF22, BIT 0*

SZIN    EQU    $100
SZOUT   EQU    $100
BITS    RMB    1       BITS/WORD INCLUDING START&STOP
RXCTR   RMB    1       BITS RCVD
RBTSTR  RMB    1       STORAGE FOR ACCUMULATED BITS
RHITS   RMB    1       STORAGE FOR NUMBER OF SAMPLES
TXCKS   RMB    1       TIMES PULSE CHECKED
RXCKS   RMB    1       TIMES PULSE CHECKED
XTMP    RMB    1       TEMP STORAGE FOR TX CHAR
RTMP    RMB    1       TEMP STORAGE FOR RX CHAR

ONXTI   RMB    2       PTR FOR NEXT CHAR INTO OUT BUFFER
ONXTO   RMB    2       PTR FOR NEXT CHAR FROM BUFFER TO SEND
INXTI   RMB    2       PTR FOR NEXT RCVD CHAR TO BE STORED
INXTO   RMB    2       PTR FOR NEXT RCVD CHAR TO BE SHOWN


        TITLE  INTERRUPT HANDLER
FIRQ    PSHS   B
RFIRQ   LDB    RXCTR   SEE IF RECEIVING ALREADY
        BEQ    RFNDST   NO, GO LOOK FOR START BIT
        DEC    RXCKS    YES
        BEQ    RUPDT
        LBRA   RIDON

RFNDST
        TST    RXCKS   IF 0, LOOKING FOR FIRST HINT OF START BIT
        BEQ    FSTRT1
        DEC    RXCKS   ALREADY INTO IT; CHECK DELAY
        LBNE   RIDON   STILL WAITING
        LDB    $FF22   GET IT
        RORB
        BCS    RSTRT2
        INC    RBTSTR  UPDATE COUNTER
RSTRT2  INC    RHITS   UPDATE NUMBER OF SAMPLES
        LDB    RHITS
        CMPB   #6
        BEQ    RSTRT3
        LDB    #2      NOT DONE, DELAY
        STB    RXCKS
        LBRA   RIDON

RSTRT3  LDB    RBTSTR
        CMPB   #4
        BLO    NOSTRT  NOT GOOD ENOUGH, START OVER
        LDB    #11     DELAY INTO NEXT FRAME
        STB    RXCKS
        LDB    BITS    SETUP TO GET DATA
        SUBB   #2      ADJUST, ALREADY HAVE START BIT
        STB    RXCTR
RSTRT4  CLR    RHITS
        CLR    RBTSTR
        LBRA   RIDON
NOSTRT  CLR    RXCKS
        BRA    RSTRT4

FSTRT1  LDB    $FF22
        RORB
        BCS    RIDON   NO START BIT,EXIT
        LDB    #5       START BIT, DELAY
        STB    RXCKS
        BRA    RIDON

RUPDT   LDB    $FF22   GET DATA BIT
        RORB           SHIFT INTO CARRY
        BCC    RUPD1   DATA BITS A 0
        INC    RBTSTR  DATA BITS A 1, COUNT IT

RUPD1   LDB    #2
```

Assembly language decoding algorithm for the 6809 microprocessor.

```
                STB     RXCKS   WAIT 2 SAMPLE TIMES, START AGAIN
                INC     RHITS
                LDB     RHITS
                CMPB    #6      6 SAMPLES YET?
                BNE     RIDON   NO, DONE FOR NOW
                LDB     RBTSTR  WE HAVE 6 SAMPLES, HOW MANY WERE 1?
        RUPD2   CMPB    #4      IF ( 4,  THE CMP WILL CAUSE A
        *                       BORROW, AND SET THE C BIT IN THE
        *                       CONDITION CODE REGISTER.  WE'LL CALL
        *                       THIS BIT A ZERO.
                EXG     B,CC    IF ) 4 ONES, C WILL BE CLEAR, AND
        *                       WE'LL CALL THE BIT A 1
                EORB    #1      THE C BIT IS THE COMPLEMENT OF THE
        *                       REAL DATA, SO TOGGLE THAT BIT
                EXG     B,CC    NOW RESTORE REGISTERS
                LDB     RTMP    GET THE BITS WE'VE ALREADY GOT
                RORB            ROTATE NEW DATA BIT INTO TEMP
                STB     RTMP     STORAGE
                LDB     #11     SETUP TODELAY 3 SAMPLES FOR NEXT BIT
                STB     RXCKS
                CLR     RHITS
                CLR     RBTSTR  INITIALIZE COUNTERS
                DEC     RXCTR
                BNE     RIDON   WE'RE DONE.
        RSTOR   PSHS    X
                LDX     INXTI   GET PTR
                LDB     RTMP
                CMPB    #$FF    CK FOR ERRONEOUS END OF DATA FLAG
                BNE     RSTOR1    WHICH MAY HAVE BEEN CAUSED BY NOISE
                LDB     #$FE    IF SO, CHANGE TO $FE, WHICH WON'T AFFECT
        *                         BAUDOT, AND WILL HAVE MINIMAL EFFECT
        *                         ON ASCII TEXT. (NEVER INTENDED TO XFER
        *                         BINARY FILES IN ASCII)
        RSTOR1  STB     ,X+     TOBUFFER
                CMPX    #INBUF+SZIN
                BNE     RBFUP
                LDX     #INBUF

        RBFUP   STX     INXTI   UPDATE BUF PTR
                CMPX    INXTO   THIS EXTRA ATTENTION TO BUFFER
                BNE     RBFUP1    MANAGEMENT IS NECESSARY TO
                LEAX    1,X       PREVENT NOISE INDUCED ERRATIC
                CMPX    #INBUF+SZIN
                BLO     RBFUP2    BEHAVIOR DURING DISK OPERATIONS
                LDX     #INBUF    OR BUFFER TRANSMISSION.
        RBFUP2  STX     INXTO
        RBFUP1  PULS    X

        RIDON   PULS    B
                RTI
```

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.

Article G **HAM RADIO**

product REVIEW

(continued from page 59)

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 packeteers 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 accessable 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 $79.95.

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 simultaneouos user connections on the same frequency. It does this without using any extra software, like Desqview 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.

N1ACH

NEW products

New Kantronics publications released

Kantronics, Inc./Kantronics Press has published several digital communication books and other books related to Amateur Radio. The latest title releases include: *RS-232 and Packet, Advanced Packet Operation, Packet Commands, The Packet Glossary of Terms, Quick Start Packet, Communications Tables, The Hamfest Book*, and *The Ham Club Book*.

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 × 25 × 15.1 inches, fits inside Rohn 45 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 $3,975.

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

Circle #303 on Reader Service Card.

New guide to technical specs available from Nemal

Nemal Electronics International has published a revised edition of its Cable and Connector Selection Guide. The new 40-page guide offers detailed technical specifications on more than 1000 military and commercial products. Product listings include triaxial cable and connectors, RF coaxial and semi-rigid cable and connectors, and crimping tools. To obtain a copy, please contact Nemal Electronics International, Inc., 12240 N.E. 14th Avenue, North Miami, Florida 33161 or call 800-522-2253 or FAX your request to 1-305-895-8178.

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.

1989 catalog of high-tech products

Radio Shack®, a division of Tandy Corporation has a new consumer products catalog featuring its 1989 product Included are: cellular telephones, video tape recorders, televisions, computers, software and peripherals, office equipment and more.

The computer products shown in the consumer catalog also appear in three other computer-specific catalogs. These catalogs include Tandy's entire line of software, peripherals and personal computers, including the industry's first IBM® Micro Channel™-compatible business computer and the $699 Tandy® 1000 HX computer.

Radio Shack catalogs are available, free of charge from your local Radio Shack outlet or by writing Radio Shack Circulation Department, 300 One Tandy Center, Fort Worth, Texas 76102.

Circle #305 on Reader Service Card.

Versatile CTCSS encoder-decoder

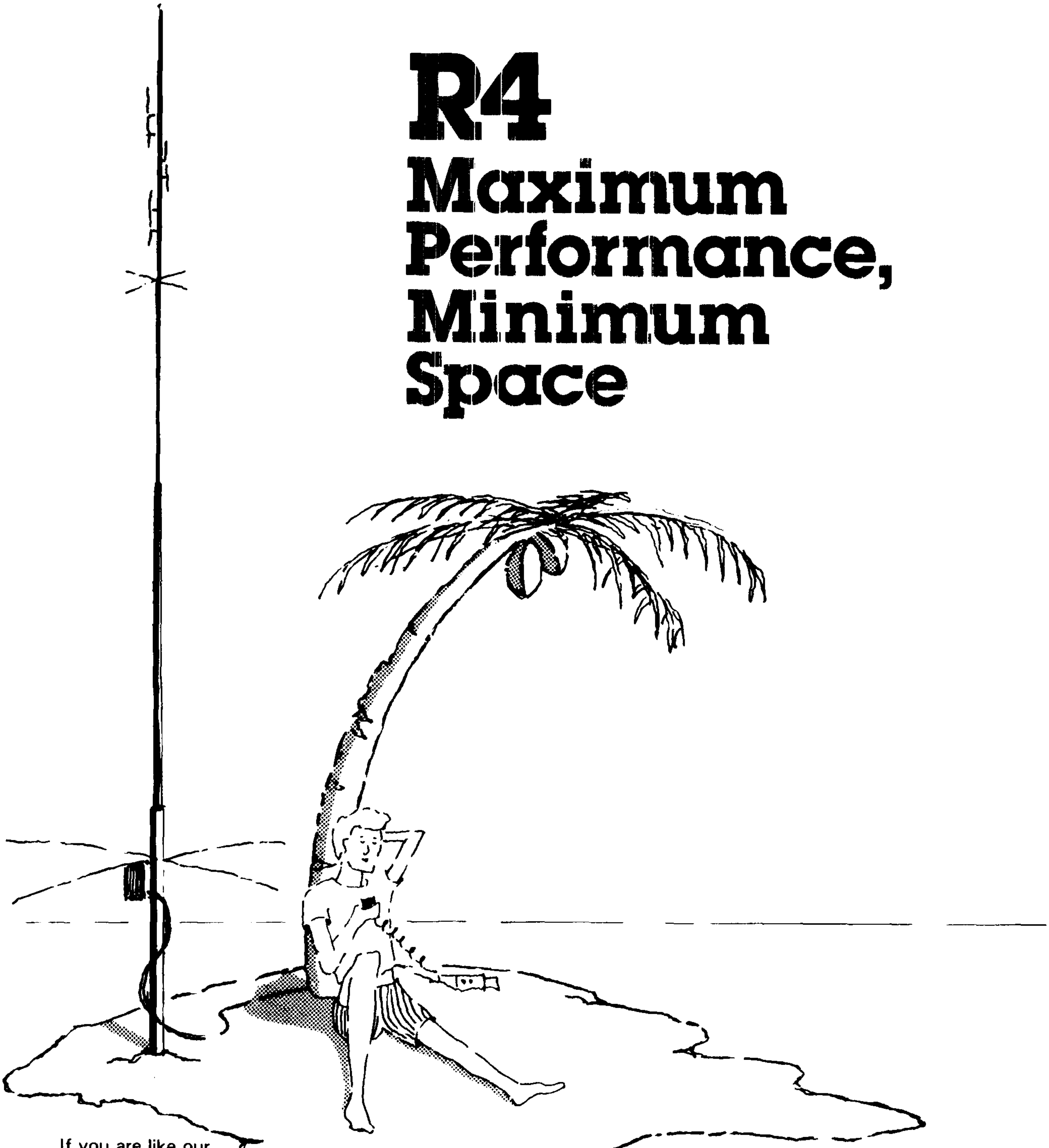
Communications Specialists introduces the TS-32P Programmable CTCSS Encoder-Decoder. It has all the features of the TS-32, but uses a new microcircuit for more tone versatility. The new IC-110 microcircuit in the TS-32P contains a 32-bit reprogrammable memory that allows specification of any 32-tone 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 ± .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 × 2.0″ long × 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.

(continued on page 104)

R4
Maximum Performance, Minimum Space



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.

✓ 144

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

cushcraft CORPORATION

Available through dealers worldwide

48 Perimeter Road, Manchester, NH 03108 USA
603-627-7877 Telex 4949472
Fax 603-627-1764

rf enterprises

rfe

• We Specialize In Antennas & Towers. • We Ship Worldwide.

ANTENNAS

KLM

World Class Antennas for the Serious Amateur!

KT34A .... $395.00 KT34XA $585.00

Monobanders: 80-10 Meters!
High Performance VHF & UHF antennas.

hy-gain

Tribanders

TH7DXS TH5Mk2S
Explorer-14 TH3JrS

Monobanders

204 BAS	203 BAS	205 BAS
155 BAS	153 BAS	105 BAS
103 BAS	66 BAS	

VHF, OSCAR & VERTICAL ANTENNAS!
NEW! High Performance 144 & 432 MHz Antennas. Call For Prices!

cushcraft

WINTER SPECIAL! The "A3S."

The Popular A3 with Stainless Steel Hardware at a Special RFE Price.

A4S ...
A744 Add on Kit ...
A3SK & A4SK Stainless Kits ...
AV3 & AV5 Verticals ...
AP8 & APR 18 ...
40-2CD 2-el. 40 Mtr. Beam ...

Monobanders For 10, 15, & 20 In Stock!

617-6B 6 Mtr BOOMER ...
A50-5, A50-6 ...
A147-11, A147-20T ...
215WB & 230WB 15 & 30 el 2 Mtr ...
AOP-1 Satellite System ...
4218XL & 3219 for 144-146 MHz ...
220B, 424B BOOMERS ...
CALL

Large Inventory Of Other Antennas & Accessories

BUTTERNUT

HF6V ... HF2V ...
RMK II Kit ... STR II Kit ...
TBR-160S Coil ... CALL SC-3000 Antenna ... CALL
HF5B ... CALL

ALPHA DELTA

DX-A .... $46.95 DX-DD .. 64.95 DX-KT 27.50

NEW! DX-CC All band dipole $79.95
Full line Alpha Delta switches & Transi-traps!

HUSTLER

6BTV .... $134.95 5BTV $124.95
G6-144B .... 86.95 G7-144 .... 114.95
G7-220 .... 114.95

Complete HF Mobile Systems. CALL!

MOSLEY

TA-33 CLASSIC 33
TA-34 PRO-67

TONNA

ANTENNA SPECIALISTS

ROTORS

TELEX
HDR-300 ...... CALL
T2X ...... CALL
HAM IV ...... CALL
CD 45 II ...... CALL
AR-40 ...... CALL

ALLIANCE
HD-73 ...... CALL

YAESU
G400/400RC .... CALL
G600RC .... CALL
KR2000RC .... CALL
G5400B .... CALL

DAIWA
MR 750 PE .... CALL

TEN-TEC

MODEL 561 CORSAIR II

OTHER TEN-TEC PRODUCTS:
Model 585 Paragon
Model 425 Titan Linear Amplifier
Model 229A 2KW Antenna Tuner
Model 2510 Satellite Station

Full line of filters, power supplies, mobile antennas, and accessories in stock.

ASTRON POWER SUPPLIES

Rack mount and speaker models in stock!

RS-4A ... $37.95	RS-7A 49.95	RS-12A ... 69.95
RS-20A ... 88.95	RS-35A .. 135.95	RS-50A .. 193.95
RS-20M .. 106.95	RS-35M .. 153.95	RS-50M .. 216.95
VS-20M .. 124.95	VS-35M .. 171.95	VS-50M .. 232.95

YAESU

FT-757 GXII All Mode Transceiver

AMPLIFIERS & TUNERS

MIRAGE
AMERITRON
MFJ

RFC 2-317

rfconcepts
AMP SUPPLY
TEN-TEC

NYE-VIKING
MB-V-A

MAGNUS SOLID STATE HF LINEAR AMPS

MFJ

CLOCKS KEYERS ACCESSORIES TUNERS

SPECIAL!
989B Tuner $275.00

SSB ELECTRONIC & MICROWAVE MODULES TRANSVERTERS, PREAMPS, & ACCESSORIES. CALL!

TOWERS

HY-GAIN

Crank-up, self-supporting, galvanized steel towers. SS rated at 9 ft; HD at 16 ft.

HG-37SS HG-54HD CALL FOR PRICES HG-52SS HG-70HD

ROHN

Self-supporting: Ratings: HDBX at 18 ft, HBX at 10 ft, BX at 6 ft.

HBX 40 .... HBX 48 .... HBX 56 .... CALL
HDBX 40 .... HDBX 48 .... BX 64 .... CALL

Galvanized steel with base and rotor plate. Today's best buy. Freight additional **but** you save with our volume shipper's discount!

GUYED TOWER SECTIONS:

25G, 45G, 55G Sections and All Accessories in Stock. Call for Current Prices.

