FLASH
220-222 MHz
LOST!
SEE Page 4

SEPTEMBER 1988 $2.50

HAM RADIO

A Direct Digital Synthesis VFO

The Weekender:

An easy-to-build NiCd pulse charger

Processor for code tapes

Plus...

All your favorite columnists, Ham Notes, and more!

ICOM

IC-761 HF Transceiver

1988 Canada/USSR Trans Polar Ski Trek

"For more than three months, under the most exacting conditions, the Icom equipment performed superbly in support of the Polar Bridge Expedition. . . Icom equipment was our first choice."
— Barry Garratt VE3CDX/VE8CDX/4K0DX, Chief Operator/North Pole 28
1988 Canada/USSR Trans Polar Ski Trek

ICOM IC-761 ON TOP OF THE WORLD

The Canada/USSR Trans Polar Ski Trek did not include leeway for second best. That's why they chose Icom's IC-761 HF transceiver. With amateur radio as the sole means of communication in their 1,240 mile venture across the frozen Arctic, exceptional performance and dependability were vital to their mission. Just as they are to your globe-spanning home station activities.

THE COMPLETE HF TRANSCEIVER!

Includes: • Built-in AC power supply • Automatic antenna tuner • 105dB dynamic range • Exceptionally low phase noise • 100W output on most modes • 100% duty cycle • High stability crystal oscillator • Self-calibrating SWR bridge • Multiple filter selection • Dial or front keypad frequency selection • 32 memories • All bands, all modes with general coverage receiver • Passband tuning • IF shift • Built-in iambic keyer • Semi or full QSK rated at 60WPM • Built-in wide/narrow SSB and CW filters.

BEST IN RELIABILITY!

Field proven top performance backed by a one-year warranty and four North American service centers. Icom's IC-761. . . when there is no room for second best.

✓ 115

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. 761688

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

- **Initiate phone calls from your HT or mobile**
- **Receive incoming phone calls**
- NEW! **Telephone initiated control . . .**
  - ✓ **Operate your base station with complete control from any telephone**
  - ✓ **Change frequencies from the controlling telephone**
  - ✓ **Selectively call mobiles using regenerated DTMF from any telephone**
  - ✓ **Eavesdrop the channel from any telephone**
  - ✓ **Use as a wire remote using ordinary dial up lines and a speaker phone as a control head.**

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

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

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

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

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

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

✓ = NEW FEATURE

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

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

OPTIONS

1. ½ second electronic voice delay
2. FCC registered coupler
3. CW ID chip

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

AMATEUR ELECTRONIC SUPPLY
Milwaukee WI, Wickliffe OH, Orlando FL, Clearwater FL, Las Vegas NV
BARRY ELECTRONICS CORP.
New York NY
EGE, Inc.
Woodbridge VA
ERICKSON COMMUNICATIONS
Chicago IL
HAM RADIO OUTLET
Anaheim CA, Burlingame CA, Oakland CA, Phoenix AZ, San Diego CA, Van Nuys CA, Atlanta GA

HENRY RADIO
Los Angeles CA
INTERNATIONAL RADIO SYSTEMS
Miami FL
JUNS ELECTRONICS
Culver City CA
MADISON ELECTRONICS SUPPLY
Houston TX
MIAMI RADIO CENTER CORP.
Miami FL
MIKES ELECTRONICS
Ft. Lauderdale, Miami FL
N&G DISTRIBUTING CORP.
Miami FL

OMNI ELECTRONICS
Laredo TX
PACE ENGINEERING
Tucson AZ
THE HAM STATION
Evansville IN
WESTCOM
San Marcos CA
CANADA:
CARTEL ELECTRONIC DISTRIBUTORS
Surrey B.C.
COM-WEST RADIO SYSTEMS, LTD.
Vancouver B.C.

✓ 116

HAM RADIO

SEPTEMBER 1988

volume 21, number 9

T. H. Tenney, Jr., W1NLB
publisher
and editor-in-chief

Terry Northup
managing editor

Marty Durham, NB1H
technical editor

Robert D. Wilson, WA1TKH
consulting editor

Tom McMullen, W1SL
Joseph J. Schroeder, W9JUV
Alfred Wilson, W6NIF
associate editors

Susan Shorrock
production editor

Peggy Tenney, KA1QDG
copy editor

Beth McCormack
editorial assistant

editorial review board

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

publishing staff

J. Craig Clark, Jr., N1ACH
assistant publisher

Henry S. Gallup, KA1RYG
advertising sales manager

Dorothy Sargent, KA1ZK
advertising production manager

Susan Shorrock
circulation manager

Therese Bourgault
circulation

Phil Alix, N1FPX
traffic manager

Maribeth Buchanan
HAM RADIO Bookstore

Hans Evers, PAØCX
cover

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 109

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

W7SX, Page 10

Ham Notebook, Page 38

DEPARTMENTS

FLASH FCC TAKES 220-222 MHz!

On Thursday August 4, the FCC announced its reallocation of 220-222 MHz to the Land Mobile Service. Despite overwhelming opposition from industry, government agencies and Amateurs, the three sitting commissioners concluded unanimously that the reallocation was in the "public interest." The ARRL immediately filed a Petition for Reconsideration and vowed a vigorous fight. The FCC's action came despite well supported ongoing concurrent resolutions, opposing reallocation, in the US House (Resolution 317) and Senate (Resolution 127). All Amateurs must contact their Congressional Representative and Senators to protest this FCC action.

de W9JUV and N1ACH

publisher's log

Here it is! This issue marks one of the more significant milestones in the twenty-year history of HAM RADIO Magazine. As you leaf through this month's issue, you are going to see a blend of exciting new graphics carefully put together with a revised mix of the very best reading that you will find in Amateur Radio today.

This has not been an easy task. HAM RADIO has long enjoyed the unique reputation of being the most professional of any of the magazines in our field. Although we felt that it was time for some changes, we also recognized that it was vital to respect our past and build on what we have done so very well.

Over the past year, we've asked a lot of questions and listened very carefully to the answers. We have been talking to our readers, and to those who should be our readers, in an attempt to find out just how we could do an even better job in serving today's Amateur. Several important ideas continually dominated what we heard.

Don't let anything compromise the high technical standards that Jim Fisk set for HAM RADIO from the very beginning. We have always believed very strongly in this, and it was very reassuring to hear that so many of you overwhelmingly agree with us.

Print more construction articles and see to it that these projects are practical. Make sure they're constructed from available parts, suitable for the home builder to put together and get working properly in a reasonable amount of time.

Offer more short technical articles. Keep the quality there, but deliver more of it in smaller more easily digested pieces. Include these along with the longer, more in depth discussions readers expect from HAM RADIO.

It all adds up to a tall order, but I think we've managed to assemble what you've been asking for. From now on you'll be seeing at least two Weekenders each month. These short building projects are designed to stimulate your best workshop talents. We already have a backlog of really great projects waiting for you, and are continuing to scour the realm of Amateur Radio in our search for nifty stuff to direct toward your soldering iron.

We're going to be listening to what you like and don't like in the way of these projects. Look for the yellow page bound into this issue and you'll find details of our reader evaluation program. You can cast your vote each month and tell us which of our ideas really cut the mustard and which don't. To make it even more satisfying, you have a chance to win a handheld radio at the same time. Be sure to check this out and join in the fun.

We haven't forgotten our authors in all this excitement! The originator of each month's most popular project will also be awarded a handheld. Why don't you share the results of your latest brainstorm with our readers and see if you can't be our lucky writer one of these months? I'll bet you've already built the project. It's just a matter of putting your results on paper and sending it along to us.

It's a very careful balancing act, but you'll see us putting a greater stress on the shorter tutorial pieces. However, as we said before, we will **not** be compromising the high standards you have learned to expect and enjoy in HAM RADIO Magazine.

You'll see a new look to our pages this month. It's been a long time since the original design was conceived. Our original layout has served us well and even now, over twenty years later, we are still the best looking Amateur magazine. But, much has changed in the technology and standards of the graphics arts field. It seemed that now was a perfect time to take advantage of all this and make HAM RADIO even more enticing. I'm sure you'll agree!

Finally, you will also find that two much requested old friends are back this month. The magazine is again in a mailing wrapper, and the reader service card has returned.

We've listened carefully, and we're going to keep tuning in for your comments and ideas. Use our evaluation card or drop us a note. Please let us know what you think of everything we're up to. It's being done especially for **you**. If it's not just right, then we want to make it so. We may already be the leader, but we want to do an even better job as your favorite Amateur Radio magazine.

Skip Tenney, W1NLB

KENWOOD

...pacesetter in Amateur Radio

NOW! 70 cm

All Mode Mobility!

TR-751A/851A

Compact all mode transceivers

It's the "New Sound" on the 2 meter band—Kenwood's TR-751A! Automatic mode selection, versatile scanning functions, illuminated multi-function LCD and status lights all contribute to the rig's ease-of-operation. All this and more in a compact package for VHF stations on-the-go!

- Automatic mode selection, plus LSB

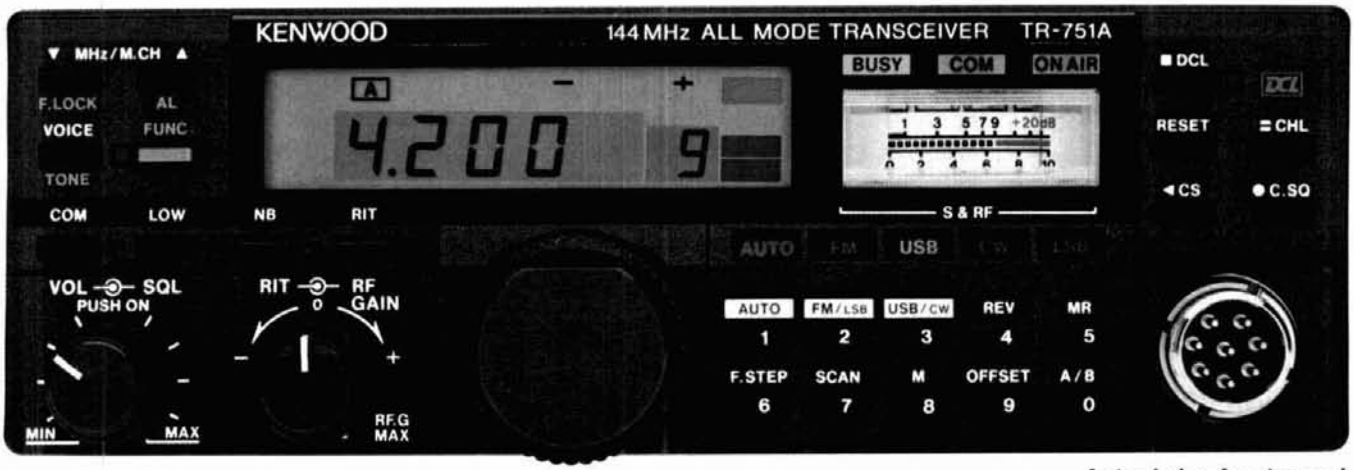
144.0	144.1	144.5	145.8	146.0	148.0 MHz
CW	USB	FM	USB	FM	

- Optional front panel-selectable 38-tone CTCSS encoder
- Frequency range 142-149 MHz (modifiable to cover 141-151 MHz)
- High performance receiver with GaAs FET front end
- VS-1 voice synthesizer option
- 25 watts high/5 watts adjustable low
- Programmable scanning—memory, band, or mode scan with "COM" channel and priority alert
- 10 memory channels for frequency, mode, CTCSS tone, offset. Two channels for odd splits.
- All mode squelch, noise blanker, and RIT
- Easy-to-read analog S & RF meter

- Dual digital VFOs
- Semi break-in CW with side tone
- MC-48 16-key DTMF hand microphone and microphone hook included
- Frequency lock, offset, reverse switches
- Digital Channel Link (DCL) option

Optional accessories:

- **CD-10** call sign display
- **PS-430, PS-30** DC power supplies
- **SW-100A/B** SWR/power meter
- **SW-200A/B** SWR/power meter
- **SWT-1** 2 m antenna tuner
- **SWT-2** 70 cm antenna tuner
- **TU-7** 38-tone CTCSS encoder
- **MU-1** modem unit for DCL system
- **VS-1** voice synthesizer
- **MB-10** extra mobile mount
- **SP-40, SP-50B** mobile speakers
- **PG-2N** extra DC cable
- **PG-3B** DC line noise filter
- **MC-60A, MC-80, MC-85** deluxe base station mics.
- **MC-43S** UP/DOWN mic.
- **MC-55** (8-pin) mobile mic.
- **MA-4000** dual band antenna with duplexer



Actual size front panel

TR-851A

70 cm SSB/CW/FM transceiver

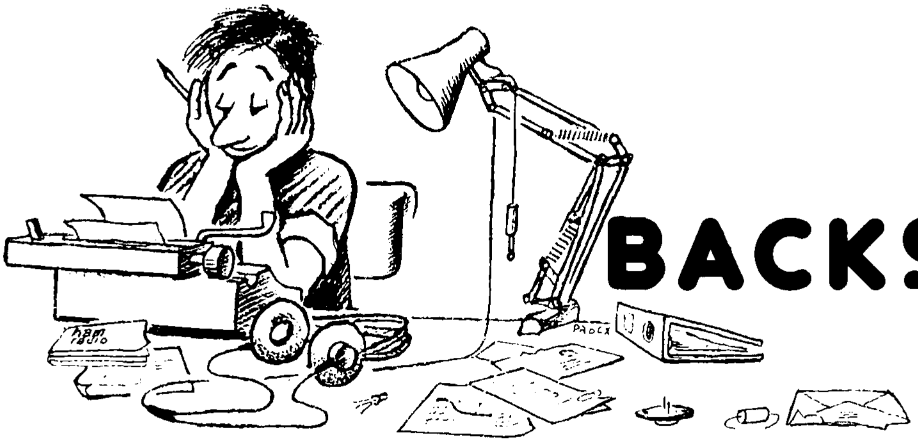
The same winning features are yours on 70 cm with the TR-851A!

- Covers 430-439.999 MHz
- 25 W high power/5 W adjustable low
- MC-43S UP/DWN mic. and mic. hook included

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.
Specifications guaranteed for the 144-148 MHz Amateur band only.



BACKSCATTER

Field Day — Preparedness or Party Time?

Ask any Amateur — "What's the purpose of Field Day?" and you'll hear in response, "Test our ability to set up and operate under adverse conditions...Emergency preparedness...Demonstrate Amateur Radio's readiness to respond to disaster..." Surely noble intentions, but do they square with the realities of Field Day?

For most clubs, planning for a serious Field Day effort is a many month — often year-long — exercise. Picnic groves and company recreation areas are reserved, generators and cherry pickers rented, long lists of equipment, towers and antennas located and inventoried, operating crews organized and scheduled, and food and beverage needs tabulated. Then, at the appointed hour on the appointed Saturday in June, it all comes together when the bands come alive with big signals and each club's top ops grind out QSOs at a blistering pace.

For the next 24 hours we'll devour mountains of hotdogs and hamburgers washed down with oceans of coffee, pop and beer, while our "designated hitters" run up big contest scores in stations that are often as well laid out and equipped as a top-rated contest station. But what has all this got to do with "emergency preparedness," operation "under adverse conditions," or "readiness to respond to disaster?" Field Day as it's presently enjoyed is surely a great combination of multi-op contesting and early summer cookout, but adequate preparation for the next big earthquake or the day the dam breaks it ain't!

Isn't it time to decide what we really expect from Field Day? Should it be simply a multi-op contest operation in an outdoor setting, or should it become a serious effort to better prepare ourselves and our equipment for the day when smoothly functioning Amateur communications can save lives?

If the answer is better emergency preparedness, let's consider one way that might be accomplished. For example, instead of scheduling Field Day on a specific June weekend simply set it for some June weekend — to be announced by a "QST" from W1AW the Friday evening of that weekend. Consider how much more flexible your Field Day organization would have to be if it's going to have to set up and get on the air with less than 24 hours notice — how much more responsive, as in an actual unexpected emergency, you'd become!

In its present form Field Day is a great deal of fun and a fine opportunity to spend a weekend in the sun with some of your best friends. Maybe, without doing serious damage to that aspect of it, we could also turn it into a much more useful training experience. Any ideas?

Joe Schroeder, W9JUV

Sorry Joe. I don't buy it.

Field Day is one of the most enjoyable events we have in Amateur Radio. Every year thousands of Hams from across the country turn out. Prior planning of schedules allows many to rearrange vacations or business trips (or do the necessary chores) to accomodate their desire to operate. Plenty of Amateurs, who haven't missed a Field Day in years, might have to miss it due to other commitments if the change you propose was to be implimented.

This year, I participated in a Field Day effort with our local club. We hadn't done one before and, as we sat and planned our effort in the months preceeding the event, it became apparent that this group was *truly* excited. For new and old Ham alike, the spirit of Field Day was infectious. What didn't exist, however, was a cutthroat desire to win at all costs. Our desire was to set up a portable radio station in a suitable location and talk to as many others as possible.

I'm confident that from the lessons we learned, the club could put at least one station on the air in a few hours or less in the event of an emergency. The exper-

(continued on page 103)

MFJ 3 KW Roller Inductor Tuner

. . . lets you get your SWR down to *absolute* minimum -- something a tapped inductor tuner just can't do . . .

. . . *plus* you get a ***peak* reading** Cross-Needle SWR/Wattmeter, 6-position antenna switch, balun for balanced lines and 1.8-30 MHz coverage...$239.95

NEW

MFJ-986

$239⁹⁵

MFJ's innovative new Differential-T Tuner™ uses a differential capacitor that makes tuning foolproof and easier than ever. It ends constant re-tuning with broadband coverage and gives you minimum SWR at only *one* setting.

The new MFJ-986 is a rugged no-compromise 3 KW PEP Roller Inductor antenna tuner that covers 1.8-30 MHz continuously, including MARS and all the WARC bands. **The roller inductor lets you tune your SWR down to the absolute minimum** -- something a tapped inductor tuner just can't do.

A 3-digit turns counter plus a spinner knob gives you *precise* inductance control -- so you can quickly return to your favorite frequency.

You get a lighted Cross-Needle meter that not only gives you SWR, forward and reflected power at a glance -- but also gives you a **peak-reading** function! A new directional coupler gives you even more accurate readings over a wider frequency range.

You get a 6-position ceramic antenna switch that lets you select two coax lines and/or random wires (direct or through tuner), balanced line and external dummy load.

A new **current** balun for balanced lines minimizes feedline radiation that causes field pattern distortion, TVI and RF in your shack. Ceramic feedthru insulators for balanced lines withstand high voltages and temperatures.

New Antenna Tuner Technology

MFJ brings you **three innovations** in antenna tuner technology: a new *Differential-T*™ circuit simplifies tuning; a new *directional coupler* gives you more accurate SWR, forward and reflected power readings; and a new *current balun* reduces feedline radiation.

Differential-T Tuner™: A New Twist on a Proven Technology

By replacing the two variable capacitors with a single *differential capacitor* **you get a wide range T-network tuner with only *two* controls** -- the differential capacitor and a roller inductor.

That's how you get the new MFJ Differential-T Tuner™ that makes tuning easier than ever, gives you minimum SWR at only one setting and has a broadband response that ends constant re-tuning. You'll spend your time QSOing instead of fooling with your tuner.

The compact 10¾ x 4½ x 15 inch cabinet has plenty of room to mount the silver-plated roller inductor away from metal surfaces for maximum Q -- you get high efficiency and more power into your antenna.

The wide spaced air gap differential transmitting capacitor lets you run a full 3 KW PEP -- no worries about arcing.

A New Directional Coupler: Accurate SWR and Power Reading

MFJ's Cross-Needle SWR/Wattmeter gives you more accurate SWR and power readings over a wider frequency range with no frequency sensitive adjustments.

That's because MFJ's new directional coupler gives you up to an order of magnitude higher directivity and coupling factor than conventional circuits . . . *plus* it gives you a flat frequency response that requires **no** frequency compensation.

The cross-needle meter lets you read forward/reflected power in 2 ranges: 200/50 and 2000/500 watts. The meter lamp is front-panel switched and requires 12 volts.

A switch lets you select peak or average power readings.

A New Current Balun: Reduces Feedline Radiation

Nearly all commercially built tuners use a "voltage" balun. The "voltage" balun forces the *voltages* to be equal on the two antenna halves. It minimizes unbalanced currents *only* if the antenna is perfectly balanced --not the case with practical antennas.

The MFJ-986 uses a true **current balun** to force equal *currents* into the two antenna halves -- *even* if your antenna is not perfectly balanced -- so you get minimum unbalanced currents.

The *current* balun gives superior balance over the "voltage" balun.

Minimum unbalanced current reduces field pattern distortion -- which concentrates your power for a stronger signal -- *plus* it reduces TVI and RF in your shack caused by feedline radiation.

The MFJ-986 Differential-T Tuner™: Get *absolute minimum* SWR

Get the tuner that incorporates the latest innovations by the world's leader in antenna tuner technology.

See your dealer today for the new MFJ-986 Differential-T™ 3 KW Roller Inductor Tuner. Include $10 shipping/handling if ordering direct.

WHY CHOOSE AN MFJ TUNER?

Hard-earned Reputation: There's just no shortcut. *MFJ is a name you can trust* -- more hams trust MFJ tuners throughout the world than all other tuners combined.

Proven Reliability: *MFJ has made more tuners for more years than anyone else* -- with MFJ tuners you get a highly-developed product with proven reliability.

First-rate Performance: MFJ tuners have earned their reputation for being able to match just about anything -- *anywhere.*

One full year *unconditional* guarantee: That means we will repair or replace your tuner (at our option) *no matter what* for a full year.

Continuing Service: MFJ Customer Service Technicians are available to help you keep your MFJ tuner performing flawlessly -- no matter how long you have it -- just call 601-323-5869.

Your very best *value*: MFJ tuners give you the most for your money. Not only do you get a *proven* tuner at the lowest cost -- you also get a one year *unconditional* guarantee and *continuing* service. That's how MFJ became the world's leading tuner manufacturer -- by giving *you* your very best *value.*

Choose your MFJ tuner with confidence! You're getting proven performance and reliability from the most trusted name in antenna tuners. Don't settle for less.

Call or write for a *free* full-line MFJ catalog with all 10 of our tuners and tons of ham radio accessories!

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

COMMENTS

more information needed

Dear HR:

I picked up a copy of the June 1988 issue and saw your editorial. I think you may have missed part of the point.

The suggestion on encouraging old folks to become hams has considerable merit, but is that the only approach? I think the ham radio groups that have opened their hamfests to computerists are perhaps moving in a better direction, as the broadest field of potential hams is computer users of all ages. I suspect this has been a drawback of all the more "slick" ham magazines that they have minimized that aspect. Computer users are motivated toward electronics already.

Kids can get into computers from a keyboard — kids of all ages. (Perhaps that is why so many hams have gotten into them.) Can people get into ham radio by an as easily learned path? If they can, I haven't seen it in print. The kids overcome problems much more severe than Morse code with computers. The relation should be obvious, particularly with the advent of packet radio and ham radio teletype.

As I see it, there are two impediments. One is a simple but effective method of learning the code to the modest required speed. I and others have developed possible solutions to that. Laws are simple memory work. Neither of these need to be a roadblock.

As I see it, adequate simplification of basic electrical and electronic circuits along with suggesting simple circuits prospectives can build are needed. That was how many of us got started, and many of us have contributed to the advance of the field. But sound basics along with simple construction kits dependent on simple discrete elements are needed. Heathkits are no longer available for simple enough circuits for this. They have to be more mistake-resistant than most IC projects. The individual must be able to do the building without damaging either the parts themselves or the mounting circuit boards. (You can't easily find a kit meeting these requirements any more, at least ones suitable for starters. I have looked.)

In addition, it is not possible to put together even a simple audio amplifier that will work as planned based on data available. If one wants to make an audio amplifier using a bipolar transistor that will have a voltage gain of 50, one should use an audio oscillator source, a bipolar transistor with a load resistance of about 1200 ohms, with a direct voltage drop across the load resistor of about 1.25 volts. The series base resistance back to collector supply is adjusted to give the required voltage drop across the collector resistance. Have you ever seen that stated anywhere? Try it!

The point is that even this simple information is *not available* in any information source available for the potential ham. But any user of computers is a potential ham. He or she is eminently susceptible to trying something for use with a computer, and from there go to ham radio.

Present-day hams can't very well be experimenters based just on what is available in the ARRL handbook or most other sources because the important facts, such as why the above design works, are not available. (The transconductance of a bipolar transistor is (q/kT) times output current, and the voltage gain is that value times the load resistance, or in the above case about 48 to 50.)

We can correct this, and we need to correct this. But no one seems to care.

Keats A. Pullen, Jr., W3QOM,
Kingsville, Maryland 21087-1050

storing lead-acid batteries

Dear HR:

As I was reading the excellent article, "A Battery-backed Master Power System," by Eric Smitt, K9ES, I was disappointed by incorrect statements about lead-acid batteries. It cautioned against placing these batteries on concrete floors ("...the calcium in the floor will cause the battery to die.") and said they should be "Mounted on a wooden surface..." Such statements are unadulterated hogwash and I am disappointed that such a glaring error made it past the editors of Amateur Radio's finest technical publication.

Because a battery is contained within an insulating enclosure, there can be no electrical current between whatever it sits on and the internal cells. Similarly, because the battery case is chemically inert and impermeable, there can be no reaction between the environment and the internal chemistry of the battery.

What was stated has been an old "mechanic's tale" for years. As a college student, I worked as a "go-fer" in an automobile garage. One day, the mechanics and I had an argument about whether it was safe to set a lead-acid car battery upon a concrete floor or whether it should be set upon wood. I bet each of the mechanics that a brand new battery would not be affected by a concrete floor. The subject battery was to be compared to an identical new battery mounted upon a piece of wood. Both were to be left in place for about a month and receive no charging of any kind. Total battery voltage and cell specific gravity were the test parameters.

Need I state that I won the bet?

(continued on page 101)

A DIRECT DIGITAL SYNTHESIS VFO

Robert J. Zavrel, Jr., W7SX, c/o Digital RF Solutions, Inc., 3080 Olcott Street, Suite 200d, Santa Clara, California 95054

RF generated directly from digital information

The direct digital synthesizer (DDS) has arrived in Amateur Radio!* In the past several months DDS state of the art has progressed to the point where good radio performance is obtainable using DDS local oscillators. The DDS offers some attractive features over the analog or phase-locked loop (PLL) synthesizer. Like the PLL synthesizer, DDS is digitally controlled. Tuning is regulated by either memories or counters which, in turn, are controlled by rotary optical couplers. Unlike the PLL, DDS doesn't use a VCO, loop filter, phase detector, or digital divider and prescaler. Waveform information is generated using digital information only. The last step uses a digital-to-analog converter (DAC) to actually generate the rf signal.

review of local oscillator basics

The *local oscillator* is used to mix with the incoming received signal and produce the i-f signal. Because the i-f is usually fixed, a frequency agile LO is required if the received frequency is tuned. The LO signal should have excellent short and long term "drift" stability. It should also have adequate resolution or sufficiently small "step" sizes if digital control is used. Finally, it should be free from phase noise and spurious responses. The importance of phase noise specifications was demonstrated in an article by KI6WX.[1] Synthesizer science remains one of the most important areas in rf engineering, and improvements in these specifications are a continuing goal.

comparison of PLL and DDS techniques

Excellent drift stability has been achieved with PLL synthesizers; it is equally good with DDS. Frequency stability in both systems is determined by crystal reference stability.

Although drift characteristics are similar in DDS and PLL systems, others are not. For example, in PLL systems there is a tradeoff between the resolution and phase noise specifications. Generally, the smaller the step size the worse the phase noise. The step size represents the reference frequency for the PLL, perhaps 100 Hz. This signal must then be multiplied up to the LO frequency, usually 10's of MHz in an hf receiver. The phase noise contribution of the PLL is 20 log N, where N is the multiplier. Because N is usually very large, the phase noise is frequently difficult to minimize. This is not the case in DDS systems, where resolution is completely independent of phase noise. The VFO described here has a resolution of about 1.2-Hz. The addition of a second LSI CMOS phase accumulator (NCMO™) in this design could provide nanohertz resolution with no degradation in phase noise specifications, but 1.2 Hz resolution is more than adequate for most Amateur Radio applications.

Phase noise manifests itself as sidebands around the LO signal. In any modulation process AM, FM, or PM sidebands are generated in familiar ways. There are sidebands present in any oscillator signal; a spurious-free oscillator is only a theoretical ideal. A VCO in a PLL oscillator is controlled by a voltage that comes from a phase comparator by way of a loop filter. Both the comparator and filter are imperfect and consequently a noise voltage is superimposed on the dc control voltage. This noise signal, in turn, phase modulates the VCO. These sidebands are undesirable because they represent energy at frequencies offset from the main LO signal. The receiver will respond to signals offset from the desired receive frequency because of the mixing process. The reciprocal mixing process can limit the strong signal handling capabilities of the receiver and its dynamic range. Synthesizers with very low phase noise response are necessary to build high-performance receivers. Recent model Amateur Radios using PLL synthesizers have begun to approach such specifications. But units employing an analog PTO oscillator can't be equaled for spectral purity. A properly designed LC analog oscillator is hard to beat for overcoming phase noise and spurious performance.

Spurious responses can also cause problems with LO signals. Unlike the "broadband" noise sideband response indicative of phase noise, spurs show themselves as secondary CW signals almost anywhere in the passband. They can be measured by a simple dB relationship with the LO carrier. Like the phase noise signal, a spurious LO signal can limit the dynamic range of the receiver. To maintain a 80-dB dynamic range, all spurs appearing in the LO signal must be at least 80 dB below the LO carrier.

DDS basics

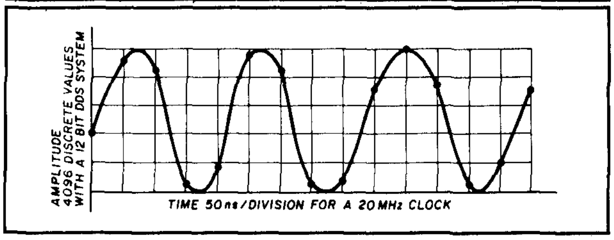
Figure 1 shows the key to understanding DDS systems. A 20-MHz clock has a period of 50nS. The Nyquist theorem states that a sine wave digital synthesizer needs at least two sample points per cycle. This fundamental law suggests that with a 50-nS sample rate the maximum possible output frequency is 10 MHz. This upper limit is called the "Nyquist frequency", one-half the clock frequency. The more samples per cycle the better the approximation will be. Consequently, better performance can be expected at lower operating frequencies in most DDS systems. The critical fact for DDS is that is doesn't matter *where* along the sine wave the samples are taken. If you can compute a continuous string of exact amplitude values (sinusoidal) and then convert these values to an analog signal, you can synthesize any quantized frequency approximation below the Nyquist frequency.

Amplitude computation is done with a specialized digital counter called a "phase accumulator". As **fig. 1** suggests, a discrete frequency can be defined as a specific change in phase-per-unit time. With a 20-MHz clock the unit of time is 50nS. Using the 50-nS sample rate, any discrete frequency can be defined by a discrete change in phase, $d\theta/dt = \Omega$.

The phase accumulator output is a digital bus that counts in a linear manner. Sine waves, on the other hand, vary sinusoidally. Therefore, you must convert a linear progression of numbers into a sinusoidal one. If the numbers are all digital, the easiest way to do this is with a read only memory (ROM). As the memory address is sequenced in a linear manner, the memory data bus outputs the appropriate amplitude value for that moment in time. The "oscillating" digital numbers are then applied to a DAC and the rf signal is the output. **Figure 2** shows a block diagram of a simple DDS system.

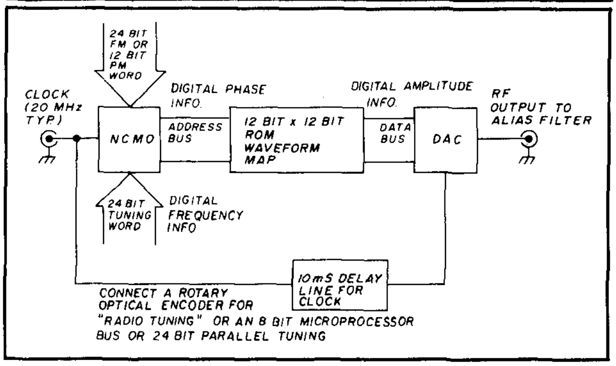
The present limitation of DDS is the spur level. This design renders all spurs below −75 dB in the desired 5 to 5.5-MHz VFO range. Typical spur response within the desired 500-kHz bandwidth is better than −80 dB.

FIGURE 1



Sine wave generation using direct digital synthesis.

FIGURE 2



NCMO-based DOS synthesizer.

The primary cause of spurious signal generation is nonlinearity in the DAC. The DAC state of the art has been evolving for the several decades, and a lucrative DDS market now gives DAC manufacturers an incentive to produce products with DDS applications in mind. In the next two years new fabrication techniques should produce DACs that realize −100 dB spur levels at 5 MHz. Faster DACs with higher resolution (more bits) will be required for better performance at higher frequencies.

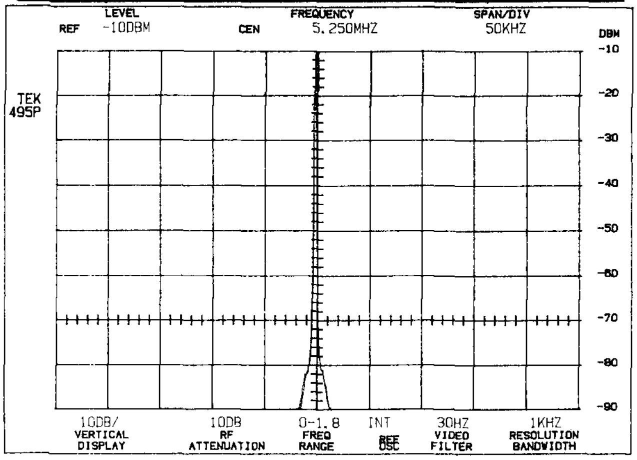
If an ideal 12-bit DAC were used, the limit of spur suppression would be the quantizing error inherent to *digital approximation*. We haven't reached this level yet but I believe that we are very close, as figures and specs in this article suggest. Conventional wisdom suggests that a 6-dB improvement in spurious levels will be realized for the addition of one bit of resolution. (This makes intuitive sense because with each additional bit the voltage or current error will be halved, or −6 dB.) But convention doesn't hold to experimental evidence. At Digital RF Solutions we are seeing 8-dB/bit improvement in spurious response. If this rule holds, an ideal 12-bit DDS system would give a 96-dB spurious response. We haven't found adequate information quantifying the relationship between DAC linearity and the 8 dB/bit rate. The analysis will involve Fourier transformations and sampling theory.

*ICOM's 781 uses DDS. Ed.

the NCMO DDS system

The NCMO (conceived and designed by Earl McCune Jr., WA6SUH) is a highly integrated CMOS phase accumulator with numerous interface and modulation features. It uses a 24-bit phase accumulator counter controlled by a 24-bit tuning word. The 24-bit tuning resolution implies over 16 million equally spaced discrete frequencies in an NCMO system; 16 million "channels" suggests about 1.2-Hz steps with a 20-MHz clock. Half of the frequencies appear between the Nyquist and clock frequencies. These are simply "folded over" back below the Nyquist frequency, so there are actually only about 8 million possible discrete frequencies. Only the most significant 12 bits are used in this project. This affects only the sampling error and not the 24-bit frequency resolution. There is no advantage in using more ROM address bits than DAC resolution bits.

FIGURE 3



Spectrum of 5 to 5.5 MHz with the VFO set to 5.25 MHz. All spurious signals are below −80 dB.

tuning

The NCMO can be tuned in three ways:

- a parallel mode connecting to 24 pins on the IC,
- a strobed mode for three eight-bit words, mainly for microprocessor interface,
- a serial mode which allows direct connection to a rotary optical coupler so it can "feel" like an analog tuner.

This VFO uses the serial mode. Interface to a tuning memory can be implemented, if you need or want such a feature. The tuning word can also be controlled by an external counter for a scanner, hopper, or search function.

modulation

These functions alone would make the NCMO a remarkable innovation. But WA6SUH also built FM and PM modulation into the NCMO. Another 24-bit port will accept a digitized modulating signal up to the Nyquist frequency! FM linearity is 24 bits; deviation is controlled absolutely and is constant from dc to the Nyquist frequency. Imagine a sweep oscillator with 24-bit sweep linearity from dc to 10 MHz. Because there is no loop time constant, QSY is effected in two clock cycles (or 100nS) with no settling time, and complete phase continuity. QSY from 4 Hz to 7.002052 MHz is possible without glitches in 100nS. The two most difficult functions in a signal generator — frequency agility and modulation — are performed digitally within the NCMO.

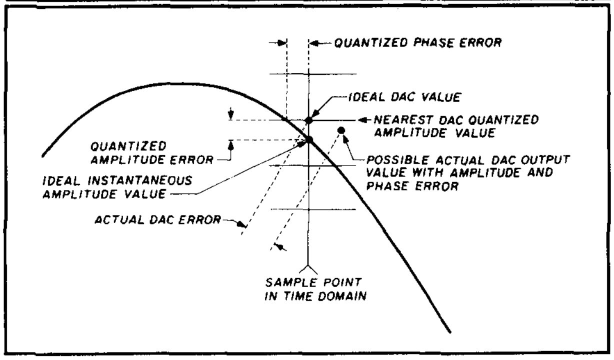
AM modulation can be effected by a digital multiplier inserted between the memory and DAC. This adjusts the instantaneous digital sinusoidal amplitude value just before data conversion. Single-quadrant multiplication yields full-carrier AM; four-quadrant multiplication yields double sideband suppressed carrier AM. Since AM, FM, and PM are accomplished simultaneously, any known form of modulation is possible within the constraints of Nyquist and 24-bit resolution. FSK is achieved by keying the appropriate number of FM bits for a desired deviation. A similar situation exists for PSK. Simultaneous AM and PM yield complex data communication constellations with direct digital control. Creating a 9600 baud, RTTY, DTMF, or any other digital encoding scheme is now a software function.

the NCMO VFO

For on-the-air tests I have a Corsair II which uses a super low noise PTO VFO. The output level of the TRW1012 DAC is similar to the requirements of the Corsair (about +5dBm). Switching back and forth between the Corsair VFO and NCMO VFO proved to be a good "qualitative" test. Results were excellent; only a few weak spurs were noted. The results were confirmed in our quantitative tests.

Figure 3 shows a spectrum of 5 to 5.5 MHz with the VFO set to 5.25 MHz. Note that all spurious signals are

FIGURE 4



Graph shows the ideal instantaneous amplitude value, error points due to quantized approximation or the ideal DAC value, and the DAC output error from the ideal DAC value. Phase noise and spurs result from both the quantized error and DAC errors.

below −80 dB. The close-in noise pedestal shown in this figure results from the phase noise of the Tektronix 495P *spectrum analyzer, not the DDS synthesizer itself.* Other measurements show the spurs down about −90 dB, with some special worst-case signals down about −75 dB. If absolute optimization is required, the worst-case spurs can be sent well outside the bandpass by adjusting the clock frequency 2 or 3 MHz. An interesting clock frequency is 16.777216 MHz. Here the step size will be exactly 1 Hz. This frequency also allows excellent spur shifting for a 5 to 5.5-MHz VFO.

spurs and phase noise

As stated earlier, the spurious signals originate in the DAC. There are two levels of DDS error — the DAC linearity contribution and the limits of quantization. **Figure 4** shows how these relate to an ideal sample point on a sine wave. Twelve-bit resolution implies 4096 possible amplitude values. Even an ideal DAC will provide an approximation of this value, giving rise to a minute amplitude and phase error. This is the quantized error. Because the DAC won't be ideal; it will miss the ideal quantized value, giving rise to additional error from DAC nonlinearity. The most important technique for minimizing spurs and noise is proper synchronization of the NCMO, memory, and DAC. The DAC and NCMO run off the same clock, but the signal from the NCMO "sees" a propagation delay through the ROM. A delay line must be included for the DAC clock assuring that the DAC's latched input "sees" a settled ROM address bus. Without this delay line, several bits can be in error and performance will be poor. Phase noise is also related to DAC linearity, but phase noise isn't a problem for the most demanding Amateur applications using the NCMO system. It is limited largely by the phase noise properties of the clock. An inexpensive digital clock is used in this project; much better phase noise performance is possible if you use a high-quality crystal and take care to build a high-quality clock oscillator.[1-6]

aliasing filters

Alias signals are produced in addition to the fundamental signal. The worst case alias signal falls between the Nyquist and clock frequencies. If we synthesize a frequency, F, this alias will appear at F(clock)-F. The closer you operate to the Nyquist frequency, the more difficult alias filtering becomes. This VFO uses a five-pole 7.5-MHz Chebychev low-pass filter of conventional design.[2] It is sufficient for filtering the 15-MHz alias at 5-MHz operation. More sophisticated filter designs can be used if needed.

specifications

The phase noise measurements in **table 1** were performed on an HP-3048A phase noise analyzer at E-Systems in Dallas, Texas. These phase noise specifications were taken with a low-noise HP clock. Using a typical $2.00 digital clock, the phase noise in dBc/Hz will be about −60 dB at 1 Hz, and settle in at about −135 at 1 kHz offset. Our most recent measurements using a low-noise reference indicate −110 dBc/Hz at 1 Hz, and an ultimate of about −145 at 1 kHz and greater spacing.

tests with the Corsair II

Two tests were performed with the Corsair II. There was no difference between the internal VFO and the NCMO for minimum sensitivity. There was also no difference in overload performance. A few additional weak spurs were observed using the NCMO that were not detected on the spectrum analyzer. This was expected because the receiver has a wider dynamic range than the analyzer. A 5 to 10 dB reduction in dynamic range can be anticipated at these discrete frequencies. However, only two or three of these spurs

TABLE 1

18X 2070 NCMO VFO specifications.

Specification		Units
Frequency coverage:	0-10.0	MHz
Tuning step size:	1.2	Hz
	or 19	Hz
	or 305	Hz
	or 4.9	kHz
	or 78	kHz
	or 1.25	MHz
	(selectable on front panel)	
Phase noise at 1 Hz offset	−95	dBc/Hz
10 Hz offset	−115	dBc/Hz
100 Hz offset	−128	dBc/Hz
1 kHz offset	−135	dBc/Hz
Spurious signal generation	−75 (worst case) dB	
	−90 (typical)	dB
Output level into 50 ohms	+3	dBm
Power supply	±5	volts
Circuit power consumption	1.5	watts

"The amateur world knows us well"

For more than 60 years we've been a world leader in amateur radio. . .selling the finest equipment at a fair price. We manufacture a quality line of high power linear amplifiers and we stand behind what we sell. That's why thousands of amateurs keep coming back.

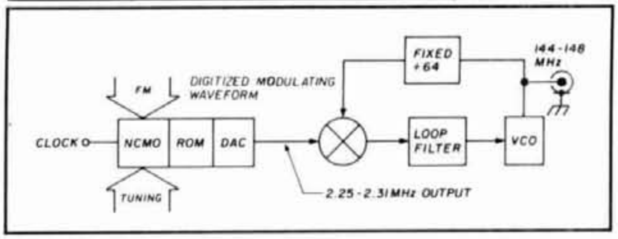
☆ Featuring a large inventory of fine equipment from the world's leading manufacturers ☆ A knowledgeable staff dedicated to amateur radio ☆ A complete line of accessories ☆ A well stocked repair shop staffed by experienced technicians ☆ We take trade-ins and sell used equipment ☆ Generous discounts on cash purchases ☆ We accept Visa, Mastercard and Discover and carry our own term financing

Some of the names we stock include: HENRY • TEMPO • KENWOOD • ICOM • YAESU • ACE • ADVANCED RECEIVER RESEARCH • AEA • ALINCO • AMECO • AOR • AMPHENOL • ANTRONIC • ARRL • ASTRON • B&K • B&W • BEARCAT • BECKMAN • BENCHER • BIRD • BUTTERNUT • CES • CETRON • CENTURIAN • COMM SPEC • CONNECT SYSTEMS • CUSHCRAFT • DAIWA • DIGIMAX • DOWKEY • EIMAC • FANON • GE • GRUNDIG • HAL • HUSTLER • HYGAIN • JABRO • JIL • KENPRO • LANDWEHR • LARSEN • LUNAR • MFJ • MICRO • NYE • PALOMAR • PIPO • SANGEAN • SIMPSON • SWITCHCRAFT • TRIEX • TRIPPLITE • TX/RX • UNADILLA • VIBROPLEX • WINEGARD •

Henry Radio

2050 S. Bundy Dr., Los Angeles, CA 90025 (213) 820-1234
Butler, Missouri 64730 (816) 679-3127
TOLL FREE ORDER NUMBER: (800) 421-6631
For all states except California. Calif. residents please call collect on our regular numbers.