FOLD-OVER TOWERS:

FK2548 .... FK2558 .... FK2568 .... CALL
FK4544 .... FK4554 .... FK4564 .... CALL

Prices 10% higher in western states.

ROOF TOWERS & CLIMBING BELTS ..... Call!

TOWER HARDWARE

Guywire: 3/16EHS / ¼ EHS, per ft. $0.15/0.18
CCM Cable Clamps: 3/16 / ¼ 0.39/0.49
Turnbuckles: 3/8" E & E/E & J 6.95/7.95
½" E & E/E & J 12.95/13.95
Thimbles: ¼" (3/16 & ¼" cable) 0.39
Earth Anchor: 4 ft. Screw-in 13.95
Preformed "Big Grips": 3/16 & ¼ 2.49/2.99
Guy Insulators: 500 D/502 .... 1.69/2.99

PHILLYSTRAN GUY SYSTEMS

HPTG-2100/-4000/-6700 Cable 0.30/.50/.70
Cable Ends: 9901LD/9902LD 8.95/10.95
Socketfast Potting Cmpd 15.95

WIRE & CABLE

BELDEN COAX

9913 low loss . $0.45/ft	RG-8X(9258) 0.20
RG-213/U(8267) ... 0.46	RG-11A/U(8261) .. 0.41
RG-8/U(8237) 0.36	RG-58A/U(8259) .. 0.15
RG-8/U(8214) 0.40	RG-59/U(8241) 0.16

RG-214/U(8268) $2.25/ft.
450 Ohm Ladder Line 0.10

COPPERWELD ANTENNA WIRE
Solid: 12 ga. .... 0.10 14 ga. 0.08
Stranded 14 ga. 0.10

Plus Wide Selection Baluns, Insulators, Accessories

ROTOR CABLE
Std (6-22, 2-18) .... 0.19 Hvy (6-18, 2-16) ... 0.36
Others in stock.

AMPHENOL CONNECTORS
PL-259: std/silver/teflon 0.89/1.25/1.45
UG-21B (8261) Type N Male 2.95
T's, angles, adaptors, jacks, & BNC in stock!

COAX AVAILABLE IN PRECUT LENGTHS WITH CONNECTORS ATTACHED.

• • COAXIAL SWITCHES • •

ANDREW HELIAX & CONNECTORS
½" LDF4-50A ...... CALL 7/8" LDF5-50A ...... CALL

THANK YOU ... AND HAPPY HOLIDAYS TO OUR CUSTOMERS AROUND THE WORLD
RALPH-KØIR, GEORGE-ADØS, GWEN-WDØDZL, RANDY-KAØVVO, MEL, CHERYL, AND BRIAN

VISA

RETURNS REQUIRE AUTHORIZATION & SUBJECT TO 15% RESTOCKING CHARGE

Prices subject to change without notice.
Minnesota residents add 6% tax.
Shipping additional except as noted.

ORDER ONLY:
1-800-233-2482
SHIPPING, INFO., TECHNICAL, MN & DX.
218-765-3254
TELEX: **4933032 RFE UI** FAX **218-765-3308**

rf enterprises
HCR Box 43
Merrifield, MN 56465
(Located at Jcn. Co. 3 & 19)

Others May Try to Imitate, But...

Only One Can Be The Best

Morse Code - Baudot - ASCII - AMTOR - Packet - Facsimile - Navtex

Amateur Net Price $319.95

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^{tm}) 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.

PC Pakratt Packet TX/RX Display

Facsimile Screen Display

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

AEA Brings you the Breakthrough!

✓ 150

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.[1] 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

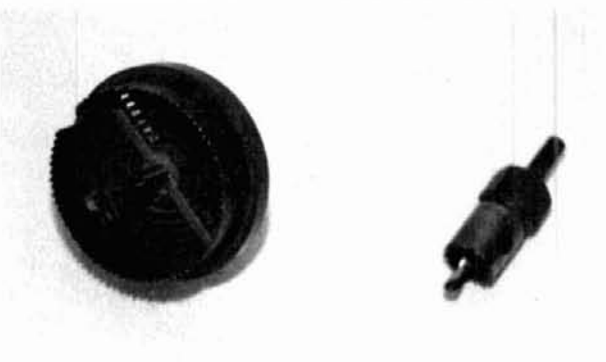
The dial's key feature is the use of dial cord and pulleys for the drive mechanism. Selecting the proper pulley diameter makes almost any tuning ratio possible. For example, I wanted to use 250 degrees of dial rotation for a 0 to 250 kHz tuning range and 25 to 30 kHz per turn of the main knob to give 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.[2]

FIGURE 1



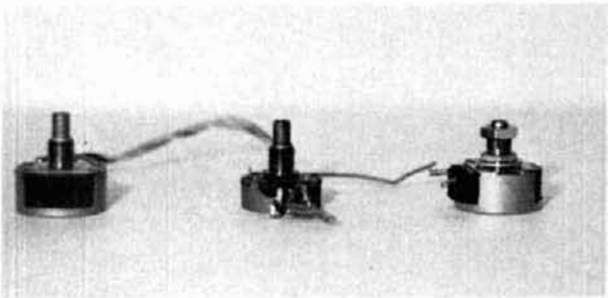
Drill attachments for cutting pulleys.

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.

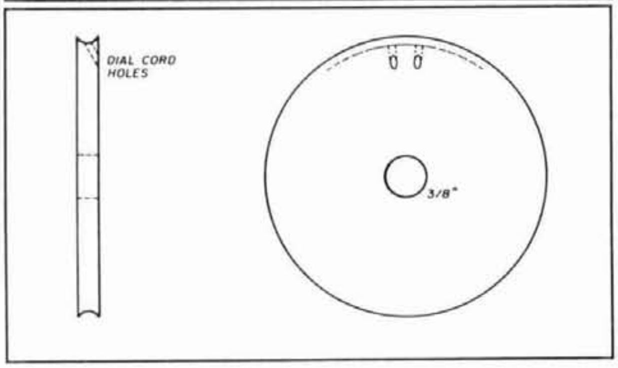
After cutting the disc, remove any imperfections and cut the groove in the outer surface. Enlarge the center hole to 3/8 inch diameter. Find a potentiometer with a locking shaft (**fig. 2**). It looks like an ordinary potentiometer, but the mounting bearing has four or six slots and a one-way locking 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.[3]

FIGURE 2



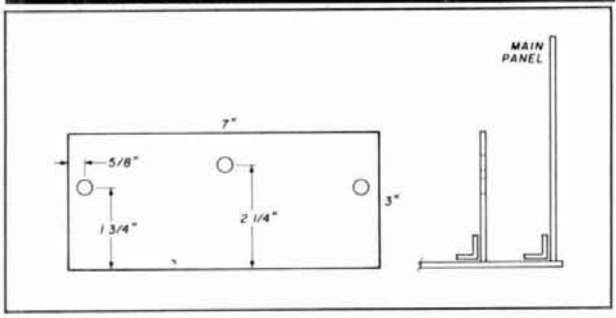
Potentiometer's source for bearings. Note one on right has a shaft-locking nut

FIGURE 3



Pulley details.

FIGURE 4



Mounting panel.

Gently extract the bearings from the potentiometers by removing a C-clip from the shaft and prying open the body. Tear away the top covers and discard the remains.

Purchase a 3-1/2 inch length of 1/4 inch steel shaft from the hardware store. You will need about 2 inches for the capacitor drive pulley and about 1-1/2 inches for the dial shaft pulley. Long shafts from the potentiometers can be salvaged and used. Mount a rough-cut pulley on the locking bearing, lock it onto the 1-1/2 inch shaft, and place it in the chuck of your electric drill. Clamp the drill body in a vise, turn it on with the locking button and start filing the outer edge.

When the pulley is perfectly round, use the edge 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.[4]

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

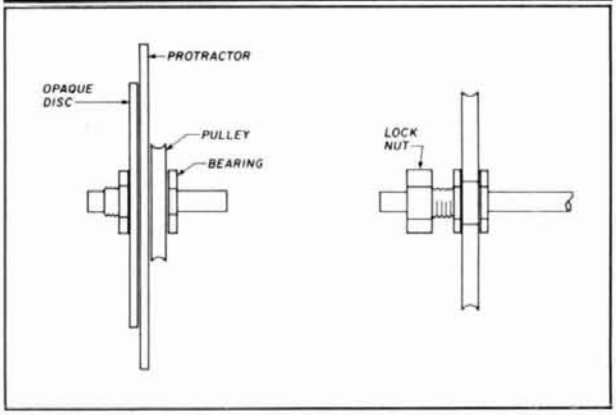
I used the capacitor mentioned earlier by mounting it 5/8 inch off the bottom panel on two brackets.

My favorite oscillator circuit is one that always works with any combination of L and C.[5] Use silver mica capacitors in the tank circuit.

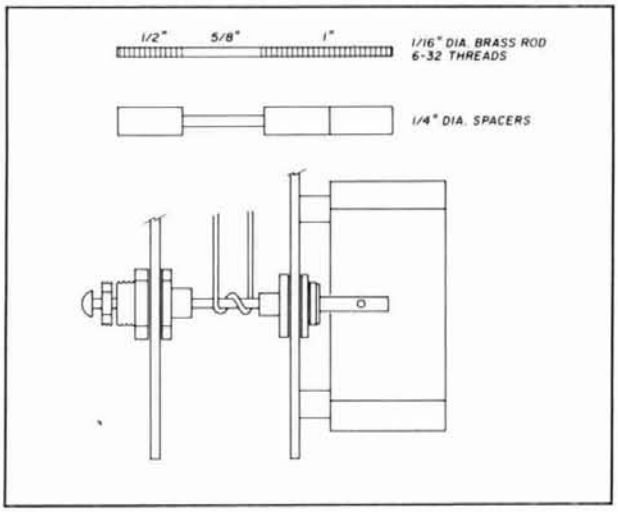
You can do some calculations to determine how far off a linear frequency dial will be with a linear capacitance tuning capacitor (see Appendix). In my case I wanted to tune 11.5 to 11.75 MHz. I calibrate the two ends of the dial, adjust L at the low frequency end and C at the high frequency end. The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

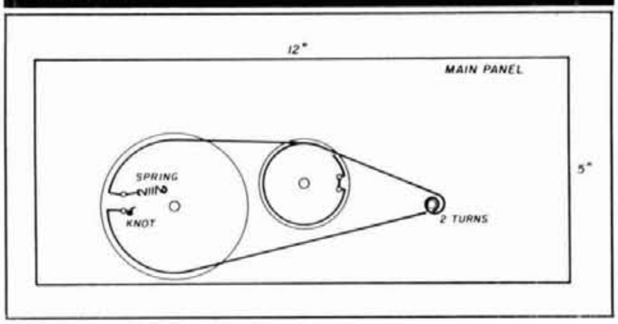


A. Pulley assembly.



B. Drive shaft.

FIGURE 6



Dial string diagram.

that same factor. Note, however, that the theoretical error also increases to 4.7 kHz at the center of the dial.

measured results

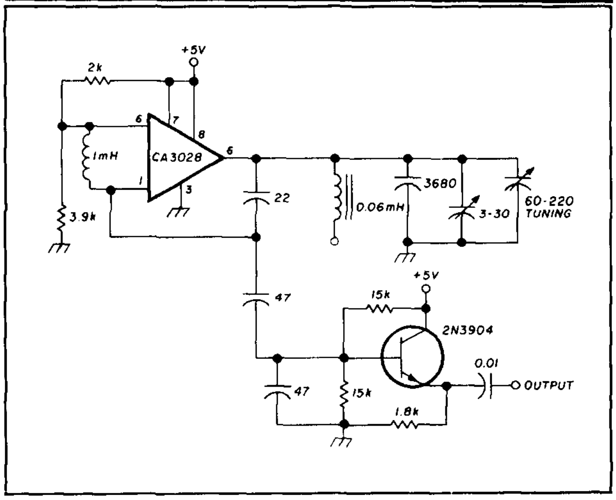
Table 1 lists actual frequency counter readings taken with the circuits in **figs. 7** and **8**. The +2 to −3 kHz errors agree with the calculated figure of 4.7 worst case.

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.

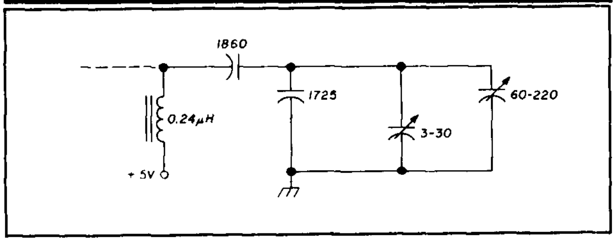
Give this homebrew dial a try. I'm sure you'll enjoy its economy and accuracy.

FIGURE 7



Oscillator circuit.

FIGURE 8



Modified tank circuit.

TABLE 1

Frequency counter readings taken with the oscillator and modified tank circuits.

dial setting (degrees)	frequency (kHz)	error (kHz)
0	11,500	0
50	11,549	−1
100	11,597	−3
150	11,647	−3
200	11,699	−1
250	11,752	+2

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.
5. *Linear Data Book,* National Semiconductor, June 1976, pages 10-132.

Appendix

Assume you are using a linear capacitance variable which goes from C_{max} to C_{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:

$$Flo = 1/2\pi \sqrt{L\,(C + Cmax)} \qquad (1)$$

and the high frequency:

$$Fhi = 1/2\pi \sqrt{L\,(C + Cmin)} \qquad (2)$$

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

$$(C + Cmax) \times Flo^2 = (C + Cmin) \times Fhi^2 \qquad (3)$$

$$C = \frac{Cmax \times Flo^2 - Cmin \times Fhi^2}{Fhi^2 - Flo^2}$$

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

$$(Cmax - Cmin) / 2 + Cmin = (Cmax + Cmin) / 2 \qquad (4)$$

and the frequency will be:

$$Fmid = 1/2\pi \sqrt{L[C + (Cmax + Cmin) / 2]} \qquad (5)$$

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

$$C = \frac{220 \times 11.5^2 - 60 \times 11.75^2}{11.75^2 - 11.5^2} \qquad (6)$$

$$C = 3580.43\ pF$$

From equation (1):

$$Flo = k / \sqrt{3580.43 + 220} \qquad (7)$$

At Flo = 11.5, k = 708.9477 then:

$$Fhi = 708.9477 / \sqrt{3580.43 + 60} = 11.74999 \qquad (8)$$

$$Fmid = 708.9477 / \sqrt{3580.43 + 140} = 11.62298$$

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

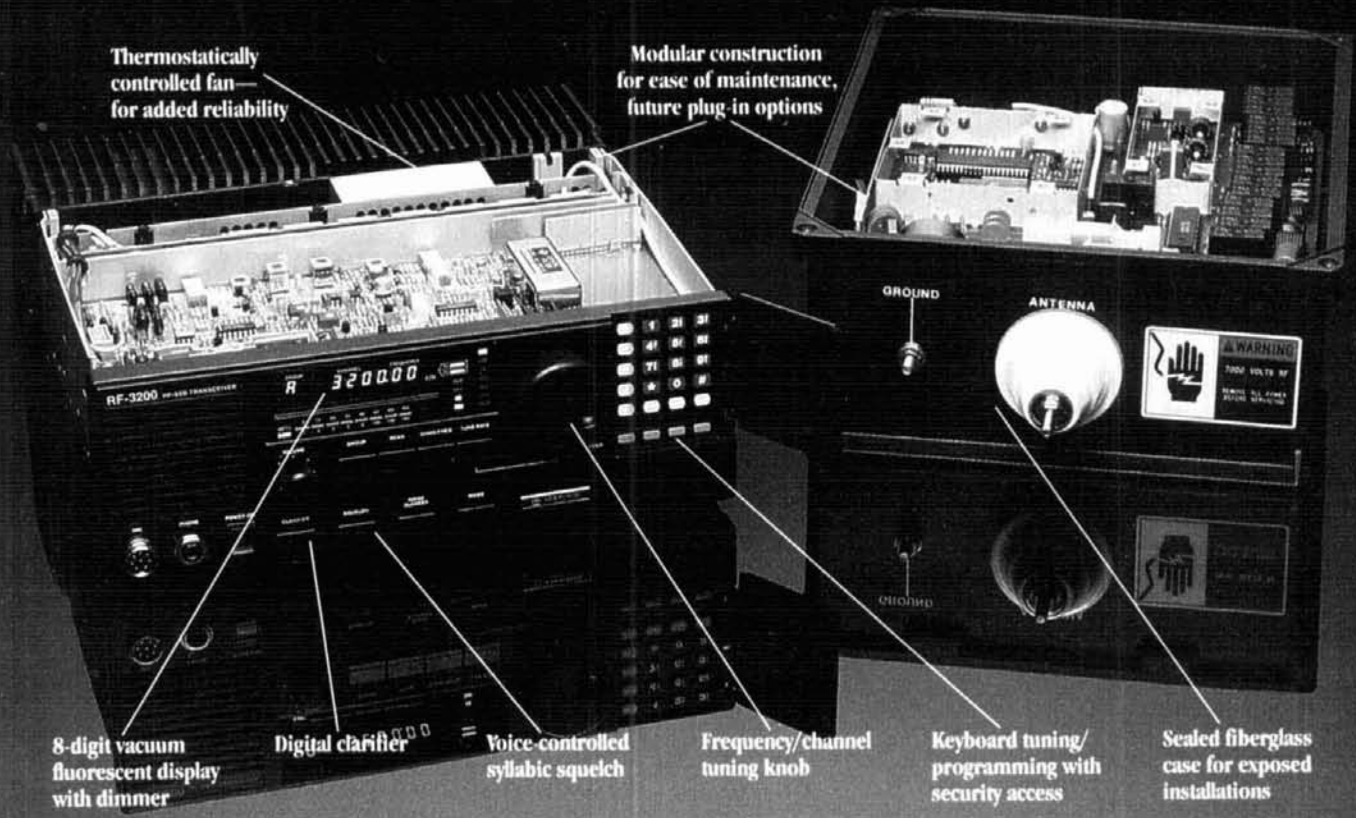
Article H **HAM RADIO**

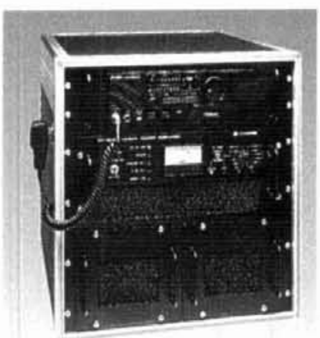
OCTOBER WINNERS

A round of applause for Ronald Murdock, WB5FIX, 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.*

RF-3200 SERIES

The *New* SSB Transceiver for Professional Communicators





RF-3230 1kW Solid-State Amplifier with RF-3200

RF-3200 Series Transceiver

RF-3281 Digital Antenna Coupler

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.