FIGURE 5



Use of a DDS system as a reference in a PLL multiplyer. A very low N value of 64 implies low phase noise output at 144 MHz. Both tuning and modulation are accomplished digitally at the NCMO.

were observed within the 5 to 5.5-MHz VFO range. Tuning is smooth, especially when using the 19-Hz step function. On-the-air tests produced excellent signal reports on transmit, indicating that the Corsair's specs weren't seriously degraded with this VFO.

other design configurations

VHF and UHF synthesis is possible using a DDS synthesizer as a reference in a phase-lock loop. Frequency agility and modulation in the 7 or 8-MHz range allow for low N values in the loop, minimizing phase noise and spurious levels. **Figure 5** shows a possible DDS/PLL VHF synthesizer.

If two waveform maps (sine and cosine) are used with two DACs, two signals in quadrature can be synthesized and will remain in excellent quadrature over the entire bandwidth (dc to Nyquist). Direct conversion SSB tranceivers can be built easily for 160, 80, and 40 meters using this design and references 7, 8, and 9.

Unfortunately, very little on DDS has appeared in print, particularly on practical designs and spurious minimization. Some of the better references can be found in the bibliography.

ordering information

You can purchase assembled DDS boards from Digital RF Solutions, Inc. *These boards are recommended for advanced experimenters. As a minimum, a low-frequency spectrum analyzer is required before attempting experimentation.* For more information contact Doug Hammed at 3080 Olcott St. Suite 200d, Santa Clara, CA 95054.

references

1. John Grebenkemper, KI6WX, "Phase Noise and its Effects on Amateur Communications-part 1," *QST*, March 1988, page 14.
2. Robert J. Matthys, *Crystal Oscillator Circuits*, Wiley-Interscience, 1983.
3. Ulrich L. Rohde, DJ2LR/KA2WEU, *Digital PLL Frequency Synthesizers*, Prentice-Hall, 1983.
4. Wes Hayward, W7ZOI, *Introduction to Radio Frequency Design*, Prentice-Hall, 1982.
5. Sabin, Schoenike, et al., *Single-Sideband Systems and Circuits*, McGraw-Hill, 1987.
6. *The 1988 ARRL Handbook for the Radio Amateur*, available for $20.95 plus $3.50 shipping and handling from the *ham radio* Bookstore, Greenville, New Hampshire 03048.
7. Robert J. Zavrel, Jr., W7SX, "ICs Simplify Design of Single-Sideband Receivers," *EDN*, April 1986.
8. Robert J. Zavrel, Jr., W7SX, "New Low Power Single-Sideband Circuits," Signetics Application Note no. AN1981.
9. Gary A. Breed, K9AY, "A New Breed of Receiver," *QST*, January 1988, page 16.

bibliography

1. Neil Albaugh, N7BBN, "New ADCs for Signal Processing," *RF Design*, November 1987.
2. Earl W. McCune, Jr., WA6SUH, "Direct Digital Synthesis and the Number Controlled, Modulate Oscillator," Proceedings RF Technology Expo, February 11-13, 1987.
3. Fred Williams, "A Digital Frequency Synthesizer," *QST*, April 1984, page 24.
4. Robert J. Zavel, W7SX, "Digital Modulation Using the NCMO," *RF Design*, March 1988, page 27.

Article A **ham radio**

THE WEEKENDER

AN EASY-TO-BUILD NiCd PULSE CHARGER

R. L. Measures, AG6K, 6455 La Cumbre Road, Somis, California 93066

The solid metal plate nickel-cadmium (NiCd) battery was invented around 1900, and it had one serious drawback. High internal resistance caused the cell voltage to fall to very low levels with heavy loads, restricting its use to low-current applications. This limitation persisted for about 35 years until the sintered-plate NiCd battery was invented in Germany.

Sintering is a processs that heats a tightly packed mass of microscopic-sized metal spheres to just below the melting point and then compresses them until surface fusing takes place at the points where they touch. The result is a semi-solid block of welded metal particles with a tremendous surface area — a *metal sponge*. Since chemical activity can take place only where the liquid electrolyte touches the surface of the metal, the large surface area gives the sintered plate a chemical activity area hundreds of times larger than a solid plate of the same dimensions. This reduces the internal resistance of the sintered-plate NiCd cell to an incredibly low value. I have an H-Type wet cell NiCd battery rated at 26 volts/5.7Ah (ampere hours). It is a small 15-pound battery, and yet the per cell voltage drops $<$0.06 volts with a 40A/1000 watt load! This means that each cell has a resistance of $<$0.002 ohms. The rated maximum current load for this battery is 150A. It is *very* dangerous to short out this battery.

The sealed type of NiCd used in Amateur Radio equipment is also a sintered-plate type. It too is capable of producing dangerous fireworks if it is shorted out, but on a smaller scale than the H-Type NiCd (designed for gas turbine and piston engine starting service).

The process of charging a sintered-plate NiCd battery is complicated by the fact that a charge must be delivered not only to the surface particles on the sintered plate, but also to the particles buried inside the plate. A slight overcharge must be applied to the surface particles in order to get to the buried particles and achieve a full charge. To do this you must apply a substantial minimum current during the charging process. This minimum charging current is usually one-tenth of the Ah capacity (C) of the cell. This is written as "0.1C".

If the charging current of 0.1C is maintained after a wet cell NiCd battery is fully charged, the surplus charging energy that the battery can't store converts the water in the cell's liquid electrolyte to hydrogen and oxygen gas. This causes no damage to the cell as long as distilled water is added periodically to maintain the proper electrolyte level. It's not convenient to add water in a sealed NiCd cell; an internal process of turning the hydrogen and oxygen gas back into water is designed into the cell. When hydrogen and oxygen unite to form water they release energy in the form of heat, causing cell heatup. If the cell is continually cooled enough to maintain cell temperature below $\approx$35°C, the sealed cell won't be damaged by overcharging. If the cell temperature is allowed to rise above $\approx$35°C during charging, the cell won't last long.

The problem with most NiCd battery packs is that no provision is made to cool the batteries during the charging process. If you leave your handheld transceiver plugged into a 0.1C constant-current wall charger for the recommended 14 to 16 hours and the pack is only 50 percent discharged at the beginning of the charge time, the batteries will overheat during the last $\approx$8 hours of the charge cycle and their life expectancy will be shortened considerably. Should you inadvertently leave an initially 100 percent discharged battery pack on the charger for more than 16 hours, the cells will overheat and the batteries will die young.

You can eliminate overcharging by using a constant voltage to charge the batteries. With constant-voltage charging, you use approximately 1.43 volts per cell to charge the batteries. The initial cell voltage is low compared to the constant-charge voltage, so the initial charge current is high. As the cells become charged, their voltage rises and the charge current decreases below the critical 0.1C level. This is both good and bad. It is good that the cells will not be overheated by being force-fed current after they have become charged; it is bad because not enough current will be supplied near the end of the charging process to fully charge the deep parts of the plate. The result is that

RADIO TELEGRAPH TERMINAL

AR-501

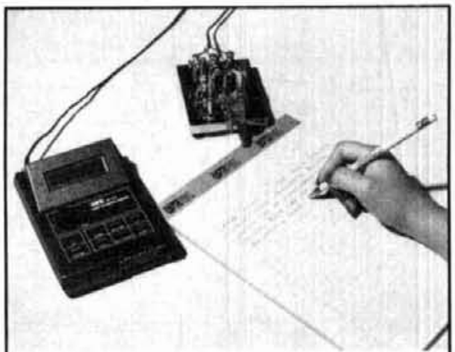
MORSE CODE DECODER — ELECTRONIC KEYER

MORSE CODE TRAINER

Only—$229.00

DECODER

Input level	• 10mV to 2V RMS.
Input impedance	• 8 to 1kΩ—600Ω typical
Decoding speed	• 5 WPM to 30 WPM
Audio filter	• 800 Hz ± 80 Hz Active and PLL filters 700 Hz to 900 Hz internally adjustable.



TRAINER

Code generator	• Random code generator 5 characters/code group
Speed	• 5 WPM to 30 WPM 1 WPM increment

ELECTRONIC KEYER

Paddle input	• TTL level —LO/Actuating, HI/Stop Contact input —ON/Actuating, OFF/Stop
Key input	• TTL level —LO/Mark, HI/Space Contact input —ON/Mark, OFF/Space
Keying speed	• 5 WPM to 30 WPM 1 WPM increment
Keyer output	• Transistor switching, Open collector type

SPECIFICATIONS

Model	• AR-501 Radio telegraph terminal
Power source	• DC 12V to 13.8V—165mA
Size	• 4.5"-W x 2.24"-H x 6.25"-D
Weight	• 12.5 oz. (358 g)
Controls	• Power On/Off • Random code generator On/Off • Print-out On/Off • Monitor speaker level • Electronic keyer mode select • Speed Up & Down
Display	• LCD 32 characters—16 per line
Indicators	• Power On—Green LED • Tuning—Red LED
Front connections	• Paddle—Standard/Iambic • Ordinary telegraphic key • Headphone/Earphone
Rear connections	• DC 13.8V input • Audio input • External speaker • Keyer output • Printer output

PRINTER PORT

• Compatible with Centronics 8-bit parallel printer. At least 4K byte data buffer is required in a printer.

BACK TO BASICS — • — • But far more advanced — — • —

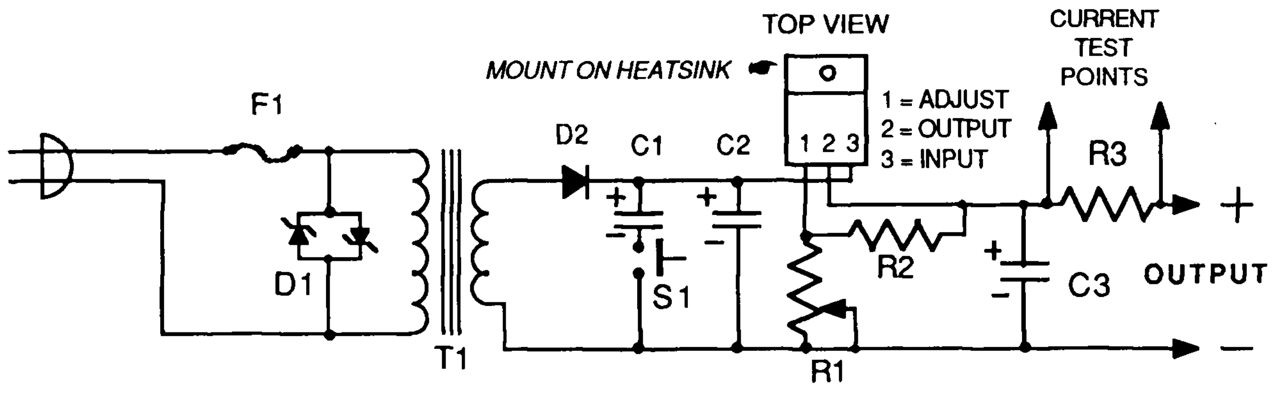
The AR-501, triple mode CW terminal in a small package, is a powerful gear to practice and play with. For the Novice, SWL and Amateur radio operators it detects Morse code between 5 to 30WPM. Just plug the AR-501 to your receiver to start translating the Morse code onto full 32 character LCD display. Very simple and easy to operate. You ask; for code practice?, both receive and transmit? Yes, the AR-501 does just that. It will improve your cord reception and keying technique at the speed you want. More?. it operates as an electronic keyer both standard and iambic. More Yet? How about a printer port? You bet, the AR-501 provides parallel printer port for hard copy. You can Log the QSO, and Practice. It will help you immeasureably. We even offer a standalone Nicad operated thermal printer as an option. **ACCESSORIES SUPPLIED:** The AR-501 Radio telegraph terminal comes complete with Receiver cable, DC Power cable, Miniature Phone plug, Miniature stereo phone plug, Spare fuse, Wall receptacle style power adaptor and Instruction manual. **ACCESSORIES AVAILABLE:** CC-501 Parallel printer cable — **$30.00**/DPU-411 Standalone Thermal printer with 8K buffer.—**$235.00**

ORDERING INFORMATION: For fastest service, call **800-523-6366** from 9 A.M. to 4 P.M. P.S.T. Send mail orders to: ACE Communications, Inc. 22511 Aspan Street, Lake Forest, CA 92630. VISA and MasterCard orders and certified or cashier's check or money order shipped within 48 hours of receipt. Rush service by UPS/Overnight, UPS/2nd Day Air and Federal Express is available at extra shipping charges. Purchase orders accepted from Government agencies. CA residents add 6% sales tax. **COD is $3.00 extra. WARRANTY INFORMATION:** The AR-501 covered by One Year Warranty. Extended warranty service available at the following rates: **3 Years—$25.00, 2 Years—$15.00. SATISFACTION GUARANTEE:** If, for any reason, the ORIGINAL PURCHASER, is not satisfied with the unit purchased, a full refund of the purchase price will be issued if the unit and all accessories are returned to us UNDAMAGED WITHIN 25 DAYS of the date of original purchase (Invoice date). This policy excludes any additional freight that may be incurred, and in no event modifies or limits the limited warranty.

ACE Communications

22511 Aspan Street • Lake Forest • California • 92630-6321 • (714) 581-4900 • Toll Free 1-800-523-6366

FIGURE 1



D1: small (9mm size) metal-oxide varistor rated at line voltage used.
D2: 3A ≥ 100 PIV silicon rectifier.
C1: ≥ 220 μF 35 volts.
C2, C3: ≥ 1μF 35 volts tantalum mounted close to the IC.
F1: ≥ 0.5A for 100-125 volts line voltage; 0.25A for 200-250 volts line voltage, 3AG.
R1: 1k, multiturn trimpot. If more than nine NiCds are to be charged use 2k.
R2: 100 ohm 1/4 watt.
R3: Charge current sampling resistor. 1 ohm, 2 watt for charging AA batteries; 0.1 ohm, 2 watt for charging C or D batteries. Monitor the voltage across the resistor with a DMM or oscilloscope. For the 0.1 ohm resistor: 1 millivolt = 10 milliamperes.
T1: ≥ 1A secondary. If nothing larger than an AA cell is to be charged, a 0.5A transformer is adequate. Secondary voltage depends on how many cells are to be charged. Esec = 1.1 x (number of cells) + 3 volts, RMS. The no-load secondary voltage must be ≤ 24 volts RMS.

Schematic of NiCd pulse charger.

Note: D1 is an MOV.

only about 80 percent of the rated C of the battery can be realized by constant-voltage charging.

A method of charging is needed with a current that doesn't drop below the critical 0.1C level or cause the unsafe cell heating found with constant-current charging. The solution is voltage-limited pulse charging. The needed current of ≥0.1C is pulsed at a greatly reduced duty cycle, so the average heat dissipated by the cell is reduced to a safe level. The pulse discharger's disadvantage is that while it produces a higher C than constant-voltage charging, it won't allow 100-percent utilization of a battery's C. This is a small tradeoff for greatly extended battery life.

There have been several articles on pulse chargers for NiCds over the last few years, but none of the ones I saw were easy to build. I designed my pulse charger with this in mind. **Figure 1** shows the schematic.

circuit description

The pulse source for this charger is the half-wave rectified line frequency. Pulse duration is about 8.33mS with 60-Hz line frequency; the time between pulses is 16.67mS. Because the battery will be charged only when the charger voltage exceeds the battery voltage, it is the crest of the half-wave pulse that charges the battery. The duration of this charging pulse is ≈2mS to 3mS. The resting time between charge pulses is ≈13mS. The maximum voltage of the pulse is controlled by an LM-317T adjustable three terminal regulator IC. The output current is monitored by measuring the voltage drop across a known resistance (R3). The varistor (D1) in the charger takes care of the voltage spike that appears across the transformer windings and the half-wave rectifier (D2) when the charger is unplugged from the power source.

The recommended transformer current rating of ≥1A may seem high but is necessary for two reasons. First, half-wave rectification is especially hard on a transformer since a dc current flows in the secondary of the transformer. Second, the available peak current at the beginning of a charge cycle needs to be high enough to assure that any reversed cells will be automatically repolarized. If you need higher current output, the 5A LM-338 can be used in place of the LM-317T along with a heavier transformer, fuse, one-tenth of the resistance of R3, and a 6A rectifier (D2).

adjustment

Follow the steps below to make adjustments to the charger.

With no battery connected to the charger, depress S1 and set R1 for an output voltage of ≈1.43 volts per NiCd cell to be charged. Release S1.

Connect a DMM across the current test points. The initial average charge current will be about 0.3C which will decline as the battery is charged; the charge current plateaus after the cells are fully charged. R1 should then be reset for a charge current of ≈0.02C.

You can see the peak charging current on an oscilliscope by connecting the scope across the current test points. The peak charging current should be ≈0.1C when the average charging current is 0.02C. The transformer secondary voltage may be too high if it is less that 0.1C, or the current-monitoring resistor (R3) may need to be reduced by a factor of 10 times. This changes the calibration factor.

There won't be any damage to the battery if it is left connected to this charger for several days. However, you shouldn't charge the battery if the ambient temperature is above 35°C or 95°F.

myths about NiCds

Some people believe that it's best to let a NiCd pack run completely down to 0 volts before recharging. This is an acceptable practice with solid-plate NiCds, but it is the quickest way I know to short out a sintered-plate NiCd battery. According to one NiCd manufacturer, General Electric, a NiCd battery should never be discharged below 1.1 volts per cell. Allowing the cell voltage to go to 0 may also cause one or more of the cells in a battery pack to reverse polarize in the last few minutes of discharge. The normal constant-current charge rate of 0.1C isn't usually enough current to reverse the wrong polarity of the cell. This means that one cell won't recharge until it is reversed by a much larger current. A voltage-regulated pulse charger can usually supply enough initial charging current to reverse a reversed cell.

Another myth about NiCd batteries is that they have a "memory" which causes them to lose C. I have seen many NiCds that have lost part of their C; this was due to loss of electrolyte caused by overcharging and overheating. New NiCds can gain C after a few charge/discharge cycles and this appears to be a normal occurrence with newly manufactured cells. I have never seen the "memory effect" discussed in some NiCd literature.

Many feel that NiCds can be expected to last only a couple of years. This is probably true if they are carelessly charged with a constant-current charger. The 26 volt/5.7Ah battery I mentioned earlier was made in 1962. The two paralleled halves of this battery (13 volts) will still start an automobile engine.

A final myth is that NiCds should be stored fully discharged and shorted out. This is almost certain to cause an eventual, but fatal, short circuit between the plates of a sintered-plate NiCd. The proper way to store a NiCd is to charge the battery, place it in a sealed plastic container (so that it can't be inadvertently shorted), and put it in a freezer compartment. You'll need to repeat this process every 3 years.

disadvantages of NiCd cells

Besides being dangerous if shorted out, NiCds also have some other disadvantages. One of these is the problem of self-discharge. At room temperature, a sealed NiCd cell loses about 1 percent of its stored energy daily with no load on the battery. Self-discharge is highly dependent on the ambient temperature. Reducing the ambient temperature 10°C cuts the self-discharge rate in half. An ordinary freezer with a temperature of −15°C causes only about 1/20th of the self-discharge rate that you could expect on a warm summer day.

Another pesky problem with NiCds is their flat discharge curve. They maintain a cell voltage of ≥1.15 volts right up to the end. Unlike carbon-zinc or alkaline-manganese cells, the end comes without warning. The only way to keep track of the remaining charge in a NiCd is with a high-resolution 3-1/2 digit DVM.

summary

Nickel-cadmium cells have their limitations. They wouldn't be good to use in smoke detectors, watches, or any place where low self-discharge is essential. But they work well for portable handheld transceivers. The only thing they require is a charger that can't inadvertently heat them during charging.

Article B **ham radio**

MEASURING TRANSMISSION LINE PARAMETERS

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

Three methods of determining velocity factor

There are several applications that require fairly accurate knowledge of the velocity factor of a transmission line. The ratings listed in data sheets and tables are only approximations, and the velocity factor varies not only between different suppliers but between different sections of cable on a reel.

Say, for example, you want to find the length of a coax cable that is half a wavelength long. Because this length (or an integral multiple of it) reproduces its load impedance (for instance, the impedance of an antenna) at its input, you can make remote antenna measurements via this cable.

input impedance measurement

The simplest, although not the most accurate, method is to short circuit the cable and place a 51-ohm resistor in series with its input and a signal generator (see **fig. 1**). Monitor the cable input voltage with an rf voltmeter and adjust the frequency for minimum input signal.[1] Consider a section of RG-58 C/U coax that is 19.93 feet long. To predict the lowest frequency at which the input impedance is 0, calculate the frequency that corresponds to a full wavelength for a cable whose velocity factor (v) is 0.66 (used as a starting point).

$$f_o = \frac{984 \cdot 0.66}{\ell} \qquad (1)$$

where f_0 is the frequency in MHz and ℓ the cable length in feet. Based on a velocity factor of 0.66, frequency f_0 would equal 32.587 MHz. So, for half the frequency of f = 16.293 MHz, this cable is half a wavelength long and the input voltage is 0 because the cable output is shorted. Now make an actual frequency measurement and incorporate its value in the following formula:

$$v = \frac{f \cdot \ell \cdot 2}{984} \qquad (2)$$

If the measured frequency is determined to be f = 16.131 MHz, the velocity factor becomes:

$$v = \frac{16.131 \cdot 19.93 \cdot 2}{984} = 0.653$$

FIGURE 1

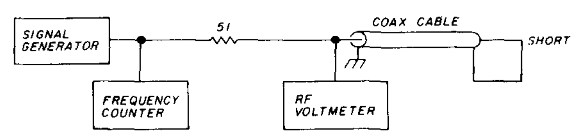


fig. 1. Signal generator is adjusted until rf voltmeter dips to lowest value.

three-coil method

Figure 2 shows a three-coil method presented by George Downs, W1CT.[2] It uses a grid dip meter in conjunction with three different coils connected to the input of the cable with a shorted output. The test procedure is as follows:

- Prepare three coils by winding a No. 20 bare wire with a 0.25-inch coil diameter. Space turns evenly with short pigtails on each coil. Make coils with three, two, and one turns, respectively.
- Solder the three-turn coil to the cable input. Determine the resonant frequency with a grid dip meter and monitor the frequency with a frequency counter. Use minimum coupling.
- Repeat this test with the other two coils.
- Plot the results (turns versus frequency) on linear graph paper as shown in **fig. 3**. Find the frequency at which you can calculate the velocity factor by extrapolating the curve (asymptote) to zero turns. You may be able to obtain a nearly straight line by spacing

FIGURE 2

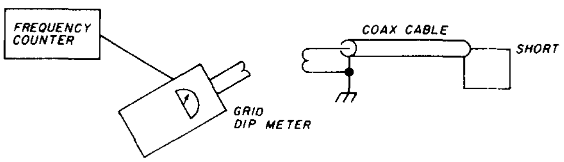


fig. 2. Three different coils are used to generate data.

FIGURE 3

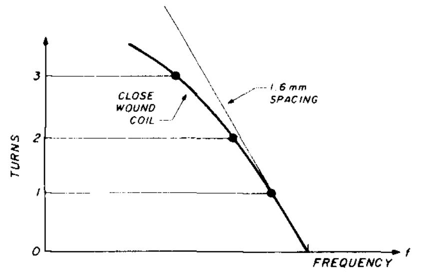


fig. 3. Asymptote intersects frequency axis at "zero turn" point. This frequency when substituted into *eqn. 2* determines velocity factor.

FIGURE 4

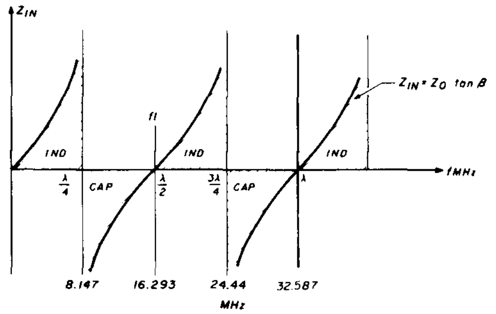


fig. 4. Inductive and capacitive substitution method of determining velocity factor depends on alternating reactance sign of input transmission line impedance.

the turns properly. **Figure 4** explains how this method works. It shows the input impedance (in this case a pure reactance) of a 19.93-foot shorted and *lossless* cable versus frequency, and for a velocity factor of 0.66. Note that the input impedance is a pure capacitance between 8.147 and 16.293 MHz and the cable can be resonated by an external inductance. At frequencies between 16.293 and 24.44 MHz the cable is inductive and can be resonated by an external capacitor. In both cases, you have a parallel-tuned resonant circuit. The smaller the external inductance, the closer the frequency is to the half-wavelength frequency of 16.293 MHz.

This explains why it is impossible to determine cable length accurately with a grid dip meter and coupling coil. You resonate the external inductance with the cable capacitance, but do not measure the correct frequency f_1 in this way.

The method's main disadvantage lies in the difficultly of making a one-turn coil because its pigtails affect the value of its inductance. In practice, the three points in **fig. 3** don't always line up very well.

three-capacitor method

By using external capacitors, you can operate the cable as the *inductive element of a parallel-tuned circuit*. The obvious advantage is that you can measure capacitances precisely. The voltage peak at resonance is easy to observe and accuracy is better than with the previous methods. Since you have a parallel-tuned circuit, you must feed the signal from a high impedance source. A 4.7 k resistor is sufficient (see **fig. 5**).

- Determine the resonant frequencies for each of three different capacitors.
- Calculate the three capacitive reactances:

$$\frac{1}{\omega C} \qquad (3)$$

where C is the total external capacitance and $\omega = 2\pi f$, with f the resonant frequency for each respective capacitor.

- *Plot the curve:*

$$\frac{1}{\omega C}$$

versus f and extrapolate the curve to find the intersection point on the frequency axis.

- Insert this value in **eqn. 2.**

Add the input capacitance of the rf voltmeter to the external capacitor value and measure the physical length of the cable as accurately as possible. If you

FIGURE 5

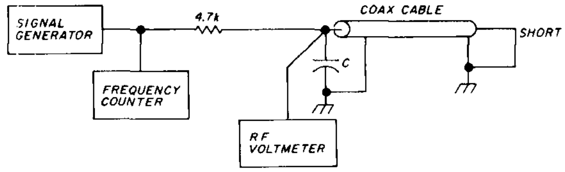


fig. 5. Third and most accurate method of determining velocity factor utilizes capacitors that resonate with the cables inducting reactance.

don't have access to an rf voltmeter; build a single-stage amplifier (A simple wide-band, RC coupled one) followed by a rectifier, using voltage doubling. Then amplify the resulting dc voltage with a 741 operational amplifier that drives a meter. Feed the amplifier by way of an emitter follower to reduce the probe capacitance that forms part of the total capacitance. If you can select the cable length, choose one longer than 16.4 feet in order to keep the resonant frequency in the range of 10 to 20 MHz and reduce the effect of parasitic inductances.

The capacitors must be connected with the shortest possible leads between center conductor and shield. (I recommend using a small pc board as a groundplane and ground reference.) If the capacitor leads are too long the apparent capacitance is increased, due to the series inductance, and the measured resonance frequency will be lower — falsely indicating a smaller value of velocity factor.

Consider a piece of RG-58 C/U coax, 21.01 feet long. The three values of capacitance chosen are 235 pF, 773 pF, and 1658 pF (which includes 3 pF for the probe capacitance). **Table 1** shows the measured frequencies and the corresponding calculated values of capacitive reactance.

TABLE 1

Measured frequencies and calculated values of capacitive reactance.

C	pF	235	773	1658
f	MHz	18.377	16.58	16.0
$\frac{1}{\omega C}$	Ω	36.85	12.42	6.0

Before plotting the curve:

$$\frac{1}{\omega C}$$

versus frequency, calculate the input impedance of this cable for a velocity factor of 0.66 and a characteristic cable impedance of 50 ohms. The input impedance of a shorted cable can be calculated from:

$Z_{IN} = Z_o \tan\beta$

where Z_o is the characteristic cable impedance and β its electrical length in degrees. At the half-wavelength point (f = 16.293 MHz), β is 180 degrees and the input impedance is 0. For a frequency of 16.4 MHz, for example, the corresponding β value is:

$$\beta = 180 \cdot \frac{16.4}{16.293} = 181.18 \text{ deg} \quad (4)$$

and Z_{IN} = 1.03 ohms. You can draw the whole curve Z_{IN} versus frequency for v = 0.66 and Z_o = 50 ohms, as shown in **fig. 6** (curve A). A frequency of f = 15.46

MHz is found by extrapolation of curve B. Using **eqn. 2**, you will obtain:

$$v = \frac{15.46 \cdot 21.01 \cdot 2}{984} = 0.66$$

The measured points on curve B line up well. Drawing the curve for v = 0.66 (curve A) facilitates the plotting of the measured curve.

measuring the characteristic impedance of a cable

A good method for measuring Z_0 is to use two different termination resistors R_A and R_B (different from Z_0) and then measure the corresponding input impedances $Z_1 = R_1 + jX_1$ and $Z_2 = R_2 + jX_2$ with an impedance bridge. The termination resistors can also be 0 and infinite (short circuit and open circuit). In general, you should select termination resistors that provide input impedances well within the measuring range of the bridge. Calculate the characteristic cable impedance from:

$$Z_o = \sqrt{\frac{(Z_1 - R_A)\, R_B\, Z_2 - (Z_2 - R_B)\, R_A\, Z_1}{Z_1 - Z_2 - R_A + R_B}} \quad (5)$$

Since Z_1 and Z_2 are complex quantities, the calculations are quite cumbersome.

The advantage of the three-capacitor method is that the characteristic impedance Z_0 can be obtained easily from the plot

$$\frac{1}{\omega C}$$

versus frequency. By referring to **fig. 6**, you'll see that curve A was calculated for Z_0 = 50 ohms and v = 0.66. Curve B of the example has the same intersection point at the X-axis of 15.46 MHz (because v = 0.66), but it has a higher slope than curve A. Because the mathematical representation of curve A is:
$Z_{IN} = Z_0 \tan \beta$
the slope of the curve is governed by the value of Z_0. By taking the

$$\frac{1}{\omega C}$$

values of f = 18.2 MHz, for example, you'll find 31.2 ohms and 34 ohms. This makes the Z_0 value for this cable:

$$Z_o = 50 \cdot \frac{34}{31.2} \cong 54.5 \text{ ohms} \quad (6)$$

If the velocity factor were smaller than 0.66, curve B would lie to the left of curve A. If v is smaller than 0.66 and Z_0 is larger than 50 ohms, you must shift the curve to the right, until it has the same intersection point as curve A, to determine the slope difference.

FIGURE 6

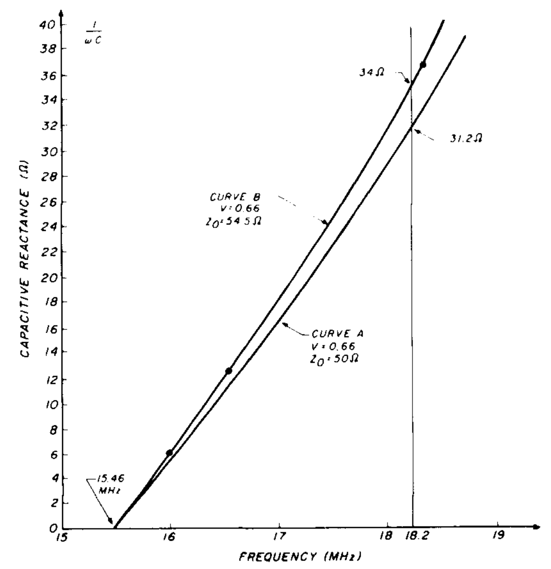


fig. 6. Data from curves used to determine a transmission line's characteristic impedance.

summary

I have presented three methods of measuring the velocity constant of a transmission line. In all three, the cable output is shorted. The first method uses a small series resistor of 51 ohms between the cable input and signal generator. The frequency at which the cable input voltage is at a minimum can be used to calculate v.

The second method employs three different inductors at the cable input and uses the cable as the capacitive element of a parallel-tuned circuit.

The third, and most accurate, method uses three or more different capacitors of known value at the cable input, with the cable acting as the inductive part of a parallel-tuned circuit. The circuit is fed by a high value resistor from a signal generator. From the plot

$$\frac{1}{\omega C}$$

versus frequency, the velocity factor (v) can be calculated.

This same plot can be used to calculate the characteristic impedance Z_0 of a cable more easily than with other existing methods, and without the need for an impedance bridge and time-consuming calculations.

references

1. Joe Carr, K4IPV, "Practically Speaking: Coax Velocity Factor," *ham radio*, November 1986, page 79.
2. George Downs, W1CT, "Measuring Transmission Line Velocity Factor," *QST*, June 1979, page 27.

Article C **ham radio**

HAM RADIO TECHNIQUES

Bill Orr, W6SAI

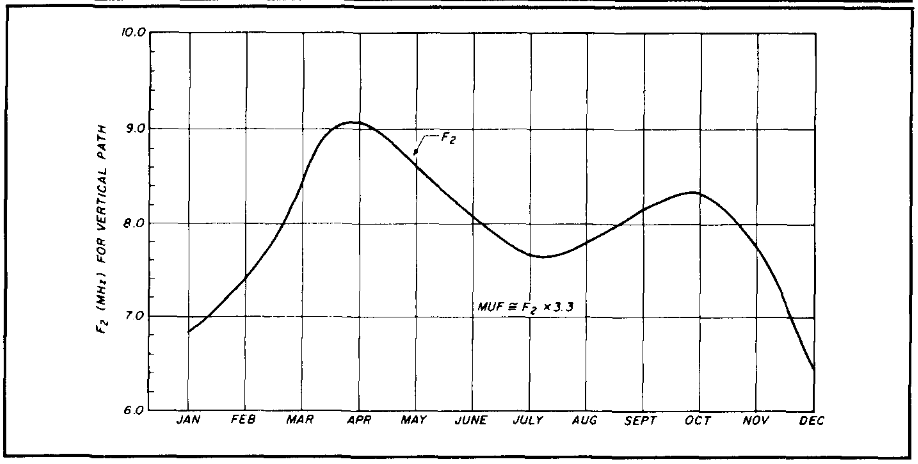
on our way up!

"**Been down for so long** it feels like up to me!" That's the story of the sunspot cycle and DX. At last things are on the way up. The sun is getting spottier and the higher frequency Amateur bands are coming to life.

Of course it didn't seem that way during the summer months. DX tends to fizzle out in warm weather and there's a lot of short skip in its place. But DX will pick up again in the fall months, as it has for many years.

My good friend Steve, KH6SB, has maintained a running record of various aspects of the solar cycle over a period of 34 years. Steve is stationed at the NOAA Ionospheric Research Station at Maui, Hawaii. The graph in **fig. 1** is my copy of his record (taken in Maui) of the ionospheric measurements of the maximum reflection frequency of the F2 layer, as measured by the radio sounder. This critical frequency is that of a pulsed radio wave, projected vertically to the ionosphere, whose reflected signal is monitored at the sounder site. At Maui, the MUF (maximum usable frequency) is about 3.3 times the maximum measured reflection frequency. The graph shows what most DXers know from experience — the best DX months are in the spring (March and April) and the fall (September and October). Winter and summer months are poorer because the average MUF is lower. The 10, 12, and 15-meter bands are particularly sensitive to this annual cycle.

FIGURE 1



Recorded maximum frequency of vertical incident sounder (Maui) averaged over 34 years.

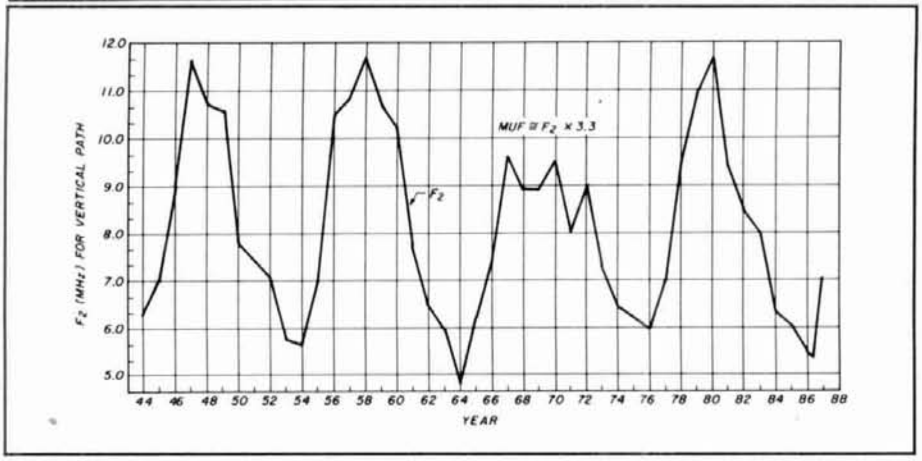
You might infer from the graph that spring is better than fall for DX on the higher bands. This may be true for Hawaii, but not necessarily for the rest of the world. The chart gives a quick overview of the ionosphere and its effect on DX conditions, as logged over three decades of observation.

what about September?

And what about the month of September? **Figure 2** shows the record of F2 vertical sounding for September since 1944 and covers over four sunspot cycles. The factor of 3.3 shows that during sunspot minima (1986, for example) the median vertical sounding frequency averaged about 5.5 MHz, indicating that the MUF ran around 18 MHz. During the minimum year of 1976, the September MUF averaged around 19.8 MHz. But during the very low period of September 1964, the MUF averaged only 15.8 MHz. This was good news for the 20-meter DXer who operated near the edge of the MUF, but bad news for the operator on 15 and 10 meters. (The actual median values shown are for a 24-hour period, and the MUF near noon is probably higher than the values discussed.)

On the other hand, during the great sunspot cycle year of 1957, the September median value of MUF may have run as high as 39.6 MHz; for the October period of that year, the MUF

FIGURE 2

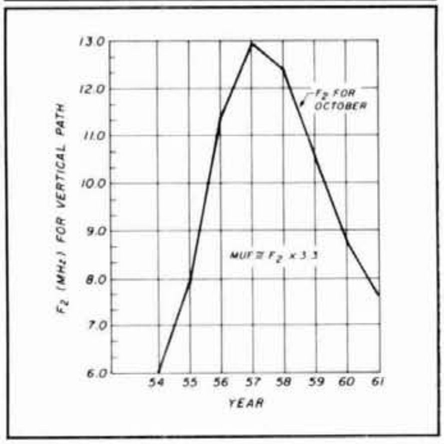


F_2 vertical sounding record (Maui) over 4 sunspot cycles (month of September).

ran as high as 43.5 MHz! (See **fig. 3**.) Looking back at old copies of *QST* magazine, I found reports of fabulous 50-MHz DX in late 1957. The East Coast was working Hawaii, the West Coast was working South Africa and Europe, and the MUF was reaching occasional peaks of 52 MHz!

What are the probabilities of DXers being able to repeat the fabulous conditions of the fall of 1957? Some specialists think the chances are good for a high sunspot cycle peak in a year or two. If this comes to pass, the 50-MHz band will explode with strong DX signals from all over the world. I'm keeping my fingers crossed on that one!

FIGURE 3



During October 1957 the median MUF peaked near 43.5 MHz.

the darker side

A high sunspot count is welcomed by the DXer who "pushes" the MUF — increases his operating frequency as the MUF rises. For the operator who prefers the lower frequencies, a high sunspot count is bad news. As the operating frequency falls behind the MUF, the absorption of signals increases and conditions deteriorate. Thus the "DX-ability" of 160 through 20 meters will decline as the solar cycle progresses. I remember that at the peak of the 1968 cycle 20 meters would be dead for days, while 10 meters was full of enticing DX signals. Forty and 80 meters were not considered serious DX bands. Old DX columns in *QST* confirm these facts. A perusal of these columns gives a good indication, in retrospect, of how conditions really are at various periods during the sunspot cycle. So look ahead to good DX conditions on 15 and 10 (and possibly 6) meters and poorer conditions on 160, 80, 40 (and possibly 20) meters.

MININEC revisited

The classic MININEC antenna analysis program developed by the Naval Oceanic Systems Center is well known to many Amateurs. It is used to model antennas for any operating frequency within the range of the antenna design. It can evaluate published designs, modify an existing antenna, or create a new antenna design at the user's command. When used with a beam antenna, it will provide forward gain, front-to-back ratio, beam width, side lobe levels, input impedance, azimuth and elevation patterns, and more.

MININEC is designed for the IBM PC and compatible computers. While suitable for Amateur Radio applications, some modifications can make it even easier for hams to use. Brian Beezley, K6STI, has generated an MN antenna analysis program suited to the Amateur.* MN requires an IBM PC or compatible machine with about 250K of free memory; the plotting program requires an additional 150K. You'll need a Hercules Graphics Card to view the plots, but the MN analysis program can use any display.

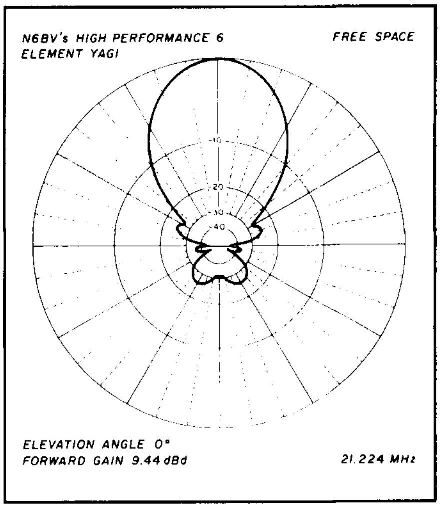
The MN program contains over 50 predesigned antenna files in its library and gives an easy starting point for antenna modeling. The plotting program provides azimuthal and elevation plots like those shown in **figs. 4** and **5**. The latter shows the first plot I've ever seen of a terminated Beverage antenna, popular on 160 meters. Note the excellent front-to-back ratio of the 2-wavelength antenna! Note also that at an elevation of 10 feet, this Beverage wire shows the main lobe to be at an elevation angle of about 26 degrees. The gain of the Beverage is about 6 dB less than a dipole. But this is of little consequence because the comparative loss in signal strenth can be recovered easily in the receiver preamplifier.

160-meter beacon signals

A group of mysterious beacon signals are heard during the June-September period on the 160-meter band. They are most noticeable in the Northwest and Alaska. Dan, KL7Y, reports hearing them as early as June and as late as September, after which time they vanish. It is assumed the beacons are used during the fishing season by Japanese or Russian commercial fishing fleets in the Bering Sea or northern Pacific. In periods of good

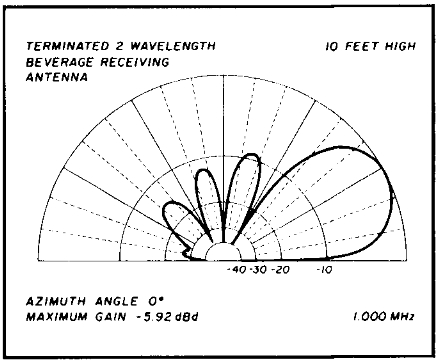
*For information on the MN program send an SASE to K6STI, Bryan Beezley, 507-1/2 Taylor Street, Vista, California 92084.

FIGURE 4



MN program plot of 6-element Yagi (21 MHz) pattern.