HARRIS

FCC Type Accepted

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.

HAM RADIO

MAGAZINE EVALUATION & SWEEPS ENTRY CARD

Here's YOUR chance to comment on this issue of HR and enter our monthly radio drawing. Carefully read all the articles in this issue. Then, rate each article in this issue. Also let us know what you think of our changes to the magazine. Each article is marked with a letter on the last page.

Article	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
I LIKE IT																				
OK																				
SORRY, NO.																				

MAGAZINE OVERALL GOOD____ OK____ NOT SO GOOD____ I like the ☐ Old ☐ New HR Better

NAME ____________ Class License ________ Age ______

ADDRESS ____________

CITY ____________ STATE ________ ZIP ________

Please run more: ____________

Please run less: ____________

DEC. 88

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 ________

☐ Check if this is a renewal DEC. 88

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.

HAM RADIO Reader Service

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!

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

Limit 15 inquiries per request.

NAME ____________ CALL ________

ADDRESS ____________

CITY ____________ STATE ________ ZIP ________

PLEASE USE BEFORE FEBRUARY 28, 1989 DECEMBER 1988

AFFIX POSTAGE
OR
POST OFFICE
WILL NOT
DELIVER

HAM RADIO
MAIN STREET
GREENVILLE, N.H. 03048

Please enter my subscription

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY CARD

First Class Permit No. 1 Greenville, NH

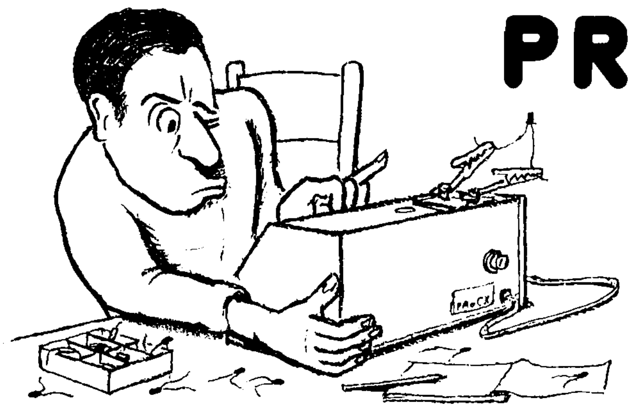
Postage Will Be Paid By Addressee

HAM RADIO
Greenville, NH 03048

AFFIX POSTAGE
OR
POST OFFICE
WILL NOT
DELIVER

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

ATTN: Reader Service Dept.



PRACTICALLY SPEAKING

Joe Carr, K4IPV

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

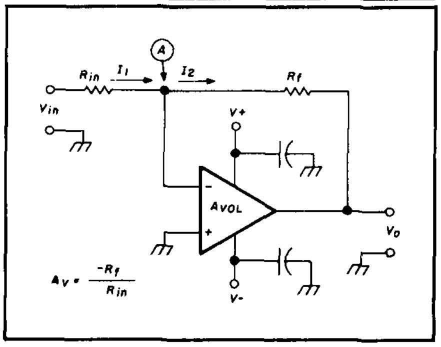
Last month I gave you the basics of the operational amplifier and other linear IC devices. I discussed the properties of the ideal op amp, and some common problems that represent departures from that ideal. This month I'll take a look at the standard circuit configurations and the derivation of transfer 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 $A_V = V_O/V_{in}$.

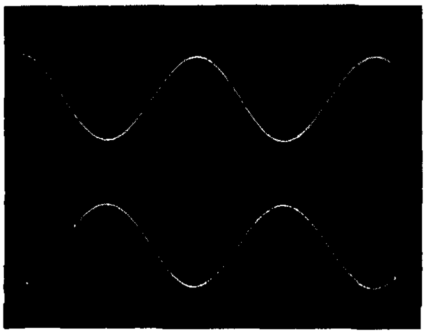
The noninverting input is grounded in the inverting follow circuit, so you must treat the inverting input as if it were also grounded. Ideal property number 6 (see last month) requires that the inverting input be treated as if it were also grounded, as at zero volts potential. This gives rise to a somewhat 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.

FIGURE 1



Inverting follower circuit.

PHOTO A



Input (top) and output (bottom) waveforms of a gain of −1 inverting follower.

Let's consider the currents appearing in node "A" of **fig. 1**. You know from ideal property number 3 (Z_{in} is infinite) that I3, 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,

$$I1 = -I2 \quad (1)$$

You also know from Ohm's law that

$$I1 = V_{in}/R_f \quad (2)$$

and,

$$I2 = V_o/R_{in} \quad (3)$$

Thus, when you substitute these two equations into KCL:

$$(V_{in}/R_{in}) = -(V_o/R_f) \quad (4)$$

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

$$A_v = V_o/V_{in} \quad (5)$$

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

$$V_o/V_{in} = -R_f/R_{in} \quad (6)$$

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

$$A_v = -R_f/R_{in} \quad (7)$$

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 R_f yields:

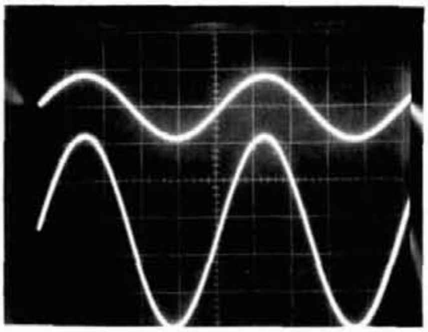
$R_f = A_v \times R_{in}$

$R_f = (100) \times (10{,}000 \text{ ohms})$

$R_f = 1{,}000{,}000 \text{ ohms}$

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.)

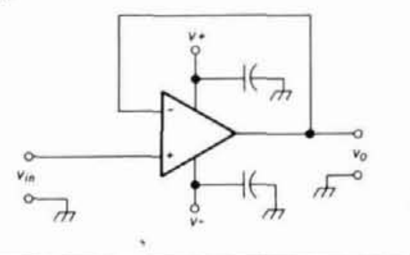
PHOTO B



Input (top) and output (bottom) waveforms of gain of +2 noninverting follower.

FIGURE 2

A



Unity gain noninverting follower.

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.

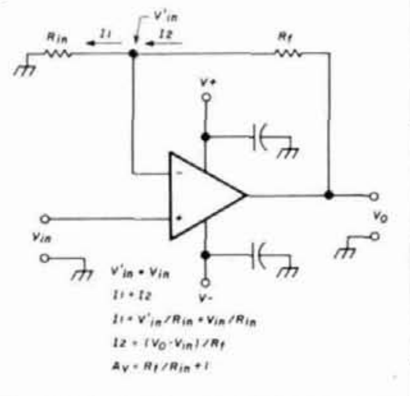
Impedance transformation occurs because the input impedance is very high, while the output impedance is very low. You can use this circuit when acquiring a signal from biological electrodes or chemical transducers, etc., where the source impedance is extremely high. A pH electrode, for example, has source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

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

FIGURE 2

B



Noninverting follower with gain.

method produces a voltage gain of:

$$A_v = (R_f/R_{in}) + 1 \quad \textbf{(8)}$$

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.

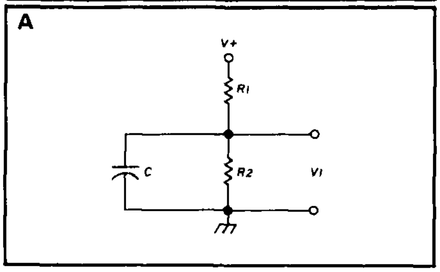
Another scheme is to use the regular monopolar DC power supply for V+, and a DC-to-DC converter circuit for V−. Such a circuit is little more than an AC or square wave oscillator in the 20 to 500-kHz range, with its output signal rectified and filtered to produce the V− voltage.

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 (V1) is given by the standard voltage divider equation:

$$V1 = \frac{R2 \times (V+)}{R1 + R2} \quad \textbf{(9)}$$

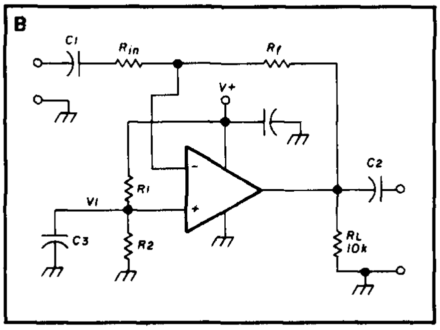
FIGURE 3

A



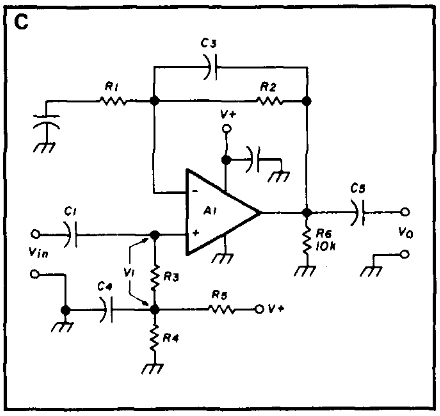
Resistor voltage divider.

B



Inverting follower operated from single supply.

C



Noninverting follower operated from single supply.

In most cases, the value of V1 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 R1 = R2. The value of R1 and R2 is usually selected so that it falls between 1k and 100k. The capacitor shunting resistor R2 is used to decouple AC variations on the power supply line. The capacitance value is selected for a reactance value of one-tenth R2 (i.e., R2/10) at the lowest frequency of operation. For example, suppose R2 = 10k, and the lowest frequency of operation is 10 Hz. If R2 is 10k, then the capacitive reactance of the shunt capacitor should be: R2/10 = (10k)/10 = 1k. Solving the usual capacitive reactance equation for C gives you:

$$C_{\mu F} = \frac{1{,}000{,}000}{2 \pi F X_c} \quad \textbf{(10)}$$

$$C_{\mu F} = \frac{1{,}000{,}000}{(2)(3.14)(10 \text{ Hz})(1000 \text{ ohms})}$$

$$C_{\mu F} = \frac{1{,}000{,}000}{62{,}800}$$

$$C_{\mu F} = 15.9_{\mu F}$$

The value 15.9 µF is non-standard, so you'd select a 16, 20, or 22 µF 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 V1 to the noninverting input. This voltage (V1) also appears on the inverting input, making DC blocking capacitor C1 necessary. The output terminal is biased according to the value of V1, 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 C1 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 $R_{in}C1$ as a high-pass filter with a cutoff frequency, F_c, equal to $1/(6.28\ R_{in}C1)$. The object is to choose a value of C1, 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 R3. The purpose of R3 is to maintain a high input impedance to signals applied to the noninverting input. The minimum value of R3 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 R3 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+)/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.

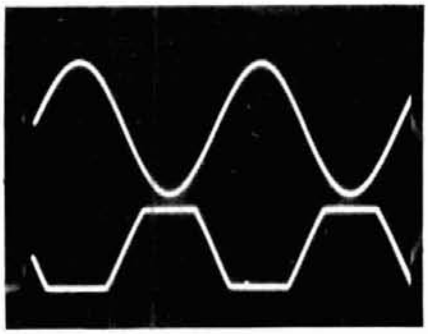
Some common problems

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−(V+) iş 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.)

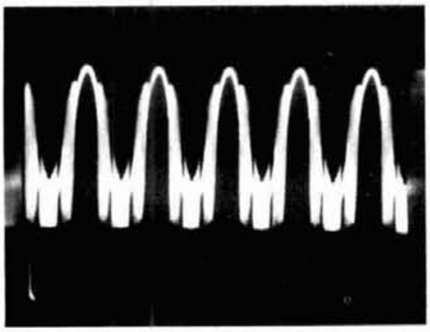
Photo C shows the result when the amplifier inputs are overdriven for the circuit conditions. Three factors can lead to the clipping shown in the output signal (lower trace). The first is excessive input signal. (This situation can also be dangerous to the op amp's health.) The second is a value that's 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

PHOTO C



Input (top) and output (bottom) waveforms of an overdriven amplifier showing "clipping."

PHOTO D



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.

Article I **HAM RADIO**

THE WEEKENDER

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.

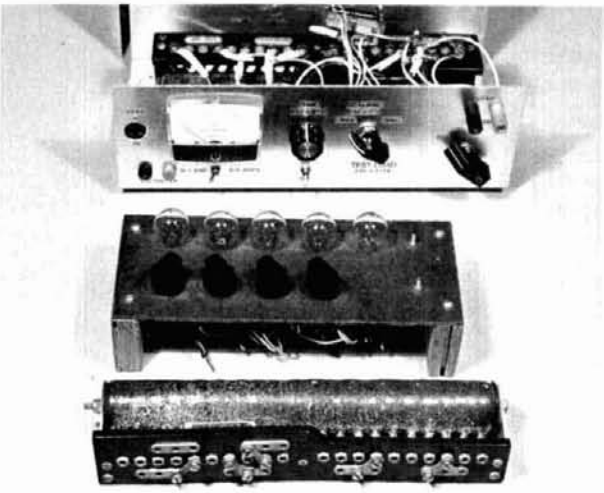
Many devices using NiCds come with a charger. Proper charging is usually easy to accomplish; it's simply a matter of charging them for a fixed period of time — often 16-20 hours. Proper discharge is not quite as easy to achieve.

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

By W. C. Cloninger, Jr., K3OF, 4409 Buckthorn Court, Rockville, Maryland 20853

PHOTO A

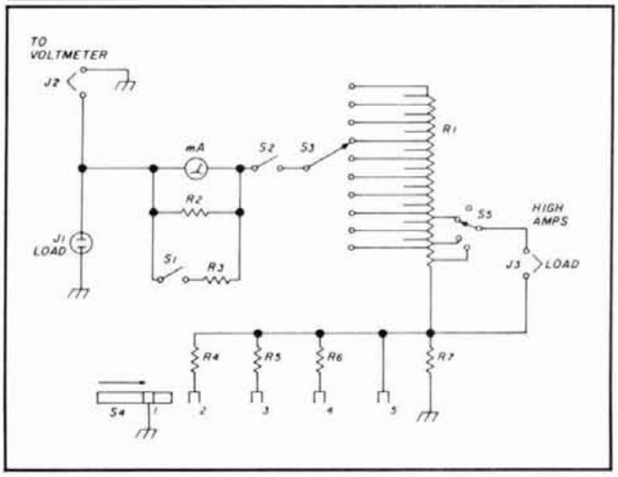


Multi-purpose test load is just a special purpose resistance substitution box.

PHOTO B

The multi-tapped resistor is the heart of the test load. Note the heavy-duty switch at the upper right for high amps.