FIGURE 5



MN plot of 2-wavelength Beverage antenna (1.8 MHz) elevation pattern.

propagation, Dan has heard as many as 26 different beacons in a day. A smaller number are heard on the West Coast. They are not heard in the Midwest, and apparently are not heard in the southern Pacific area either. KL7Y reported that he heard a QSO in progress between WØZV and Australian stations directly on top of a beacon and neither operator appeared to hear it. **Table 1** gives a list of some of the beacons and their approximate frequency.

The frequency range of 1800-1810 kHz is reserved for radiolocation in Region 1 of the ITU (International Telecommunications Union); this includes an area of the Bering Sea near the coast of Siberia. Radiolocation is also permitted in Region 2 (the Americas). It seems that the legality of the beacons is a fuzzy matter that may be open to question. Reports on these signals from other areas of the world would be welcome.

TABLE 1

160-meter beacon signals*

Frequency (kHz)	Beacon Identification (CW)
1800	DS45
1803	OU42
1805	OS13, Z12–
1817	4XI
1820	ZI8–, HI53–
1822.5	LO5
1823	BD6
1825	GGI, 6VOD, BA1–
1827	NI9–
1828	YKT5–
1833	ZA4–
1835	AI6–
1841	BD1–
1848	550A–
1863	GL1, XC4
1865	LN3–
1870	5X4
1871	N6AT (not a ham call!)
1873	KJ38
1962	IK43
1964	BD3–, K8–, DH2, DU2
1977	TA7W
1993	OR36

(– indicates a long dash following the ID)
*Compiled by KL7Y.

Orr's familiar quotation

In my last few columns I have given a well-known quotation from a popular book, just to see if you're on the ball, or if you're only "couch potatoes" alternating between the tube and the operating desk. Here's another quotation from a popular book. Give me the title of the book and the author:

"I keep picturing all those little kids playing some game in this big field of rye and all. Thousands of little kids, and nobody's around — nobody big, I mean — except me."

What book? What author? If you know, send me the answer on your QSL card. I'll list all who are correct. My QTH is Box 7508, Menlo Park, California 94025.

Article D **ham radio**

GREAT CIRCLE COMPUTATIONS
USING LOTUS 1-2-3®

Thomas M. Hart, AD1B, 54 Hermaine Avenue, Dedham, Massachusetts 02026

In the last few years, there have been a number of interesting articles in various Amateur publications about computing great circle angles and distances. For the most part, the articles have featured BASIC programs driven by a set of formulas available in standard reference works. They all do a good job and are designed for a variety of computers, from the Sinclair ZX-81 through time-sharing terminals. With very little effort, most of the programs can be adapted to virtually any computer able to run one of the many dialects of BASIC.

I think a far better solution to the problem of computing great circle calculations is available in the form of an electronic spreadsheet like Lotus Development Corporation's 1-2-3. This article presents the information necessary to set up a simple spreadsheet that, in theory at least, can record more than 8,000 target locations and compute the angle and distance to each in a neatly formatted report. In practice, because of memory limitations, something on the order of 2,500 target locations can be stored. The resulting data can be sorted and presented in any order (distance, angle, alphabetical). A new starting point can be entered and all the information for successive locations can be rapidly recomputed. A useful way to use the spreadsheet might be to enter the name, QTH, latitude, and longitude of all the members of a 20-meter net. A customized print could then be prepared for each of the participants, listing the angles and distances to all the other members. On a smaller scale, you could enter the latitudes and longitudes of the members of a 2-meter net on a spreadsheet and generate the antenna bearings from each member to the others.

Electronic spreadsheets are productivity tools often found in educational or business applications. Spreadsheet programs allow the use of a very complete set of mathematical functions, including trigonometric formulas like tangent, sine, and cosine. The most popular spreadsheet program is 1-2-3, although many others like Microsoft's Multiplan®, Software Group's Enable®, and Lotus' Symphony® have similar features. You should be able to adjust the formulas in this article to work with any of the other major spreadsheets. With the proliferation of IBM (and clone) equipment during the last few years, using one of the major spreadsheets is just as practical as programming in BASIC.

The sample worksheet in **fig. 1** shows a few international targets by angle and distance from my own QTH; if I were to change the starting latitude and longitude to another station, the new computations would be completed in seconds. This is one of the

FIGURE 1

GREAT CIRCLE WORKSHEET
AD1B

ENTER SOURCE LONGITUDE AND LATITUDE IN DECIMAL DEGREES:

LAT1 --> 42.2 LOCATION: Dedham, Ma.
LON1 --> 71.2

TARGET LOCATION:	ENTER LAT:	LON:	DISTANCE (MILES)	HEADING (DEG.)
BAGHDAD	33.4	-44.4	5,809	49
BANGKOK	13.5	-100.6	8,547	10
BOGATA	4.0	75.0	2,650	186
BOMBAY	19.0	-72.5	7,612	37
BUENOS AIRES	-35.0	58.0	5,399	169
CAIRO	30.0	-31.2	5,427	60
CAPE TOWN	-34.0	-18.0	7,705	117
CHICAGO	41.9	87.6	838	274
DUBLIN	53.4	6.2	3,001	52
ISTANBUL	41.2	-29.0	4,827	52
MOSCOW	56.0	-37.5	4,482	36
PARIS	48.9	-2.2	3,440	56
PERTH	-32.0	-116.0	11,621	328
RIO de JANEIRO	-22.9	43.3	4,839	153
ROME	41.9	-12.4	4,098	59
SAN FRANCISCO	37.8	122.4	2,683	281
STOCKHOLM	59.2	-18.1	3,759	39
TEHRAN	35.8	-51.5	5,944	43
TOKYO	35.7	-139.8	6,707	335
WARSAW	52.2	-21.0	4,082	46

Sample worksheet for great circle computations.

great advantages of a spreadsheet over a BASIC program. You can create a database, in this case the list of cities around the world, and manipulate the information for a variety of purposes. The computer screen shows the final report in the form it will take when sent to the printer.

FIGURE 2

```
C1: 'GREAT CIRCLE WORKSHEET
C2: '          AD1B
A3: \=
B3: \=
C3: \=
D3: \=
E3: \=
F3: \=
G3: \=
H3: \=
A4: 'ENTER SOURCE LONGITUDE AND LATITUDE IN DECIMAL DEGREES:
I4: 'CONV
K4: 'POLES
L4: 'ADJ
I5: 'TO RAD
K5: 'TEST
L5: 'LAT/LON
A6: 'LAT1 --->
D6: 'LOCATION:
I6: (B6)*@PI/180
K6: @IF(@ABS(I6)>1.5533,1.5533*(I6/(@ABS(I6))),I6)
L6: (K6)
A7: "LON1 --->
I7: (B7)*@PI/180
L7: (I7)
A8: \=
B8: \=
C8: \=
D8: \=
E8: \=
F8: \=
G8: \=
H8: \=
I8: \=
J8: \=
K8: \=
L8: \=
M8: \=
N8: \=
O8: \=
A9: 'TARGET
C9: 'ENTER
E9: 'DISTANCE
F9: 'HEADING
I9: 'CONV
J9: 'CONV
K9: 'POLES
L9: 'OPP
M9: 'DIST
N9: 'ANGLE
O9: 'ANGLE
A10: 'LOCATION:
C10: 'LAT:
D10: 'LON:
E10: '(MILES)
F10: '(DEG.)
I10: 'LAT2
J10: 'LON2
K10: 'TEST
L10: 'TEST
M10: '(RAD)
N10: 'TEST
A11: \
B11: \
C11: \-
D11: \-
E11: \-
F11: \-
G11: \-
H11: \-
I11: \-
J11: \-
K11: \
L11: \-
M11: \-
N11: \-
O11: \-
E12: (,0) 69.06*(M12)*180/@PI
F12: (,0) (O12)
I12: (C12)*@PI/180
J12: (D12)*@PI/180
K12: @IF(@ABS(I12)>1.5533,1.5533*(I12/(@ABS(I12))),I12)
L12: @IF(@ABS($L$7-J12)>3.124139#AND#((-1*@ROUND($L$6*120,0))=(@ROUND(J12*12
0,0))),J12+0.01745,J12)
M12: @IF(@ROUND($L$7*120,0)=@ROUND(L12*120,0),@ABS($L$6-K12),@ACOS(@SIN($L$6
)*@SIN(K12)+@COS($L$6)*@COS(K12)*@COS(L12-$L$7)))
N12: @IF((@ROUND($L$7*120,0)=@ROUND(L12*120,0)),(@IF($L$6>K12,@PI,0)),@ACOS(
(@SIN(K12)-@SIN($L$6)*@COS(M12))/(@SIN(M12)*@COS($L$6))))
O12: (,1) @IF(@SIN(L12-$L$7)<0,(2*@PI-N12)*(180/@PI),(N12*180/@PI))
```

Listing of entries to create a 1-2-3 spreadsheet.

In addition to the sample output sheet, I have included a listing of the entries in **fig. 2** to create a 1-2-3 worksheet and a listing of the formulas in **fig. 3** used in creating a great circle spreadsheet. Once this file is complete, simply copy the formulas from line 6 down for as many lines as you need. The formulas are designed to work in a combination of absolute and relative references so that they may be copied as many times as required.

To prepare your own great circle worksheet, refer to **fig. 2** listing; it contains two sections. The first column is comprised of a reference to the cell where text and formulas are to be entered. For example, "C1:" means that the first cell in column "C" receives the information that follows on the same line of the listing. Text entries are indicated by an apostrophe as the first character in the string. The apostrophe itself is not typed into the worksheet, but is generated by the computer whenever it detects a text entry. A formula has no apostrophe and, once again, is entered as shown in the listing.

FIGURE 3

```
THE FORMULAS USED IN DETERMINING THE ANGLE AND DISTANCE
BETWEEN TWO LOCATIONS ARE SHOWN BELOW.

THE FORMULAS ARE FROM THE ARTICLE BY NS6N ET AL. IN HAM RADIO.
=========================================================================

A. IN ORDER TO CONVERT DECIMAL DEGREES TO RADIANS (THE FORMAT REQUIRED
   BY THE COMPUTER), THE FOLLOWING FORMULAS ARE USED:

                   (LAT1)*PI/180      LATITUDE CONVERSION
                   (LON1)*PI/180      LONGITUDE CONVERSION

B. IF ONE OF THE LOCATIONS IS A POLE, THE LATITUDE IS SET AT
   +/ 1.5533 RADIANS IN ORDER TO AVOID COMPUTATIONAL ERRORS.

          IF LAT1 > 1.5533 THEN LAT1 = 1.5533
          IF LAT1 < -1.5533 THEN LAT1 = -1.5533
          IF LAT2 > 1.5533 THEN LAT2 = 1.5533
          IF LAT2 < -1.5533 THEN LAT2 = -1.5533

C. IF THE LOCATIONS ARE DIAMETRICALLY OPPOSED, A SMALL VALUE IS ADDED TO
   THE TARGET LONGITUDE IN ORDER TO AVOID COMPUTATIONAL ERRORS.

IF (ABS (LON1 - LON2) > 3.124139) AND ((-1.0 * ROUND (LAT1 *120)) =
  (ROUND (LAT2 * 120))) THEN LON2 = LON2 + 0.01745

D. CHECK FOR EQUAL LONGITUDES.

IF ROUND(LON1*120) = ROUND(LON2*120) THEN DISTANCE = ABS(LAT1 - LAT2)

IF LAT1 > LAT2 THEN HEADING = PI ELSE HEADING = 0.0

E. DISTANCE

DISTANCE = ARCCOS(SIN(LAT1)*SIN(LAT2)+COS(LAT1)
           *COS(LAT2)*COS(LON2-LON1))

F. HEADING

HEADING = ARCCOS((SIN(LAT2) - SIN(LAT1)*COS(DISTANCE))/
           (SIN(DISTANCE)*COS(LAT1)))

G. DETERMINE IF HEADING NEEDS TO BE REVERSED.

IF SIN(LON2-LON1) < 0.0 THEN HEADING = 2 * PI - HEADING
```

List of formulas used to create a great circle spreadsheet.

There is nothing radically new in using a computer to generate great circle information. I have relied on articles by other authors to learn the basics of the computations. NS6N did a good job of explaining the trigonometry involved; even I can understand the principles.[1] The formulas for the computations, summarized in an accompanying table, should make the job of adapting the spreadsheet to other programs fairly easy.

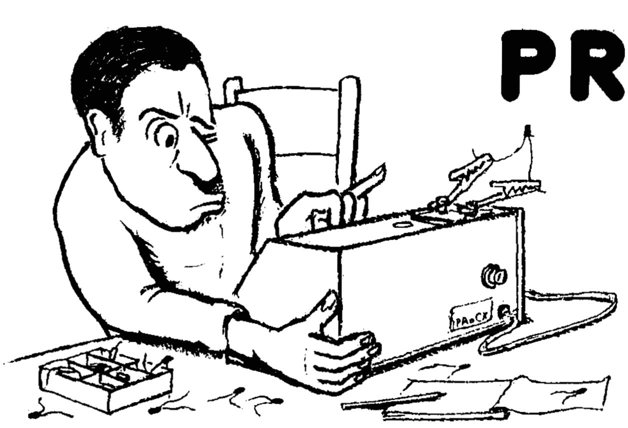
references

1. Van Brollini, NS6N, and Walter Buchanan, "DXing by Computer," *ham radio*, August 1984, page 81.

bibliography

1. Carl Wagar, VE3EKR, "Computerized Global Calculations", *73*, December 1977, page 106.
2. Dennis Bodson, W4PWF, and Bob Fenichel, WA2TMT/4, "Aim Your Antenna With a Micro," *73*, June 1977, page 108.

Article E **ham radio**



PRACTICALLY SPEAKING

Joe Carr, K4IPV

transmission lines and their typical ac responses

In an earlier column we looked at several parameters pertaining to radio transmission lines (some only rarely considered by Amateurs). We also discussed the step-function response of the transmission line. This month we'll talk about the ac response of the transmission line and some special cases of "looking into" impedance. Although some of this material is a little esoteric, my mailbag indicates sufficient interest for a column on the subject. Knowing this material can help you design antenna feed systems and matching systems based on transmission lines, and understand transmission line problems.

the ac response of a transmission line

When a CW rf signal is applied to a transmission line the excitation is sinusoidal (**fig. 1**), so it's useful to investigate the steady-state ac response of the line. The term "steady state" implies a sine wave of constant amplitude, phase, and frequency. When ac is applied to the input of the line it propagates along the line at a given velocity. The ac signal amplitude and phase will decay exponentially in the manner shown below:

$$V_R = Ve^{-r\ell} \quad (1)$$

where:
V_R is the voltage received at the far end of the line
V is the applied voltage
ℓ is the length of the line
r is the propagation constant of the line

The propagation constant (r) is defined in several equivalent ways, each illustrating its nature. For example, the propagation constant is proportional to the product of impedance and admittance characteristics of the line:

$$r = [ZY]^{1/2} \quad (2)$$

or, since $Z = R + j\omega L$ and $Y = G + j\omega C$, we may write:

$$r = [(R + j\omega L)(G + j\omega C)]^{1/2} \quad (3)$$

We may also write an expression for the propagation constant in terms of the line attenuation constant (a) and phase constant (B):

$$r = a + jB \quad (4)$$

If we assume that susceptance dominates conductance in the admittance term, and reactance dominates resistance in the impedance term (both usually true), then we may neglect the R and G terms altogether and write:

$$r = j\omega [LC]^{1/2} \quad (5)$$

We may also reduce the phase constant (B) to:

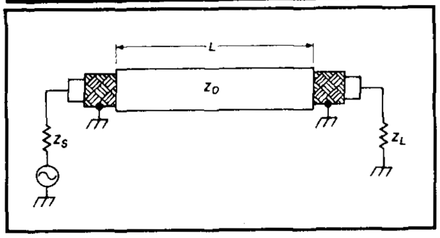
$$B = \omega [LC]^{1/2} \quad (6)$$

or, $B = \omega Z_o C$ rad/m (7)

and, of course, the characteristic impedance remains:

$$Z_o = [L/C]^{1/2} \quad (8)$$

FIGURE 1



Coaxial transmission line excited by a sine-wave generator with source impedance Z_s and load impedance Z_L.

special cases of looking into impedance

The impedance looking into a transmission line (Z) is the impedance presented to the source by the combination of load impedance and transmission line characteristic impedance. The equations that follow define the looking-in impedance "seen" by a generator or source driving a transmission line.

When the load impedance and line characteristic impedance are matched the definition is:

$$Z_L = R_L + j0 = Z_o \quad (9)$$

The load impedance is resistive and equal to the characteristic impedance of the transmission line. The line and load are matched, and the impedance looking in will be simple $Z = Z_L = Z_o$. Other cases present different situations where Z_L is not equal to Z_o.

1. Z_L is not equal to Z_o in a random length lossy line:

$$Z = (Z_o)\ \frac{Z_L + Z_o Tanh\ (r\ell)}{Z_o + Z_L Tanh\ (r\ell)} \quad (10)$$

where:
Z is the impedance looking in, in ohms
Z_L is the load impedance, in ohms
Z_o is the line characteristic impedance, in ohms
ℓ is the length of the line in meters
r is the propagation constant

2. Z_L is not equal to Z_o in a lossless

or very low loss random length line:

$$Z = (Z_o) \frac{Z_L + jZ_oTan\ (B\ \ell)}{Z_o + jZ_LTan\ (B\ \ell)} \quad (11)$$

Equations 10 and **11** above serve for lines of any random length. Special solutions are found for lines that are either integer multiples of half wavelength, or odd integer (1, 3, 5, 7, etc.) multiples of quarter wavelength. Some of these solutions are very useful in practical situations. For example,

3. Half-wavelength lossy lines:

$$Z = (Z_o) \frac{Z_L + Z_oTanh\ (a\ \ell)}{Z_o + Z_LTanh\ (a\ \ell)} \quad (12)$$

example 1

A lossless 50-ohm (Z_o) transmission line is exactly one-half wavelength long, and is terminated in a load impedance of Z = 30 + j0. Calculate the input impedance looking into the line (note: in a lossless line a = 0).

solution:

$$Z = (Z_o) \frac{Z_L + Z_oTanh\ (a\ \ell)}{Z_o + Z_LTanh\ (a\ \ell)}$$

$$Z = (50\ ohms) \frac{30 + [(50)\ (tanh((0)(\pi)))]}{50 + [(30)(tanh((0)(\pi)))]}$$

$$Z = (50\ ohms) \frac{30 + [(50)(tanh(0))]}{50 + [(30)(tanh(0))]}$$

$$Z = (50\ ohms) \frac{30 + 0}{50 + 0}$$

Z = (50 ohms) (30/50) = **30 ohms**

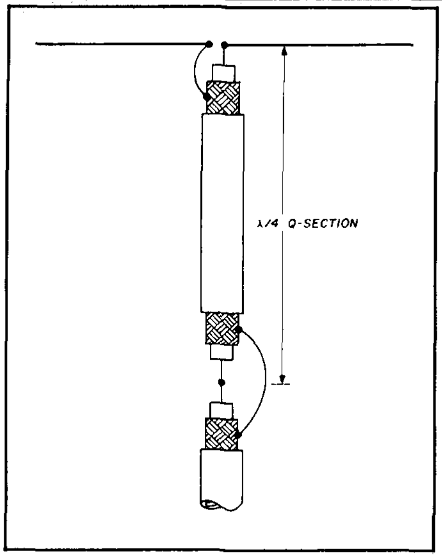
The preceding example shows that the impedance looking into a lossless or very low loss half-wavelength transmission line is the load impedance:

$Z = Z_L$ **(13)**

The fact that line input impedance equals load impedance is useful in certain practical situations. For example, a resistive impedance is not changed by the line length. So when an impedance is inaccessible for measurement purposes, the impedance can be measured through a transmission line that is an integer multiple of half wavelength.

The next case involves a quarter-wavelength transmission line, and

FIGURE 2



Quarter wave "Q-section" impedance-matching system.

those that are odd integer multiples of quarter wavelength (even integer multiples of quarter wavelength obey the half-wavelength criteria).

4. Quarter-wavelength lossy lines:

$$Z = (Z_o) \frac{Z_L + Z_oCoth\ (a\ \ell)}{Z_o + Z_LCoth\ (a\ \ell)} \quad (14)$$

and,

5. Quarter-wavelength lossless or very low loss lines:

$$Z = \frac{[Z_o]^2}{Z_L} \quad (15)$$

Equation 15 shows an interesting property of the quarter-wavelength transmission line. First, divide each side of the equation by Z_o:

$$\frac{Z}{Z_o} = \frac{[Z_o]^2}{Z_LZ_o} \quad (16)$$

$$\frac{Z}{Z_o} = \frac{Z_o}{Z_L} \quad (17)$$

The ratio Z/Z_o shows an inversion of the load impedance ratio Z_L/Z_o, or stated another way:

$$\frac{Z}{Z_o} = \frac{1}{Z_L/Z_o} \quad (18)$$

We can deduce another truth about quarter-wavelength transmission lines from **eqn. 15**:

If

$$Z = \frac{[Z_o]^{1/2}}{Z_L} \quad (19)$$

Then

$Z\ Z_L = [Z_o]^{1/2}$ **(20)**

Which means

$Z_o = [Z\ Z_L]^{1/2}$ **(21)**

Equation 21 shows that a quarter-*wavelength transmission line can be* used as an impedance-matching network. Called a Q-section (**fig. 2**), the quarter-wavelength transmission line used for impedance matching requires a characteristic impedance Z_o (if Z is the source impedance and Z_L is the load impedance).

example 2

A 50-ohm source must be matched to a load impedance of 36 ohms. Find the characteristic impedance required of a Q-section matching network.

solution:

$Z_o = [Z\ Z_L]^{1/2}$

$Z_o = [(50\ ohms)(36\ ohms)]^{1/2}$

$Z_o = [1800\ ohms]^{1/2} = $ **42 ohms**

6. Transmission line as a reactance:

Reconsider **eqn. 11**, which related impedance looking in to load impedance and line length:

$$Z = (Z_o) \frac{Z_L + jZ_oTan\ (B\ \ell)}{Z_o + jZ_LTan\ (B\ \ell)} \quad (22)$$

In the case of a shorted line (Z_L = 0), the solution is:

$$Z = (Z_o) \frac{0 + jZ_oTan\ (B\ \ell)}{Z_o + j(0)Tan\ (B\ \ell)} \quad (23)$$

$$Z = (Z_o) \frac{jZ_oTan\ (B\ \ell)}{Z_o} \quad (24)$$

$Z = jZ_oTan\ (B\ \ell)$ **(25)**

Recall that:

$B = \Omega Z_o\ C$ **(26)**

Substituting **eqn. 26** into **eqn. 25** produces:

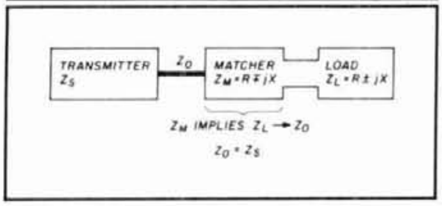
$Z = j\ Z_o\ Tan\ (\Omega\ Z_o\ C\ 1)$ **(27)**

or,

$Z = j\ Z_o\ Tan\ (2\ \pi\ F\ Z_o\ C\ 1)$ **(28)**

Because the solution to **eqns. 27** and **28** is multiplied by the j operator,

FIGURE 3

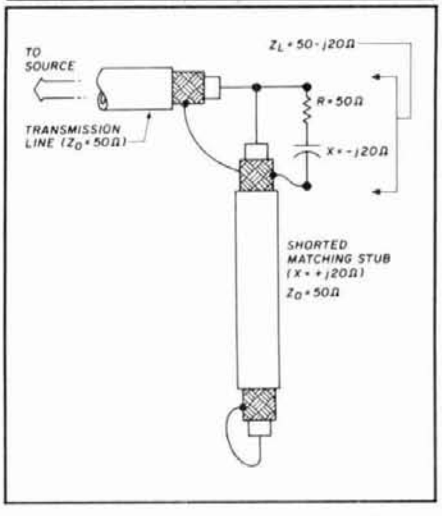


Elements of impedance-matching system.

the impedance is actually a reactance ($Z = 0 + jX$). Almost any reactance possible (within certain practical limitations) can be achieved by adjusting the length of the transmission line and shorting the load end. This fact leads to a practical method for impedance matching.

Figure 3 shows an unmatched load connected to a transmission line with characteristic impedance Z_o. The load impedance Z_L is $Z = R + jX$, in this case equal to $50 - j20$ ohms. A complex impedance load can be matched to its source by interposing the complex conjugate of the impedance. For example, where $Z = 50 - j20$, the matching-impedance network will require an impedance of $50 + j20$ ohms. The two impedances combine to produce 50 ohms. **Figure 4** shows a matching stub with a reactance equal in magnitude, but opposite in sign, with respect to the reactive component of the load impedance. Here the

FIGURE 4



Shunting matching stub "tunes out" reactance $-/+jX$.

stub has a reactance of + j20 ohms to cancel a reactance of − j20 ohms in the load.

A quarter-wavelength shorted stub is a stub concept that finds particular application in radio systems. (Microwave waveguides, incidentally, are based on the properties of the quarter-wavelength shorted stub.) The current is maximum across the short, but wave cancellation forces the current to 0 at the input terminals. Because Z = V/I, the impedance goes infinite when I goes to 0. This means that a quarter-wavelength stub has an infinite impedance at its resonant frequency, and acts as an insulator. The stub is in effect a "metal insulator."

conclusion

This month we looked at some of the more esoteric applications of transmission lines — proving once again that they are more than just wires for carrying rf to the antenna. In October we'll take a look at SWR.

Attention "Poor Man's Spectrum Analyzer" fans: A company that makes a "budget" spectrum analyzer informs me that they'll make a loaner available for me to test. I'll let you know if the product is as good as the salesman claims.

This material is derived from Joe's forth coming Tab book, *Practical Antenna Handbook*. Joe Carr, K4IPV, can be reached at POB 1099, Falls Church, Virginia 22041; he'd like your comments and suggestions for this column.

Article F **ham radio**

THE HAM NOTEBOOK

bicycle mobile

I'm an avid bicyclist and ride about 22 miles each day. The roads in my part of the island of Hawaii are lonely, especially early in the morning. They stretch over the lava for considerable distances without any visible habitation except for some feral donkeys.

A number of times I've passed stalled vehicles way out in the boonies with worried and scared drivers peering hopefully at the passing traffic. At times like this I wished for a handheld so I could inform someone of their plight. But a standard 2-meter HT on a rough-riding 12 speed with 110 pounds of tire pressure wouldn't survive for very long.

I had an opportunity to examine all of the HTs out of their cases and noted quite a variation in construction. I needed something sturdy with a waterproof case to cope with the sudden tropical showers of Hawaii. Only one of all those I looked at met my specifications — the Yaesu FT 23 R.

My problem was to mount the HT (and an antenna) on the bike in a way that would make it easily accessible without requiring any separate clip-on mike or speaker. Placing it just below the handlebars allows for relatively easy speaking and listening when riding along.

I wanted to place the Yaesu, in spite of its obvious ruggedness, in a shock mounted container bolted to the handlebar stem. I built the container out of double-sided circuit board material soldered all around and lined with 3/8″ plastic foam. A Velcro™ strap attachment holds the radio in place (see **photo A**).

PHOTO A

Velcro strap holds radio in place.

During a visit to Silicon Valley I procured shock mounts from Hal Tech, a surplus parts supplier in Mountain View, California. I selected three shock mounts from their large inventory and used two on the HT box and one on the antenna. These were 1″ x 1″ round rubber items with isolated 1/4-20 studs protruding from each end. As you can see in **photo B**, they bolt through a short piece of 1″ x 1″ x 1/4″ aluminum angle which is bolted, in turn, to the HT box. The whole assembly is then attached to a TV antenna "U" bolt that has been shortened to fit. This goes around the bike handlebar stem and, when tightened in place, provides a very strong mount for the radio.

PHOTO B

Bolt assembly for radio mount.

My next problem was the antenna. I wanted a half-wave device to avoid the requirement for a groundplane. AEA's Hot Rod proved to be ideal, particularly since it had a BNC connector for its base. Mag mounts would be useless on an aluminum bike. I cut a short piece of 1″ x 1″ x 1/4″ aluminum angle and bent each end 90 degrees. One end was drilled to fit two BNC bulkhead connectors and the other to fit the rear bike carrier. I soldered on RG-8/X cable and sealed the whole assembly with epoxy putty, shaped to a pleasing appearance while it was still soft. The antenna assembly is shown in **photo C**.

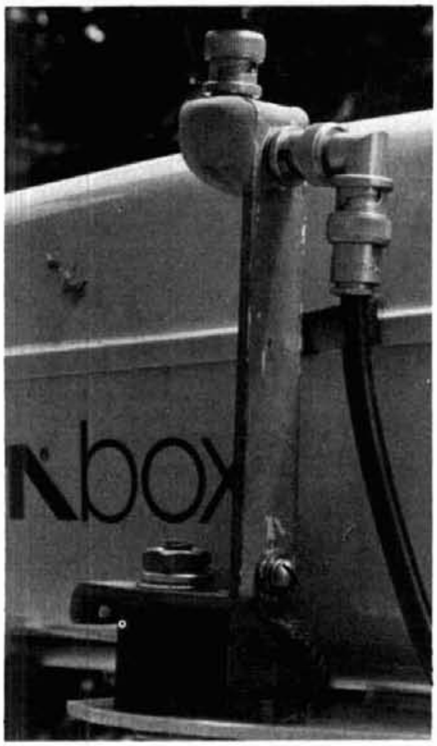
I attached the feedline to the bike's top tube with nylon ties and then to the HT with a right-angle BNC connector.

Bicycle Mobile has been in active, daily use for about 6 months; the only failure has been the antenna. The Hot

Rod rotated from vibration, and the coil broke loose from the connector. It was a simple matter to reconnect it. This time I didn't use heat shrink tubing around the coil but opted for two layers of rubber tape and one of plastic.

With this setup, I've been able to give assistance to stranded motorists. Their reactions are amusing when I wheel up and ask if I can call for help.

PHOTO C



Antenna assembly.

With relief, they look around for the hoped-for roadside phone. Of course there is no such thing on our bucolic island's roads, and some people become peeved until I explain that the little box under the handlebars is a ham radio. They feel much better when I tell them I can contact fellow hams on this or any other of the Hawaiian Islands by way of our trusty '7.02 repeater atop Mount Haleakala on Maui, the next island up the chain.

All I need now is a cape and mask to become the Lone Stranger on wheels. Who knows, maybe this unusual method of rescue will produce some new Amateur Radio enthusiasts!

William Schreiber, NH6N

intermittent reception due to lightning

When my receiver started to give me trouble in the form of intermittent reception, I would have been hard pressed for some clue as to where the trouble was but for a fortunate incident.

In checking an electric clock that had stopped running about the time my receiver had gone haywire, I spotted a hole burned into the middle of the motor coil. Only an induced lightning surge could have burned such a deep hole so far from any lead or terminal. This gave me the clue for where to look for trouble in the receiver.

The receiver antenna coil is held in place on the coil form by leads twisted so tightly that the antenna coil fits snugly around it. Not exactly good construction practice, as events proved.

Looking at the coil through a magnifying glass and under a bright light, I thought I saw a slight smudge or charred spot on the twisted leads. I would have paid no attention had I not been looking for just such evidence.

To keep the coil in place I doped it with some Duco cement. When the cement was dry, I unsoldered one lead and carefully unwound the twists. When I untwisted the charred part, I caught a slight glint of bare copper, which proved that my hunch was correct.

When I had the leads completely separated, I resoldered the one lead. The receiver has worked ever since.

John Labaj, W2YW

simple tower guards

After fencing in a large portion of my back yard to make a playground, I was soon aware of an unforeseen situation. My toddler son and his friends were using my two towers for gym sets. I'd seen articles dealing with this problem, but the solutions offered were, more often than not, bulky and unwieldy frameworks that attached to the tower legs. I wanted a simpler, more aesthetically pleasing solution to the problem.

attaching material to the tower

After examining the construction of my chain-link fence closely, I discovered the perfect way to secure my towers: I bought several feet of chain-link fabric. After securing one edge to a tower leg, I wrapped the tower with the fabric. After reaching the starting point, I cut the fabric to length by unweaving the appropriate fabric wire.

At this point, if you're patient enough, you can reweave both edges together to form a continuous loop of fencing around the tower or simply fasten the finishing edge to the tower leg.

materials — available, inexpensive

Chain-link fabric comes in widths measuring from 36 to 48 inches in 6-inch increments, and from 48 to 84 inches in 12-inch increments. Fabric wire standards are 6, 8, 9, 11, and 12 gauge. I recommend using at least a 9-gauge fabric in the 48-inch width. I chose fabric with a green vinyl coating because it's less conspicuous than the standard galvanized type. The vinyl-coated fabric costs about $2.00 per linear foot.

Aluminum tie wires, used by installers to fasten the fabric to the fence framework, are also ideal for fastening the fabric to the tower legs and across supports. A bag of 50 tie wires — more than enough for any single tower installation — costs about $3.00.

Materials may be purchased from local fence companies or through national outlet stores such as Sears.

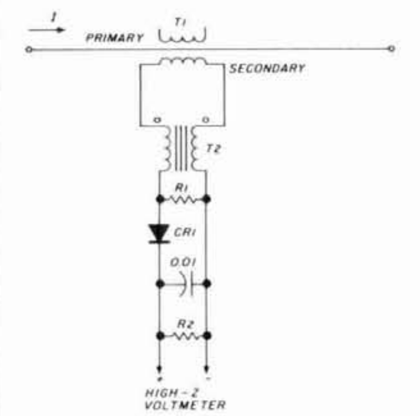
Peter Bertini, K1ZJH

easy measurement of antenna currents

An rf current transformer is useful for measuring the current ratios in phased antennas, horizontals, and verticals. This transformer (usually only a few turns on a toroidal core) drives a rectifier and filter to create a voltage which can be calibrated against an rf ammeter.

To use this device, break the antenna feed, insert it through the core, and reconnect it to make the measurement; then disconnect it and go through the whole procedure at the next measurement point. A clamp on the transformer was constructed using Palomar Engineers' FSB 1/4 split bead (core), rated 1 to 1000 MHz; it worked great on the first try.

FIGURE 1



CR1	1N34 or Equivalent Germanium
R1	100 ohm 1/2 watt carbon
R2	1 m 1/2 watt carbon
T1	Primary 1 turn, secondary 10 turns. Palomar FSB 1/4 core. The turns go through the core center. The secondary turns go over the ends and back through the core.
T2	5 Bifilar turns Palomar 619-379 or equivalent

RF current transformer's output is read on voltmeter. The primary is the antenna feed under test. The split core opens up by compressing the clothespin-like device to accept the antenna feed wire.

I solved the need for some type of holder with an inexpensive plastic "snack bag" clamp, available at True Value hardware stores. It looks like a large clothespin after the side extensions are cut off. Wind the ten-turn secondary on one side of the core, then put both sides together and epoxy onto the plastic clothes pin. The other components are attached to the side of the pin to which the secondary is attached.

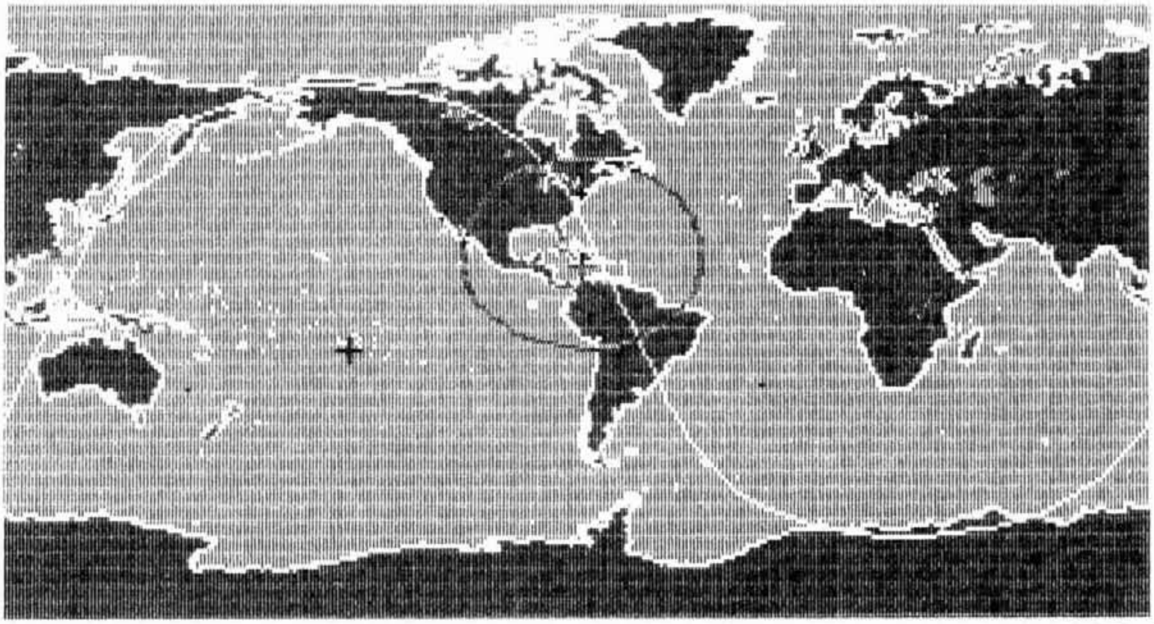
The values chosen allow low levels of drive to be used for minimum interference and reduced heating of the drive source.

The rf current transformer can also be used to check the wires in cases of RFI.

Bruce Clark, KO1F

Satellite Tracking

with your PC and the Kansas City Tracker & Tuner



The **Kansas City Tracker** is a hardware and software package that connects between your rotor controller and an IBM XT, AT, or clone. It controls your antenna array, letting your PC track any satellite or orbital body.

The **Kansas City Tuner** is a companion product that is used in satellite work to provide automatic doppler-shift compensation. It interfaces to your radio through its serial computer control port (RS232) or "mike click" interface to update the receive and/or transmit frequencies once a second. It can be used in digital or analog modes. The **Tuner** is compatible with most rigs including the Yaesu 726 & 736, the ICOM 271/471, 275/475, and R-7000. Call regarding your specific rig.

The **Kansas City Tracker** and **'Tuner** have several advantages over other products available today. They do not use you computer's COMM ports or hardware interrupts. The software runs in your computer's "spare time," letting you run other programs at the same time. Several Kansas City products can be installed in one PC, letting you control up to 16 separate antenna arrays at the same time.

The **Kansas City Tracker** consists of an interface card that can be plugged into a PC short-card slot, a Terminate-And-Stay-Resident (TSR) rotor control program, and a TSR status "pop-up" program. The **Kansas City Tracker** can be connected directly to a Yaesu/Kenpro 5400/5600 rotor controller, or to any other rotor on the market today using our Rotor Interface Option.

The rotor driver and status programs are TSR programs that attach themselves to DOS and "disappear." You can run other DOS programs while your antenna tracks its target under computer control at the same time. This unique feature is especially useful for satellite and land digital work, as communications programs like PROCOMM can be run while the PC aims the rotors at the same time. The status "pop-up" allows the user to view and change the current antenna position and upcoming pass information. The **Kansas City Tracker** is compatible with DOS 2.00 or higher, and will run under DESQ-VIEW.

Satellite and EME Work

The **Kansas City Tracker** and **Kansas City Tuner** are fully compatible with AMSAT's QUIKTRAK (3.2) and with Silicon Solution's GRAFTRAK (2.0). These programs can be used to load the **Kansas City Tracker's** tables with more than 50 satellite passes. We also supply assembled & tested TAPR PSK modems with cases and 110v power supplies.

DX, Contests, and Nets

Working DX or contests and need three hands? Use the **Kansas City Tracker** pop-up to work your antenna rotor for you. The **Kansas City Tracker** is compatible with all DX logging programs. A special callsign aiming program is included for working nets.

Packet BBS

The **Kansas City Tracker** comes complete with special control programs that allow the packet BBS user or control-op to perform automated antenna aiming over an hour, a day, or a week. Your BBS or packet station can be programmed to automatically solicit mail from remote packet sites.

Vision-Impaired Hams

The **Kansas City Tracker** has a special morse-code sender section that will announce the rotor position and status automatically or on request. The speed and spacing of the code are adjustable.

The **Kansas City Tracker** and **'Tuner** packages includes the PC interface card, interface connector, software diskette, and instructions. Each Kansas City unit carries a one year warranty.

- KS Tracker package for the Yaesu/Kenpro 5400/5600 controller $169
  Interface cable for Yaesu/Kenpro 5400/5600 .... $ 19
- KC Tracker with Rotor Interface Option (to connect to ANY rotors) $199
- KC-Tracker and Tuner combination: Add to the price of the 'TRACKER version you need Mike-Click version ..... $ 59
  RS232-Interface version .... $ 79
- Assembled & Tested TAPR PSK modem with case & 110v power supply $199
- AMSAT QUIKTRAK software .... $ 75

Visa and MasterCard accepted.
Shipping and handling: $5, $10 for 2nd day air, $15 for international shipments. Prices subject to change without notice.

L. L. Grace
Communications Products
41 Acadia Drive • Voorhees, NJ 08043
Call (609) 751-1018 evenings & weekends (EST) for more info.

A DTMF TONE SIGNALING CIRCUIT

Michael S. R. Moore, WV6A, 221 West Manly Avenue, Santa Ana, California 92704

Selective calling device alerts specific operators

Using Amateur Radio to contact a specific ham presupposes that he or she is monitoring the same frequency. This is usually accomplished by arranging schedules or coordinating by telephone. On 2 meters, members of a group usually monitor one frequency, often that of a local repeater. But unfortunately, if you're waiting for a call from someone in the group, you have to monitor that frequency. This can be tedious, especially if a ragchewing session that doesn't interest you is in progress. What's needed is a signaling device that ignores all traffic except that which is intended for *you.*

The digital tone signaling circuit (DTSC) described here employs the same DTMF tones as those used for a similar purpose on the telephone system. Fortunately, many 2-meter radios are equipped with a touchtone pad that can generate the full complement of dual tones.

The DTSC is a device that inputs an audio signal (for example, from the earphone outlet of a 2-meter HT) and searches the audio for DTMF tones. When detected, the tones are converted into a digital code and compared to a number previously stored in memory. When a sequence of input tones matches a sequence stored in memory, an alarm is generated.

The design shown here is arranged so that a four-digit number "dialed" within a 20-second time-out period causes an audible beeper and an LED to oscillate on and off at about half-second intervals. A five-digit number (with the first four numbers the same as above) causes the beeper and the LED to turn on without interruption. A six-digit number (again, all numbers must be dialed within the time-out period) will cause the alarm to clear.

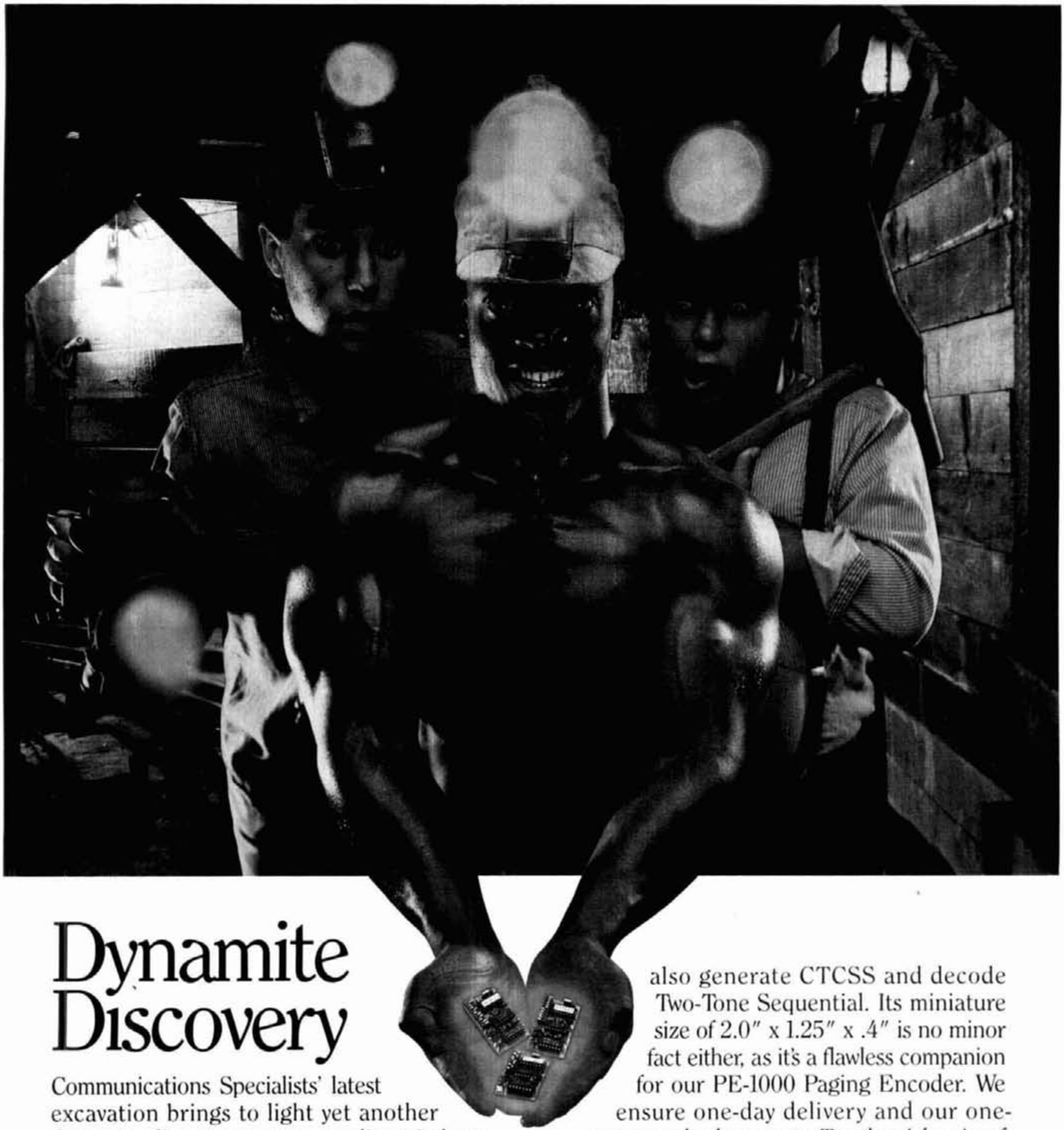
Two of these units — each responding to a different set of numbers — have been in operation for several months. Each was built into a plastic case that accommodates an HT that receives its power from the unit; the unit's audio lead plugs directly into the radio. Tests show that the DTSC can determine the correct tones in noisy environments where audio signals are barely readable, in both simplex and repeater operation.

theory of operation

Essentially a Programmable Read Only Memory (PROM), the DTSC is loaded with a six-digit hexadecimal number by the operator who wants to activate the alarm. Audio output from a radio is fed to a DTMF tone decoder chip for comparison against the code in PROM. The alarm circuit is activated by the decoding counter output, which counts the number of correct digits received during a preset time interval. One incorrect digit causes the circuit to reset and wait for the correct sequence to be re-entered.

Twenty seconds after power up (see **fig. 1**), the 20-second timer, U1, times out, loading the 74LS193 counter, U2, with 0000. The counter is used to address the PROM (U3, a 74S287) and the PROM outputs a hex digit loaded at that address to U4, the 74LS85 comparator. An audio input from an HT or other radio is fed through a dc blocking capacitor to U5, a DTMF Decoder IC (Radio Shack Part No. 276-1303). Any valid DTMF tone pair will cause it to output a hex digit to the comparator; 7 microseconds later it will raise its strobe line. If the comparator sees a match between this hex number and the one that's output by the PROM, it outputs a 1 to the D flip-flop, U6 (a 74LS74), which is then clocked by the DTMF decoder chip data-valid strobe. This occurs only after the data is valid, allowing the comparator to set up before the strobe arrives. The data-valid strobe is also used to trigger the 20-second timer, releasing the loading pulse on the 74LS193 counter.

The 74LS74 flip-flop, U6, sets its *Q* bar output low, preventing the counter from being reset to zero and allowing it to advance by one count on the falling edge of the DTMF data-valid strobe. This happens when the tone pair is no longer being received. Since the



Dynamite Discovery

Communications Specialists' latest excavation brings to light yet another dynamite discovery—our new dip switch programmable SD-1000. No need to tunnel your way through Two-Tone Sequential decoding anymore. We've mined this amazing unit! Now, for the first time, you can stock one unit that will decode all calls in a 1000-call paging system with ±.2Hz crystal accuracy. The EEPROM onboard memory can even be programmed for custom tones, and every unit includes group call. Universal switched outputs control your call light, squelch gate and horn. The SD-1000 can also generate CTCSS and decode Two-Tone Sequential. Its miniature size of 2.0″ x 1.25″ x .4″ is no minor fact either, as it's a flawless companion for our PE-1000 Paging Encoder. We ensure one-day delivery and our one-year standard warranty. Tap the rich vein of Communications Specialists and unearth the SD-1000 or other fine gems.

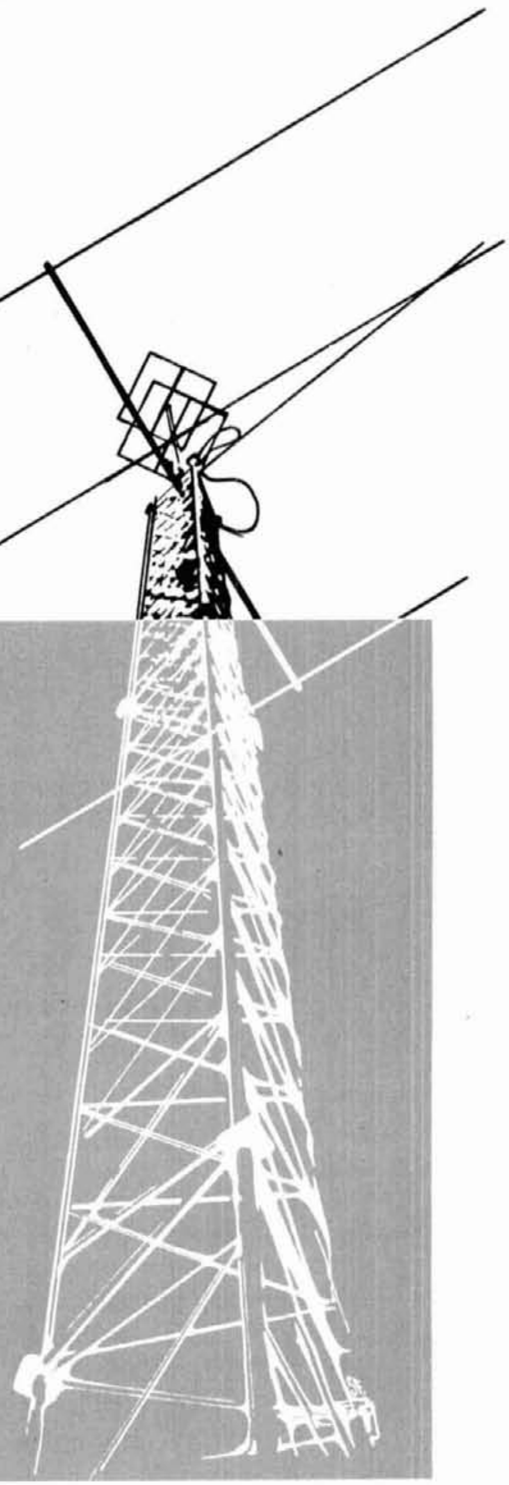
$59.95 each

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

✓ 140

A Great New ARRL Antenna Book

Twice the size of the previous edition
Over 700 pages
987 figures
Edited by Gerald L. Hall, K1TD
QST Associate Technical Editor



Available in August

The 15th Edition of *The ARRL Antenna Book* has been dramatically expanded in a similar fashion to recent editions of the *ARRL Handbook* and the *ARRL Operating Manual.* We've drawn on material produced by the ARRL Technical Department and from 16 well-known outside authors who have done much to contribute to the state-of-the-art in antenna and transmission line design. Available in softcover only for $18 at your dealer or directly from ARRL (shipping and handling: $2.50, $3.50 for UPS)

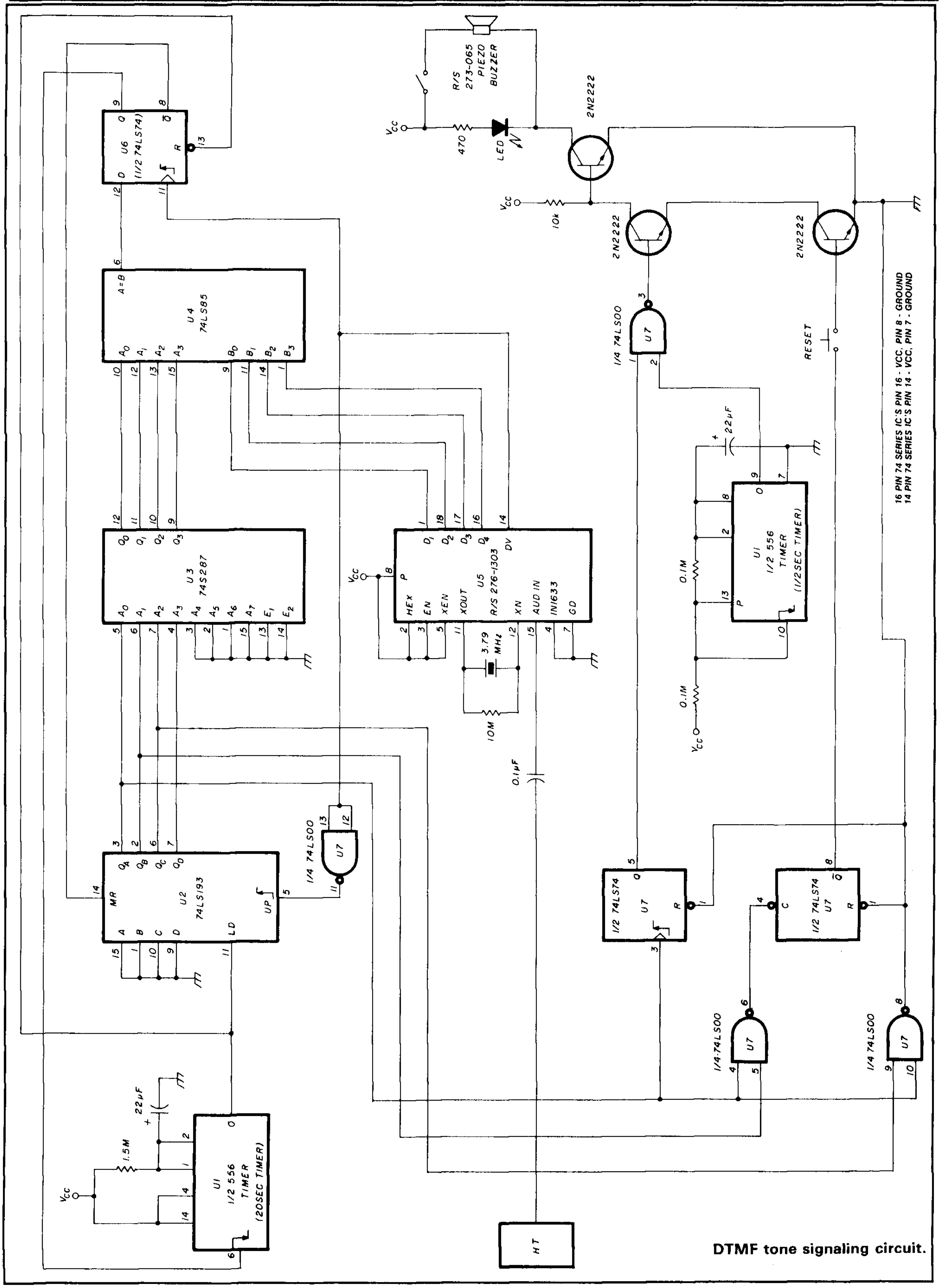
CHAPTER LINEUP:

The number of pages appears in parentheses after the chapter title. Page counts may vary slightly. Safety First (18), Antenna Fundamentals (42), The Effects of the Earth (14), Selecting Your Antenna System (30), Loop-Antennas (16), Multielement Arrays (42), Broadband Antennas (12), Log Periodic Arrays (24), Yagi Arrays (26), Quad Arrays (14), Long Wire and Traveling Wave Antennas (18), Direction Finding Antennas (26), Portable Antennas (10), Mobile and Maritime Antennas (30), Repeater Antenna Systems (20), VHF and UHF Antenna Systems (44), Antennas for Space Communications (32), Spacecraft Antennas (8), Antenna Materials and Accessories (20), Antenna Supports (22), Radio Wave Propagation (26), Transmission Lines (26), Coupling the Transmitter to the Line (18), Coupling the Line to the Antenna (28), Antenna and Transmission-Line Measurements (36), Smith Chart Calculations (16), Topical Bibliography on Antennas (32), Glossary and Abbreviations (4), Contents, Index, etc (16).

ARRL 225 MAIN ST., NEWINGTON, CT 06111

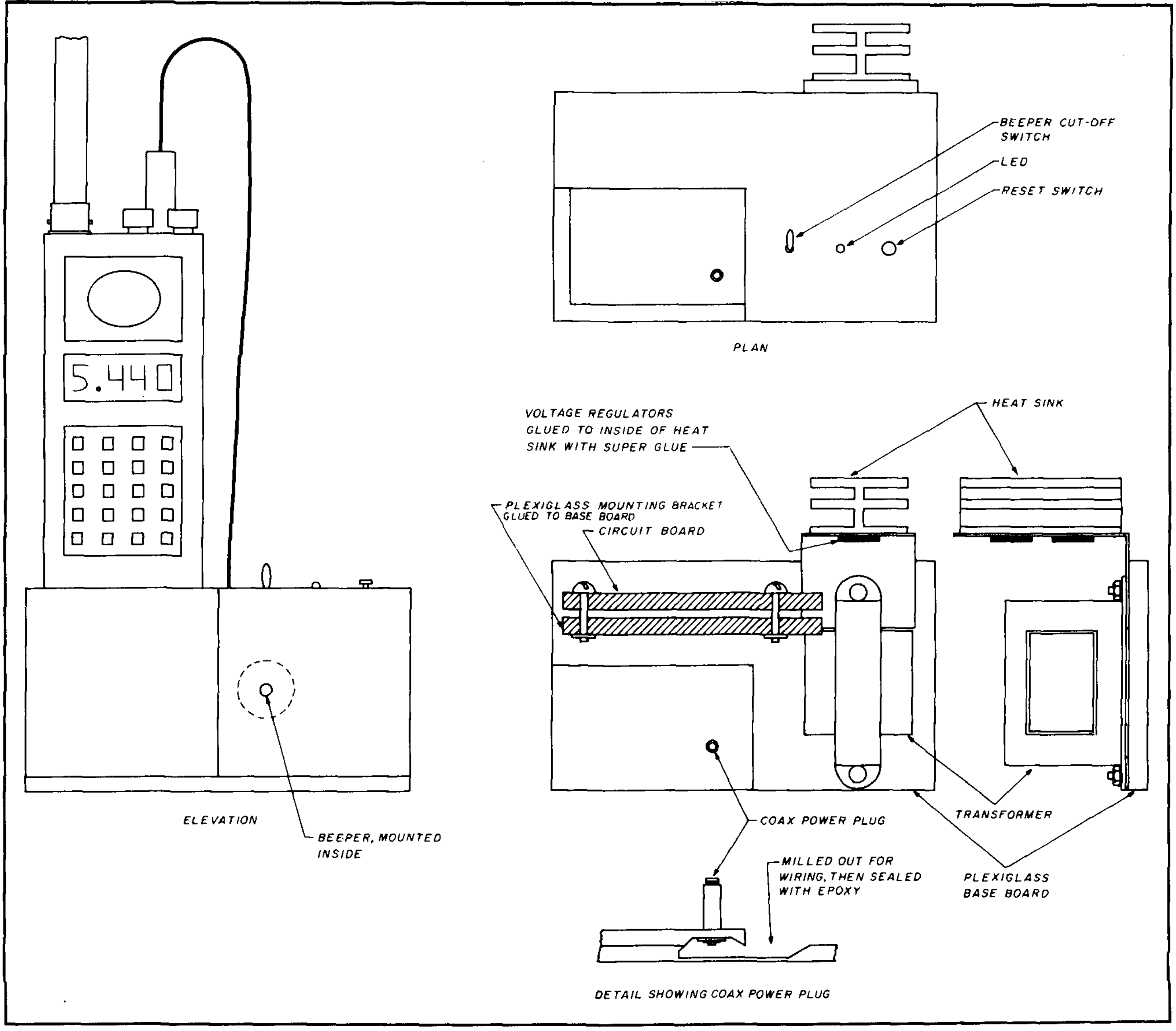
✓ 141

FIGURE 1



DTMF tone signaling circuit.

FIGURE 2



Mounting details for circuit board, voltage regulators, and other decoder unit components.

counter is now advanced, the output from the PROM becomes the new number for comparison.

If a number doesn't match the one in the PROM, the comparator will output a zero, causing the D flip-flop to go high, which in turn reloads the counter with 0000, the starting position address for the PROM. The code must now be re-entered from the beginning for the alarm to be activated.

After four correct numbers have been received, the second D flip-flop, U6, is clocked, enabling a 74LS00 gate of U7, to pass the half-second signal developed by the 556 timer, U1. The transistors are then arranged to flash the LED and sound the beeper. After five digits are received, the third D flip-flop, U8, causes the LED and beeper to turn on without interruption. A sixth correct digit will cause the LED and beeper to turn off.

It should be noted that all numbers must be received in the correct order within the time period (about 20 seconds) set by the 556 timer, U1. After this period the counter is reset and you must "dial" the correct sequence again. This reduces the possibility of accidental triggering. This could occur, for example, when a sixth tone follows five correct tones accumulated gradually throughout the day, causing the alarm to reset.

It's also possible to "advance the state of alarm" from oscillating on and off repeatedly to continuously on, giving some indication of who is calling if the five-digit code is restricted to one person.

construction notes

I built the circuit on perf board, using sockets for all ICs. I chose perf board because I wasn't interested in making printed circuit boards for such a complex project, and because I wanted to allow for easy modification.

The power supply, which conserves battery life while you're monitoring the frequency, was built around a transformer salvaged from a discarded cordless telephone set and capable of delivering just under 1 amp at about 16 volts. Though this isn't enough to allow the HT to transmit at its 5-watt power level, the HT is somewhat inconvenient to operate when it's sitting in its stand. When the alarm is triggered, the HT can be quickly removed from its stand and operated from its battery.

Low-power Schottky logic was chosen because it was readily available. The circuit could be reworked, however, with any of the logic families; CMOS would be a good choice if battery-powered operation is required, as in a unit designed for portable or emergency operations. Any PROM could be used with suitable wiring changes, although circuit design is easier if at least a four-bit data type is used. It would be easy to program several different codes into the PROM using the unused address lines to select which code will be the active one. Since very little data is actually needed, a simple breadboard was set up with suitable power supplies to burn the PROM by hand.

The unit was built on a baseboard of Plexiglas™, which was bought as off-cuts from a plastics supply house at about a dollar a pound. It's easy to cut with a hand saw and glue with a solvent adhesive also available from the supplier. The case was made from the same material, with the back left open to permit air circulation.

Two voltage regulators — 5 volts for the logic and 12 volts for the radio power supply — were glued to a piece of aluminum with Superglue™. A piece of an old heat sink from a discarded TV monitor was added to increase the dissipation area (see **fig. 2**).

The Yaesu 209RH can be powered through a coaxial-type plug in the base of its battery pack. When inserted, this plug isolates the battery from the supply, allowing the radio to monitor using power from the DTSC only. The battery is not trickle charged, since doing so would limit the useful life of the NiCad™. The coax plug was glued into a piece of Plexiglas™, which was then glued onto the baseboard, which has a channel milled out for the 12-volt power supply wiring. The coax plug was positioned to engage as the radio is lowered into the DTSC. Using nuts, bolts, and standoffs, I mounted the circuit board to another piece of Plexiglass™ that was glued to the baseboard.

Article G **ham radio**

This article gives you the basics. A later piece will tell you how to program your PROM. *Ed.*

product REVIEW

Facsimile Software for MS-DOS computers and the PK-232 Data Controller

We live in the age of computer generated information and one of the biggest drawbacks is knowing how to take advantage of all the information available to us. The AEA PK-232 Data Controller's WEFAX capability gives you the ability to tap into the global network of weather reporting stations.

Maps and pictures, thousands of them in fact, are available twenty-four hours a day, seven days a week showing every aspect of the weather conditions. In fact there is so much available, it's sometimes tough to weed out what you don't want!

In days gone by, FAX receiving stations generated mountains of very expensive paper. Sometimes it would take an hour or two just to get one map. Obviously, this was very wasteful and there was a need for new technology

The latest technological breakthrough came with the advent of personal computers and specialized TNC's (like the AEA PK-232) acting as WEFAX receiving stations. This allowed ordinary graphics compatible printers to print WEFAX information; also a wasteful practice, as you are still running the printer. That's all been changed with the release of AEA's PK-FAX program.

The program works with all IBM and compatible computers to send and receive radio facsimile pictures through the PK-232 Data Controller. You can either print the pictures with a graphics compatible printer, display the picture on the screen of the computer, or save the images to disk. This saves oodles of paper!

Program setup is well covered in the instruction manual. Read and re-read the manual several times before attempting to use the program; it will save you plenty of time. First of all, make a copy of the disk to protect yourself from any serious faux pas. Next, set the configuration parameters for your system. The configuration menu is well explained and easy to follow, so this takes just a few minutes.

Since I covered the basics of receiving FAX in an earlier review, I won't repeat that information. Once you get the hang of it, it takes but a few seconds.

receive pictures

The PK-FAX program stores pictures to the computer's buffer and displays them on the computer screen. You can also retrieve images that have been stored on a data disk. One nice feature of the FAX program is that you can set it up to automatically receive images while you're not around and save them to disk for later use. If, for instance, you want the maps that are sent from noon to 2 pm on a Tuesday while you are at work. First, select the configuration menu and set the auto-save disk file prefix to Tuesday. Then establish an auto-save start time of 1200 and an auto-stop time of 1400. Press the escape key to return to FAX and the "F" key to turn on the stop-when-full feature. The contents of the buffer will automatically be saved to disk even if the transmitted stop signal is missed. The start signal that begins the next line will start to refill the buffer.

transmitting pictures

AEA recommends that you create images using one of the many graphics software packages available. The PK-232 is shipped with the transmit tones set at 1200 and 2200 Hz with a 1000 Hz shift.

To transmit, first read an image from disk to the buffer. Press the "T" key and you're transmitting a facsimile picture. It's really quite simple. Make sure you use the standards for transmission listed in the instruction manual. If you don't, sending pictures will be a very frustrating experience. AEA suggests a number of different transmission standards and time of transmission estimates as guidelines.

summary

That's all there is to it! While this program is easy to use, it facilitates the acquisition of a tremendous amount of information for the home FAX user. I am constantly amazed at the ability of these programs and the power that they bring into the Ham Shack. Just think what capabilities will be available from the software developers in the next few years!

de N1ACH

NEW products

TH-55AT new 1200 MHz pocket

Kenwood introduces the TH-55AT — an all new 1200-MHz handheld transceiver. The TH-55AT uses the same accessories as the TH-25AT series HTs, with the exception of frequency-related accessories like antennas.

Features include:

- 1 watt high power, with optional PB-8; with standard PB-6 battery pack, 800 mW high. Low power is 100 mW.
- Frequency coverage 1258—1300 MHz.
- Front panel DTMF pad.
- Automatic Power Control (APC) circuit for reliable rf output and final protection.
- 14 memories; two for "odd split."
- Large multi-function LCD display.
- Rotary dial to select memory, frequency, CTCSS, and scan direction.
- T-ALERT for quiet monitoring. Tone Alert beeps when squelch is opened.
- Band scan memory scan.
- Automatic power off circuit.

Supplied accessories include a StubbyDuk, battery pack, wall charger, belt hook, wrist strap, and water resistant dust caps. Other accessories are available.

The suggested retail price of the new TH-55AT 1200 MHz Pocket Transceiver is $499.95. For details see your authorized Kenwood dealer or write: Kenwood USA Corporation, 2201 E. Dominguez Street, Long Beach, California 90810.

new software for Kenwood radios

TS-COMM, a communications and control system for Kenwood radios, provides a computer software system to control Kenwood Amateur Radio products with IBM-PC/XT/AT series or true compatibles. Full control of frequency, mode, memory channels, and many front panel controls are supported.

System requirements are: IBM-PC, PC-AT or true compatible, DOS 2.1 or greater, 512K memory, one floppy disk drive, a serial communications port (COM1 or COM2), and 80-column printer.

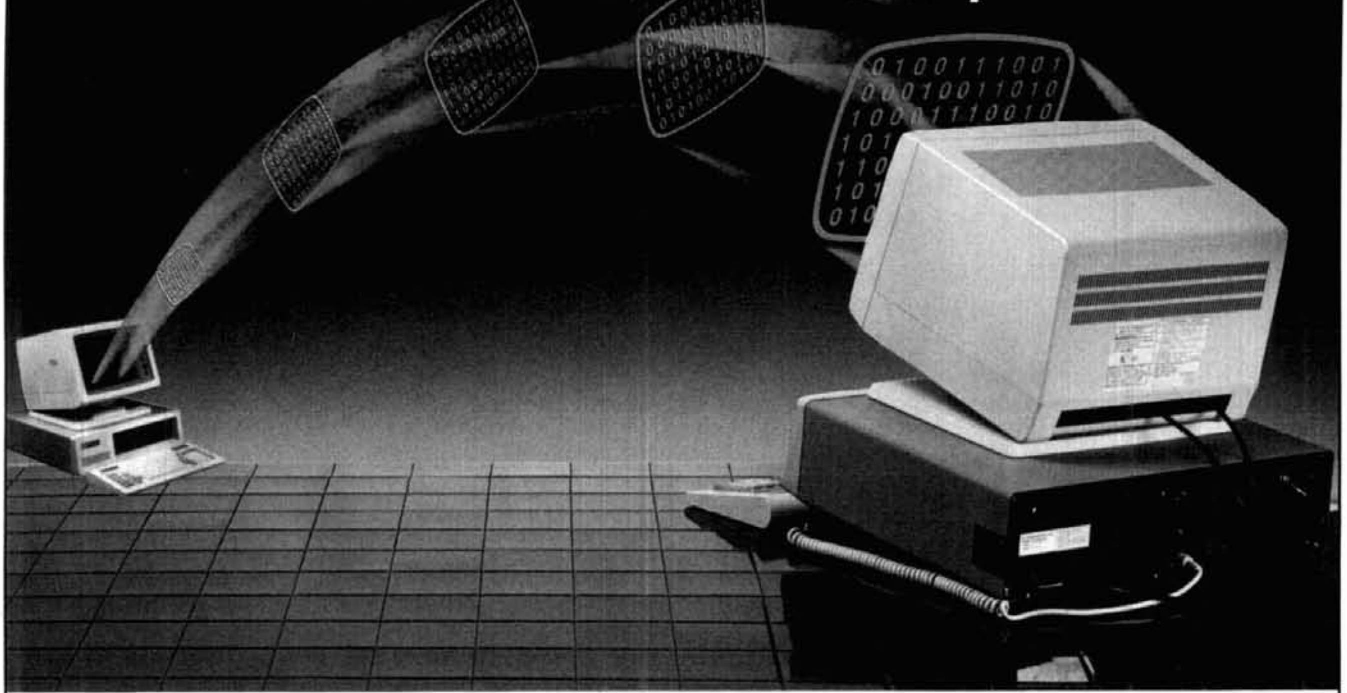
Radio requirements: Kenwood IF-232 RS-232 interface/12 VDC P.S.; TS-940 requires the IF-10B, TS-711A/TS-811A require the IF-10A; TS-440/R-5000 require the IC-10.

The TS-COMM retails for $69.95 and is available exclusively from Ham Radio Outlet, 2620 W. LaPalma, Anaheim, California 92801.

Circle #301 on Reader Service Card.

Reader Service CHECK—OFF Page 116 ✓ 145

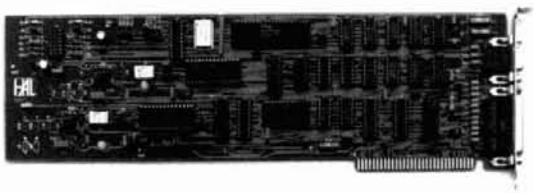
From The Creative Minds at HAL Communications
Packet Radio Made Easy . . .



THE RPC-2000

TWO-CHANNEL RADIO PACKET CONTROLLER

- **Menu driven – No commands to memorize**
- **Works on VHF or HF**
- **Built-in Modem and RS-232C I/O**
- **Exclusive HAL CALLpath programmable directory**
- **Software included**



The RPC-2000 is a two-channel radio packet controller that adds fast, error-free data communications to radio links. It plugs into an expansion slot of the HAL DS-3200 Radio Data Communications Terminal or any fully compatible PC, PC-XT, or PC-AT computer. The RPC-2000 uses Packet Radio protocol based on AX.25 to provide data communications at rates from 45 to 4800 BPS.

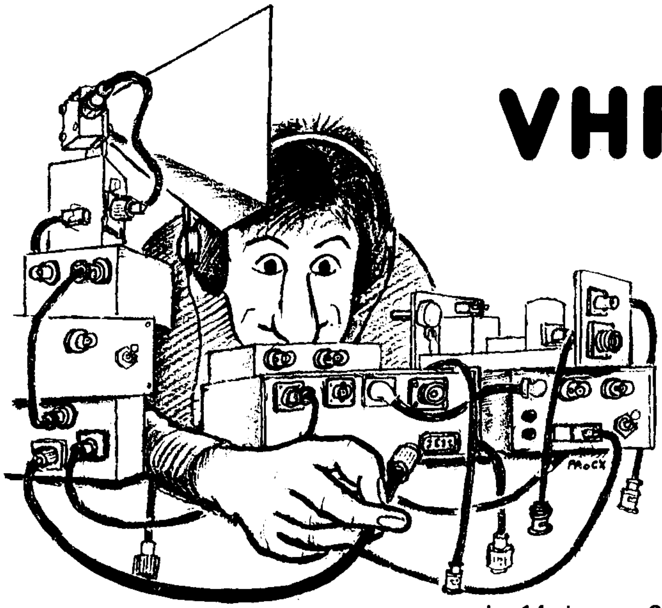
The standard configuration of the RPC-2000 uses an RS-232C I/O port (Channel A) for an external HF modem (such as the HAL ST-8000) and a 7910 modem for a VHF link (Channel B). The M2-RPC option converts Channel A to a second 7910 modem.

The RPC-2000 is driven entirely from disk-based software that provides on-screen menus to choose all features and modes, eliminating the need to memorize complicated commands and procedures.

DISCOVER HOW EASY PACKET RADIO CAN BE. CALL OR WRITE US FOR MORE SPECIFICATIONS.

HAL COMMUNICATIONS CORP.
P.O. BOX 365
URBANA, IL 61801
Phone 217-367-7373

✓ 148



VHF/UHF WORLD

Joe Reisert, W1JR

more loose ends

Judging from some of the comments I've received, many of you enjoyed February's "Loose Ends" column[1]. I thought I'd write another to answer all your latest questions.

antennas

This is always a popular topic; the one place where Amateurs can get the "most bang for the buck!" Whether you buy, build, or buy and redesign, there is something here for everyone.

It looks as if the May 1986 "VHF/UHF World" column[2] encouraged lots of you to build simple high performance Yagis. I still get calls and letters on both the 2- and 6-meter beams featured in that column.

Some readers have built and used 2-meter beams for meteor scatter; many have used them on portable expeditions. Others have designed complete EME arrays. WA4NJP uses four of the 6-meter models on 50-MHz EME where he holds the worldwide DX record. W7IUV is very successful on 2-meter EME using sixteen of the 2-meter antennas in an array.

The 12-foot boom is convenient for portable operation. It's small and the boom is easily broken in half for travel. My son, AD1C, and I have both used this eight-element Yagi during several contests, to put out rare "grids" on 2-meters, and for portable EME using eight of them. Compared to the popular 14 element 2.2 wavelength 2-meter Yagi on a 15-foot boom length, its gain is only 0.75 dB lower with far less weight and wind load.

Even though I confirmed that there were no errors on the 2-meter Yagi element lengths in a subsequent column[1], I still get questions on the driven and reflector element lengths. They are correct as printed! But, as I pointed out in the original article[2], any changes in the feed system or mechanical changes (like through-the-boom mounting) could greatly affect the driven element length. This is of no real consequence because all you are trying to do is to obtain an impedance match. The driven element length, within reason, will not affect Yagi gain or pattern. One more thought: these antennas are optimized for a specific frequency. If you want to build one for the middle or upper portion of the 2-meter band (145-148 MHz), you should scale the element lengths and spacings. Failure to do so may seriously degrade the pattern.

Reduce each element by 0.400 inches for OSCAR use; the boom length, the distance between the reflector and the last director, should be 140 inches (versus 142 inches). For the upper FM band (147 MHz) shorten all elements by 0.750 inches and use a 139-inch overall boom length.

transmission lines and connectors

A lot of you have been interested in the newer type of low-loss transmission lines like Belden 9913 (or its equivalent). These coaxes usually have some air rather than being completely filled with a solid or foam dielectric. As a result, they are more susceptible to humidity and moisture.

Once moisture gets inside, it stays there and performance is permanently degraded. One solution is to carefully wrap the connectors with COAX-SEAL™ or Vapor-Wrap from Decibel Products, Inc. Another technique is to first wrap the connector with several layers of plastic electrical tape and then coat them with a layer of Scotchkote™ from the Electro-Products Division/3M Corporation.

Never use substitute connectors on 9913. Several companies now offer connectors specifically designed for 9913, albeit slightly higher priced than standard UG-21 types. These newer connectors are worth the money because they maintain constant impedance, are weatherproof, and don't require any filing or drilling of the center conductor.

You may remember that in the October 1986 "VHF/UHF World" column[3] I recommended using crimp connectors to decrease cost and assembly time. Some potential problems have surfaced with these since then.

Crimp connectors are fine if they use the normal base materials (like steel or brass) and are properly plated. But connectors made from aluminum base material, especially unplated ones, can be a disaster when used outdoors.

I recently took down a large array of 6-meter through 2304-MHz antennas for repair and upgrading. After many years of exposure to the elements and acid rain, they showed various states of wear or deterioration.

While disassembling these antennas, I took a careful look at the dozens of different connectors that I had used.

They were typically wrapped with plastic electrical tape or COAX-SEAL for 1 to 8 years. Some of the common types, especially those that were plated, showed little change except for occasional discoloration. But wherever I had used aluminum connectors, there were severe oxidation problems — even after only one year. In some cases they were so oxidized that they couldn't be removed without completely destroying the connector; this included several types of aluminum connectors like antenna mounted, cable crimp, and hard line. I recommend that you use aluminum connectors only indoors or where there is no other alternative.

After removing all the antennas, I took down all the associated transmission lines from the shack to the tower. They're about 130 to 150 feet long — tall trees require even taller towers away from the house! Each line was tested for VSWR and insertion loss at 50, 144, 220, 432, 903, and 1296 MHz; all results were carefully recorded.

I was truly astounded; every Andrew Corporation Heliax™ transmission line measured within or better than specification. Maximum attentuation on 135 feet of 7/8 × ″ LDF at 1296 MHz was about 2.0 dB. All these transmission lines had copper conductors and Andrew Corporation connectors.

The 1/2- and 7/8-inch alumifoam coaxes were another story. Insertion loss was always higher than specification. One of the 7/8″ lines had an insertion loss that was higher than the equivalent length 1/2″ line! At 1296 MHz a 130-foot piece of 1/2″ alumifoam measured 5.8-dB insertion loss while a similar length of 7/8″ alumifoam measured 6.5 dB. In the future I'll do everything I can to avoid using aluminum coax or connectors in any form!

As I've been saying here for almost five years — buy good quality feedline. The initial cost may be higher, but it will give you a lifetime of pleasure with little or no deterioration. See reference 4 for recommended feedline types and selection tips.

propagation and new dx record update

My last column hadn't even gone to press before more VHF records were broken. There was some great propagation this spring in the Gulf states and along the Eastern seaboard.

During one Gulf coast opening in late April, 2-meter and 70-cm stations with only 10-50 watts and single Yagis were working from Miami, Florida (EL95) to western Texas (DM91) — about 1300 miles! On May 19th, stations as far north as New Hampshire and Massachusetts were treated to what is probably the first ever Caribbean 2-meter and 70-cm openings. VP5D on Providenciales (FL31US) in the Grand Turks Islands did the honors.

The best reported 2-meter DX was 1474 miles to W1JSM (FN43NC) and 1417 miles on 70 cm to W1RIL (FN42AH). From the reports I received, these contacts had all the earmarks of ducting because the stateside stations either had to be right near the coast or, if more than 15 miles inland, at elevated locations.

Spring 6-meter sporadic E propagation returned to North America on schedule, but this year the European openings to the United States came earlier and more often. To add to the excitement, several new countries were activated as 50-MHz privileges expanded in Europe.

If the unbelievable increases in solar activity continue, there may be some

TABLE 1

Some of the major VHF and above oriented publications. They are not listed in any particular order.

1. VHF/UHF and Above Information Exchange: c/o Rusty Landes, KA0HPK, P.O. Box 126, St. Mary of the Woods, Indiana 47876. Published monthly at $16.50 per year.
2. VHF Communications: Available from TimeKit, P.O. Box 22277, Cleveland, Ohio 44122. Published quarterly at $18.95 per year.
3. DUBUS (Dx Ueberreichweiten Bau von Geraten Uhf Shf Magazin): Available from KA0HPK (see item 1 above). Published quarterly at $18.95 per year.
4. 2-meter EME bulletin: c/o Gene Shea, KB7Q, 417 Staudaher Street, Bozeman, Montana 59715. Published monthly at $18.00 per year.
5. 220 Notes: c/o Walt Altus, WD9GCR, 215 Villa Road, Steamwood, Illinois 60103. Published 6 times yearly at $6.00 per year.

TABLE 2

This table shows some of the smaller society and club oriented publications. They are not in any particular order.

1. Midwest VHF Report: c/o Roger Cox, WD0DGF, 3451 Dudley Street, Lincoln, Nebraska 68503-2034. Published monthly at $10.00 per year.
2. MidWest VHF-UHF Society: c/o David Forbes, KD8FO, 1271 Jeanette Drive, Dayton, Ohio 454232. Published monthly at $5.00 per year.
3. Feed Point: The North Texas Microwave Society, c/o Wes Atchinson, WA5TKU, Rt. 4, Box 565, Sager, Texas 76266. Published 6 times per year at $12.00 per year.
4. Pack Rats' Cheese Bits: The Mt. Airy VHF Radio Club, c/o Doc Cutler, K3GAS, 7815 New Second Street, Elkins Park, Pennsylvania 19117. Published monthly at $5.00 per year.
5. Northeast VHF News: c/o Lew Collins, W1GXT, 10 Marshall Terrace, Wayland, Massachusetts 01778. Published 6 times per year at $3.00 per year.
6. East Coast VHF Society: c/o Dave Collins, K2LME, 709 Saddle River Road, Saddle Brook, New Jersey 07662. Published several times yearly at $10.00 per year.
7. Six Shooter, SMIRK Newsletter: c/o Ray Clark, K5ZMS, 7158 Stone Fence, San Antonio, Texas 78229. Published quarterly at $3.00 per year for SMIRK members.
8. West Coast VHF-ER: 560 W. Yucca Street, Oxnard, California. Published monthly at $10.00 per year.

6-meter F2 propagation as early as October 1988. With several stations reporting over 80 DXCC countries worked on 6-meters to date, can the first-ever VHF DXCC be far behind?

Two-meter sporadic E not only started earlier this season, but more openings seem to have been logged. The most significant opening was probably the one on June 6th – single-hop contacts were in progress between Alabama and Colorado at the same time that double-hop contacts were reported between the states of Alabama and Washington. So, unless I hear otherwise, we have a new 2-meter sporadic E record. At about 0245 UTC on June 6, 1988, several contacts may have bettered the DX record of 1980 miles set last June. Then at 0250 UTC, Dale Peterson, WA4CQG (EM72FO), worked Merle Cox, Kirkland, Washington (CN87VR), for a record breaking 2172 miles (3495 km). Both stations were well-equipped, with approximately 500 watts and antenna gains of 15-20 dBi. This contact took place on SSB and signals were not strong, but perfectly Q5. Congratulations to Dale and Merle. Can this record last very long? Stay tuned.

VHF/UHF microwave publications and societies

I have mentioned several times that to really know what's cooking on the VHF and higher frequencies, you should join a VHF, UHF, or Microwave group, or at least subscribe to one or more of the available newsletters. Many thanks to all those who sent me copies of their newsletter, especially to those who continue to do so. They are an excellent source of information.

I first ran a column on these publications in March 1985.[5] Since then there have been lots of changes; **tables 1** and **2** list the latest newsletters and publications.

Table 1 shows the major VHF/UHF publications available by subscription and includes addresses, cost (where known), and frequency of publication. Contact the publisher directly for specific details. **Table 2** is a partial list of the clubs and societies that have newsletters. Some are available on a subscription basis. Again, I recommend that you contact them directly. In addition to these publications, there are VHF/UHF columns in each of the major Amateur magazines. Professional publications are also available; see reference 5 for details.

summary

This month's column touched briefly on some your most commonly asked questions, discussed events in the VHF/UHF community, and listed some of the most popular VHF/UHF publications.

acknowledgments

Thanks to Pete Heins, K1FJM/4, and Bob Cooper, VP5D, for their input on some recent tropo openings. Thanks also for your topic suggestions; they're always welcome.

important VHF/UHF events

September 3-4	*International Region 1 VHF Contest (2-meters)*
September 10-12	*ARRL September VHF QSO party*
September 11	*New moon*
September 17-18	*ARRL 10-GHz Cumulative Contest, second weekend*
September 21	±2 weeks. Optimum time for TE propagation
September 25	*EME perigee*
October 1-2	*International Region 1 UHF/SHF Contest (70-cm and up)*
October 1-2	*Mid-Atlantic States VHF Conference, Warminster, Pennsylvania (contact WB2NPE/WC2K)*
October 9	*Predicted peak of the Draconids meteor shower at 0900 UTC*
October 10	*New moon*
October 20	*Predicted peak of the Orionids meteor shower at 1400 UTC*
October 23	*EME perigee*
October 22-23	*ARRL International EME Contest*

references

1. Joe Reisert, W1JR, "VHF/UHF World: Loose Ends," *ham radio*, February 1988, page 82.
2. Joe Reisert, W1JR, "VHF/UHF World: Optimized 2- and 6-meter Yagis," *ham radio*, May 1987, page 92.
3. Joe Reisert, W1JR, "VHF/UHF World: RF Connectors — Part II, *ham radio*, October 1986, page 59.
4. Joe Reisert, W1JR, "VHF/UHF World: Transmission Lines," *ham radio*, October 1985, page 83.
5. Joe Reisert, W1JR, "VHF/UHF World: Keeping VHF/UHFers up-to-date," *ham radio*, March 1985, page 126.

Article H **ham radio**

NEW products

ICOM dual band handheld

ICOM has just announced the new IC-32AT dual-band handheld. It features five watts of power output on each band, receives 138-174 MHz and 440-450 MHz, and transmits 140-150 MHz and 440-450 MHz.

Other features include full-duplex capability, 40 memory channels, programmable scan, and memory scan. There is also an optional UT-40

tone squelch unit which silently monitors a busy channel for your calls. When the preprogrammed subaudible tone is received, the unit beeps and the LCD flashes; it works like a beeper/pager.

The IC-32AT has DTMF keyboard access and a repeater input monitor. Priority watch monitors the call channel, memory channel, or all memory channels every five seconds while operating on another frequency. With the DIAL SELECT function you can change directly from 1 MHZ, 100 kHz digit, or the memory channel.

See your local ICOM dealer for details.