FIGURE 1

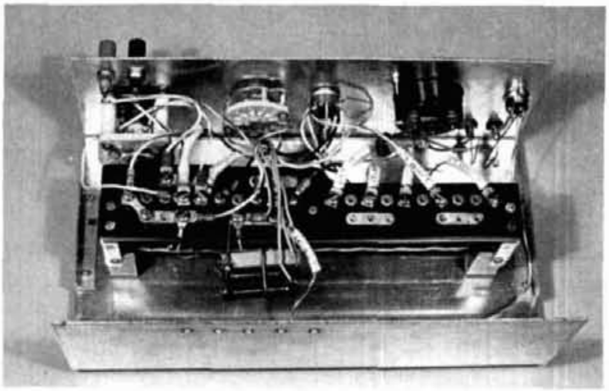


Simple circuit for old-fashioned resistance-substitution box.

cycles is necessarily an indicator of when a NiCd cell needs to be replaced.

For years I discharged NiCds with almost anything

PHOTO C



Foreground: Load resistor R1 before installation. Center: 10-A continuous-duty test load is guaranteed to brighten up your shack.

PARTS LIST

R1	*6.5 ohm 200 watt multi-tapped resistor**
R4	*100 ohm 10 watt*
R5	*50 ohm 10 watt*
R6	*20 ohm 10 watt*
R7	*30 ohm 10 watt*
S3	*10 pole rotary switch*
S4	*5 pole shorting rotary switch*
S5	*4 pole high amp ceramic switch*
Meter	*0-1 mA, or to suit*
R2,R3	*shunt resistors to suit meter*
J1,J2,J3	*Jacks to suit needs*

**H & R Corporation, 401 E. Erie Avenue, Philadelphia, Pennsylvania 19134*

Part number TM23K513. $5.50 in December 1986 catalog.

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 6.5-ohm resistor in a catalog.[1] 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

$$\left(I = \frac{E}{R},\ I = \frac{13.8}{13.8} = 1\ A\right)$$

equals 13.8 watts ($P = 1 \times 13.8 = 13.8$ watts). Because five resistors (R1, R4, R5, R6, and R7) share varied amounts of the 13.8 watts, no resistor needs to be rated over 10 watts. Switch S4 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

TABLE 1

Approximate resistance ranges of switch S4 when used with switch S3 for fine adjustment.

Range 1	**1.1– 7.0 ohms**
2	**9.8–15.6 ohms**
3	**16.6–22.4 ohms**
4	**24.1–29.8 ohms**
5	**31.2–37.0 ohms**

higher wattage resistor where required. **Table 1** gives the approximate resistance ranges of switch S4, when used with switch S3 for fine adjustment.

Construction

There's nothing special about the construction (**photo C**). Just about everything I used came from my junkbox. R1 is the only component purchased specifically for this project. Even the wires with the terminals were "cut-offs" from disassembled equipment. Switches S3 and S4 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.

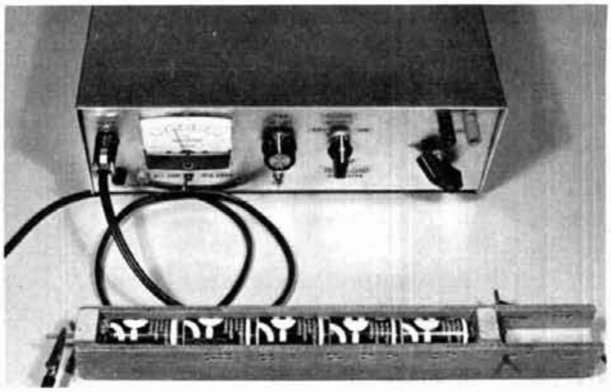
Start by connecting one end of the resistor wire to the meter. Use a clip lead on the other terminal of the meter, and slide the other end of the clip lead along the resistance wire until you get the proper reading. (Place another ammeter in series for reference.) Solder a wire to the resistance wire at this point, and connect the wire to the meter. I added switch S1 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 S2, 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 S5 and jack J3. 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 R1 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 D



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 voltage 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

1. H & R Corporation, 401 E. Erie Avenue, Philadelphia, Pennsylvania 19134.

Article J **HAM RADIO**

HAM RADIO cumulative index 1984-1988

ANTENNAS AND TRANSMISSION LINES

general

hf antennas

vhf antennas

Aries—1

Amateur Radio Integrated Entry System

ALL MODE — SOFTWARE

```
ID(Sta):WØABC        Name:CHAR_      City:DENVER            State:CO
Date:08-10-88        Begin:21:05     End QSO:21:07:22       Freq:28.485.0
Type (mode):USB      My RST:         His RST:59             Power:     QSL:
Remarks:
Data:                  Data Base / Status Window
Status:  [T/R]  [CLS]   Manual Mode                [CLD] [Sr/F] [Qu/eX]
------------------------------- Log of NV2I -------------------------------
WØABC DENVER CHARLIE
HOME BREW XMTR, 3 ELEMENT TRIBANDER, LIVES NEAR UNCLE JOE

                         Scratch-Pad
                              /
                      Term Unit I/O Window

---------------------------------------------------------------------------
                   CW/RTTY/AMTOR type ahead Window
1MANUAL 2 RTTY 3 CW 4 AMTOR 5 PACKET 6 TneON 7 TneOFF 8 Clear 9 Log 10 Optns
```

FOR IBM PC/XT/AT PS/2 & COMPATIBLES - $89.95 -

Aries—1...

... Inserts DATE / TIME from **Computer** – FREQUENCY / MODE from **Transceiver** (certain **Kenwood** and **Icom** models) into log.
... Interfaces with **Kantronics KAM** and **AEA PK-232 Terminal Units** for totally integrated ON-SCREEN I/O.
... 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 TU Modes, operating parameters and files data into the Log file with the press of a key or the click of a mouse.
... Has a **Contest Mode** and automatic string replacement capability which give new meaning to quick exchanges.
... Has Automatic **Dup checking** and the ability to search / print data base by Call, Country, Freq, QSL info, etc.
... Lets you run other programs (or access DOS) while staying resident in memory along with your data.
... Logs voice contacts, while simultaneously connected to a packet mail box and down-loading messages into a capture 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

ashton ITC

PO Box 1067 - Vestal, NY 13851 - (607-748-9028)

✓ 167

LOGWRITE™

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

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

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

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

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

Aerospace Consulting
P.O. Box 156, Gwynedd, Pa. 19436

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

✓ 170

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 × 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

✓ 171

Dick Smith is alive and well in Indiana

and the

1989 CATALOG is NOW AVAILABLE!

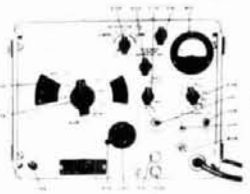
The Dick Smith Electronics Catalog is the fun way to find the electronic things you need. And now the 1989 Catalog is bigger - 160 pages crammed full of the things the other guys don't offer - and better - with more of our exclusive data pages including the new "feed back" section that invites your participation. 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!

SHERRY BLUM, Catalog Subscriptions
P.O. BOX 468, GREENWOOD, IN 46142
Phone 317-888-7265 - Fax 317-888-7368

DICK SMITH ELECTRONICS

✓ 168

Signal Generators SG-103/URM-25F

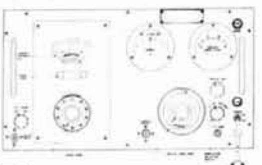


$125.00

Accessories Available
$25.00 Additional

- 10 kHz-50 MHz in 8 Bands
- Sub-Microvolt to 2 Volt RF Output
- Resistive Attenuator
- Crystal Calibrator
- Checked out with schematic

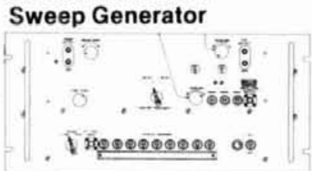
TS-497 B/URR



$100.00

- 2.0 - 400 MHz in 6 Bands
- Sub-Microvolt to .1 Volt RF Output
- Piston Attenuator
- Checked out with schematic

SG-336/U-KAY 380 Sweep Generator



$125.00

- 30 or 60 MHz Center Frequency
- 3 or 20 MHz Sweep Width
- 9 Crystal Marker Capability (Five Equipped)
- Variable Marker with External Oscillator
- Operators Manual Reprint & Schematic included

✓ 169

N. E. Litsche
P.O. Box 191 • Canandaigua, NY 14424-0191
716-394-9099 • 716-394-0148

CADDELL COIL CORP.

35 Main Street
Poultney, VT 05764
802-287-4055

BALUNS

Get POWER to your antenna! Our Baluns are already wound and ready for installation in your transmatch or you may enclose them in a weatherproof box and connect them directly at the antenna. They are designed for 3-30 MHz operation. (See ARRL Handbook pages 19-9 or 6-20 for construction details.)

100 Watt (4:1, 6:1, 9:1, or 1:1 impedence—select one)	$19.50
Universal Transmatch 1 KW (4:1 impedence)	14.50
Universal Transmatch 2 KW (4:1 impedence)	17.00
Universal Transmatch 1 KW (6:1, 9:1, or 1:1—select one)	16.00
Universal Transmatch 2 KW (6:1, 9:1, or 1:1—select one)	18.50

Please send large SASE for info.

matching and tuning

towers and rotators

transmission lines

AUDIO

COMMERCIAL EQUIPMENT

COMPUTER-AIDED DESIGN

CONSTRUCTION TECHNIQUES

DIGITAL TECHNIQUES

FEATURES AND FICTION

FILTERS

FM AND REPEATERS

HAZARDS

INTEGRATED CIRCUITS

KEYING AND CONTROL

MEASUREMENTS AND TEST EQUIPMENT

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-strip cavity construction for outstanding performance through UHF. No lossy wafer switches are used.
- Positive detent ball bearing switch drive tells you which position you're in . . . without guessing . . . without looking.
- DELTA-4 handles full legal power.
- Designed and produced in the U.S.A. by Alpha Delta.

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

175

BLACK DACRON® POLYESTER ANTENNA ROPE

- UV-PROTECTED
- HIGH ABRASION RESISTANCE
- REQUIRES NO EXPENSIVE POTTING HEADS
- EASY TO TIE & UNTIE KNOTS
- EASY TO CUT WITH OUR HOT KNIFE
- SIZES: 3/32" 3/16" 5/16"
- SATISFIED CUSTOMERS DECLARE EXCELLENCE THROUGHOUT U.S.A.

LET US INTRODUCE OUR DACRON® ROPE TO YOU • SEND YOUR NAME AND ADDRESS AND WE'LL SEND YOU FREE SAMPLES OF EACH SIZE AND COMPLETE ORDERING INFORMATION.

Dealer Inquiries Invited

synthetic textiles, inc. 2472 EASTMAN AVE., BUILDING 21 VENTURA, CALIFORNIA 93003 (805) 658-7903

182

PC Slow Scan $149.95

A complete slow scan television station for your IBM PC or compatible. Send and receive images in up to 10 shades of gray depending upon your graphics card and printer.

Includes:
Demodulator Modulator 75 Page Manual
Software Tutorial Cassette

Requires:
Ham transceiver PC with 640K Parallel Port
Graphics Card Tape Recorder Serial port

Slow Scan Formats: 8,12,17,23,34,36,48,72 sec.

Software Systems Consulting
1303 S. Ola Vista
San Clemente, CA 92672
(714) 498-5784

160

LOW BAND DX-ING COMPUTER PROGRAMS
by John Devoldere, ON4UN, for Apple IIe/c, MS-DOS, Commodore C-128 Apple Macintosh and Kaypro CPM Computers

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

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

LOW BAND DX'ING
by John Devoldere ON4UN

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

☐ AR-UN Softbound $9.95

BUY'EM BOTH SPECIAL OFFER

Book & Software Reg. $49.90 ($59.90 for Mac)
Just $44.90 ($54.90 for Mac)

☐ UN-SO (specify computer) $44.90
☐ UN-MSO Macintosh Special $54.90

SAVE $5

Please enclose $3.50 shipping & handling

ham radio BOOKSTORE
GREENVILLE, NH 03048 603-878-1441

MISCELLANEOUS TECHNICAL

NOVICE READING

OPERATING

OSCILLATORS

PACKET

POWER SUPPLIES

PROPAGATION

RECEIVERS AND CONVERTERS

general

hf

vhf

RTTY

SATELLITES

SEMI-CONDUCTORS

SINGLE SIDEBAND

SOFTWARE

TELEVISION

TRANSMITTERS AND POWER SUPPLIES

general

hf

TROUBLE-SHOOTING

VHF AND UHF

general

antennas

receivers and converters

transmitters

microwave techniques


WE SHIP WORLDWIDE
Barry Electronics Corp.
WORLD WIDE AMATEUR RADIO SINCE 1950
Your one source for all Radio Equipment!
For the best buys in town call:
212-925-7000
Los Precios Mas Bajos en Nueva York
WE SHIP WORLDWIDE!
KITTY SAYS: WE ARE NOW OPEN 7 DAYS A WEEK.
Saturday & Sunday 10 to 5 P.M.
Monday-Friday 9 to 6:30 PM Thurs. to 8 PM
Come to Barry's for the best buys in town.
ONV Safety belts-in stock
ICOM
IC-R71A, 751A, 781, 28A/H, 38A, 48A, Micro2/4, R-7000, IC-761, IC-375A, 275A/H, 3210A, 475A/H, 735, IC-900, IC-228H
Santa Kitty says, "Seasons Greetings To All"
See you Dec. 4, 8pm-BARA (speech), Paramus NJ (Bergen CC)
YAESU
FT-767GX, FT-757GXII, FT-311 RM, FRG-8800, FT-736, FRG-9600, FT-711RH, FT-4700RH, FT 212/712RH.
SMART PATCH
CES Simplex Autopatch 510-SA Will Patch FM Transceiver To Your Telephone Great For Telephone Calls From Mobile To Base Simple To Use. 510SA/510SAII
YAESU FT-23/73/33/727R FT-2/1/709R/H FT-1903/1123 FTH-2005/7005
ICOM IC2AT/12AT ICO2AT-32AT IC2/4GAT IC-A2/U16
Landmobile HT's ICOM: U16, H16, V100, U400 MAXON, MOTOROLA, YAESU: FTH 2005/2007 UNIDEN, REGENCY, KING, TAD MARINE ICOM: M5, M55, M700 AVIATION ICOM: A20 H.T.
KENWOOD
Antennas
A-S, AES, Cushcraft, Hy-Gain, Hustler, KLM, METZ, Mosley, MODUBLOX, TONNA
PRIVATE PATCH IV, Duplex 8000
TS440S/AT, R-5000, R-2000, TS-940 S/AT, TM 221A/421A, TM-2570A/50A/30A, TR-751A, Kenwood Service Repair, TM-721A, TS-711/811A, TM3530A, TH205AT, TH215A, TM-621A, TM-321A, TS140S, TS680S, RZ-1, TS-790A.
RF Concepts
TUNERS STOCKED:
NYE MBV-A3 Killowatt Tuner
Budwig ANT. Products
NEL-TECH DVK-100 Digital Voice Keyer
FLUKE 77 Multimeter
Media Mentors— Amateur Radio Course $99.95
ALINCO ALD 24T
DJ-100T
VoCom/Mirage/Alinco
Tokyo Hy-Power/TE SYSTEMS
Amplifiers &
5/8λ HT Gain
Antennas IN STOCK
FREQUENCY COUNTERS: 1MHz-1.3GHz $169.95
COMMERCIAL & HAM REPEATERS STOCKED. WRITE FOR QUOTES
KANTRONICS
UTU, KAM, UTU-XT, KPC 2400, KPC IV, KAM
MFJ-989C
Computer Interfaces Stocked: MFJ-1270B MFJ-1274, MFJ-1224, AEA PK-88, MFJ-1278, PK-232 W/FAX.
MICROLOG-ART 1, Air Disk, SWL, Morse Coach
Soldering Station 48 Watts $68.
MOTOROLA AUTHORIZED DEALER
KACHINA COMMUNICATIONS DEALER
Ten-Tec Tuner 229B
SHORTWAVE RECEIVERS STOCKED
COMET ANTENNAS STOCKED
DIGITAL FREQUENCY COUNTERS
Opto electronics model 1300H, 0-1300MHz
Trionyx, Model TR-1000, 0-600 MHz
Long-range Wireless Telephone for export in stock
HEIL EQUIPMENT IN STOCK
METRON MA-1000 B STOCKED
SANGEAN Portable Shortwave Radios
EIMAC 3-500Z 572B, 6JS6C 12BY7A & 6146B
BENCHER PADDLES, BALUNS, LOW PASS FILTERS IN STOCK
Hy-Gain Towers & Antennas, and Rotors will be shipped direct to you FREE of shipping cost.
AEA 144 MHz
AEA 220 MHz
AEA 440 MHz
ANTENNAS
BIRD Wattmeters & Elements In Stock
MIRAGE AMPLIFIERS
ASTRON POWER SUPPLIES
Saxton Wire & Cable, Int'l Wire
New TEN-TEC Corsair II, PARAGON
AMERITRON AUTHORIZED DEALER
MAIL ALL ORDERS TO: BARRY ELECTRONICS CORP., 512 BROADWAY, NEW YORK CITY, NY 10012 (FOUR BLOCKS NORTH OF CANAL ST.)
New York City's LARGEST STOCKING HAM DEALER COMPLETE REPAIR LAB ON PREMISES
"Aqui Se Habla Espanol"
BARRY INTERNATIONAL TELEX 12-7670
MERCHANDISE TAKEN ON CONSIGNMENT FOR TOP PRICES
Monday-Friday 9 A.M. to 6:30 P.M. Thursday to 8 P.M. Saturday & Sunday 10 A.M. to 5 P.M. (Free Parking)
IRT/LEX-"Spring St. Station". Subways: BMT-"Prince St. Station". IND-"F" Train-Bwy Station" Bus: Broadway #6 to Spring St. Path-9th St./6th Ave. Station.
COMMERCIAL RADIOS STOCKED: ICOM, Motorola, MAXON, Standard, Yaesu. We serve municipalities, businesses, Civil Defense, etc. Portables, mobiles, bases, repeaters...
ALL SALES FINAL
We Stock: AEA, ARRL, Alinco, Ameco, Ameritron, Antenna Specialists, Astatic, Astron, B&K, B&W, Bencher, Bird, Butternut, CDE, CES, Cushcraft, Daiwa, Eimac, Henry, Heil, Hustler, Hy-Gain, Icom, KLM, Kantronics, Larsen, MJF, J.W. Miller, Mirage, Nye, Palomar, RF Products, Saxton, Shure, Tempo, Ten-Tec, TUBES, Yaesu, Vibroplex, Duplexers, Repeaters, Scanners, Radio Publications, Uniden, Kenwood, Maxon, RFC.
WE NOW STOCK COMMERCIAL COMMUNICATIONS SYSTEMS
HAM DEALER INQUIRES INVITED PHONE IN YOUR ORDER & BE REIMBURSED
COMMERCIAL RADIOS stocked & serviced on premises.
Amateur Radio Courses Given On Our Premises, Call
Export Orders Shipped Immediately. TELEX 12-7670
FAX: 212-925-7001

NEW products

(continued from page 70)

For more information contact Communications Specialists, Inc., 426 West Taft Avenue, Orange, California 92665-4296.

Circle #306 on Reader Service Card.

900-MHz phase lock loop synthesizer

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 on-board 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.

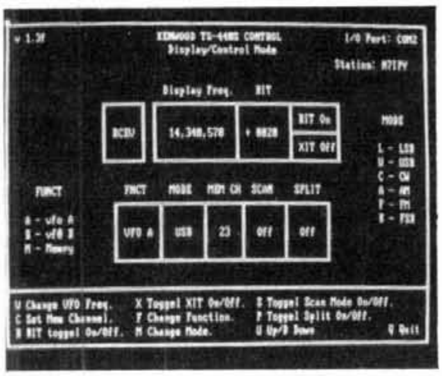
The price in quantities of 1-9 is $95.00.

For more information, please contact RF PROTOTYPE SYSTEMS, (619) 538-6771, 12730 Kestrel Street, 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 radio-computer 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 #308 on Reader Service Card.

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 × 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 × 2.55″H × 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 × 2.55″H × 1.1″D. The CM-300 is equipped with UHF connectors.

•Low-loss coax mounting kits. The CK-5LX is the 5DQEV + RG188A/u. The CK-5LX is usable from 1 MHz to 1.5 GHz. The CK-3LX is the 3.5DQEV + RG188A/u, The CK-3LX is usable from 1 MHz to 900 MHz. The loss for the coax is: 3.5DQEV at 400 MHz 3.5, at 1000 MHz 5.6 per 100 feet. 5D-QEV 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 #309 on Reader Service Card.

(continued on page 125)

RAMSEY ELECTRONICS

Quality Test Gear & Electronic Kits for Professionals and Hobbyists

COM-3

$2495.00

THE COMMUNICATIONS SERVICE MONITOR THAT WORKS HARDER FOR LESS.

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

PR-2 COUNTER PREAMP

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

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

PS-2 AUDIO MULTIPLIER

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

$69.95 wired
PS-2 kit $49.95

PS-10B 1.5 GHz PRESCALER

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

$89.95 wired includes AC adapter

CT-70 7 DIGIT 525 MHz

$139.95 WIRED, INCLUDES AC ADAPTER

CT-90 9 DIGIT 600 MHz

$169.95 WIRED INCLUDES AC ADAPTER

CT-50 8 DIGIT 600 MHz

$189.95 WIRED INCLUDES AC ADAPTER

CT-125 9 DIGIT 1.2 GHz

$189.95 WIRED INCLUDES AC ADAPTER

FREQUENCY COUNTERS

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

ACCESSORIES FOR COUNTERS

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

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

MINI KITS—EASY TO ASSEMBLE—FUN TO USE

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

COLOR ORGAN
See music come alive! 3 different lights flicker with music. One light each for, high, mid-range and lows. Each individually adjustable and drives up to 300 W, runs on 110VAC.
ML-1 Kit **$8.95**

VIDEO MODULATOR
Converts any TV to video monitor. Super stable, tunable over ch 4-6. Runs on 5-15V, accepts std. video signal. Best unit on the market! Complete kit VD-1 **$7.95**

FM WIRELESS MIKE
Transmits up to 300' to any FM broadcast radio, uses any type of mike. Runs on 3 to 9V. Type FM-2 has added sensitive mike preamp stage.
FM-1 Kit **$3.95**
FM-2 Kit **$4.95**

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

MAD BLASTER
Produces LOUD ear shattering and attention getting siren like sound. Can supply up to 15 watts of obnoxious audio. Runs on 6-15 VDC.
MB-1 Kit **$4.95**

40 WATT 2 mtr PWR AMP
Simple Class C power amp features 8 times power gain 1 W in for 8 out, 2 W in for 15 out, 5 W in for 40 W out. Max output of 50 W, incredible value, complete with all parts, less case and T-R relay.
PA-1, 40 W pwr amp kit **$27.95**
TR-1, RF sensed T-R relay kit **6.95**

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

UNIVERSAL TIMER
Provides the basic parts and PC board required to provide a source of precision timing and pulse generation. Uses 555 timer IC and includes a range of parts for most timing needs.
UT-5 Kit **$5.95**

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

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

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

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

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

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

FM MINI MIKE
A super high performance FM wireless mike kit! Transmits a stable signal up to 300 yards with exceptional audio quality by means of its built in electret mike. Kit includes case, mike, on-off switch, antenna, battery and super instructions. This is the finest unit available.
FM-3 Kit **$14.95**
FM-3 Wired and Tested **19.95**

NEW

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

NEW

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

ALL NEW KITS

PERSONAL SPEED RADAR

Complete kit SG-7 **$89.95**

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

RADIOS

40 & 80 METERS HAM RECEIVERS

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

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

QRP TRANSMITTER KITS, 40 & 80 METERS

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

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

AIRCRAFT RECEIVER KIT

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

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

SHORTWAVE RECEIVER KIT

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

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

PACKET RADIO

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

Complete kit PC-1 **$49.95**

FM COMMUNICATIONS/2 METER RECEIVER

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

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

NEW MINIKITS—NEW MINIKITS

BROADBAND PREAMP

A sensitive all purpose preamp, ideal for scanners, TV sets, VHF, UHF rigs, counters, etc. Features low noise, 4 db NF, 20 db gain, 100 KHz—1 GHz operation. Runs on 9—12 VDC, 50 ohms input.

Complete kit SA-7 **$12.95**

LIGHT BEAM COMMUNICATORS

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

Transmitter kit LB-6 **$8.95**
Receiver kit LB-5 **$9.95**

HIGH POWER FM WIRELESS MIKE

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

FM-4 kit **$9.95**
Sensitive microphone cartridge **$2.95**

2 MTR & 220 BOOSTER AMP

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

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

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

MasterCard VISA

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

PHONE ORDERS CALL 716-586-3950

FAX 716-586-4754

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

✓ 177

HAM MART

Ham Radio's guide to help you find your local

California

A-TECH ELECTRONICS
1033 HOLLYWOOD WAY
BURBANK, CA 91505
(818) 845-9203
New Ham Store and Ready to Make a Deal!

JUN'S ELECTRONICS
3919 SEPULVEDA BLVD.
CULVER CITY, CA 90230
213-390-8003
800-882-1343 Trades
Habla Espanol

Colorado

ALLIED APPLIANCE & RADIO
4253 SOUTH BROADWAY
ENGLEWOOD, CO 80110
(303) 761-7305
Rocky Mts Amateur/Shortwave Specialists, Ten-Tec, Yaesu, JRC-NRD, Sony , MFJ, KLM, and other fine gear. New and used. Visa/MC. Antennas, books, discount prices too!

COLORADO COMM CENTER
525 EAST 70th AVE.
SUITE ONE WEST
DENVER, CO 80229
(303) 288-7373
(800) 227-7373
Stocking all major lines
Kenwood Yaesu, Encomm, ICOM

Connecticut

HATRY ELECTRONICS
500 LEDYARD ST. (SOUTH)
HARTFORD, CT 06114
203-527-1881
Call today. Friendly one-stop shopping at prices you can afford.

Delaware

AMATEUR & ADVANCED COMMUNICATIONS
3208 CONCORD PIKE
WILMINGTON, DE 19803
(302) 478-2757
Delaware's Friendliest Ham Store.

DELAWARE AMATEUR SUPPLY
71 MEADOW ROAD
NEW CASTLE, DE 19720
302-328-7728
800-441-7008
Icom, Ten-Tec, Microlog, Yaesu, Kenwood, Santec, KDK, and more. One mile off I-95, no sales tax.

Florida

AMATEUR ELECTRONIC SUPPLY
1898 DREW STREET
CLEARWATER, FL 33575
813-461-4267
Clearwater Branch
West Coast's only full service Amateur Radio Store.
Hours M-F 9-5:30, Sat. 9-3

AMATEUR ELECTRONIC SUPPLY
621 COMMONWEALTH AVE.
ORLANDO, FL 32803
305-894-3238
Fla. Wats: 1 (800) 432-9424
Outside Fla: 1 (800) 327-1917
Hours M-F 9-5:30, Sat. 9-3

Georgia

DOC'S COMMUNICATIONS
702 CHICKAMAUGA AVENUE
ROSSVILLE, GA 30741
(404) 866-2302 / 861-5610
ICOM, Yaesu, Kenwood, Bird...
9AM-5:30PM
We service what we sell.

Hawaii

HONOLULU ELECTRONICS
819 KEEAUMOKU STREET
HONOLULU, HI 96814
(808) 949-5564
Kenwood, ICOM, Yaesu, Hy-Gain, Cushcraft, AEA, KLM, Tri-Ex Towers, Fluke, Belden, Astron, etc.

Idaho

ROSS DISTRIBUTING COMPANY
78 SOUTH STATE STREET
P.O. BOX 234
PRESTON, ID 83263
(208) 852-0830
M 9-2; T-F 9-6; S 9-2
Stock All Major Brands
Over 7000 Ham Related Items on Hand

Illinois

ERICKSON COMMUNICATIONS, INC.
5456 N. MILWAUKEE AVE.
CHICAGO, IL 60630
312-631-5181
Hours: 9:30-5:30 Mon, Tu, Wed & Fri; 9:30-8:00 Thurs; 9:00-3:00 Sat.

Indiana

THE HAM STATION
220 N. FULTON AVE.
EVANSVILLE, IN 47710
(800) 523-7731
(812) 422-0231
ICOM, Yeasu, Ten-Tec, Cushcraft, Hy-Gain, AEA & others.

Maryland

MARYLAND RADIO CENTER
8576 LAURELDALE DRIVE
LAUREL, MD 20707
301-725-1212
Kenwood, Ten-Tec, Kantronics. Full service dealer.
M-F 10-7 SAT 9-5

Massachusetts

TEL-COM, INC.
675 GREAT ROAD, RTE. 119
LITTLETON, MA 01460
617-486-3400
617-486-3040
The Ham Store of New England You Can Rely On.

Missouri

MISSOURI RADIO CENTER
102 NW BUSINESS PARK LANE
KANSAS CITY, MO 64150
(800) 821-7323
Missouri: (816) 741-8118
ICOM, Kenwood, Yaesu
Same day service, low prices.

Nevada

AMATEUR ELECTRONIC SUPPLY
1072 N. RANCHO DRIVE
LAS VEGAS, NV 89106
702-647-3114
Dale Porray "Squeak," AD7K
Outside Nev: 1 (800) 634-6227
Hours M-F 9-5:30, Sat. 9-3

New Hampshire

RIVENDELL ELECTRONICS
8 LONDONDERRY ROAD
DERRY, N. H. 03038
603-434-5371
Hours M-S 10-5; THURS 10-7
Closed Sun/Holidays

Dealers: YOU SHOULD BE HERE TOO!
Contact Ham Radio now for complete details.

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 K4IPV column, August 1988) R3 should have been R1. Equation 9 should have read:

$$X_{C2} = R2\sqrt{\frac{R1/R2}{(Q_2+1)-(R1/R2)}}$$

Equation 12 should have read:

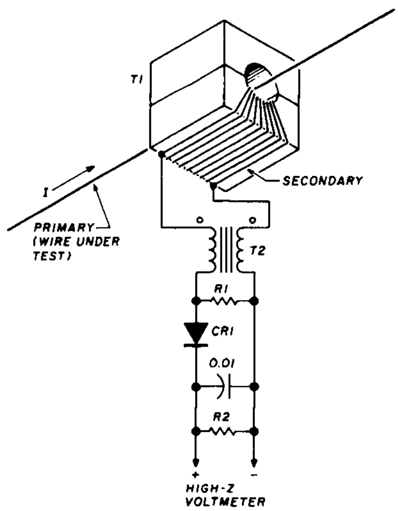
$$X_{C1B} = \frac{R1}{\sqrt{\frac{R1(Q^2+1)}{R2} - 1}}$$

Ed.

Corrected drawing

Corrected version of **fig. 1** for KO1F ham note "Easy Measurement of Antenna Currents," *Ham Radio*, September 1988, page 40.

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.

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 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 p-l-e-n-t-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**

1988-89 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. ©1988.
AR-RD88 **Softbound $4.95**
AR-2RD88 (Buy 2 & Save) **$7.95**

ANTENNAS
by John Kraus, W8JK, 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, helixes, 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-35422 **HARDBOUND $59.95**

1988 CALLBOOK SUPPLEMENT
The CALLBOOK SUPPLEMENT contains all of the new licenses, address and callsign changes from all the countries around the world. It also includes all of the new postal rate changes, current QSL bureaus, and many other helpful, handy features. A must for the active Ham -- it's the only way to have all the current addresses and callsigns. 320 pages © 1988
CB-S88 **Softbound $9.95**

EASY-UP ANTENNAS for Radio Listeners and Hams
by Ed Noll W3FQJ
Noll has 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 BCB'ers, present and prospective Hams and scanner listeners. Includes dipoles, 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**

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** **Hardbound $20.95**

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

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**

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 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 © 1988
NH-BEV **Hardbound $15.95**

SHORTWAVE DIRECTORY
by Bob Grove, 1988 Edition
Now includes both VLF 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 just about every user possible from the US Government to as 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 **Softbound $17.95**

1989 RADIO AMATEUR CALLBOOKS
(Available late November 1988)
GET YOURS NOW!

NORTH AMERICAN EDITION
Fully updated and edited to include all the latest FCC and foreign government callsigns 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
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 $28.95**

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

MASTERING PACKET RADIO: the hands on guide
by Dave Ingram K4TWJ
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 OCSARs 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 VHF SOCIETY CONFERENCE PAPERS
Papers in this book were submitted for the 1988 Central States VHF Society meeting. Includes: Microwave EME, predicting 144 MHz "Es" openings, matching versus noise figure trade-offs in pre-amps, 902 MHz transverter, power amplifier and antennas, how to measure your own K index plus much more. A must publication for the active VHF'er. ©1988
☐**AR-22CS** **Softbound $11.95**

PASSPORT TO WORLDBAND 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
☐**IBS-RDI89** **Softbound $14.95**

CONFIDENTIAL FREQUENCY LIST 7th EDITION now includes RTTY stations
Compiled by Geoff Halligeg
This new edition is jam-packed with all the latest frequencies, callsigns and other important information. Inside you'll 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.