ICOM's IC-3210 dual band mobile

ICOM has introduced the IC-3210 25-watt, two-meter, 440-MHz dual band mobile. It measures only 5.5 inches wide by 2.0 inches high by 7.1 inches deep. Features include:

- Wideband Rx coverage of 138-174 MHz; Tx 140-150 MHz; receives and transmits 440-450 MHz.
- 20 memory channels with lock-out function.
- Two call channels — 1 VHF, 1 UHF.
- Programmable scan.
- Memory scan.
- Priority watch.

Also available are three new accessories for ICOM's base station transceivers: the AG-30 preamplifier for the 220 MHz IC-375A, the AH-610 dual band antenna (6M/10M) for the IC-575A/H, and the FL-100 500Hz CW filter for the IC-575A/H 6 meter/10 meter base station.

For more information about any of these products contact ICOM America, Inc., 2380 116th Avenue N.E., P.O. Box C-90029, Bellevue, Washington 98009-9029.

Circle #306 on Reader Service Card.

new logging program with text processor

Aerospace Consulting announces LOGWRITE™, an Amateur Radio logging program. It includes a split-screen feature allowing you to use your computer keyboard to jot down notes or to copy code while using the program to keep your log book records. To do this, LOGWRITE™ divides the screen into several regions. The top and bottom of the display consist of blocks into which the usual log book information is entered; the rest of the display shows text and program prompts. The program is entirely menu driven, works on all IBM PCs and compatibles, and is a fully-compiled program that runs by itself; it doesn't need to be run under basic. LOGWRITE™ can also print and edit records, search for call signs or prefixes, and automatically stamp time and date on contacts.

LOGWRITE™ is available from Aerospace Consulting, P.O. Box 156, Gwynedd, Pennsylvania 19436, for $24.95. (Pennsylvania residents add $1.50 for sales tax.) Place MasterCard and Visa orders by calling 800-345-4156 ext. 54, evenings and weekends.

Circle #307 on Reader Service Card.

100-channel handheld cobra scanner

Cobra has developed the first pocket-sized 100-channel scanner with 11-band coverage (including 10, 6, and 2 meters and 70 cm), keyboard programming, electronic digital tuning, and five memory banks. Each bank stores up to 20 frequencies and can be monitored separately or together in any combination at a scan speed of 15 channels per second. Channels can be grouped within the banks in any order for fast, easy access.

Automatic operating functions include auto and manual scan, automatic search, channel lockout, channel priority, selective scan delay, and channel hold.

The SR-15's backlit, six-digit LCD display shows the channel position and frequency readout during automatic and manual scan. The display also indicates the status of three operational modes (priority, lockout and delay) and the five memory banks.

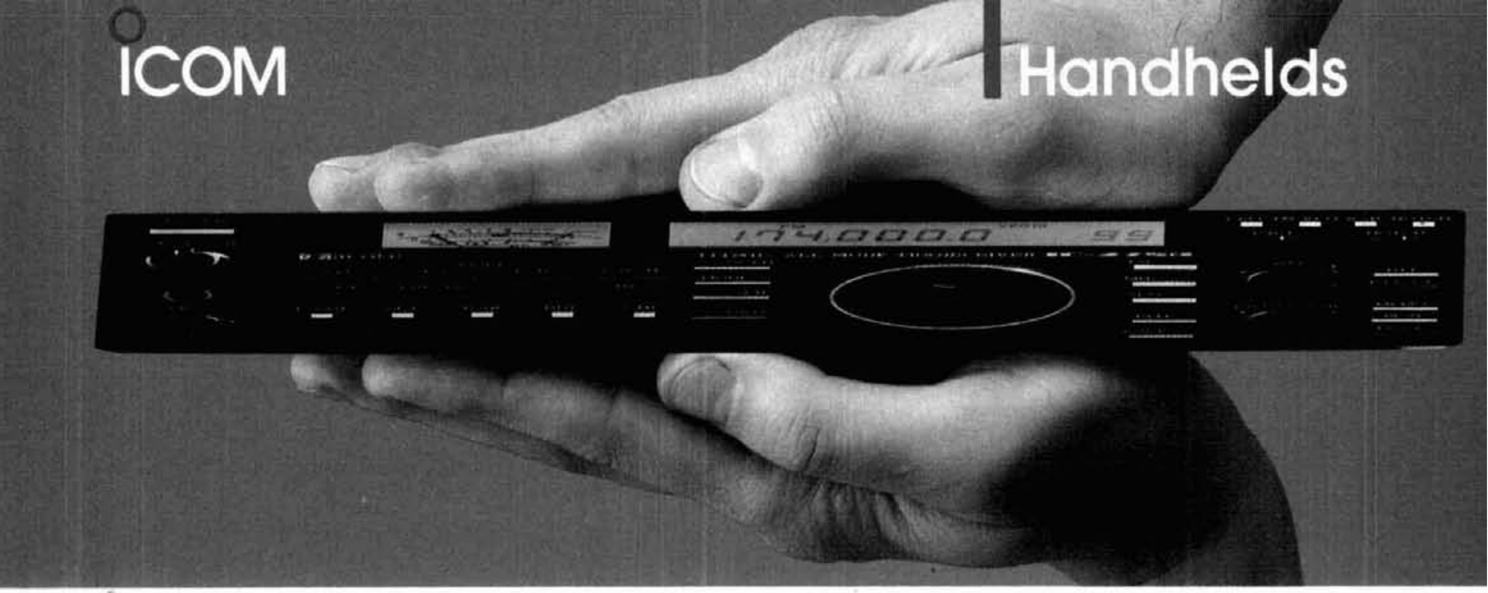
The scanner is only 6″ high x 2-3/4″ wide x 1″ deep with a weather-resistant case of anodized aluminum and high-impact ABS. Accessories include a flexible rubber antenna, rechargeable NiCd battery pack, ac adapter/charger, earphone, and carrying case. The SR-15 is priced at $299.95 (suggested retail).

For more information contact Cobra Consumer Electronics Group/Dynascan Corp., 6500 West Cortland Street, Chicago, Illinois 60635.

Circle #308 on Reader Service Card.

Correction for DMQ Technology

The loop antenna featured in the New Products section for August 1988 *HAM RADIO* can handle 1500 watts P.E.P. and is 39 inches in diameter. The antenna is wrapped with a heat shrinkable PVC, comes assembled and ready for use. For more information contact DMQ Technology, 221 Slater Boulevard, Staten Island, New York 10305.



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.

✓ 144

e top of the pack!

WEFAX, CW and Radioteletype, you'll have Dual-Port Operation (the only TNC offering this feature), Personal Packet Mailbox™, KA-NODE™, gateway, and digipeater operation.

You can operate non-packet modes on HF while maintaining a packet station at the same time on VHF. Or run an HF/VHF accessible personal mailbox or pc-based BBS totally dedicated to packet. Configure your KAM as an HF to VHF digipeater (gateway) or KA-NODE. Or open your LAN to the world. All these modes and more features are waiting to be discovered. Increase your station abilities to the most advanced available.

Today and Tomorrow

KAM is packed with all the latest features of today with Kantronics-written firmware. And since we write and copyright our own firmware, we're in a position to lead you into the exciting modes of tomorrow first. We have a history of keeping our customers current. Proof is in our firmware updates (2.7 in 1987 and 2.83 in 1988) offered at a fraction of the cost of a new purchase.

So join the fun, join the Top of the Pack.

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

✓ 150

THE WEEKENDER

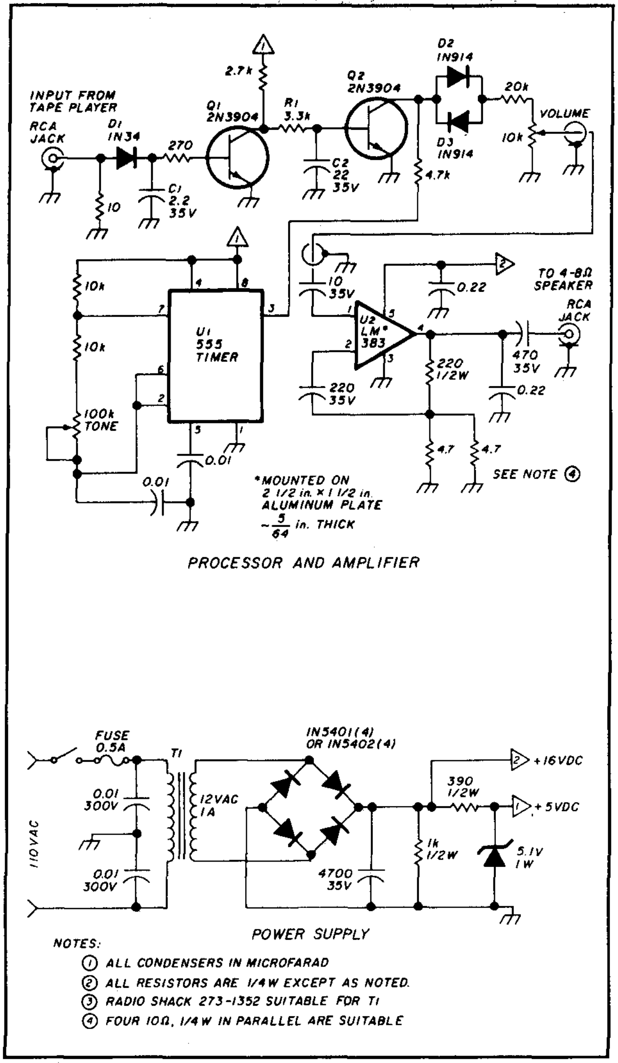
PROCESSOR FOR CODE TAPES

By Andy S. Griffith, W4ULD, 203 Lord Granville Drive, Rt. 2, Morehead City, North Carolina 28557

As a volunteer examiner (VE) I was concerned about the audio quality of many code tapes and audio amplifiers. In many cases the code tapes have tones that aren't clear, with objectionable background noise. Commercial amplifiers cause "thumps" which are sometimes audible at the beginning of each character on the tapes. The processor and amplifier described here eliminate all these problems. They provide quality audio from the worst of tapes and allow for adjustment of the code tone.

The simple circuit is shown in **fig. 1**. When a tone is input from the tape deck, diode D1 and capacitor C1 rectify and smooth the tone to a dc voltage which is amplified and inverted by Q1. Q1 drives gate Q2. The 555 timer (U1) generates a continuous tone which is applied to the collector of Q2 through a 4.7k resistor. When Q2 is "off", the tone is shorted to ground; when Q2 is "on", the tone passes to the input of audio amplifier, U2. Diodes D2 and D3 prevent leak-through of a residual tone when Q2 is off. The peak tone voltage must exceed 0.7 volts to pass to U2. The code characters are shaped by C2 and R1. As a result, the code coming out of U2 to the speaker is independent of the code quality and background noise on the code tape. The code sounds like a code practice oscillator with no background noise. Incidentally, I tried to key the supply voltage to U1 with the rectified input signal but was unable to eliminate clicks and shape the characters. I went to the gating circuit shown instead.

FIGURE 1

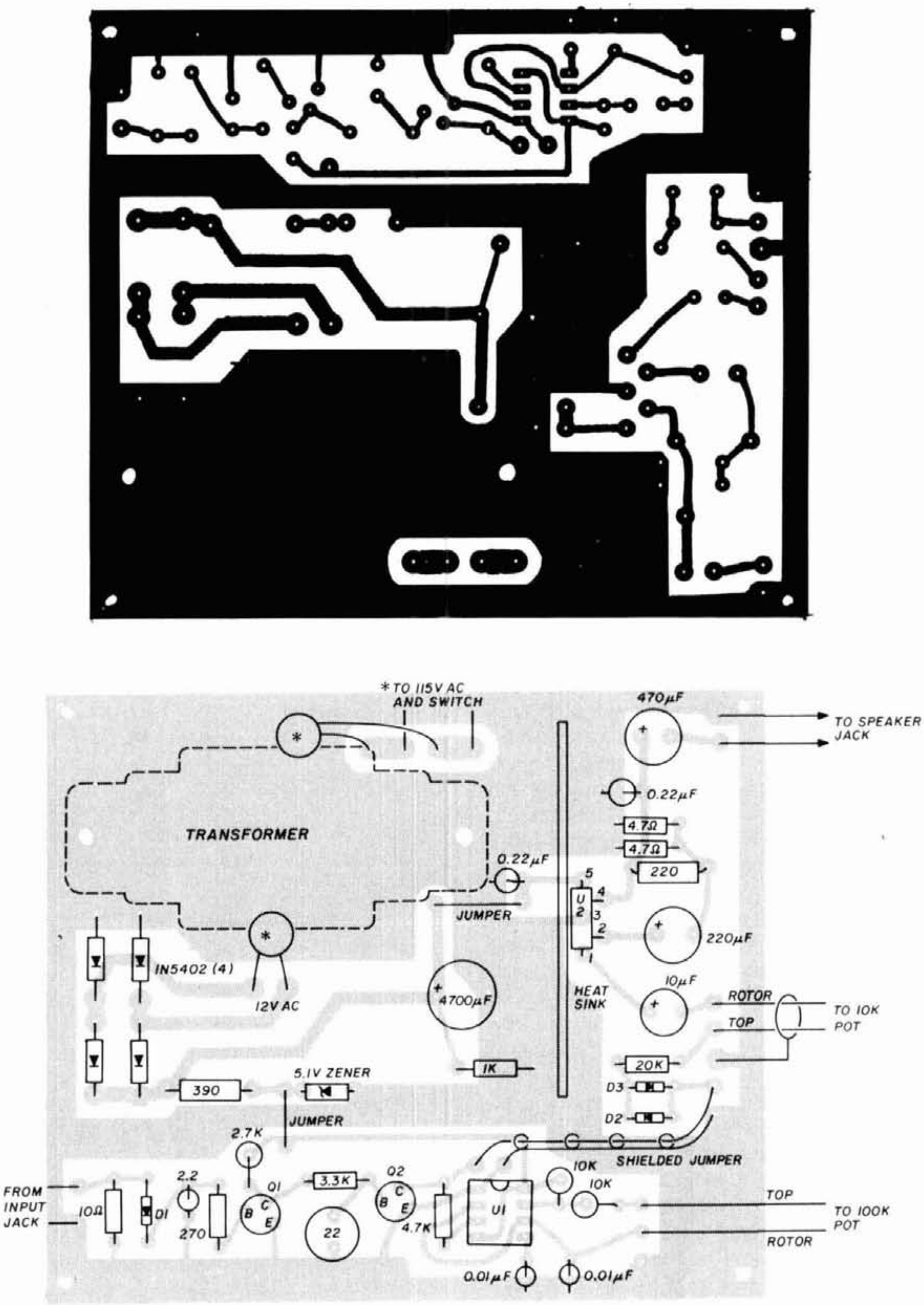


Schematic diagrams of the processor and amplifier and power supply circuits.

Except for the audio amplifier (U2), construction isn't critical. I used a single-etched circuit board (4-1/2″ x 3-7/8″) to mount all components but the volume control, tone control, and power switch (See **fig. 2**). These are mounted on the front panel of the 5-1/8″ x 2-3/4″ x 5-1/2″ cabinet. The input and speaker jacks are mounted on the rear panel. The audio amplifier is mounted vertically on the circuit board and screwed to a vertical heat sink about 2-1/2″ x 1-1/2″ x about 5/64″. Use thermal grease between U2 and the heat sink. It is important that all ground connections for U2 and its associated components be made close together; otherwise the amplifier will produce a hum. I believe that all components except the cabinet can be obtained from Radio Shack. Other suppliers list the cabinet in their catalogs. The circuit board can probably be reduced to fit a smaller cabinet.

Operation of the processor is simple. Use shielded cables to connect the processor to a suitable speaker and

FIGURE 2



Printed circuit board and parts layout.

Parts list

Resistors
- 1 10
- 1 270
- 1 2.7k
- 1 3.3k
- 1 4.7k
- 1 20k
- 2 10k
- 1 220 1/2 watt
- 2 4.7
- 1 1K 1/2 watt
- 1 390 1/2 watt

Capacitors
- 1 2.2μ 35 volt
- 1 22μ 35 volt
- 2 0.01μ 35 volt
- 1 10μ 35 volt
- 1 220μ 35 volt
- 2 0.22μ 35 volt
- 1 470μ 35 volt
- 2 0.01 300 volt
- 1 4700μ 35 volt

Pot
- 1 10k
- 1 100k

Diodes
- 1 1N34
- 2 1N914
- 4 1N5401/1N5402

Zener diode
- 1 1N3826/1N4733

Transistors
- 2 2N3904

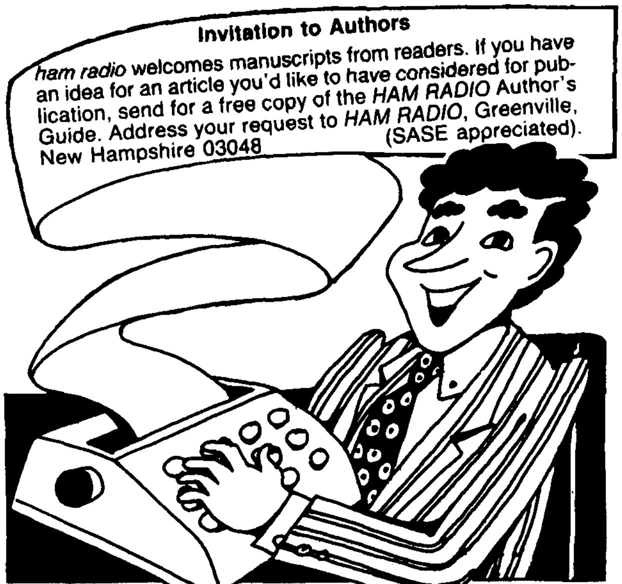
ICs
- 1 555
- 1 LM383

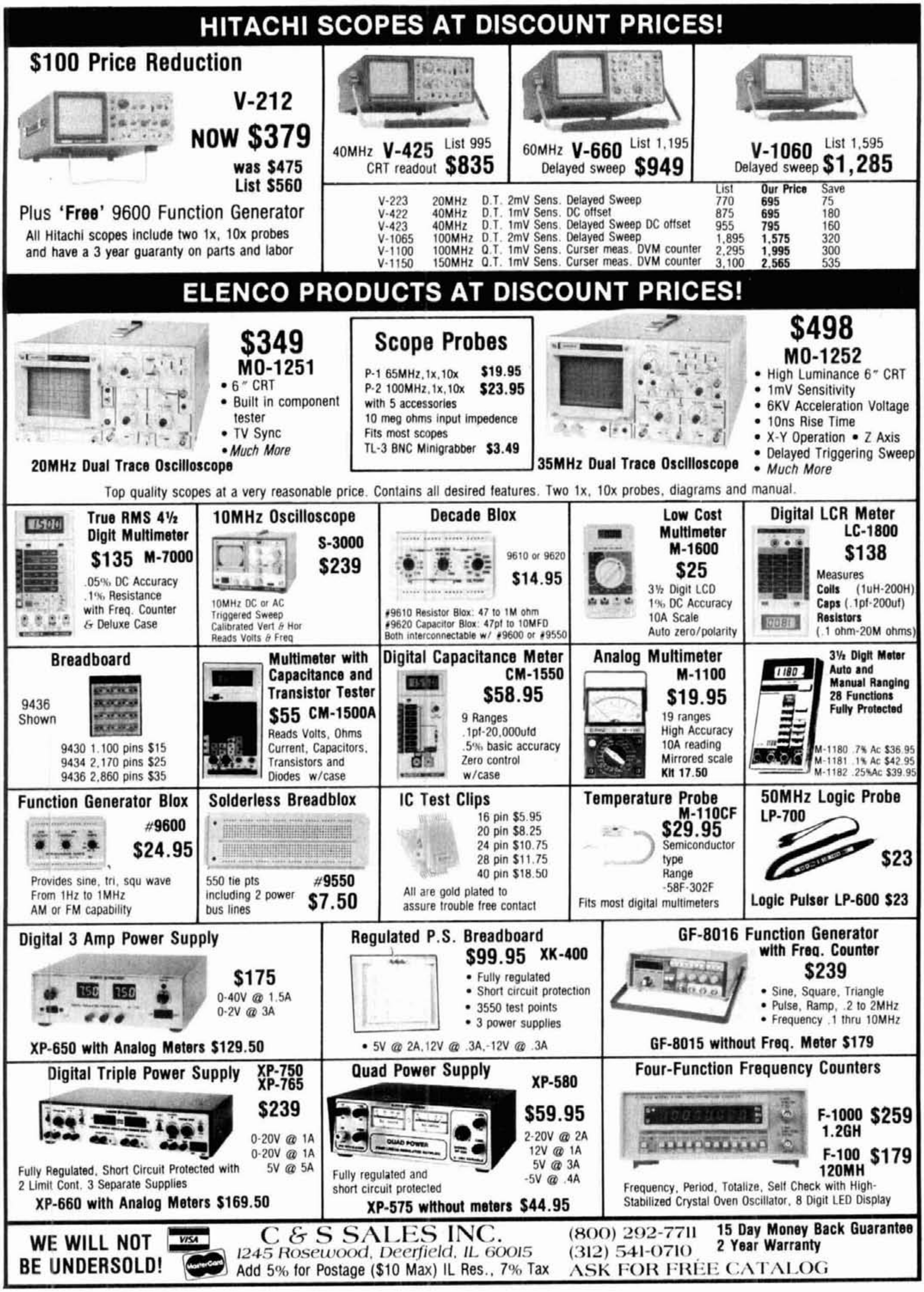
Miscellaneous
- 1 PCB
- 1 Transformer (RS 273-1352)
- 2 RCA jack
- 2 Knobs
- 1 Enclosure
- 24" Shielded cable
- 1 Switch
- 4' Power cable
- 1 .5A Pigtail Fuse

to the "ear", or output, of a tape deck. Turn on the processor. Set the tone control to about midscale and advance the volume about one-quarter. Insert a code tape in the tape deck and start it. Advance the volume control on the tape deck until you hear code from the speaker. Adjust the speaker volume and the tone with the controls on the processor. The best setting of the volume control on the tape deck should be just above the point where code is first heard in the speaker. The examinees at my VE sessions have commented on the high quality of code from the processor. I think you will find this a worthwhile project.

A pc board is available from FAR Circuits, 18N640 Field Court, Dundee, Illinois 60188 for $6.00 postage paid.

Article I **ham radio**




HITACHI SCOPES AT DISCOUNT PRICES!
$100 Price Reduction
V-212
NOW $379
was $475
List $560
Plus 'Free' 9600 Function Generator
All Hitachi scopes include two 1x, 10x probes and have a 3 year guaranty on parts and labor
40MHz V-425 List 995
CRT readout $835
60MHz V-660 List 1,195
Delayed sweep $949
V-1060 List 1,595
Delayed sweep $1,285
List Our Price Save
V-223 20MHz D.T. 2mV Sens. Delayed Sweep 770 695 75
V-422 40MHz D.T. 1mV Sens. DC offset 875 695 180
V-423 40MHz D.T. 1mV Sens. Delayed Sweep DC offset 955 795 160
V-1065 100MHz D.T. 2mV Sens. Delayed Sweep 1,895 1,575 320
V-1100 100MHz Q.T. 1mV Sens. Curser meas. DVM counter 2,295 1,995 300
V-1150 150MHz Q.T. 1mV Sens. Curser meas. DVM counter 3,100 2,565 535
ELENCO PRODUCTS AT DISCOUNT PRICES!
$349
MO-1251
• 6" CRT
• Built in component tester
• TV Sync
• Much More
20MHz Dual Trace Oscilloscope
Scope Probes
P-1 65MHz, 1x, 10x $19.95
P-2 100MHz, 1x, 10x $23.95
with 5 accessories
10 meg ohms input impedence
Fits most scopes
TL-3 BNC Minigrabber $3.49
$498
MO-1252
• High Luminance 6" CRT
• 1mV Sensitivity
• 6KV Acceleration Voltage
• 10ns Rise Time
• X-Y Operation • Z Axis
• Delayed Triggering Sweep
• Much More
35MHz Dual Trace Oscilloscope
Top quality scopes at a very reasonable price. Contains all desired features. Two 1x, 10x probes, diagrams and manual.
True RMS 4½ Digit Multimeter
$135 M-7000
.05% DC Accuracy
.1% Resistance
with Freq. Counter
& Deluxe Case
10MHz Oscilloscope
S-3000
$239
10MHz DC or AC
Triggered Sweep
Calibrated Vert & Hor
Reads Volts & Freq
Decade Blox
9610 or 9620
$14.95
#9610 Resistor Blox: 47 to 1M ohm
#9620 Capacitor Blox: 47pf to 10MFD
Both interconnectable w/ #9600 or #9550
Low Cost Multimeter
M-1600
$25
3½ Digit LCD
1% DC Accuracy
10A Scale
Auto zero/polarity
Digital LCR Meter
LC-1800
$138
Measures
Coils (1uH-200H)
Caps (.1pf-200uf)
Resistors (.1 ohm-20M ohms)
Breadboard
9436 Shown
9430 1,100 pins $15
9434 2,170 pins $25
9436 2,860 pins $35
Multimeter with Capacitance and Transistor Tester
$55 CM-1500A
Reads Volts, Ohms
Current, Capacitors,
Transistors and
Diodes w/case
Digital Capacitance Meter
CM-1550
$58.95
9 Ranges
.1pf-20,000ufd
.5% basic accuracy
Zero control
w/case
Analog Multimeter
M-1100
$19.95
19 ranges
High Accuracy
10A reading
Mirrored scale
Kit 17.50
3½ Digit Meter
Auto and Manual Ranging
28 Functions
Fully Protected
M-1180 .7% Ac $36.95
M-1181 .1% Ac $42.95
M-1182 .25%Ac $39.95
Function Generator Blox
#9600
$24.95
Provides sine, tri, squ wave
From 1Hz to 1MHz
AM or FM capability
Solderless Breadblox
550 tie pts
including 2 power bus lines
#9550
$7.50
IC Test Clips
16 pin $5.95
20 pin $8.25
24 pin $10.75
28 pin $11.75
40 pin $18.50
All are gold plated to assure trouble free contact
Temperature Probe
M-110CF
$29.95
Semiconductor type
Range -58F-302F
Fits most digital multimeters
50MHz Logic Probe
LP-700
$23
Logic Pulser LP-600 $23
Digital 3 Amp Power Supply
$175
0-40V @ 1.5A
0-2V @ 3A
XP-650 with Analog Meters $129.50
Regulated P.S. Breadboard
$99.95 XK-400
• Fully regulated
• Short circuit protection
• 3550 test points
• 3 power supplies
• 5V @ 2A, 12V @ .3A, -12V @ .3A
GF-8016 Function Generator with Freq. Counter
$239
• Sine, Square, Triangle
• Pulse, Ramp, .2 to 2MHz
• Frequency .1 thru 10MHz
GF-8015 without Freq. Meter $179
Digital Triple Power Supply
XP-750
XP-765
$239
0-20V @ 1A
0-20V @ 1A
5V @ 5A
Fully Regulated, Short Circuit Protected with 2 Limit Cont. 3 Separate Supplies
XP-660 with Analog Meters $169.50
Quad Power Supply
XP-580
$59.95
2-20V @ 2A
12V @ 1A
5V @ 3A
-5V @ .4A
Fully regulated and short circuit protected
XP-575 without meters $44.95
Four-Function Frequency Counters
F-1000 $259
1.2GH
F-100 $179
120MH
Frequency, Period, Totalize, Self Check with High-Stabilized Crystal Oven Oscillator, 8 Digit LED Display
WE WILL NOT BE UNDERSOLD!
VISA
MasterCard
C & S SALES INC.
1245 Rosewood, Deerfield, IL 60015
Add 5% for Postage ($10 Max) IL Res., 7% Tax
(800) 292-7711
(312) 541-0710
15 Day Money Back Guarantee
2 Year Warranty
ASK FOR FREE CATALOG

159

TUNING INDICATOR
FOR RTTY AND PACKET RADIO

By **Bruce L. Meyer, W0HZR,** 9410 Blaisdell Avenue South, Bloomington, Minnesota 55420

Circuit plus scope provides simple, useful displays

The tuning indicator in this article can enhance your RTTY/Packet operations. It provides rapid acquisition of the received signal with indications of signal strength, correct tuning, frequency shift, selective fading, and noise content — at a glance.

The device described here, an upgraded version of a previously published one[1], is made up of integrated circuits and synthetic inductors instead of vacuum tubes and low-Q wire-wound inductors. These enhancements improve the display and allow it to work with audio frequency shifts as narrow as 50 Hz. I call it the "X-display."

I have found that a simple receiving demodulator (terminal unit, receiving converter, or computer interface unit), when tuned properly to the received signal, can outperform a much more expensive unit that is not quite on frequency, especially in the presence of noise. To acquire a signal correctly, all the operator has to do is turn the receiver tuning dial until an upright "X" appears on the face of the CRT (cathode ray tube). When the signal is off-tune the X will lean or rotate to the left or to the right, depending on whether the frequency is too low or too high.

The *angle* between the legs of the X represents the amount of frequency shift. The *length* of each leg represents the instantaneous signal strength of the marking or spacing tone. With a nonfading signal, the legs will be the same length (see **fig. 1**). When a single tone is received, only one line will appear on the screen. During FSK the persistence of vision and the persistence of the CRT phosphor allow the marking and spacing tones, which appear as separate lines, to form the X.

As you tune the receiver to acquire the FSK signal the X pattern will rotate on the CRT face, and indicate correct tuning when the X is upright. At this point the user can compare the angle between the legs of the X with the calibration marks for the 170-Hz or 200-Hz frequency shift previously placed on the CRT face. **Figure 2** illustrates incorrect tuning of the receiver. **Figure 3** shows a frequency shift that is too narrow; too wide a shift is shown in **fig. 4**. If the transmitted signal contains extraneous frequencies, like those caused by power supply hum or keying transients, the legs of the X will be wide. There can even be two or more X patterns superimposed and slightly offset in angle from each other (see **fig. 5**). This is an indication of incidental FM.

The heart of the X-display device is a simple RLC series network (**fig. 6**). This network discriminates between signal frequencies above and below its series resonant frequency, but does not appreciably affect the amplitude of the received signal as measured across the inductor. The amplitudes of the marking and spacing frequencies may be measured or viewed independently of each other.

Component selection for the RLC network isn't difficult. The inductor should have as high a Q as possible, within reason. If the Q is too low (20, for instance), the CRT will display an ellipse rather than a line. The ellipse is useful but slightly more difficult to interpret. I tried several commercial toroidal inductors in the range of 88 to 800 mH. None had a Q of more than 20 at the chosen display center frequency of 2210 Hz. Fortunately, a synthetic inductor called a "gyrator" is available.[2] I recommend one consisting of two inexpensive operational amplifiers, one capacitor, and several resistors. It has a Q close to 200 and is ideal for this application. (More about this circuit later.)

type of scope required

It should be emphasized at this point that it is not necessary to construct a custom oscilloscope in order to obtain the X-display. Any oscilloscope with separate inputs for X and Y deflection may be used, provided that the oscilloscope amplifiers have sufficient gain and that the controls can be locked in place when frequency calibration has been made.

A block diagram showing the major elements of an X-scope adapter for an existing oscilloscope or modification thereof appears in **fig. 7**. The major elements shown are the input amplifier/equalizer, the discriminator, the horizontal output buffer amplifier, and the vertical output buffer amplifier.

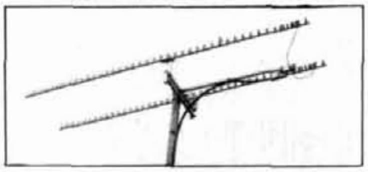
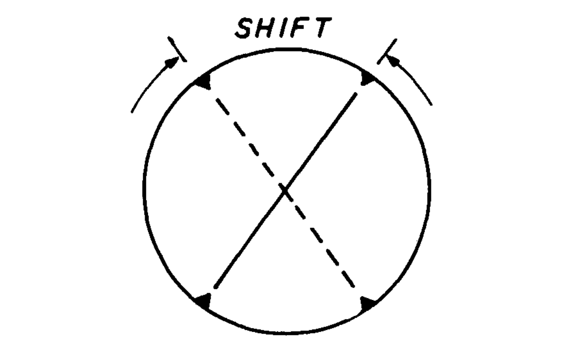
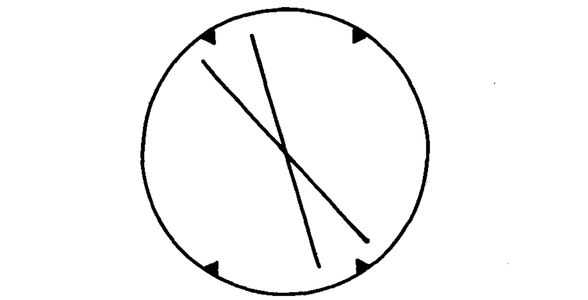


FIGURE 1



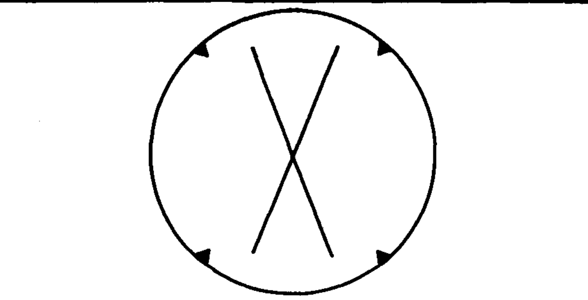
Line slopes with audio frequency.

FIGURE 2



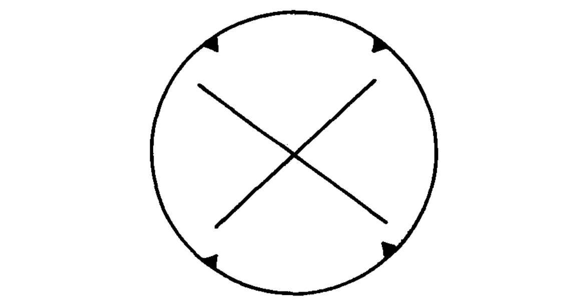
Receiver is mistuned.

FIGURE 3



Shift is too narrow.

FIGURE 4



Shift is too wide.

The buffer amplifiers of **figs. 8** and **9** are not needed if you simply wish to feed the discriminator outputs to the corresponding inputs of an existing oscilloscope. If, however, the oscilloscope is modified to leave only the deflection amplifiers, the buffer amplifiers may be needed to provide isolation and gain.

Another consideration is the power supply. Both positive and negative voltages in the range of 9 to 15 volts are needed by the X-scope adapter. These may already be available in a solid-state scope. The current requirements are modest, less than 50 mA. If a vacuum tube scope is used, you'll have to construct or buy a power supply. The parts cost shouldn't exceed $20.00.

The resistor in the discriminator circuit serves two purposes: first, it provides the entire voltage drop between the signal source and the LC network at resonance; second, it prevents a high voltage from appearing across the inductor at resonance. The size of the resistor isn't critical. It is selected so that there is little difference among the voltages across the inductor at, above, and below resonance. The voltage across the inductor will naturally increase with increasing frequency. For that reason it is desirable to use a low-pass de-emphasis network ahead of the RLC discriminator. This network or equalizer causes the signal trace on the CRT screen to have a nearly constant vertical deflection throughout the frequency range of interest. A simple equalizer circuit appears in **fig. 10**.

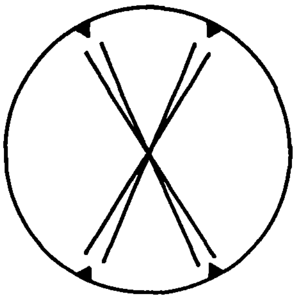
The discriminator circuit of **fig. 11** consists of R_5, C_2, and the gyrator circuit shown separately in **fig. 12**. The gyrator is the L of the RLC network described above.

theory of operation

Those familiar with oscilloscope presentations will recognize a sloping line display as representing two alternating current signals that are either in phase or 180 degrees out of phase. This is exactly what happens in an RLC circuit containing a lossless capacitor and lossless inductor. Above resonance the voltage across the inductor is greater than the voltage across the capacitor. Below resonance the voltage across the capacitor predominates. At resonance the voltages are equal and opposite in phase, so they cancel and there is no horizontal deflection of the CRT beam. The net voltage across the inductor and capacitor in series is compared by the oscilloscope with the voltage across the inductor alone, resulting in the in-phase or out-of-phase presentation on the CRT screen.

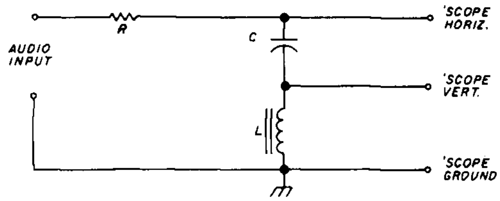
The equalizer circuit in **fig. 10** consists of a 741 or equivalent operational amplifier with capacitive negative feedback, whose time-constant complements that of the FSK discriminator network to provide an essentially flat frequency response for the vertical deflection system.

FIGURE 5



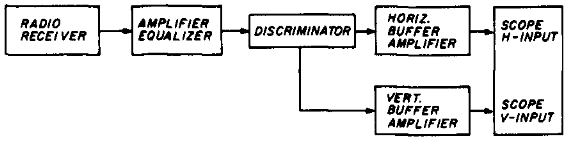
Incidental FM.

FIGURE 6



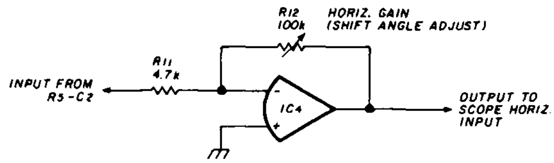
Basic RLC network.

FIGURE 7



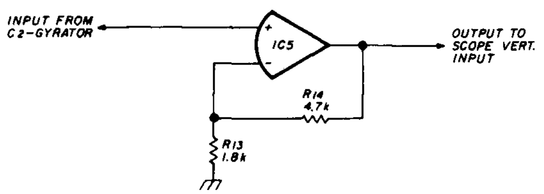
System block diagram.

FIGURE 8



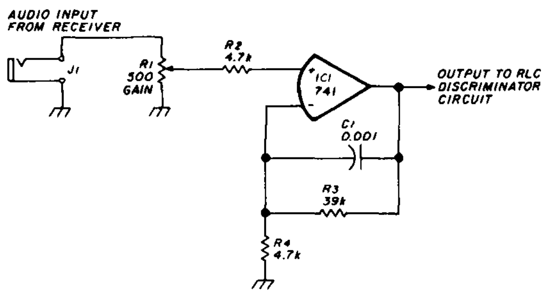
Horizontal buffer-amplifier.

FIGURE 9



Vertical buffer-amplifier.

FIGURE 10



Audio Equalizer (de-emphasis network).

The gyrator circuit of **fig. 12** is made up of two 741 operational amplifiers which comprise the integrator coupled with a negative impedance converter. The combination appears at the input as an inductor with a Q approaching 200. An ordinary variable resistor in the gyrator circuit is used to vary the effective inductance and to tune the FSK discriminator to the proper resonant frequency.

This is a good place to mention that very few if any inductors are lossless, although capacitors may be nearly so. A lossy inductor will not provide an ac voltage drop that is exactly 180 degrees out of phase with the voltage drop across the capacitor. The internal resistance of the inductor will cause a small phase shift which will result in the display of an ellipse instead of a straight line. The higher the Q of the inductor, the closer the trace will resemble a straight line. For this reason the use of a synthetic inductor or gyrator is recommended.

The horizontal buffer amplifier of **fig. 8** is used to set the gain of the horizontal deflection circuits. It isn't required if the scope has a high-gain horizontal amplifier in place. The amount of gain used controls the width or angle of the legs of the X displayed.

The vertical buffer amplifier of **fig. 9** provides a modest amount of gain but its main role is to isolate the gyrator from resistive loading, which would degrade its Q. If a commercial oscilloscope with a very high input impedance is used, the vertical buffer amplifier circuit may not be required. The scope input may then be connected directly to the junction of C_2 and the gyrator circuit.

construction project

One problem that arises in dedicating a lab scope to this application is that the beam tends to burn the phosphor of the CRT face so that a permanent X pattern appears, with a dark spot at the crossing point. This does not drastically affect the screen of the scope

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

INSIDE VIEW — RS-12A

ASTRON POWER SUPPLIES

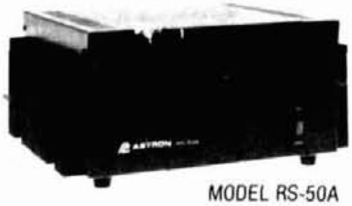
• HEAVY DUTY • HIGH QUALITY • RUGGED • RELIABLE •

SPECIAL FEATURES

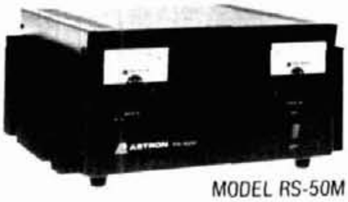
- SOLID STATE ELECTRONICALLY REGULATED
- *FOLD-BACK CURRENT LIMITING* Protects Power Supply from excessive current & continuous shorted output
- CROWBAR OVER VOLTAGE PROTECTION on all Models **except RS-3A, RS-4A, RS-5A.**
- MAINTAIN REGULATION & LOW RIPPLE at low line input Voltage
- HEAVY DUTY HEAT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

PERFORMANCE SPECIFICATIONS

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



MODEL RS-50A



MODEL RS-50M

MODEL VS-50M

RM SERIES

MODEL RM-35M

19″ × 5¼ RACK MOUNT POWER SUPPLIES

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

RS-A SERIES

MODEL RS-7A

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

RS-M SERIES

MODEL RS-35M

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

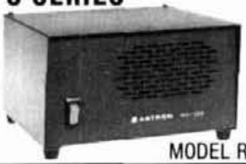
VS-M AND VRM-M SERIES

MODEL VS-35M

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

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

RS-S SERIES



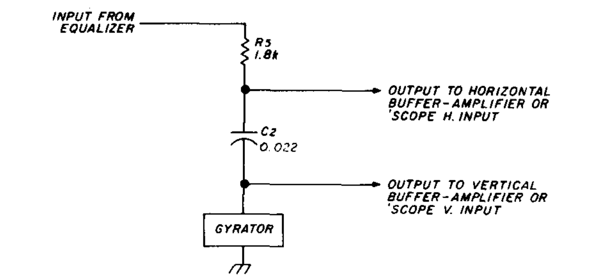
MODEL RS-12S

- Built in speaker

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

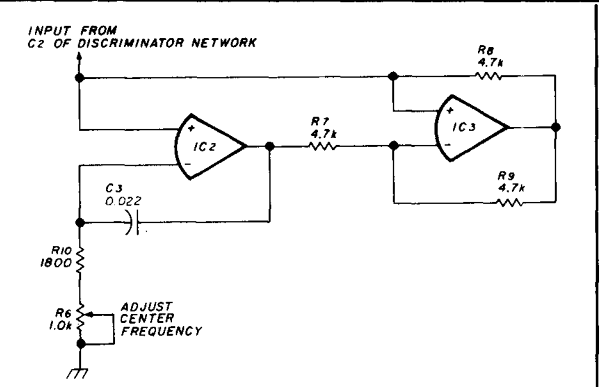
*ICS—Intermittent Communication Service (50% Duty Cycle 5min. on 5 min. off)

FIGURE 11



RLC discriminator network.

FIGURE 12



Gyrator circuit (synthetic inductor).

but is somewhat unsightly. After one has used the lab scope to verify the utility of the system, it may be a good idea to purchase an inexpensive one at a flea market and modify it as required to incorporate the FSK discriminator. Audio oscilloscopes like those built from kits can be found for as little as $15.00.

An advantage in modifying an inexpensive scope is that its gain controls can be locked in place to preserve the frequency calibration. It doesn't matter whether the scope has vacuum tubes or transistors in its deflection circuits, as long as the user can adapt the FSK discriminator to the deflection circuits and provide the correct power supply voltages. The scope's timebase circuits can be removed or disconnected.