GL-CF **Softbound $19.95**

MasterCard VISA

HAM RADIO BOOKSTORE

ANTENNA BOOKS

AM RADIO LOG BOOKS
RDER IN TIME FOR HOLIDAY GIVING
ick by popular demand
oom for over 2100 QSO — that's over twice as many as e other log book. For contesters, each page contains 30 SO's for east counts. You also get the latest up-to-date equency spectrum chart. ITU callsign list and ARRL DXCC t. Spiral bound to lay flat on your desk. Unquestionably e best log book value around. © 1988.

HR-LB — Spiralbound $2.95
HR-3LB Special buy 3 price, Save 22% Get 3 offer — $6.95

EVERAGE ANTENNA HANDBOOK
Victor Misek, W1WCR
ecognized around the world as the definitive work on everage Antennas. Misek delves deep into the secrets of e single wire Beverage and SWA (Steerable Wave Anten-) with helpful hints and tips on how to maximize perfor-ance based upon wire size, height above ground, overall ngth and impedance matching. Also includes information center fed Beverages constructed out of several wire pes. *CITY LOT OWNERS* Note: Misek has developed a everage for you too! Called the Micro-SWA, it is just 60 long. You get excellent directivity and null steering pabilities. Transformer design information for both term-ation and feedline matching is completely revised. 1987 80 pages 2nd Edition

VM-BAH — Softbound $14.95

RANSMISSION LINE TRANSFORMERS
Jerry Sevick, W2FMI
ontains a complete explanation and discussion of trans-ission 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
ased upon the popular Ham Radio Magazine series, this ok includes notes, charts, graphs as well as other addi-onal information not found in the original text. W2PV was own world-wide as one of the most knowledgeable ex-rts on antenna design and optimization. This book is full his contest winning "trade secrets." Eight chapters ver: Performance calculations, Simple Yagi antennas, gi antenna performance optimization, Loop antennas, e effects of ground, Stacking, Practical design, and actical Amateur Yagi antennas. A wealth of information a modest price—Lawson's book should sell for much ore—every Ham should get a copy for their bookshelf. 1986 1st edition

AR-YD — Hardbound $14.95

HE AMATEUR RADIO VERTICAL HANDBOOK
Cpt. Paul H. Lee, USN (Ret.), N6PL
sed upon the author's years of work with a number of ferent vertical antenna designs, you'll get plenty of the and design information along with a number of practi- construction ideas. Included are designs for simple 1/4 d 5/8-wave antennas as well as broadband and multi-ment directional antennas. Paul Lee is an engineer and d ham and is Amateur Radio's resident expert on the tical antenna. © 1984, 2nd edition

CQ-VAH — Softbound $9.95

1FB's ANTENNA NOTEBOOK
Doug DeMaw, W1FB
tennas have been one of DeMaw's passions in Amateur dio. He has worked with countless designs of all shapes d configurations. This fully illustrated book gives you w-to instructions on a number of different wire and verti-antennas for 160 through 10 meters. Also includes in-mation on radial systems, tuners, baluns and impedance nsformers. Easy and fun reading. © 1987 120 pages

AN — Softbound $7.95

GB HF ANTENNAS FOR ALL LOCATIONS
HF — $11.95

RL ANTENNA COMPENDIUM
AC — $9.95

ANTENNA BOOKS
by W6SAI & W2LX

BEAM ANTENNA HANDBOOK
RP-BA Beam antennas galore — $11.95

WIRE ANTENNA HANDBOOK
RP-WA Wire antennas for all installations — $11.95

ALL ABOUT CUBICAL QUAD ANTENNAS
RP-CQ "The" quad book — $9.95

INTERFERENCE HANDBOOK by WA6FQG
RP-IH Great reference text for RFI problems — $11.95

ALL ABOUT VERTICAL ANTENNAS
RP-VA Everything you want to know — $10.95

THE RADIO AMATEUR ANTENNA HANDBOOK
RP-AH Complete guide to antennas — $11.95

OTHER BOOKS

TRANSMITTER HUNTING: RADIO DIRECTION FINDING SIMPLIFIED
T-2701 All about DF'ing — $17.95

QRP HANDBOOK
AR-QRP by Noted QRP expert W1FB — $5.00

RADIO HANDBOOK by Bill Orr W6SAI
22424 "The source book" — $26.95

ARRL MICROWAVE UPDATE Sept. 1987
AR-MU Colorado Microwave Papers — $9.95

21st CENTRAL STATES CONFERENCE
AR-CS July 1987 papers — $9.95

RADIO COMMUNICATIONS RECEIVERS
MH-53570 by DJ2LR — $69.95

RACE ON THE EDGE OF TIME
MH-21088 The "roots" of RADAR — $19.95

DX POWER: EFFECTIVE TECHNIQUES
T-1740 The inside view to DX'ing — $9.95

THE COMPLETE DX'ER by W9KNI
ID-DX — $10.95

RSGB VHF/UHF MANUAL
RS-VH — $17.95

RADIO COMMUNICATION HANDBOOK
RS-RCH RSGB's Amateur Handbook — $21.95

THE BUYER'S GUIDE TO AMATEUR RADIO
RS-BG Handy book to have around — $11.95

MID-ATLANTIC VHF CONFERENCE
AR-MID — $9.95

Special Low Price Books

SOFTWARE FOR AMATEUR RADIO by G3ZCZ
T-1560 — $4.95

MICROCOMPUTERS IN AMATEUR RADIO by G3ZCZ
T-1305 — $4.95

PROGRAMMING FOR THE TI-59 & HP41
T-1442 — $4.95

TTL COOKBOOK
21035 REG. $14.95 — $9.95

REPAIR AND TROUBLESHOOTING GUIDES
22353 APPLE II, II+, IIe REG. $19.95 — $9.95
22358 IBM PC REG $19.95 — $9.95
22363 C-64 REG. $19.95 — $9.95

MICROPROCESSOR CIRCUITS
21877 VOL. 1 REG. $9.95 — $4.95

COMMODORE PROGRAMMER'S HANDBOOK
22056 REG. $19.95 — $9.95

APPLE PROGRAMMER'S HANDBOOK
22175 REG. $22.95 — $11.95

COMMODORE C-64 STARTER BOOK
22293 REG. $17.95 — $8.95

PACKET

YOUR GATEWAY TO PACKET RADIO
by Stan Horzepa, WA1LOU
Here is the complete beginner's guide to Packet Radio written by ARRL Packet expert, WA1LOU. Beginners will find the complete easy-to-understand explanations eliminate many of the frustrating aspects of packet operation. Full of helpful hints and tips that come from thousands of hours of on-the-air experience. Keep from re-inventing the wheel — learn from an expert. 208 pages 1987

AR-PKT — Softbound $9.95

GET***CONNECTED TO PACKET RADIO
by Jim Grubbs K9EI
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, packet accessories and 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, GLB/TAPR cross reference guide, Xerox 820 info, other publications, suppliers and WØRLI commands. Written in an easy-to-read, informal manner, this handbook is must reading for all packet users. © 1986 208 pages 1st edition

JG-PR — Softbound $12.95

THE PACKET RADIO HANDBOOK
by Jonathan Mayo, KR3T
Packet radio is the fastest growing mode in Amateur operation today. No wonder — it combines the power of today's microcomputer with worldwide digital communications. Newcomers will find this book to be full of helpful tips, tricks and information that will help get them on Packet as quickly as possible. Providing you first with packet basics, this book progresses through the inner workings and operational aspects of packet to a look at future technology still in developmental stages. Also includes: using bulletin boards, traffic handling on packet, modulation methods and networking principles, protocols (both AX.25 and VADCG) and a thorough discussion of the various TNCs and accessories available. © 1987 1st Edition 218 pages

T-2722 — Softbound $14.95

ARRL COMPUTER NETWORKING CONFERENCES 1-4
Pioneer Papers on Packet Radio 1981-1985
This collection of Packet Radio papers should be in every Packet enthusiasts shack! Written during the formulative years of Packet development, these papers (too numerous to mention them all) cover: theory, practical applications, protocols, software and hardware subjects. You also get a complete up-to-date collection of all published "Gateway", the ARRL Packet Radio newsletter. As big as the ARRL HANDBOOK. © 1985 over 1000 pages

AR-CNC — Softbound $17.95

5th ARRL COMPUTER NETWORKING CONFERENCE PAPERS
AR-CNC5 — Softbound $9.95

6th ARRL COMPUTER NETWORKING CONFERENCE
August 1987
AR-CNC6 — Softbound $9.95

ARRL OPERATING MANUAL
This book has been completely revised and up-dated! Over 600 pages are crammed full of the information every ham should have at their fingertips. In addition to message handling, emergency operating, repeaters and contesting, this book includes sections written by noted DX'ers W9KNI and WB4ZNH, a new section on packet radio and over 60 pages in full color describing operating awards from around the world. © 1987 688 pages

AR-OG — Softbound $14.95

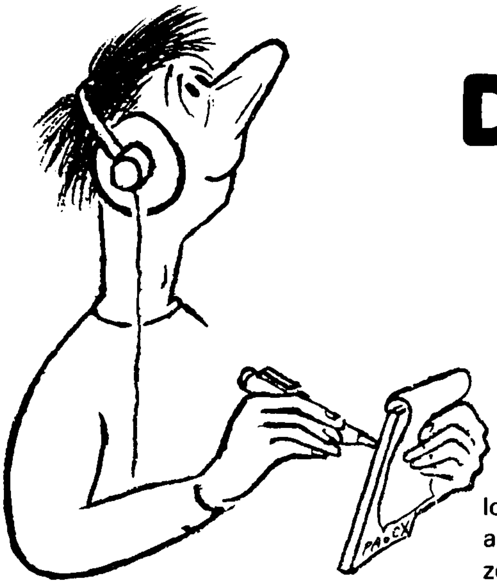
THE BASIC GUIDE TO VHF-UHF HAM RADIO
by Ed Noll W3FQJ
Written for the beginner, this book is designed to answer all the questions normally asked about getting on the higher frequencies. Set-up and operation of your first FM transceiver and easy-to-install antennas get priority. Includes hints on repeater operation, contests, multi-mode radios and much more. Emphasis on 6, 2, 135 cm and 70 cm bands. 1st edition 78 pages © 1987

TP-VHF — Softbound $6.95

lease enclose $3.50 shipping & handling.

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

MasterCard VISA



DX FORECASTER

Garth Stonehocker, KØRYW

Winter DX Anomalies

The winter DX season usually has higher signal strengths and lower thunderstorm noise 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 thunderstorms are located over 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 transmit points on the signal's propagation path. The southern position of the sun lowers this angle and, in turn, lowers the absorption.

The anomally 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 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.

DECEMBER

WESTERN USA

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

MID USA

MST	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	7:00	6:00	5:00	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	7:00	6:00	5:00	
ASIA FAR EAST	40	40	40	40	40	30	30	30	30	20	20	40	40	40	40	40	40	30	30	30	30	30	30	40	N
EUROPE	30	30	30	30	30	30	20	20	20	20	20	20	40	40	40	40	40	40	40	40	40	40	40	40	NE
S. AFRICA	15	15	12	12	10	10	10	10	10	12	12	12	15	20	20	20	20	20	20	20	20	20	20	20	E
S. AMERICA	12	12	10	10	10	10	10	12	12	12	15	15	20	20	20	20	20	20	20	20	20	20	15	15	SE
ANTARCTICA	12	12*	12	12	12	12	15	15	15	20	20	20	20	20	20	20	20	20	20	20	15	15	12	12	S
NEW ZEALAND	10	12	12	12	15	15	15	20	20	20	20	20	20	20	20	20	20	20	20	15	12	12	10	10	SW
OCEANIA AUSTRALIA	10	12	12	15	20	20	15	15	20	20	20	20	20	20	20	20	20	20	20	20	20	15	12	10	W
JAPAN	20	20	20	40	40	40	40	40	30	30	40	40	40	40	40	40	40	30	30	30	30	30	30	20	NW
CST	5:00	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	7:00	6:00	5:00	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	7:00	6:00	

EASTERN USA

EST	6:00	5:00	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	7:00	6:00	5:00	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	7:00	
ASIA FAR EAST	40	40	40	40	30	30	30	30	30	30	30	20	20	40	40	40	40	40	40	30	30	30	30	40	N
EUROPE	40	30	30	30	30	20	20	20	20	20	20	20	20	30	40	40	40	40	40	40	40	40	40	40	NE
S. AFRICA	20	20	15	12	12	10	10	10	10	10	12	12	12	15	20	20	20	20	20	20	20	20	20	20	E
CARIBBEAN S. AMERICA	12	12	10	10	10	10	10	10	12	12	12	15	15	20	20	20	20	20	20	20	20	20	15	15	SE
ANTARCTICA	12	12*	12*	12	12	12	12	15	15	15	20	20	20	20	20	20	20	20	20	20	20	20	15	15	S
NEW ZEALAND	12	10	10	10	12	15	15	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	15	SW
OCEANIA AUSTRALIA	10	10	12	12	15	20	20	20	15	15	15	20	20	20	20	20	20	20	20	20	20	20	20	12	W
JAPAN	20	20	20	40	40	40	40	40	40	30	30	40	40	40	40	40	40	40	30	30	30	30	30	30	NW

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.

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

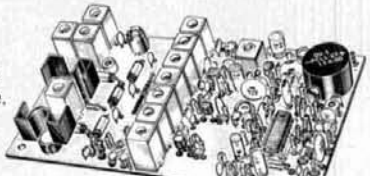
HAM RADIO

THE MOST AFFORDABLE REPEATER
ALSO HAS THE MOST IMPRESSIVE PERFORMANCE FEATURES
(AND GIVES THEM TO YOU AS STANDARD EQUIPMENT!)

KIT, ONLY $675
WIRED $975
VHF OR UHF

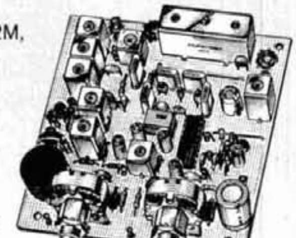
FEATURES:
- **SENSITIVITY SECOND TO NONE! GaAsFET front end** on vhf models gives 12dB SINAD of 0.12uV (vhf), 0.15uV (220). UHF model 0.25uV std, 0.1uV with optional helical resonator preamp.
- **SELECTIVITY THAT CAN'T BE BEAT!** Both 8-pole xtal filter & ceramic filter for **> 100dB at only ±12kHz.** Helical resonator front end to combat desense & intermod.
- **CLEAN, STABLE TRANSMITTER,** up to 18W output standard; 50W with accessory power amplifier.
- **FCC TYPE ACCEPTED** for commercial high band and uhf.
- **Courtesy beep,** field-programmable CWID, flutter-proof squelch, automatic frequency control to compensate for off-frequency transmitters (all standard features).
- **Full range of options** available, such as autopatch, phone line or radio remote control, sub-audible tones, duplexers.

HIGH PERFORMANCE TRANSMITTERS & RECEIVERS FOR REPEATERS AUDIO & DIGITAL LINKS, TELEMETRY, ETC.



- **FM EXCITERS:** Kits $99, W/t $179. 2W continuous duty. TCXO & xtal oven options available.
- **TA51 for 10M, 6M, 2M, 150-174, 220 MHz.**
- **TA451 for uhf.**

FCC type accepted for commercial bands.
- Call for latest information on 900 MHz transmitters.
- **VHF & UHF AMPLIFIERS.** For FM, SSB, ATV. Output from 10 to 50 Watts. Several models, kits starting at $79.



- **R144/R220 FM RECEIVERS** for 2M, 150-174, or 220 MHz. **GaAs FET** front end, 0.12uV sensitivity! Both crystal & ceramic filters plus helical resonator front end for exceptional selectivity: > 100dB at ±12kHz (best available anywhere)! Flutter-proof squelch. AFC tracks drifting transmitters. Kit $149, w/t $229.
- **R451 UHF FM RCVR.** Similar to above. Tuned line front end, 0.25uV sens. (0.1uV with optional hel. res. preamp). Kit $149, w/t $229.
- **R901 FM RCVR FOR 900 MHZ.** Triple-conversion, GaAs FET front end, 0.2uV sens. Kit $169, w/t $259.
- **R76 ECONOMY VHF FM RCVR** for 10M, 6M, 2M, 220. Without hel res or afc. Kits only $129.