I chose to build a complete X-scope with cabinet, low- and high-voltage power supplies, solid-state deflection circuits, and a 2AP1 CRT. The discriminator and amplifier circuits described above were placed on a small purchased pre-perforated circuit board. The circuit board had copper pads at every hole. I used No. 30 wire-wrap wire for interconnection because the insulation can withstand soldering heat. The insulation is tough; I recommend that you use a stripping tool designed for No. 30 AWG wire.

After the circuit was assembled, the circuit board was mounted on standoffs above the oscilliscope chassis. The circuit was then wired into the rest of the scope circuits. This technique should be adaptable to almost any scope foundation or chassis.

calibration

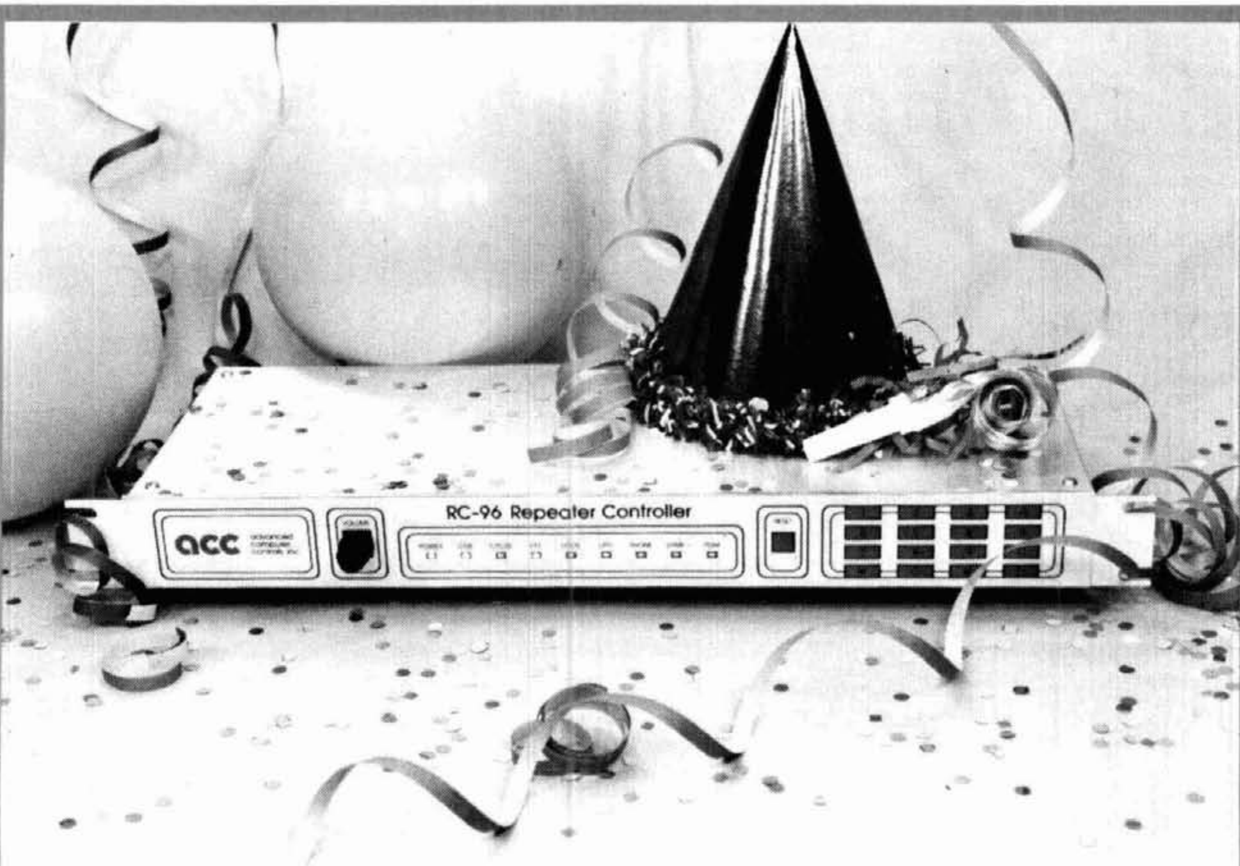
For the initial calibration of the completed X-scope circuit, an audio signal generator is needed that can generate the marking and spacing tones used by a modem/interface unit/terminal unit (typically 2125 and 2295 Hz for 170-Hz shift). You'll also need a tone midway between the two frequencies. The indications of the X-scope will be only as accurate as the frequency source.

The tone may be taken from the audio signal across the voice coil of a loudspeaker, at a comfortable listening level, and applied to the input of the equalizer circuit. While watching the CRT display you must adjust the gyrator inductance by varying R_6 until the selected center frequency (2210 Hz) causes a vertical trace to appear on the CRT face. At this point there is no horizontal input to the deflection circuits. The input frequency is now changed to either the marking or the spacing tone to observe the angular deflection from vertical. It should be between 30 and 40 degrees. If it is not, you must adjust the horizontal gain to achieve the desired angle. By alternately applying marking and spacing tones to the input, you can cause the CRT trace to lean alternately to the right and left, or vice versa. The slope depends on the vertical amplifier phasing with respect to that of the horizontal amplifier. The connections of one set of deflection plates, or the inputs of one set of differential amplifiers in the oscilloscope, can be reversed for opposite slope.

The next step in calibration is to mark the face of the CRT or its protective screen with the positions of the marking and spacing tone traces. Use marker pen, crayon, or masking tape arrows. Be sure to center the beam before starting. Carefully log all oscilloscope gain control settings and check them for reset ability. If you find that you cannot reset the controls precisely, you may be a candidate for a custom scope unit that doesn't have variable gain controls.

using the X-scope

Once the display is calibrated, disconnect the audio signal generator and connect the output of the radio receiver in its place. Tune the receiver to a radio teletypewriter signal or to a packet radio signal and observe the display. During frequency shift signal reception the CRT screen will display an X-shaped pattern with some faint lines between the legs of the X. These faint lines represent the transient response of the receiver and the discriminator and should be ig-



"Give your repeater something to celebrate!"

The new RC-96 controller for your repeater will make its day. And yours.

For you, remote programming will let you easily make changes to your repeater from anywhere without a trip to the hill. Change codes, autodial numbers, ID messages and more, with reliable storage in E^2PROM memory.

Your users will love the outstanding patch and autodialer, with room for 200 phone numbers. The talking S-meter will let them check their signal strength into the repeater. Plus support for pocket pagers, linking to other repeaters, and a bulletin board.

Your technical crew will appreciate the built-in keypad and indicators. And the ease of hookup through shielded DIN cables. With pots and DIP switches easily accessible at the rear of the unit. They'll be impressed by the gas discharge tube across the phone line and transient supressors on each I/O signal to keep lightning from taking your system down.

And most important, your repeater will have a new sense of pride in being able to serve you better. You'll even hear it in its voice!

Something for everyone. A real party animal!

The RC-96 Repeater Controller – the newest choice from ACC.

acc advanced computer controls, inc.

2356 Walsh Avenue, Santa Clara, California 95051 (408) 727-3330

✓ 168

complete parts list

Capacitors	
C1	0.001 μF, 10% Mylar
C2,C3	0.022 μF, 10% Mylar
Resistors	
R1	potentiometer, 500 ohms (not critical)
R2,R4,R7, R8,R9,R11, R14	4.7k, 1/4 watt. 5%
R3	39k, 1/4 watt, 10%
R5,R10,R13	1.8k, 1/4 watt, 10%
R6	potentiometer, 1k
R12	potentiometer, 100k
Integrated circuits	
U1,U2,U3, U4,U5	Type 741 operational amplifier, or equivalent. (Dual or quad units may be used also.)

nored. When the signal is properly tuned in, the X will be upright and centered. If the receiver is tuned too high or too low the X will tilt to the left or to the right. *The frequency shift is indicated by the angle between the legs of the X only when the X is upright and centered.* The length of each leg of the X will vary with signal strength. Often with selective fading one leg or the other of the X will shrink to nothing. If copy is good at this time, you have a superior receiving demodulator.

You can observe signal quality of the FSK transmitter by examining each leg of the X. If the trace is a narrow line it indicates that a pure tone is being received. If the trace is wide at the ends, or if more than two traces are seen, the sending station may have a problem wth contact bounce or with modulating tones that contain hum or other spurious frequencies. A common problem is ac ripple in the dc power supply output to the AFSK signal source at the transmitting station. This hum causes incidental FM which rides atop the FSK signal in the rf output of the SSB transmitter.

Atmospheric noise or QRM will confuse the display by generating Lissajous patterns. It is important that noise levels be kept low if the display is to be correctly interpreted. It is very helpful to use the narrowband filter of the receiver, or a bandpass audio filter between the receiver and the X-display to remove signals that are outside the audio spectrum of interest. In doing so you must be careful not to use too narrow a filter as the marking or spacing signal may be cut off.

conclusion

I have found the X-scope to be a valuable and fascinating addition to the equipment in the ham shack. Not only can it be used to monitor 170 or 200-Hz frequency shifts, but if the center frequency is changed and the horizontal gain reduced, it can monitor 425 or 850-Hz shifts as well. There are some interesting signals to be found between the ham bands, like multiplex, which may produce four traces on the screen of the X-scope.

Anyone who is reasonably skilled in the construction of analog circuits should have no difficulty building the X-scope. I'll be happy to answer questions you may have; please enclose an SASE.

references

1. Bruce Meyer, WØHZR, "FSK Tuning Indicator," *CQ*, The Radio Amateurs' Journal, May 1956.
2. "Filter Design Techniques," *The Lenkurt DEMODULATOR*, May 1975.

Article J **ham radio**

Minimizes weight,
wind resistance,
to realize gain
from height

a five-band dipole

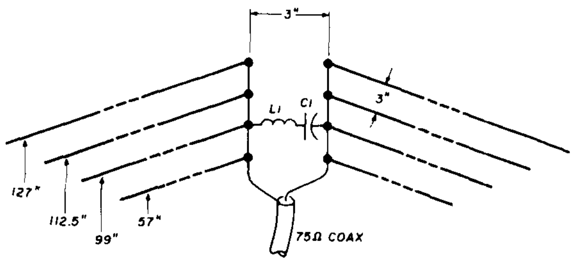


fig. 1. Electrical dimensions of the 5-band dipole. L1 and C1 are used only for 2-meter matching. C1 is 2.2 pF ceramic and L1 is 3 turns of No. 12 wire, 2-inch inner diameter, 1 inch long, air wound.

The advantage of antenna height is well known to DXers. Frequently a light-weight low-gain antenna at a respectable height will outperform a higher gain antenna of lower elevation. My new QTH was in a heavily wooded area and there was an 85-foot fir tree close to the shack. Comparisons of two antennas, one at treetop and one 40 feet lower, demonstrated the height advantage.

I gave much thought to the development of a design that would perform effectively at treetop level on five of my favorite bands: 15, 12, 10, 6, and 2 meters. A beam that would cover all of these bands was ruled out as too cumbersome and heavy to be carried to the top of an 85-foot tree. I feared the frequency separation of the 15, 12, and 10-meter bands would be inadequate for a conventional trap antenna to perform efficiently. Weatherproofing the traps would also be a problem. I resorted to a technique I had seldom used in the past — parallel dipoles. Results have been quite satisfactory; spaced only 3 inches apart, parallel dipoles on these bands seem to perform with almost no interaction.

Because the antenna is horizontal it was necessary to use a rotator. The pattern is bidirectional so only 180° of rotation is needed, and it is possible to get by with as little as 90°. The antenna is light in weight (26 pounds) and has low wind resistance; only a small rotator is needed.

A schematic of the five-band dipole is shown in **fig. 1**. The four dipoles are adjusted for half-wave resonance at frequencies of 21.25, 24.9, 28.6, and 50.3 MHz. The 10-meter dipole works as a 5/2 wavelength dipole on 2 meters where it has a theoretical gain of 3 dB over a half-wave dipole. A serious 2-meter operator would probably want to add elements for a four- or five-element Yagi to the same boom and feed it with a diplexer such as shown in **fig. 2**. Alternatively a small 2-meter Yagi could be added to the same mast. However, my own results with only 3 dB of gain have been quite satisfactory on 2 meters. Admittedly, my elevation (5300 feet ASL) has been a contributing factor.

A purist would want to feed this antenna with a 1:1 balun. Measurements with a current probe[1] have shown the rf current on the outside of the coax to be quite small compared with the dipole current, so no balun was used.

The 2-meter impedance of the 10-meter dipole turned out to be capacitive at my operating frequency near 144.2 MHz. It was necessary to cancel this reactance with a shunt inductance. In order not to upset the feed impedance of the lower frequency dipoles, the inductance was placed in series with a series-tuned circuit, resonant at 144.2 MHz. The series-tuned circuit inductance is in series with the matching inductance and the two inductances can be combined into a single larger inductance of about $0.8\mu H$. The series

By Fred Brown, W6HPH, Box 73, Palomar Mountain, California 92060

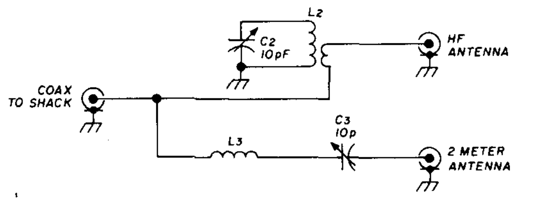


fig. 2. This 2-meter diplexer will permit use of the same coax feeder for a separate 2-meter antenna without compromising performance on either 144 MHz or the lower bands. Both L2 C2 and L3 C3 are carefully tuned to 144 MHz. The link on L2 is one turn. L2 and L3 can be 4 turns No. 18, 1/2-inch diameter, 3/8 inch long.

capacitance of 2.2 pF is too small to upset the resonant frequencies of the lower bands.

construction

As you can see in **fig. 3**, the antenna is made almost entirely of material that is frequently discarded at construction sites. By salvaging such material the total cost can be held to almost nothing. The dipoles are made of No. 12 (.081 inch diameter) solid copper wire stretched between ends of a slightly bowed nonmetalic boom. The center 155 inches of the boom is made of 1-1/2 inch PVC pipe commonly used in construction. PVC pipe of this diameter is not rigid enough for a boom length this size so I reinforced the center 119 inches with 1-1/2 inch wood dowel. To make the dowel, I planed off the corners of 1-1/2 inch square stock to form an octagonal cross section; and then planed the eight corners further to make a force fit into the PVC pipe. This is not easy without a power planer. You can use 1-3/8-inch diameter closet pole purchased from any lumber yard. Leave 18 inches empty on each end to receive 69-3/4 inch lengths of 1-inch PVC to make an overall length of 258 inches, or 0.46 wavelength at 21.15 MHz. The "1-inch" PVC has an outside diameter of about 1.32 inches, so wrap these lengths with vinyl tape as shown in **fig. 3** to build up the diameter and form a snug fit inside the 1-1/2 inch PVC pipe.

Teflon™ insulators are used at the far ends of the 6, 10, and 12-meter dipoles, but the 15-meter dipole ends are secured directly to the PVC boom in order to minimize the overall length. PVC has a bad reputation as an rf insulator[2], but at a power level of 65 watts I could detect no temperature rise in the PVC at the 15-meter dipole end points. If you comtemplate high power, I recommend checking for temperature rise before raising the antenna.

For the 12-inch diameter boom mounting plate I used high-strength plastic. Metal or fiber glass can also be used. If you use plywood, weatherproof it by painting with hot tar before assembling.

Seal all holes in the boom with RTV and cement end caps to the far ends of the 1-inch PVC sections. As an extra precaution against moisture accumulation,

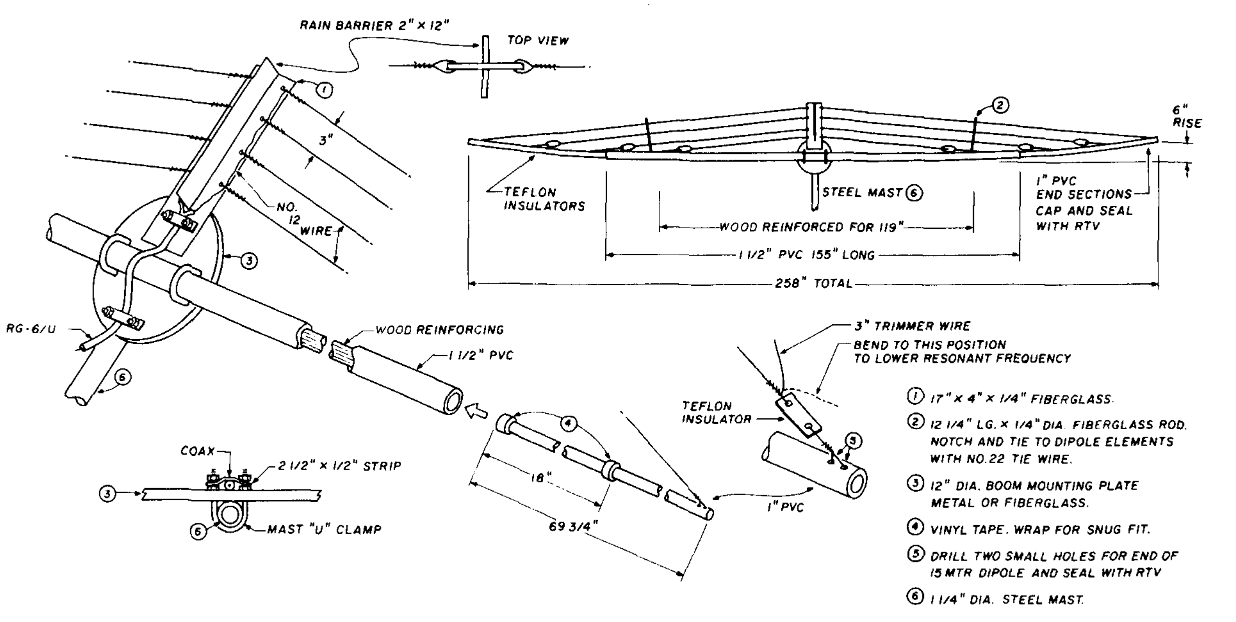


fig. 3. Construction details.

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 . . .

L. Juli

May We Help You With the Best in Commercial and Amateur Radios? Lew W2BIE, Toni, Kitty WA2BAP, and Jan KB2RV.
SEE You Sept. 18–LIMARC, Westbury, NY.

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

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

ONV Safety belts-in stock

YAESU

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

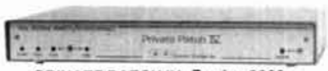
KENWOOD

Antennas
A-S
Cushcraft
Hy-Gain
Hustler
KLM
METZ
Mini-Products
MULTIBAND
Mosley
MODUBLOX
TONNA

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.

YAESU	ICOM
FT-23/73/33/727R	IC2AT/12AT
FT-2/1/709R/H	ICO2AT-32AT
FT-1903/1123	IC-O3/04AT
FTH-2005/7005	IC-A2/U16

Landmobile HTs
ICOM: U16, H16, V100, U400
YAESU: FTH 2005/2007
UNIDEN, REGENCY, KING, TAD
MARINE ICOM: M5, M55, M700
AVIATION ICOM: A20 H.T.



PRIVATE PATCH IV, Duplex 8000

RF Concepts

Budwig ANT. Products
NEL-TECH DVK-100 Digital Voice Keyer
FLUKE 77 Multimeter
Media Mentors—
Amateur Radio Course: $99.95

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

NYE MBV-A 3 Kilowatt Tuner

AMERITRON AMPLIFIER AUTHORIZED DEALER

COMET ANTENNAS STOCKED

MFJ-989B

ALINCO ALD-24T

Soldering Station,
48 Watts, $68

Computer Interfaces Stocked: MFJ-1270B, MFJ-1274, MFJ-1224, AEA PK-87, MFJ-1278, PK-232 W/FAX.

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

Ten-Tec Tuner 229B

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

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

Complete Butternut Antenna Inventory In Stock!

DIGITAL FREQUENCY COUNTERS
Optoelectronics model 1300H, 0-1300MHz
Trionyx, Model TR-1000, 0-600 MHz
AMP SUPPLY STOCKED
Long-range Wireless Telephone for export in stock

HEIL EQUIPMENT IN STOCK

SANGEAN Portable Shortwave Radios

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

BIRD Wattmeters & Elements In Stock

BENCHER PADDLES, BALUNS, LOW PASS FILTERS IN STOCK

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

New TEN-TEC
Corsair II, PARAGON, Argosy II

Tri-Ex Towers
Hy-Gain Towers & Antennas, and Roters will be shipped direct to you FREE of shipping cost.

AEA 144 MHz
AEA 220 MHz
AEA 440 MHz
ANTENNAS

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

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

"Aqui Se Habla Espanol"

BARRY INTERNATIONAL TELEX 12-7670
MERCHANDISE TAKEN ON CONSIGNMENT FOR TOP PRICES

Monday-Friday 9 A.M. to 6:30 P.M. Thursday to 8 P.M.
Saturday & Sunday 10 A.M. to 5 P.M. (Free Parking)

AUTHORIZED DISTS. MCKAY DYMEK FOR SHORTWAVE ANTENNAS & RECEIVERS.

Subways: IRT/LEX-"Spring St. Station"
BMT-"Prince St. Station"
IND-"F" Train-Bwy. Station"

Bus: Broadway #6 to Spring St.
Path—9th St./6th Ave. Station.

Commercial Equipment Stocked: ICOM, MAXON, Midland, Standard, Wilson, Yaesu. We serve municipalities, businesses, Civil Defense, etc. Portables, mobiles, bases, repeaters...

Wanted: Full time Technicians

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

WE NOW STOCK COMMERCIAL COMMUNICATIONS SYSTEMS

HAM DEALER INQUIRES INVITED PHONE IN YOUR ORDER & BE REIMBURSED

COMMERCIAL RADIOS stocked & serviced on premises.

Amateur Radio Courses Given On Our Premises, Call

Export Orders Shipped Immediately. TELEX 12-7670

ALL SALES FINAL

drill 1/4-inch drainage holes through the underside of both pipes 17 inches from each end of the 1-1/2 inch PVC.

pruning

Make final adjustments at least 10 feet above ground. You should get SWR curves similar to **fig. 4**. The final dipole lengths should be very close to those shown in **fig. 1. Figure 3** shows a trimmer adjustment scheme that will help avoid a lot of pruning.

If you check SWR between the ham bands you may find additional resonances where adjacent dipole reactances cancel. For instance, there is a resonance near 27 MHz where the capacitive reactance of the 12-meter dipole resonates with the inductive reactance of the 10-meter dipole. These "false" resonances can be distinguished from the main dipole resonance by their narrow bandwidth. At the frequency of a false resonance, a check with an rf current probe[1] will reveal current on two adjacent dipoles; at "true" resonance current will be strongly concentrated on only one dipole.

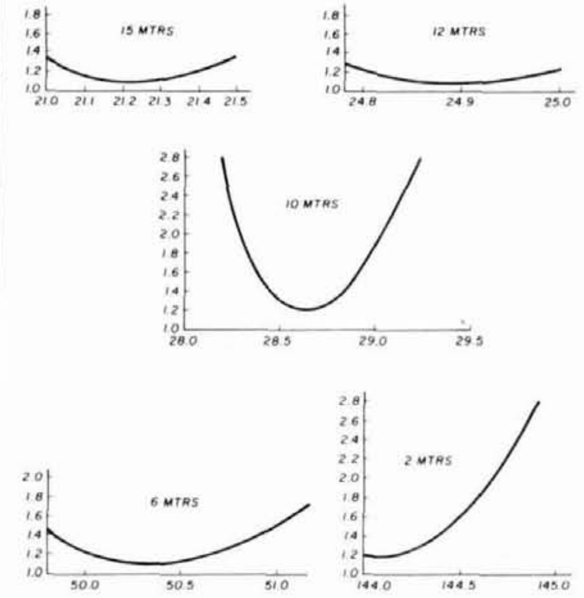


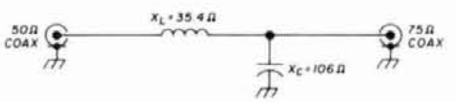
fig. 4. **SWR curves measured on 75-ohm coax. The antenna was matched at the low end of 6 and 2 meters where all operating for this particular station is done.**

The antenna impedance is close to 70 ohms — a good match to 75-ohm coax and not a bad one to 50-ohm coax. The latter will have a minimum SWR of 1.4 at resonance on each band. Perfectionists can obtain a better match to 50 ohms with a simple L section as shown in **fig. 5**. These L sections are extremely broad band, so no tuning is necessary once you have chosen the correct inductance and capacitance values.

In fact, the 12-meter L section is so broad it will provide a good match over the 15 and 10-meter bands as well. Determine inductance values with a grid-dip meter by shorting the input port, leaving the 75-ohm port open. Target resonant frequencies are given in the table on **fig. 5** along with the L and C values.

results

My antenna is fed through about 100 feet of low-loss 75-ohm 1/2 inch hard line. (I used a cable TV discard.) My results have been impressive on all bands. Sometimes I've worked stations that can't even be heard on a lower antenna. The broad azimuthal coverage provided by four main lobes on 2 meters is often a decided advantage over a beam in working multistation round tables.



BAND (METERS)	L	C	RESONANT FREQUENCY
10, 12, 15	0.21 μH	56 pF	46.4 MHz
6	0.112 μH	30 pF	86.6 MHz
2	0.039 μH	10 pF	255 MHz

fig. 5. This simple L-section will provide a broad-band match between 50 and 75 ohm coax. Target values for the inductive and capacitive reactances are 35.4 ohms and 106 ohms, respectively, but values are not critical. The bandwidth is so broad that the 15, 12, and 10 meter bands can be covered with one fixed L-section. If the 50-ohm port is shorted the inductance can be adjusted with a grid dip meter to the frequencies shown in the table.

In a pinch, the five-band dipole can even be used on 20 meters in conjunction with an antenna tuner in the shack. The SWR measured a surprisingly low 7:1 on 20, a figure that might be higher if a 1:1 balun had been used at the feedpoint. In any event, a 7:1 SWR will not increase coax losses prohibitively. For instance, if line loss is 1 dB with flat line it will increase only another 1.75 dB when the SWR is 7, or 2.75 dB total. Of course, an SWR of 7 will require an antenna tuner in the shack to bring the impedance back to 50 or 75 ohms resistive. Judging by on-the-air reports, performance on 20 is not bad at all. Maybe it should be called a six-band dipole.

references

1. F. Brown, W6HPH, "Better Results with Indoor Antennas," *QST*, October 1979, page 21, Figure 5.
2. "A Dielectric No-no," Hints and Kinks, *QST*, April 1977, page 56.

Article K **ham radio**

RADIOTELEGRAPH CODES:

THERE'S NOT JUST ONE

W. Clem Small, KR6A, R1, Box 64A, Middlebury, Vermont 05769

When radio was young, it was a time of experimentation and growth such as the technical world had never seen. Researchers like DeForest, Marconi, Lodge, and Popov, to name a few, were sharing their findings with an expectant and excited world. It was not clear how best to operate these new radio systems, and various persons and organizations became involved in developing the necessary techniques and procedures.

American Morse code and variations

When it came to the use of coded signals on the airwaves, it might seem that the Morse code was the only way to go. The code had been developed for the land-line telegraph invented by Morse and was in common use in the United States. But, in fact, American Morse code was not even the popular code of the day; **fig. 1** shows the other codes in use.

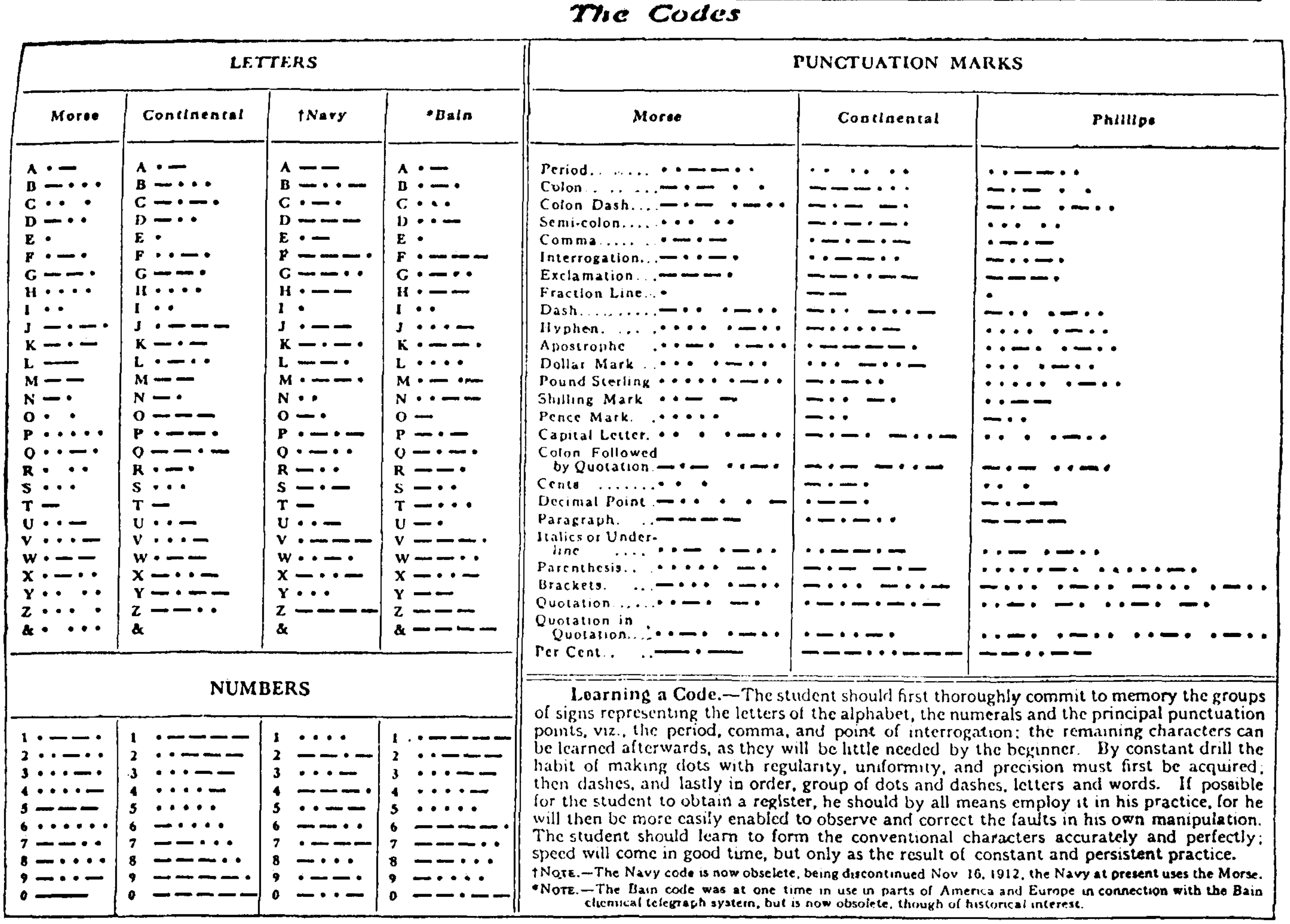
The information in the figure is from *Audel's Handy Book of Practical Electricity*, copyrighted in 1924.[1] As you can see, there were at least five different telegraphic codes being used publicly in the United States back in the early 1900s: Morse, Continental, Navy, Bain, and Phillips. The first four are alphabetic codes, while Phillips provides punctuation. Although much radio communication can be carried on with a minimum of punctuation, the Phillips code was important in radio services reporting newspaper stories. Notes at the bottom of **fig. 1** indicate that the Navy and the Bain codes were already obsolete when Audel's book was published.

international code: the winner

The American Morse code referred to above was Samuel Morse's original code. It seems it was called the "American" version because it was developed and used in the United States. In contrast, the Continental Morse code was used "on the Continent," or in-and-around Europe. You can see from **fig. 1** that these two codes have both similarities and differences.

You may hear old-timers refer to the Continental Morse code as the "general service code."[2] Today, it is known as "International Morse code," and seems

FIGURE 1


The Codes

LETTERS

Morse	Continental	†Navy	*Bain
A	A	A	A

NUMBERS

PUNCTUATION MARKS

Morse	Continental	Phillips
Period		
Colon		
Colon Dash		
Semi-colon		
Comma		
Interrogation		
Exclamation		
Fraction Line		
Dash		
Hyphen		
Apostrophe		
Dollar Mark		
Pound Sterling		
Shilling Mark		
Pence Mark		
Capital Letter		
Colon Followed by Quotation		
Cents		
Decimal Point		
Paragraph		
Italics or Underline		
Parenthesis		
Brackets		
Quotation		
Quotation in Quotation		
Per Cent		

Learning a Code.—The student should first thoroughly commit to memory the groups of signs representing the letters of the alphabet, the numerals and the principal punctuation points, viz., the period, comma, and point of interrogation; the remaining characters can be learned afterwards, as they will be little needed by the beginner. By constant drill the habit of making dots with regularity, uniformity, and precision must first be acquired; then dashes, and lastly in order, group of dots and dashes, letters and words. If possible for the student to obtain a register, he should by all means employ it in his practice, for he will then be more easily enabled to observe and correct the faults in his own manipulation. The student should learn to form the conventional characters accurately and perfectly; speed will come in good time, but only as the result of constant and persistent practice.

†NOTE.—The Navy code is now obselete, being discontinued Nov 16, 1912, the Navy at present uses the Morse.
*NOTE.—The Bain code was at one time in use in parts of America and Europe in connection with the Bain chemical telegraph system, but is now obsolete, though of historical interest.

Telegraphic codes used in the early 1900s.

to be the only hand-sent radiotelegraphic code in general use. International code has long been more popular than American, even though American Morse code was said to be about five percent faster because it has fewer dashes.[3] Graf indicates that American Morse code was used, to a limited extent, at least as late as 1962 on land telegraph lines in this country.[4]

The secret of the International code's success over American may lie in this quotation from the 1924 edition of the International Correspondence School's *Radio Operator's Handbook*: "The International Morse code is used all over the world for radio and submarine telegraphy, and for wire telegraphy in almost every country except the United States, Canada, and parts of Australia. It is superior for signaling through long submarine cables, as some of the recording devices used in that work do not give accurate signals when used with spaced letters."[5]

Although it may appear that International Morse code is the only telegraphic code we have ever had, history tells us otherwise. There is still a proliferation of radiotelegraphic *type* codes today. Aside from the International Morse code used for CW, there are a number of machine-dependent codes. These are: RTTY Baudot code, and the variants used with SITOR, AMTOR, and packet. There's also the ASCII computer code used in machine-dependent radiotelegraphy.

While the use of hand-sent code is not as prevalent as in the past, radiotelegraphic *type* codes are far from becoming an endangered species. Indeed, communications on the air waves, and even over telephone lines, would be seriously diminished without them!

references

1. Frank D. Graham, *Audel's Handy Book of Practical Electricity*, Theo. Audel & Co., New York, 1924, page 831.
2. Rufus P. Turner, *The Illustrated Dictionary of Electronics*, Tab Books, Blue Ridge Summit, Pennsylvania, 1980, page 167.
3. Sidney Gernsback, *1927 Radio Encyclopedia*, originally published by Sidney Gernsback in 1927, reprinted in 1974 by Vintage Radio, Palos Verdes Penninsula, California, page 38-39.
4. Rudolph F.Graf, *Modern Dictionary of Electronics*, Howard W. Sams & Co. Inc., Indianapolis, 1962.
5. International Correspondence Schools Staff, *Radio Operator's Handbook*, The John C. Winston Co., Chicago, 1924, page 406.

Article L **ham radio**

Low-cost
direct frequency display
for any receiver

add a digital readout to the "'poor man's spectrum analyzer'"

An article in the September 1986 issue of *ham radio*, "Low-cost Spectrum Analyzer with Kilobuck Features" by W4UCH, illustrated the use of a voltage-tuned (varactor) TV tuner as a swept, tuned filter. I wanted to add a circuit that would directly read out the center frequency of the CRT display.

The unusually high i-f frequency (610 MHz) used in the modified cable TV tuner makes this application different from the usual Amateur receiver digital readout. Typical receiver i-f frequencies are relatively low: 455 kHz; and 4, 9, 10.7, and 21.4 MHz. Expansion of activity into the VHF, UHF, and microwave bands is forcing receiver designers to use much higher i-f frequencies to reduce image problems.

My solution is an inexpensive circuit combining both digital and analog circuitry, which simplifies the task of accommodating a wide range of i-f offset frequencies. While the circuit was developed specifically for the "Poor Man's Spectrum Analyzer", it can be used for any other type of receiver. A simple potentiometer adjustment is all that is needed to accommodate any i-f frequency from zero to hundreds of MHz.

previous approaches to the problem

Most frequency readout circuits use the local oscillator signal to generate the display. Because this signal is offset from the incoming rf signal by an amount equal to the i-f frequency, some arithmetic must be performed to either add or subtract the i-f from the LO signal to get back to the received frequency. The biggest problem with other "universal" frequency displays has been the circuitry required to offset the display of the receiver's local oscillator frequency by the i-f frequency. Heterodyne oscillators or presetting counters had to be used to add or subtract the i-f, or games had to be played with the timebase to accomplish the same result. None of these methods provided a very satisfactory solution.

the numbers involved

The varactor tuner used in the spectrum analyzer is a cable tuner modified to tune from 0 to 500 MHz as the tuning voltage is varied from 0 to 24 volts. The incoming signal is upconverted to 610 MHz in the tuner by mixing it with a voltage-controlled oscillator (VCO), which is varied from 610 MHz to 1110 MHz. This VCO signal is also fed to a prescaler in the tuner which divides it by 256. The output of the prescaler is a signal that swings from 2.38 MHz (610 divided by 256) to 4.34 MHz (1110 divided by 256) as the tuner tunes from 0 to 500 MHz. This signal is brought out to a terminal on the side of the tuner and is the signal that I had to work with to create my direct digital frequency display.

To analyze how the circuit works, I stopped the sweep, picked a single input frequency, and followed it through to the display (see **fig. 1**). I tuned to 100 MHz. Because the tuner upconverts to 610 MHz, the VCO must operate at 610 MHz above or below 100 MHz. In this tuner it operates above the incoming signal, so it is oscillating at 710 MHz. The prescaler divides this 710 MHz signal by 256, producing an output of 2.77 MHz. Now the 2.77 MHz number must be converted to display 100 on the digital readout.

Multiplying this 2.77 number by 256 reverses the action of the divide-by-256 prescaler and returns it to the local oscillator frequency. A conventional counter could then be used to display this frequency, but the

By **Murray Barlowe, WA2PZO**, P.O. Box 310, Bethpage, New York 11714

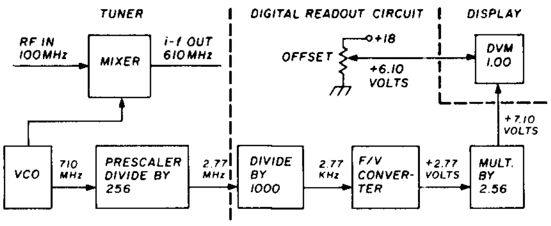


fig. 1. System block diagram.

resulting display would always be 610 MHz higher than the actual frequency. I would then have to subtract 610 from the number displayed to determine the actual center frequency or build an offset counter with dip switches to preset the i-f frequency offset. I didn't care for either of these methods. The first was too inconvenient, and the second was too expensive and limited.

I wondered how the new state-of-the-art receivers display the received frequency. A little investigation revealed that they were all synthesized and used microprocessors to provide the data for the display.

must the solution be "digital only"?

A friend, KA2TCH, mentioned that some voltage-to-frequency converter chips could also be run as frequency-to-voltage converters. Looking through the data books, I found a Precision V/F converter chip (LM-331) that would also work as an F/V converter. However, the data sheet disclosed that 10 kHz was the highest input frequency it could accept. I figured I could do something about that. Breadboarding the circuit proved that it really worked as advertised. A plot of the input frequency versus the output voltage illustrated its excellent linearity. The result was a simple, precise one-chip frequency-to-voltage converter.

Since the output of the prescaler as it is tuned from 0 to 500 MHz is approximately 2 to 4 MHz, dividing it by 1,000 brings it down to 2 to 4 kHz. This fits well into the input frequency range of the F/V converter. I chose to use a pair of dual decade divider chips (74LS390) to perform this function. Each chip contains two divide-by-2 and two divide-by-5 circuits. Cascading all the circuits in each chip provides a divide-by-100 result. As division by 1,000 was required, the first chip was connected to divide by 100, and only half of the second chip was used to divide by 10. These two chips were added in front of the F/V converter, and sure enough, the 2 to 4 MHz input from the prescaler produced 2 to 4 volts dc out of the F/V converter.

more breakthroughs

At this point, I could use a digital voltmeter as a digital frequency display. This saves the cost and inconvenience of building a LED or LCD decoder, driver, and display circuit. It also has the added advantage of eliminating a serious source of RFI generated by more TTL and multiplexing circuitry that could be picked up by the spectrum analyzer.

recap

The four steps taken so far in the F/V conversion scheme are:

- The incoming 100-MHz signal is upconverted to 610 MHz. This means that the VCO is operating at 710 MHz (rf + i-f = OSC).
- The prescaler divides this 710-MHz signal by 256, producing a 2.77-MHz signal.
- The two counter chips divide this 2.77-MHz signal by 1,000, providing a 2.77-kHz signal for the F/V converter chip.
- The F/V converter chip converts the 2.77-kHz signal to 2.77 volts.

the second half of the process

So far the incoming 100-MHz signal has been converted to 2.77 volts. Now it's time to reverse the process, return to 100 MHz, and display the result.

First, interpret the 2.77-volt reading displayed on the meter as 2.77 MHz — a mental conversion which accomplishes two steps. I performed a voltage-to-frequency conversion (2.77 volts = 2.77 MHz) and then reversed the action of the divide-by-1,000 part of the circuit by accepting the concept that the number 2.77 was in MHz, rather than in kHz (2.77 kHz × 1,000 = 2.77 MHz). This reversed the action of the third and fourth steps in the previous F/V conversion process, bringing us to the second step — the divide-by-256 prescaler.

Now 2.77 volts (representing 2.77 MHz) must be multiplied by a number which will result in 710, the frequency of the VCO in MHz. Since the prescaler divided 710 by 256 to get 2.77, multiplying 2.77 by 256 comes back to 710. This presents a bit of a problem. We are dealing with dc voltages and so 710 volts requires high-voltage power supplies and other high-voltage components. Another mental conversion is needed so that a voltmeter display of 7.10 volts represents 710 MHz. Now the process can be continued with practical voltage levels. Multiply 2.77 volts by 2.56 to get 7.10 volts. A simple direct coupled op-amp with a gain of 2.56 does the job. All that remains is to subtract 610 from 710 to get the original 100-MHz rf input signal.

Since the level of the numbers has been scaled down by a factor of 100, subtract 6.10 volts from 7.10 volts to get 1.00 volt to represent 100 MHz. This 610 represents the i-f offset frequency, which has always been a major problem when designing a universal direct digital frequency display. The solution to this last problem is one some of us old-timers, who played with analog computers long before the advent of their digital counterparts, will like. To have a voltmeter read 1.00 volt when the positive terminal is connected to 7.10 volts requires only that the negative terminal of the meter be connected to + 6.10 volts. The difference of 1.00 volt now appears across the meter terminals.

Returning the negative terminal of the meter to the center arm of a potentiometer connected across the supply and labeling the control "offset" creates a universal direct digital frequency display (see schematic). A simple adjustment of a potentiometer allows offsetting (subtracting) of any i-f frequency and display of the rf frequency tuned by the receiver. Who said analog computers were obsolete?

display options

I designed this circuit (shown in **fig. 2**) so that it could use your digital voltmeter as the frequency display. With the meter set on the 20-volt dc scale, 0 to 500 MHz would be displayed as 0.00 to 5.00 volts. I found the decimal point annoying at first, but was soon able to ignore it. Later, I bought a $29 digital voltmeter (DVM), disabled the decimal point, and used it in my spectrum analyzer application. Now the display reads out directly in MHz. Miniature DVMs that are ideal for this application are available from Acculex. They measure 1 x 2 x 0.5 inches and mount easily into a rectangular cutout.