- **Weather satellite & AM Aircraft receivers also avail.**

FCC TYPE-ACCEPTED TRANSMITTERS & RECEIVERS AVAILABLE FOR HIGH-BAND AND UHF. CALL FOR DETAILS.

GaAs FET PREAMPS
at a fraction of the cost of comparable units!

LNG -(*)
GaAs FET PREAMP

ONLY $59!
Wired/tested

FEATURES:
- **Very Low Noise:** 0.7dB VHF, 0.8dB UHF
- **High Gain:** 13-20dB, depending on frequency
- **Wide Dynamic Range:** to resist overload
- **Stable:** new-type dual-gate GaAs FET

** Specify tuning range desired: 26-30, 46-56, 137-150, 150-172, 210-230, 400-470, or 800-960 MHz.*

LNW -(*)
MINIATURE GaAs FET PREAMP

ONLY $24/kit, $39 Wired/tested

GaAs FET Preamp similar to LNG, except designed for **low cost & small size**. Only 5/8"W x 1-5/8"L x 3/4"H. Easily mounts in many radios.

** Specify tuning range desired: 25-35, 35-55, 55-90, 90-120, 120-150, 150-200, 200-270, or 400-500 MHz.*

LNS-(*)
IN-LINE PREAMP

ONLY $79/kit, $99 Wired/tested

GaAs FET Preamp with features similar to LNG series, except **automatically switches out of line during transmit.** Use with base or mobile transceivers up to 25W.

**Specify tuning range desired: 120-175, 200-240, or 400-500 MHz.*

HELICAL RESONATOR PREAMPS

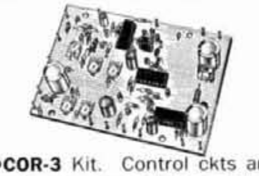
Low-noise preamps with helical resonators **reduce intermod & cross-band** interference in critical applications.
MODEL HRA-(*), $49 vhf, $84 uhf.

** Specify tuning range desired: 143-150, 150-158, 158-162, 162-174, 213-233, 420-450, 450-465, or 465-475 MHz.*

NEW HIGH-SPEED DIGITAL RF LINKS

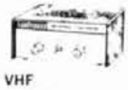
You've waited a long time for a simple, reliable, **low-cost 9600 baud PACKET NETWORKING system.** Now you've got it! Our new MO-96 MODEM and direct FSK Transmitters and Receivers for 220 or 440 MHz interface directly with most TNC's. Fast diode switched PA's output 15 or 50W. **Call for complete info on the right system for your application.**

ACCESSORIES



- **COR-3** Kit. Control ckts and audio mixers needed to make a repeater. Tail & time-out timers, local spkr ampl, courtesy beep $49
- **CWID** Kit. Field programmable, timers, the works $59
- **TD-2 DTMF DECODER/CONTROLLER** Kit. Full 16 digits, switches 5 functions, toll call restrictor, programmable, much more. Great for selective calling too! $79
- **AP-3 AUTOPATCH** Kit. Use with above for repeater autopatch. Reverse patch and phone line remote control std. ... $79
- **AP-2 SIMPLEX AUTOPATCH TIMING BOARD** Kit. Use with above for simplex autopatch $39
- **MO-202 FSK DATA MODULATOR** Kit. Run up to 1200 baud digital signals through any fm transmitter with full handshakes. Radio link computers, telemetry gear, etc. $39
- **DE-202 FSK DATA DEMODULATOR** Kit for rcvr end of link $39

RECEIVING CONVERTERS



VHF MODELS
- Kit with Case $59
- Kit less Case $39
- Wired w/case $89

UHF MODELS
- Kit with Case $69
- Kit less Case $49
- Wired w/case $99

Antenna Input Range	Receiver Output
28-32	144-148
50-52	28-30
50-54	144-148
136-138	28-30
144-146	28-30
145-147	28-30
146-148	28-30
220-222	28-30
220-224	50-54
222-224	28-30
432-434	28-30
435-437	28-30
432-436	144-148
432-436	50-54
439.25	61.25
902-928	422-448
902-922	430-450

See catalog for full line of 2w transmitting converters for vhf & uhf. Kits only $79. Linear Amplifiers avail. up to 50 w.

- **Send $1 for 36 page catalog by return mail.** (Send $2.00 or 4 IRC's for overseas mailing)
- **Order by phone or mail • Min $3 S & H per order**
- **Use Visa, Mastercard, Check, or UPS COD.**

Our 25th Anniversary

hamtronics, inc.
65-H MOUL ROAD•HILTON NY 14468-9535
Phone: 716-392-9430 Hamtronics® is a registered trademark

ASSOCIATED RADIO

8012 CONSER BOX 4327
OVERLAND PARK, KANSAS 66204

VISA-MC
AMEX-DISC.

EVERY DAY A HAMFEST

BUY — SELL — TRADE

ALL BRANDS NEW AND RECONDITIONED

WE'LL BUY YOUR EXTRA RIG

STATIONS-ESTATES ETC.

Call 913/381-5900

FAX 913 648 3020

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.

KB1T, Box 1015-H, Amherst, NH 03031

Discover CAROLINA WINDOM

80-10 M
Use transmatch
132' overall
Matching XFMR
Line Isolator
Vert Radiator
Coax fed
Assembled
$69.96

High performance
Proven results
$70 Beam?

The RADIO WORKS

Your Passport To a world Of new ideas And exceptional HF wire antennas

Rugged new baluns
Full range of HF, UHF, mobile antennas, ducks, wire, coax, parts, line, accessories.

SEE WHAT WE'RE DOING NOW!

Contact Jim, W4THU
- free discount catalog
Send $1 for catalog by 1st Class mail.
Box 6159, Portsmouth, VA 23703
(Dealer inquiries welcome)

804-484-0140

CAROLINA WINDOM

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 on 80 - 10. A $70 beam? If you hear one, you'll want one.

Made with pride by The RADIO WORKS in VA/USA

190

"ONLINE" U.S. CALL DIRECTORY

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

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

188

NEW SUPER LONG PLAY TAPE RECORDERS

12 Hour Model — $105.00*

USES D-120 TAPE

Modified Panasonic Slimline, high quality, AC-DC Recorders provide 6 continuous hours of quality recording & playback on each side of cassette for a total of 12 hours. Built-in features include • Voice level control, • Digital counter, etc. TDK DC 120 Cassette Furnished.

PHONE RECORDING ADAPTER

Records calls automatically. All Solid state connects to your telephone jack and tape recorder. Starts recording when phone is lifted. Stops when you hang up. **$24.50***

FCC APPROVED

VOX VOICE ACTIVATED CONTROL SWITCH

Solid state. Self contained. Adjustable sensitivity. Voices or other sounds automatically activate and control recorder. Uses either recorder or remote mike. **$24.95***

*Add for ship & hdlg. Phone Adapter & Vox $1.50 ea. **Recorders $4.00 ea. Cal. Res. add tax. Mail order, VISA, M/C, COD's OK. Money Back Guarantee. Qty. disc. avail., Dealer Inquiries invited, Free data. ©

AMC SALES INC., DeptH 9335 Lubec St., Box 928, Downey, CA 90241 Phone (213) 869-8519

189

Sparky J Antennas

• Install Fast • Extend Range • Improve Reception •

The Sparky J-Antenna is a flexible half wave radiator fed by 1/2 wavelengths of low loss coax through an efficient linear matching transformer. Sparky J's beat duckies, 1/4, & 5/8 wave antennas, need no ground plane. Low flat SWR curve gives edge to edge band coverage. Great portable--rolls up to fit in pocket. Completely assembled with BNC connector.

• Easily hidden • Effective indoors or out. • Money-back guarantee •

Available for every band from 50 to 440 MHz

$39.95 each Two for $65.00 Add $5 P & H

Int-pack $1 by 1st class mail

AntennasWest

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

122

TEXPRO

snap -on- choke

ELIMINATES RF INTERFERENCE IN: TV sets, Radios, 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 rewire connectors. Unique, split ferrite core design fits up to RG8U coax cables.

WORKS IN "COMMON MODE", filters current induced in the braid of shielded cables and ground wires!

Special ferrite material effective 0.5 - 200 MHz.

DOES NOT VOID EQUIPMENT WARRANTY

Availuble from your dealer or order direct from:

computeradio
Box 282, Pine Brook, NJ 07058
Tel: (201) 227-0712

Package of 4 chokes with inst. instructions
$12.99
+ $2.00 shipping

Send personal check with order, we ship same day First Class. 30-day money back warranty. Quantity discounts.

191

ELMER's NOTEBOOK

Tom McMullen, W1SL

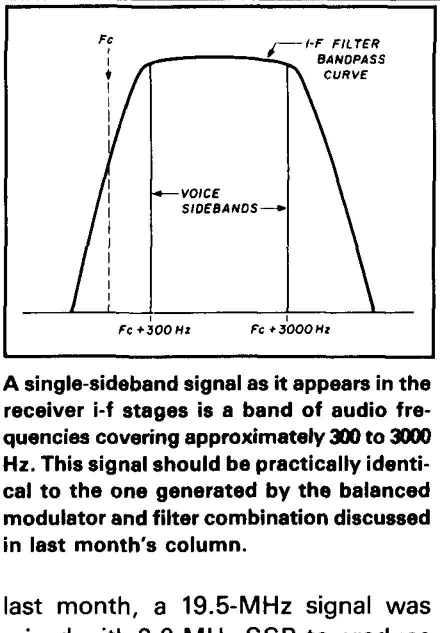
SSB basics — receiving the signal

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 then filtered before being amplified and transmitted. In fact, many of today's popular transceivers use the very same filters for the i-f in receiving a signal as they do for generating the sidebands in a transmitter. The filter is switched between the receiving and transmitting circuitry by means of diodes and/or transistors, and thus made to serve double duty. The resulting output from this filter is a range of voice "sidebands" that covers approximately 300 to 3000 Hz, just as in the transmitter. (See **fig. 1**.)

FIGURE 1

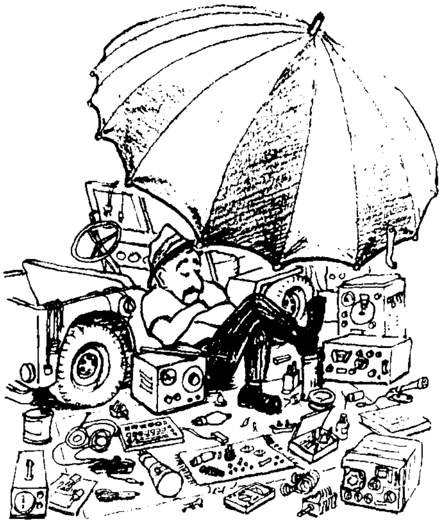


A single-sideband signal as it appears in the receiver i-f stages is a band of audio frequencies covering approximately 300 to 3000 Hz. This signal should be practically identical to the one generated by the balanced modulator and filter combination discussed in last month's column.

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



FLEA MARKET

RATES Noncommercial ads 10¢ per word; commercial ads 60¢ per word **both payable in advance**. No cash discounts or agency commissions allowed.

HAMFESTS Sponsored by non-profit organizations receive one free Flea Market ad (subject to our editing) on a space available basis only. Repeat insertions of hamfest ads pay the non-commercial rate.

COPY No special layout or arrangements available. Material should be typewritten or clearly printed (**not** all capitals) and must include full name and address. We reserve the right to reject unsuitable copy. **Ham Radio** cannot check each advertiser and thus cannot be held responsible for claims made. Liability for correctness of material limited to corrected ad in next available issue.

DEADLINE 15th of second preceding month.

SEND MATERIAL TO: Flea Market, Ham Radio, Greenville, N. H. 03048.

BEGINNER'S RADIO CLEARINGHOUSE. On a space available basis, we are going to offer you, OUR SUBSCRIBER, free of charge, a chance to find a home for your used equipment with a new Ham. Please send us a short description of what you want to sell along with price, name, address and phone number. We'll run it once in a special section of the classified ads under the heading of BEGINNER'S RADIO CLEARINGHOUSE. Please limit your ad to 20 words or less.

HELP! Budding Novice inherited Galaxy Xcvr w/out power supply. Desperately need supply or manual. Please help. M.C. MacDonald, 333 No. 17th St, San Jose, CA 95112.

BEGINNER needs MorseMaster II by Stone Mountain Engineering. Advise your selling price. Roy Keeley, Rt3, Box 316, Theodore, AL 36582.

SELL: NCX-3 transceiver with ac supply. 80-40-20 SSB, CW. $100 or best offer. Grant Zehr, WA9TFB (309)-662-8210.

SWAP Hamerlund 180 Rcv, mint, for Drake T4XC. Ed Malinowski, Rt 1, Loyal, WI 54446. Phone 1-715-255-9958.

COMPUTER CODE COURSE: Apple II + /c/e/GS. C-64/128. 37 modes, graphics, 1-100 WPM, menus, proportional spacing, variable frequency, more ($29.95). With word processor ($39.95). Manual ($10). Check/MO. LARESCO, POB 2081-HR, Calumet City, IL 60409. 1-312-891-3279.

UHF PARTS. GaAs Fets, mmics, chip caps, feedthrus, teflon pcb, high Q trimmers. Moonbounce quality preamps. Electronic sequencer boards. Send SASE for complete list or call (313) 753-4581 evenings. MICROWAVE COMPONENTS, PO Box 1697, Taylor, MI 48180.

KITS*PARTS*PLANS. We have hard to find parts! Variable tuning capacitors, tuning coils, crystal and magnetic headphones, germanium diodes, crystal, shortwave and tube type kits. Very inexpensive. Send 25 cent stamp for catalog. Yeary Communications, 12922 Harbor #800HR, Garden Grove, CA 92640.

CUSTOM EMBROIDERED EMBLEMS, & Enameled Pins, your design, excellent quality, low prices, free booklet. A.T. PATCH CO, Box 682 Dept 19, Littleton, NH 03561. (603) 444-3423).

QUALITY HAM SOFTWARE for the IBM-PC and compatibles. Many shareware and public domain disks for all aspects of ham radio. Business SASE for catalog. JK&S Dept HC, PO Box 50521, Indianapolis, IN 46250-0521.

COMMODORE/AMIGA chips, parts, diagnostics, hard to find items. Authorized service center. Fast repairs, low cost (eg. C64-$49.49 plus UPS). Heavy duty power supplies for the C64-$28.00 plus UPS. KASARA MICROSYSTEMS, Inc, 24 West Street, Spring Valley, NY 10977. 1-800-248-2983 (outside NY) or 914-362-3131.

IBM-PC RTTY/CW. New CompRtty II is the complete RTTY/CW program for IBM-PC's and compatibles. Now with larger buffers, better support for packet units, pictures, much more. Virtually any speed ASCII, BAUDOT, CW. Text entry via built-in screen editor! Adjustable split screen display. Instant mode/speed change. Hardcopy, diskcopy, break-in buffer, select calling, text file transfer, customizable full screen logging, 24 programmable 1000 character messages. Ideal for MARS and traffic handling. Requires 256k PC or AT compatible, serial port, RS-232C TU. $65. Send call letters (including MARS) with order. David A. Rice, KC2HO, 144 N. Putt Corners Rd, New Paltz, NY 10219.

FLOOD YOUR MAILBOX! You get 100's of radio and electronics specialty catalogs. Send $2, name and address to: Electronic List Services, Dept C, PO Box 1683, Brookline, MA 02146.

HAMLOG COMPUTER PROGRAMS. Full features. 17 modules, auto-logs, 7-band WAS/DXCC. Apple $19.95, IBM or CP/M, KAYPRO, Tandy, C128 $24.95. HR-KA1AWH, POB 2015, Peabody, MA 01960.

VHF-UHF-SHF. Large SASE. West Coast VHFer, POB 685, Holbrook, AZ 86025.

CHASSIS & CABINET KITS. SASE. K3IWK, 5120 Harmony Grove Rd, Dover, PA 17315.

CALL SIGN BADGES: Custom license plate holders. Personal, distinctive. Club discounts. SASE. WB3GND, Box 750, Clinton, MD 20735. (301) 248-7302.

ANALOG AND RF CONSULTING for the San Francisco Bay area. Commercial and military circuits and systems. James Long, Ph.D., N6YB (408) 733-8329.

RTTY JOURNAL—Now in our 36th year. Read about RTTY, AMTOR, PACKET, MSO'S, RTTY CONTESTING, RTTY DX and much more. Year's subscription to RTTY JOURNAL $10.00, foreign slightly higher. Order from: RTTY JOURNAL, 9085 La Casita Ave., Fountain Valley, CA 92708.

CHRISTIAN AIRCRAFT MECHANIC wants family out of big city. Seeking farm, ranch, logging, other country opportunities. Call (512) 695-3006. N5MPW.

RUBBER STAMPS: 3 lines $5.00 PPD. Send check or MO to G.L. Pierce, 5521 Birkdale Way, San Diego, CA 92117. SASE brings information.

ELECTRON TUBES: Receiving, transmitting, microwave... all types available. Large stock. Next day delivery, most cases. DAILY ELECTRONICS, PO Box 5029, Compton, CA 90224. (213) 774-1255.

WANTED: Amateur related video tapes of large antenna arrays, unusual equipment or events, or anything out of the ordinary for personal collection. Beta or VHS format. Will pay all costs involved. Ron Rollinson, NR8O, 128 Julep, Cincinnati, Ohio 45218.

CUSTOM MADE EMBROIDERED PATCHES. Any size, shape, colors. Five patch minimum. Free sample, prices and ordering information. HEIN SPECIALTIES, Inc., Dept 301, 4202 N. Drake, Chicago, IL 60618.

WANTED: Military Surplus Radio Equipment. We need ARC-164, ARC-114, ARC-115, ARC-116, ARC-150, ARC-159, ARC-186, ARN-127, ARN-118, RT-1159A, APN-171, RT-524/VRC, RT-246/VRC, antenna couplers 490T-1, 490T-9, 490S-1, CU-1658A/ARC, CU-1669/GRC, CU-937/UR, CU-2007/URR. Top dollar paid or trade for new Amateur gear. Write or phone Bill Slep (704) 524-7519, SLEP ELECTRONICS COMPANY, Highway 441, Otto, NC 28763.

RECONDITIONED TEST EQUIPMENT $1.25 for catalog. Walter, 2697 Nickel, San Pablo, CA 94806.

COMING EVENTS

Activities — "Places to go . . ."

SPECIAL REQUEST TO ALL AMATEUR RADIO PUBLICITY COORDINATORS: PLEASE INDICATE IN YOUR ANNOUNCEMENTS WHETHER OR NOT YOUR HAMFEST LOCATION, CLASSES, EXAMS, MEETINGS, FLEA MARKETS, ETC, ARE WHEELCHAIR ACCESSIBLE. THIS INFORMATION WOULD BE GREATLY APPRECIATED BY OUR BROTHER/SISTER HAMS WITH LIMITED PHYSICAL ABILITY.

INDIANA: January 7. South Bend Hamfest Swap & Shop, first Saturday after New Year's Day, Century Center downtown on US 33 Oneway North between Trustcorp Bank Building and river. Four lane highways to door from all directions. Tables: $5/5 ft. round; $15/8x2.5 rectangular; $20/8 ft. wall locations. Talk in freq: 52-52, 99-39, 69-09, 34-94, 145.29. K9IXU (219) 233-5307.

WISCONSIN: January 14. The West Allis Radio Amateur Club's 17th annual Midwinter Swapfest, Waukesha Co. Expo Center Forum, 8 Am to 3 PM. Admission $2/advance; $3/door. 4' tables $3/advance; $4/door. Elec $5. Dealers welcome. Amateur exams—write for details. For tickets or information write WARAC Swapfest, POB 1072, Milwaukee, WI 53201. SASE please.

OPERATING EVENTS

"Things to do . . ."

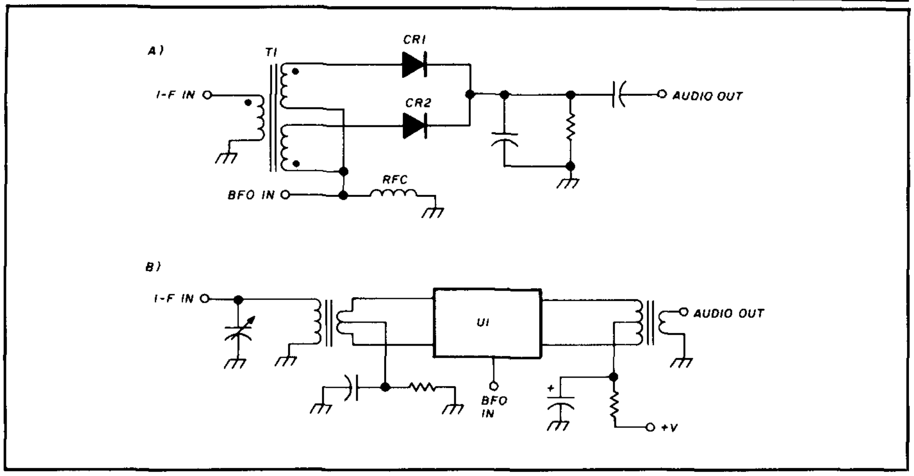
December 3: The Everglades ARC will operate W4SVI 1400Z December 3 to 1900Z December 4 from Flamingo, Florida, to celebrate the 41st anniversary of Everglades National Park. Send QSL and 2 unit stamps for unfolded certificate to EARC, POB 113, Homestead, FL 33090-0113. Novice certificate for those who identify as Novices on 2 of 3 bands. No stamps required.

December 17-23: The Iowa Radiosport Society will be operating special event station K200RW in celebration of the Constitutional Bicentennial and the 150th anniversary of Burlington, Iowa as the first territorial capitol. CW and SSB. Special QSL cards will be available for SASE, SAE and IRC sent to 923 N. 9th Street, Burlington, IA 52601.

December 24: The Garland Amateur Radio Club will operate K200QHD from Garland, Texas. 0001Z to December 30 2359Z. 80-10m, CW, SSB and Digital. For a special QSL send your QSL and SASE to KF5PE, 2934 Cotton Gum Road, Garland, TX 75044.

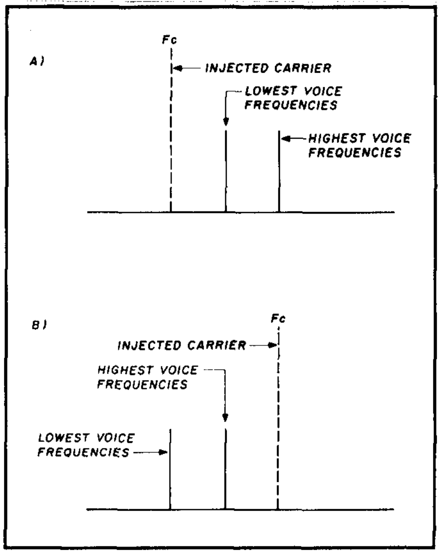
THE MIT UHF REPEATER ASSOCIATION and the MIT Radio Society offer monthly HAM EXAMS. All classes Novice to Extra. Wednesday, December 21, 7 PM, MIT Room 1-150, 77 Mass Avenue, Cambridge, MA. Reservations requested 2 days in advance. Contact Ron Hoffmann at (617) 484-2098. Exam fee $4.50. Bring a copy of your current license (if any), two forms of picture ID, and a completed form 610 available from the FCC in Quincy, MA (617) 770-4023.

FIGURE 2



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.

FIGURE 3



Placing the local carrier on the wrong side of the SSB signal can produce unintelligible audio. At A, the carrier is correctly placed below the upper sideband signal and the audio is "right-side-up." If the carrier is placed on the other side, as at B, the audio is inverted; i.e., the higher voice frequencies are near the carrier and the lower ones are farther from it. The resulting inverted voice frequencies are unreadable.

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. Incidently, 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

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 improved 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 **HAM RADIO**

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)

Frequency: all amateur (1.8 - 21 MHz)
Drive: 50 - 80 watts for full output
Output: 1500 watts PEP
Input Impedence: 50 ohms unbalanced
Input VSWR: 1.5:1 (higher on WARC)
Output Impedence: 50 ohms unbalanced
Harmonic Supp: greater than -45 dB
Intermod prods: more than -35 dB down
Duty: CCS (cont. commercial svc.)
Tubes: EIMAC 3CX800A7 (two)
ALC: 0 to -6 VDC
Output Configuration: Pi-L
AC Power: 230 VAC at 20A
Size (WHD in inches) & Weight
Microcontroller: 10x6x9 at 5 lbs
RF/AC unit: 14x22x13 at 86 lbs

EEB

Orders: 800-368-3270

Local & tech info 703-938-3350

Electronic Equipment Bank

516H Mill St. NE, Vienna, VA 22180

(just minutes from Washington, DC)

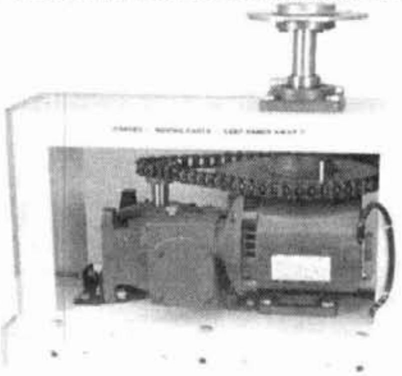
✓ 198

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 (wlh)

Write for complete specs and installation information

Distributed Exclusively by EEB

EEB

Orders: 800-368-3270

Local & tech info 703-938-3350

Electronic Equipment Bank

516H Mill St. NE, Vienna, VA 22180

(just minutes from Washington, DC)

✓ 199

NEW products

(continued from page 104)

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 1300A 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 handheld 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 C9090, Everett, Washington 98206 or call toll free 800-443-5853, 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 accomodate 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 microhm meters.

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.

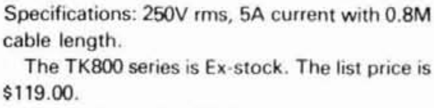
The TK800 series is Ex-stock. The list price is $119.00.

For details contact OK Industries, 4 Executive Plaza, Yonkers, New York 10701, 1-800-523-0667.

Circle #312 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 redial, 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 #313 on Reader Service Card.

ADVERTISER'S INDEX AND READER SERVICE NUMBERS

Listed below are the page and reader service number for each advertiser in this issue. For more information on their products, select the appropriate reader service number make a check mark in the space provided. Mail this form to *ham radio* Reader Service, I.C.A., P.O. Box 2558, Woburn, MA 01801.

Name ______________________ Call ____________

Address ______________________

City ______________ State ________ Zip ________

*Please contact this advertiser directly. Please use before January 31, 1989.

PRODUCT REVIEW/NEW PRODUCT

ORDER TOLL-FREE 1-800-821-7323

204

Dependable Service At The Right Price . . . Everytime

MasterCard—VISA—Discover

Missouri Radio Center

KENWOOD

TS-940 "DX-CELLENCE"
- All Band, All Mode Transceiver
- Direct Keyboard Entry
- Engineered for the DX-Minded and Contesting Ham
- Its Got It All!

YAESU

FT-767GX HF/VHF/UHF BASE STATION
- Add Optional 6m, 2m & 70cm Modules
- Dual VFO's
- Full CW Break-in
- Lots More Features

ICOM

IC-761 HF "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

SALE PRICED

KENWOOD

TS-140S AFFORDABLE DX-ing!
- HF Transceiver With General Coverage Receiver
- All HF Amateur Bands
- 100 W Output
- Compact, Lots of Features

YAESU

NEW!

FT-736R VHF-UHF BASE STATION
- SSB, CW, FM on 2 Meters and 70 cm
- Optional 50 MHz, 220 MHz or 1.2 GHz
- 25 Watts Output on 2 Meters, 220 and 70 cm
- 10 Watts Output on 6 Meters and 1.2 GHz • 100 Memories

ICOM

IC-781 NEWEST SUPER RIG
- 5 Function Display Screen
- Built-in Spectrum Scope
- 150 Watts Output
- Built-in PS and AT

rf concepts

2m and 220 MHz Amplifiers GaAsFET Receive Pre-Amps and High SWR Shutdown Prctection

MODEL	144 MHz
2-23	2 in/30 out
2-217	2 in/170 out
2-117	10 in/170 out
	220 MHz
3-22	2 in/20 out
2-211	2 in/110 out
3-312	30 in/120 out

SALE PRICED

CALL

KENWOOD

TM-721A DELUXE FM DUAL BANDER
- 2 Meters (138.000-173.995 MHz) 70 cm (438.000-449.995 MHz) Receiver Range
- 45 Watts on 2 Meters 35 Watts on 70 cm
- 30 Memory Channels

YAESU

FT-212RH

THE "ANSWERING MACHINE" MOBILE
- Rx: 138-174 MHz
- Tx: 144-148 MHz
- 45W Output
- Digital Voice Recorder
- FT-712 RH for 70cm

ICOM

IC-900 SIX BANDS IN ONE MOBILE
- Remote Controller, Interface A Unit, Interface B Unit, Speaker, Mic and Cables
- Six Band Units to Choose
- 10 Memories Per Band
- Programmable Band Scan
- Fiber Optic Technology

SALE

ASTRON

• RS7A $50	• RS35M . . $155
• RS12A . . . $72	• VS35M . . $175
• RS20A . . . $92	• RS50A . . $199
• RS20M . . $109	• RS50M . . $225
• VS20M . . $129	• RM50M . $245
• RS35A . . $139	• VS50M . . $239

KENWOOD

TH-25AT

POCKET-SIZED AND POWERFUL
- Frequency Coverage: 141-163 MHz (Rx), 144-148 MHz (Tx)
- Front Panel DTMF Pad
- 5 Watts Output
- 14 Memories
- TH-45AT Available for 440 MHz

YAESU

FT23/73R
- Super "Mini" HT's
- Zinc-Aluminum Alloy Case
- 10 Memories
- 140-164 MHz, 440-450 MHz
- 2W Battery Pack or Optional 5W Pack

ICOM

IC-μ2AT
IC-μ4AT

MICRO HT'S FOR 2M, 440
- Pocket Size HT Fun
- Ten Memories
- LCD Readout
- Wideband Coverage
- Up to 3 Watts Output
- 32 Built-in Subaudible Tones

Kantronics

KAM
- Packet, WEFAX, ASCII, AMTOR, RTTY, CW
- Simultaneous Operation on HF and VHF
- Personal Packet Mailbox™

SALE PRICED

102 N.W. Business Park Lane Kansas City, MO 64150
Call For Best Trade-In Deal

Call Toll Free—9am - 6pm Mon.-Fri. 9am - 2pm Sat.
In Missouri Call—816-741-8118

MOST ORDERS SHIPPED SAME DAY

YAESU • UNIDEN • RF CONCEPTS • NYE VIKING • MIRAGE/KLM • MFJ • LARSEN • KENWOOD • KANTRONICS

• DAIWA • HUSTLER HYGAIN • ICOM •

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!

The brains of a base station. "Sophisticated operation" takes on new meaning in the FT-411. You get 49 memories, plus dual VFOs for quick band-hopping. Keyboard frequency entry. Automatic repeater shift. DTMF autodialer with ten memories of up to 15 digits each. *Built-in CTCSS encode/decode.* Selectable channel steps: 5/10/12.5/20/25 kHz. Programmable band scan with upper/lower limits. Selectable memory scan. And extended receive coverage of 140-174 MHz (MARS/CAP permit required for transmit on 140-150 MHz).

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 (defeatable) 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

✓ 207

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

...pacesetter in Amateur Radio

All New Compact HF!

"DX-citing!"

TS-440S Compact high performance HF transceiver with general coverage receiver

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 key-down for periods exceeding one hour. RF input power is rated at 200 W PEP on SSB, 200 W DC on CW, AFSK, FM, and 110 W DC AM. (The PS-50 power supply is *needed for continuous duty.*)
- **Adjustable dial torque**
- **100 memory channels**
  Frequency and mode may be stored in 10 groups of 10 channels each. Split frequencies may be stored in 10 channels for repeater operation.
- **TU-8 CTCSS unit (optional)**
- **Superb interference reduction**
  IF shift, tuneable notch filter, noise blanker, all-mode squelch, RF attenuator, RIT/XIT, and optional filters fight 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**

Optional accessories:
• AT-440 internal auto. antenna tuner (80 m–10 m) • AT-250 external auto. tuner (160 m–10 m) • AT-130 compact mobile antenna tuner (160 m–10 m) • IF-232C/IC-10 level translator and modem IC kit • PS-50 heavy duty power supply • PS-430/PS-30 DC power supply • SP-430 external speaker • MB-430 mobile mounting bracket • YK-88C/88CN 500 Hz/270 Hz CW filters • YK-88S/88SN 2.4 kHz/1.8 kHz SSB filters • MC-60A/80/85 desk microphones • MC-55 (8P) mobile microphone • HS-5/6/7 headphones • SP-40/50B mobile speakers • MA-5/VP-1 HF 5 band mobile helical antenna and bumper mount • TL-922A 2 kw PEP linear amplifier • SM-220 station monitor • VS-1 voice synthesizer • SW-100A/200A/2000 SWR/power meters • TU-8 CTCSS tone unit • PG-2S extra DC cable.

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

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