For those who would rather use a regular digital frequency counter instead of a digital voltmeter to display the result, a second F/V chip connected as a voltage-to-frequency converter would do the trick. The voltage that was intended for the DVM would now be converted to a frequency that could be read by the counter. However, the 1.00 volt displayed on the DVM and read as 100 MHz would now produce 1.00 kHz on the counter — which would also have to be interpreted as 100 MHz.

displaying the center frequency while scanning

The tuner used in the spectrum analyzer is voltage tuned so that it can be swept across a wide range of frequencies with a sawtooth voltage waveform. This action makes the tuner function as a voltage-tuned filter, which is a key element of a spectrum analyzer. As the tuner sweeps across the band, all signals received are amplified and rectified, and the resulting voltage is applied to the vertical input of a scope. The horizontal sweep of the scope is synchronized with the sawtooth used to cause the tuner to scan, so that the scope display shows a series of vertical "pips", each one representing a received signal. The vertical amplitude of the pip is proportional to the strength of the signal, while its location on the horizontal axis represents its frequency.

To simplify the analysis of how the circuit works, I put aside the fact that the local oscillator in the spectrum analyzer was being swept above and below the center frequency by the 20-Hz sawtooth. (This is not a problem for those who would use this circuit in a more conventional receiver.)

The VCO in the spectrum analyzer is constantly changing frequency. It is being swept several MHz above and below the center frequency, approximately 20 times per second, by the sawtooth scanning voltage. The center frequency of the band of frequencies being scanned must be displayed.

One approach used by commercial spectrum analyzers is to use a comparator to sense when the sawtooth is halfway through its scan, open a gate for a millisecond or so, and sample and display the VCO frequency. Then, a counter that has been preset to add or subtract the i-f frequency (depending on whether the VCO is operating above or below the incoming signal) is used to count and display the center frequency. This would require a complete offset digital counter, along with a stable timebase, plus the necessary gating circuits.

My original plan was to add a circuit that would dectect the center of the sawtooth sweep waveform, as in commercial analyzers, and use a sample and hold circuit to save the value of the dc produced by the F/V converter. However, after completing the circuit and using the tuner without the sweep, I realized that this additional circuitry might be unnecessary. The frequency-to-voltage converter uses an RC time constant across which it develops the dc output voltage. I reasoned that if the sawtooth sweep were symmetrical about the center frequency, it would produce a 20-Hz ac component riding on the dc component that represented the center frequency. The average dc voltage would not be changed. In addition, the time constant (1 μF × 100k) might be large enough to absorb this small ac component. Applying the sawtooth sweep to the tuner proved that my reasoning was correct. The display remains constant unless the sweep width is increased to hundreds of MHz, when it might become unsymmetrical.

constructing the circuit

To simplify construction, the art work for the double-sided pc board is shown in **figs. 3** and **4**. I found it necessary to use a double-sided board with maximum groundplane on both sides to eliminate RFI generated by the two digital chips. Construction is straightforward. All the components are mounted on one side of the board.

A number of test points have been provided for test-

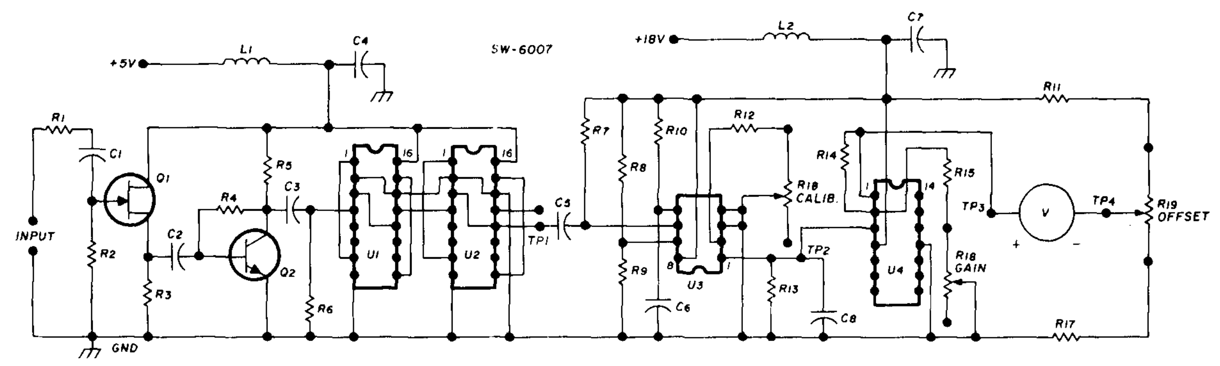


fig. 2. Center frequency digital display.

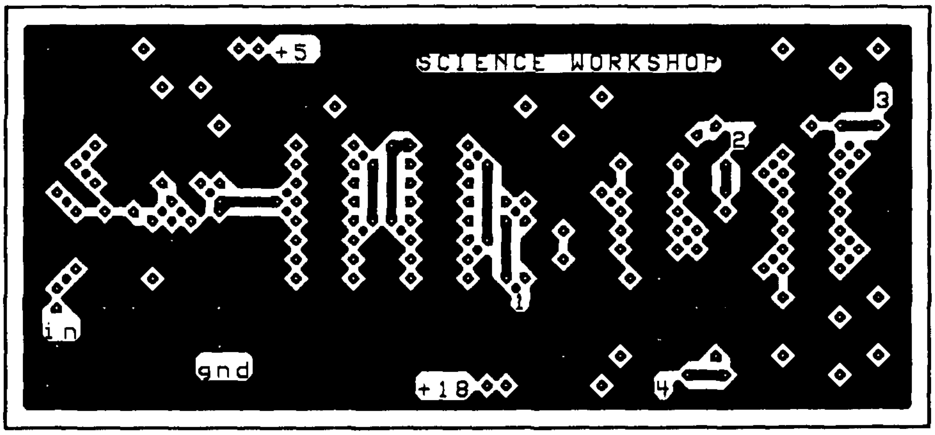


fig. 3. Component side of double-sided pc board.

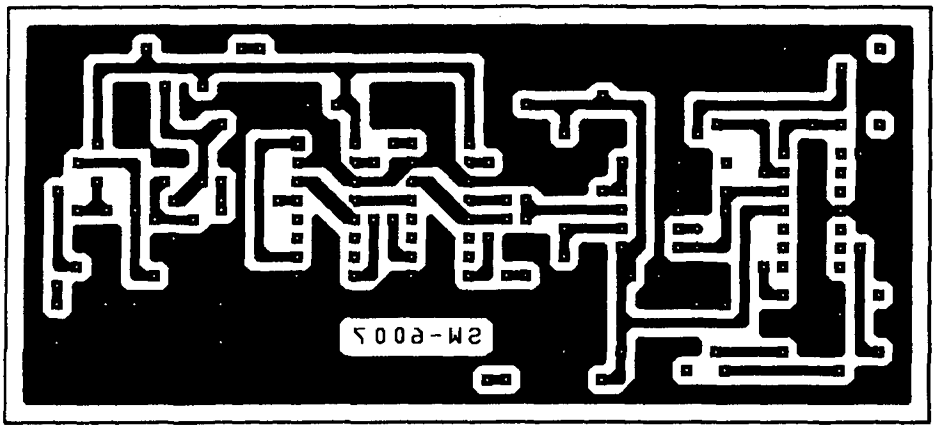


fig. 4. Top side of double-sided pc board.

ing and calibration. The following assembly procedure is recommended:

- Install eight jumpers as indicated in **fig. 5**. The jumpers labeled 1, 2, 3, and 4 will be used as test points for calibration and should be formed as "loops" (see **fig. 5**). Install two inductors, 16 resistors, and three

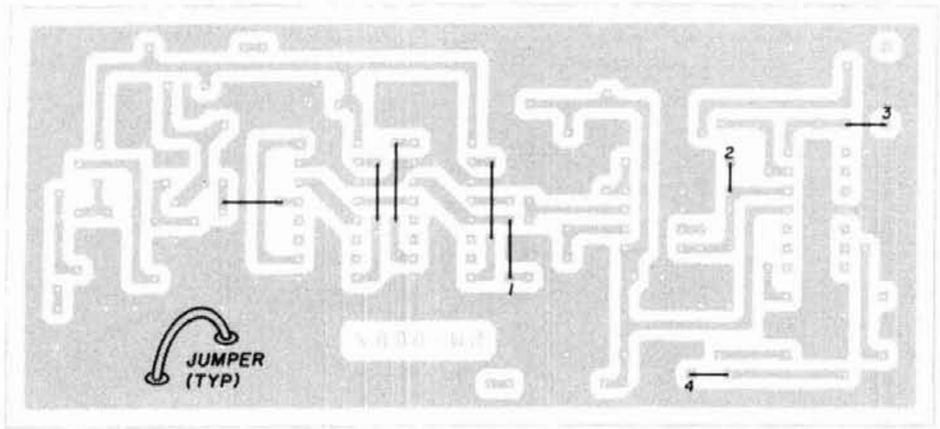


fig. 5. Jumpers numbered 1 through 4 should be formed into "loops" for test points. Numbers 3 and 4 are also used as "output" terminals. See jumper closeup in lower left hand corner.

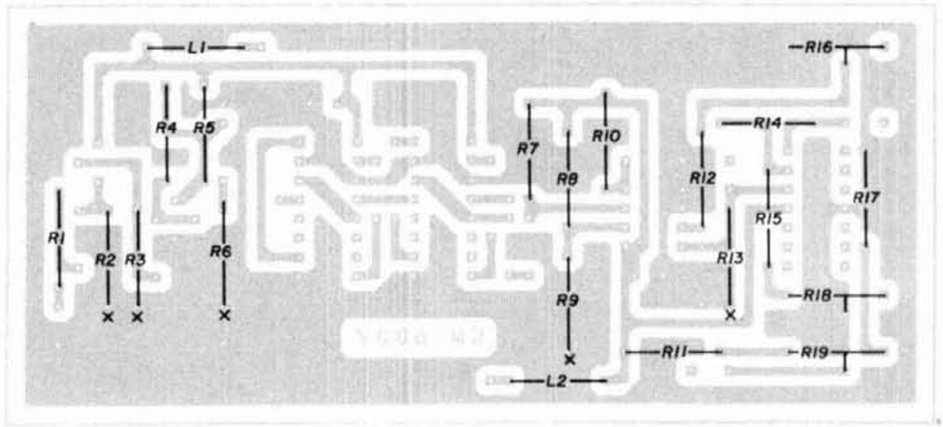


fig. 6. Inductors, resistors and trimpots.

trimpots as indicated in **fig. 6**. Solder the grounded ends of the five resistors marked "x" on both sides of the pc board.

- Install two transistors and eight capacitors as indicated in **fig. 7**. For ease of installation, use sockets for the four chips. Insert them in the locations indicated. (Note the location of the number 1 pin.)
- Check your work carefully for excess solder, splashes, shorts, or "cold" solder joints. This completes the assembly of the frequency readout board.

test and calibration procedure

The accuracy of the display is directly related to the stability of the supply voltage. Final calibration should not be performed until the power supply has warmed up and is stable. Since the circuits work with small dc voltages, paying careful attention to setup measurements will assure accurate results. Proceed as follows:

- Connect a digital voltmeter between test point 3 and ground.
- Connect regulated +18 volts between the +18 volt terminal and ground. Neither the +5 volt supply nor the input signal needs to be connected at this time.
- Apply +2.77 volts between test point 2 and ground.
- Adjust the gain trimpot (R18) for 7.10 volts at test point 3.
- Shift the digital voltmeter negative test lead from ground to test point 4. Leave the positive test lead at test point 3.
- Adjust the offset trimpot (R19) for 1.00 volt on the DVM.
- Now connect the output of the prescaler of the tuner to the input of the digital readout board. Also con-

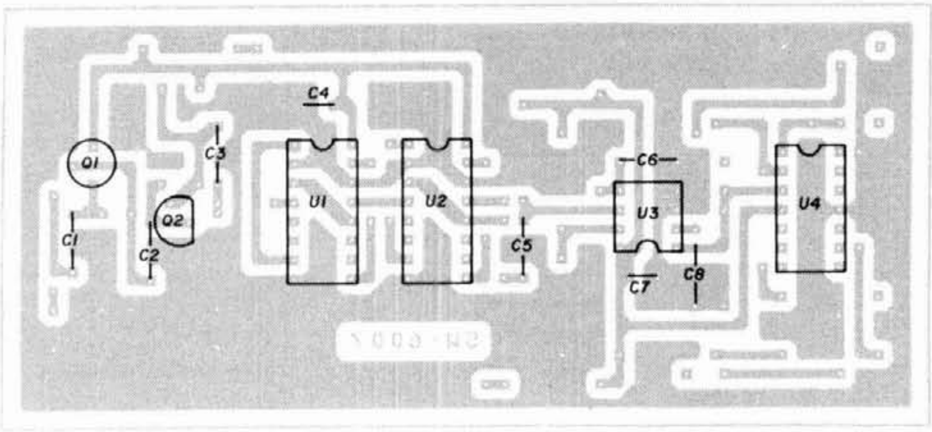


fig. 7. Transistors, capacitors and chips.

Parts list

Capacitors	
C1	.02 µF
C2	.02 µF
C3	.02 µF
C4	.1 µF
C5	470 pF
C6	.01 µF
C7	.1 µF
C8	1.0 µF
Inductors	
L1	1 mH rf choke
L2	1 mH rf choke
Resistors	
R1	2.2k
R2	1 megohm
R3	750 ohm
R4	68k
R5	470 ohm
R6	1k
R7	10k
R8	10k
R9	68k
R10	6.8k
R11	33k
R12	13k
R13	100k
R14	68k
R14	100k
R15	39k
R16	5k*
R17	20k
R18	10k*
R19	5k*
* = trimpots	
Transistors	
Q1	S31801
Q2	5972

nect the +5 volt regulated supply between the +5 volt terminal and ground.

• If a signal generator is available, set it to 100 MHz and tune the spectrum analyzer so that the 100-MHz signal is centered on the CRT. Use a relatively small scan width setting on the analyzer. (If a signal generator is not available, any known signal can be used.)

• Adjust the calibration trimpot (R16) for 1.00 volt (representing 100 MHz) on the DVM. This completes the calibration process.

troubleshooting

Your scope and DVM are all you need to find a problem if the calibration procedure can't be performed. The first part of the calibration procedure uses the circuits of the op-amp, U4. Any problem here would be limited to this chip and its components.

The second part of the procedure depends upon the correct operation of the remainder of the circuit. It can be broken down into three parts — the preamp, the dividers, and the F/V converter. Use your scope to check the operation of the preamp (Q1 and Q2) and the dividers (U1 and U2). Trace the 2.38 to 4.34-MHz signal from the tuner presecaler output to the board and through the preamp. Remember, +5 volts must be supplied to the prescaler +5 terminal on the tuner. The jumper between the output of the preamp and pin 4 of U1 is a convenient place to check for the preamp output. It should be approximately 3 volts peak to peak. No signal would indicate a problem in the preamp.

Next check test point 1. You should find a squarewave of almost 5 volts peak to peak. No signal would indicate a problem in the divider circuits.

Finally, your DVM connected to test point 2 should show a dc voltage that will vary from 2.38 volts to 4.34 volts, depending on the frequency tuned by the varactor tuner.

The divider circuits on this board may generate spurious signals that can get into the tuner and show up on the CRT display. Check this by disconnecting the input signal to the board. Using a double-sided board with maximum groundplane area, in conjunction with L1 and L2, should prevent this. If it persists, check the grounding between the groundplanes of the pc board and the chassis. It may be necessary to add additional capacitive filtering to the +5 and +18 volt leads at the board terminals. This means both high-frequency (feedthrough) capacitors and electrolytic

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

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
I LIKE IT																
OK																
SORRY, NO.																

MAGAZINE OVERALL GOOD____ OK____ NOT SO GOOD____

NAME ____________________

ADDRESS ____________________

CITY____________________ STATE__________ ZIP__________

Please run more: ____________________

Please run less: ____________________

☐ *One year* *12 issues* *$22.95*
☐ *Two years* *24 issues* *$38.95*
☐ *Three years* *36 issues* *$49.95*

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

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 OCTOBER 31, 1988

SEPTEMBER 1988

AFFIX POSTAGE
OR
POST OFFICE
WILL NOT
DELIVER

ham radio magazine

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 magazine

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

ATTN: Reader Service Dept.

capacitors; otherwise, the power supply leads may radiate.

other applications

This direct frequency readout circuit can be used with any i-f. All you need to do is feed the local oscillator signal into the input of the board, making sure that the output frequency of the dividers falls within the range (approximately 0.5-10 kHz) of the F/V converter, and performing the calibration procedure. Adding a divide-by-256 prescaler (as in the cable tuner) ahead of the pre-amp input on the board allows use of local oscillator inputs over 1 GHz.

Changing some of the jumpers (note the extra hole above the jumper at test point 1) provides extra flexibility. You can choose the output of the dividers so that the input is divided by any combination of the four divide-by-2 and divide-by-5 stages. The input and output of the individual divider stages can be brought out to a front panel switch to provide a wide range of frequencies that can be measured by this circuit. I'd be interested in hearing any ideas you might have for using this circuit.

A complete kit of parts is available from the author.

Article M **ham radio**

7/8-inch hardline coax connectors

construct your own at low cost

Increased Amateur use of the VHF and UHF bands has generated more interest in "hardline" coaxial cables because of their inherent low loss. Other articles have addressed one of the prime pitfalls of hardline use for Amateurs — coaxial connectors. Most discussions deal with connectors for CATV cable and develop methods for adapting UHF style connectors to this cable.[1-4] I'll deal with the modification of a commercially available "N" style connector for use on 7/8-inch, 50-ohm hardline.

7/8-inch hardline cable

Commercial 50-ohm hardline of the Heliax™ variety is quite expensive; if you can afford that, the cost of connectors is probably not a major concern. But, 7/8-inch Prodelin cable is available through a surplus dealer* for a fraction of the cost. The cable comes in any length up to 7500 feet and is made to rigid government tolerances with a thick, noncontaminating vinyl jacket that allows direct burial. (**Tables 1** and **2** list the hardline characteristics.) Though Prodelin™ cable is much cheaper than Heliax, commercial connectors can run $75 apiece. Because I wanted to use this high-grade 7/8-inch cable without the prohibitive expense of the mating connectors, I began to evaluate other alternatives.

connector "specs"

Requirements for any good connector include:

- minimal discontinuity in line impedance,
- no electrolytic action between dissimilar metals, and
- resistance to moisture penetration.[1]

An "N" style connector maintains excellent impedance matching and power handling properties at frequencies exceeding 450 MHz. UG-982 or UG-982/A connectors fit the requirements perfectly by providing a high-quality male "N" connector with a moisture resistant body that is easily adapted to 7/8-inch Prodelin-style hardline using simple tools. These connectors are common at hamfests and are also available from a number of sources.** Prices vary between $2 and $12 *depending on source and condition.*

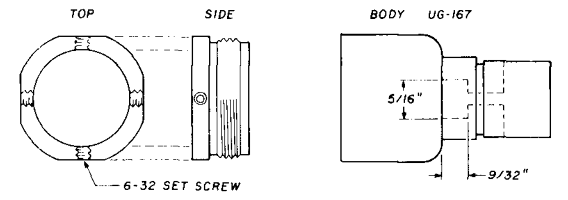


fig. 1. Construction drawing of the connector body.

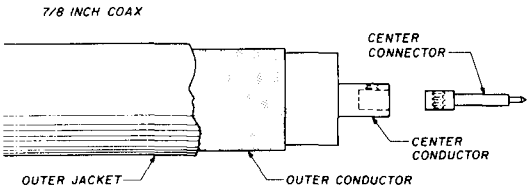


fig. 2. Drawing of the hardline indicating the modification of the center conductor to mate the center pin of the connector.

materials and tools

Table 3 lists the common tools (found at any hard-

* A.G.W. Enterprises, Inc., RD -10, Route 206, Vincentown, New Jersey, 08088.

**The R.F. Connection (Joel G. Knoblock, Proprietor), Suite 11, 213 North Frederick Avenue, Gaithersburg, Maryland 20877 and Nemal, 12240 NE 95 14th Avenue, N. Miami, Florida 33161.

By John M. Mathis, M.D., WA5FAC, 6270 Mt. Chestnut Road, Roanoke, Virginia 24018

Table 1. Physical and electrical properites of the Prodelin hardline

- 50-ohm impedance
- 7/8-inch aluminum corrugated shield
- Copper-clad aluminum solid center conductor
- Foam dielectric
- Black heavy-duty, noncontaminating outer jacket
- Can be directly buried

Table 2. Attentuation in dB/100 feet

Frequency (MHz)	RG8A/U-RG214/U	7/8-inch Hardline
3.5	0.30	0.10
7.0	0.45	0.14
14	0.66	0.19
21	0.83	0.23
50	1.35	0.37
144	2.5	0.70
220	3.3	0.90
450	4.8	1.3

Table 3. Materials

- Electric drill
- Rotary rasp (to be used with drill)
- Hacksaw
- Needle-nose pliers
- Pocket knife
- Soldering iron
- File
- 6-32-inch tap and no. 36 drill
- 7-32 and 9-32-inch drills
- Five 6-32 x 1/4-inch set screws
- *Dremel tool and rotary saw blade (optional)*

ware store) which were used to modify the connector and prepare the cable ends.

Refer to the construction drawings (**figs. 1** and **2**) during the fabrication procedure described below:

1. Cut through the black vinyl with a sharp knife. (I recommend wearing leather gloves.) Stabilize the cable with a clamp or vise. Grab the free end of the vinyl with a pair of needle-nose pliers and peel it off the aluminum outer conductor. Warming the vinyl makes this process easier. Remove about 1-1/2 inches of the black vinyl.
2. With a small hacksaw (or Dremel tool with rotary saw blade), cut through the corrugated aluminum shield 7/8 inch from the end. Try not to cut deeply into the foam dielectric. Now cut diagonally across the 7/8-inch section of shield. Peel the aluminum shield off the dielectric with a pair of needle-nose pliers (like opening a sardine can).
3. Using a pocket knife, remove the end 7/16-inch of foam dielectric from the center conductor.

fig. 3. Partially and fully assembled connectors are pictured on 7/8" hardline coax.

4. With the 7/32-inch drill, center then make a hole 11/32 inch deep in the center conductor. Using a 9/32-inch drill, enlarge the proximal 1/16 inch of this hole leaving only the copper outer jacket of the center conductor.
5. Prepare the center pin by tapping the hole already present in the side collar to accept a 6-32 x 1/4-inch tap screw. Insert the tap screw until it contacts the opposite inner wall of the pin. With the soldering iron, fill the remaining hollow portion of the pin with solder. This stabilizes the otherwise thin wall of the pin and provides a pretapped hole for the set screw. Remove the set screw for now.
6. Hold the center pin alongside the center conductor and mark the location of the tapped hole. (Location may vary slightly with different manufacturers' pins.) Drill and tap this hole for a 6-32 inch also. Now insert the center pin into the center conductor. Align the set screw holes, insert the 6-32 x 1/4-inch set screw, and tighten. Fold the 1/16 inch of outer copper jacket over the pin body and solder the two together. (This will take at least a 150-watt iron.) If you botch the job, just cut the center conductor off and start again with step no. 2.
7. Locate the back collar of the UG-982; next we will

a flat edge every 90 degrees. Drill and tap each of these flattened edges for a 6-32-inch set screw.

8. Place the collar in a vise (the jaws of the vise should contact only the flattened edges, not the threaded portion). Don't overtighten the vise. With the rotary rasp, widen the inner diameter of the collar so that it fits snugly over the corrugated aluminum shield. Go slowly and check your progress often.
9. The connector is now ready for final assembly. Place the collar (with four 6-32 x 1/4-inch set screws) and moisture-proof "O" ring assembly over the cable. Slide on the main connector body and engage the threads between the connector collar and body. First tighten

the collar and body of the connector together; then secure the four set screws to the aluminum outer jacket. (**Figure 3** shows both partially and fully assembled hardline connectors.)

10. Waterproof the connector body and adjacent cable with 1-inch heat shrink. Silicone rubber* along the edges of the heat shrink finishes the job.

In my installation, I have 500 feet of 7/8-inch hardline between my shack and the top of my tower. Multiple measurements have revealed that the hardline, with adapted connectors, meets hardline specifications (**table 2**) with no measurable loss due to the connectors.

*GERTV 162-302 tubes are available from the **HAM RADIO** Bookstore for $9.95, plus $3.50 shipping and handling.

references

1. John H. Ferguson, W1IIM, "Connectors for CATV Coax Cable," *ham radio*, October 1979, pages 52-55.
2. Bud Weisburg, K2YOF, "Homebrew Hardline-to-UHF Coaxial Cable Connectors," *ham radio*, April 1980, pages 32-33.
3. James R. Yost, N4LI, "Plumber's Delight Coax Connector," *ham radio*, May 1981, pages 50-51.
4. Doug DeMaw, W1FB, "Connectors for CATV Hardline and Heliax," *QST*, September 1980, page 43.

Article N **ham radio**

CONSTRUCTION TECHNIQUES USING PVC PIPE
TO MAKE ANTENNAS

By Van R. Field, W2OQI, 17 Inwood Road, Center Moriches, New York 11934

Support plus protection from the elements

PVC (polyvinyl chloride) pipe is a plumbing and electrical material that can be used to support, enclose, and seal antennas from the weather. Acid rain can cause antenna damage particularly in salt water areas. If you doubt you have a problem, hunt up an old corroded 2-meter beam, file a bright spot on each end of a director and apply your ohmmeter across the element. Try each element. I bet you'll find some open circuits.

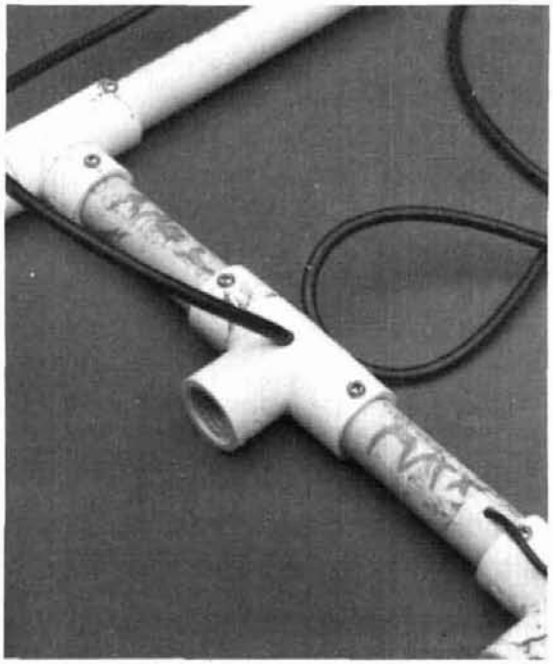
PVC pipe and its associated fittings make for easy construction of antennas with the added advantage of providing protection from the atmosphere. A plumbing supply house stocks many kinds. CPVC is the size and equivalent of copper tubing but is hard to find and will *not* fit regular pipe equivalent PVC.

In addition to the regular gluable PVC there is a gray threadable PVC. This is more expensive and not as handy. The glue-together white PVC is the best choice.

The pipe comes in different thicknesses. Schedule 40 is heavy duty, cold resistant, and the most common. In the South, thin wall schedule 20 is used — it's quite a bit lighter — a big advantage for antenna elements.

There is a full complement of plastic pipe fittings available for antenna construction: tees, elbows, caps, four-way junctions, to name a few. Larger diameter pipe can be used for hf verticals or masts. Short pieces make good insulators, feeder spreaders, and loading coil forms. PVC pipe can be cut with a hacksaw, a tubing cutter, or a special tool sold in plumbing supply houses.

You can use almost any type of copper wire inside the plastic pipe. I find no. 14 or no. 16 "enameled" solid wire the easiest to use. Put the end of a length in a vise, grab the other end with a heavy pair of pliers, and pull until the wire stretches or gives. This straightens the wire and allows it to be cut to size and worked easily. A good grade of twin lead works well, and is easier to keep in place inside the pipe.

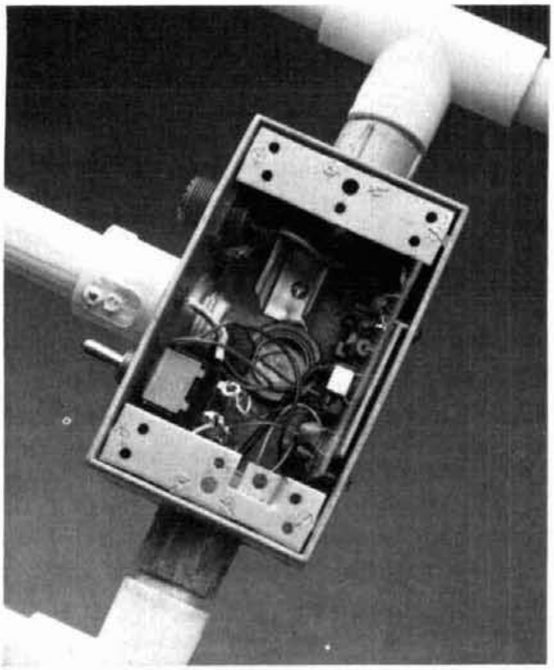


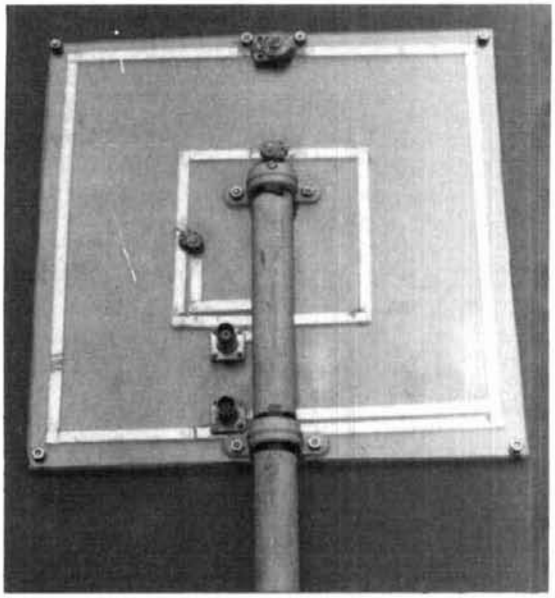
Styrofoam peanuts stuffed in the pipe and anchored with silicone rubber (RTV) will hold the wire in place. Thin string or lacing cord can be tied to the wire and held by the plastic pipe caps on the ends.

If you want to take it apart again, fasten the PVC pipe together with sheet metal screws. For a permanent job use the cement made for this purpose.

A mop handle will support your VHF antenna better than PVC because pipe is too flexible to hold a system of two or more elements. For portability, fit the end of the wooden support with an adapter (designated slip to male pipe thread). Then fit the center of your antenna with a tee-combination (slip x slip x female pipe thread); this will give you a threaded end on your support mast.

If you wish to install some electronics at the antenna, like a preamp or a doppler DF circuit, use a





waterproof outlet box with five threaded 1/2-inch holes. Purchase a box at an electrical supply outlet; a Mulberry no. 30221 or equivalent is needed. This cast aluminum box with its waterproof cover can be used at the center of the array to house the electronics and perform the job of a tee section. Electrical and plumbing supply houses carry threaded to slip joint transitions. The electrical (gray) ones thread into boxes easily.

PVC pipe has a velocity factor of 0.95. This has little effect on antenna length, but shortens a tuned stub an additional five percent when slipped into the PVC pipe. I tuned a twin lead J antenna for 157 MHz for a spare marine radio antenna. I inserted it into some schedule 40 PVC, rechecked, and found I had a 149-MHz antenna!

W6SAI demonstrated the use of PVC pipe for a collinear 2- meter antenna and a 160-meter vertical in his May 1987 column. Yagis for 432 MHz and above can be made of brazing rods stuck through a PVC boom.

I use a signal generator with a sensitive VSWR indicator to "VFO" around to find out where the VSWR dips. A frequency counter is tee-ed on the line to check the frequency accurately. An HT with extended frequency coverage may be used on low power for a signal generator.

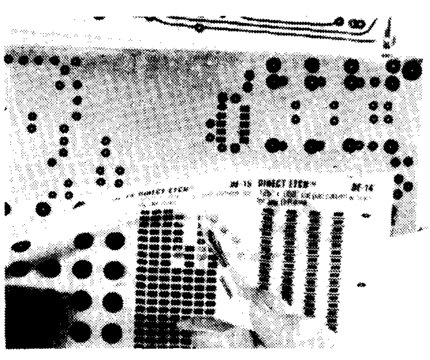
This inexpensive, easy-to-use material gives the experimenter a good way to try out a new antenna.

Article O **ham radio**

NEW products

high quality printed circuit board

DIRECT ETCH™ is a new system for making high quality printed circuit boards without formal artwork. You can try different circuit layouts without changing the master art and refabricating. The system is useful for optimizing rf and microwave designs where wavelengths approach physical circuit dimensions, and in high impedance circuits. It's also easy to make a "quick and dirty" prototype where a printed circuit is not economical.



The DE-973 DIRECT ETCH™ set has 69 different sheets of plastic etch-resist patterns that transfer directly onto a copper-clad circuit board. The DE-973 costs $34.95; two sheet refill sets are $2.00.

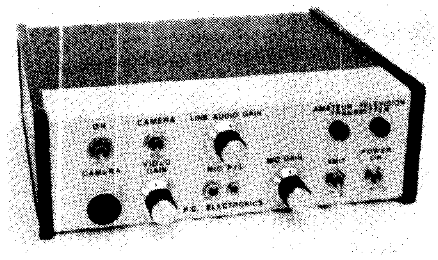
For details contact The DATAK Corporation, 3117 Paterson Plank Road, North Bergen, New Jersey 07047.

Circle #302 on Reader Service Card.

TX23 ATV transmitter

P.C. Electronics has introduced their model TX23 1-watt 23-cm (1240-1300 MHz) ATV transmitter. The small transmitter (7x7x2.5") lets Novice class or higher Amateurs transmit live action color or black and white composite video and audio from cameras, VCRs, or computers to other hams. The TX23-1 is a companion to the TVC-12G receiving downconverter.

The TX23-1 contains a 1-watt PEP (sync tip) transmitter, video modulator, and broadcast standard 4.5-MHz sound subcarrier. The unit comes with 1 crystal on the simplex frequency of 1289.25 MHz, or the customer can order one of the other ATV channels in the ARRL bandplan. A switch selects video and audio input from either the 10-pin VHS-type home color cameras on the front panel, or phono jacks for other cameras, VCRs, computers, and any composite video and line level audio source on the back. A mic jack and "push to look" (same as push to talk, but this is video) jack are available for low-impedance dynamic microphones and transmit/receive switching. The mic and line mixed audio levels have 2 independent volume controls, handy for voice over descriptions of home video tapes. The external power requirement is 12 to 14 Vdc at 600 mA, plus the 12-volt camera. The



antenna connector is a type N; a BNC outputs to the receiving downconverter from the built-in RF T/R relay.

The TX23-1's shielded cabinet will fit in a knapsack for portable work. The theoretical snow-free line-of-sight DX distance using the 1-watt TX23-1, TVC-23G downconverter, and 23 element Tonna beams, is 5 miles. The output power and sync-stretcher in the system's video modulator matches the 20-watt Downeast Microwave amplifier's linear input vs. output range.

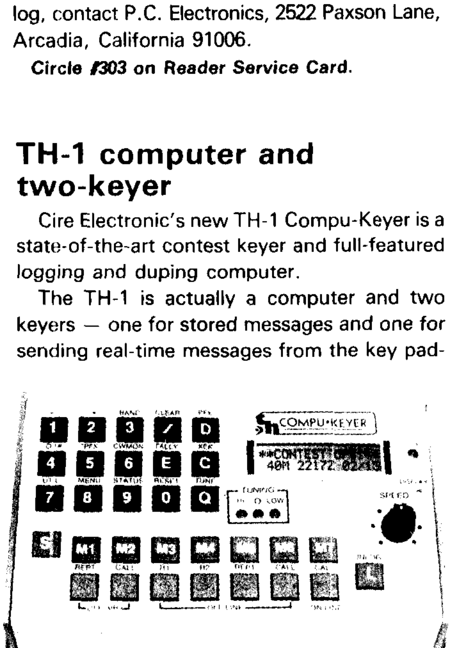
The TX23-1 transmitter is $299 delivered UPS surface in the contiguous United States. Another version of the transmitter, RTX-23, is available in a diecast aluminum box for use in repeater or link systems. For more information and a catalog, contact P.C. Electronics, 2522 Paxson Lane, Arcadia, California 91006.

Circle #303 on Reader Service Card.

TH-1 computer and two-keyer

Cire Electronic's new TH-1 Compu-Keyer is a state-of-the-art contest keyer and full-featured logging and duping computer.

The TH-1 is actually a computer and two keyers — one for stored messages and one for sending real-time messages from the key paddle. Each keyer is independent of each other and both can run simultaneously. This design feature allows you to send a pre-programmed report while entering the station's call and received report into the computer.



The computer uses a large array of static CMOS RAM and its memory is backed up by lithium batteries for fail-safe storage of preprogrammed messages and contest logs. A fully expanded memory allows for over 8,000 contacts per contest.

There is a RS-232 port that can be connected to either a terminal or printer to print the log. At the end of a contest, plug in your printer and enter a set of printer commands from the TH-1 keyboard for a finished, formatted, and dupe-checked printout of the log. For additional safety during a contest, a printer can be connected to the TH-1 to print all entries as they are logged.

The TH-1 can accomodate up to 8 operators, each with a bank of 7 messages and a pre-set offline-keyer speed control. Also included are a non-volitile clock and calendar, full RFI shielding, cartridge port for further expansion, large LCD display, and provision for external keyboard connection. A digital voice recorder for phone contests is in the prototyping stages.

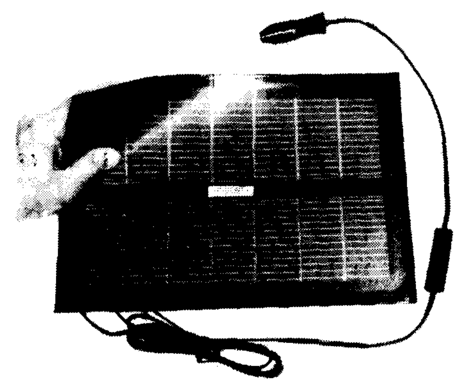
For more information, contact CIRE Electronics, 521 Leicester, Plymouth, Minnesota 48170.

Circle #304 on Reader Service Card.

let the sun do the work

Sovonics Solar Systems™, a subsidiary of Energy Conversion Devices, Incorporated, has introduced Sun Flex, Sun Pal, and Flexcharge™.

Products from the Sun Flex line can provide from 2 to 30 watts of power for everything from charging your RV or boat battery, to powering portable TVs and radios. The larger models can be used either singly or in arrays for increased power capabilities.



The Sun Pal series provides maximum power from minimum size. Any of the Sun Pal series, when folded for storage, take up the approximate space of a school notebook, but the 12 watt model provides enough power to run your radio — even on a partly cloudy day.

Sovonics also manufactures many other solar power related items.

For more information contact, Hal-Tronix, 12671 Dix-Toledo Highway, Southgate, Michigan 48195. Hal-Tronix is a registered dealer for Sovonics.

Circle #305 on Reader Service Card.

(continued from page 9)
Battery voltage and cell specific gravity were checked each day during that time and there was no significant difference between the two batteries.

As an additional testimonial, emergency power is supplied to our club repeater through a deep-discharge, marine-type lead-acid battery. The battery is maintained by a special charger. It has been sitting on bare concrete for about three years and still performs admirably when required.

It is a shame that such a good, worthwhile article was damaged by such a careless oversight. Please strive to maintain your excellent technical standards and avoid such errors in the future.

Kim Elmore, N5OP
Longmont, Colorado 80501

Dear Kim

Re: "Killer concrete strikes again." A possible explanation is that some acid had spilled over the surface of the battery and onto the floor which in essence established a conductive external path between the postive and negative terminals leading to premature battery death. I remember once measuring a quite finite resistance between any two points on the surface of a lead acid battery. Also what is the bulk resistivity of concrete? I don't believe it's infinite. Ed.

batteries on concrete

Dear HR:

Thank you for your rapid reply; it was refreshing and most appreciated! I would simply like to reiterate the point of my letter: there is nothing special about concrete as a mounting surface for a lead-acid battery. The scenarios you proposed do not, in any way, rely upon any quality inherent in concrete. The first, an acid spill, could occur on any type of surface. The acid solution, being an electrolyte, is a relatively good conductor and such circumstances could arise with any material. The second, surface conductivity along the battery case, could be caused by any (water-soluable) electrolytes on the battery surface. Acid is one, but any soluble salts will also act as conducting media in the presence of water. Many salts are hygroscopic and do not require the presence of "standing water" or a clearly wet surface; the water can be absorbed directly from the air. This is not to say that your explantions are invalid, but rather reiterate my point that concrete is not a special or requisite component in lead-acid battery discharge.

This doesn't mean is isn't a wise idea to place a lead-acid battery on something. Any acid spill can be catastrophic, depending on what it contacts. However, there is nothing inherently wrong with placing a lead-acid battery directly on a concrete surface.

By the way, at no point in my letter did I state that concrete had infinite resistivity. I stated: "Because a battery is contained within an insulating enclosure, there can be no electrical current between whatever it sits upon and the internal cells." If taken literally, that statement is false because "no electrical current" implies infinite resistivity. However, from an engineering standpoint the statement is accurate. From the arguments presented above — and in my previous letter — the resistivity of the substance the battery sits on, from an engineering standpoint, is of no consequence.

In any event I could not find, in any handy reference, a value for the bulk resistivity of concrete other than: "Completely dry concrete has a very high resistivity, but extensive tests have shown that when concrete is embedded in earth so that moisture can penetrate it, its resistivity is about the same as that of the surrounding soil and follows its seasonal variations." (R.H. Golde, Editor, "Lightning, Volume 2: Lightning Protection," Academic Press, Inc., New York, New York 1977, page 588.)

Thank you again for your response and attention in this matter. Keep up the good work; I enjoy *ham radio* very much.

Kim Elmore, N5OP
Longmont Colorado 80501

HAM RADIO BOOKSTORE FALL FLYER

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 (Available late October 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

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)

NORTH AMERICAN EDITION
Fully updated and edited to include all the latest FCC and foreigr government callsigns and addresses for Hams in North America. Includes plenty of handy operating aids such as time charts, QS bureau addresses, census information and much more. Calls from Northern Canada to tropical Panama. Now is the time to bu a new Callbook when you'll get the most use out of your investment. ©1988
☐ **CB-US89** Softbound $25.9!

INTERNATIONAL EDITION
QSL's are a very important part of our hobby. All sorts of awards, including the coveted DXCC, require confirmation of cor tact 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 c tremendous help in getting QSLs. Handy operating aids round out this super book value. ©1988
☐ **CB-F89** Softbound $28.9!

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 simple, easy-to-understand style. Topics covered include: a bas primer, home computers and data communications terminals, a survey of equipment available, how to set up a station plus muct more. Great compliment to the other packet books available. 20 pages ©1988 1st edition
☐ **22567** Softbound $12.9

THE ARRL SATELLITE ANTHOLOGY
Taken from the pages of the "Amateur Satellite News" column i 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 a unpublished article detailing UoSAT-OSCAR 11 operation. Digital modes, tracking, antennas, RUDAK, microcomputer processing c telemetry plus much more is contained in this valuable new volume. 112 pages ©1988
☐ **AR-SA** Softbound $4.9

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 $11.9

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 198! Edition ©1988
☐ **IBS-RDI89** Softbound $14.9

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 $19.9

Please enclose $3.50 shipping & handling.

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

(continued from page 6)

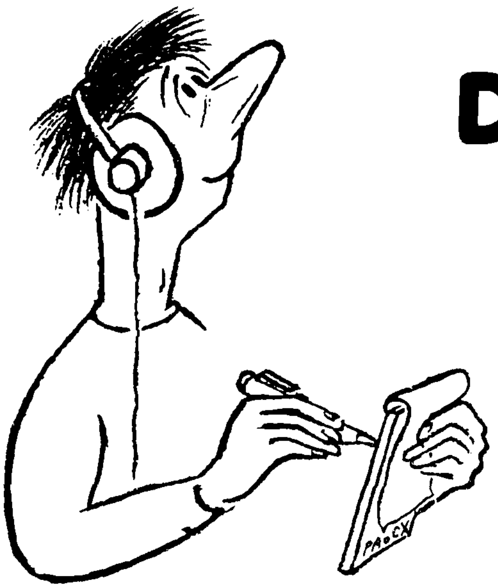
ience of putting up temporary antennas and solving emergency power and RFI problems, all adds up to very valuable training. This is true even though it was all planned weeks in advance. The military trains constantly for situations that must eventually be handled instantly.

In the twenty years I've been doing Field Day, only one group I was with was seriously concerned with winning the contest. Don't get me wrong, if that's what they want to do, that's their perogative. It's tough to get overly serious about a contest when you are at the top of Tuscarora Summit in South Central Pennsylvania with the Chambersburg Club watching the sun rise Sunday morning as you cook breakfast (I'd like to go back there again.) As for the assumption that clubs use only their best operators to run off thousands of "Qs" in an all out effort to win — my guess is that's a very small percentage of the overall participation. This year we got a number of our group on the air who just don't operate that much. These hams all had fun — and that is what Field Day is all about.

Why not use another event like the Simulated Emergency Test (or make one up) to really measure the ability for true emergency communications capabilities. Make it a 12-hour event to minimize disruption to the family and de-emphasize scoring. Leaving the rest of your proposal intact, we could truly test Amateur's ability to communicate in an emergency situation.

Leave Field Day alone. It's too much fun now as it is. I'd hate to miss one due to a show, vacation, or other previously scheduled commitment.

Craig Clark, N1ACH



DX FORECASTER

Garth Stonehocker, KØRYW

high sunspot propagation problems

The sunspot numbers in cycle 22 are now high enough to increase the probability of major flares. These flares lead to a sequence of propagation problems. Understanding the sequence and its timing helps when working DX; knowing what to expect and what action or remedy to take will help alleviate the poor signal. When a sunspot or filament (demarcation between sunspots or regions) flares, a burst of energy erupts sending electromagnetic radiation and particles out from the sun. The burst of energy in its various forms arrives at the earth's ionosphere at different times, each form causing unique propagation effects. Three main propagation effects (events) occur in a sequence as shown in **table 1.**

The sudden ionospheric disturbance, SID, is an abrupt increase in the absorption of the signal's energy in the D region. It is caused by the increased light (ultraviolet) and x-rays entering the earth's atmosphere immediately following the sun's flare. The light that reaches us 8 minutes later indicates there is a flare on the sun. This absorption resembles what you see at sunrise. It is greatest directly under the sun (subsolar point, noon standard time) and decreases in all directions. SID events don't occur on your path after sundown. The signal usually loses strength (many 10's of dB for large events) in about 5 to 15 minutes. Then there is a slow recovery period of 20 minutes to an hour or two before signal strength returns to normal. SID's signal loss and duration increase with flare size and duration.

You might find it interesting to look at the portion (longitudes) of the world affected by a SID on a world time "wheel" calculator. Set the wheel dial (time of flare from WWV at 18 minutes after the hour) to Greenwich, London, 0° longitude. Then look around the wheel dial from 06 to 18 hours on the noon side, not a.m. and p.m. These are the longitudes where the propagation path would experience SID; the greatest SID effect occurs at 12 noon. The midnight side of the wheel dial from 18 hours to 06 hours wouldn't have SID.

What should you do if you're working DX when a SID comes? You can go to the highest band propagating to the DX's location, use an alternate propagation path, or just wait it out on frequency until signals return in a half hour or so.

Polar cap absorption, PCA, also causes signal loss as the signal passes through the lower ionosphere, but only inside the auroral zone in the polar cap. Protons are the most energetic particles emitted from sunspots during a flare. They are numerous and fast enough to increase solar wind density and speed, and are the first particles to reach the earth. They can't get here directly as do x-rays and light because they can't cross perpendicular to the earth's magnetic field lines. Only those parallel to the field lines may enter the atmosphere so they enter at the poles, coming down the field lines into the ionosphere. Once there, they cover the polar cap during the daytime. A location outside the sunlit polar cap may experience some darkness during the 24-hour period so the absorption of the signal will stop until the daylight hours return. This cycle repeats over the next 1 to 3 days until the disturbance ends. The duration and the number of dBs of PCA absorption depend not only on flare size and duration, but also on its solar location to feed the solar wind and the particular proton-producing characteristic. The only propagation paths affected are those crossing the polar cap in the sunlight. (Remember the seasonal aspect of night and day above 66° north or south.) The PCA is limited in the propagation paths that are affected. The higher frequencies are limited over the pole; taking an alternate direction or waiting until darkness may be the only remedies if a PCA occurs while DXing. The most complicated of the three effects in the

TABLE 1

Three main propagation events caused by major solar flares.

Event	Cause	When/Where	Duration
SID	Ultraviolet light and x-rays	Immediate in daylight	1/2 to 2 hours
PCA	Proton particles	Polar daylight in 1 to 10 hours	1 to 3 days (daylight)
Fade-out	Electron particles	Auroral zone south in 1 to 3 days (mainly nighttime)	1 to 3 days

SEPTEMBER

WESTERN USA

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

MID USA

MDT	5:00	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	7:00	6:00	5:00	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	7:00	6:00	
ASIA FAR EAST	20	_40_	_40_	_40_	_30_	30	30	30	30	20	20	20*	20	20	_40_	_40_	_30_	30	30	30	20	30	20	20	N
EUROPE	30	30	20	20	20	20	15	15	15	15	15	20	30	_40_	_40_	_40_	30	30	_40_	_40_	_40_	_40_	30	30	NE
S. AFRICA	15	15	12	12	12	10	10	10	10	10	12	12	15	20	_20_	_20_	_20_	20	_20_	_20_	_20_	20	20	20	E
S. AMERICA	10	10	10	10	10	10	12*	12	15	15	20	_20_	_20_	_20_	_20_	_20_	_20_	20	20	20	15	15	12	12	SE
ANTARCTICA	12	12	12	12	12	12	15	15	15	20	_30_	_30_	_30_	_30_	_30_	_30_	30	20	20	20	15	15	12	12	S
NEW ZEALAND	10	10	12*	12	12	15	15	20	_20_	_20_	_20_	_20_	_20_	20	20	15	15	15	12	12	12	10	10	10	SW
OCEANIA AUSTRALIA	10	12	12	15	15	_20_	_20_	_20_	20	20	_20_	_20_	_20_	20	20	15	15	15	12	12	12	10	10	10	W
JAPAN	15	15	15	20	20	30	_30_	_30_	_30_	30	30	30	_40_	_40_	_30_	_30_	30	30	30	20	20	20	15	15	NW
CDT	6:00	5:00	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	7:00	6:00	5:00	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	7:00	

EASTERN USA

EDT	7:00	6:00	5:00	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	7:00	6:00	5:00	4:00	3:00	2:00	1:00	12:00	11:00	10:00	9:00	8:00	
ASIA FAR EAST	20	_40_	_40_	_30_	_30_	30	30	30	30	20	20	15	20	20	20	_40_	_40_	_40_	_30_	30	30	30	30	20	N
EUROPE	30	30	20	20	20	20	15	15	15	15	15	15	20	20	20	30	_40_	_40_	_40_	_40_	_40_	_40_	40	30	NE
S. AFRICA	15	15	12	12	12	10	10	10	10	10	10	12	12	15	20	_20_	_20_	_20_	_20_	_20_	_20_	20	20	20	E
CARIBBEAN S. AMERICA	10	10	10	10	10	10	12*	12	12	12	15	15	20	_20_	_20_	_20_	_20_	_20_	20	20	15	15	12	12	SE
ANTARCTICA	12	12	12	12	12	12	15	15	15	20	_30_	_30_	_30_	_30_	_30_	_30_	30	30	20	20	15	15	12	12	S
NEW ZEALAND	10	10	10	12*	12	15	20	_20_	_20_	_20_	20	20	_20_	_20_	_20_	20	20	20	15	15	12	12	10	10	SW
OCEANIA AUSTRALIA	10	10	12	12	15	_20_	_20_	_20_	20	20	20	20	_20_	_20_	_20_	20	20	20	15	15	15	12	12*	10	W
JAPAN	15	15	15	20	20	30	_40_	_30_	_30_	_30_	30	30	30	30	_40_	_40_	_30_	_30_	30	30	30	30	20	20	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.

sequence, the fade-out, will be discussed next month.

last-minute forecast

The higher frequency 10 to 30-meter bands (the daylight bands) should be very good the first and last two weeks of September. The probability of transequatorial one-long-hop late evening (to 2200 local time) openings to southern countries should start to increase. Sporadic E short-skip openings, however, will probably become scarce. Transequatorial openings may be enhanced during the equinox seasonal increase in geomagnetic disturbances expected around the 1st, 8th, 21st, and 27th. The lower frequency nighttime bands should be best the second and third weeks of the month. Look for DX from unusual countries in east-west directions during the disturbances listed. Lower thunderstorm noise later in the month (except during fall weather frontal passages) should help the signal get through. The full moon and its perigee will fall on September 25. The autumnal equinox occurs on the 22nd at 1929 UTC. There will be an annual eclipse of the sun on September 11 from 0200 in East Africa, across South Asia, Indonesia, and New Zealand, ending in Antarctica at 0730 UTC.

band-by-band summary

Ten, 12, 15, and 20 meters provide many openings during the daytime. As you go up in frequency the openings will be shorter, centered around noon, and mainly in southerly directions. Fifteen meters is only a transition band between 12 and 20. Twenty meters, the mainstay daytime band for northerly directions, will be useful towards the south in the evenings.

Thirty, 40, 80, and 160 meters are all good for nighttime DX. Thirty and 40 meters are the night frequencies for the east-west and northerly directions, and for distances of 1600 miles if increased solar activity has occurred. With little solar activity so far, the MUF will approach 80 meters and signals will usually be stronger.

ham radio

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

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.

Amateur Radio Dealer

New Jersey

ABARIS SYSTEMS
276 ORIENTAL PLACE
LYNDHURST, NJ 07071
201-939-0015
Don WB2GPU
ARRL, Astatic, Astron, B&W, Belden, Bencher, Hustler, Kenwood, Larsen, RF Concepts, Tonna and much, much more!
Tues-Fri 10 am-7:30 pm
Thurs 10 am-9:00 pm
Sat 10 am-4:00 pm
VISA/MC

KJI ELECTRONICS
66 SKYTOP ROAD
CEDAR GROVE, NJ 07009
(201) 239-4389
Gene K2KJI
Maryann K2RVH
Distributor of: KLM, Mirage, ICOM, Larsen, Lunar, Astron. Wholesale - retail.

New York

BARRY ELECTRONICS
512 BROADWAY
NEW YORK, NY 10012
212-925-7000
New York City's Largest Full Service Ham and Commercial Radio Store.

VHF COMMUNICATIONS
915 NORTH MAIN STREET
JAMESTOWN, NY 14701
716-664-6345
Call after 7 PM and save! Supplying all of your Amateur needs. Featuring ICOM "The World System." Western New York's finest Amateur dealer.

Ohio

AMATEUR ELECTRONIC SUPPLY
28940 EUCLID AVE.
WICKLIFFE, OH 44092 (Cleveland Area)
216-585-7388
Ohio Wats: 1 (800) 362-0290
Outside Ohio: 1 (800) 321-3594
Hours M-F 9-5:30, Sat. 9-3

DEBCO ELECTRONICS, INC.
3931 EDWARDS RD.
CINCINNATI, OHIO 45209
(513) 531-4499
Mon-Sat 10AM-9PM
Sun 12-6PM
We buy and sell all types of electronic parts.

UNIVERSAL AMATEUR RADIO, INC.
1280 AIDA DRIVE
REYNOLDSBURG (COLUMBUS), OH 43068
614-866-4267
Featuring Kenwood, Yaesu, Icom, and other fine gear. Factory authorized sales and service. Shortwave specialists. Near I-270 and airport.

Pennsylvania

HAMTRONICS, DIV. OF TREVOSE ELECTRONICS
4033 BROWNSVILLE ROAD
TREVOSE, PA 19047
215-357-1400
Same Location for over 30 Years

Texas

MADISON ELECTRONICS SUPPLY
3621 FANNIN
HOUSTON, TX 77004
713-520-7300
Christmas?? Now??

K COMM dba THE HAM STORE

5707A MOBUD
SAN ANTONIO, TX 78238
512-680-6110
800-344-3144
Stocking all major lines. San Antonio's Ham Store. Great Prices — Great Service. Factory authorized sales and service.
Hours: M-F 10-6; SAT 9-3

MISSION COMMUNICATIONS
11903 ALEIF CLODINE
SUITE 500 (CORNER HARWIN & KIRKWOOD)
HOUSTON, TEXAS 77082
(713) 879-7764
Now in Southwest Houston—full line of equipment. All the essentials and extras for the "ham."

Wisconsin

AMATEUR ELECTRONIC SUPPLY
4828 W. FOND DU LAC AVE.
MILWAUKEE, WI 53216
414-442-4200
Wisc. Wats: 1 (800) 242-5195
Outside Wisc: 1 (800) 558-0411
M-F 9-5:30 Sat 9-3

Foreign Subscription Agents for Ham Radio Magazine

Ham Radio Austria
Karin Ueber
Postfach 2454
D-7850 Loerrach
West Germany

Ham Radio Belgium
Stereohouse
Brusselsesteenweg 416
B-9218 Gent
Belgium

Ham Radio Holland
Postbus 413
NL-7800 Ar Emmen
Holland

Ham Radio Europe
Box 2084
S-194 02 Upplands Vasby
Sweden

Ham Radio France
SM Electronic
20 bis, Ave des Clarions
F-89000 Auxerre
France

Ham Radio Germany
Karin Ueber
Postfach 2454
D-7850 Loerrach
West Germany

Canada
Send orders to
Ham Radio Magazine
Greenville, NH 03048 USA
Prices in Canadian funds
1 yr. $41.85, 2 yrs. $74.25
3 yrs. $99.90

Ham Radio Italy
Via Maniago 15
I-20134 Milano
Italy

Ham Radio Japan
Katsumi Electronic Co., Ltd
27-5 Ikegami
4 Chome, Ota-Ku
Tokyo 146, Japan
Telephone (03) 753-2405

Ham Radio Switzerland
Karin Ueber
Postfach 2454
D-7850 Loerrach
West Germany

Ham Radio England
c/o R.S.G.B.
Lambda House
Cranborne Road
Potters Bar
Herts EN6 3JW
England

Holland Radio
143 Greenway
Greenside, Johannesburg
Republic of South Africa

ELMER's NOTEBOOK

Tom McMullen, W1SL

the mysterious "Q"

A sometimes mystifying concept for many Amateurs is a thing called "Q". It has a habit of appearing in questions, theory discussions, and product descriptions. Sometimes it's met with mild curiosity; at others it's given moderate study and passed over in hopes that it will never be needed.

It doesn't need to be treated that way. True, a circuit designer must know how to toss jargon around with ease, and put the idea into practice to achieve a desired result. For the rest of us, a basic understanding of what Q does is sufficient and not all that difficult.

so, what is Q?

Reduced to basics, Q is a measure of quality. When textbooks speak of the Q factor, they are talking about the quality factor of some component or circuit. It's a measure of how well a circuit performs — or more simply, how much loss there is in the circuit and its components.

When referring to components, things that affect Q are the type of dielectric in a capacitor and the wire size and material in an inductor. This includes the form (if any) the coil is wound on, and any conductive or nonconductive objects within its magnetic field.

All of these losses affecting Q are ac losses; the actual dc loss because of wire resistance is usually low enough to be ignored. At radio frequencies, however, losses can mount up and do contribute to lowered Q in resonant circuits.

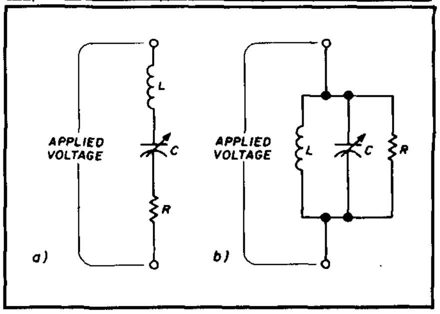
more is not always better

At first glance, it would seem that higher quality (higher Q) would be the thing to strive for. After all, the less energy we lose the better, right? Not always. It depends on where the circuit is to be used. A high-Q circuit placed in the output of a transmitter will sometimes cause an air-dielectric capcitor to arc over, or heat a solid dielctric enough to make it break down and cause a short circuit. The solution is to tailor the Q of a transmitting circuit for the best compromise between losses, no breakdowns, and circuit bandwidth (more about bandwidth later). The energy involved in a receiver circuit isn't great enough to cause arcs or dielectric breakdown, so high-Q circuits are permitted. In fact, this is where high-Q circuits do their best by providing needed selectivity in different sections of the receiver.

what determines Q?

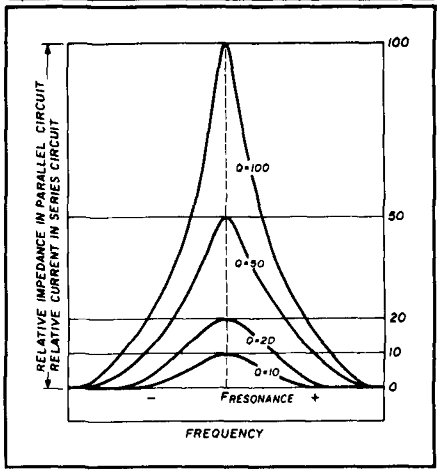
The Q of a resonant circuit is affected by the losses in the components that make up the circuit: dielectric losses in capacitors, wire skin resistance, and some dielectric effects in coils. The schematic in **fig. 1A** shows a series-tuned circuit with its loss (R) in *series with the inductor and capacitor.* This is the functional equivalent of the parallel circuit of **fig. 1B** which has the loss (R) in parallel with the inductor and capacitor. Either circuit tunes very sharply if there are no losses and a

FIGURE 1



(A) A series-resonant circuit with losses (R) shown in series with the inductor and capacitor. (B) A parallel-resonant circuit with the loss (R) in parallel with the tuned circuit.

FIGURE 2



Frequency response curves of tuned circuits with different Q factors. The lower the Q, the more broad the frequency response. A high Q translates to high impedance across a parallel circuit and high current through a series circuit.

curve at resonance might look like the one shown as $Q = 100$ in **fig. 2**.

The resistance (R) in both circuits is caused by component losses, but it will absorb energy and dissipate it as heat just as if the energy were dc and the resistor a normal carbon resistor connected in the circuit. Because the losses dissipate some of the energy in the circuit, the quality (Q) of the circuit is lower. Some examples are shown in the curves of **fig. 2** marked $Q = 50$, $Q = 20$, and $Q = 10$.

Here's a simple experiment you can perform with a grid-dip meter to see the difference between high- and low-Q circuits. Almost any dip meter will do. Wind a coil of perhaps 15 turns of enameled wire on a small form; a diameter of 3/8 to 1/2 inch diameter will do. Select a small trimmer capacitor in the range of 10 to 50 pF and connect it across the coil. Place the tuned circuit on a nonconductive surface (wooden table or a couple of books), bring the dip meter close and find the circuit's resonant frequency. When the dip meter is very close, you'll notice that the dip is deep and sharp and that the tuned circuit "pulls" the meter's frequency over a considerable range. Move the meter away from the circuit slowly until you find the place where the dip is just noticeable. Mark the position of the meter and the tuned circuit. Next, connect a resistor across the tuned circuit — try about 2200 ohms, 1/2 watt for starters — and make sure it is carbon composition or carbon film. Place the tuned circuit back in the same position, bring the dip meter up close, and find the resonant frequency again. You can adjust the trimmer until the frequency is the same as before. Note the difference in response of the dip meter; the dip should be much less sharp. Move the meter away until the dip is again just noticeable. You'll find the distance is much smaller.

The losses you just added to the circuit lowered its Q in the form of a resistor dissipating energy. Where is the energy coming from? It is being induced in the circuit by the magnetic field from the dip meter. This induced energy flowing through the coil creates a magnetic field of its own, which is maximum at resonance and then reacts with the tuned circuit in the dip meter. This reaction is shown as a dip (decrease) in energy in the dip meter — and that's what makes a dip meter work.

If you want to experiment some more, connect the resistor in series with the LC combination and find the resonant frequency again while noting the response of the dip meter. Try different values of resistance, both in parallel and in series with the circuit. You'll note that a lower resistance in series with the LC permits a higher Q, but has just the opposite effect in a parallel arrangement.

practical applications of Q

As mentioned earlier, a high-Q circuit in a transmitter is a "no-no." One of the interesting things about tuned circuits and Q is that the effective voltage across a circuit can be much higher than the applied voltage. It's not unusual for a transistorized circuit that has a dc voltage of 12 volts to develop an rf voltage in a resonant circuit of 40 or 50 volts if the external loading is light.

A common setup in many Amateur stations is a transmitter feeding 200 watts into a 52-ohm coaxial transmission line. That amount of power develops approximately 102 volts across the coax ($E = \sqrt{P \times R}$). If this is applied to an antenna coupler (tuner) with a Q of 50, the tuned circuit can develop 5100 volts across the coil and capacitor ($E_{circuit} = Q \times E_{applied}$). Aside from the *good* practice of not causing QRM when tuning up your transmitter/antenna coupler, this is another reason to make all the adjustments at low power. Who needs the sound and aroma of things frying while you try to get the proper loading!

Loading can consist of several things. The device (tube or transistor) providing power to the circuit will load it and lower the Q, as will the next stage in a transmitter, or an antenna coupler, feedline, and antenna. The lighter the loading, the higher the unloaded Q. (Unloaded Q is referred to by those in the know as Q_u; loaded Q is written as Q_L.)

People who design transmitter circuits work out a compromise that matches the transistor or tube with the necessary impedance, provides an impedance transformation to feed the next stage, and does a reasonable job of rejecting unwanted signals. A high-Q circuit is great at rejecting harmonics or any other signal that is not at the resonant frequency. As the Q is lowered, through losses or by design, the harmonic rejection also decreases until at some point the circuit is not selective. The bandwidth of the circuit can be calculated by the formula $\text{Bandwidth}(-3\text{ dB}) = F_o/Q$, where F_o is the frequency of resonance. This means that if the curves in **fig. 2** are plotted on a frequency and dB scale, the two points at which they intercept the 3-dB down curve (half power, or −3dB) will indicate the circuit's selectivity (determined by the bandwidth at the −3dB points).

Today's multiband, broad-banded transceivers can have transmitter circuits made up of several tuned circuits, precisely tailored to provide a match between the output device (transistor or tube) and the antenna circuit over a specific range of frequencies. They can also be designed to attenuate harmonics, minimizing interference to other services. This is an area where a knowledge of Q and impedance matching is valuable to designers.

Receivers, on the other hand, require a different approach. An important function of Q in receiver circuits is to reject signals that are either outside the band or just a few kHz away. In a typical bandpass design, selectivity in the rf amplifier stages can be tailored to cover just the Amateur band and reject signals that are more than a few kHz outside. This requires several circuits with just the right amount of Q and correct coupling between them to pass a "band" of frequencies.

When it comes to rejecting signals within the band, the i-f circuits do their thing. Sharply tuned circuits with low losses (high Q_u) are one approach. Many receivers use either mechanical filters, crystal filters, or ceramic resonators to achieve the required result. All of these devices have a very high Q, which means they do an excellent job of rejecting off-resonance signals. But if this is carried too far, as in very narrow filters for CW use, the energy stored in the circuit tends to stay there so long that it produces a sort of echo (called ringing) and makes life difficult in the high-speed lane.

calculating Q

I've left this part for last to prevent scaring anyone who's allergic to formulas, but they're really not that bad. The basic Q_u can be calculated by:

$Q_u = X/R_s$

where: Q_u = quality factor (unloaded)
X = reactance of either L or C in ohms (remember that they are equal and opposite in a tuned circuit at resonance)
R_s = series resistance (loss) in ohms

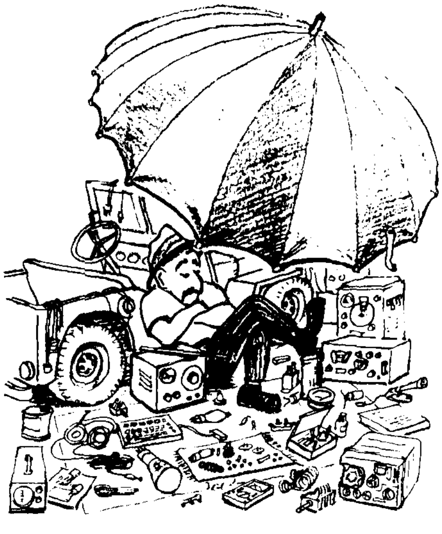
Loaded Q is calculated by:

$Q_L = R_p/X$

where: Q_L = quality factor (loaded)
R_p = parallel load resistance in ohms
X = reactance in ohms

In summary, Q is a concept that can be used as a tool to design matching circuits, bandpass filters, band-reject filters, signal traps, interstage coupling and matching, and many other important parts of the radio world. It needn't be regarded as a mysterious entity lurking in the theory books just waiting to trip you up. It's simply a part of the language of electronics alongside R, E, I, and all the rest.

Article P **ham radio**



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.

HALL ELECTRONICS buys radio broadcast equipment for *cash! Jon Hall, WB4MMV, PO Box 7732, Charlottesville, VA 22906.* (804) 973-8697.

DIGITAL AUTOMATIC DISPLAYS. All Radios. GRAND SYSTEMS, POB 2171, Blaine, WA 98230.

FOR SALE: ICOM IC-215 crystal xcvr plus 30 watt amp. Drake DTMF mike and many crystals. Like new. Best offer. Don Shukay, 123 Dwight Road, Longmeadow, MA 01106.

SIGNAL-ONE CX7-B updated by W8CXS $1250. Kenwood R-820, 4 filters $400. James Craig, 32 Birchwood Drive, Rye, NH 03870.

TEN-TEC, new boxed latest 1988 production, USA made, 585 Paragon, 561 Corsair II, 425 Titan 1.5 kw linear amplifier, 229B antenna tuner TT920 Airband HT, mobile HF antennas, plus accessories all models, take Ten-Tec gear in trade, for best deal, write or phone Bill Slep, (704) 524-7519, SLEP ELECTRONICS COMPANY, Highway 441, Otto, NC 28763.

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.

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).

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.

CONTRACT MANUFACTURER. We cater to the small volume manufacturer (1-500 units). Prototypes, backlogs and overflows our specialty. SMT OK. Your schedule is our schedule. Dromedary Technical Services, 141 Jackson Road, Roopville, Georgia 30170.

TEKTRONIX SCOPE MODEL T922 15 MHz Dual trace compact portable $300. Model 454 150 MHz $500. Ten-Tec 979 12V/5A supply $40. Ten-Tec 679 keyer $15. Central Electronics 10A exciter (poor condition-no case) $15. Navy Panadaptor SB-8B 5 MHz rack mount with power supply $15. Stancor filament transformer 7.5 VCT 25 amps $25. Dave Roscoe, W1DWZ, 49 Cedar, East Bridgewater, MA 02333. (508) 378-3619.

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

COMMODORE and AMIGA chips, parts, diagnostics, hard to find items. Heavy duty power supplies for the C64-$28.00 plus UPS. KASARA, INC, 36 Murray Hill Drive, Spring Valley, NY 10977. 1-800-642-7634, 1-800-248-2983 (outside NY) or 914-356-3131.

HAMS-HELP. Handicapped Ham needs working HF rig with 10 meters, reasonably priced. Please help. Clem, KA3OUE. Call any time (412) 531-7443 EST.

CLOSED CIRCUIT TELEVISION EQUIPMENT. Discount pricing on cameras, monitors, sequential switches, pan tilt units, etc. Expert design assistance available. Dan Marshall, DETECTION DYNAMICS, *4700 Loyola Lane, #119, Austin, Texas* 78723. (512) 345-8401.

WANTED: Collins KWM-2A, power supply, accessories, Heath Mohican, Apache, also Drake TR-4CW, E.F. Johnson Ranger II, Hammarlund SP-600. Very good to excellent shape only. Steve Stutman, KL7JT/1, (617) 494-9393, 27 Lillian, Sudbury, MA 01776.

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.

ROHN 55, 175 ft. 3 type sections plus five guying insert plates,hardware, shackles, etc. Great disaster stash for B.C. Stn. Will trade for fraction value Rohn 45, 12 45G, 2 45AG-4, 1 6845FOK or offer. N5IE (808) 261-1356.

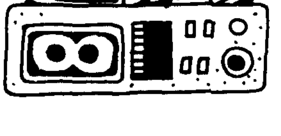
CHRISTIAN AIRCRAFT MECHANIC wants family out of big city. Seeking farm, ranch, logging, other country opportunities. Call (512) 695-3006. N5MPW.

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.

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.

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.

PENNSYLVANIA: September 10. Uniontown ARC (W3PIE) 39th annual Gabfest, Club grounds, Old Pittsburgh Road, Uniontown. Registration $3.00 each or 2/$5.00. Talk in on 147.045/.645 & 145.17/144.57. For information: UARC Gabfest, John T. Cermak, WB3DOD, POB 433, Republic, PA 15475. (412) 246-2870.

PENNSYLVANIA: September 11. Butler Hamfest, Butler Farm Show Grounds, Rt 68, 3 miles west of Butler. 9 AM to 4 PM. Handicap parking. For information John Varljen, K3HJH 174 Oak Hills Hts, Butler, PA 16001. (412) 283-9403.

WISCONSIN: September 11. The Tri-County ARC, W9MQB will hold its 2nd annual Fall-Fest, Black Hawk Technical College parking lot, Hwy 51 between Janesville and Beloit. Admission $2.00. Bring tables. Talk in on 144.85/145.45.

NEW JERSEY: September 11. The Tri-County Radio Association's *annual indoor Hamfest/Flea Market, Passaic Township* Community Center, Stirling. 8 AM to 3 PM. Donations $3.00. Talk in on 147.855/255, 146.52 and 444.975/449/975. For information call Dick Franklin, W2EUF (201) 232-5955 or write POB 182, Westfield, NJ 07090.

INDIANA: September 11. The LaPorte and Michigan City ARC's Summer Hamfest, LaPorte County Fairgrounds, State Rt 2, LaPorte. Talk in on 146.52. *For information/registration contact* the LaPorte ARC, POB 30, LaPorte, IN 46350. Table reservations Tom, KA9ZUM at same address. Fairgrounds are wheelchair accessible.

ILINOIS: September 11. The Bolingbrook Amateur Radio Society's 4th annual Ham/Computerfest, Inwood Recreation Center, 3000 West Jefferson St, Joliet. Talk in on 147.33 and 224.54. For information/reservations Ed Weinstein, WD9AYR, 7511 Walnut, Woodridge, IL 60517. (312) 985-0527.

MICHIGAN: September 17. The Grand Rapids Amateur Radio Association's 40th annual Electronic Flea Market, West Catholic High School, 1801 Bristol NW, Grand Rapids. Gates open 8 AM. Tickets $3.00. Vendors $2.00 additional. Talk in on 86/26 and 224.64. For reservations or information call Don Hazelswart, KA8BCI, (616) 363-0649 or write POB 1248, Grand Rapids, MI 49501.

CALIFORNIA: September 17. The 6th annual SCRA Ham Radio Flea Market, National Guard Armory, 1500 Armory Drive, Santa Rosa. 8 AM to 2 PM. Free admission. Talk in on 146.13/73. For information/tickets write Sonoma County Radio Amateurs, Box 116, Santa Rosa, CA 95402.

NEW JERSEY: September 18. The South Jersey Radio Association's 40th annual SJRA Hamfest, Pennsauken High School parking lot, Route 73 and Remington Avenue. 8 AM to 2 PM. Admission $3.00. *Talk in on 144.69/145.29. For information* Alan Sherman, WB2OEZ, Hamfest Chairman, (609) 768-8380 or SJRA, POB 1026, Haddonfield, NJ 08033.

NEW YORK: September 18. LIMARC ARRL Long Island Hamfair, New York Institute of Technology, Rt 25A, Northern Blvd, Old Westbury. Admission $3.00. Non-ham women and kids free. 7:30 AM sellers; 9 AM buyers. Talk in on 146.25/85. For information Mark Nadel, NK2T (516) 796-2366.

VIRGINIA: September 23-25. QCWA National Convention, McLean Hilton Hotel, McLean, VA. Tech programs, FCC forums, Saturday banquet. For information call or write Chairman John Kelleher, W4ZC. (301) 924-1605. Deadline for hotel reservations September 8. FCFS.

OREGON: September 24. The Walla Walla Valley ARC's 42nd annual W7DP Hamfest, Community Building in Milton-Freewater. 8 AM to 5 PM. Admission, registration, swap tables FREE. Talk in on 147.28/88 or 146.52. For information Paul Hamon, KA7VHL, 1412 Walla Walla Street, Walla Walla, WA 99362. (509) 525-0512.

NEW YORK: September 24. The Elmira ARA will hold its 13th *annual International Hamfest,* Chemung County Fairgrounds. 6 AM to 5 PM. Tickets at gate or from Dave Lewis, RD 1, Box 191, Van Etten, NY 14889.

COLORADO: September 25. BARCFEST '88 sponsored by the Boulder ARC, Boulder County Fairgrounds Exhibit Bldg, Nelson and Hover Roads, South Longmont. Donation $3.00 per person over age 12. Nearby shopping and camping. For *information/registration Barcfest '88 Chairman* Barbara McClune, N0BWS, 5338 Spotted Horse Trail, Boulder, CO 80301.

CONNECTICUT: September 25. The 6th annual Natchaug ARA giant flea market, French Club, Cemetery Road, Willimantic. Starts 9 AM. Admission $2.00. Under 16 free. Talk in on 90/30 and 52. For information Ed Sadeski, KA1HR, 49 Circle Dr, Mansfield, Center, CT. (203) 456-7029 after 4 PM.

OHIO: September 25. The Cleveland Hamfest Association's annual Hamfest and Computer Show, Cuyahoga County Fairgrounds, Berea. 8 AM to 4 PM. Admission $3.50 advance; $4.00 gate. Talk in on 146.52. For information C.H.A., POB 81252, Cleveland, OH 44181-0252.

NEW MEXICO: September 24. Northern New Mexico ARC's Hamfest, US Army Reserve Center, 2501 Cerrillos Rd, Santa Fe. 9 AM – 6 PM. Admission $5 adults; $3 children under 12 (includes lunch). Talk in on 146.22/.82. Contact: Clem Burke, W5IXR, Box 73, Ojo Sarco, NM 87550. SASE please.

PENNSYLVANIA: October 1-2. The Pack Rats (Mt. Airy VHF ARC) will have their 12th annual Mid-Atlantic VHF Conference, Warrington Motor Lodge, Rt 611, Warrington and the 17th annual Hamarama on Sunday, Bucks County Drive-In Theater, Rt 611, Warrington. Conference only registration $5.00 advance; $6.00 door includes admission to flea market. Flea market only $4.00 per person, $7.00 per carload. Gates open 6 AM rain or shine. Bring tables. Send to Hamarama '88, POB 311, Southampton, PA 18966. For information call Pat Cawthorne, WB3DNI (215) 672-5289.

MISSOURI: October 2. St. Peters ARC's 4th annual Swapfest, McNair Park Day Care Center, St. Charles. 6 AM to 2 PM. Admission $1.00. Talk in on 145.41 repeater and 146.52. For information Allen Underdown (314) 723-4200.

ILLINOIS: October 2. ARRL Illinois State Convention and Rockford Hamfest-Computerfair, National Guard Armory, 605 No. Main St, Rockford. 9 AM to 3 PM. Tickets $3/advance; $4/door. Talk in on 146.01/.61, 223.68/224.28, 146.52. For booth/table reservations Roger Sawvell, KD9MQ (815) 633-0520. Advance reservations SASE to Rockford Hamfest, POB 10003, Rockford, IL 61131.

INDIANA: October 2. The Lake County ARC's 16th annual Hamfest, Hammond National Guard Armory, 2530 – 173rd Street, Hammond. 8 AM to 2 PM. General admission $3.50. Talk in on Lake County ARC repeater 147.00 or 146.52. For information Lucy Schenders, N9DTG, 812 E. 40th Place, Griffith, IN 46319 or call (219) 923-4873.

KANSAS: October 1-2. The Wichita ARC will host the annual ARRL Kansas convention, Red Coach Inn, 53rd and North I-135, Wichita. Pre-registration $5.00; $6.00 at the door. Out-of-Towners talk in on 146.82; locals 146.94. Send reservations to Vern Heinsohn, WA0ZWW, 950 Back Bay, Wichita, KS 67203.

NEW HAMPSHIRE: October 8. The Hosstraders will hold their Fall Tailgate Swapfest at the fairgrounds on Route 125 in Kingston, NH. Admission $5 per person, no extra charge for sellers or commercial types. Profits benefit Shriners' Hospitals. Our Spring 1988 donation was $17,055.00! Questions SASE to Norm, WA1IVB, RFD Box 57, West Baldwin, ME 04091.

OPERATING EVENTS

"Things to do . . ."

September 3-9: The San Mateo Radio Club station W6LMN will operate W200LMN to help celebrate the 200th anniversary of the U.S. Constitution. All modes/bands from 1500Z to 0500Z daily. For QSL send your QSL and large SASE to W6LMN Trustee, POB 751, San Mateo, CA 94401.

September 3-5: The Corona Norco ARC will operate W200TKV from Sacramento on Labor Day Weekend as part of the Bicentennial Celebration of the U.S. Constitution. Send QSL and SASE to W6TKV, 5464 Peacock Lane, Riverside, CA 92505.

October 2: The Mahoning Valley Amateur Radio Association will operate special event station W8QLY in conjunction with the Boardman Rotary Octoberfest. From 1200Z in General phone of 40 and 20m. For a special certificate send SASE to MVARA Special Event Station, POB 2950, Youngstown, OH 44511.

THE MIT UHF REPEATER ASSOCIATION and the MIT Radio Society offer monthly HAM EXAMS. All classes Novice to Extra. Wednesday, September 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.

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 October 31, 1988.


ORDER TOLL-FREE 1-800-821-7323
Dependable Service
At The Right Price . . . Everytime
MasterCard—VISA—Discover
Missouri Radio Center
KENWOOD
TS-940 "DX-CELLENCE"
• All Band, All Mode Transceiver
• Direct Keyboard Entry
• Engineered for the DX-Minded and Contesting Ham
• Its Got It All!
YAESU
FT-767GX HF/VHF/UHF BASE STATION
• Add Optional 6m, 2m & 70cm Modules
• Dual VFO's
• Full CW Break-in
• Lots More Features
ICOM
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 Protection
144 MHz
MODEL
2-23 2 in/30 out
2-217 2 in/170 out
2-117 10 in/170 out
220 MHz
3-22 2 in/20 out
2-211 2 in/110 out
3-312 30 in/120 out
CALL
SALE PRICED
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
AEA • ALINCO • ASTRON • ALPHA-DELTA • ANTENNA SPEC • B & W • BENCHER • BUTTERNUT • CUSHCRAFT
• DAIWA • HUSTLER
HYGAIN • ICOM •
KANTRONICS • KENWOOD • LARSEN • MFJ • MIRAGE/KLM • NYE VIKING • RF CONCEPTS • UNIDEN • YAESU

OPTOELECTRONICS INC.

NEW

FREQUENCY COUNTERS

POCKET SIZE

SIZE: 4" H x 3.5" W x 1" D
MADE IN USA

TO 2.4 GHZ

8 LED DIGITS · 2 GATE TIMES
ALUMINUM CABINET
INTERNAL NI-CAD BATTERIES INCLUDED
AC ADAPTER/CHARGER INCLUDED

#TA-100S

EXCELLENT SENSITIVITY & ACCURACY

AC-DC · PORTABLE OPERATION

Small enough to fit into a shirt pocket, our new 1.3 GHz and 2.4 GHz, 8 digit frequency counters are not toys! They can actually out perform units many times their size and price! Included are rechargeable Ni-Cad batteries installed inside the unit for hours of portable, cordless operation. The batteries are easily recharged using the AC adapter/charger supplied with the unit.

The excellent sensitivity of the 1300H/A makes it ideal for use with the telescoping RF pick-up antenna; accurately and easily measure transmit frequencies from handheld, fixed, or mobile radios such as: Police, firefighters, Ham, taxi, car telephone, aircraft, marine, etc. May be used for counter surveillance, locating hidden "bug" transmitters. Use with grid dip oscillator when designing and tuning antennas. May be used with a probe for measuring clock frequencies in computers, various digital circuitry or oscillators. Can be built into transmitters, signal generators and other devices to accurately monitor frequency.

The size, price and performance of these new instruments make them indispensible for technicians, engineers, schools, Hams, CBers, electronic hobbyists, short wave listeners, law enforcement personnel and many others.

STOCK NO:

#1300H/A	Model 1300H/A 1-1300 MHz counter with preamp, sensitivity, < 1mV, 27MHz to 450MHz includes Ni-Cad batteries and AC adapter	**$169.95**
#2400H	Model 2400H 10-2400 MHz microwave counter includes Ni-Cad batteries and AC adapter	**$299.95**
#CCA	Model CCA counter/counter, for debugging, ultra sensitive, < 50 micro volts at 150MHz! 1-600 MHz with adjustable threshold, RF indicator LED. Includes Ni-Cad batteries and AC adapter	**$299.95**

ACCESSORIES:

#TA-100S	Telescoping RF pick-up antenna with BNC connector	**$12.00**
#P-100	Probe, direct connection 50 ohm, BNC connector	**$20.00**
#CC-12	Carrying case, gray vinyl with zipper opening. Will hold a counter and #TA-1000S antenna.	**$10.00**

AVAILABLE NOW!

209

ORDER FACTORY DIRECT

FLA (305) 771-2050 **1-800-327-5912**

MasterCard VISA

OPTOELECTRONICS INC.

5821 N.E. 14th Avenue
Ft. Lauderdale. Florida 33334

Orders to US and Canada add 5% of total ($2 min, $10 max)
Florida residents add 6% sales tax. COD fee $2.
Foreign orders add 15%

Yaesu's FT-736R. Because you never know who's listening.

Why just dream of talking beyond earth?

With Yaesu's new FT-736R VHF/UHF base station, you can discover some of the best DX happening in ham radio. Via moonbounce. Tropo. Aurora. Meteor scatter. Or satellites.

You see, the FT-736R is the most complete, feature-packed rig ever designed for the serious VHF/UHF operator. But you'd expect this of the successor to our legendary FT-726R.

For starters, the FT-736R comes factory-equipped for SSB, CW and FM operation on 2 meters and 70 cm (430-450 MHz!), with two additional slots for optional 50-MHz, 220-MHz, or 1.2-GHz modules.

Crossband full duplex capability is built into every FT-736R for satellite work. And the satellite tracking function (normal *and* reverse modes) keeps you on target through a transponder.

The FT-736R delivers 25 watts RF output on 2 meters, 220 MHz, and 70 cm. And 10 watts on 6 meters and 1.2 GHz. Store frequency, mode, PL frequency, and repeater shift in each of the 100 memories.

For serious VHF/UHF work, use the RF speech processor. IF shift. IF notch filter. CW and FM wide/narrow IF filters. VOX. Noise blanker. Three-position AGC selection. Preamp switch for activating your tower-mount preamplifier. Even an offset display for measuring observed Doppler shift on DX links.

And to custom design your FT-736R station, choose from these popular optional accessories: Iambic keyer module. FTS-8 CTCSS encode/decode unit. FVS-1 voice synthesizer. FMP-1 AQS digital message display unit. 1.2-GHz ATV module. MD-1B8 desk microphone. E-736 DC cable. And CAT (Computer Aided Transceiver) system software.

Discover the FT-736R at your Yaesu dealer today. But first make plenty of room for exotic QSL cards. Because you *never* know who's listening.

YAESU

210

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

Prices and specifications subject to change without notice. PL is a registered trademark of Motorola, Inc. FT-736R shown with 220 MHz option installed.

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
2201E. 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.